Low Carbon Green Growth Roadmap for Asia and the Pacific

Turning resource constraints and the climate crisis into economic growth opportunities

Fact sheets and Case studies

UNITED NATIONS
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Economic and Social Commission for Asia and the Pacific

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FACT SHEET

Appliance standards and labelling

Key point

- ***Energy standards and labelling schemes for appliances and equipment are a cost-effective policy tool for transforming markets and encouraging energy-efficient products.***

Appliance standards and labelling explained

Energy-efficiency standards are procedures and regulations that prescribe the energy performance of manufactured products, sometimes prohibiting the sale of products that are less energy efficient than the minimum standard, often called minimum energy performance standards, or MEPS.

Energy-efficiency labels are informative labels affixed to manufactured products to describe the product's energy performance (usually in the form of energy use, efficiency, or energy cost); these labels give consumers the data necessary to make informed purchases.

An energy efficiency standards and labelling programme is one of the most effective policy tools for improving energy efficiency at end use and reducing greenhouse gas emissions. It can be integrated as a part of the national standards.

How they works

Consensus building between governments and private sector

For the standards setting, governments usually follow a process of consensus and negotiation of standards that the industry can meet with reasonable increase in prices. A voluntary target is applied usually before going into a mandatory phase. As the market transformation proceeds, the targets are introduced as standards.

Two approaches in setting targets

Standards can be set using a top-down approach in which the reference point of technologies that are best in the market are taken for standards settings and reasonable time period is provided for manufacturers. This approach has been made famous by Japan with its Top Runner programme. The other recognized tactic is the bottom-up approach in which standards are carefully planned by keeping the technology or international standards in mind. It is mostly an incremental approach to reaching these standards so as to mitigate the effect of inflated prices of better products and technology. Usually this is used by countries where the industry is not that mature.

Strengths with standards and labelling

- **Reduces negative environmental impacts**, such CO_2 emissions, and saves energy.
- **Saves money for building tenants** (such as reduced energy costs).
- **Nurtures green businesses:** Manufacturers whose products are in compliance with energy standards can increase a business opportunity in the market, while inefficient products are kicked out of the market.

Challenges to using standards and labelling

- **Impact depends on the level of stringency of the standards.** Different levels of stringency of standards bring about different results. Standards that are too strong lead to over-investment in energy efficiency, which can be a burden for manufacturers. It can also become a consumer burden because products may be more expensive than the amount people will recover from their utility bill savings. If standards are too weak, low-quality products become prevalent and thus they can contribute to higher electricity bills.

Implementing strategies

Make the public procurement of energy-efficient appliances mandatory. Public procurement of energy-efficient products in public buildings has been used to accelerate the popularity of them among consumers by demonstrating a government's commitment. Because public procurement is generally based on a least cost basis, the life-cycle cost is used to justify energy-efficient products with higher prices.

Offer financial incentives for purchasing energy-efficient products. Financial incentives can help entice consumers to purchase energy-efficient appliances. They are often funded by utility companies and/or local or regional governments, although they usually have a fixed time duration. For instance, a subsidy can be provided to projects that aim to phase out inefficient incandescent lights and replace them with LEDs.

Review periodically testing procedures, standards and labels. It is important for governments to adjust the test procedures, adjust the stringency of standards and redesign labels as new technology emerges and use patterns change.

Further reading

Barrier Removal for Energy Standards and Labelling Project Factsheet: Standards & Labelling for Energy Efficiency (Dhaka, Bangladesh, United Nations Development Programme, 2011).

Energy Efficiency Labels and Standards: A Guide Book for Appliances, Equipment, and Lighting (Washington, D.C., Collaborative Labelling and Appliance Standards Program, 2005). Available from www.clasponline.org/GB2ndEdition/Chapter2/Chapter2.htm

Energy Labelling and Standards Program Throughout the World, by Lloyd Harrington and Melissa Damnics (Victoria, Australia, National Appliance and Equipment Energy Efficiency Committee, 2004).

Bioenergy

Bioenergy explained

Biomass refers to all biological material from living or recently living organisms that can be burned, gasified or fermented to produce bioenergy. Beneficial sources of bioenergy can be divided into four categories:

1) Energy crops grown specifically for use as biofuel on land that cannot be used for food crops(more advanced technology can use algae harvested from water)
2) Agricultural crop residues, such as rice husks
3) Sustainable wood and forest residues
4) Urban and industrial wastes.[1]

How it works

As with geothermal and solar thermal energy, steam generated from burning organic matter can be used to turn a turbine to produce electricity or can be used directly to heat an adjacent space. Organic matter can also be heated under pressure to form a gas called syngas, which can power gas or steam turbines or be further processed into combustible liquid biofuel. Organic matter, most typically municipal or agricultural wastes, can be digested anaerobically (in oxygen-free environments) to produce combustible methane gas. Because biomass electricity production relies on thermal energy conversion, it is well suited for cogeneration or combined heat and power (CHP) production.

Opportunities in Asia and the Pacific

- **Abundant resources, such as agricultural waste and energy cropland:** The region is very rich in biomass resources, with more useable resources from agricultural waste and energy cropland than any other continent.[2]
- **Easily used in the existing fossil fuel power plant:** Fuels from biomass are particularly well-suited for electricity production in the region because they can be added to the fuel mix in many coal- and natural gas-burning power plants, avoiding the need to build all new infrastructure. Co-firing can also be done at a small scale with the addition of combustors and gasifiers to micro-turbines and Stirling engines, which will then buttress a system of distributed generation to electrify rural parts of the region.[3]

Trends in development

Heavy reliance on traditional burning of biomass for cooking and heating: As of 2008, 1.7 billion people relied on traditional biomass fuels, mostly in South Asia.[4] Although derived from renewable resources, traditional biomass usage does not have mechanisms in place to limit local air pollutants or greenhouse gases. It leads to negative health impacts, particularly on women and children in the home. The use of traditional biomass is mainly limited to the household and small-scale industrial sectors and is highly inefficient when compared with modern biomass technologies.

[1] Union of Concerned Scientists website "How Biomass Energy Works" (29 October, 2010). Available from www.ucsusa.org/clean_energy/technology_and_impacts/energy_technologies/how-biomass-energy-works.html#18 (accessed 26 September 2011).

[2] K. Sakanishi, "Bio-fuels (bioethanol and BDF) production from various biomass resources in Asian countries", PowerPoint presentation. Available from http://home.hiroshima-u.ac.jp/hicec/coe/kaigi/6thSympo/PPT_Dr.Sakanishi.pdf (accessed 26 September 2011).

[3] R.L. Bain, W.A. Amos, M. Downing and R.L. Perlack, *Biopower Technical Assessment: State of the Industry and Technology* (Golden, Colorado, National Renewable Energy Laboratory, 2003). Available from www.fs.fed.us/ccrc/topics/urban-forests/docs/Biopower_Assessment.pdf (accessed 26 September 2011).

[4] ESCAP estimate based on International Energy Agency data.

Modern production is underdeveloped: Modern biomass energy production, including CHP, remains underdeveloped in the Asia-Pacific region. In 2008, biomass power plants accounted for 3,272.43 MW of electric generation capacity in ASEAN countries.[5] Across the region, biofuels contributed 28,730 GWh, or 0.4 per cent of total electricity production.[6]

Biofuels for transport: A number of countries in the region are seriously looking at increasing energy production from biomass, particularly by using liquid biofuels to displace the use of oil for transport purposes. The Philippine Government has set the most ambitious targets in the region, namely to displace 15 per cent of diesel and 20 per cent of gasoline with biofuels by 2030. Indonesia has a broader goal of supplying 5 per cent of the total energy mix with energy from biomass by 2025.[7] With transport sector energy consumption projected to grow faster than any other sector (5.6 per cent) in ASEAN states, developing alternative fuels from biomass could help alleviate issues associated with oil imports, including price fluctuations and energy security.

Strengths with bioenergy

- **Sustainable use of resources:** Waste-to-energy biomass projects can provide the co-benefit of mitigating waste disposal challenges in the region's quickly growing urban areas.
- **Job creation potential:** Expanding bioenergy production facilities has the added benefit of a much higher job creation rate per TWh, compared with fossil fuel and nuclear energy.[8]

Challenges to using bioenergy

- **Low energy intensity:** Many types of biomass have relatively low energy intensities (compared with traditional fossil fuels).[9] Thus, efficiently collecting and processing biomass materials is a major challenge. Additionally, some types of biomass are better than others in terms of higher energy return and lower pollution levels.
- **Air pollution and emissions:** Some sources of biomass can actually emit more greenhouse gases than non-renewable sources, such as coal, because of their lower energy intensities. Burning biomass can also generate harmful air pollution, often more than natural gas-fired power plants, although less than coal-fired power plants of equivalent size.[10] Generally, the gasification process makes biomass burn cleaner, with fewer greenhouse gas emissions and other air pollutants.[11]
- **Transportation costs of bulky feedstock:** In addition to low energy intensities, biomass resources are produced over a wide-ranging area, requiring collection. The collection and transportation of biomass feedstock generally rely more heavily on truck transport as opposed to pipeline or rail, as in the case of fossil fuels. Transportation costs of moving feedstock from source to a processing plant and then to an electricity-generation facility can be high, both in economic and environmental costs.[12]

[5] M. H. Hung, "Status of renewable energy in the ASEAN region", PowerPoint presentation at the IEA-RETD Workshop on Cross-Regional Dialogue on Renewable Energy Visions and Initiatives, Tokyo, 18 November, 2009. Available from www.iea-retd.org/files/091118_ASEAN_policies.pdf (accessed 26 September 2011).

[6] Aggregation of 2009 electricity/heat generation data from IEA for Asia excluding China, China, and OECD Asia and Oceania. International Energy Agency, Statistics and Balances (Paris, 2009). *Statistics and Balances*. Available from www.iea.org/stats/electricitydata.asp?COUNTRY_CODE=12 (accessed 16 February 2012).

[7] ASEAN Center for Energy, *The 3rd ASEAN Energy Outlook* (Jakarta, 2011). Available from http://talkenergy.files.wordpress.com/2011/06/t3aeo-complete-outlook.pdf (accessed 26 September 2011).

[8] S. Karekezi, K. Lata and S. Teixeira Coelho, "Traditional biomass energy: Improving its use and moving to modern energy use", presented at the International Conference for Renewable Energies, Bonn, 1-2 June, 2004. Available from www.ren21.net/Portals/97/documents/Bonn%202004%20-%20TBP/Traditional%20Biomass%20Energy.pdf (accessed 26 September 2011).

[9] S. Ashton and P. Cassidy, "Energy basics", in W. Hubbard, L. Biles, C. Mayfield, S. Ashton , eds., *Sustainable Forestry for Bioenergy and Bio-based Products: Trainers Curriculum Notebook* (Athens, GA, Southern Forest Research Partnership, Inc., 2007).

[10] National Renewable Energy Laboratory, *Biopower Technical Assessment: State of the Industry and Technology* (Golden, Colorado, 2003). Available from www.fs.fed.us/ccrc/topics/urban-forests/docs/Biopower_Assessment.pdf (accessed 26 September 2011).

[11] Union of Concerned Scientists website "How Biomass Energy Works" (29 October, 2010). Available from www.ucsusa.org/clean_energy/technology_and_impacts/energy_technologies/how-biomass-energy-works.html#18 (accessed 26 September 2011).

[12] D. Yemshanov and D. McKenney, "Fast-growing poplar plantations as a bioenergy supply source for Canada", *Biomass and Bioenergy* (2008), vol. 32, pp. 185-197.

- **Trade-offs with food crisis and land-use issues:** The production of first-generation biofuels, which rely on oils from food crops such as sugarcane and corn, dominates current production and is likely contributing to rising food prices.[13] Ensuring wise land-use and sustainable harvesting practices may also present challenges, particularly when governments offer financial incentives for energy crop production.

Implementing strategies

Use careful policymaking to support sustainable production: Supporting some but not all types and methods of bioenergy production requires highly detailed policy informed by expert economic, environmental and land-use knowledge. Second- and third-generation biofuels do not rely on food crops for production and are one approach to reducing the impact of biomass energy production on food prices and availability. Second-generation biofuels harvest fuel from the processing of cellulose or from agricultural and forestry waste materials; but these processes are more complex than deriving fuel from first-generation biofuel sources. Third-generation biofuels encompass usable oils from algae. Policy incentives must be well defined to target those types of biomass energy production.[14]

Blanket rural users with education and training: To implement small-scale, distributed generation to minimize the transportation costs of feedstock, education and training programmes should be developed and made available in rural areas.

Invest in densification R&D: Investing in R&D for more efficient densification processes (pelleting and briquetting of solid biomass feedstock) could expand the economic and geographic range of electricity from biomass or co-firing as well as increase the efficiency of burning.

[13] International Energy Agency, *From 1st to 2nd Generation Biofuel Technologies: An Overview of Current Industry and RD&D Activities* (Paris, IEA and OECD, 2008).

[14] ibid.

Building certification

Key points

- ***Building certification communicates the advanced environmental performances of buildings, such as energy efficiency and water consumption.***

- ***Building certification helps consumers make informed decisions by comparing with a range of similar buildings, thereby making green buildings more competitive in the real estate market. This can be a great incentive for convincing builders to invest in better environmental performance.***

Building certification explained

Building certification, often referred to with rating or labelling, is a scheme to assess and disclose the environmental performance of buildings. Its purpose is to close the information gap between developers, real estate agents, building owners and tenants. The criteria of certification can vary, ranging from annual energy consumption to efficiency of equipment, building orientation, access to public transport and indoor air quality.[1] Certification can be specialized in energy related performance, such as Energy Star developed by the US Department of Energy. Energy performance building certification may show either the total level of energy consumption or the energy-efficiency rating of buildings.

How it works

For a building's energy performance to be certified:

- First, the energy performance is assessed by a competent assessor. The performance assessment can be based on either the data acquired from building specifications (known as asset rating) or the measurement of the actual energy consumption (known as operational rating).
- Second, a building energy certificate is issued that reflects the rating the building's energy performance, which, in some cases, also includes information on how to achieve better energy savings. Most certification schemes have a limited validity period for the certificate.
- Third, communicate the information openly through publication of the certificate.

Certification can be useful for new as well as existing buildings. For new buildings, it indicates if a new construction complies with the building (energy) standards and codes. For existing buildings, it indicates the energy performance and provides information that is useful for creating demand for more efficient buildings, thus acting as a prerequisite for improving the energy efficiency of the existing stock of buildings.

The responsibility for managing and issuing certification can be placed either under government authorities or private institutions. Depending on the country, building certification takes a form of either a mandatory or voluntary scheme as seen the following examples:

- **Comprehensive Assessment System for Building Environmental Efficiency** (CASBEE) is a building rating system to assess the environmental efficiency of buildings that was developed by the Japan Sustainable Building Consortium. CASBEE is adopted as a voluntary programme by local governments, with training for assessors and third-party assessments.

[1] Examples of the comprehensive building certification include the Leadership in Energy and Environment Design (LEED) in the USA, Green Building Mark in the Singapore and Comprehensive Assessment System for Built Environment Efficiency (CASBEE) in Japan.

- **The Energy Star** is a voluntary scheme developed by the US Department of Energy and is awarded to new buildings with energy performances that exceed the 2006 Industrial Energy Efficiency Coalition Code by at least 15 per cent. Subsidies and tax exemptions have helped Energy Star to play an important role in energy markets towards higher energy efficiency.
- **European building energy certificates** are designed to push for performance that surpasses building codes and standards under the Energy Performance of Buildings Directive. It is mandatory to have energy performance certificates when buildings are constructed, sold or rented. Large public buildings must be certified regularly every ten years and are required to display the energy performance certificate.

Strengths of building certification

- Reduces negative environmental impacts, such CO_2 emissions, and saves energy.
- Saves money for building tenants (such as reduced energy costs).
- Increases the marketability of green buildings.
- Guides further improvement efficiency.
- Accumulates of data on the environmental performances of buildings for future policymaking.

Challenges to using building certification

- **Upfront administrative costs:** Issuing the certifications requires skilled professionals and expertise; this can translate into an additional burden for developers and building owners because it is often at their own cost to get a building certificate. More labour and auditing are required for assessing existing buildings.
- **Lack of coordination among certifications:** Different approaches can lead to different energy performance findings for a building and the possibility of a different rating, which may cause confusion.
- **Limited impacts of voluntary basis:** It may be difficult to obtain voluntary participation of builders or building owners without the use of incentives; those who receive a low performance rating are going to be reluctant to remain in the building certification scheme.

Implementing strategies

Supplement with supportive measures: Certification is most successful when complemented with other initiatives that support energy efficiency such as financial incentives and building codes. Builders and building owners and tenants should be ensured access to up-to-date information about incentive programmes. Issued certificates should be clearly communicated to builders, building owners and tenants so that the environmental performance of buildings indicated on the certificate is factored into their decision-making processes.

Build up technological and administrative capacity: A training strategy can be set at the planning strategy and competent assessors should be ensured before launching a building certification scheme.

Require reliable data and continued quality control: Data should be collected in a comprehensive administrative system and should be monitored. Quality control is a key factor for the ongoing success of a certification scheme; thus, a comprehensive quality-assurance system should be established and related disciplinary procedures should be prepared. A certification scheme should be adapted to changes in policy and legislation.

Examples

Green Rating for Integrated Habitat Assessment in India: India has a second voluntary building environmental performance rating system developed by the Energy and Resources Institute (TERI) jointly with the Indian Ministry of New and Renewable Energy (MNRE), which targets buildings that are not necessarily fully air-conditioned. The rating scheme promotes the use of solar passive design to optimize indoor thermal and visual comfort, resorting to air-conditioning only during periods of extreme discomfort. Considering the fact that India faces a serious shortage of resources, such as fossil fuel and water, the MNRE provides financial assistance to developers, design teams and institutions involved in developing and promoting energy-efficient and green buildings. There are so far more than 100 buildings already registered for the green rating for integrated habitat certification.

Green Building Mark in Singapore:[2] The Building and Construction Authority launched the Green Building Mark Scheme in 2005 to drive the construction industry towards more environment-friendly buildings. The initiative aims to green 80 per cent of buildings across Singapore by meeting the Green Buildings Mark standard by 2030, which would lead to large energy savings and also provide environmental and health benefits. Since April 2008, the initiative has required that all new buildings be constructed to the Green Mark standard. As of the end of 2010, 551 new buildings and 65 existing buildings had been certified.

Leadership in Energy and Environmental Design in the United States:[3] The Green Building Council developed the Leadership in Energy and Environmental Design (LEED) certification programme in 1998, which targets buildings of all types and sizes. It is a point-based system in which building projects earn LEED points for meeting specific green building criteria including use of renewable energy, energy efficiency, electrical demand, water consumption, access to public transportation, indoor environment, waste management, etc. The LEED standard can be obtained on different levels: certified, silver, gold and platinum, with increasing adherence to the different requirements for the building. An analysis in 2003 found that certified buildings were on average 25–30 per cent more energy efficient; more recent studies confirmed that certified buildings achieve other benefits, including higher rents, sale prices and occupancy rates as well as lower capitalization.

Further reading

Energy Performance Certification of Buildings: A Policy Tool to Improve Energy Efficiency (Paris, IEA and OECD, 2010).

[2] Building and Construction Authority website “About BCA Green Mark Scheme”. Available from www.bca.gov.sg/GreenMark/green_mark_buildings.html (accessed 27 January 2012).

[3] United States Green Building Council website “An Introduction to LEED”. Available from www.usgbc.org/DisplayPage.aspx?CategoryID=19 (accessed 27 January 2012).

Building energy standards and codes

Key points

- ***Once a building is constructed, it is very costly and sometimes impractical to attain the efficiency that can be achieved cost-effectively at the time of construction.***

- ***Energy-efficiency improvements in new buildings can have significant savings of energy for emerging countries.***

Building energy standards and codes explained

Building energy standards and codes are legal requirements that regulate buildings' energy performance and address energy consumption in the building envelope[1] and building equipment, such as heating, cooling and lighting. Europe and North America were the first to introduce energy-efficient design requirements in building after the first oil crisis of 1973. European Energy Performance in Buildings Directive requires member States of the European Union to establish requirements for energy efficiency in new buildings effective from January 2006. Separate energy efficiency requirements, known as prescriptive code, and energy performance requirements, known as performance code, are the two most widely used building energy standards and codes (Table 1).

Table 1: Types of building energy standards and codes

	Prescriptive code	**Performance code**
Description	Separate energy efficiency requirements are set for each component of the building (thermal transfer values for walls, roof and windows) and for each part of the equipment (heating/cooling system, lights, fans, pumps, etc.).	Performance building codes are based on annual energy consumption or the building's implied emissions of greenhouse gases
Pros	Easy to follow and verify	More flexibility in reducing energy consumption of buildings
Cons	Potential to hamper the adoption of the most cost-efficient measures for increasing the overall energy efficiency of buildings Potential to discourage innovation	Requires more skilled building professionals due to the use of computer-based models and sophisticated calculation on building energy performances

Source: Adjusted from J. Laustsen, *Energy Efficiency Requirements in Building Codes, Energy Efficiency Policies for New Buildings*, IEA Information Paper in support of the G8 Plan of Action (Paris, Organisation for Economic Co-operation and Development and International Energy Agency, 2008).

How they works

Building standards and codes have been in use a long time, enforced to ensure safety standards. There are now movements to upgrade building codes to reflect minimum environmental performance.

[1] Building envelop refers to the building fabric embracing the basic structure of buildings such as roofs, walls, window, floor, etc.

New buildings are typically subject to building codes, in many cases, as a legal obligation for construction approval. A few countries, such as Germany, apply the building codes to existing buildings when they are renovated. In Germany, a certain level of energy performance is required for renovations if more than 20 per cent of the building area is to be renovated.

Enforcement

Building standards and codes can be enforced in several ways. The responsibility of adoption, enforcement, inspection, and verification can be delegated to local authorities as the case in many countries including Canada, Japan, and China. In Singapore, the Building Construction Authority operating under the Ministry of National Development is in charge of operating the building energy codes.[2] Penalties for not complying with the energy code can include stopping construction and withholding permits and levying fines.[3]

- In Germany, enforcement is based on the self-certification of the builder-architect to the owner. In some states, municipalities carry out spot checks and if the requirements are not met, the Energy Saving Law specifies penalties between 5,000 and 50,000 euros.[4]
- Chinese authorities in Tianjin municipality are conducting third-party inspections to address some of the limitations. If the improper installation of wall insulation is identified through a random site inspection, for example, the General Station for Building Construction Quality Supervision can suspend the construction and require a developer to complete remedial measures before the sanction is lifted.[5]
- In Japan, all new constructions and remodelling of buildings larger than 2,000 square metres are mandated to submit an energy conservation report to local authorities. However, there is no provision for site inspections.[6]
- Building owners in Republic of Korea are required to submit an energy-saving worksheet signed by a licensed professional, such as architect, mechanical and electrical engineer. The relevant authority has the right to conduct an audit of the buildings after construction and revoke the permit or order the building to be rebuilt if elements of the energy-saving worksheet were not followed.[7]

Strengths of building standards and codes

- **Energy savings from building sector** (at national level): Building codes are cost-effective regulatory measures for reducing the energy consumption within buildings. A recent review of China's low-carbon development found that enforced building codes resulted in an energy savings of 31 million tonnes of coal equivalent (Mtce) from 2006 to 2008, which constituted 40 per cent of total energy savings in the building sector.[8]
- **Reduced utilities bills:** Tenants who live in buildings that are compliant with building codes can save on their utilities bills due to the energy savings achieved from the installation of technologies that meet energy-efficiency requirements.
- **Potential for creating new market:** Stringent requirements of building codes can create a new market for more energy-efficient appliances and equipment, such as double-glazed windows and LEDs, and encourage the development of new energy technologies.

[2] Singapore, Building Control Act 1989. Available from www.bca.gov.sg/BuildingControlAct/building_control_act.html#946439071-000193 (accessed 31 January 2012).

[3] Pacific Northwest National Laboratory, *Country Report on Building Code in Canada* (Richland, Washington, 2009).

[4] Liu Feng, A. S. Meyer and J. F. Hogan, "Mainstreaming Building Energy Efficiency Codes in Developing Countries: Global Experiences and Lessons from Early Adopters", World Bank Working Paper No. 204 (Washington D.C., World Bank, 2010).

[5] ibid.

[6] Alliance to Save Energy, *Building Energy Codes: Best Practices Report for APEC Economies* (Washington D.C., 2009).

[7] ibid.

[8] Climate Policy Initiative Beijing, *Review of Low Carbon Development in China: 2010 Report*, Executive Summary (Beijing, 2011).

Challenges to using building standards and codes

Such regulatory measures as building energy codes require strong enforcement, monitoring and verification. Even in developed countries, compliance doesn't come easily because of the high transaction costs required for inspection and verification. In the United Kingdom, for example, only 40 per cent of new buildings comply with the building codes[9] and compliance in the Netherlands is as low as 20 per cent due to reluctance to enforce regulations on building owners.[10]

The root causes of weak enforcement tend towards:

- **Lack of awareness on the opportunities arising from efficiency gains:** Most building owners are not aware of the opportunities for saving energy in buildings. Building owners can be more attentive to construction costs than energy costs over the life cycle of buildings.
- **Financial institutions hampering access to credit to cover additional costs:** Financial institutions may not be willing to provide loans for several reasons: ignorance of energy efficiency benefits; mismatch between the current financial scheme pursuing short-term profits and the energy efficiency gains achieved in a long run; and the risks associated with energy-efficiency projects.
- **Premature market:** High-tech energy-efficiency equipment is often not available in the local market of developing countries and thus only supplied by importing.

Implementing strategies

- **Communicate the benefits:** Building energy codes can be introduced on a voluntary basis to increase knowledge and expertise about energy efficiency among professionals in the initial stage. Demonstration projects for public buildings, such as schools, can be another good measure for outreach.
- **Supplement with incentives:** The incentives can be provided to both producers of energy-efficient products and goods and consumers, such as building users. The current German Minister for Environment, for example, proposed that tenants be allowed to pay less rent if the landlord does not ensure a certain level of energy use.[11]
- **Measures to discourage non-compliance:** Fines, sanctions, and injunctions can be imposed for any responsible part that violates the enforcement of building codes.
- **Ensure good quality of codes and continuous updates:** Building codes should be adapted to the local context and reflecting each country's building circumstances, such as climate. Generally, governments set national building codes that can be adopted or adjusted on a lower level of governance. As technologies progress and the costs of energy-efficient equipment decline, building energy codes should be regularly updated to remain relevant and effective.

Examples

Japan: The national Energy Conservation Law contains performance criteria for residential buildings that are both prescriptive and performance oriented. This focuses on heat transfer coefficients, resistance of insulation materials and summer solar heat gain coefficients.[12]

[9] J. Deringer, M. Iyer and Yu Joe Huang, "Transferred Just on Paper? Why Doesn't the Reality of Transferring/Adapting Energy Efficiency Codes and Standards Come Close to the Potential?", presented at the 2000 ACEEE Summer Study on Energy Efficiency in Buildings. Pacific Grove, CA, 20-25 August 2004.

[10] European Insulation Manufacturers Association, *Better Buildings through Energy Efficiency: A Roadmap for Europe* (Meerseen, Netherlands, 2006).

[11] Sonja Koeppel, Diana Ürge-Vorsatz, *Assessment of Policy Instruments for Reducing Greenhouse Gas Emissions from Buildings*, Report for the UNEP-Sustainable Buildings and Construction Initiative (Budapest, Central European University, 2007). Available from www.unep.org/themes/consumption/pdf/SBCI_CEU_Policy_Tool_Report.pdf (accessed 2 February 2012).

[12] Liu Feng, A. S. Meyer and J. F. Hogan, "Mainstreaming Building Energy Efficiency Codes in Developing Countries: Global Experiences and Lessons from Early Adopters", World Bank Working Paper No. 204 (Washington, D.C., The World Bank, 2010).

[13] ibid.

China: The Government enforced requirements for cost-effective reduction of heating and cooling loads, and new buildings must save 50 per cent on energy use. Cities with the largest construction markets, such as Beijing and Tianjin, have adopted more stringent regulations to further reduce the energy consumption by 30 per cent through the use of more envelope insulation and windows that have lower thermal losses.[13]

Further reading

Status of Energy Efficient Building Codes in Asia, by Joe Huang and Joe Deringer (Hong Kong, China, Asia Business Council, 2007).

Understanding Building Energy Codes and Standards, by R. Bartlett, M.A. Halverson and D.L. Shankle (Richland, WA, Pacific Northwest National Laboratory, 2003).

Cap-and-trade scheme

Key points

- ***A cap-and-trade scheme obligates polluters to pay for their emissions and creates certainty over the total quantity of the emission reductions that will be achieved.***

- ***Developing countries can implement a cap-and-trade scheme in a phased approach, which gives businesses time to adjust to the necessary changes in their production and management practices.***

Cap-and-trade scheme explained

A cap-and-trade or emissions-trading scheme is one form of pricing greenhouse gas emissions. It is a market instrument in which a government puts a "cap" or limit on the total amount of greenhouse gases that can be emitted. Under such a scheme, greenhouse gas emitters are obligated to pay for each tonne of carbon dioxide or carbon dioxide equivalent[1] they emit.[2] Hence, it rewards those who reduce their emissions.

The entities covered by the scheme are allocated allowances (permits) that permit them to emit a specific amount of greenhouse gases. Each emission allowance represents one tonne of greenhouse gas that is allowed to be emitted within a determined period or phase. The entities that emit more than the regulated amount can buy emission allowances from those entities that reduce their emissions to below the assigned threshold. Allowances are thus traded – bought or sold – among the participants in the trading scheme. The price of emission allowances or carbon is determined by the supply and demand of these allowances in the carbon market, similar to the trading of stocks. Because only a fixed amount of allowance is allocated, the cap-and-trade scheme assures certainty over the total quantity of emission reductions. Additionally, because the price of emission allowances is determined by the market, the scheme promotes the least-cost action for meeting the assigned emissions cap.

How it works

Caps

To ensure compliance of the "caps", the participating entities are obligated to measure, report and verify their emissions to the designated authority. The total amount of greenhouse gases that can be reduced depends on how stringent the cap is set. As well, there are different types of caps. An "absolute" cap ensures that a specific level of emissions will not be exceeded.[3,4] A "relative" cap restricts emissions relative to national or sector-specific levels of output. It thereby allows for emissions to increase in correspondence with the rise in production levels or GDP.[5] Another way to allocate caps is by assigning a target emission pathway to the participating entities ("baseline and credit" scheme). The entities then receive tradable credits if their emissions are below the baseline level or they have to purchase credits if their emissions are above the baseline level.[6] Additionally, caps

[1] One tonne of carbon dioxide equivalent is a measure for the quantity of another greenhouse gas that gives the same amount of global warming based on the conversion factors adopted by the United Nations Framework Convention on Climate Change (UNFCCC).

[2] Christina Hood, *Reviewing Existing and Proposed Emissions Trading Systems* (Paris, International Energy Agency, 2010). Available from www.iea.org/papers/2010/ets_paper2010.pdf (accessed 12 April 2011)

[3] ibid.

[4] For instance the EU Emissions Trading System (EU ETS) imposes an absolute cap.

[5] ibid.

[6] ibid.

can be set through negotiated benchmarks, such as greenhouse gas emissions per unit of output or input.[7] These benchmarks can also be changed to become more stringent as new technologies develop.[8]

Offsets

Offsets can be used to minimize the costs for meeting the emissions reduction targets. Offsets are basically credits generated through greenhouse gas emission reductions from projects outside the sectors or regions covered by the cap. They can be generated, for example, via Joint Implementation (between industrialized countries) or the Clean Development Mechanism (between industrialized and developing countries) of the Kyoto Protocol. These credits must be additional,[9] measurable and verifiable. Some cap-and-trade schemes limit the amount of offsets that can be used to meet the reduction targets. This is due to the fact that although offsets reduce the costs for meeting emission targets, they also reduce the rate of domestic transition to low-carbon energy systems because they shift emission reductions to other regions.[10]

Participants and coverage

Designing the cap-and-trade scheme as a generator-based "upstream" system, which applies to fuel suppliers, such as oil refiners and gas processors, assures a simple and less costly implementation because it involves relatively few participants and readily available data coverage.[11] A "downstream" approach is a load-based system that covers the direct emitters of greenhouse gases and offers a more immediate price signal to stimulate behavioural change of consumers, which provides more emissions reduction options and has been more widely used to date.[12] An example of a downstream approach is requiring automobile users to pay for the carbon emissions from the fuel they use.

The coverage varies from system to system and can range from sector-wide to economy-wide approaches. In many cap-and-trade schemes, the coverage usually includes the electricity, energy and industry sectors. It is determined by the availability of information on emissions and the respective measurement methods and systems in place. Pilot schemes and modelling exercises are used to determine the best measuring methodologies. Through them, the greenhouse gases, sectors and entities (including the scale) that will be covered in the cap-and-trade scheme can be determined, based on eco-efficiency criteria. The coverage must also be evaluated by the government, the participating entities and the public. To ease their introduction, cap-and-trade schemes can start with a narrow coverage and then gradually expand to include additional sectors or entities that will be subjected under the scheme at a later stage or it can be linked to other cap-and-trade schemes or regions, for example via the offset mechanisms.

Allowance allocation and auctioning

Governments determine how the allowances are distributed, based on national allocation plans. The distribution of allowances is primarily carried out in the form of a free allocation or through auctioning. Free allocation is based on participating entities' historical emissions (also referred to as "grandfathering") or on estimates of future conditions or production levels. In the initial start-up period of the cap-and-trade scheme, allowances or permits may be allocated for free to participating entities to discourage them from moving outside the designated boundaries of the scheme (country, state, etc.), which would cause "carbon leakage" (see details further on). Free allocation is also a way to reduce the financial burden that is incurred on the scheme's participants and protects their competitiveness during the adjustment period. Other transitional measures include different

[7] Julia Reinaud, *Trade, Competiveness and Carbon Leakage: Challenges and Opportunities*, Energy, Environment and Development Programme Paper 09/01 (London, Chatham House, 2009). Available from www.chathamhouse.org/sites/default/files/public/Meetings/Meeting%20Transcripts/0109reinaud.pdf (accessed 12 April 2011).

[8] ibid.

[9] Additional means that the emission reductions would not have occurred without the offset scheme under business as usual conditions.

[10] Hood, op. cit.

[11] Pew Center on Global Climate Change and The Pew Center on the States, *Climate Change 101: Understanding and Responding to Global Climate Change* (Arlington, VA, 2009). Available from www.pewclimate.org/docUploads/Climate101-Complete-Jan09.pdf (accessed 26 February 2012).

[12] ibid.

entry dates into the scheme for businesses relative to their readiness, selling allowances at a fixed price, a transitional price cap, partial obligations or prohibiting the banking of allowances to subsequent periods.[13]

Governments have to keep in mind that over-allocation and "gaming"[14] can delay action by the participants. As well, grandfathering permits can fall short of the emissions reduction potential and also reduce government revenue.

Box 1: The European Union's Emissions Trading System

The European Union's Emissions Trading System (EU ETS) features a combination of auctioned and free allocations (table 1). In the third phase of the EU ETS, starting from 2013, 100 per cent of the allowances for the power sector will be auctioned.[15] Other sectors will have to purchase only 20 per cent of their allowances through auctions in 2013, while 80 per cent will be allocated for free. The share of auctioning for these sectors will be increased every year, to 70 per cent by 2020 and ultimately to 100 per cent in 2027. For sectors at risk of leakage, meaning that they may suffer competitive disadvantage against competitors outside the European Union that do not have to comply to emissions reduction commitments, up to 100 per cent may be allocated free of charge. For all sectors, benchmarking and not grandfathering will be the adopted method to arrange the free allocation.[16]

Table 1: EU ETS auctioning rates per sector, 2013 and beyond

Sector	2013	2020	2027
Power generation	100%	100%	100%
Power generation in new EU member states	30%	100%	100%
Other	20%	70%	100%
Sectors at risk of carbon leakage	Up to 100% may be allocated free of charge		

Source: CMS Cameron McKenna LLP, *Phase III of the EU Emissions Trading Scheme: Your Q&A Guide* (London, 2009). Available from www.law-now.com/cmck/pdfs/nonsecured/phase3.pdf (accessed 21 March 2012).

Market price of allowances

The price of the allowances varies as a result of their demand and supply in the market. Forecasting the business-as-usual level of emissions is difficult because it is not static; weather, economic conditions, energy resource prices and other factors affect the emission trends.[17] Thus it is also difficult to predict the price of the allowances. Placing price floors and ceilings has been one way to control the price volatility and price uncertainty and build investor confidence. In such cases, a public institution can be a seller of allowances when the price is high and a buyer when the price is low.[18] The downside of having these political interventions in the market mechanism is that they may undermine the effectiveness of the cap-and-trade scheme.

According to the World Bank, the value of the global carbon market grew in 2009 to US$144 billion, up 6 per cent from 2008, despite the financial crisis. In the European Union's Emissions Trading System (EU ETS), more than 6 billion European Union allowances (EUAs) were transacted in 2009, for a total value of US$118 billion.[19]

[13] Hood, op. cit.

[14] Gaming is when businesses embellish historical emissions or exaggerate difficulties in adjustment and thereby gain substantial profits from large allowances, according to Nicholas Stern, *Blueprint for a Safer Planet* (London, Vintage U.K. Random House, 2009).

[15] For new EU member states, that feature little interconnection with the EU electricity network or very low GDP per capita, this restriction is eased to 30 per cent auctioned allowances in 2013, but will be aligned to 100 per cent by 2020.

[16] Hood, op. cit.

[17] Hood, op. cit.

[18] Nicholas Stern, *Blueprint for a Safer Planet* (London, Vintage U.K. Random House, 2009), p.109.

[19] World Bank, "Global Carbon Market Grows to $144 billion Despite Financial and Economic Turmoil" Press release, 26 May 2010. Available from http://climatechange.worldbank.org/news/global-carbon-market-grows-144-billion-despite-financial-and-economic-turmoil (accessed 25 April 2011).

Trading

Carbon credits are exchanged on trading platforms,[20] such as the European Climate Exchange in London, the European Energy Exchange in Leipzig, the Nord Pool in Oslo, the Bluenext in Paris and the Chicago Exchange in Chicago. The credits can be traded over the counter through brokers (banks or members of the exchange), among operators of businesses and through futures and spot markets. Voluntary credits, which can be used as offsets, are sold in dedicated trading platforms.

Basic infrastructure needs to be in place before the trading begins: registries to collect data on emissions; accredited verifiers; exchanges and over-the-counter systems to enable trading; financial institutions (banks); human resources, including information providers and analysts; and project developers.

Monitoring and compliance

Strict monitoring and enforcement is critical for ensuring the credibility of the scheme. Data collection and analysis is a vital element to kick off a cap-and-trade scheme, especially for setting the appropriate emissions cap. A registry must be set up to track and verify emission reductions from the participating entities. Verification of data is carried out by a third-party audit or through self-reporting with auditing. Many developing countries, however, may lack the capacity to collect and analyse the data necessary to operate this kind of emissions registry. In this case, technical assistance from experienced industrialized countries can be effective in designing and employing cap-and-trade schemes. Some countries can build on existing systems and capacities at the national level; for example, existing data collection and monitoring infrastructure for conducting greenhouse gas inventories (which respond to the reporting requirement of the climate change National Communications under the United Nations Framework Convention on Climate Change) can be used to measure emissions and emission reductions and assure compliance with the cap-and-trade scheme.

In the case of non-compliance, penalties, such as fines, are imposed on the emitters and should be set high enough to act as a deterrent.

Carbon leakage

For many countries and industries, competitiveness is a major issue that must be considered before such a scheme is introduced. One of the more critical concerns is "carbon leakage", whereby emissions-intensive and energy-intensive businesses relocate to regions and countries that are less stringent on carbon regulation. This process undermines the environmental effectiveness of the cap-and-trade scheme. It also impacts on the industrial competitiveness of the CO_2 trade-exposed sectors, resulting in the loss of profits, outputs and jobs and is thus a significant worry for investment plans and other business decisions.

Despite the concerns about carbon leakage, studies of the EU ETS found that since 2005 the scheme had not triggered any changes in the trade flows or production patterns for cement products, iron and steel, refineries or aluminium.[21] This was attributed to policy measures designed to lessen the impact on industries, including through the free allocation of allowances. Another way to minimize carbon leakage is through the introduction of a global cap-and-trade scheme, which would make all countries subject to putting a cap on their emissions and result in a more level competing field. Other proposed alternatives include border tax adjustment systems or sector-based approaches.

Need for complementary policies

To ensure effectiveness, a cap-and-trade scheme needs to be supported by complementary policy measures, including regulations, standards and incentives. Some complementary policies are energy-efficiency standards,

[20] The Garnaut Climate Change Review (Australia) recommends certain considerations for the design of a trading platform: accessibility for those wanting to participate in the market, ability to secure the exchange quickly and at minimal cost and transparency of offers and bid prices. For more details, refer to Garnaut Climate Change Review, *Emissions Trading Scheme*, Discussion Paper (Canberra, 2008). Available from www.garnautreview.org.au/ca25734e0016a131/webobj/d0836448etspaper-final-fullcolour/$file/d08%2036448%20%20ets%20paper%20-%20final%20-%20full%20colour.pdf (accessed 25 February 2012).

[21] Reinaud, op. cit.

support for R&D and the deployment of low-carbon technologies, promoting energy-efficient vehicles and facilitating renewable energies. Not all greenhouse gases can be covered by one single cap-and-trade scheme, and thus the introduction of additional schemes working in parallel will be required.[22]

Another concern is that the accrued costs for allowances, trading and production adjustments incurred by the cap-and-trade scheme will be passed down from the energy-intensive sectors to consumers through a rise in prices for goods and services whose production entails a large amount of emissions. Studies show that even under grandfathered allocations, prices of energy-intensive products will increase because businesses will use the opportunity to maximize their profits. As such, governments will also need to consider policies that lessen the impact of such price increases on the consumers as well as those to recover windfall profits of businesses, especially from the power sector, such as limiting the amount of free allowances by adopting auctioning methods.

Employing a cap-and-trade scheme will require a steep learning curve for everyone involved. Policymakers should allow for a transitional phase in which experience and knowledge can be accumulated. During this phase, policymakers must also provide sufficient economic support, such as tax breaks and loan guarantees, to give businesses enough time and financial leverage to prepare their participation in the scheme and thus better protect their industrial competiveness.

Government use of revenue from cap and trade schemes

To gain public acceptance, governments need to provide information on the constructive use of revenues from the auctioning of allowances – uses that contribute back to society. Governments may use the revenues to fund various mitigation policies, such as R&D, to invest in renewable energy technology or to compensate low-income households for higher energy bills through direct rebates or energy-efficiency programmes. In the forthcoming third phase of the EU ETS, for example, 50 per cent of auction revenue is to be used to fund greenhouse gas reductions and climate change adaptation through R&D, renewable energy and improved energy efficiency and reduced deforestation. As well, some allowances are to be auctioned to fund demonstration carbon capture and storage projects.[23]

Strengths of a cap-and-trade scheme

- **Reduces greenhouse gas emissions efficiently.** A market mechanism, like the cap-and-trade scheme, is a powerful tool for a climate change mitigation policy that leads to a cost-efficient reduction of greenhouse gas emissions.

- **Ensures carbon emissions reduction quantities.** Cap-and-trade schemes provide more certainty over the emissions reduction potential compared with the carbon tax, although they may incur higher administrative costs.

- **Influences consumption and production patterns.** The scheme is also highly effective in influencing production and consumption patterns within the economy by adding the carbon price to energy-intensive products and thereby facilitating the shift to low-carbon production methods and goods and services.

- **Provides innovation incentives for the private sector.** Carbon markets provide price signals and incentivize the private sector to look for options that will bring the lowest abatement costs, which in turn drives technological innovations and investments.

- **Creates revenue that can be directed to compensate consumers or to fund related programmes, such as energy efficiency-improvement programmes**, low-carbon technology R&D and technology demonstration projects.[24]

[22] Hood, op. cit.

[23] Hood, op. cit.

[24] Hood, op. cit.

Challenges for implementing a cap-and-trade scheme

- **Competitiveness.** How to maintain the domestic industrial competitiveness is a central issue that needs to be considered when introducing a cap-and-trade scheme. In terms of the trade-exposed sectors, the international competitiveness is more vital. However, competitiveness concerns can be turned into business opportunities. For instance, early movers in energy-intensive sectors can improve their competitiveness by investing in R&D for low-carbon technology innovation and their commercialization and deployment (breakthrough technology).

- **Investor confidence.** Governments must build investor confidence by designing a stable and well-functioning cap-and-trade market through policies that ensure the credibility, predictability, simplicity and transparency of the scheme. Introducing the scheme will mean that businesses need to change their modus operandi by investing time and financial resources. Some businesses will need to retrofit existing infrastructure or install new infrastructure and equipment, which will require huge upfront investment. Economic instruments, such as tax incentives, loan guarantees and R&D funds, are needed to buttress the situation and minimize investment risks for the private sector.

- **Institutional capacity.** These schemes need to be well designed with good institutional foundations, including a designated authority that is responsible for the registry, monitoring, reporting and compliance systems and backed by appropriate legislation.

- **Cost of innovation.** Although technological innovation alone does not enable countries to make the transition to a low-carbon development path, it is an important driver. Inducing technological innovation, however, requires huge financial resources. A well-designed cap-and-trade scheme can generate sufficient revenues that support R&D investments.

NOTE: For a comparison between carbon taxes and cap-and-trade schemes, see the fact sheet on carbon pricing.

Implementing strategies

Strongly commit to an emissions trading scheme: The government's role in setting up an emissions trading scheme is critical, especially for fixing the cap and designating the coverage and allocation of permits. Governments must show strong leadership by providing a clear and consistent long-term vision and a strategy to motivate and obtain acceptance from all actors, especially the business sector. Governments must ensure that the necessary infrastructure is in place, such as trading exchanges and registries.

Provide predictability through long-term policy and price signals: Medium- and long-term emissions reduction goals and related policies foster a sense of predictability that incentivizes businesses to plan ahead and to look for the least expensive abatement methods, which fosters investments in R&D for technological innovations, low-carbon technologies and infrastructure. Also crucial for building investor confidence is a coherent policy framework for the energy, technology and industry sectors. Additionally, a phased cap-and-trade scheme promotes business sector reassurance, especially with periodic reviews of the cap levels.

According to an International Energy Agency study, "providing certainty over the trading scheme's environmental goals – and related prices of CO_2 – for ten years increases low-carbon investment: with less than this, it is in investors' interest to take a 'wait and see' approach and this leads to higher system prices overall."[25]

Set stringent cap levels: Mandatory target setting and emissions caps are essential. The stringency determines the effectiveness and efficiency of the schemes. Governments must ensure that the cap is set below the business-as-usual emission levels. Policymakers must take bold steps in setting and announcing the long-term goals, targets and caps at a very early stage to enable businesses and government institutions to prepare.

[25] Hood, op. cit., p. 55.

During the initial phases, caps can be set at a modest rate to help businesses adjust, make investment plans and ease the pressure on industrial competitiveness and thus lessen negative impacts.[26] At the same time, it is important that governments also provide assistance to businesses in making the transition, especially towards the carbon-intensive and trade-exposed sectors. This then is followed with a raise in the caps in the ensuing phases. Additionally, measures are needed that prevent an oversupply of allowances, which would reduce their value and lead to a price collapse.

Define the coverage scope: The coverage determines the emission sources and entities that will be responsible for emission reductions (either upstream or downstream). The coverage must be discussed and agreed by all actors in the design stage of a cap-and-trade scheme.

Embrace free allocation in the early phase of the scheme and include auctioning at the later stages: Free allocation is important in the initial phases of the scheme to ease the economic burden on participating entities. However, to prevent an oversupply of allowances in the market, governments are highly encouraged to gradually transition to fully auctioning the allowances as the cap-and-trade scheme gains maturity. This applies especially to the energy (electricity) sector. Although this shift may be very challenging politically, it can speed up the settling period of the scheme.

Consider providing support towards consumers, especially low-income households: In many cases there is resistance towards the introduction of a cap-and-trade scheme due to concerns that it may raise consumer electricity prices. A number of measures can be introduced as compensation for consumers from the revenues generated through the auctioning of allowances. Special attention needs to be given to support low-income households. Measures can include direct cash transfer, tax breaks or subsidies to limit consumer price rises (shielding). Other options can be the introduction of consumer energy-efficiency programmes, which prevent a raise in the total energy cost for the consumer despite an increase in energy prices.[27]

Use auction revenues wisely to benefit society: Revenues can also be directed towards supporting the research, development and demonstration of low-carbon technologies and low-carbon development programmes.

Ensure that the public is adequately informed about the cap-and-trade scheme before and during its implementation (particularly with regards to the benefits, challenges and government support measures): Transparency on the amount, the distribution and use of the revenues generated from the cap-and-trade schemes are important factors to garner public support.

A concise implementation checklist for developing countries is offered in box 2.

Box 2: Implementation checklist for developing countries

- ✓ Set national mitigation targets and goals.
- ✓ Consider including carbon pricing in national climate change action plans, development plans or low-carbon devlopment plans.
- ✓ Organize dialogues with parties to facilitate understanding and promote public acceptance.
- ✓ Commit to a cap-and-trade scheme.
- ✓ Consider integrating the cap-and-trade scheme as part of the nationally appropriate mitigation actions (NAMAs) framework.
- ✓ Designate an authority for implementing and overseeing the scheme.
- ✓ Consider seeking technical assistance for designing and implementing a cap-and-trade scheme, specifically to:
  - Collect baseline emission data and set up methodologies for measuring, reporting and verifying emissions
  - Undertake modelling exercises to determine the potential carbon emissions, cost, impact on industrial competitiveness and impact on society
  - Set an appropriate and manageable cap
  - Identify the coverage – the sectors, businesses and gases that will be covered

[26] Consideration is required toward ensuring that "target pathways in the early years are sufficiently ambitious for long-term cuts to remain achievable and that the ETS design options selected are compatible with ambitious caps in the long term." Cited from Hood, op. cit., p.18.
[27] Hood, op. cit.

- Determine implementing phases and respective allocation methods (free distribution or auctioning)
- Determine price floors and ceilings for allowances
- Determine appropriate systems and institutions that need to be in place (for example, registry, inventory, data collection and assessment, monitoring, verification and compliance)
- Identify and undertake institutional capacity improvement through human resource development (training and workshops).

✓ Establish and put in place appropriate systems and institutions.
✓ Provide economic incentives to businesses to support the transition.
✓ Provide support to ease consumer impact, especially for low-income households.
✓ Use revenues from the cap-and-trade scheme to benefit society.
✓ Ensure transparency of the amount and redistribution of revenues generated from the cap-and-trade scheme.
✓ Inform the public on every aspect of the scheme: why, how it works and how it benefits.

Examples from around the world

India: The National Action Plan for Climate Change[28] promotes, with the intent of expanding, the share of domestic renewable energy in India. The plan proposed an enhancement to the regulatory energy tariff regime through the introduction of a renewable purchase obligation (RPO) scheme, dubbed by the Dynamic Minimum Renewables Purchase Standard. The RPO is maintained by the State Electricity Regulatory Commission and mandates the purchase of a minimum share of renewable energy in the total consumption in the area of a distribution licensee.[29] In fiscal year 2009–2010, the minimum purchase quantity from renewable sources was set to 5 per cent of the total grid power purchase. It was also decided that this quantity shall increase by 1 per cent each year for the following four years, reaching 9 per cent by 2013.[30]

In November 2010, renewable energy certificates (RECs) were launched as a mechanism to assist states that cannot meet the RPO. The REC value is equivalent to 1 MWh of electricity injected into the grid from renewable energy sources and is issued to a renewable energy generator by a central agency. To meet their obligations, utilities may either purchase renewable power or buy the RECs from a renewable energy generator or a combination thereof.[31]

In addition, the Perform, Achieve and Trade (PAT) mechanism covers facilities that account for more than 50 per cent of the fossil fuel used in India. The mechanism will help reduce CO_2 emissions by 25 million tonnes per year by 2014–2015. Approximately 700 of the most energy-intensive industrial units and power stations in India are mandated to reduce their energy consumption. An energy saving certificate will be issued to entities that achieve savings above the mandated target. These certificates may be sold to other entities that are unable to make sufficient energy consumption cuts in their own facility to meet the mandated targets.[32]

Republic of Korea: A carbon market is envisioned as the major policy tool for the Government's National Strategy on Green Growth. Article 46 of the Framework Act on Low Carbon, Green Growth mandates the introduction of a cap-and-trade scheme to meet the national emissions reduction target. However, specifications for the registration, management, allocation and the operational structure of the scheme will be covered by a Bill for Greenhouse Gas Emissions Trading System, which is still under review. The emissions trading system is expected to start in 2015.

[28] India, *National Action Plan on Climate Change* (New Delhi, Prime Minister's Council on Climate Change). Available from http://pmindia.nic.in/climate_change_english.pdf (accessed 27 February 2012).

[29] Renewable Energy Certificate Registry of India website "About REC". Available from www.recregistryindia.in/index.php/general/publics/AboutREC (accessed 27 February 2012).

[30] India, *Maharashtra Electricity Regulatory Commission: (Renewable Purchase Obligation, its Compliance and Implementation of REC Framework) Regulations, 2010* (Mumbai, Maharashtra Electricity Regulatory Commission, 2010). Available from www.mercindia.org.in/pdf/Order%2058%2042/Final_MERC(RPO-REC)_Regulation_2010_English.pdf (accessed 21 March 2012).

[31] Renewable Energy Certificate Registry of India website "About REC". Available from www.recregistryindia.in/index.php/general/publics/AboutREC (accessed 27 February 2012).

[32] India, *India: Taking on Climate Change Post-Copenhagen Domestic Actions* (New Delhi, Ministry of Environment and Forests, 2010). Available from http://moef.nic.in/downloads/public-information/India%20Taking%20on%20Climate%20Change.pdf (accessed 27 February 2012).

As an interim measure to prepare businesses before the full-fledged emissions trading system is introduced, the Government introduced an Emissions Target Management Scheme in January 2012 that sets a cap on 1,564 facilities, including about 470 private entities,[33] that collectively emit more than 442 million tonnes of CO_2 per year.[34] Under this scheme, heavy emitters and the Government mutually agree on a viable emissions target, limiting either the amount of greenhouse gas emissions or energy consumption levels. Emission targets are to be reviewed annually. However, the penalty for non-compliance – a fine of up to 10 million won (approximately US$9,000) – may not be enough of a deterrent.

In 2010, 13 provincial governments ran a pilot cap-and-trade scheme for public organizations. A platform was established at the Korea Exchange for more than 600 public and private organizations. In Seoul, 115 transactions were made by 47 public and private firms, amounting to 654 tonnes of emissions, equivalent to more than 16 million won. The city government set the price at 22,800 won (approximately US$20) per tonne of CO_2 at the exchange, as of September 2010,based on the European Climate Exchange Market price of 15.44 euro (US$20) per tonne. The cyber trading in September 2010 alone involved 32 public agencies trading 316 tonnes of emissions, equivalent to about 3.7 million won (US$3,300). In addition, the Ulsan metropolitan government launched its first online carbon trading market in June 2010, with 228 tonnes of emissions traded so far.[35]

Ukraine: In 2010, the Government proposed a joint carbon market with its neighbouring countries, Belarus, Kazakhstan and Russia.[36] Kazakhstan is also exploring options for setting up a domestic carbon trading system.

Mexico: In 2010, the Law for Mitigation and Adaptation was approved by the Mexico City Assembly. The law allows the Mexico City government to introduce green taxes, provide financial incentives for environmental improvements and to create a domestic carbon market.[37] The Mexican Government is working on a cap-and-trade scheme, currently in the design stage, which will cover the cement, petroleum and electricity sectors.[38]

Brazil: Brazil is considering a domestic carbon market for its primary economic sectors.[39]

[33] Hyon-hee Shin, "Korea Braces for Carbon Trading System", *Korea Herald*, 12 April 2011. Available from www.koreaherald.com/business/Detail.jsp?newsMLId=20101102000986 (accessed 8 January 2012).

[34] *Point Carbon*, "Korea Unveils Carbon Scheme Rules", 21 March 2011. Available from www.pointcarbon.com/news/1.1519474 (accessed 5 January 2012).

[35] ibid.

[36] Kateryna Choursina, "Ukraine Proposes Creating a Joint Carbon Market with Russia, Kazakhstan", *Bloomberg*, 13 September 2010. Available from www.bloomberg.com/news/2010-09-13/ukraine-proposes-creating-a-joint-carbon-market-with-russia-kazakhstan.html (accessed 23 April 2011).

[37] Jennifer Andreassen, "Mexico City Passes Historic Climate Bill While U.N. Climate Talks Remain Sluggish", *Environmental Defense Fund Talks Global Climate*, 4 December 2010. Available from http://blogs.edf.org/climatetalks/2010/12/04/mexico-city-passes-historic-climate-bill-while-u-n-climate-talks-remain-sluggish/ (accessed 23 April 2011).

[38] Alex Morales, "Mexico Plans Carbon Market for Pemex, Power, Cement Businesses", *Bloomberg*, 9 April 2009. Available from www.bloomberg.com/apps/news?pid=newsarchive&sid=aKYM6lkFL70g&refer=latin_america (accessed 23 April 2011).

[39] *Point Carbon*, "Brazil Considers Domestic Carbon Market", 6 May 2010. Available from www.pointcarbon.com/news/1.1442709 (accessed 23 April 2011).

Figure 1 provides an overview of some of the mandatory emissions trading schemes currently operating around the world.

Figure 1: Mandatory emissions trading schemes

Geographical Scope	Name of ETS	Target Pollutant	Target Organisation
International ETS			
European Union[a] (2005~)	EU-ETS	6 GHGs[b]	Electricity generation and energy-intensive industries; aviation will be added from 2012.
National ETS			
New Zealand (2008~)	NZ-ETS	6 GHGs[b]	The scheme has no cap on emissions but strong links to international markets. Targets include all gases and sectors, including agriculture (from January 2015)[c]
Switzerland (2008~)	Swiss-ETS	Energy-based CO_2	Around 350 companies are covered by the scheme, though targets are negotiated on a case-by-case basis[d]
United Kingdom (2010~)	CRC Energy Efficiency Scheme	Energy-based CO_2	Around 5 000 large businesses and public sector organisations using over 6 000 megawatt-hours of electricity (excluding those covered by the EU-ETS)
Sub-national ETS			
New South Wales, Australia (2003~)	Greenhouse Gas Reduction Scheme (GGAS)	GHGs from electricity production	Energy producers and highly energy-intensive users
Alberta, Canada (2007~)	Alberta trading scheme	Industrial GHGs	Around 100 very large emitters (over 100 000 tonnes of CO_2 equivalent per year), such as oil sands mines and coal-fired power plants
North-eastern & Mid-Atlantic regions, United States (2009~)	Regional Greenhouse Gas Initiative (RGGI)	Energy-based CO_2 from power plants	Electricity generators
City-based ETS			
Santiago, Chile	Emission Offset Program of Supreme Decree No. 4	Total suspended particulates	Stationary combustion sources with an exhaust gas flow rate greater than 1 000 m^3 per hour
Tokyo, Japan (2010~)	Tokyo-ETS	Energy-based CO_2	Mandatory emissions reduction for large emitters, defined as single buildings or facilities that consume more than 1 500 KL crude oil-equivalent a year
Los Angeles, United States	Regional Clean Air Incentives Markets (RECLAIM)	NOx (nitrogen oxides), SOx (sulphur oxides)	Facilities emitting more than 4 tonnes a year of either gas
Chicago, United States	Emissions Reduction Market System (ERMS)	Volatile organic compounds, particularly tropospheric ozone	Stationary sources emitting more than 10 tonnes per season (2 seasons per year)

Notes:

a) EU 27 plus Norway, Iceland and Liechtenstein. The last three have been linked to EU-ETS since 2008; *b)* Six GHGs are carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_{2O}), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF6); *c)* Obligations are placed on emitters to surrender 1 eligible NZU (New Zealand Unit) for every tonne of CO_2 emitted. The price of 1 NZU is set at NZD 25 (though it is set at half the price, NZD 12.5 or €7, during the transition preriod, 2010-12). Participants in the scheme can import and surrender eligible Kyoto units (CERs for CDM and ERUs for JI), convert NZUs to Assigned Amount Units and export them. The goverment has the power to accept units from other ETSs; *d)* Under discussion with the EU to link the scheme to the EU-ETS from 2013.

Sources: Hood (2010); OECD (2011a); World Bank (2010a); http://environment.alberta.ca.

Source: Organisation for Economic Co-operation and Development, *Southeast Asian Economic Outlook 2011/12* (Paris, 2011). Available from: www.oecdlibrary.org/docserver/download/fulltext/4110051e.pdf?expires=1332392009&id=id&accname=ocid195767&checksum=1583F7528D8AC138CDCCBEAF3D10552D (accessed 21 February 2012).

Further reading

Reviewing Existing and Proposed Emissions Trading Systems, by Christina Hood (Paris, International Energy Agency, 2010). Available from www.iea.org/papers/2010/ets_paper2010.pdf

Climate Change 101: Understanding and Responding to Global Climate Change (Arlington, VA, Pew Center on Global Climate Change and The Pew Center on the States, 2009). Available from www.pewclimate.org/docUploads/Climate101-Complete-Jan09.pdf

Carbon capture and storage

Key point

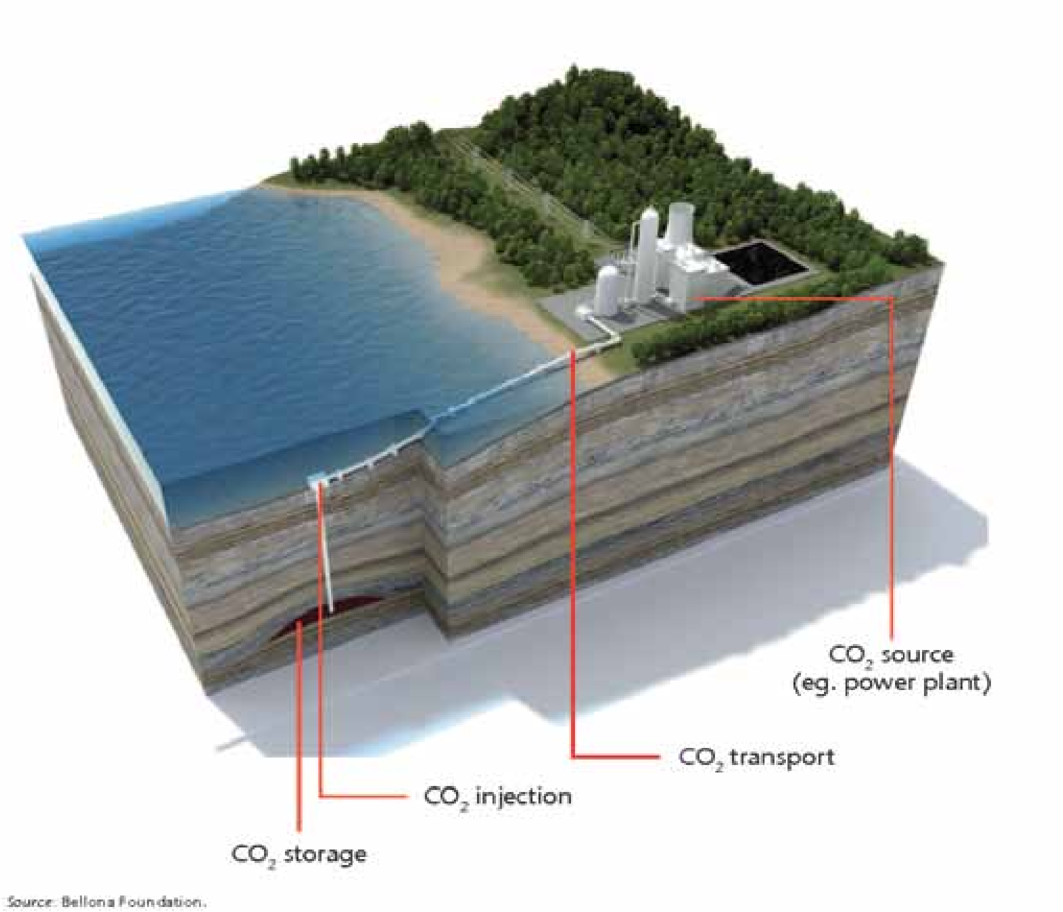
- ***Carbon capture and storage can potentially mitigate greenhouse gas emissions from large-scale fossil fuel use, although the technology is not yet ready for commercial-scale application.***

Carbon capture and storage explained

According to the International Energy Agency (IEA), carbon capture and storage is a system of technologies that integrates three stages: CO_2 capture, transport and geological storage (figure 1):[1]

1) **CO_2 capture:** Catch CO_2 from such sources as fossil fuel, power plants, industrial facilities and steel, concrete and fertilizer plants.
2) **Transport:** The transport of the captured CO_2 through high-pressured pipeline networks or via ships, trucks and trains for regions that do not have adequate storage.
3) **Geological storage:** After transporting the CO_2 to the storage site, it is injected deep into a well where it is then trapped in the geological formations below the surface. Three options for geological storage are saline formations, oil and gas reservoirs and deep un-minable coal seams.

Figure 1: Carbon capture and storage process



Source: Bellona Foundation extracted from International Energy Agency (IEA), *Technology Roadmap: Carbon Capture and Storage* (Paris, IEA and OECD, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf (accessed 20 July 2011).

Climate change mitigation potential

Carbon capture and storage (CCS) is considered the "only technology available to mitigate greenhouse gas emissions from large-scale fossil fuel usage in fuel transformation, industry and power generation", according to the IEA *Technology Roadmap: Carbon Capture and Storage*.[2]

The IEA *Energy Technology Perspectives 2010: BLUE Map Scenario* "sets the goal of halving global energy-related CO_2 emissions by 2050 (compared to 2005 levels) and examines the least-cost means of achieving that goal through the deployment of existing and new low-carbon technologies".[3] In this BLUE map scenario, the introduction of carbon capture and storage in power generation, fuel transformation and industry is expected to reduce an estimated 19 per cent of global CO_2 emissions.[4]

In parallel to the introduction of carbon capture and storage, which should be considered as an interim necessity, a variety of innovative low-carbon technologies for alternative sources of energy and energy efficiency will also be needed to reduce global CO_2 emissions.

How it works

The individual technologies that are used for carbon capture and storage are relatively mature, but the integration and the scaling up of all the technologies to a commercial scale still needs further research and demonstration. According to a working paper by the World Resources Institute, CO_2 separation and capture technology has been applied at the commercial scale in the food and beverage sector and for other industrial uses. In terms of CO_2 transport by pipeline technology, it is a mature industry used in such places as the United States. Technologies for storage selection, injection and monitoring are well developed across the petroleum industry. However, further research and experience are required in terms of storage locations and on leakage issues, which has safety implications. Power plant integration of all the carbon capture and storage technologies still needs further research.[5]

Because the integrated technology is not yet mature, carbon capture and storage requires retrofitting fossil fuel plants and building capture-ready plants so that the technology can be installed when it becomes commercially viable.

Although industrialized countries have more experience in research, development and demonstration of carbon capture and storage, developing countries with their unique geological characteristics can demonstrate the technology. Developing countries can work together with experienced countries and donors on such projects through international cooperation and innovative partnerships. The IEA expects that from 2020 onwards, carbon capture and storage will pick up in developing countries.[6] In addition to the energy security perspective, carbon capture and storage's potential for reducing CO_2 emissions is considered highly viable for countries that depend on coal as a major source of their energy.

[1] International Energy Agency, *Technology Roadmap: Carbon Capture and Storage* (Paris, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf (accessed 20 July 2011).

[2] ibid, p. 5.

[3] International Energy Agency, *Energy Technology Perspectives 2010: Scenarios & Strategies to 2050* (Paris, 2010), p.47. Available from www.iea.org/Textbase/nppdf/free/2010/etp2010_part1.pdf (accessed 1 March 2012).

[4] ibid., p. 81.

[5] F. Almendra, L. West, L. Zheng and S. Forbes, "CCS Demonstration in Developing Countries: Priorities for a Financing Mechanism for Carbon Dioxide and Capture and Storage", Working Paper (Washington, D.C., World Resources Institute, 2011). Available from http://pdf.wri.org/working_papers/ccs_demonstration_in_developing_countries.pdf (accessed 5 September 2011).

[6] International Energy Agency, *Technology Roadmap: Carbon Capture and Storage* (Paris, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf (accessed 20 July 2011).

Regulatory frameworks

To introduce carbon capture and storage technology into developing countries, several conditions are required. For instance, because the major player is the private sector, governments need to provide policy certainty and incentives through long-term policy signals that promote private sector investment and minimize the associated risks. This is especially important because of the long-term investment cost that is required.

Legal and regulatory frameworks that contribute to an enabling policy environment are needed. In parallel, existing laws should be reviewed and amended in order to carry out the demonstration projects. There also may be a need for a comprehensive framework if amendments of the law prove insufficient.[7]

Some of the carbon capture and storage specific regulations that may need to be introduced at the national level include, but are not limited to, the following:[8]

- Oil and gas legislation
- Mining legislation
- Waste legislation
- Health and safety legislation
- Property rights
- Transport legislation
- Groundwater legislation
- Environmental impact assessment legislation.

Financing for carbon capture and storage

The IEA estimates under its BLUE map scenario, that 10 gigatonnes of CO_2 emissions need capturing in 2050 to reduce global CO_2 emissions by half from the 2005 level. This translates, for example, to a total of 21 carbon capture and storage projects in India and China by 2020 and 950 projects by 2050.[9] That level of deployment in India and China will incur an additional cost of US$7.6 billion by 2020 and US$1.3 trillion by 2050.[10] Total investment requires US$19 billion by 2020 and US$1.17 trillion by 2050.[11]

Due to the high costs associated with carbon capture and storage, financing is the primary obstacle – not only for developing countries but even for industrialized countries. Currently, carbon financing is one of the main funding sources available to developing countries for reducing their CO_2 emissions. During the United Nations Framework Convention on Climate Change (UNFCCC) Conference of Parties (COP) 17 negotiations in Durban, country delegates decided that carbon capture and storage would be eligible as a project activity under the Clean Development Mechanism. This COP decision opens opportunities for projects to be financed in developing countries in the future – but not in the immediate future (see the following box).

Other possible sources of funding that developing countries may access in the future are multilateral funds, bilateral funding and emissions trading schemes. Although donor support may facilitate carbon capture and storage technology introduction, financing and partnership agreements between the public and private sector will be necessary because the amount of investment is too high for the private sector to take on alone, especially for upfront costs.

[7] ibid.

[8] ibid.

[9] The IEA BLUE Map scenario estimates that globally a total of 100 carbon capture and storage projects need to be deployed by 2020 and a total of 3,400 projects need to be deployed between 2010 and 2050 to reduce CO_2 emissions by half by 2050 from the 2005 levels; International Energy Agency, *Technology Roadmap: Carbon Capture and Storage* (Paris, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf (accessed 20 July 2011).

[10] Additional cost – the annualized expenditure for solely the CCS part of a facility. It reflects the incremental costs incurred to operators compared with the operating costs of a facility without CCS; International Energy Agency, *Technology Roadmap: Carbon Capture and Storage* (Paris, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf (accessed 20 July 2011).

[11] Total investment – the amount of financial capital needed to build a complete CCS facility; International Energy Agency, *Technology Roadmap: Carbon Capture and Storage* (Paris, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf (accessed 20 July 2011).

BOX: Carbon capture and storage and the UNFCCC negotiations

In the context of the UNFCCC negotiations, carbon capture and storage was first considered in 2005 as a possible option in the portfolio of mitigation actions. In 2009, the business sector advocated that such technology is necessary to halve emissions by 2050. In 2010, the UNFCCC COP 16 Parties in Cancun agreed that carbon capture and storage in geographical formations is eligible as a project activity under the Clean Development Mechanism, provided that such issues as project boundaries, liability, measurement, reporting and verification, environmental impacts, safety and long-term permanence are resolved in a satisfactory manner. During the COP 17 negotiations in Durban, South Africa in December 2011, the Parties agreed that carbon capture and storage would be eligible as a project activity under the Clean Development Mechanism. However, details of the specific procedures and modalities are to be discussed in future UNFCCC negotiations.

Source: Earth Negotiations Bulletin, *Summary of the Cancun Climate Change Conference: 29 November – 11 December*, vol. 12, No. 498 13 (Winnipeg, International Institute for Sustainable Development, 2010). Available from www.iisd.ca/download/pdf/enb12498e.pdf (accessed 12 March 2012).; and United Nations Framework Convention on Climate Change, *Carbon Dioxide Capture And Storage In Geological Formations As Clean Development Mechanism Project Activities*, draft conclusions proposed by the Chair, Subsidiary Body for Scientific and Technological Advice, Thirty-fifth session, Durban, 28 November to 3 December 2011 (FCCC/SBSTA/2011/L.24). Available from http://unfccc.int/resource/docs/2011/sbsta/eng/l24.pdf (accessed 12 March 2012).

Governments will need to find financial incentives for attracting private sector investment as well as allocating domestic funding, such as loan guarantees, tax breaks, risk sharing of investments with government and special financial assistance for retrofitting plants.

Public awareness and support

Carbon capture and storage facilitation will entail building public awareness in order for governments to allocate huge investments in demonstration projects. Governments must provide appropriate information and create channels in which reliable data can be accessed by the public. Consultations will be required for site selection and ensuring safety measures, especially regarding storage issues.

Current status of integrated commercial-scale projects in operation

According to the World Resources Institute, there are seven fully integrated, commercial-scale carbon capture and storage facilities around the world (table 1).[12]

Table 1: List of integrated commercial-scale carbon capture and storage projects in operation

Location	Site name	Start date	Type
USA/Canada	Weyburn	2000	Capture: Coal gasification plant; pre-combustion Transport: Pipeline (330 km) Storage: Enhanced oil recovery (2.4 Mt per year)
North Sea, Norway	Snohvit	2007	Capture: Liquefied natural gas plant, natural gas processing Transport: Pipeline (160 km) Storage: Offshore deep saline formation (0.7 Mt per year)
North Sea, Norway	Sleipner	1996	Capture: Offshore platform, natural gas processing Transport: Pipeline in same site Storage: Offshore deep saline formation (1Mt per year)

[12] Almendra, Zheng and Forbes, op. cit.

Algeria	In Salah	2004	Capture: Natural gas processing plan Transport: Pipeline (14 km) Storage: Deep saline formation/gas field (1.2 Mt per year)
USA	Salt Creek	2006	Capture: Natural gas processing plants Transport: Pipeline (132 km) Storage: Enhanced oil recovery (1Mt per year)
USA	Val Verde CO_2 pipeline	1998	Capture: Five natural gas processing plants Transport: Pipeline (132 km) Storage: Enhanced oil recovery (11Mt per year)
USA	Rangley EOR project	1986	Capture: Natural gas processing Transport: Pipeline (285 km) Storage: Deep saline formation/gas field (1 Mt per year)

Source: Extracted from F. Almendra, L. West, L. Zheng and S. Forbes, "CCS Demonstration in Developing Countries: Priorities for a Financing Mechanism for Carbon Dioxide and Capture and Storage", Working Paper (Washington, D.C., World Resources Institute, 2011). Available from http://pdf.wri.org/working_papers/ccs_demonstration_in_developing_countries.pdf (accessed 5 September 2011).

Examples

Countries such as Australia, Canada, Japan, Norway, United Kingdom and United States and the European Union have provided assistance towards financing carbon capture and storage R&D, demonstration and deployment.[13] In the emerging developing countries in the Asia-Pacific region, preliminary work includes studies ongoing in China, India and Indonesia with international assistance.[14]

Australia: In Australia, a member-based Global CCS Institute was launched in June 2009 to accelerate the deployment of technologies globally, foster cooperation on projects and technologies and to share information.[15] The Australian Government committed A$2 billion dollars to fund large-scale carbon capture and storage demonstrations domestically.[16]

Norway: Since 1991, Norway has applied an offshore CO_2 tax on gas and oil companies to reduce their emissions. This scheme has helped owners to finance the application of the CCS technology, such as the Sleipner CO_2 injection project.[17] The Norwegian Government plans to allocate 1.2 billion krone for other projects.[18]

South Africa: In March 2009, the South African Centre for Carbon Capture and Storage was established with financial support from the Government through the South African National Energy Research Institute, the Norwegian and United Kingdom governments, Agence Francaise de Development (AFD) and South African industries. The Centre pursues R&D and capacity building to prepare for a safe and reliable CCS demonstration plant in South Africa in the future.[19]

[13] International Energy Agency, *Technology Roadmap: Carbon Capture and Storage* (Paris, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf (accessed 20 July 2011).

[14] Almendra, Zheng and Forbes, op. cit.

[15] Commonwealth of Australia, Department of Resources and Energy and Tourism website, "Global Carbon Capture and Storage Institute". Available from www.ret.gov.au/resources/gccsi/Pages/default.aspx (accessed 29 January 2011).

[16] International Energy Agency, *Technology Roadmap: Carbon Capture and Storage* (Paris, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf (accessed 20 July 2011).

[17] Global Carbon Capture and Storage Institute website, "Projects: Sleipner CO_2 Injection". Available from www.globalccsinstitute.com/resources/projects/sleipner-co2-injection (accessed 7 September 2011).

[18] International Energy Agency, *Technology Roadmap: Carbon Capture and Storage* (Paris, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf (accessed 20 July 2011).

[19] South African Centre for Carbon Capture & Storage website, "About Us". Available from www.sacccs.org.za/about-us/ (accessed 7 September 2011).

Further reading

CCS Demonstration in Developing Countries: Priorities for a Financing Mechanism for Carbon Dioxide Capture and Storage (Washington, D.C., World Resources Institute, 2011). Available from http://pdf.wri.org/working_papers/ccs_demonstration_in_developing_countries.pdf

Technology Roadmap: Carbon Capture and Storage (Paris, International Energy Agency, 2009). Available from www.iea.org/papers/2009/CCS_Roadmap.pdf

FACT SHEET

Carbon pricing

Key points

- ***Carbon pricing – putting a price on greenhouse gas emissions – is an up-to-date policy mechanism for reducing emissions efficiently at the lowest cost possible in an ideal market situation.***
- ***Different pricing measures have distinctive strengths and weaknesses, and this requires policy interventions in real market situations.***

Carbon pricing explained

Carbon pricing is the general term for putting a "value" on reducing carbon emission reduction by putting a "price" on its emission. Carbon pricing internalizes the externalities by covering the cost of the damages from emissions in the production and consumption of a good or service. The carbon price provides a financial incentive for reducing CO_2 and other greenhouse gas emissions.

Carbon tax and cap and trade

Two major carbon pricing mechanisms are carbon taxes and cap and trade.

A carbon tax is a direct fee imposed on fossil fuels and other primary products (such as refrigerators), based on the amount of greenhouse gases they emit.[1] Increasingly, carbon tax is becoming an important component of a country's carbon emission reduction scheme and part of broader environmental tax reforms.[2] Cap-and-trade schemes set a limit on greenhouse gas emissions by setting the maximum allowed amount by regulations for the sectors and facilities under its coverage.[3]

In an ideal market situation (in which the greenhouse gas reduction targets are set unanimously and based on agreed scientific facts, which is not the case in reality), economic and environmental impacts of the both measures should be similar. However, in the reality of imperfect market conditions, differences exist. The major differences between the two mechanisms are as follows:

[1] Tax credits on the activities removing GHGs from atmosphere are also included in this category. World Resource Institute, "Carbon Taxes", *The Bottom Line on*, Issue 7, June 2008. Available from http://pdf.wri.org/bottom_line_carbon_taxes.pdf (accessed 27 November 2011).

[2] For more details, see: Track 2 of this Roadmap for the fact sheet on environmental tax reform and environmental fiscal reform and a case study on Austria's carbon pricing scheme.

[3] World Resource Institute, "Carbon Taxes" *The Bottom Line on*, Issue 7, June 2008. Available from http://pdf.wri.org/bottom_line_carbon_taxes.pdf (accessed 27 November 2011). For more details on cap-and-trade, see the fact sheet on cap-and-trade of this Roadmap.

Table 1: Comparison of carbon taxes and a cap-and-trade scheme

Key aspects	Carbon taxes	Cap-and-trade scheme	Measures to address
1. Price certainty for investment	☺ A set tax rate provides a clear and stable long-term policy direction for investments.	Susceptible to market price volatility (for example, the European Union emissions trading system and Japan's SOX).	Setting price floor and ceiling in a cap-and-trade scheme.
2. Certainty of environmental impacts	No guarantee to meet the reduction target. BUT: Broad-based carbon taxes can overshoot the targets.	☺ Capping, if stringent enough, guarantees achieving set emission reduction targets.	When cap-and-trade scheme is "grandfathered" (such as free allocation of emission allowances based on the participating entities' historical emissions), it undermines cap-and-trade scheme's effectiveness.
3. Flexibility to changing situation	Tax is obligatory to the target companies.	☺ Market-based pricing automatically adjusts to changing economic and climate conditions. Trading of allowances among over- and underachieving companies.	Companies may prefer a cap-and-trade scheme.
4. Cost efficiency (administration and implementation)	☺ When a country already has a well-functioning tax and fiscal structure, administration of carbon taxes would be minimal. (e.g. in Germany, the administrative costs of ETR are only 0.13% of the total tax revenue generated.)[4]	Complexity of the mechanism may require higher administrative costs and human resource capacity (trading institutions, benchmarking (in "grandfathering" cases) and governance, enforcement and monitoring mechanisms.	Experience with previous cap-and-trade schemes indicates that the costs for trading institutions are not great.[5] In many developing countries with a less transparent and efficient fiscal structure, it is an open question whether introducing carbon taxes would be simple.

5. Coverage	☺ A carbon tax can target carbon emissions in all sectors, including transportation, energy and industry.[6] Actual impacts on reduction in an economy would vary, dependent upon the tax rates as well as the extent of revenue recycling (such as research and development or low-carbon programmes, etc.)	Due to the vast number of “downstream” sources at the point of combustion and use (including households and small-sized companies), the coverage tends to focus on the heavy-emitting industries with high reduction potential only.	Cap-and-trade scheme tends to exempt the transportation sector whose carbon emission portion is significant in many countries.[7] Determining the coverage requires a bold political decision. Carbon tax rates should be significant enough to be effective in changing consumers’ demand and spur low-carbon technology innovation.[8]
6. Economic efficiency *(* In the reality of an imperfect market, given the imperfect knowledge of marginal costs of carbon emissions abatement studies)*	☺ Studies and empirical evidence indicate that a carbon tax may lead to more economically efficient results (with five times higher gains in carbon emission reduction than the optimal cap-and-trade schemes, largely due to the allowance price volatility of the latter.[9]	Volatility of the allowance price in the market is a major challenge. Miscalculated allowance rates (especially through grandfathering allowances) can result in a windfall profit for some businesses, leading to distributional inequity, less economic efficiency and extra costs.	In a hypothetical case of complete certainty about the degree of the climate change impacts and future mitigation costs, both a carbon tax and cap-and-trade scheme would result in nearly identical aggregate costs, consumer price impacts and reductions in carbon emissions.[10]
7. Impact on technological innovation	☺ Carbon taxes provide a clear price floor for carbon and thus a minimum return for any innovation.[11] This can incentivize broad-based technology innovation in energy efficiency and renewable energy throughout the economy.	☺ Cap-and-trade scheme provides incentives to encourage technology innovation for reducing CO_2 emission. An invention (such as a breakthrough technology) that reduced the cost of cutting carbon emissions could push down the price of permits, reducing investors' returns.[12]	Part of the proceeds of an auctioned allowance in cap-and-trade scheme can be invested in programmes that support low-carbon technologies and energy efficiency programmes that support innovations.

8. Revenue recycling	☺ Tax provides a revenue-raising opportunity.	Grandfathering allowances to regulated entities often limits the revenues. However, in a pilot phase, auctioning may be difficult as it is intended to be a "learning-by-doing" phase to prepare businesses.	In theory, full allowance auctioning in cap-and-trade scheme can generate fiscal revenue as well as carbon taxes.
9. Distributional impacts	Income-regressive in general. Through revenue recycling to mitigate and compensate negative impacts on the most affected, the impacts can be addressed.[13]	Depends on the ability of businesses to pass on the carbon price to their consumers. Impacts of the increased electricity price on low- and middle-income households may need to be eased by compensating from the revenue collected from auctioned cap-and-trade scheme allowances.	In principle, distributional impacts on affected businesses and households may be similar between carbon taxes and a cap-and-trade scheme, in which auctioning leads to the allowance price being similar to the tax rates.[15] Studies show in developing countries that the actual impacts (of introducing carbon taxes) may differ and the most affected may not be the most poor but the middle-income households (as in Indonesia and China).[16] In both carbon tax and cap-and-trade schemes, effective revenue recycling to mitigate the distributional impacts is important.
10. Political feasibility	In general, public acceptance to introduction of taxes is difficult, partly due to (perceived) direct impacts on the livelihoods of the taxpayers.	☺ Cap-and-trade may be more readily acceptable by the public with its explicit focus on the environment and due to perceived indirect nature of its impacts on the public.	Carbon tax needs to highlight and clearly communicate to the public its revenue neutrality and revenue recycling measures to address competitiveness and distributional concerns. In the context of ETR and EFR, its long-term economic and environmental benefits also need to be highlighted.

Interaction of carbon taxes and a cap-and-trade scheme is also worth noting. The European Union set up a regional-based cap-and trade scheme (EU Emissions Trading System, or EU ETS) but carbon and energy taxes are applied with different schemes and designs at the national levels.[16] As of 2012, Australia is introducing a carbon pricing scheme that combines the initial three years' carbon tax regime and switching to a cap-and-trade mechanism.[17]

Because each scheme differs in its strengths and weaknesses, each country should consider the options with careful detailed designs to address the expected challenges.

Carbon pricing alone will not reduce CO_2 emissions and needs to be supported by other policy measures. As the Stern Review findings conclude, other policies supporting innovation and the deployment of low-carbon technologies and removing barriers to behaviour change (regulation, information and financing polices) are also necessary to address climate change challenges.[18] In designing a carbon pricing scheme, setting the appropriate rates and coverage as well as designing revenue recycling in a way that spurs the greening of the economy will maximize the positive impacts. In the case of a cap-and-trade scheme, effective cost-constraint mechanisms and full auctioning, preferably regulated by a government body, need to be established.

NOTE: For more details of the measures of pricing carbon, see the fact sheets on cap-and-trade schemes and the case study on Australia's carbon pricing scheme.

[4] Organisation for Economic Co-operation and Development, *The Political Economy of Environmentally Related Taxes* (Paris, 2006). Available from www.oecd.org/dataoecd/26/39/38046899.pdf (accessed 10 October 2011). For more details of Germany's ETR, see Case Study of this Roadmap: European Experiences with ETR and Double Dividend.

[5] Robert N. Stavins, A U.S. *Cap-And-Trade System to Address Global Climate Change* (Washington, D.C., The Brookings Institution, 2007). Available from www.hks.harvard.edu/m-rcbg/rpp/Working per cent20papers/RPP_2007_04.pdf (accessed 10 October 2011).

[6] "Carbon Taxes Address All Sectors and Activities Producing Carbon Emissions. Carbon taxes target carbon emissions in all sectors — energy, industry and transportation — whereas at least some cap-and-trade proposals are limited to the electric industry. It would be unwise to ignore the non-electricity sectors that account for 60 per cent of U.S. CO2 emissions." For further information, Carbon Tax Centre website "Vs. Cap-Trade" (22 March 2009). Available from www.carbontax.org/issues/carbon-taxes-vs-cap-and-trade/ (accessed 10 October 2011).

[7] IEA, CO_2 Emission from Combustion 1971-2003 (Paris, OECD and IEA, 2005).

[8] World Resource Institute, "Carbon Taxes" *The Bottom Line on*… Issue 7, June 2008. Available from http://pdf.wri.org/bottom_line_carbon_taxes.pdf (accessed 27 November 2011).

[9] Jason Furman and others, *An Economic Strategy to Address Climate Change and Promote Energy Security* (Washington, D.C., The Brookings Institution, 2007). Available from www.brookings.edu/~/media/Files/rc/papers/2007/10climatechange_furman/10_climatechange_furman.pdf (accessed 10 October 2011).

[10] ibid.

[11] A tax provides a clear price floor for carbon and hence a minimum return for any innovation. For further information, see *The Economist*, "Doffing the Cap: Tradable Emissions Permits Are a Popular, but Inferior, Way to Tackle Global Warming", June 14 2007. Available from www.economist.com/node/9337630?story_id=E1_JPPSGPD (accessed 10 October 2011).

[12] For further information *The Economist*, "Doffing the Cap: Tradable Emissions Permits Are a Popular, but Inferior, Way to Tackle Global Warming", June 14 2007. Available from www.economist.com/node/9337630?story_id=E1_JPPSGPD (accessed 10 October 2011).

[13] For more details, see Track 2 of this Roadmap and Factsheet: ETR and EFR.

[14] Robert N. Stavins, A U.S. *Cap-And-Trade System to Address Global Climate Change* (Washington D.C., The Brookings Institution, 2007). Available from www.hks.harvard.edu/m-rcbg/rpp/Working per cent20papers/RPP_2007_04.pdf (accessed 10 October 2011).

[15] Studies suggest that a carbon tax may be progressive in some developing countries because higher-income groups (as in the case of China and Indonesia) tend to buy more carbon-intensive goods and energy-intensive sectors tend to employ skilled labour rather than low-paid informal workers. For more details refer to Track 2 of the Roadmap. M. Brenner and others, "A Chinese sky trust? Distributional impacts of carbon charges and revenue recycling in China", Energy Policy (2005), vol. 35, pp. 1771-1784; Arief Anshory Yusuf, *The Distributional Impact of Environmental Policy: The Case of Carbon Tax and Energy Pricing Reform in Indonesia* (Singapore, Economy and Environment Program for Southeast Asia, 2008).

[16] For details of the ETR measures in UK and the EU countries, see: Case Study of this Roadmap: the UK Climate Change Levy (CCL) and Case study: European Experience of ETR and Double Dividend.

[17] See: Case study of this Roadmap: Australia's Carbon Pricing Scheme.

[18] Nicholas Stern, *The Stern Review: The Economics of Climate Change* (Cambridge, Cambridge University Press, 2007).

Further reading

An Economic Strategy to Address Climate Change and Promote Energy Security, by J. Furman and others (Washington, D.C., The Brookings Institution, 2007). Available from www.brookings.edu/~/media/Files/rc/papers/2007/10climatechange_furman/10_climatechange_furman.pdf

The Stern Review: The Economics of Climate Change, by Nicholas Stern (Cambridge, Cambridge University Press, 2007).

Cellular development

Key points

- ***The primary goal of cellular development is to increase the accessibility to a variety of destinations that people would visit on a daily or weekly basis.***
- ***Coupled with proximate access to mass-transit and walkable streets, this development framework creates successful, self-sustaining communities, thus reducing the need for trips made by private cars.***[1]

Cellular development explained

Cellular development, often referred to with the mixed-use development, is based on the concept of a cell or village that integrates a variety of destinations, including housing, retail, office and entertainment, as well as educational, cultural and religious destinations into a smaller, denser area.

How it works

The concept can be applied in a variety of situations and environments, whether in a large metropolis or smaller town centre or suburban setting or whether for new planned development or for infill projects.

- **Macro level:** The concept can be put in place around a large transit-oriented development or mass transit hub. It is ideal to have the cells in a city, region or community linked by transit to allow better access for all its residents.
- **Micro level:** The cellular concept integrates a short walking radius from a centre point, and development radiates around the centre point to include a careful mix of uses and building types. Within that range, the mix of uses allows citizens to walk or bicycle to many of their daily destinations and the services that they require.
- **Retrofitting projects:** The cellular development concept can be applied in a way that supplements the existing core to provide communities with employment opportunity, shelter, schools and shopping malls.

Strengths of cellular development

- **Increases walkability:** By structuring cellular development around a central nucleus and promoting mixed-used, high to medium density, and a range of amenities, a cellular development creates walk-able environment, while reducing the need for driving.
- **Reduces urban sprawl:** By concentrating all community amenities and land uses into a dense, cellular development with specified boundaries, the protection of surrounding green areas from sprawl becomes possible.
- **Reduces energy consumption, emissions and traffic from automobiles:** By creating a more walkable community with close proximity to where residents live, work, and interact, the need to drive longer distances is eliminated. Due to the fact that a mass-transit hub acts as the nucleus of most cellular developments, the need to drive to other communities is also reduced.

[1] International City/County Management Association, *Smart Growth Network: Getting Smart about Climate Change* (Washington D.C., 2010).

Challenges to cellular development

- **Conflicting land use policies:** If a comprehensive, compatible set of land use policies is not adopted, developments can only be partially implemented and cells can be consumed by infill development and sprawl.
- **Land use codes and zoning regulations:** Over the past century, land use codes and zoning regulation promoted fractured development, with large amounts of land zoned for specific uses. These policies are often static, inflexible, and can inhibit creative solutions.

Weaknesses

- In the event that a large number of automobiles are in a cellular development, major traffic problems may arise.
- If not properly designed, noises and pollutions from shops and vehicles may negatively affect the daily lives of people.

Implementing strategies

Instigate site analysis and land use plans: The design of the cell begins with proper zoning. This process should begin with a comprehensive analysis of location, including existing natural environment and topography, the scale and scope of the desired cell, anticipated traffic flow, urban-growth boundaries, and potential future trends that may require further zoning changes. Consideration for access and commuting time between various residential, commercial and industrial locations should be considered throughout the planning process.

Enforce regulations: Once a comprehensive site analysis is completed, the appropriate combination of mixed-use, mixed-income and density regulations should be implemented.

Set complementary measures: Urban design standards and policies that focus on streetscapes, walkability, public space and traffic flow should be compatible with the land use plan and desired growth. Due to the fact that the each community, city and urban region is unique, with their own needs and desires for future growth, a range of techniques and strategies should be investigated and created.

Examples

Kuala Lumpur Sentral, Malaysia: Kuala Lumpur Sentral is an exclusive urban centre built around Malaysia's largest transit hub. The 72-acre development is designed to be a "city-within-a-city, including numerous office towers, hotels, condominiums and a shopping mall.[2]

Annapolis, Maryland, United State of America: The town centre of Annapolis serves as a model redevelopment to turn an expansive surface parking lot with no access to mass transit into a mixed use centre. The freed up land has turned into various public places such as plazas and outdoor cafes, encouraging more street level vibrancy as well as adding economic vitality.

Further reading

Mixed-Use Development Handbook, by Dean Schwanke, Second edition (Washington, D.C., Urban Land Institute, 2003).

[2] Kuala Lumpur Sentral website: www.klsentral.com.my/Home.aspx (accessed 27 February 2012).

FACT SHEET

Citywide slum upgrading

Key points

- ***The poor and the vulnerable in cities and towns can aspire to have security, shelter, basic infrastructure and services with citywide slum upgrading.***

- ***Up to 35 per cent of Asia-Pacific urban residents in slums with proper urban planning can have adequate shelter and basic services through proper urban planning.***[1]

Slum upgrading explained

On-site slum upgrading means improving the physical, social, economic and environmental conditions of an existing informal settlement – without displacing the people who live there. Upgrading informal communities is the least expensive and most humane way of improving a city's much-needed stock of affordable housing rather than destroying it. Unlike resettlement, upgrading causes minimal disturbance to people's lives and to the delicate networks of mutual support in poor communities.

How it works

Urban poor groups take an active role in savings, surveying, planning and working with city authorities to make large-scale citywide upgrading possible. This is happening in more than ten Asian countries and represents an important shift in the role of the urban poor in improving their land and housing situation. Underpinning this, new financial systems linking community savings into larger city and national development funds allow the upgrading to materialize. The emphasis is on flexible financing, giving community groups the freedom to plan, to implement and to use the available funds to solve their housing and land problems. This holistic approach to urban poverty develops community networks and builds partnerships with local parties.

Strengths of slum upgrading

- **Provides low-cost homes:** The urban poor who can neither afford to own a home nor improve their housing conditions can participate with the community for access to information, consultations, expertise and loans to help them acquire or refurbish a home.
- **Financial benefits accrue:** Because the urban poor and residents of informal settlements usually do not have access to formal finance opportunities to resolve their housing needs, flexible forms of finance enable them to borrow from the community through savings groups.
- **Instils social benefits and livelihoods:** Belonging to a strong-knit community group, each family can rely on others for moral support and increase their livelihoods through income-generating activities and welfare programmes they set up.

Challenges to slum upgrading

- **Rapid urbanization:** The magnitude and pace of urbanization and rural-to-urban migration have caused immense pressure on limited space and resources to create sufficient employment for new migrants and to improve the housing situation.

[1] UN-HABITAT, *State of the World Cities 2010-2011: Bridging The Urban Divide* (Nairobi, 2010).

- **Achieving critical mass:** To be successful in upgrading the slums, collective decision and solidarity is needed to push through ideas; often disagreements among the community members can either delay or derail the process.
- **Technical capacity needed:** Citywide housing solutions require a range of special services: social and technical support to communities, participatory planning, architecture and engineering, guidance on appropriate technologies, programme coordination, project and contract management, construction skills that match needs in informal areas, engineering and construction, affordable building materials and micro-finance services.

Weaknesses

- When financial crisis hits a country, the fiscal budget of the central and municipal governments have to be reduced, and usually housing upgrading projects are the first to be cut, creating uncertainties in the housing loan schemes.
- In some countries, powerful and wealthy interest groups are involved in land speculation and large-scale land development plans that have bulldozed slums and squatter settlements; the urban poor have no outlet or legal rights to seek any countermeasure.

Implementing strategies

Ensure strong local government support: The creation of citywide slum upgrading programme requires strong support and capacities from local governments to mobilize their resources efficiently and to work in tandem with a vibrant civil society.

Encourage community action and participation: Slum dwellers through self-help and community group movements can become aware, connected and organized to develop their own plans for housing and settlement improvements and to follow through on the plans, maintaining control over the construction and upgrading process.

Build win-win partnerships: The responsibilities can be shared in developing a slum upgrading programme with various partners who have vested interest in the well-being of the community as well as for themselves. NGOs and the private sector can assist in terms of building up skills and other capacities, negotiating on-site land-sharing agreements and subsidizing relocation as compromise solutions.

Secure land tenure: Providing secure tenure is a vital part of community upgrading to reassure inhabitants to invest the money and time without fear of eviction.

Examples

In Thailand since 2003, the Government has been engaged in a national slum upgrading programme known as Baan Mankong (secure housing) in cities across the country. The programme has led to upgraded housing conditions for more than 90,000 households with low-interest government loans, through the Community Organisations Development Institute (CODI).[2]

In Viet Nam over the past 12 years, the Asian Coalition for Housing Rights has been working in ten cities with the National Women's Union to set up savings groups, which have generated US$1.4 million for housing and land projects, including rehabilitation response to areas devastated by the typhoon that hit Quinhon, Vihh and Ha Tinh provinces in November 2009.[3]

Further reading

The State of Asian Cities 2010/2011 (Nairobi, UN-HABITAT, 2010).

[2] 107 Cities in Asia, *Second Yearly Report of the Asian Coalition for Community Action Program*, December 2010.

[3] ibid.

FACT SHEET

Combined heat and power

Key points

- ***Combined heat and power can help to improve fuel efficiency by recycling residual heat – which would otherwise be wasted – from power plants. It is also integral to decentralized energy generation.***

- ***The application of this technology depends on the policy objective and local context, in light of its flexibility to accommodate both conventional fossil fuel and renewable energy sources.***

Combined heat and power explained

Combined heat and power (CHP, or co-generation) refers to energy systems that concurrently generate electricity and heat from the same fuel source. In conventional power plants, about two thirds of the primary energy that is converted to produce electricity is lost as waste heat.[1]

How it works

CHP increases overall energy efficiency by supplying useful heat in addition to electricity. A number of technologies and fuel sources can be used in CHP applications, including renewable biomass. CHP integrates a heat recovery system to capture waste heat from electricity production and uses the recovered heat to satisfy heating demand of nearby users. CHP applications can be grouped into three categories: industrial, commercial and district heating and cooling.

CHP facilities can be connected to the electricity grid or stand-alone off-grid systems. Where possible, interconnected CHP facilities can sell excess electricity generation and feed it into the grid. CHP facilities can also function as back-up power production plants.

Opportunities for Asia and the Pacific

Currently, CHP accounts for about 10 per cent of electricity production worldwide, but most of the installed capacity is in a handful of European countries. Emerging economies, such as many in the Asia-Pacific region, are particularly lucrative places for CHP development because installing CHP production plants at the same time as building new industrial facilities reduces the challenge of high overall capital costs. China leads Asia with CHP plants, contributing 13 per cent of its electricity production, and India follows, at 5 per cent. Both countries have the potential to produce more than 25 per cent of their total electricity by CHP by 2030.[2]

Strengths in using combined heat and power

- **Increased energy efficiency:** Depending on the technology used, CHP plants operate at 65–80 per cent efficiency. Producing the same amount of electricity and heat conventionally through separate power plants and boilers would require about 50 per cent more units of fuel because it operates at around 50 per cent efficiency. On-site electricity production further increases efficiency by eliminating transmission losses.

[1] International Energy Agency, *CHP and District Cooling: An Assessment of Market and Policy Potential in India* (Paris, IEA and OECD, 2008). Available from www.iea.org/G8/CHP/docs/IEA_India.pdf (accessed 4 November 2011).

[2] International Energy Agency, *Cogeneration and District Energy* (Paris, IEA and OECD, 2009). Available from www.iea.org/files/CHPbrochure09.pdf (2 November 2011).

- **Lower energy costs possible:** In many cases, fuel savings leads to cost savings. However, the costs of CHP need to be analysed because it will not lead to cost savings in all cases, especially if the cost of grid electricity is subsidized or otherwise very low.
- **Lower emissions:** By combusting around two thirds of the fuel used by conventional systems to generate the same amount of heat and electricity, CHP systems increase eco-efficiency and reduce greenhouse gas emissions from energy production. And because many CHP plants rely on natural gas, the energy produced in them has further efficiency gains over the fuel mixes for electricity and heat production in many countries that rely heavily on coal.
- **Fuel-switching flexibility:** CHP systems can be configured to accept an array of feedstocks, which can help the system's users hedge against fuel cost volatility.
- **Opportunity for development of decentralized energy supply system:** Because CHP plants need to be located near end users of heat generation, the development of such plants encourages the decentralization of the energy supply system, putting the supply plants closer to users.
- **Important vehicle for promoting energy market diversification:** By encouraging the involvement of more diverse actors in energy production, CHP can be a driver for energy market reform.

Challenges to using combined heat and power

- **Capital costs:** High capital costs of new CHP plant are a significant hurdle to development in the region.
- **Geographical limits:** Heat can only be transported over very short distances, limiting the use of the heat generated to areas adjacent to the plant. There is also a limited need for heating in much of the region. Use of waste heat for cooling requires additional infrastructure.
- **Infrastructural limits:** Pipelines needed to distribute district heating or cooling from CHP plants are under developed or have limited access in many cities. City planning and investment to make these pipeline resources more accessible is required.
- **Operations and maintenance costs:** High maintenance costs can cut into cost savings by up to 30 per cent.
- **Reliance on thermal energy conversion:** Most CHP plants rely on conventional electricity production technologies. Although they increase the overall system's efficiency by harnessing waste heat for use, they do still burn fossil fuels and create greenhouse gas emissions.

Implementing strategies

Install CHP when the existing system needs to be upgraded: To reduce the barrier of high additional capital costs, CHP systems can be installed when existing boilers or other heating or cooling equipment needs to be replaced or upgraded.

Use biomass resources, including waste: Because CHP plants need to be distributed and are often placed at large commercial or medium-sized industrial facilities, using co-firing or biomass-powered plants could be a viable option and help the facilities manage their wastes.

Sell the emissions reductions: Avoidance of greenhouse gas emissions can qualify CHP facilities for national or international incentives, such as the certified emissions reductions (CERs) through the Clean Development Mechanism. Sale of CERs can provide an additional revenue stream.

Optimize CHP in solar thermal and geothermal development: Developers of renewable thermal energy technologies should be cognizant of increased efficiency of CHP when heating or cooling demand centres are nearby.

BOX 1: Cutting-edge heating and cooling with dramatic savings in the Republic of Korea

Under the district heating and cooling (DHC) system, apartment buildings, business buildings and commercial buildings no longer need to install heating and cooling generation systems individually. Instead, co-generation and heat generation facilities equipped with cutting-edge pollution prevention equipment economically generate energy and supply it to a multitude of users. This advanced urban infrastructure offers the benefits of energy savings and pollution reduction when compared with existing energy generation methods. Recognizing these benefits, the Korean Government by end 2008 had provided district heating service to 1.7 million households (about 12 per cent of all households). The Government's rigorous measures for DHC distribution (2001-2008) resulted in 23 per cent average annual energy saving, mitigation of 40 per cent of average annual CO_2 emissions and waste energy recovery of about 13 per cent from the total energy production. Aiming to reduce peak energy loads in the summer, the Korean Government announced its plan to provide subsidies of 2 billion KRW in 2011 for district cooling installations, which are expected to contain 12 MW of maximum electricity demand and contribute an annual energy saving of 1,565 tons of coal equivalent. An energy welfare programme was introduced providing subsidies for heating bills for low-income families.

Source: Korea District Heating Corp., *The Third Basic Plan for Integrated Energy Supply* (Seoul, Ministry of Knowledge Economy, Republic of Korea, 2009). Available from www.kdhc.co.kr (accessed 3 March 2012).

Further reading

Cogeneration and District Energy (Paris, IEA and OECD, 2009). Available from www.iea.org/files/CHPbrochure09.pdf

Cogeneration and Renewable Energy (Paris, IEA and OECD, 2011).

Compact development

Key points

- ***The increasing density of urban area allows for more efficient use of resources, including land and energy.***

- ***It is important to develop adequate infrastructure within dense areas and supplement them with other development concepts in order to not hamper the liveability of people.***

Compact development explained

Compact development aims for a more efficient use of land through higher-density planning. In light of rapid urbanization, many emerging cities are turning to compact development as a means to more efficiently use scarce resources required for economic and social activities. Compact development is often supplemented with mixed-use development to incorporate a variety of functions (housing, offices, retail, etc.). Densely located, a good combination of built infrastructure can reduce the need for driving and promote walkability. Without strategic planning and coordination, the increased density of single-use development might cause problems and unpleasantness due to the lack of utility services.

How it works

The concept can be applied in new urban development as well as for retrofitting projects, such as:

- **Infill or brownfield development:** Dense, infill developments make use of vacant and underused properties in already developed areas. Redeveloping brownfield sites provides opportunities to reuse both the land and the existing infrastructure, including roads, underground utilities and street lighting.
- **Cluster development:** Setting standards for a minimum number of housing units per land parcel can limit the sprawl of smaller towns and villages. In neighbourhoods that are not densely developed, policies that promote accessory housing units will reduce the need for urban expansion.
- **Compact development along with mass transit:** Density growth can be promoted along mass transit corridors.

Strengths of compact development

- **Reduces sprawl:** By maximizing the land use in cities, for instance, via redevelopment of abandoned and vacant properties, green development on the urban periphery can be avoided.
- **Reduces dependency on private car use:** Compact development, along with public transit integration, will encourage people to be less reliant upon vehicles, thus reducing greenhouse gases, traffic congestion and dependence upon fossil fuels.
- **Creates walkable environments:** Brownfield sites, vacant lots and abandoned properties often create barriers between existing districts and neighbourhoods. This often inhibits walking, cycling and other more sustainable forms of transportation and promotes the use of the automobile. With careful compact development design, pedestrian-friendly districts can connect with each other.
- **Increases economic efficiency in delivering basic urban services:** Utilities service can be delivered cost-efficiently in more densely populated areas. Due to the economies of scale in supplying energy, water and treating waste, it is less costly to deliver urban utilities service in compact cities than in suburban areas.

Challenges to compact development

- Local codes and regulations can often make it difficult, particularly for higher-density infill.
- Existing comprehensive plans may promote competing priorities and codify single-use development.

Weaknesses

- Without a proper planning process and coordination, compactness can result in overdevelopment, air quality problems, noise pollution or unused and unprofitable developments.
- The increased cost of living in dense urban cores may contribute to gentrification, dispersion of low-income residents and the creation of impoverished areas with insufficient resources and infrastructure.

Implementing strategies

Develop master planning: Other development concepts, such as mixed use and transit-oriented development and the inclusion of affordable housing as well as parks and recreation areas, should be supplemented to serve various functions required for economic and social activities in cities.

Adopt and enforce ordinances that encourage cluster development, high-density population and mixed-use zoning: For instance, setting a maximum limit for the size of a building's footprint and decreasing lot sizes in single-unit housing districts will promote compact neighbourhood and vertical growth while preventing over-sized tower block development.

Build adequate infrastructure to complement density policies: The necessary infrastructure needs to be available to support compact development. This includes street and highway design, water and wastewater systems and altered utility installations.

Set urban growth boundaries as supplementary measures: Creating an urban-growth boundary that requires new development to be maintained within a specified municipal area will encourage the density within the designated areas.

Examples

Delhi, India: The city government set an urban-growth boundary along the Ridge, a dense forest near the capital, to prevent urban sprawl and promote compact development within the city.[1]

Bangkok, Thailand: In 2010, the deputy governor announced plans to redevelop a 740 square kilometre informal settlement within the city, including residential compact development incorporated with green space.[2]

Further reading

Compact Development: Changing the Rules to Make It Happen, ULI Community Catalyst Report Number 6 (Washington, D.C., ULI Urban Land Institute and National Multi Housing Council, 2006). Available from www.uli.org/~/media/Documents/ResearchAndPublications/Reports/Community%20Catalyst/Report%206%20Compact%20Development.ashx.

Compact Development for More Livable Communities (Sacramento, CA, Local Government Commission Center for Livable Communities, 2005). Available from www.lgc.org/freepub/docs/community_design/focus/compact_development.pdf

[1] Economist Intelligence Unit and Siemens AG, *Asian Green City Index: Assessing the Environmental Performance of Asia's Major Cities* (Munich, 2011).

[2] ibid.

FACT SHEET

Congestion and road-use charge

Key points

- ***Roads are not a free resource. Private cars generate congestion, air pollution, greenhouse gas emission, noise, vibration and other forms of environmental and social costs plus general wear and tear of roads.***

- ***Heavy traffic can be eased by charging private vehicles access to public roads. The charge should reflect the extra costs the road user causes.***

Congestion and road-use charge explained

Sometimes called a congestion charge (drivers are charged only in highly congested areas or times of the day), road-use charging is one way to confront road users with external costs, which otherwise would go unpaid. Road-use charging rationalizes road space so that it is used only by those who are prepared to pay for the costs they impose on the greater society.

How it works

Road-use charging can take several forms:[1]

- **Road tolls** – generally found on highways and bridges, where the fee is collected each time a motorist uses a stretch of road.
- **Cordon tolls** – drivers are required to pay for entering a particular area, usually the city centre.
- **Distance-based fees** – drivers are required to pay for each unit of distance travelled. This includes schemes currently being considered in Europe in which cars are tracked via satellite and charged according to their movement.

These three types can be applied in a way that the charge differs according to the level of congestion. Although real-time measurements of congestion could be reflected in the price, proxy indicators are used in practice, such as the time (hour) of day and the day of week.

Strengths of congestion road-use charges

- A road-use charge cuts down on traffic levels and thereby reducing the social and environmental costs.
- The flexibility means that a fee can reflect the “real” costs of certain users to society. Thus, a higher fee could be charged for heavy-goods vehicles (which impose a larger degree of wear and tear on the infrastructure), or cars entering the congestion charge zone at the most congested times of the day can be made to pay a higher fee.
- The generated revenue can be invested into public transport.

Challenges to imposing a road-use charge

- Lack of certainty over the impact on traffic, such as spillovers onto other roads.
- Opposition by the public, media, local businesses and politicians.
- Lack of the technology required to monitor and enforce the scheme.

[1] Todd Litman and Rowan Steele, *Land Use Impact on Transport: How Land Use Affects Transport* (Vancouver, Victoria Transport Policy Institute, 2011). Available from www.vtpi.org/landtravel.pdf (accessed 26 February 2012).

Implementing strategies

Bolster political leadership with supportive data: Public opposition can be mitigated through strong political leadership, supported by public communication of the long-term benefits of congestion or road-use charging, including the reduction of traffic and associated environmental and social impacts.

Back up credible projection and piloting: Extensive ex-ante modelling and piloting can help portray the consequences of the congestion or road-use charge on traffic patterns, including unexpected spillover effects (such as increase in traffic on certain roads that are not under the congestion charge).

Recycle revenue towards public transport: Financial revenue raised from the scheme can be redistributed to support public transport and other forms of sustainable transport. Public awareness is also an important factor; making the public aware that the revenues generated will be invested into public transport or highway maintenance may help gain their acceptance.

Incrementally increase the amount charged: Easing the public into the change and the new charges with gradually imposed increments can alleviate public resistance.

Provide alternative modes of transport: Public transport and non-motorized transport should be available to cater to the demand for mobility.

BOX 1: Tips for a road-use charging scheme

Charging system: The charges should take into account existing taxes and charges. Various methods can be implemented for pricing, such as a flat entry fee or variable charging system based on time, distance and place of driving. Introducing minimum and maximum limits for distance-based charges make them more acceptable.

How to zone the areas: The zones depend on local conditions, size of the city and the extent of roads subjected to congestion. The area should be zoned in a way that safeguards against anyone avoiding the charge when driving through.

Time frame: Peak time is the most congested. It is sensible to implement the congestion charge in peak hours. The London congestion charge operates from 7 a.m. to 6 p.m. Monday–Friday. There's no charge on weekends and public holidays. Some cities operate the charging scheme 24 hours a day, 7 days a week.

Types of vehicle to be subjected to the scheme: All vehicles should be subjected to the scheme to make considerable impact on the congestion. However, discounts and exemptions must be given to greener vehicles, emergency vehicles for accidents or breakdowns, residents' vehicles within the zones, high occupancy vehicles to encourage car sharing and high-occupancy disabled persons' vehicles.

Technologies used will decide the implementing costs: The congestion charge can be enforced in various ways: manually by tolls, electronically by using smart cards or automatically using automatic number plate recognition cameras. Manual operation is the most cost effective. Automatic and electronic systems are relatively expensive, but are more reliable than the manual systems. There should be a balance between reliability and operational costs.

Implementing costs and payback period: Implementing costs depend on the enforcement methods. The average payback period is 2.2 years, varying from 3.1 years for the London congestion charge to 1.8 years for Hong Kong, China, road pricing.[2]

[2] Jack Opiola, "London congestion charging" PowerPoint presentation at the International Transportation Finance Summit, Nice, France, 17–19 April, 2005. Available from www.ibtta.org/files/PDFs/Opiola_Jack.pdf (accessed 16 November 2011).

Examples

Singapore: An electronic road pricing scheme has been operational since 1975, mitigating the city from deadlock.

Stockholm, Sweden: Congestion charging was successfully invoked on a permanent basis in 2007 through careful public consultation and referendums.

London, United Kingdom: The revenues from the congestion charge are used to improve bus service quality and other aspects of the public transport network.

Further reading

Congestion Charging (London, Transport for London, 2007). Available from www.cclondon.com/whatis.shtml.

Success Stories within the Road Transport Sector on Reducing Greenhouse Gas Emission and Producing Ancillary Benefits (Copenhagen, European Environment Agency, 2008). Available from www.eea.europa.eu/publications/technical_report_2008_2.

"The CEDAR Project: Charging electronically by distance and road", by John Walker and others, Paper 3038 at ITS World Congress, Stockholm, 21-25 September 2009.

FACT SHEET

Corporate social responsibility and environmental reporting

Key points

- ***Reporting on environmental performance and abiding by the rules of corporate social responsibility raises public awareness and enables governments to monitor corporate environmental impacts.***
- ***Corporate social responsibility can give businesses a competitive edge and can help developing countries attract quality investors and improve the position of their products in the international market.***
- ***Instead of mandating corporate social responsibility or environmental reporting, it can be more feasible for governments to act as facilitator, partner or advocate.***

Corporate social responsibility and environmental reporting explained

In a broad sense, corporate responsibility can be defined as the overall contribution of businesses towards achieving sustainable development goals.[1] The World Business Council on Sustainable Development adds that corporate social responsibility (CSR) is "the continuing commitment by business to contribute to economic development while improving the quality of life of the workforce and their families as well as of the community and society at large".[2]

The European Commission characterizes CSR as a voluntary concept for enterprises willing to go beyond minimum legal requirements and obligations.[3] In general, a CSR policy works as a self-regulating scheme in corporate governance.

"Part of the bargain, the social contract which allows companies to be as large as they are, is that they become engaged in the challenges the world faces, rather than dismissing them as someone else's problem,"[4] explains John Manzoni, chief executive at BP p.l.c.

Environmental reporting

An important component of corporate responsibility is environmental reporting, which describes the systematic and complete disclosure to the general public of a company's, organization's or government's environmental performance,[5] encompassing its impacts on the environment and its actions to reduce adverse effects on ecosystems or restore environmental conditions.

[1] United Nations Department of Economic and Social Affairs, "CSR and Developing Countries: What Scope for Government Action?", *Sustainable Development Innovation Briefs*, Issue 1, February 2007. Available from www.un.org/esa/sustdev/publications/innovationbriefs/no1.pdf (accessed 26 January 2012).

[2] World Business Council for Sustainable Development, *Corporate Social Responsibility: Meeting Changing Expectations* (Geneva, 1998). Available from www.wbcsd.org/pages/edocument/edocumentdetails.aspx?id=82&nosearchcontextkey=true (accessed 26 January 2012).

[3] Commission of the European Communities, *Implementing the Partnership for Growth and Jobs: Making Europe a Pole of Excellence on Corporate Social Responsibility* (Brussels, 2006). Available from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2006:0136:FIN:en:PDF (accessed 26 January 2012).

[4] Paul Hohnen, *Corporate Social Responsibility: An Implementation Guide for Business* (Winnipeg, International Institute for Sustainable Development, 2007). Available from www.iisd.org/pdf/2007/csr_guide.pdf (accessed 26 February 2012).

[5] Japan, *Environmental Reporting Guidelines* (Tokyo, Ministry of the Environment, 2004). Available from www.env.go.jp/policy/j-hiroba/PRG/pdfs/e_guide.pdf (accessed 26 February 2012).

Asia is limping behind in corporate reporting

Representing a mere 3.5 per cent of the Dow Jones Sustainability World Index, Asian companies have been slow in the uptake of international standards, indices and other initiatives for environmental reporting. Merely 17 per cent of the 7,310 participants of the UN Global Compact, which issued a blueprint on corporate sustainability leadership, are Asian signatories.[6] In fact, businesses in the Asian region are constantly making the news for failing to meet the UN Global Compact's mandatory annual communications requirement.

How it works

Corporate social responsibility

Companies can apply CSR in a variety of ways: by following internationally approved guidelines and codes of conduct, by reporting on their economic, social or environmental impact, by making socially responsible investment or by undergoing certification by third parties.[7] They can also provide health and safety measures for their employees or conduct community projects for youth education.

Mandatory and voluntary environmental reporting

Businesses can report on their environmental impact in two contexts. For voluntary reporting, a business can disclose environmental information (such as greenhouse gas emissions, waste generation, energy consumption, use of transport for business travel) in the context of corporate social responsibility. For mandatory reporting, businesses in industrialized countries are required to report their greenhouse gas emissions; this is mainly to help the government understand the total industry situation and to use the information as the basis for policies related to controlling the emissions. Both types of reporting improve the transparency of corporate activities and their impact towards reducing environmental impacts.

General guidelines and frameworks for reporting

The Global Reporting Initiative (GRI) set up Sustainability Reporting Guidelines, which more than 1,500 organizations in 60 countries are using.[8] The International Organization for Standardization (ISO) is developing the ISO 26000 guidance on social responsibility. There are also a number of reporting frameworks prepared by associations in the private sector; the World Business Council for Sustainable Development and the World Resources Institute, for example, provide a reporting framework for member companies, called *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard*.[9] The International Federation of Accountants provides International Guidance on Environmental Management Accounting.[10]

The UN Global Compact issued a blueprint on corporate sustainability leadership. It specifies 50 criteria for leadership that all companies should work towards. In the blueprint, companies are required to establish transparency and disclose their activities, to share information relevant to sustainability with all interested parties and to respond appropriately to inquiries and concerns.[11]

[6] Lloyd's Register Quality Assurance, *CSR in Asia: The Real Picture* (Coventry, United Kingdom, 2010). Available from www.lrqa.vn/Images/LR-CSR_2010_tcm112-197937.pdf (accessed 22 February 2012).

[7] European Commission, *ABC of the Main Instruments of Corporate Social Responsibility* (Brussels, 2004). Available from www.bmask.gv.at/cms/site/attachments/4/3/5/CH0113/CMS1218196434160/csr_abc[1].pdf (accessed 05 March 2012).

[8] Eaton Corporation website "Global Reporting Initiative". Available from www.eaton.com/Eaton/Sustainability/AccountabilityTransparency/GRI/index.htm (accessed 22 February 2012).

[9] For more information, please see the Greenhouse Gas Protocol website "Standards". Available from www.ghgprotocol.org/standards (accessed 23 February 2012).

[10] International Federation of Accountants, *International Guidance Document: Environmental Management Accounting* (New York, 2005). Available from www.ifac.org/sites/default/files/publications/files/international-guidance-docu-2.pdf (accessed 23 February 2012).

[11] United Nations Global Compact, *Blueprint for Corporate Sustainability Leadership* (New York, 2010). Available from www.unglobalcompact.org/docs/news_events/8.1/Blueprint.pdf (accessed 26 January 2012).

Box 1: Greenhouse Gas Protocol: Corporate Accounting and Reporting Standard

The revised edition of The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard is the culmination of an extensive two-year multi-actor dialogue, designed to improve the rigor, quality and user-friendliness of the first edition. It provides standards and guidelines for companies and other types of organizations preparing a greenhouse gas emissions inventory. It is supplemented by a number of electronic calculation tools, freely available on the GHG Protocol website, that provide step-by-step guidance on calculating emissions from specific sources (such as stationary and mobile combustion and process emissions) and industry sectors (pulp and paper, aluminium, iron and steel and office-based organizations). It addresses the accounting and reporting of the six greenhouse gases covered by the United Nations Framework Convention on Climate Change.

Source: World Resources Institute website "The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (Revised Edition)". Available from www.wri.org/publication/greenhouse-gas-protocol-corporate-accounting-and-reporting-standard-revised-edition (accessed 25 February 2011).

Strengths of CSR and environmental reporting[12]

- **Environmental reporting can bring cost savings and enhance competitiveness:** Business can save costs by reducing and efficiently managing the resources they use. Typical areas in which cost savings are significant include the use of raw materials and supplies, reduction in waste, water, energy use, transport, travel and packaging. Environmental reporting can help to disclose areas of improvement in resource efficiency for businesses. It is a far-sighted business strategy increasingly needed in economies in which the reputation risk is becoming greater and sustainable development is gaining importance. In general, businesses practising CSR benefit from an enhanced reputation, more efficient operations, improved financial performance, increased sales and consumer loyalty and an increased ability to attract and retain quality employees.
- **Attracting quality investors and business partners:** By addressing environmental and societal concerns, businesses can appeal to a different set of environmentally conscious investors. Additionally, these investors may be willing to provide more resources and make longer commitments because the increased transparency brought about by CSR and environmental reporting also enhances their trust in the companies.
- **Creating new business opportunities:** Integrating CSR and environmental reporting into core business processes is a creative process because it has to be tailored for every company and is conducted in close relationship with an array of actors. In this process, new environment-friendly products and business models can arise that probably would not have surfaced in typical business schemes.
- **Proliferation for developing countries:** CSR and environmental reporting not only helps developing countries to achieve their low carbon green growth strategies but also improves their national competitiveness. By increasing the transparency and credibility of their industries, developing countries attain a better standing in the competition for foreign direct investments, improve the position of their exports in the global context and increase the poverty-focused delivery of public policy goals.[13]
- **Environment reporting data necessary to introduce a carbon tax or domestic carbon emissions trading scheme:** By mandating environmental reporting, governments can start collecting the data necessary for determining the applicable and appropriate rate of carbon tax or the manageable cap for greenhouse gas emissions from every business subject to the scheme.

[12] British Council, *Corporate Social Responsibility: CSR 2004*, Seminar Series (London, 2004). Available from www.britishcouncil.org/india-rights-csr-publication.pdf (accessed 26 February 2012).

[13] Djordjija Petkoski and Nigel Twose, ed., *Public Policy for Corporate Social Responsibility*, World Bank Series on Corporate Responsibility, Accountability and Sustainable Competitiveness (Washington, D.C., World Bank Institute, World Bank Group and International Finance Corporation, 2003). Available from http://info.worldbank.org/etools/docs/library/57434/publicpolicy_econference.pdf (accessed 26 February 2012).

Challenges for CSR and environmental reporting

- **Business's fear for red tape:** Governments planning to introduce a carbon tax or to start up a domestic carbon market mechanism (cap and trade) might encounter strong opposition from the industry sector, at least from businesses emitting large amounts of greenhouse gases. These companies often expect that the mandatory reporting scheme will lead to restrictions of further emissions, which in general is perceived as a burden by businesses that either will have to install new, low carbon facilities or buy certificates.
- **National conditions and company characteristics:** CSR is specific to the cultural and historic background of every country. It varies according to the nature of social dialogue, political traditions and the degree to which certain social and environmental issues are regulated by law.[14] There is no denying that it is useful to have a common understanding about the principles and importance of CSR.[15] Ultimately how ever, the practice of CSR requires locally specific and culturally sensitive solutions.[16] As a consequence, there is no one-size-fits-all approach to CSR and transferring best practice examples can be limited.[17]
- **High transaction costs:** In addition to the actual implementing costs, preparing, interpreting and customizing CSR and environmental reporting guidelines consumes quite a large amount of time and human and financial resources. This can prevent money-constrained small and medium-sized enterprises from facing up to their corporate responsibility.
- **Limited appeal of CSR and environment reporting:** For certain types of industries, such as petrochemicals, energy and construction or the financial sector, investing in production improvements that ensure the least harm to the environment is the best way to show they take responsibility for their actions by reducing the negative impact they inflict on society and the environment. Similarly, the service sector might need time to become motivated enough to start environmental reporting as part of its CSR considering that tangible and quantifiable actions, such as planting trees, are preferred to producing a theoretical report.

Implementing strategies

Ensuring effective governance and a business environment that encourages CSR: Because CSR strategies have to be customized to national characteristics rather than simply applying models that have proven to be successful elsewhere, public entities have to identify national CSR priorities, build their instruments upon existing initiatives and capacities and strategize implementation so as to involve all relevant actors. Their overarching goal should be to facilitate the integration of long-term thinking and sustainable solutions into core business strategies and thus improve environmental and social conditions.[18]

To reach this goal, governments can take on different roles and activities, such as regulating, facilitating, partnering or endorsing, and draw measures and strategies from a large pool of intervention tools (figure 1).

[14] Commission of the European Communities, *Opportunity and Responsibility: How to Help More Small Businesses to Integrate Social and Environmental Issues Into What They Do* (Brussels, 2007). Available from http://ec.europa.eu/enterprise/policies/sustainable-business/files/csr/documents/ree_report_en.pdf (accessed 23 February 2012).

[15] United Nations Industrial Development Organization, *Green Industry: Policies for Supporting Green Industries* (Vienna, 2011). Available from www.uncsd2012.org/rio20/content/documents/policies_green_industry.pdf (accessed 26 January 2012).

[16] Djordjija Petkoski and Nigel Twose, ed., *Public Policy for Corporate Social Responsibility*, World Bank Series on Corporate Responsibility, Accountability and Sustainable Competitiveness (Washington, D.C., World Bank Institute, World Bank Group and International Finance Corporation, 2003). Available from http://info.worldbank.org/etools/docs/library/57434/publicpolicy_econference.pdf (accessed 26 February 2012).

[17] United Nations Global Compact and Bertelsmann Stiftung, *The Role of Governments in Promoting Corporate Responsibility and Private Sector Engagement in Development* (New York, 2010). Available from www.unglobalcompact.org/docs/news_events/8.1/UNGC_Bertelsmannn.pdf (accessed 26 January 2012).

[18] ibid.

Figure 1: Categories of possible government interventions regarding CSR

Public Sector Roles			
Mandating	'Command and control' legislation	Regulators and inspectorates	Legal and fiscal penalties and rewards
Facilitating	'Enabling' legislation	Creating incentives	Capacity building
	Funding support	Raising awareness	Stimulating markets
Partnering	Combining resources	Stakeholder engagement	Dialogue
Endorsing	Political support		Publicity and praise

Source: Djordjija Petkoski and Nigel Twose, ed., *Public Policy for Corporate Social Responsibility*, World Bank Series on Corporate Responsibility, Accountability and Sustainable Competitiveness (Washington, D.C., World Bank Institute, World Bank Group and International Finance Corporation, 2003). Available from http://info.worldbank.org/etools/docs/library/57434/publicpolicy_econference.pdf (accessed 26 February 2012).

It is important for governments to assess exactly when an intervention is really needed and to what extent it should promote CSR. Issuing no measures or merely voluntary codes may be the best governance strategy when it comes to market-driven CSR issues, such as payment levels for directors. Wherever market drivers are weak though, governments should take a stronger stand, such as with regulatory reforms.[19] This has worked well for the adoption and mainstreaming of "quality management", which was also met with scepticism from the private sector at first and is now an essential part of running a prosperous business.

It is important for CSR policies to strengthen the role of:[20]

- **Education, information and experience sharing:** Competent and well trained personnel are needed to tailor CSR to national conditions and company characteristics. Governments can help by providing valuable national guidelines and training facilities.
- **Civil society:** By supporting partnerships between the private sector and civil society organizations (or NGOs), governments can ensure that companies receive feedback from the people they have an impact on and can be held accountable by them. The Green Choice Alliance, for example, is a programme in China that enables environmental groups to publish lists of companies that violate environmental regulations. Via the alliance, these groups also offer to conduct a third-party audit if a company chooses to clean up its act. There are more than 3,500 environmental organizations now in China.[21]
- **Governments and multilateral institutions:** Investing only in projects of companies that are practising CSR and limiting public procurement to those businesses should be a core criterion for public spending.
- **Businesses:** Support should be given to those businesses that exercise or plan to practise CSR or environmental reporting. Creating and publicizing guidelines or CSR implementing strategies is one way to do this (table 1). Governments can also put certification schemes in place or provide external verification for systems that quantify and publicize individual or corporate efforts to protect the environment, such as the Japanese Green Power Certification System.

[19] Djordjija Petkoski and Nigel Twose, ed., *Public Policy for Corporate Social Responsibility*, World Bank Series on Corporate Responsibility, Accountability and Sustainable Competitiveness (Washington, D.C., World Bank Institute, World Bank Group and International Finance Corporation, 2003). Available from http://info.worldbank.org/etools/docs/library/57434/publicpolicy_econference.pdf (accessed 26 February 2012).

[20] ibid.

[21] David Kirby, "Made in China: Our Toxic, Imported Air Pollution", *Discover Magazine*, April 2011. Available from http://discovermagazine.com/2011/apr/18-made-in-china-our-toxic-imported-air-pollution/article_view?b_start:int=4&-C= (accessed 5 March 2012).

Table 1: CSR implementing framework for businesses

Conceptual phase (When?)	Task delineation (What?)
Plan	Conduct a CSR assessment
	Develop a CSR strategy
Do	Develop CSR commitments
	Implement CSR commitments
Check	Assure and report on progress
Improve	Evaluate and improve
Cross-check: one cycle completed	Return to plan and start the next cycle

Source: Paul Hohnen, *Corporate Social Responsibility: An Implementation Guide for Business* (Winnipeg, International Institute for Sustainable Development, 2007). Available from www.iisd.org/pdf/2007/csr_guide.pdf (accessed 26 February 2012).

Countries that legislate corporate social responsibility: There is an increasing number of government actions in Asia to guide or legislate CSR activities, as noted in box 2.

Box 2: Countries with CSR legislation

Japan: The Japanese Government has established itself as an advocate for corporate social responsibility through its environment-related and climate change-specific legislation. With the Environment Reporting Guidelines[22] and the Law Concerning Promotion of Environmental Consideration in Business Activities (2004),[23] the Government began requiring environmental reporting far earlier than other governments in the region.

China: The Chinese Government promotes CSR locally by influencing the behaviour of its state-owned enterprises. In 2006, the Government issued Guidelines for Publishing Corporate Responsibility in China. CSR is promoted as a means to improve the brand, reputation and competitiveness of Chinese companies. The Government encourages companies to publish reports.[24]

Countries with mandates on environmental reporting: There are several countries in which the private sector is required to report greenhouse gas emissions and energy consumption to the government.

Box 3: Countries with mandates on reporting

Australia:[25] The National Greenhouse and Energy Reporting Act became effective in financial year 2008/2009 and requires corporations to report information on their greenhouse gas emissions, energy production and energy consumption to the Greenhouse and Energy Data Officer.

India:[26] The Perform, Achieve and Trade scheme under the National Mission for Enhanced Energy Efficiency became effective in 2011. It established consumption targets for energy-intensive industries as well as the cap-and-trade structure.

[22] Japan, Law Concerning the Promotion of Business Activities with Environmental Consideration by Specified Corporations, etc., by Facilitating Access to Environmental Information, and Other Measures (Provisional Translation), Law No. 77 of 2004. Available from www.env.go.jp/en/laws/policy/business.pdf (accessed 29 January 2012).

[23] Japan, *Environmental Reporting Guidelines* (Tokyo, Ministry of Environment, 2004). Available from www.env.go.jp/policy/j-hiroba/PRG/pdfs/e_guide.pdf (accessed 29 January 2012).

[24] Lloyd's Register Quality Assurance, *CSR in Asia: The Real Picture* (Coventry, United Kingdom, 2010). Available from www.lrqa.vn/Images/LR-CSR_2010_tcm112-197937.pdf (accessed 22 February 2012).

[25] Commonwealth of Australia, National Greenhouse and Energy Reporting Act 2007, Act. No. 175 of 2007. Available from www.comlaw.gov.au/Details/C2009C00122 (accessed 26 February 2012).

[26] Republic of India, *National Mission on Enhanced Energy Efficiency* (New Delhi, 2009). Available from www.india.gov.in/allimpfrms/alldocs/15659.pdf (accessed 22 February 2012).

Japan:[27] Based on the Act on Promotion of Global Warming Countermeasures and the Law Promoting the Rational Use of Energy, more than 15,000 private entities are mandated to report on their energy consumption and greenhouse gas emissions, based on the Greenhouse Gas Accounting and Reporting System introduced in 2006. This is mandatory for enterprises emitting more than 3,000 tonnes of CO2 equivalents or consuming more than 1,500 crude oil equivalents per year.

United Kingdom:[28] The Carbon Reduction Commitment Energy Efficiency Scheme became effective in 2010. All organizations and companies that had an electricity demand greater than 6,000 MWh in the year 2008 are forced to participate in the mandatory scheme, which applies to about 5,000 entities at the moment.

Country experience: Carbon Disclosure Project in the Republic of Korea

The UK NGO Carbon Disclosure Project initiated a mechanism to make the carbon emitted by private sector companies “visible”. Many governments have used this mechanism as a benchmark. The Korean Committee on the Carbon Disclosure Project provides incentives for Korean companies to adhere to the programme¸ such as awards for good practice.

How it works

The Carbon Disclosure Project gathers information on behalf of 551 institutional investor signatories by sending out a questionnaire annually, asking about corporate emissions-reduction targets and energy use, information on the risks and opportunities companies face from climate change and the status of management discussions and analyses of strategies to address climate change, including emissions trading. Because the process of collecting information relies on the questionnaire response made by each company, the Carbon Disclosure Project also asks if the company conducts an external verification for its stated emissions quantities. Based on this information, the Carbon Disclosure Project announces each company’s carbon disclosure score[29] and performance score[30] in its annual report. Korean companies showed the highest response rate among the Asian countries to the Carbon Disclosure Project questionnaires, increasing their participation by 18 per cent, from 2008 to 2009, although the number of companies requested to answer doubled in that period (figure 2).

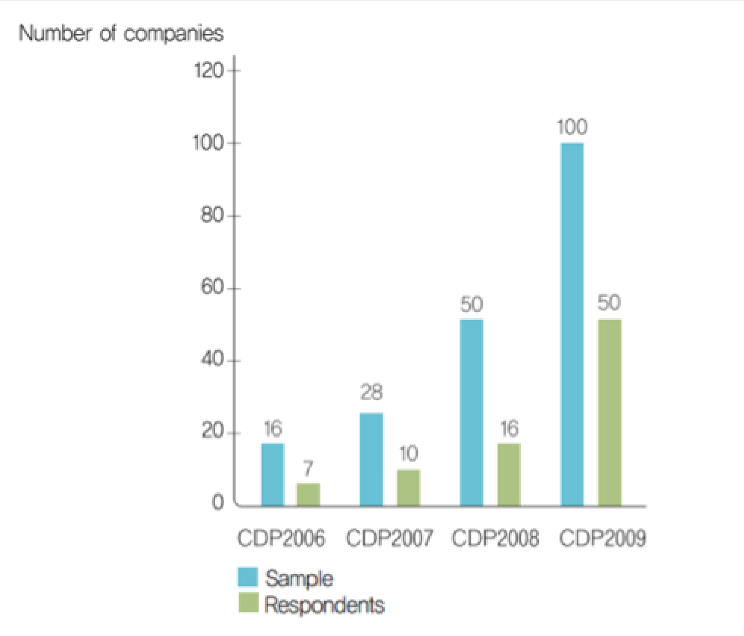
[27] Institute for Industrial Productivity website “JP-8: Mandatory GHG Emissions Reporting”. Available from http://iepd.iipnetwork.org/policy/mandatory-ghg-emissions-reporting (accessed 26 February 2012).

[28] United Kingdom Carbon Reduction Commitment website “CRC: Carbon Reduction Commitment”. Available from www.ukcrc.co.uk (accessed 22 February 2012).

[29] The Carbon Disclosure Scores assess companies on the quality and completeness of their disclosures and considers factors such as: 1) clear consideration of business-specific risks and potential opportunities related to climate change, 2) good internal data management practices for understanding GHG emissions, including energy use. See, PriceWaterhouseCoopers LLP, *Carbon Disclosure Project 2010: Global 500 Report* (London, Carbon Disclosure Project, 2010). Available from www.cdproject.net/CDPResults/CDP-2010-G500.pdf (accessed 26 February 2012).

[30] This is evaluated based on four categories: 1) strategy, 2) Governance, 3) Stakeholder communication, 4) Achievements. See, PriceWaterhouseCoopers LLP, *Carbon Disclosure Project 2010: Global 500 Report* (London, Carbon Disclosure Project, 2010). Available from www.cdproject.net/CDPResults/CDP-2010-G500.pdf (accessed 26 February 2012).

Figure 2: History of Korean sample response to Carbon Disclosure Project questionnaire



Source: Eco-Frontier, *Carbon Disclosure Project 2009: Korea 100 Report* (Seoul, Carbon Disclosure Project, 2009). Available from www.cdproject.net/CDPResults/CDP2009%20Korea100_final.pdf (accessed 26 February 2012).

Participation incentives

The participating companies are willing to provide climate change-related information to existing and potential investors to increase their transparency. The process helps them better prepare for the risks associated with climate change and to possibly expand their business opportunities. Additionally, institutional investors, including banks, pension funds, asset managers and insurance companies, are exerting pressure on companies to participate in the project because they want to include climate change-related information in their investment decision-making.

According to the 2009 responses, 67 per cent of the Korean companies had started to recognize climate change not only as a risk but also as an opportunity.[31]

Scope

The Carbon Disclosure Project releases public procurement reports to enable the national and local governments to determine the impact of climate change in their supply chains. This is done to help companies encourage their suppliers to measure and disclose climate change-related information. The Carbon Disclosure Project city reports provide standardized reporting of emissions data, analyses of climate risks and opportunities and adaptation plans.

How does it contribute to the reduction of emissions?

The Carbon Disclosure Project works as a facilitator between companies, investors, suppliers and governments to endorse, collect and distribute climate change-related information. The collective pressure exerted by investors on companies and by companies and governments on suppliers has the capacity to influence the emissions disclosure situation in the private sector in order to shift towards green production practices.

Source: PriceWaterhouseCoopers LLP, *CDP Global 500 Report 2011: Accelerating Low Carbon Growth* (London, Carbon Disclosure Project, 2011). Available from www.pwc.com/fi_FI/fi/ajankohtaista/tiedostot/CDP_2011_Global_500_Report.pdf (accessed 26 February 2012); Eco-Frontier, Carbon Disclosure Project 2009: Korea 100 Report (Seoul, Carbon Disclosure Project, 2009). Available from www.cdproject.net/CDPResults/CDP2009%20Korea100_final.pdf (accessed 26 February 2012).

[31] Eco-Frontier, *Carbon Disclosure Project 2009: Korea 100 Report* (Seoul, Carbon Disclosure Project, 2009). Available from www.cdproject.net/CDPResults/CDP2009%20Korea100_final.pdf (accessed 26 February 2012).

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FACT SHEET

Decentralized energy system

Key points

- ***Decentralized energy systems can be used as a supplementary measure to the existing centralized energy system.***

- ***Decentralized energy systems provide promising opportunities for deploying renewable energy sources locally available as well as for expanding access to clean energy services to remote communities.***

Decentralized energy system explained

A decentralized energy system is characterized by locating of energy production facilities closer to the site of energy consumption. A decentralized energy system allows for more optimal use of renewable energy as well as combined heat and power, reduces fossil fuel use and increases eco-efficiency.

A decentralized energy system is a relatively new approach in the power industry in most countries. Traditionally, the power industry has focused on developing large, central power stations and transmitting generation loads across long transmission and distribution lines to consumers in the region. Decentralized energy systems seek to put power sources closer to the end user. End users are spread across a region, so sourcing energy generation in a similar decentralized manner can reduce the transmission and distribution inefficiencies and related economic and environmental costs.

How it works

Infrastructure components

A decentralized system relies on distributed generation, energy storage and demand response:

Distributed generation: The core component of a decentralized energy system is distributed generation, also known as embedded generation, on-site generation, dispersed generation and decentralized generation. Both heat and electricity can be generated in a decentralized manner. But heat cannot be transported over long distances; thus it has been traditionally generated onsite. Shifting to decentralized power generation allows for coordinating between heat and power generation in combined heat and power plants. Doing that increases the system's efficiency with electricity and heat production because heat is a by-product of many electricity-generating techniques.

Energy storage: An important limitation in the distribution of electricity has been that electrical energy cannot be stored and must be generated as needed. Adding more generation sources in a decentralized system can lead to new difficulties in controlling supply to best match demand. However, such storage techniques as batteries, compressed air and pumped hydro storage can help keep the grid stable by storing energy when supply exceeds demand and feeding it back into the grid during peak hours. Storage is particularly helpful for intermittent renewable energy plants, which often produce at their highest capacities during non-peak hours. As with generation, storage can and should also be decentralized to maximize its efficiency; it can be off-grid or grid-connected.

Demand response: Demand-response technologies provide another tool to manage grid stability when decentralized generation is grid-connected. Conventionally, grid management has focused on supply management. But new technologies, including smart grid and smart metering, allow for real-time monitoring and communication between producers and consumers of electricity to optimize grid usage. In fact, with distributed generation and storage, many consumers of electricity will also at times be producers of energy. Implementing smart grid technologies to facilitate grid management is necessary to building a truly decentralized energy system.

Infrastructure design

Distributed generation facilities may be connected to the grid or simply serve a particular site without feeding potential excess generation into the grid.

Grid connected: Distributed electricity generation can be connected to a central grid, such as in commercial or industrial plants that have their own power production facilities but can sell excess power to the grid or to a mini-grid to serve regions located far from the central grid. As countries further develop their central grid system, mini-grids can be upgraded to form a distribution network that is connected to a larger transmission network. Linking distributed generation resources through a grid system increases their reliability, particularly when using intermittent renewable resources. Additionally, heat generated from CHP can be connected to distribution pipelines to serve a district.

Off-grid: Electricity demand management and energy storage, although at a smaller scale, are still important components of an off-grid decentralized energy system. Even a solar home system for a single housing unit operates most efficiently with battery storage and if the users manage their own loads to best match supply fluctuations.

Heat generated from CHP can also serve a single site, requiring fewer infrastructures to transmit heat to neighbouring buildings.

Opportunities in Asia and the Pacific

Rural electrification: Because grid integration of distributed generation and storage requires major technical upgrades, countries in the region can focus on distributed generation for rural electrification – either through off-grid or mini-grid systems.

Increases in the share of renewable energy: A decentralized energy system is designed to accommodate many energy sources, including the renewable sources with intermittent production, such as wind and solar. Distributed generation, demand management and storage can all facilitate increased inflows of renewable generation.

Strengths in using a decentralized system

Environmental

- The use of CHP, made possible through the decentralizing of electricity production, also increases the overall heat and power system's efficiency and thereby reduces harmful greenhouse gas emissions.

Economic

- Distributed generation sources often have lower capital costs per project, compared to large central power plants.
- In some circumstances, off-grid distributed generation can reduce the need for expensive transmission and distribution network expansion.
- Lower losses through the lengthy transmission of electricity increases eco-efficiency. Reducing losses in transmission and distribution and the incremental addition to capacity through distributed generation can help defer investment in large central power plants.
- Decentralized siting of energy generation facilities requires decentralized businesses to construct, operate and maintain the facilities, creating opportunities for local business and job creation.

Technical

- Distributed generation projects provide planning flexibility due to their small size and short construction lead times, compared to larger central power plants.
- A decentralized energy system may be a boon to energy efficiency measures. Increased information about energy flows from smart meters can make consumers more conscious of their use. Through on-site energy production, consumers of energy become producers and have a greater economic stake in efficient production and consumption.

Social

- A decentralized system, particularly through the use of isolated, off-grid units and mini-grids, are suitable in rural areas where the population density is low. Often much more economically feasible than central grid build-outs, decentralized approaches can achieve rural electrification faster.

Challenges to using a decentralized energy system

Institutional

- State-controlled electricity markets hamper the development of a decentralized energy system because distributed generation encourages myriad actors to become power producers.
- Interconnection presents not only an economic difficulties but also legal and administrative hurdles for project developers.
- Ownership schemes and pricing systems must be developed for off-grid and mini-grid services. Pricing must not only take into account the cost of producing electricity from the unit or system but also the ability and willingness of users to pay.

Technical

- If not properly planned, large-scale deployment in distributed generation may result in the instability of the voltage profile.
- Emerging technologies, such as smart grid, renewable energy and energy storage, will require the operation criteria of the whole power system to be redesigned and modified.
- Demand response technology requires constant, reliable Internet connections, making it an unsuitable option for much of Asia and the Pacific currently.

Financial

- Distributed generation sources often have higher capital cost per kW, compared to large central plants and particularly due to the interconnection transaction costs.
- The high capital costs and long life cycle of existing transmission and distribution infrastructure make it difficult to upgrade to more efficient infrastructure.
- Due to system stability issues, integration with transmission and distribution systems are considered when adding grid-connected distributed generation sources. This integration can be costly for distributed generation and grid operators.

Implementing strategies

Transform the market: Increasing the number of sites of electricity generation requires a degree of energy market diversification. In countries with fully or heavily state-controlled energy markets, institutions and policies must be overhauled to support the participation of local governments, community cooperatives and private businesses in electricity production and distribution.

Provide incentives: Promote distributed generation by establishing differentiated feed-in tariffs for grid-connected renewable energy sources to ensure that utilities will accept excess power from distributed generators and make it available to the local network.

Set standards: Standardize interconnection requirements to reduce technical and legal difficulties associated with feeding electricity to the grid. This will make entering the energy market more enticing to private entities and cooperatives.

Build up capacities and skills: Focus on capacity building to create a skilled labour force to service and operate decentralized generation, storage and distribution systems.

BOX 1: Off-grid renewable distributed generation solutions

There are a number of off-grid solutions based on renewable energy for providing electricity and heat. Such off-grid solutions are often applied in remote areas with low load needs. For instance, populations in small rural villages are often too small or too dispersed for electrification by mini-grid. In those circumstances, stand-alone solar home systems can provide electricity for lighting, television, radio and mobile phone charging. For instance, whether for agricultural drying, water heating or cooking, small solar concentrators can harness the sun's heat and serve a number of household and agricultural or industrial needs without conversion to electricity. Direct applications of geothermal heat resources, primarily for bathing, show another promising example. A small wind turbine can provide power for such services to an individual home at approximately the same cost (US$550 capital investment for 20 years of operation).[1] Off-grid renewable energy systems have a high level of flexibility and can be tailored to a site's resources and needs, as illustrated by myriad examples, including:

- **PV-diesel hybrid systems:** Many schools in Malaysian Borneo are not grid-connected. They either were not electrified or relied on diesel gensets for electric power. However, fuel and fuel delivery costs were high. The Malaysian Ministry of Education funded the capital costs of providing PV panels for PV-diesel hybrid systems to 63 schools on the island. With more reliable electricity access, the schools can provide l ighting, computer use and Internet access.[2]

- **Urban installations:** Functional off-grid installations are not limited to rural regions. Solar lanterns and more versatile solar home systems can provide lighting to urban poor households that are affected by electricity shortages due to mismanagement or pilferage. SELCO (Solar Electric Light Company) partnered with SEWA Bank (Self-Employed Women's Association) to provide affordable solar and biogas-based lighting and cooking devices to home-based workers, such as vegetable vendors in urban areas across Gujarat, India.[3]

- **Water pumping:** The Punjab area of north-western India is dry and arid but has abundant solar insolation. Around 1,400 solar-powered water pumps have been installed in the region, each capable of pumping enough water to irrigate 1.5–2.3 ha of land. Pumps are offered under a lease-finance scheme with soft loans from the Indian Renewable Energy Development Agency. By avoiding diesel fuel costs, farmers save an estimated US$800–$1,000 per year.[4]

[1] Global Environment Facility and United Nation Development Progamme, *Household-size Wind Turbines, Sri Lanka*, Paper for Small Grants Programme (New York, 2003). Available from http://sgp.undp.org/download/SGP_SriLanka1.pdf (accessed 10 February 2012).

[2] Alliance for Rural Electrification, *Best Practices of the Alliance for Rural Electrification: What Renewable Energy Can Achieve in Developing Countries* (Brussels, 2009). Available from http://www.ruralelec.org/fileadmin/DATA/Documents/06_Publications/Position_papers/ARE_Publication_-_Case_studies_for_renewable energy_in_Developing_countries.pdf (accessed 10 February 2012).

[3] Intellectual Capital Advisory Services Pvt. Ltd. and the Rockefeller Foundation, *Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building* (Bangkok and Mumbai, 2010). Available from www.rockefellerfoundation.org/uploads/files/2ad3aea5-525b-4a9b-991c-a024a59a3762-private.pdf (accessed 29 November 2011).

[4] Global Network on Energy for Sustainable Development, *Poverty Reduction: Can Renewable Energy Make a Real Contribution?* (Roskilde, Denmark, 2006). Available from www.gnesd.org/downloadables/povertyreductionspm.pdf (accessed 4 November 2011).

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Low Carbon Green Growth Roadmap for Asia and the Pacific

FACT SHEET

Decentralized wastewater management

Key points

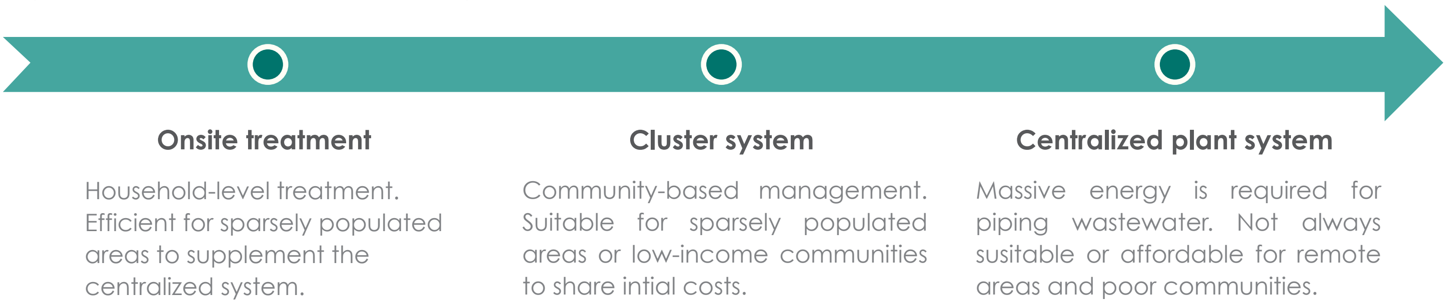
- ***A conventional centralized wastewater management system is critical at regional levels. But the centralized system is generally supply-led and requires massive energy consumption and a high level of technological knowledge.***

- ***A centralized system often does not fit into local wastewater treatment needs. A decentralized system is a supplementary option for making wastewater management more available while reducing costs and resource use.***

Decentralized wastewater management explained

Decentralized wastewater management refers to wastewater collection, treatment and disposition (discharge, reuse and dispersal) by appropriately scaled systems at local levels. As the following diagram illustrates, it can vary from onsite to a cluster to a centralized system. An appropriately localized system can save costs, water and materials.

Figure 1: Various wastewater management systems



Source: Victor A. D'Amato, PE and J. Trevor Clements, *The Role of Distributed Infrastructure Approaches in Sustainable Water Resource Management* (Research Triangle Park, North Carolina, Tetra Tech, Inc., 2009). Available from www.ncsafewater.org/Pics/Training/AnnualConference/AC09TechnicalPapers/AC09_SpecialTopics/ST_T.PM.5.00_DAmato.pdf (accessed 22 February 2012).

How it works

A decentralized wastewater management system has three primary objectives: 1) improve public health, 2) conserve energy and water and 3) protect the environment.

Community and household wastewater management is critical to reduce waterborne diseases, such as diarrhoea, and improve public hygiene. At the same time, decentralized wastewater management contributes to avoiding water losses and saves energy consumption. In particular, the decentralized system requires less energy than a centralized system, which uses extensive energy for piping. Also, in a decentralized system, the treated water goes to nearby leach fields and possibly back into the stream or is reused within houses and communities, following somewhat the natural water cycle and thus washing in environmental benefits.

The basic concept of a decentralized system is that smaller, more tailored systems can better operate more closely with users' wastewater treatment needs at a local level. Large, centralized plant systems are still important. But the addition of decentralized services close to demand reduces costs and the technological requirements. The greater sensitivity to the local context also allows systems to take advantage of low-cost and site-specific opportunities – systems are matched to specific needs.

Strengths with decentralized wastewater management

- **Economic:** A decentralized wastewater system is generally more cost-efficient for sparsely populated or impoverished communities because it does not require massive water piping and high technology. Residents and developers can assess their needs and conditions and thus avoid unnecessary costs, such as effluent piping costs.
- **Health:** Appropriate wastewater management is necessary to reduce waterborne diseases. Such diseases, particularly diarrhoea, which causes 2 million deaths a year among children younger than 5 years,[1] are preventable with a wastewater treatment system. Unlike the centralized system, which requires high investment and technology, the decentralized model more affordably reaches poor communities.
- **Environmental:** The decentralized system treats and discharges wastewater close to the source, thus maintaining a balanced natural hydrological cycle. This circulation is beneficial for conserving ecosystem productivity. It also saves energy consumption because the centralized system needs to pipe huge amounts of water to distant treatment plants, while the decentralized system relies only on small pipes that use less energy.

Challenges to implementing decentralized wastewater management

- **Lack of local capacity:** A community's lack of technical and management capacity is a major issue. Often, uncertainty to new technology stimulates unwillingness to adapt to the system.
- **Lack of institutional arrangement:** Fragmentation and overlapping of systems are critical barriers. Lack of coordination among government and local officials typically causes such problems. This can stem from the poor integration of the wastewater treatment system and the water supply system. An unfavourable regulatory climate does not help either; because wastewater management is closely related to public health, the regulatory framework is particularly significant.
- **Limited financing:** Financial constraints are major hurdles to expanding coverage, especially when it affects the rewards and incentives for engineers and users. Although public institutions provide the wastewater treatment services, local public authorities may not have the financial capacity to install the decentralized system.

Implementing strategies

Focus on local capacity development: Because the system is decentralized, communities are more integral to the management, and their capacity to install and maintain the system is paramount. Capacity development includes technical training, workshops and educational campaigns. It is also imperative that communities choose technically, economically and socially appropriate technologies that respond to their needs. Simple and affordable technology is favourable for the sustainable use of the system. For example, the green school project in the Republic of Korea underscores the importance of ensuring social acceptance for an onsite water recycling system by offering environmental education to students through the installation of an eco-friendly water system in schools.[2]

[1] United Nations Children's Fund website "Diarrhoea: Acute Diarrhoea Still a Major Cause of Child Death" (6 May 2008). Available from www.unicef.org/health/index_43834.html (accessed 2 February 2012).

[2] Soon-Myung Hong, "Integrated rainwater & wastewater recycling system: Green school projects", a paper presented at the Third Regional Workshop on Development of Eco Efficient Water Infrastructure for Green Growth in Asia, Bangkok, 23-25 November 2010. Available from www.unescap.org/esd/Energy-Security-and-Water-Resources/water/projects/eewi/workshop/3rd/documents/Presentation/Session%202-part2/Green%20School%20-%20EREDE.pdf(accessed 2 February 2012).

Secure the institutional arrangements: Although the system is decentralized, public authorities remain responsible for the comprehensive management. This includes a favourable institutional arrangement to regulate and monitor local activities. Setting appropriate criteria and monitoring schemes are critical for protecting the quality of treated water. Because wastewater management critically matters to public health, the regulatory framework has to achieve greater uniformity. In the institutional arrangement, it is beneficial to integrate the wastewater management into other water sector planning, especially water supply and resource management. The minimizing of wastewater is an effective first step for wastewater management.

Seek innovative financial mechanisms: Innovative financial strategies create financially enabling conditions, such as a multi-sourced financing scheme or public-private partnerships. Because wastewater management involves a variety of actors, including the business sector, multiple funding from several agencies is possible, and cooperation between the public sector and private sector is beneficial.

A decentralized system does not replace the centralized wastewater treatment. Its application is based on the condition-specific consideration in terms of system appropriateness and sustainability.

Examples

In the town of Hill End in New South Wales, Australia, significant amounts of effluent were piped about 3 kilometres over a mountain to the distant evaporation ponds. The surcharged wastewater then flowed into the surrounding areas from the evaporation ponds during rainstorms and consequently contaminated the groundwater. To prevent the wastewater from discharging into the environment and to minimize the export of wastewater from the town, the Hill End city authority installed a local wastewater treatment system and a water reuse scheme at low cost.[3]

Further reading

Alternative Waysof Providing Water: Emerging Options and Their Policy Implications, by X. Leflaive (Paris, Organisation for Economic Co-operation and Development, 2007). Available fromwww.oecd.org/dataoecd/53/38/42349741.pdf

Decentralized Wastewater Treatment Systems: A Program Strategy (Washington D.C., United States Environmental Protection Agency, 2005). Available from http://cfpub.epa.gov/owm/septic/septic.cfm?page_id=263&sort=name&view=doctype_results&document_type_id=2.

Guidelines on Municipal Wastewater Management (Hague, United Nations Environment Programme, World Health Organization and United Nations-Habitat, 2004). Available from http://esa.un.org/iys/docs/san_lib_docs/guidelines_on_municipal_wastewater_english.pdf

The Role of Distributed Infrastructure Approaches in Sustainable Water Resource Management, by Victor A. D'Amato, PE and J. Trevor Clements (Research Triangle Park, North Carolina, Tetra Tech, Inc., 2009). Available fromwww.ncsafewater.org/Pics/Training/AnnualConference/AC09TechnicalPapers/AC09_SpecialTopics/ST_T.PM.5.00_DAmato.pdf

[3] United Nations Economic and Social Commission for Asia and the Pacific, *Genetic Guidelines to an Eco-efficient Approach to Water Infrastructure Development* (Bangkok, UNESCAP and KOICA, 2011).

Double dividend and revenue neutrality

Key point

- ***Double dividend and revenue neutrality principles enhance effectiveness, public acceptance and feasibility of environmental tax and fiscal reform measures.***

Double dividend and revenue neutrality explained

The double dividend hypothesis states that a revenue neutral restructuring of the tax system, whereby green taxes are increased in proportion to a decrease in traditional taxes (income tax), could not only improve environmental quality (the first dividend) but also reduce the distortion of the tax system and the cost of labour, subsequently generating higher levels of employment (second dividend).

Revenue neutrality is a fiscal policy tool that can be used to overcome political resistance to an increase in environmental taxes by seeking to have the same proportional reduction in income tax, pension contributions or possibly even value-added taxes (VAT), while striving to maintain a net-zero increase in the overall taxation of the economy.

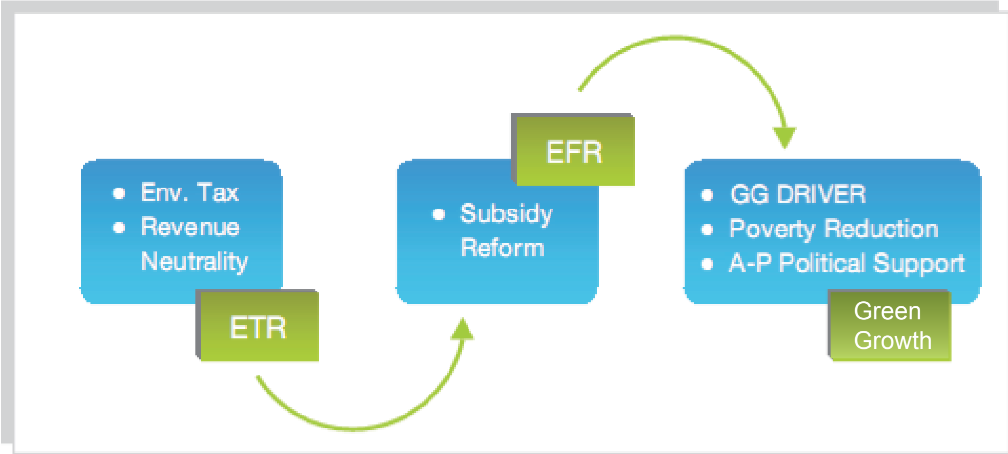
How they work

The combined application of carefully planned and designed environmental tax reform (ETR) and environmental fiscal reform (EFR) measures create opportunities and mechanisms for recycling newly generated revenue from environmental taxes to new economic activities, which are beneficial both to the environmental/ecological quality (waste management, pollution and traffic control, resource efficiency) and to the social quality (job creation, growth of economic sectors, income generation).

This approach is often combined with revenue neutrality, ensuring that while transferring the burden of taxes away from "goods" (labour and savings) and more towards the "bads" (waste and pollution) through environmental taxes, a net-zero increase in the level of taxation on the economy is achieved.

Newly generated revenue from reductions in perverse subsidies for environmentally harmful activities and revenue from environmental taxes can be recycled in a number of ways. One option is to use it to offset traditional taxes that distort economic efficiency, such as personal income tax, corporate income tax and social security or health care contributions. Such action could further the political acceptance of environmental taxes, improve the competitiveness of firms by reducing their tax burden and, as the double dividend hypothesis proposes: i) improve ecological quality; ii) while yielding higher economic growth and employment. The elimination of perverse subsidies can have a major positive influence on revenue accumulation, resulting in a net increase in unallocated budget.

Figure 1: The double dividend through environmental tax and fiscal reforms



The prospects for winning the double dividend varies from country to country and depends on the structure of relative preferences (the demand elasticity for 'dirty' goods and resources) and infrastructure available, the levels of investment in environmental research and development and the low use of distorting non-environmental taxes.

It is also important to carefully design a supporting policy system, including regulations and investment environment, that will create incentives for a change of consumers towards environment-friendly consumption and to provide alternatives to more resource-inefficient lifestyles. For example, a fuel tax targeting less use of individual vehicles will have little positive impact if mass transit infrastructure is not improved and provided as an alternative. Part of the success of Singapore's congestion charges was the investment in the very efficient public transportation infrastructure – and it was highly supported by the public.

Strengths of double dividend and revenue neutrality

- **Carbon emissions reductions:** In seven European countries that have implemented ETR (Denmark, Finland, Germany, Netherlands, Norway, Sweden and the United Kingdom), energy and carbon taxes are estimated to have brought 2–7 per cent reductions in carbon emissions from the business-as-usual scenarios without such taxes in place.[1]

  Similarly in Asia, results of recent research show that many countries have shifted from subsidizing fossil fuel taxes, which increased the budgetary liquidity of their governments and contributed to reducing CO_2 emissions per unit of GDP, as illustrated in figure 3. There is a strong correlation between the decrease in subsidies and the introduction of fuel taxes and a positive trend in reducing CO_2 emissions in the selected countries studied.

- **Improved energy-efficiency:** Rising prices of energy and resources businesses to look closely at their activities. The frequent result is that businesses discover opportunities that were hidden to them that improve energy efficiency at a low or negative cost, thereby improving economic efficiency as well as ecological efficiency.[2] The increased prices also create impetus for technology innovation as businesses

[1] Green Fiscal Commission, *The Case for Green Fiscal Reform: Final Report of the UK Green Fiscal Commission* (London, 2010) p.21

[2] Green Fiscal Commission, *Competitiveness and Environmental Tax Reform* (London, 2010), p.3. A slightly different perspective includes the argument of the Porter hypothesis that increased carbon/energy taxation would force firms to innovate both in their processes and products, thereby improving competitiveness and gaining market shares (M. Porter and C. Van Der Linde, "Toward a new conception of the environment-competitiveness relationship", *Journal of Economic Perspectives* (1995), vol. 9, No. 4; Ian Christie, Heather Rolfe and Robin Legard, *Cleaner Production in Industry: Integrating Business Goals and Environmental Management* (London, Policy Studies Institute, 1995); Ben Kriechel and Thomas Ziesemer, "The environmental porter hypothesis: theory, evidence, and a model of timing of adoption", *Economics of Innovation and New Technology* (2009), vol. 18, No. 3. pp. 267-294; Paul Ekins and Stefan Speck, eds., *Environmental Tax Reform (ETR)*: A Policy for Green Growth (Oxford, Oxford University Press, 2011)). Empirically, there are mixed results in European countries and the evidence in developing countries is very limited.

attempt to discover ways to achieve their efficiency goals at less cost.[3] Improvements in energy efficiency can, in turn, reduce energy costs, increase a business's resilience to energy price volatility and increase productivity. Empirical evidence from 15 European countries over the period of 1995–2002 show reduced energy intensity of economic activity with the energy or carbon taxes.[4]

Higher income growth and employment (economic dividend)

In conjunction with the first dividend, EFR and ETR can generate a second dividend of economic growth, particularly in the long term. This economic growth can come in the form of higher long-term GDP growth, increased employment and a green industry.

- **Higher GDP growth:** Econometric models by the United Nations Environment Programme show that in the context of rising resource and fuel prices and accelerating natural resources depletion over time, investing 2 per cent of global GDP in natural capital and efficiency improvements can generate higher economic growth compared with a business-as-usual scenario and lower environmental pressure by as early as 2017.[5]

Figure 3: Projected trends in annual GDP growth rates

Source: United Nations Environment Programme, *Green Economy Report* (Nairobi, 2011)

Higher GDP growth compared with a business-as-usual scenario is empirically and theoretically supported by cases from Europe. European countries with ETR (including Denmark, Finland, Germany, Netherlands, Sweden and United Kingdom) have shown gains in GDP growth. A study of the Green Fiscal Commission of the United Kingdom found that these countries experienced up to a 0.5 per cent increase in GDP growth while reducing fossil fuel demand by 2.6 per cent on average as a result of ETR, an example of relative decoupling.[6] Modelling exercises also indicate that with a more robust ETR and EFR measures, countries in Europe would yield higher double dividend, as the following box points out.

[3] Sustainable Prosperity, *Managing Carbon Revenue*, Policy Brief (Ottawa, 2011), p. 2.

[4] Paul Ekins and Julia Tomei, "Stimulating eco-efficiency in Asia and the Pacific: The role of public policy", Conference paper presented at the Second Regional Policy Dialogue: Role of Public Policy in Providing Sustainable Consumption Choices: Resources Saving Society and Green Growth, Bejing, 23-24 May 2006.

[5] United Nations Environment Programme, *Towards a Green Economy* (Nairobi, 2011).

Box 1: Experiences with ETR and EFR in Europe – double dividend effect

ETR in Europe began in the early 1990s, adopted by Sweden, Denmark, Norway, Finland and the Netherlands followed by Germany and the United Kingdom in the late 1990s. Numerous studies have shown that double dividends have been achieved in these countries, but the evidence is limited due to the relative novelty of the measures introduced as well as the difficult to isolate the impact of ETR out of the broader policy macroeconomic policy mixes that were instituted at the same time. Still, it is notable that there is no clear evidence of the negative economic impacts of environmental taxes; industry's claims to the contrary are widely seen as overstated.[7]

It is encouraging news that European countries with ETR (Denmark, Finland, Germany, Netherlands, Sweden and United Kingdom) have shown, at a minimum, a weak double dividend with their fossil fuel demand reduced by 2.6 per cent on average while positive GDP gains of up 0.5 per cent as a result of ETR. There is evidence to vouch that Germany and Denmark have achieved a strong double dividend.[8]

There is a room for scaling up and more extensive recycling for achieving stronger double dividends. Environmental taxes still make up a small portion of all tax revenues collected and distortionary taxes, such as labour taxes, dwarf environmental taxes at a rate of 400–1,000 per cent higher. This leaves room for further revenue recycling as well as scaling up the scope of ETR in the future, as the UK Green Fiscal Commission recently concluded.[9]

- **Increased employment:** Reducing taxes on labour will allow employers to invest in more jobs and more resource efficiency through improved productivity of their workers. High labour taxes can have a counter-effect on employment-generating policies, making employment of workers less cost effective than investment in robotic production systems, especially when prices of fossil fuels and energy are low. This is especially important in the Asia-Pacific region, where labour-intensive growth in production sectors is necessary for poverty reduction.

  Experience in Europe, in particular in Germany where 86 per cent of the revenue from environmental taxes was allocated to compensate a reduction of direct contributions to social security from employers, there has been a steady increase in employment.[10] Increased employment in turn boosted consumption, which drove further economic growth. The sector that benefited the most in Germany was that of renewable energy, which experienced a significant boost in terms of investments and job creation. As of 2009, the renewable energy sector accounted for 300,000 jobs in the country, an 8 per cent increase from the previous year and 87 per cent higher than in 2004.[11]

  An International Labour Organization study found that imposing a price on carbon emissions and recycling the revenue to social security funds to compensate the decrease in social security contributions (due to lowering labour costs) and investments in new green sectors would create 14.3 million net new jobs over a period of five years, which is equivalent to a 0.5 per cent rise in world employment.[12]

[6] Green Fiscal Commission, *Competitiveness and Environmental Tax Reform* (London, 2010), p.5.

[7] Noriko Fujiwara, Jorge Núñez and Christian Egenhofer, "The Political Economy of Environmental Taxation in European Countries", Centre for European Policy Studies Working Documents No. 245 (Brussels, 2006).

[8] National Environmental Research Institute, Cambridge Econometrics, Economic and Social Research Institute, Institute for Economics and Environmental Policy, Policy Studies Institute and Vienna Institute for International Economic Studies, Competitiveness Effects of Environmental Tax Reforms, Final Report to the European Commission, DG Research and DG Taxation and Custom Union (Roskilde, Denmark, 2007). Available from www2.dmu.dk/cometr/COMETR_Summary_Report.pdf (accessed 15 March 2012).

[9] Green Fiscal Commission, *The Case for Green Fiscal Reform: Final Report of the UK Green Fiscal Commission* (London, 2010).

[10] Employment impacts since 2005 should be understood as the results of the combination of ETR and ETS.

[11] According to interim results of an ongoing BMU research project.

[12] International Labour Organization, *World of Work Report 2009: The Global Jobs Crisis and Beyond* (Geneva, 2009), cited in United Nations Environment Programme, *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication – A Synthesis for Policy Makers* (Nairobi, 2011).

- **Developing a domestic green industry:** EFR and ETR provide a number of beneficial ways in which to engage the private sector in green growth and develop a new domestic green industry. A strong and consistent price signal on carbon allows private sector investment to consider green investments to be less risky, thereby allowing investment to flow from "brown" investments to "green" investments.

  Recycling a portion of the tax revenues from ETR into energy efficiency investments and clean technology by the government can complement the strong price signal. These government investments can help develop a nascent green industry that may need large upfront investments to reach economies of scale; these large investments may be difficult to source from private investors. Together, ETR and EFR can develop the type of green industries seen in China, Denmark and Germany, as described in case studies in this chapter.

  In addition, the increased commercial viability of clean technology and efficiency improvements can help redirect excess liquidity in the global market, regarded as a potentially destabilizing factor during the more recent financial crisis, into investments necessary for greening the economy. In this way, ETR/EFR can help to address problems in times of financial crisis.

Improving ecological quality (environmental dividend)

Prices play a significant role in affecting people's behaviour. With a higher price on a good (energy), people tend to change their behaviour by reducing their consumption or switching to a more affordable alternative, or both. Taxes can be used to change the price and thereby change people's behaviour.

As currently configured, prices of resources do not reflect their growing scarcity, pollution and other social costs. By integrating these costs into the price via taxes, the right price signal of natural resources and ecological services can provide strong incentives to use less and increase the efficiency with which we use resources.

Putting a price on carbon also sends a strong price signal that increases the commercial viability of alternative energy sources thereby attracting private investors to shift energy investments towards renewable energy and away from fossil fuels. Shifting towards renewable energy can increase energy security and secure cleaner and healthier environments by reducing carbon emissions.

Challenges to achieving the double dividend

- **Lack of supporting regulatory policy measures.**
- **Existing subsidies encouraging environmentally harmful consumption and production.**
- **Entrenched and locked-in unsustainable consumption and production patterns.**
- **Lack of well-developed and well-functioning labour and income tax system in developing countries.**

It is also necessary to underline that revenue neutrality principles may not and cannot always be realized; they are mostly applied to make ETR, EFR and subsidy reform measures widely accepted and supported by all parties.

Implementing strategies

Garner public acceptance and support: Successful adoption of any policy will require a clear understanding of the local socio-political institutional context. For example, where do the political powerhouses reside and what are the country-specific drivers and processes of policy reformation? Which parties stand to lose and win the most from a new green tax initiative or subsidy reform? Building political coalitions and engaging relevant parties in the policy design phase will be crucial for overcoming many political obstacles.

Choose the timing of a reform carefully: Timing is a major factor in determining whether a policy will be adopted. Implementing ETR and EFR after an environmental or economic crisis might prove to be more politically feasible due to the public's greater awareness of the further consequences that could arise if the problems are not addressed. For instance, it wasn't until Ghana, which relies heavily on hydropower generation, experienced a major power crisis after an extended drought, that policymakers there were able to rationalize increased energy prices to fund investments in non-hydro forms of energy production.[13] Policymakers in China capitalized on a period of low oil prices in 2008 to usher in fuel taxes.

Blanket the public with information explaining the issues: Garnering broad public acceptance for a new environmentally related fiscal instrument has generally been correlated to the level of awareness of the severity of the environmental problem being addressed by the policy and the effectiveness of the instrument to improve the problem. Polls in Europe and the United states have shown that 70 per cent of voters actually supported environmental tax reform after having it explained to them clearly.[14] This evidence lends weight to the importance of properly educating the public on the issues related to the policy through awareness campaigns well in advance.

Recycle the revenue into programmes and schemes that will enhance a sense of fairness in the policy. Concerns about fairness of the policy usually derives from the possible negative effects on international/sectoral competitiveness and the poor. Effectively articulating to the public who is responsible for the environmental problems (often the sectors affected by the new policy) and the specific measures (tax rebates, etc.) taken to prevent any unfair impacts can bode well for garnering greater public acceptance.

This is the approach undertaken in Indonesia in 2005 when a fuel subsidy reform was initiated to overcome the budget deficit and reduce spending of 20 per cent of the government budget on the subsidies. Public acceptance and support was stirred up by a programme directed to benefit poor households. In addition to reduced carbon emissions, the reform provided economic and social benefits as well. The fuel subsidy reform freed up US$10 billion in 2006 alone, and US$2.3 billion was used to support direct cash assistance for 19 million families, a low-income rice distribution programme, a programme for improved education for children and an increase of low-scale credit facilities.

Even though the earmarking of green tax revenue has usually been argued by many economists as inefficient, politicians have sometimes had to rely on at least short-term partial earmarking as a means for amassing political support for new green tax initiatives. Voters are concerned about how this new tax revenue will be used and don't want to see it wasted or fall prey to corruption. Partial earmarking thus offers policymakers a tool for achieving a balance between efficiency and public acceptance.

[13] Edward B Barbier, *A Global Green New Deal: Rethinking the Economic Recovery* (Cambridge, Cambridge University Press, 2010).

[14] David Malin Roodman, *The Natural Wealth of Nations* (New York, W.W. Norton & Company, 1998).

Eco-city

Key points

- ***Countries in the region experiencing rapid urbanization have a leapfrogging opportunity to avoid the "grow first, clean up later" model of development.***

- ***Integrating eco-efficiency into city development can be a win-win strategy for governments to yield both energy and ecological security on one hand and economic growth and quality life on the other.***

Eco-city explained

The concept of an "eco-city" was introduced in the 1987 book *Ecocity Berkeley: Building Cities for a Healthy Future* by Richard Register. Similar concepts sprouted around the same time, such as ecopolis, sustainable city, carbon-neutral city, garden city, green city and self-sufficient city. The general purpose behind these movements is to integrate environmental concerns and balance the development of a city within the scope of the carrying capacity of the ecological system.

Eco-city projects started out largely as experiments in which emerging technologies were applied on a small scale. In other cases, incremental improvements were made by simply adding on green areas or reducing the pollution of existing systems. Recent efforts with eco-city development, however, incorporates broader socio-economic plans, such as creating business opportunities and jobs in the green sector, providing eco-efficient public transport and utility services and promoting sustainable land use planning. The following table describes several eco-city models and their features.

Table 1: The types and characteristics of the selected eco-cities models

Type	Description	Examples
Renewable energy city	The city is powered by renewable energy to various scales – from the buildings to the districts and the entire city. Renewable energy can be tapped from such sources as biofuels, sunlight, wind or geothermal, according to the local context. Cities are required to restructure their infrastructure (such as power generation and buildings) and institutions in a way that allows the penetration of renewable energy.	Masdar, United Arab Emirates; Dezhou solar city, China and Vauban, a suburb of Freiburg in Germany
Carbon neutral city; zero-carbon city; low-carbon city	The city aims to be free from carbon emission by improving energy efficiency as well as by replacing fossil fuel with renewable energy sources. There are several initiatives to emit zero carbon on a small scale, such as within a building or at the district level. Greenhouse gas emission reduction has been integrated as an integral part in many eco-city projects.	The U.K. Government mandate that all urban development in the public sector be carbon neutral by 2016 and China's low-carbon cities project
Garden city	The city incorporates intensive greening as part of the urban environment. Green areas can be placed in the lower-density enclaves of a city, such as suburbs, or can be integrated into the urban built environment, such as green roofs. Urban green areas can be also used for urban agriculture, renewable energy crops growing and greening the high-density parts of cities.	A honey bee project now considered as a symbolic urban "satoyama" in Ginza, Japan's commercial district.[1]

[1] Japan for Sustainability, "The Ginza Honeybee Project: Urban Development Inspired by Beekeeping", *JFS Newsletter*, No.86 (October 2009). Available from www.japanfs.org/en/mailmagazine/newsletter/pages/029489.html (accessed 27 January 2012).

Resource-efficient city	The city relies on both upstream and downstream waste management systems. The city encourages the use of sustainable resources in both production and consumption practices while being equipped with citywide infrastructure designed to maximize the 3R habits (reduce, reuse, recycle), waste-to-energy technology and sustainable composting.	Many cities in Japan; the industrial symbiosis in the United Kingdom; China's circular economy and eco industrial parks in the Republic of Korea
Self-sufficient city	Eco-efficiency is realized through localized and self-sufficient production and consumption. The city can save the economic and environmental costs for importing as well as exporting products and services by maximizing the use of available resources inside the city.	The concept of self-sufficiency economy in Thailand and Yusuhara in Japan
Distributed city	The city, relying on small-scale and neighbourhood-based water and energy systems, can save costs occurred in the transmission process of the centralized system.	Small-scale community sewage system in the town of Hill End, New South Wales, Australia, PV-diesel hybrid systems for electrification of 64 schools in Borneo, Malaysia
Smart city	The city uses information technology as part of improving environmental sustainability. For instance, a city can provide real-time information through transport network as well as allow the interactive data management in green building, energy, water and waste system.	Smart city project in Yokohama, Japan

Source: Adjusted from Peter Newman, Timothy Beatley and Heather Boyer, *Resilient Cities: Responding to Peak Oil and Climate Change* (Washington D.C., Island Press, 2009).

Indicators

Various attempts have been made to measure the progress towards creating an eco-city; but many of them tend to touch only on the environmental performance, as the following explains. But going forward, there will be need to have a clear and comprehensive measurement of a city's environmental as well as economic performance and their intrinsic interaction.

- **Asian Green City Index:** Developed by the Economic Intelligence Unit, its first evaluation of 22 major cities (capital and business centres) in Asia covers nine categories with 29 indicators in the areas of energy and CO_2, land use and buildings, transport, waste, water, sanitation, air quality and environmental governance.[2]
- **Global Urban Competitiveness Index:** Developed by the Chinese Academy of Social Science, it provides an annual ranking of 500 cities worldwide in terms of the competitiveness in nine indexes, based on measures of enterprise, industrial structure, human resources, "hard" business environment, "soft" business environment, living environment and global connectivity. The 2010 report includes Beijing, Hong Kong, China, Singapore, Seoul and Tokyo among the top 10 in environment competitiveness.[3]
- **Global Liveability Report:** Developed by the Economist Intelligence Unit, it assesses lifestyle in 140 cities in terms of stability; health care, culture and environment, education and infrastructure.[4]
- **Worldwide Quality of Living Survey:** Developed by the Mercer consulting firm, the survey includes an eco-ranking that is based on water availability, drinkability, waste removal, quality of sewerage systems, air pollution and traffic congestions.[5]

[2] Economist Intelligence Unit and Siemens AG, *Asian Green City Index: Assessing the Environmental Performance of Asia's Major Cities* (Munich, 2011). Available from www.siemens.com/press/pool/de/events/2011/corporate/2011-02-asia/asian-gci-report-e.pdf (accessed 27 January 2012).

[3] Global Urban Competitiveness Project website "The Abstract of 2007-2008 Global Urban Competitiveness Report". Available from www.gucp.org/en/report.asp?bigclassid=2&smallclassid=20 (accessed 27 January 2012).

[4] Economist Intelligence Unit website "Global liveability Report: Melbourne Takes the Crown of Most Liveable City from Vancouver" (2012). Available from www.eiu.com/site_info.asp?info_name=The_Global_Liveability_Report&page=noads (accessed 27 January 2012).

[5] Mercer website "2011 Quality of Living Worldwide City Rankings: Mercer Survey" (29 November 2011). Available from www.mercer.com/press-releases/quality-of-living-report-2011 (accessed 27 January 2012).

- **International Ecocities Framework and Standards:** Currently being developed by Ecocity Builders and its network of Partner Advisers, the standards will allow participating cities to assess their ecological condition in conjunction with a global network of local governments, and a whole-systems improvement process will be taken. An eco-city assessment will have 15 criteria, grouped into natural, social and financial capital: food, energy, ecological integrity, carrying capacity, biodiversity, air, access by proximity or localization, well-being, education, economy, culture, community capacity or participation, water and soil.[6]

Strengths of an eco-city

- **Ecological benefits:** greenhouse gas emission reduction and enhanced environmental resilience via quality of air and reduced heat island effect.

- **Economic benefits:** energy and water securities, business opportunities and job creation potential through investment in the green sector including renewable energy industry, and costs savings from increased resource efficiency.

- **Social benefits:** increased liveability and quality of life.

Challenges to building up an eco-city

- **Lack of awareness:** Because the principles for what an eco-city is have not been fully agreed, there can be a lack of common understanding and thus challenging for policymakers to introduce a comprehensive set of policy measures in an integrated manner.

- **Fragmented institutions:** While the development of eco-cities requires concerted efforts of many actors, inefficient or insufficient institutions following a sector-based approach may hamper coordination for cross-cutting issues, such as integrated land and transport planning.

Implementing strategies

Strong leadership and commitment: The government needs to kick-start the process in the initial stage. China is a good example in which the central Government, the National Development and Reform Commission, leveraged the local government to take up eco-efficiency as a tool for city development via the low-carbon city project in July 2010.

Integrated institutions: Successful planning and design policies depend on setting up the right policy framework and governance structures that fully engage the relevant actors and mobilize the needed financial resources. In Singapore, the Urban Redevelopment Authority (URA) has a critical role in delivering long-term strategic plans that provide guidance and coordinate actors for prudent and sustainable land use.

Information and knowledge sharing: Governments can benefit from the information networks of local governments as well as national and regional networks (see the following box). Planning and design measures can be a starting point for developing the physical structure of eco-cities.[7]

[6] Ecobuilders website "International Ecocity Framework & Standards Initiative: IEFS Indicator Development" (2011). Available from www.ecocitystandards.org/ecocity-level-1-conditions/iefs-indicator-development (accessed 27 January 2012).

[7] The fact sheets on compact development, cellular development, integrated land use and transit planning, preservation of open and green space and walkability provide more detailed guidance.

BOX 1: Annual conferences on eco-city development

Maintaining up-to-date working knowledge of the latest techniques, strategies and policies towards achieving sustainability helps local governments in ensuring smart and green growth, as the following examples highlight:

- **Ecocity World Summit:** Since 1990, the Ecocity World Summit has promoted the theme of the sustainable city (the first conference, in Berkeley, California (USA) focused on cities that changed hearts and minds). The conference has since taken place in Adelaide, Australia, in Dakar/Yoff, Sénégal, in Curitiba, Brazil, in Shenzhen, China, in Bangalore, India, in San Francisco, United States of America and in Istanbul, Turkey (www.ecocity2011.com).

- **Sustainable Cities Conference in Singapore:** The third Sustainable Cities Conference in 2011, organized by IBC Asia with the theme of Building Liveable Cities of the Future through Green Design and Good Governance, explored how good design and planning can improve city management, drive economic growth, promote sustainable development and deliver a better quality of life. Leading experts from industry, academia and governments examined pressing issues affecting property development and the green business with Asia's urban population boom (www.sustainablecitiesasia.com).

- **Green Cities:** Started in Sydney in 2007, Green Cities is an annual event jointly hosted by the Green Building Council of Australia and the Property Council of Australia. This event has venues in Sydney and Melbourne and attracts national and international green building professionals (http://greencities.org.au).

FACT SHEET

Eco-labelling

Key points

- ***Eco-labels mark energy efficient and environment-friendly products to increase their share in the market.***
- ***Awarding criteria and the certification process for eco-labels need to follow specific principles to bring about the desired results.***
- ***To make the labelling system effective, governments need to safeguard the credibility and accessibility of eco-labels.***

Eco-labelling explained

Eco-labels are indications on a product, given by an impartial third party, that explicitly convey the non-market value of a good or service in terms of its environmental impact. They are critical for raising environmental awareness, fostering sustainable consumption and assisting consumers (both business and individual) in identifying green products and services and thus promoting their demand and supply.

How it works

Each label defines several specific awarding criteria that indicate the overall environmental sensitivity of a product within a particular product category, based on life-cycle considerations.[1] They are a special subset of the value-based labels[2] and put value on environmental goods and services that are generally not counted into the monetary production costs and therefore do not appear in the price of the final product. They are intended to convey the hidden value to the consumer or buyer.[3] Thus, eco-labels internalize negative environmental externalities into the market price of the product.[4]

The criteria determining the award of an eco-label must be comprehensive, relevant, attainable, measurable and scientifically valid. The certification process should be unbiased, transparent and as simple as possible, incurring minimal administrative costs.

Origin and trends of eco-labelling

Eco-labelling has been applied since the late 1970s to help consumers make more environmentally conscious purchases. Initially, the driving force behind the development of eco-labels and their supportive legislation were green-conscious consumers and multinational corporations in Europe seeking to improve their corporate social responsibility and to green their global supply chains that spanned the whole of Asia. Recently, environment-related labels targeting Asia-Pacific consumers, including those in developing countries, have been steadily growing in numbers (such as Japan's Eco Mark, Republic of Korea's Eco-Labelling Programme, Singapore's Green Label and Thailand's Green Label). In promotion of carbon disclosure through labelling, countries such as Japan, Republic of Korea and Thailand have adopted a carbon footprint programme on a trial, voluntary or mandatory basis.

[1] Global Ecolabelling Network, *Introduction to Ecolabelling* (Ontario, 2004). Available from www.globalecolabelling.net/docs/documents/intro_to_ecolabelling.pdf (accessed 10 February 2012).

[2] In addition to eco-labels, value-based labels also encompass the certification of fair trade, ethical workplace practices in production (such as no child labour or animal experimentation) or other ethical concerns.

[3] Elizabeth Barham, "Towards a theory of values-based labeling", *Agriculture and Human Values* (2002), vol. 19, No. 4, pp. 349-360.

[4] Paul Upham, Leonie Dendler and Mercedes Bleda, "Carbon labelling of grocery products: public perceptions and potential emissions reductions", *Journal of Cleaner Production* (2010), vol. 19, No. 4, pp. 348-355.

Strengths in eco-labelling

Eco-labels are important tools for achieving green growth, both in industrialized and developing countries. Increased use of eco-labels can reduce the environmental impacts of the manufacturing industries, advance sustainable consumption and production patterns and improve market access of ecologically efficient products, thus increasing their international competitiveness.

Challenges for eco-labelling

The unregulated proliferation of labels that are issued by many entities tends to weaken the effectiveness of eco-labelling. Not all eco-labels have a robust verification scheme, a transparent standard-setting process or scientifically validated standards. As well, the complexity of the information may hinder the customers' clear and well-informed purchase choice. Ensuring reliable, truthful and verifiable information is critical to strengthen the credibility of the eco-labelling scheme and to increase customers' confidence in it.[5]

From the producers' point of view, the costs to conduct environmental impact and life-cycle assessments drive up production costs. The lack of expertise and financial and organizational capacity to conduct the assessments and transform their production and procedures into more environmentally sound ones are common challenges, particularly in developing countries.

Box 1: ENERGY STAR®

ENERGY STAR is an American voluntary labelling programme designed to identify and promote energy-efficient products to reduce greenhouse gas emissions. The US Environmental Protection Agency (EPA) introduced the programme in 1992 for energy-efficient computers. In 1995 the programme expanded to include office equipment products and residential heating and cooling installations.[6] As of 2010, the ENERGY STAR programme covers more than 60 product categories for home and office products.

Since its introduction, the ENERGY STAR programme has dramatically increased the use of energy-efficient products and promoted widespread efficiency improvements in the United States and beyond. In 2010, Americans reportedly saved US$20 billion on their utility bills with the help of ENERGY STAR, through more than 240 billion kWh of energy savings. This was equivalent to about 5 per cent of the country's electricity demand at that time and amounted to more than three times the savings through ENERGY STAR in 2000. In addition, 195 million metric tons of greenhouse gas emissions were prevented as an impact of the programme, equivalent to the annual emissions from 38 million vehicles.[7]

The programme's success can be attributed to its ability to reduce the costs and risks associated with purchasing energy-efficient products. The ENERGY STAR rating system provides consumers with an easy-to-understand and unbiased label that reduces the costs (time and risks) for consumers during the search for a reliable energy-efficient product. The robust application of the programme, from the verification process for the rating, regular monitoring and selective product tests to periodic updating of the performance specification, reduces the technology risk associated with the purchase of an energy-efficient product. Strong partnership with industry and equipment manufacturers helped ENERGY STAR to become an effective information and branding campaign, successfully conveying the core messages of energy bill savings and environmental protection. The ENERGY STAR programme has been adopted by Australia, Canada, Japan, New Zealand, Switzerland, Taiwan Province of China and the European Union.[8]

[5] Mario Teisla, Jonathan Rubin and Caroline Noblet, "Non-dirty dancing? Interactions between eco-labels and consumers", *Journal of Economic Psychology* (2008), vol. 29, No. 2, pp. 140-159.

[6] United States Environmental Protection Agency, *ENERGY STAR®: the Power to Protect the Environment through Energy Efficiency* (Washington D.C., United States of America, 2003). Available from www.energystar.gov/ia/partners/downloads/energy_star_report_aug_2003.pdf (accessed 16 February 2012).

[7] United States Environmental Protection Agency, *ENERGY STAR® and Other Climate Protection Partnerships: 2010 Annual Report* (Washington D.C., United States of America, 2011). Available from www.energystar.gov/ia/partners/publications/pubdocs/2010%20CPPD%20Annual%20Report.pdf (accessed 16 February 2012).

[8] Ibid.

Box 2: WindMade™, the first global consumer label specific to wind energy

WindMade™ is the first global consumer label identifying products and companies that use wind energy. It was initiated by a group of global companies and NGOs, including as founding partners the Global Wind Energy Council, the World Wildlife Fund, Bloomberg, PricewaterhouseCoopers International, the UN Global Compact and the LEGO Group.[9] The coalition was led by Vestas, a global leader in wind power from Denmark.[10] The initiative was officially launched in New York City in November 2011.

The WindMade label grants qualifying companies the ability to communicate their commitment to wind energy to their consumers, which distinguishes their brands from other manufacturers. To be certified by the WindMade label, companies need to source a minimum of 25 per cent of their electricity consumption from wind power.[11] The share of the wind energy can be procured in multiple ways, including procurement through a company-owned wind power generation facility, a long-term power purchase agreement for wind power or the purchase of high-quality renewable energy certificates approved by WindMade. The label indicates the exact percentage of the wind energy share that is consumed during the production process.

For the consumer, the label provides transparent information on the energy use of the companies they purchase their products from, and thus gives them the possibility to make environmentally responsible consumption decisions. In the future, the success of the WindMade label may engender the possible creation of other voluntary-based consumer label systems specific to other renewables, such as geothermal or solar energies.

Box 3: Environmental product declarations

The environmental product declaration (EPD) is an alternative to a certification label. It is based on the idea of simply disclosing information on the environmental impacts of a product (including raw material acquisition, materials and chemical substances used, energy consumption, efficiency, emissions to air, soil and water and waste generation), making it readily available to buyers and consumers.[12] The goal of the EPD is "…through communication of verifiable and accurate information, that is not misleading, on environmental aspects of products and services, to encourage the demand for and supply of those products and services that cause less stress on the environment, thereby stimulating the potential for market-driven continuous environmental improvement."[13]

Unlike prototype eco-labels, declarations do not contain any valuation of the provided information. The EPD multi-standard approach enables customers to make an informed and prudent purchase choice. By using more than one indicator (such as energy efficiency), several types of environmental impacts can be communicated simultaneously. This is useful to reflect the holistic nature of environmental quality and sustainability. Sometimes referred to as "environmental nutrition labels" (similar to nutrition labels on food products), EDPs provide a range of labels that detail greenhouse gas emissions, water use and other environmental impacts separately. This enables a decision based on consumers' or buyers' own weighting of environmental priorities. Thus EPDs are less susceptible to becoming a black-and-white labelling system in which the weighing of different factors may be made rather arbitrary, leaving producers generally little say in the matter. Thus consumers or buyers can decide for themselves whether greenhouse gas emissions are more pressing than, say, water conservation.[14]

[9] Global Wind Energy Council website "WindMade appoints first CEO" (10 June 2006). Available from www.gwec.net/index.php?id=30&no_cache=1&tx_ttnews%5Btt_news%5D=294&tx_ttnews%5BbackPid%5D=4&cHash=b13192d922 (assessed 15 December 2011)

[10] See the Factsheet: CASE STUDY: Wind power takes flight: Denmark's success with renewable energy policies.

[11] WindMade, *WindMade Label Program: WindMade Standard for Companies and Organizations*, Version 1.1 (Brussels, 2011) Available from www.windmade.org/media/7232/2011-12-09_-_windmade_standard_-_version_1.1.pdf (assessed 15 December 2011).

[12] EPDs are defined by ISO Standard 14025 as being "quantified environmental data for a product with pre-set categories of parameters based on the ISO 14040 series of standards, but not excluding additional environmental information". For more details, see The Green Standards website "EPDS". Available from www.thegreenstandard.org/EPD_System.html (accessed on 15 February 2012).

[14] Raffaella Manzini, Giuliano Noci, Massimiliano Ostinelli and Emanuele Pizzurno, "Assessing environmental product declaration opportunities: a reference framework", *Business Strategy and the Environment* (2006), vol. 15, No. 2, pp.118-134.

[14] Aman Singh Das, "Confusion & Doubts Face Wal-Mart as it Ponders Sustainability Index", *Vault blogs*, February 19, 2010. Available from http://blogs.vault.com/blog/in-good-company-vaults-csr-blog/confusion-doubts-face-wal-mart-as-it-ponders-sustainability-index (accessed 30 January 2012).

Implementing strategies

Principles and criteria for more effective eco-labelling: Major challenges include improving credibility and increasing user-friendliness of the labels. The abundance of similar labels in the market tends to confuse customers, weakening the trust and credibility of the scheme. Tackling this problem includes limiting the number of labels and regulating and harmonizing the awarding procedures. Governments need to safeguard that the claims made by eco-labels are based on actual environmental benefits and are consistent with recognized and up-to-date scientific findings.

Some governments have already developed state-defined standards and national labelling programmes, as in Japan (beginning from the 1980s). Now the European Union is looking at similar restrictions on an international level.[15] In the United States, where there are more than 300 types of eco-labels in use, the Federal Trade Commission has started to take a closer look at eco-labelling and to crack down on "greenwashing", which has an extremely negative impact on the perceived credibility of eco-labelling schemes (box 4).[16]

Box 4: Greenwashing

Businesses that use a "greenwashing" strategy claim to provide environment-friendly products, production processes or services, without going through a sound and robust verification process. The practice poses a serious problem for eco-labelling because it adds to the confusion of consumers, who are often already overwhelmed by the sheer number of labels all around them, leading to a misinformed purchase choice. Unlike eco-labels, pure advertisement labels that are used in greenwashing are not verified by a third-party and fail to signal a true increase of environmental integrity and protection.

Source: Gwendolyn Bounds, "As Eco-Seals Proliferate, So Do Doubts", *The Wall Street Journal*, 2 April 2009. Available from http://online.wsj.com/article/SB123862823846680371.html (accessed 13 March 2012).

Effective eco-labelling practices require the following design and implementation principles:[17]

- Accurate, comprehensible and reliable information – the consumer must understand and trust the information conveyed
- Transparent and inclusive processes for setting standards
- Relevant, attainable and measurable criteria that are based on scientifically valid standards and consistent with applications of the product life-cycle approach
- Mandatory review mechanism set within the scheme, which enables flexibility in the awarding scheme and is subject to changes in scientific knowledge, relevant signals from the market or best-practice examples of eco-labels
- A robust verification scheme through a qualified third-party verifier
- Simplicity in the certification process to minimize the administrative burden on producers
- Voluntary participation
- Unbiased, independent nature of the awarding organization
- Open participation, equitable to all kinds of businesses and organizations
- Avoidance of unnecessary obstacles to trade.

Standardizing the product life-cycle analysis, labelling, greenhouse gas management and ecological footprinting methodology across countries and international markets is critical for promoting green products and services as well as for reducing the costs that suppliers incur to meet varying criteria. Options for increasing intraregional trade would be to agree on a common definition of green products or to harmonize the methodology for calculating a product's ecological footprint and for awarding a green label.

[15] Raffaella Manzini, Giuliano Noci, Massimiliano Ostinelli and Emanuele Pizzurno, "Assessing environmental product declaration opportunities: a reference framework", *Business Strategy and the Environment* (2006), vol. 15, No. 2, pp.118-134.

[16] Candice Lee Jones, "How green is your label", *Kiplinger's Personal Finance*, July 2010, p. 49.

[17] Global Ecolabelling Network, *Introduction to Ecolabelling* (Ontario, 2004). Available from www.globalecolabelling.net/docs/documents/intro_to_ecolabelling.pdf (accessed 10 February 2012).

Further reading

"Eco-labelling: Enabling Developing Countries to Seize Eco-label Opportunities" (United Nations Environment Programme website). Available from www.unep.fr/scp/ecolabelling/

Introduction to Ecolabelling (Ontario, Global Ecolabelling Network, 2004). Available from www.globalecolabelling.net/docs/documents/intro_to_ecolabelling.pdf

"Psychological determinants of paying attention to eco-labels in purchase decisions: model development and multinational validation", by J. Thogersen, Journal of Consumer Policy (2000), vol. 23, No. 3, pp. 285-313.

Eco-resorts and hotels

Key point

- ***Investment in energy-efficiency within hotels not only helps reduce the operating costs and the frequency of maintenance but it showcases what guests can do at home.***

Eco-resorts and hotels explained

Eco-resorts and hotels are types of commercial buildings in which the eco-efficiency measures are adopted throughout the lifecycle of the building, ranging from orientation, design, operation and maintenance.

Amid rising environment pressures and soaring resource prices, there is great need for businesses to develop environment-friendly policies and adopt green practices, including the hospitality sector. Eco-resorts and hotels reduce the operational costs of buildings and/or improve the image of companies as part of corporate social responsibility. In addition to the benefits accrued to the business, hotels and resorts have a great potential to influence the behaviour of their guests and to showcase good examples of sustainable practices.[1]

How it works

Supply-side management is important in hotels and resorts rather than demand-energy management. Compared with other types of buildings, the average resource consumption of hotels and resorts is higher because customers tend to over-consume electricity and water owing to their non-direct responsibility for the utility payment.

The environmental performance of eco-resorts and hotels cover water conservation, waste management, energy production and conservation, conservation of natural areas and surroundings, protection of flora and fauna, protection of air, water and soil, and environmental education.

Examples of eco-resorts and hotels

Evason Phuket in Phuket, Thailand:[2] The Evason Phuket resort, which is certified by 'Green Leaf', one of the eco-label for green hotels and resorts, demonstrates how environment-friendly upgrades made in older buildings can improve energy efficiency and reduce water use, wastes and costs. The installation of resource- and energy-efficient equipment in the resort makes both economic and environmental sense. The investment in the energy-efficient equipment to manage energy, water and wastes brought about the following economic benefits and energy savings:

[1] Singapore, Environment Council website: http://sec.org.sg/awards/ecohotel (accessed 25 January 2012).

[2] World Wildlife Fund, Horwath HTL, and Hotel Investment Conference Asia Pacific, *Towards the Business Case for Sustainable Hotels in Asia* (2010).

Table 1: Costs and benefits of the eco-efficient measures taken in Evason Phuket

Item	Investment	Annual savings	Payback
Energy monitoring system	US$11 000	About 10%	N/A
Quantum heat recovery	US$9 000	US$7 500	1.2 years
Centralized mini chillers	US$130 000	US$44 000	1.8 years
Energy efficient light bulbs	US$8 500	US$17 000	6 months
Biomass absorption chillers	US$11 5000	US$41 000	2.8 years
LPG boilers for laundry	US$27 000	US$17 000	1.6 years
Rainwater reservoir	US$36 000	US$330 000*	1 month

* Estimated cost if water is purchased from private water companies

Source: Six Senses Resorts and Spas (undated), *Six Senses Environmental Policy*.

ITC Sonar hotel in Kolkata, India: The ITC Sonar is the first resort hotel in the world to be registered as a clean development mechanism project by the United Nations Framework Convention on Climate Change for its energy improvement activities. The resort uses 15 appropriate fixtures, such as solar power for heating the spa and variable frequency drive for the main kitchen exhaust fan. The project results in energy saving of 6.32 GWh per year and an emission reduction of 1,962 tonnes CO_2.[3] The resort has received 1,996 carbon credits per year for the past ten years.[4]

Strengths with eco-resorts and hotels

- **Reduces operation costs:** Investment in energy-efficiency measures help to reduce the operating costs and the frequency of maintenance. In addition, improved resource efficiency can help to achieve environmental compliance, higher productivity and greater equipment reliability.
- **Showcases of good examples of green practices:** An improved company image by increasing awareness on the environment of hotels and resorts can be used as a marketing tool.
- **Reduces greenhouse gas emissions:** Investment projects that transform eco-hotels and resorts can contribute to reducing CO_2 emissions and thus attain recognition as a clean development mechanism project by the United Nations Framework on Climate Change and Convention.

Challenges with eco-resorts and hotels

- **Lack of access to finance:** The current financing tools are often insufficient to finance substantial amount of investment required for upgrading equipment and facilities. This is because the benefits and risks of retrofitting projects or constructing green buildings are not sufficiently examined and communicated to financial institutions.
- **Lack of awareness or incentives of customers:** Hotels and resorts are a good example of the motivation gap between owners and customers. The owners, who have the responsibility of paying the utility bills, are incentivized to invest in improving efficiency measures. However, the actual resource savings are also dependent on the behaviour of customers, who are free to make any payment for using the utilities. Promotional materials about sustainable use of energy and resource for customers, such as brochures or online publications, are important tools to expand customer awareness about the issues. And they can further help customers change their way of life at home.
- **Misperception of eco-resorts and hotels:** An eco-resort is not a necessarily fancy accommodation but it can be more natural and more attractive to tourists. Specific features of eco-resorts should be tailored according to the climate condition as well as the environment.

[3] United Nations Framework Convention on Climate Change, *UNFCCC CDM Project Monitoring Report: Improvement in Energy Consumption of a Hotel*, Project 0686 (Kolkata, India, 2007). Available from http://cdm.unfccc.int/filestorage/r/e/p/report.334/ITC%20Sonar%20Bangla%20Ver%20Report%20_Jan%20-%20dec%2006_%20draft.pdf?t=Umd8bHlnYXVzfDBZwUwnjpgasxToxXj_Oq49 (accessed 27 November 2011).

[4] Namrata Singh and Reeba Zachariah, "ITC Sonar First Hotel to Earn Carbon Credits'', *The Economic Times*, April 28 2010. Available from http://articles.economictimes.indiatimes.com/2010-04-28/news/28441771_1_carbon-credits-tonne-of-carbon-dioxide-itc-hotels (accessed 27 November 2011).

Considerations for replicating

- **Support eco-hotels and resorts as part of eco-tourism:** Asian and Pacific countries, such as Indonesia and Thailand where the share of GDP from tourism is high, can realize economic and environmental benefits by promoting eco-resorts and hotels. Given the abundant natural resources adjacent to many hotels or resorts, there should be more practices among the industry to promote eco-tourism rather than only promoting an eco-hotel.

- **Provide various sources of financing:** Retrofitting and/or renovating projects may be aided by donors and government or they can be funded by private sector investment. In developing countries, there is also potential for hotels that plan to upgrade their property to develop clean development mechanism projects with their emission reductions. Soneva Fushi Resort in Kunfunadhoo Island, Maldives, is a good example of how hotels and resorts can address the financial challenge through a public-private partnership. In line with the national carbon neutral strategy, a special agency provided funding to the resort for making energy-efficiency adjustments and adopting sustainable practices.

- **Publicize via eco-label and certification:** There is a tendency to misuse or overuse green labels, and green criteria can be misled if there is no authority to monitor them. Internationally acceptable guidelines can be presented by such credible organization as the International Organization for Standardization (ISO). There are several voluntary national, regional and international eco-labelling and certification programmes in the hotel industry, such as the Eco-Hotel Certification of the Singapore Environment Council and Canada's Green Key Eco-Rating Program. The European Union's eco-label programme for tourist accommodations has set a level of efficiency in six criteria for eco-friendly accommodations: energy, water, general management, wastes, information to guests and information on the European Union eco-label.[5] The Green Leaf Foundation in Thailand provides a certificate called Green Leaf; the criteria for the certificate include energy, water efficiency, waste management and green procurement.[6]

Further reading

Towards the Business Case for Sustainable Hotels in Asia, by World Wildlife Fund, Horwath HTL and Hotel Investment Conference Asia Pacific (2010).

[5] The European Commission, *The EU Ecolabel for Tourist Accommodations* (Brussels, 2010). Available from www.euecolabel.eu/userfiles/file/Fact%20Sheet%20tourism.pdf (accessed 30 January 2012).

[6] Green Leaf Foundation website "Green Leaf Programs". Available from www.greenleafthai.org/en/green_programs/application_greenleaf/ (accessed 30 January 2012).

FACT SHEET

Ecotourism

Key points

- ***Tourism is a growing industry whose economic potential looms particularly large in developing countries. Minimizing tourism's environmental impacts while maximizing its economic benefits for development and poverty alleviation is in line with the overall green growth goal.***

- ***Experiences indicate the important role of governments in setting a guiding framework that maximizes benefits, protects the interests of indigenous communities and avoids "greenwashing".***

Ecotourism explained

Although the concept of ecotourism is widely used, there is no universal definition. However, the various descriptions of ecotourism feature some recurring characteristics of the concept: environmental conservation, minimizing environmental impacts and involving and promoting the interest of the local community and its economy.[1] The International Eco-tourism Society defines ecotourism as "responsible travel to natural areas that conserves the environment and improves the well-being of local people."[2] Similar terms such as "green tourism", "ecologically responsible tourism", "carbon-free tourism" or "carbon-neutral tourism" also mean the same thing as ecotourism.

How it works

Ecotourism is considered the fastest-growing market in the tourism industry.[3] Within ecotourism, linking of tourism with environment and community interests takes place – a practice that has become an essential movement in light of global climate challenges and the Millennium Development Goals (MDGs).

Greater potential in developing countries in the Asia-Pacific region

Tourism in general is one of the major growing service industries. Because it involves many sectors, from construction to daily commodity suppliers, it can be an important driver of socio-economic changes and progress, especially in developing countries where the economic contribution from tourism is significant.[4] In 2009, the global travel and tourism industry accounted for an estimated 7.9 per cent of global GDP and 8.1 per cent of worldwide employment.[5] The share of emerging and developing economies in this figure grew twice as fast as that of industrialized countries between 1995 and 2007. The significance of tourism industries in least developed

[1] United Nations World Tourism Organization and United Nations Environment Programme, *Quebec Declaration of Ecotourism* (Quebec, 2002). Available from www.gdrc.org/uem/eco-tour/quebec-declaration.pdf (accessed 19 January 2012). Other suggested components include: active contribution to the conservation of natural and cultural heritage, promotion of local culture, education on the importance of environmental protection and the value of ecosystems, initiatives by hospitality providers to promote recycling, energy efficiency, water reuse, and the creation of economic opportunities for local communities.

[2] The International Ecotourism Society website "What is Ecotourism?" Available from www.ecotourism.org/what-is-ecotourism (accessed 18 January 2012).

[3] Alison M. Johnston, *Is the Sacred for Sale? Tourism and Indigenous People* (Sterling, VA, Earthscan, 2006).

[4] United Nations World Tourism Organization, *From Davos to Copenhagen and Beyond: Advancing Tourism's Response to Climate Change*, Background Paper (Madrid, 2009). Available from http://sdt.unwto.org/sites/all/files/docpdf/fromdavostocopenhagenbeyondunwtopaperelectronicversion.pdf (accessed 21 February 2012).

[5] World Travel & Tourism Council, *Travel & Tourism Economic Impact 2009: Germany* (London, 2009). Available from http://torc.linkbc.ca/torc/downs1/germany%20wttc.pdf (accessed 20 February 2012).

countries (LDCs) is even greater – for 46 of the 50 LDCs, tourism is the primary source of foreign exchange earnings.[6] In many small island countries, such as the Maldives, one half to two thirds of the GDP derives from tourism.[7]

In the Asia-Pacific region, the prospect of growth for tourism is especially high: With an average growth rate of 8 per cent in international tourist arrivals over the past several years, the region is among the leaders in the global tourism industry. For example, tourists arriving in the region exceeded the 200 million mark in 2010, equalling a 13 per cent increase from 2009 arrivals.[8] In the Asia-Pacific countries, expenditures by inbound tourists rose to US$249 billion in 2010, marking an increase of nearly 22 per cent within a single year.[9]

Importance of greening the tourism industry

Tourism has a significant impact on the environment because it generally entails resource consumption (such as for building tourist accommodations and providing food and water), solid and liquid waste generation and ecosystem disturbance or degradation (such as when coastal ecosystems are built on or used by bathing or boating tourists). The CO_2 emissions from the tourism industry account for 5 per cent of the global total emissions.[10] In a business-as-usual scenario, the emissions level in the tourism industry is expected to rise by 130 per cent by 2035.[11]

Because of these significant impacts on the environment and the economic importance of tourism in developing countries, it is one of the most important green adjustments on the way to low carbon green growth. Ecotourism tackles environmental and climate challenges while maximizing tourism's potential for economic growth, social development and poverty reduction.

Strengths of ecotourism

- **Conservation of biodiversity and ecosystems through a market-based mechanism:** Ecotourism's potential contribution to poverty alleviation and environmental protection, particularly for endangered ecosystems, was officially recognized in the World Summit on Sustainable Development in Johannesburg in 2002. In that same year, marked as the UN International Year of Ecotourism, the Quebec Declaration on Ecotourism was adopted, along with its recommendations for developing ecotourism activities in the context of efficient development. More recently, the importance of tourism in tackling climate change has raised policy attention. The Davos Declaration (Climate Change and Tourism Responding to Global Challenges, 2007) calls for urgent actions by governments and other actors in sustainable tourism to address climate challenges while also concentrating on other development and poverty goals.[12]

  The relevance of ecotourism in green growth is considerable and direct, particularly for conserving biodiversity (such as by protecting species that are rare or at risk of extinction) and protecting forestry and ecosystems as a primary source for carbon capture and storage.

[6] United Nations World Tourism Organization, *From Davos to Copenhagen and Beyond: Advancing Tourism's Response to Climate Change*, Background Paper (Madrid, 2009). Available from http://sdt.unwto.org/sites/all/files/docpdf/fromdavostocopenhagenbeyondunwtopaperelectronicversion.pdf (accessed 21 February 2012).

[7] United Nations Economic and Social Commission for Asia and the Pacific, *Study on the Role of Tourism in Socio-Economic Development* (Bangkok, 2007). Available from www.unescap.org/ttdw/Publications/TPTS_pubs/pub_2478/pub_2478_fulltext.pdf (accessed 21 February 2012).

[8] United Nations Economic and Social Commission for Asia and the Pacific, *Statistical Yearbook for Asia and the Pacific 2011* (Bangkok, 2011). Available from www.unescap.org/stat/data/syb2011/ESCAP-syb2011.pdf (accessed 20 February 2012).

[9] ibid.

[10] United Nations World Tourism Organization, United Nations Environment Programme, World Economic Forum, World Meteorological Organization and Swiss Federal Department of Economic Affairs, *Davos Declaration: Climate Change and Tourism Responding to Global Challenges* (Davos, 2007). Available from http://sdt.unwto.org/sites/all/files/docpdf/davosdeclaration.pdf (accessed 19 January 2012).

[11] United Nations World Tourism Organization, *From Davos to Copenhagen and Beyond: Advancing Tourism's Response to Climate Change*, Background Paper (Madrid, 2009). Available from http://sdt.unwto.org/sites/all/files/docpdf/fromdavostocopenhagenbeyondunwtopaperelectronicversion.pdf (accessed 21 February 2012).

[12] United Nations World Tourism Organization, United Nations Environment Programme, World Economic Forum, World Meteorological Organization and Swiss Federal Department of Economic Affairs, *Davos Declaration: Climate Change and Tourism Responding to Global Challenges* (Davos, 2007). Available from http://sdt.unwto.org/sites/all/files/docpdf/davosdeclaration.pdf (accessed 19 January 2012).

Box 1: Ecological value of the forest in Sumatra

The forest peatlands in Sumatra, Indonesia, are known as the most efficient terrestrial ecosystem for carbon storage. But deforestation due to illegal logging is leading to an annual loss of more than US$1 billion. According to a recent United Nations Environment Programme report, a hectare of coastal peat-rich forest in Sumatra, where the last 6,600 Sumatran orangutans live, may be worth up to US$22,000 at the current carbon price, and thus much more than the US$7,400 per hectare when cleared for palm oil plantations.

Source: Serge Wich and others, eds., *Orangutans and the Economics of Sustainable Forest Management in Sumatra* (Nairobi, United Nations Environment Programme, Great Apes Survival Partnership, PanEco, Yayasan Ekosistem Lestari, World Agricultural Centre and GRID-Arendal, 2011). Available from http://hqweb.unep.org/pdf/orangutan_report_scr.pdf (accessed 21 February 2012).

- **Greening tourism for poverty reduction and strengthening communities and their economies:** For developing countries with funding constraints, well-designed ecotourism could provide an effective financing mechanism to sustain the well-being of communities, the economy and natural environments.

  Travel and tourism are labour intensive, employing 230 million people, or 8 per cent, of the global work force. One job in the core tourism industry creates an estimated one and a half additional or indirect jobs in the tourism-related economy.[13] The greening of the sector is expected to reinforce its employment potential with increased local hiring and sourcing. Increasing the involvement of communities in the tourism value chain is essential to develop local economies and reduce poverty.

Challenges for ecotourism

- **Finding the right balance between industrial growth and conservation:** Investing in natural capital is important to stimulate ecotourism. However, governments should set restrictions and regulations to prevent the overexploitation of the natural resources.

- **Distinguishing credible ecotourism providers:** To avoid "greenwashing", it is important to establish common standards and certification mechanisms for eco-resorts (or ecolodges) and ecotourism products.[14] The certification process should be managed and supervised by a single, independent regulatory body.

- **Accepting changes in conventional tourism patterns:** Environmentally and socially responsible tourism can bring about higher costs and less comfort and convenience for tourists; for example, by incorporating carbon offset payment schemes for long-distance travel by aircraft to ecolodge destinations; limiting access to sensitive ecosystems to specific areas or seasons; or reducing the availability of imported goods that accumulate a huge carbon footprint to reach remote tourist areas.

[13] United Nations Environment Programme, *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication* (Nairobi, 2011). Available from www.unep.org/greeneconomy/Portals/88/documents/ger/GER_synthesis_en.pdf (accessed 21 February 2012).

[14] While global standards would be desirable, due to the cultural differences and different contexts of economy, it may be a challenging task. For more information, see Untamed Path website "Defining Ecotourism" (January 2007). Available from www.untamedpath.com/Ecotourism/defining.html (accessed 18 January 2012).

Country experience: Thailand's green initiative in tourism

Thailand is pushing forward a "green initiative" under the conceptual framework Seven Green Concept and Programmes, developed by the Tourism Authority of Thailand. To provide reliable and objective rating systems for the certification of major tourist sites and accommodations, the Government is creating a database of "environmentally responsible" tourism operators and service providers. In one of the seven concepts, the Green Destinations, a star-rating for beaches in the country was introduced, led by Thailand's Pollution Control Department.

Source: Tourism Authority of Thailand News Room website "Thai Tourism Going 'Green'". Available from www.tatnews.org/tat_news/3852.asp (accessed 21 February 2012).

Implementing strategies

Standards, information and economic incentives: Motivating tourists to understand and choose ecotourism requires not only education changes, spanning from school curricula to media coverage of environment- and ecotourism-related themes, but also regulations that make the disclosure of specific environmental information mandatory for public and private actors. For example, making accurate and timely global and regional information on climate and other environment-related issues available to the tourism industry helps operators and service providers adjust their business and investment plans and strategies.[15] Establishing an objective and reliable certification mechanism to verify ecotourism and to distinguish it from similar marketing attempts (such as greenwashing) and providing economic incentives, such as tax credits, would considerably encourage investors' confidence towards introducing and expanding ecotourism services.

Designing, incentivizing and regulating to protect indigenous communities and the environment: If not well planned and regulated, ecotourism can threaten indigenous peoples' sovereignty, which will bring about conflicts and tensions in their communities and threaten the delicate balance they have established with their surrounding natural environment.[16] To prevent such undesirable impact, governments should guide ecotourism businesses (beginning in their planning stage), set guidelines and adjust existing legal frameworks to ensure that the industry takes a responsible approach. One country that follows this strategy is India, which has issued ecotourism guidelines (box 2).

Box 2: India's ecotourism guidelines

India's ecotourism guidelines, issued by the Ministry of Tourism, include the following principles:

- Communities should be involved, leading to the overall economic development of an area.
- The likely conflicts between resource use for ecotourism and the livelihoods of local inhabitants should be identified and attempts made to minimize them.
- The type and scale of ecotourism development should be compatible with the environment and socio-cultural characteristics of the local community.
- Ecotourism should be planned as a part of the overall area development strategy, guided by an integrated land-use plan that avoids inter-sector conflicts and ensures sectoral integration, associated with commensurate expansion of public services.

Source: Republic of India, Ministry of Tourism website "Eco Tourism". Available from http://tourism.gov.in/TourismDivision/AboutContent.aspx?Name=Tourism%20Infrastructure%20Development&CID=20&INO=14 (accessed 21 February 2012).

[15] United Nations World Tourism Organization, United Nations Environment Programme, World Economic Forum, World Meteorological Organization and Swiss Federal Department of Economic Affairs, *Davos Declaration: Climate Change and Tourism Responding to Global Challenges* (Davos, 2007). Available from http://sdt.unwto.org/sites/all/files/docpdf/davosdeclaration.pdf (accessed 19 January 2012).

[16] Serious concerns regarding the rigorous approach of the ecotourism industry were raised during the UN Commission on Sustainable Development, the Convention on Biological Diversity and the International Year of Ecotourism in 2002.

Strengthening local initiatives: Although it is ideal that ecotourism schemes are guided by policies established at the national level, some cases indicate that locally initiated movements provide a new growth driver for local economies. They also help to improve the quality of life of a local population while having a catalytic influence in raising awareness and triggering policy formation at the national level, as illustrated in the case of Suncheon City, Republic of Korea (box 3).

Box 3: Ecotourism in Suncheon City, Republic of Korea

Located in a region known for its petrochemical plants and steel mills, Suncheon City was left behind in the Republic of Korea's industrialization race so city planners there decided to follow a different growth path. Starting in the late 1990s, the city administration turned its undeveloped tidal flats into the largest sanctuary for hooded cranes in the world, which became a competitive advantage for the city. As a result of concerted efforts by the city government and its citizens, Suncheon Bay was designated as a wetland of international importance by the Ramsar Convention on Wetlands in 2006 and is now one of the five largest coastal Ramsar-selected sites in the world. Additional investment in complementary infrastructure facilitated the arrival of more than 2.3 million visitors in 2009, a dramatic increase from the 0.1 million tourists in 2002. More than US$79 million was generated in 2009, and by the end of that year about 6,400 jobs had been created in a city of just over 200,000 people.

Such success did not come easily. Plans to restore the Suncheon Bay ecosystem met strong resistance from business and land owners whose private interests were restricted when commercial areas were relocated out of the bay area and rice fields were turned into a reserve for migratory birds. Strong leadership by a mayor, who was convinced that the rich and vibrant Suncheon Bay ecosystem could be a driver of growth, was the critical factor in turning initial resistance into support and eventually into political success.

Source: United Nations Economic and Social Commission for Asia and the Pacific, "Investment in the sustainable management of natural resources: Emerging opportunities and policies", E/ESCAP/MCED(6)/8, A Note by the Secretariat at the Ministerial Conference on Environment and Development in Asia and the Pacific, Astana, 27 September-2 October 2010. Available from www.unescap.org/mced6/documents/Documents/MCED6_8E.pdf (accessed 24 February 2012).

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From Davos to Copenhagen and Beyond: Advancing Tourism's Response to Climate Change (Madrid, United Nations World Tourism Organization, 2009). Available from http://sdt.unwto.org/sites/all/files/docpdf/fromdavostocopenhagenbeyondunwtopaperelectronicversion.pdf

Study on the Role of Tourism in Socio-Economic Development (Bangkok, United Nations Economic and Social Commission for Asia and the Pacific, 2007). Available from www.unescap.org/ttdw/Publications/TPTS_pubs/pub_2478/pub_2478_fulltext.pdf

Electric vehicles

Key points

- ***Electric vehicles represent alternatives to conventional, high-emission technologies in a low carbon green growth economy.***

- ***National targets demonstrate public commitment and send encouraging signals to the private sector that long-term investments will be secure.***

- ***Electric vehicles are subject to the same challenges confronting the adoption of green technologies and need support to compete with their brown counterparts.***

Electric vehicles explained

There are two types of electric vehicles:

- **Electric vehicles (EVs):** Battery-powered vehicles use an electric motor for propulsion and batteries for electricity storage. The energy in the batteries provides all of the motive and auxiliary power on board of the vehicle. Batteries can be recharged via grid electricity, brake energy recuperation or via off-grid sources, such as photovoltaic panels.

- **Plug-in hybrid electric vehicles (PHEVs):** Hybrid electric vehicles use both an engine and a motor, featuring sufficient battery capacity to store electricity generated by the engine or by brake energy recuperation. The batteries power the motor when needed, provide auxiliary motive power to the engine or even allow the engine to be turned off at low speeds.[1]

How they work

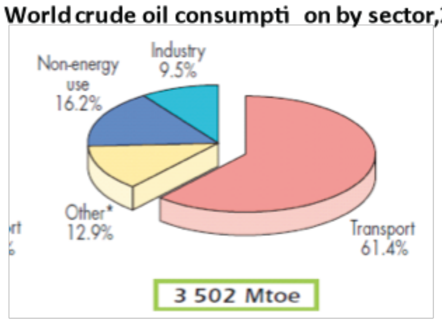
Electric vehicles are considered viable substitutes for conventional vehicles, which are the biggest oil consumers [2], and the second-largest carbon dioxide emitters [3] globally (figure 1). Because electric vehicles avoid or reduce the use of fossil fuels, they are destined to be part of the low carbon green growth solution.

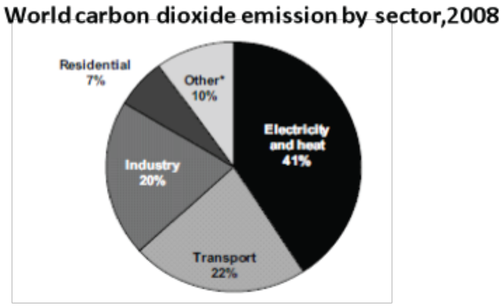
[1] International Energy Agency (IEA), *Technology Roadmap: Electric and Plug-in Hybrid Electric Vehicles* (Paris, OECD/IEA, 2009). Available from www.iea.org/papers/2009/EV_PHEV_Roadmap.pdf (accessed 26 January 2012).

[2] International Energy Agency (IEA), *2010 Key World Energy Statistics* (Paris, OECD/IEA, 2010). Available from www.iea.org/textbase/nppdf/free/2010/key_stats_2010.pdf (accessed 26 January 2012).

[3] International Energy Agency (IEA), *CO_2 Emissions from Fuel Combustion Highlights* (Paris, OECD/IEA, 2011). Available from www.iea.org/co2highlights/co2highlights.pdf (accessed 26 January 2012).

Figure 1: Global crude oil consumption and carbon dioxide emission by sector, 2008





Source: International Energy Agency, *Key World Energy Statistics* (Paris, 2010); and International Energy Agency, *Carbon Dioxide Emissions from Fuel Combustion* (Paris, 2010).

Strengths in adopting electric vehicles

Electric vehicles provide three important benefits:

- **Decreased demand for crude oil:** Both types of electric vehicles consume less fossil fuel than conventional vehicles. The International Energy Agency estimates that if electric vehicle sales reach 5 million per year by 2020, the resulting 20 million electric vehicles on the road at that point will avoid oil consumption of 0.4 million barrels a day.[4]
- **Reduced greenhouse gas emissions:** Electric vehicles offer the prospect of zero-vehicle emissions of greenhouse gases and air pollutants. This is a hugely important advantage over conventional vehicles.[5]
- **A value chain that generates jobs:** The development of a domestic market and industries for electric vehicles can attract numerous green finance investments in either the direct production or its related industries and services.

Challenges to adopting electric vehicles

- **High cost:** The cost of electric vehicles is likely to remain substantially higher than that of conventional vehicles for at least the next five to ten years and will be the main challenge for competing with fossil fuel vehicles.
- **The reliability of electric vehicle technology:** The next biggest drawback of electric vehicles is the low energy and power densities of the batteries compared with liquid fuels.
- **The availability of infrastructure:** Public recharging infrastructure for electric vehicles is very limited or non-existent in most cities. A few cities have made the leap and installed a significant system of recharging infrastructure as part of pilot projects and other programmes.
- **Transforming consumer habits:** Consumer acceptance of electric vehicles is a critical factor determining the ultimate success or failure of the technology. The fact that electric vehicles lag behind their conventional counterparts in terms of performance and recharge convenience is an important reason for consumers to turn their back on an otherwise viable green solution.

Implementing strategies

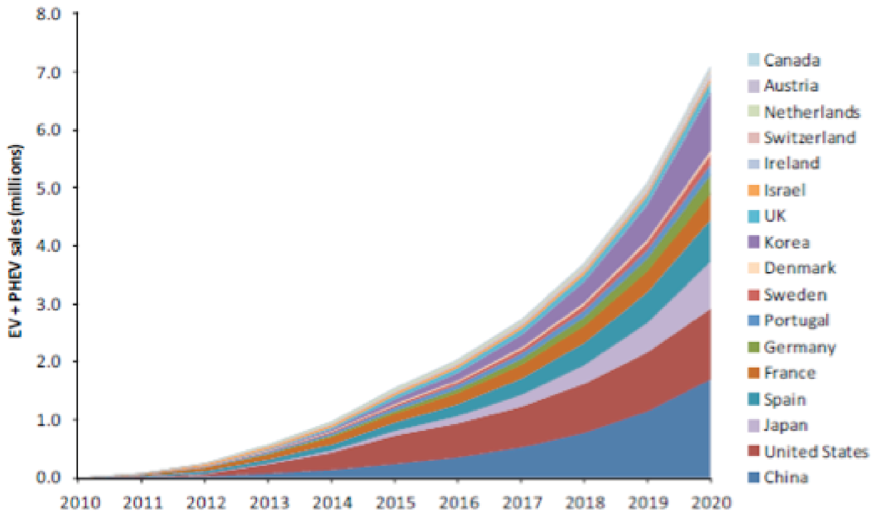
Because electric vehicles are relatively novel, technological applications and government policies are crucial in helping to establish a stable market for them and to encourage customers to make the switch. The following policy options are important steps that governments can take to promote this green industry sector:

[4] International Energy Agency (IEA), *Transforming Global Markets for Clean Energy Products: Energy Efficient Equipment, Vehicles and Solar Photovoltaics* (Paris, OECD/IEA, 2010). Available from www.iea.org/papers/2010/global_market_transformation.pdf (accessed 26 January 2012).

[5] International Energy Agency (IEA), *Energy Technology Perspectives 2010: Scenarios & Strategies to 2050* (Paris, OECD/IEA, 2010). Available from www.iea.org/Textbase/nppdf/free/2010/etp2010_part1.pdf (accessed 26 January 2012).

Set national targets: Since the 1990s, several countries have adopted national targets to increase the number of electric vehicles in use. The International Energy Agency estimates that the global sales will reach 7 million per year by 2020 as a result of compliance with the national targets in 17 countries (figure 2).[6]

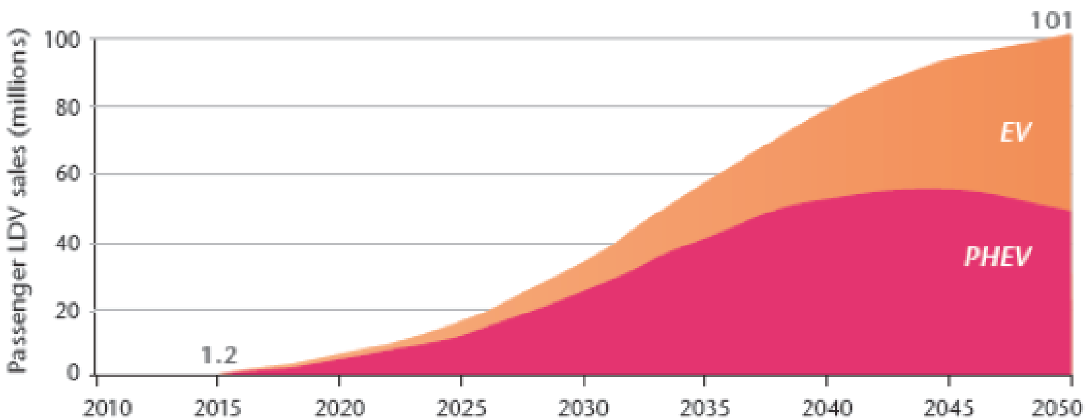
Figure 2: Aggregated national targets for electric vehicles (millions per year)



Source: International Energy Agency, *Clean Energy Progress Report* (Paris, 2011).

Create a roadmap. A roadmap is a useful tool for policymakers to sketch a comprehensive strategy that will help them expedite a desired policy. It is basically a handbook on how to achieve a national target and thereby helps to select appropriate implementing actions and to track the achievements. The International Energy Agency published an electric vehicle technology roadmap in 2009, which provides useful information about future trends to both the public and governments (figure 3). It features the so-called BLUE map scenario, which describes how the deployment and distribution of electric vehicles have to change in order to halve the amount of CO2 emissions by 2050, compared with 2005 levels.

Figure 3: Annual global electric and plug-in hybrid electric vehicles in the BLUE map scenario



Source: International Energy Agency, *Technology Roadmap: Electric and Plug-in Hybrid Electric Vehicles* (Paris, 2009).

[6] International Energy Agency (IEA), *Clean Energy Progress Report* (Paris, OECD/IEA, 2011). Available from http://iea.org/papers/2011/CEM_Progress_Report.pdf (accessed 26 January 2012).

Provide incentives: Some of the practical difficulties for the widespread use of electric vehicles, such as their high costs, low performance and the lack of necessary recharging infrastructure, have to be bridged with the help of government incentives. This is necessary as long as the conventional brown technologies do not reflect the real environmental or social price they inflict and thus can be purchased on the market at lower prices than their green counterparts. Policy options that are currently being introduced also focus on improving the affordability of existing electric vehicles through grants and purchase incentives.

Accelerate R&D process: For electric vehicles, it is crucial to reduce battery costs and improve the performance and safety through technical innovation.

Develop the charging infrastructure: It is critical to provide a reliable and convenient electricity supply for electric vehicles. The charging infrastructure must be available and applicable to home-based systems and the public recharging stations must be conveniently located.

Table 1: Policy options to accelerate the adoption of electric vehicles

Vehicle and fuel price related	Not cost-related
Rebate system at the time of vehicle purchase	Guarantees for re-sale values and battery replacements
Favourable financing terms, battery leasing to minimize upfront and monthly costs	Differential treatment for EVs and PHEVs in terms of regulations
Differential carbon dioxide-based fuel taxes	Additional credits under regulatory systems
Reductions in highway tolls and other vehicle fees	Electric-drive vehicles favoured by strong regulations addressing pollutants
Incentives for providing recharging infrastructure in commercial public areas	Initial introduction electric vehicles in government fleets to help boost sales for manufacturers
Sublimation of the cost of recharging infrastructure for households and apartment buildings	Public transport vehicles, two- and three-wheeled vehicles, exploit electric vehicles in these segments to promote them among consumers and increase the scale of battery production
	Direct provision of recharging infrastructure in public areas

Source: Alfred Wiederer and Ronald Philip, *Policy Options for Electric Vehicle Charging Infrastructure in C40 Cities* (2010).

As noted in figure 2, 17 countries have already set a national target for electric vehicle sales and issued a series of polices to reach their goal (table 2). Although the promotion strategies have yet to be adjusted to the specific market, infrastructure features and the consumer base in each country, they are still illustrative examples for other countries considering their own framework for promoting electric vehicles.

Table 2: Electric vehicle policies in several countries

Country	Sales target	Fiscal incentives	Other comments
China	Production of 500 000 cars by end of 2011	Up to USD 8 800 per vehicle	Incentives available in 12 Chinese cities
France	Up to 2 million stock by 2020; 50 000 purchase order for government fleets	USD 6 300 (EUR 5 000) tax credit per vehicle	Total funding of USD 1.9 billion (EUR 1.5 billion) includes funding for four million recharging points by 2020, battery production
Japan	About 1 million sales by 2020 (based on 20% share of LDV sales target)	Up to USD 14 000 (JPY 1.3 million) per vehicle	Fiscal incentives can change frequently
Germany	1 million total stock by 2020	No direct incentives at this time	USD 350 million (EUR 285 million) for infrastructure development and battery R&D
Spain	250 000 sales by 2014	Up to USD 7 500 (EUR 6 000) per vehicle	Primary focus on Madrid, Barcelona, Seville
United Kingdom	1.5 million stock by 2020	Up to USD 7 500 (GBP 5 000) per vehicle	Total funding of USD 375 million (GBP 250 million) for low-carbon transport
United States	1 million total stock by 2015	Up to USD 7 500 per vehicle	US DOE providing R&D funding and grants of over USD 2 billion

Source: International Energy Agency, *Transforming Global Markets for Clean Energy Products: Energy Efficient Equipment, Vehicles and Solar Photovoltaics* (2010).

Further reading

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Transforming Global Markets for Clean Energy Products: Energy Efficient Equipment, Vehicles and Solar Photovoltaics (Paris, International Energy Agency, 2010). Available from www.iea.org/papers/2010/global_market_transformation.pdf

FACT SHEET

Energy service companies

Key points

- ***Companies specialized in energy-efficiency projects reduce the costs of and accelerate the transition to a low-carbon economy.***

- ***Because ESCOs are fairly new businesses outside of the United States and Europe, their assimilation into developing countries demands government support.***

Energy service companies explained

Definitions for what constitutes an energy service company, or ESCO, vary from country to country. Broadly defined, an ESCO is a business that develops, implements and finances energy-saving projects. The National Association of Energy Service Companies in the United States defines an ESCO as "a company that provides energy efficiency-related and other value-added services and for which performance contracting is a core part of its energy efficiency services business."[1]

How it works

History of ESCOs

The ESCO industry emerged in the United States as a result of the oil crisis, which led to exorbitant energy prices in the 1970s.[2] After that, the ESCO concept disseminated to most industrialized countries. Developing countries, however, took more time to adopt the business model. In the 1990s, the first ESCOs were created in developing countries, first in the Republic of Korea in 1992, then in China in 1995, followed by Thailand in 2000 and Nepal in 2002.[3] The first Asian ESCO conference took place in Thailand in October 2005.[4]

Business model

Typically, ESCO services are offered through performance-based contracting. An ESCO acts as a project developer. The costs of a project are covered by the generated energy savings. In other words, an ESCO's revenue is directly linked to the actual energy savings from the project it conducts. Within this model, an ESCO bears the responsibility for performance and technical risks of its projects and thereby has a direct interest in assuring that all projects indeed save the amount of energy guaranteed. Services offered by ESCOs include comprehensive energy savings projects, installation and maintenance of energy-efficient equipment and the measurement and verification of energy savings.[5]

[1] ICF International and National Association of Energy Services Companies, *Introduction to Energy Performance Contracting* (Fairfax, 2007). Available from www.energystar.gov/ia/partners/spp_res/Introduction_to_Performance_Contracting.pdf (accessed 7 February 2012).

[2] Diana Ürge-Vorsatz and others, *An Assessment of on Energy Service Companies* (ESCOs) Worldwide (Budapest, 2007).

[3] ibid.

[4] Mark Stoughton and Anbumozhi Venkatachalam, *Green Services and Emergence and Recovery from the Global Economics Slowdown in Developing Asian Economies* (Tokyo, 2010). Available from www.adbi.org/files/2010.03.31.wp209.green.services.emergence.recovery.gfc.asia.pdf (accessed 24 January 2012).

[5] National Association of Energy Service Companies, *What is an ESCO?* (Washington, D.C., 2011). Available from www.naesco.org/resources/esco.htm (accessed 25 January 2012).

Box 1: Examples of ESCO business models

The list ranges from the full-service or high-risk contracts to low-service or low-risk contracts:

Full-service ESCO: The ESCO designs, finances and implements a project, verifies energy savings and shares an agreed percentage of the economic value of the actual energy savings over a fixed period of time with a customer.

End-use outsourcing: The ESCO takes over the operation and maintenance of the equipment and sells the output (steam, heating, cooling or lighting) to a customer at an agreed price. Costs for all equipment upgrades, repairs, etc. are borne by the ESCO, but ownership typically remains with the customer.

ESCO with third-party financing: The ESCO designs and implements the project but does not finance it, although it may arrange for or facilitate financing. The ESCO guarantees that the energy savings will be sufficient to cover debt service payments.

ESCO variable terms contract: This is similar to the full-service ESCO, except that the contract terms can vary depending on actual savings. If actual savings are less than expected, the contract can be extended to allow the ESCO to recover its agreed payment.

Equipment supplier credit: The equipment supplier designs and commissions the project, verifying that the energy savings match expectations. Payment can be made on a lump-sum basis either after commissioning or over time (typically part of the estimated energy savings). Ownership of the equipment is transferred to the customer immediately.

Equipment leasing: Similar to equipment supplier credit, the supplier receives fixed payments from the estimated energy savings. In this case, however, the supplier owns the equipment until all the lease payments and any transfer payments are completed.

Technical consultant (with performance-based payments): The ESCO conducts an audit and assists with project implementation. The ESCO and the customer agree on a performance-based fee, which can include penalties for lacking energy savings and bonuses for higher savings.

Technical consultant (with fixed payments): The ESCO conducts an audit, designs the project and either assists a customer in implementing a project or simply advises the customer for a fixed, lump-sum fee.

Source: World Bank, *World Bank GEF Energy Efficiency Portfolio Review and Practitioner's Handbook* (Washington, D.C., 2004).

Market size and trends of ESCO industries in Asia

Energy-efficiency projects help conserve natural resources, reduce dependence on fossil fuel for electricity generation, increase energy securities and improve industrial and commercial competitiveness through cost reduction and increased productivity. The potential for improving energy efficiency is present in all residential, commercial, industrial, agricultural and municipal corners of an economy. Because the ESCO is a relatively new concept outside of the United States and Europe, there is much room for market expansion in Asia and the Pacific. For example, ICF International, a consultancy firm, estimated the investment potential in energy efficiency in India at around US$10 billion.[6]

[6] Amit Khare, New Delhi, 14-15 January 2010. presented at the Asia ESCO Conference, January 2010. Available from www.asiaesco.org/pdf/presentation/1-1.pdf (accessed 25 January 2012).

Country experience: Energy conservation target and energy-saving service sector in China

China has targeted cutting its energy consumption and CO_2 emissions per unit of GDP by 16 per cent by 2015. To achieve this goal, the country is building a system to benchmark energy-efficiency performance in each sector of the economy. Additionally, it plans to help enterprises realize the energy-efficiency target by developing an energy-saving service sector, which focuses its operations on the transportation and constructing building sectors. During the five-year plan period, the domestic energy-saving service sector is supposed to create a market value of 300–500 billion yuan and more than 1,000 companies.[7]

Sources: Mechanical Engineering Magazine, "Energy Conservation Gets Local in China", September 2011. Available from http://memagazine.asme.org/Articles/2011/September/Global_Window.cfm (accessed on 7 February 2012); and Deborah Seligsohn and Angel Hsu, "How Does China's 12th Five-Year Plan Address Energy and the Environment?", *World Resources Institute News*, March 7, 2011. Available from www.wri.org/stories/2011/03/how-does-chinas-12th-five-year-plan-address-energy-and-environment (accessed 13 March 2012).

Strengths of energy service companies

- **Help businesses improve energy performance:** Due to the high capital cost, long payback time and lack of technical capabilities in project implementation, measuring and verifying, companies are reluctant to invest in energy saving projects. The ESCO industry offers a way to fill the time and price gaps of capital-intensive energy-efficiency projects. ESCOs can serve institutional, industrial or residential clients who want to improve their energy performance.

  Especially regarding the costs arising from an energy-efficiency project that are often seen as a burden, the ESCO can provide businesses with a reasonable and marketable option to transform this perceived burden into a cost-saving opportunity by designing projects that can be financed through the energy costs they save.

- **ESCOs assume the risk:** The ESCO risk policy appeals to clients; the ESCO often works under a performance guarantee, which shifts the risk from the client to the ESCO. If the energy savings lag behind the quantity that has been promised, the ESCO receives adjusted and decreased revenue. The flexibility of many ESCO contracts and measures is a favourable asset. The ESCO can implement additional measures to meet the agreed energy savings goal in time, or the contract period can be prolonged.

- **Variety of options:** There is a large variety of ESCO companies, ranging from full-service ESCOs and equipment suppliers to technical consultants. With this array of options, every business can find the ESCO solution that is best suited for its management strategy and company features.

Challenges for energy service companies

Some major barriers to the development of an ESCO industry include:

- Lack of information and understanding of the benefits of energy efficiency
- Lack of understanding of energy-performance contracting
- Lack of project financing, the low price of electricity
- Burdensome administrative procedures to measure and verify energy savings
- Lack of government support.

[7] *Mechanical Engineering Magazine*, "Energy Conservation Gets Local in China", September 2011. Available from http://memagazine.asme.org/Articles/2011/September/Global_Window.cfm (accessed on 7 February 2012).

Table 1: Policy challenges to developing an ESCO industry

Barrier	Elements of barrier
Lack of governmental policy and leadership on energy efficiency and ESCO industry	No policy or leadership on energy efficiency or demand-side management, or on ESCO industry; no energy codes and standards; energy audits are not mandatory, nor subsidized.
Low cost of electricity and other energy carriers (gas and district heating)	Subsidized energy costs; externalities not included; results in long payback periods; energy prices equal average costs rather than long-run marginal costs.
Lack of budgeting and standardized public procurement rules, contracts, procedures and guidelines for ESCO services	Especially for state-owned properties and the municipal sector.
Large economic and political uncertainty	Little attention paid to energy efficiency.
Conflicts with other government policies	Little attention paid to energy efficiency.
Unfavorable tax regimes	Existing tax and fiscal system discourage energy efficiency.
No existing legal framework for protecting the interests of EPC participants	EPC unknown in country.

Source: Edward Vine, "An international survey of the energy service company (ESCO) industry", *Energy Policy* (2005), vol. 33, pp. 691-704.

Implementing strategies

Actions for promoting the ESCO industry

There are several types of strategic actions that have been used internationally to promote the development of the ESCO industry. A few examples are: [8, 9]

- **Creating awareness and increasing information about the energy-efficiency projects, financing opportunities and services that ESCOs offer**. This can be achieved by using government facilities for demonstration projects for energy savings to build confidence among other consumers.
- **Providing incentives for financial institutions to invest in ESCOs.** In some cases, financial institutions may require guarantees in order to invest in energy-efficiency financing. Governments can create a "guarantee fund" to address this concern in the early stage of the market development. The fund can be phased out once the financing market for ESCOs matures.
- **Providing funding sources for ESCOs to develop their businesses.** For example, governments can set up an energy-efficiency fund to finance energy-efficiency projects or provide loans to small and medium-sized ESCOs through co-financing.[10]
- **Promoting energy-performance contracting at all government levels.**
- **Developing standardized contracts to help end users, ESCOs and investors to better understand performance contracting.** In the same breath, standards for measuring and verifying energy savings need to be developed to ensure the quality of the ESCO services. Governments can set up an ESCO association to take up this role and to standardize and streamline the process. More specific actions include setting up a database of model contracts and procedures that can be accessed by all ESCOs. Collaboration with international ESCOs and associations can also be useful for sharing information and lessons learned.

[8] Bill Huei-Jiunn Chen and Bing-Chwen Yang, "Activities of ESCO in Taiwan", presented at the Asia ESCO Conference, January 2010. Available from www.asiaesco.org/pdf/presentation/3-6.pdf (accessed 29 January 2012).

[9] Hidetoshi Nakagami, "Recent Activity of the ESCO Industry in Japan & Asian Countries", presented at the Asia ESCO Conference, January 2010. Available from www.asiaesco.org/pdf/presentation/3-1.pdf (accessed 29 January 2012).

[10] J. P. Painuly, H. Park, M. K. Lee and J. Noh, "Promoting energy efficiency financing and ESCOs in developing countries: mechanisms and barriers", *Journal of Cleaner Production* (2003), vol. 11, No. 6, pp. 659–665.

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Environmental tax reform and competitiveness

Key points

- ***Environmental tax and fiscal reforms can have an overall positive effect on competitiveness***
- ***ETR stimulates investments in resource efficiency, while EFR off-sets additional costs with targeted incentives***
- ***At the level of individual enterprises, fist movers will enjoy a competitive advantage, while the potential negative effect on some energy-intensive sectors can be mitigated***

Competitiveness explained

Competitiveness is a measure of a country's advantage or disadvantage in selling its products in international markets.[1]

How it works

A country (or a firm) is competitive if the cost of production and commercializing, including labour and expense of materials, marketing and other overhead expenses, generate products and services of a quality and price on par with similar products and services in the market place.

Environmental tax and fiscal reforms change market prices of different inputs to production, such as energy, natural resources and labour.

The revenue collected from environmental taxes can be successfully directed into investments in measures that will boost the competitiveness of domestic producers, including resource efficiency improvements of small and medium enterprises.

Concerns related to environmental tax and fiscal reforms

Critics of the environment tax and fiscal reforms (ETR and EFR) have made claims that environmental taxes adversely impact the competitiveness of the levying countries and cause resource-intensive industries or firms to flee to other countries with less strict environmental protection policies. Within the literature this is often referred to as the pollution haven hypothesis.[2] Although a pattern of industries relocating from industrialized to developing countries does exist, it appears that the prevailing opinion within the pollution haven hypothesis literature is that environmental regulation is a small, almost inconsequential variable. More significant factors as to the reason for relocation might be the emergence of new or faster growing markets, lower corporate income taxes or cheaper labour. Box 1 provides a summary of a recent European Union study on the impact of environmental taxes on competitiveness, which concluded that, overall, the impact of such tax reform is largely beneficial to industries and the economy.

[1] OECD glossary of statistical terms, available from http://stats.oecd.org/glossary/detail.asp?ID=399 (accessed 15 March 2012).

[2] The pollution haven hypothesis argues that environmental taxes adversely impact the competitiveness of the levying countries and cause resource-intensive industries or firms to flee to other countries with less strict environmental protection policies.

BOX 1: Impact of environmental tax reform on competitiveness in Europe

The purpose of imposing carbon and energy taxes has generally been to reduce carbon emissions and energy consumption while not compromising economic growth. This concept of detaching economic growth from energy consumption and carbon emission growth is often referred to in the literature as "decoupling". Studies indicate that European Union member countries that have used market-based instruments, such as carbon and energy taxes, are more energy efficient and competitive than the European Union on average.

According to the Competitiveness Effects of Environmental Tax Reforms (COMETR) project, six European countries (Germany, United Kingdom, Finland, Denmark, Netherlands, and Sweden) that adopted environmental tax reform (ETR) experienced reductions in demand for fuel (an average of 2.6 per cent in 2004) with no negative impact on economic growth regarding GDP. Largely as a result of the ETR by 2004, emissions in the six countries had decreased by an average of 3.1 per cent and a remarkable 5.9 per cent in Finland. Carbon and energy taxes did cause an increase in the consumer price index – which was expected – and certain energy-intensive industries were slightly affected. However, due to revenue recycling and exemptions, the negative impacts were minimal.

Source: Competitiveness Effects of Environmental Tax Reforms Project website: www2.dmu.dk/COMETR/ (accessed 15 March 2012).

Alterations in policy that place some companies in a better competitive position will undoubtedly put others in a worse position. It is thus beyond question that under the application of ETR and EFR, both "losers" and "winners" will arise. The winners, however, will be the businesses that can adapt by improving their eco-efficiency through new innovative solutions and ideas and, at the end of the day, increase their competiveness within both domestic and international markets.

Such tax and fiscal reforms can drive long-term innovation and resource productivity improvements, which will help businesses hedge their risks in an extremely volatile commodities market and countries reduce their dependence of foreign resources, such as fossil fuels.

While theoretically policymakers should be more concerned with long-term national competitiveness, more often in reality greater attention has been directed to the short-term consequences affecting certain losing sectors and, sometimes, even specific businesses. This has probably been due to the political ramifications that may arise from the expressed discontent of "losers", which tend to voice their perspective in public arenas more actively than winners.

Measures to address competitiveness concerns in introducing ETR

Various measures can be adopted to not only appease losing firms and sectors but also to ensure their ability to adequately adapt to new policy measures and maintain international competitiveness. These may include the following:

- **Introduce special arrangements for energy-intensive industries.** While most industries and firms are not likely to be significantly affected by competitiveness impacts, there may potentially be more pronounced impacts for sectors that simultaneously exhibit a high energy-intensity, high trade-intensity, a high share of costs as energy expenditures and a low ability to pass costs on to consumers.[3] In cases of highly energy intensive industries, the use of energy is essential to the processes and therefore makes up a large portion of operating costs. This may include sectors such as aluminium, steel, cement, paper, glass, etc. In these situations, special arrangements such as tax rebates, sectoral exemptions, voluntary agreements, targeted subsidies for R&D, green job training and transition assistance, have been used in many European countries with ETR. These special arrangements can address competitiveness concerns and increase the political feasibility of ETR.

[3] Paul Ekins and Stefan Speck, *GFC Briefing Paper 7: Competitiveness and Environmental Tax Reform* (London, Green Fiscal Commission, 2010).

Box 2: The United Kingdom's Climate Change Levy

In order to address competitiveness concerns of the Climate Change Levy (an energy tax targeting business and commercial users), the UK government introduced Climate Change Agreements, a concessionary tax reduction scheme allowing individual industrial sectors to flexibly negotiate with the government over sector specific targets of energy efficiency improvement or GHG reduction in conjunction with the Agreement. As a result, eligible energy-intensive industries can obtain up to 65 per cent discount from the climate change levy, on condition that they meet agreed targets in energy-efficiency improvements or carbon emissions reductions.

- **Utilize part of the revenues in a way that can offset increased energy costs for enterprises.** Reducing corporate taxes can provide incentives for capital accumulation and encourage more investment and business activities. This, in turn, may partly or entirely offset increased energy costs especially for those firms with a low level of energy- or resource-intensity. In Europe, this revenue recycling has played a critical role in compensating for the higher energy prices and bringing about a positive GDP gain of up to 0.5 percent.[4] Tax reductions can have different impacts on different firms, depending on their energy and labour intensity and the tax/fiscal structure.[5] For example, labour tax cuts may benefit labour-intensive producers. Reducing labour taxes or social security contributions may also address competitiveness concerns. This has been the case of some European countries with introduction of ETR: Denmark, Germany and the UK reduced employers' social security contributions while Finland and Sweden reduced labour taxes as a part of their ETR. In Germany, reducing employers' social security contributions substantially decreased the energy tax burden on both chemicals and basic metals.[6]

- **Gradually phase-in the reforms.** Gradually increasing tax rates over a set time period can ease the initial burden of compliance and provide financial flexibility to retool the production capacities. Relevant policy options include providing lead-in times, announcing the level and implementation date in advance and enacting a relevant law.

- **Ensure predictability and consistency of reforms.** Credible, clear and concrete future policy directions and goals within a firm legal and regulatory framework enables businesses to make long-term strategic and investment decisions.

- **Involve affected industries and other stakeholders in the design stage.** Widely consulting and involving industries and other stakeholders will make them not only effective partners but also genuine supporters for the reform measures. The stability and consistency of the ETR policies are shown to be positively related to firms' willingness to invest in low-carbon technology.

Concerns about business relocation and carbon leakage

Competitiveness issues can also translate into environmental concerns: if firms relocate to other countries with less stringent environmental policies, net carbon reductions may remain neutral or even increase. While studies provide a high range of variation in leakage rates, experiences indicate that business relocation and consequent carbon leakage may be unlikely to be substantial in practice, if ETR is properly designed and implemented with other complementary measures.[7] It may be partly due to the fact that business location has been driven by local market size and demand, transportation costs, wage levels and product variety rather than carbon/energy taxes and the cost effects of ETR tend to be small.[8]

[4] Ibid.

[5] Ibid.

[6] Ibid.

[7] Terry Barker and others, "Carbon leakage from unilateral environmental tax reforms in Europe, 1995-2005", Mikael Skou and Paul Ekins, eds., *Carbon Energy Taxation: Lessons from Europe* (Oxford, Oxford University Press, 2009).

[8] National Environmental Research Institute, Cambridge Econometrics, the Economic and Social Research Institute, Institute for Economic and Ecological Policy and the Vienna Institute for International Economic Studies, *Competitiveness Effects of Environmental Tax Reform (COMETR)*, Publishable Final Report to the European Commission, DG Research and DG Taxation and Customs Union (Roskilde, Denmark, 2007).

Border tax adjustments (BTAs) can, in theory, create a level competing field for competition between domestic and foreign producers and reduce potential emissions leakage related to shifts in production. Border tax adjustments are levies imposed on imported goods that were produced in countries that do not tax carbon or energy and rebated on domestically produced goods for export. However, border tax adjustments are a rather sensitive issue due to their potential to be used as a protectionist measure; not enough evidence exists on their effectiveness. Considering the high administrative and monitoring costs, their use should be carefully assessed.

Environmental tax reform and environmental fiscal reform

Key points

- ***Environmental tax reform and environmental fiscal reform (ETR/EFR) are among the most effective tools for a fundamental transformation towards a green economy***

- ***ETR and EFR can be the main driver for green growth***

Environmental tax reform and environmental fiscal reform explained

Environmental taxes are defined as "any compulsory, unrequited payment to the general government levied on tax-bases deemed to be of particular environmental relevance".[1]

Environment taxes and fiscal reform policies refer to a wide spectrum of fiscal measures that have the potential to simultaneously increase revenue and foster green growth. More specifically, these include:

- A shift of the tax burden from traditional areas of taxation, such as income, savings and capital gains, to products and activities with harmful impact on the environment, like fossil fuels and waste (tax "bads", not "goods").
- Redirecting of subsidies from environmentally harmful activities towards activities that promote green growth and poverty reduction.

The basis for the entire reform of the fiscal system is to maintain revenue neutrality: a net-zero increase in the level of taxation on the economy, while improving its overall economic and ecological efficiency, changing consumption approaches and channelling investments towards increased resource efficiency, reduced waste, eco-efficient technological innovation and green business.

How it works

Environmental tax reform

Environmental tax reform (ETR) is essentially a restructuring of the tax system whereby the tax base is shifted from traditional taxes, such as those based around labour and income, to taxes on activities that are having a detrimental impact on the environment, such as pollution from fossil fuels use, inefficient use of natural resources and waste generation. ETR can internalize the negative external social and environmental costs, which are not usually reflected in the market price.

Labour taxes are distortive. On the other hand, low or no taxes on fossil fuels induce a highly polluting fossil-fuel dependency in the economy. Underpriced fossil fuel-based energy and natural resources often translate into higher investments in manufactured capital and less investment in labour.

The concept of environmental tax reform (ETR) is not a new idea and has been adopted by numerous countries since the late 1980s to address issues related to the environment, resource productivity and economic progress. Recently, there has been growing interest in applying similar instruments in developing countries in the Asia-Pacific region. Some examples are described in section 2.2.2 of the Roadmap.

ETR can be used to correct the system of traditional taxation while increasing the cost of inefficient resource use

[1] Organisation for Economic Co-operation and Development, Glossary of Statistical Terms, available from http://stats.oecd.org/glossary/detail.asp?ID=6270 (accessed 12 March 2012)

and reducing that of labour to companies, thus correcting the negative distortions (and increasing eco-efficiency) of the market. This includes rationalizing prices (of utilities such as electricity and water, and waste management for example) based on the level of its respective use and by reflecting external environmental and social costs. This practice results in collecting the desired payments while also encouraging future energy-efficiency improvements and resource-saving behaviour.

Figure 1: ETR: Shifting tax base from "goods" to "bads" based on revenue neutrality[2]

Source: United Nations Commission for Asia and the Pacific, *Training of Trainers Toolkit: Green Growth Capacity Development Programme* (Bangkok, 2009).

Environmental fiscal reform

While environmental tax reform can greatly help governments to internalize social and environmental costs not reflected in market prices, it doesn't address the problem of environmentally harmful subsidies that can also distort prices.

Environmental fiscal reform (EFR) can remedy that shortfall. EFR refers to a range of taxation and pricing measures that raise fiscal revenues in pursuit of environmental goals.[3] EFR aims to reform the structure of government's revenue allocations (including those from ETR) in a way that internalizes the social and environmental externalities.

EFR extends beyond ETR by including subsidy reforms, which entail phasing out subsidies on environmentally harmful activities and products, such as fossil fuels or pesticides, and redirecting public spending towards more socially and environmentally beneficial activities. Similar to taxation, subsidies often are skewed in a way that distorts economic activity. EFR looks to remove harmful subsidies and level the playing field so that environmentally beneficial activities are not at a disadvantage to environmentally harmful activities.

Strengths of environmental tax and fiscal reforms

- **Increases efficiency:** When well-planned and applied strategically, environmental tax and fiscal reforms can correct the market price, which will encourage desirable activities like employment and investment and will discourage undesirable activities, such as waste and pollution.

[2] United Nations Commission for Asia and the Pacific, *Training of Trainers Toolkit: Green Growth Capacity Development Programme* (Bangkok, 2009).

[3] Organisation for Economic Co-operation and Development, *Environmental Fiscal Reform for Poverty Reduction*, DAC Guidelines and Reference Series (Paris, 2005).

- **Generates revenue:** ETR is an excellent economic instrument for raising revenue from inefficient use of natural resource and re-directing it to investments in the development of sustainable infrastructure, cleaner production technologies, green industries and even to programmes providing access to water, sanitation and energy for poor communities and to social welfare programmes. At the same time, EFR can close the "time gap" by providing public funding for green investments and thus providing another long-term price signal for investors and businesses in a country's transformation towards a green economy. For example, revenue raised from fuel taxes can be channelled to support the development of sustainable transport and mobility.
- **Increases cost-effectiveness:** Administrative costs associated with ETR and EFR measures are important for their success. A number of studies conducted in Europe found that environmental taxes are less costly to administer than command-and-control measures and other taxes, such as corporate income taxes.[4] Thus environmental taxes can be designed in a way that they generate revenue with little administrative costs. Cost implications may differ in developing countries, where tax and fiscal structures and implementation capacity may not yet be fully consolidated.

Challenges related to the implementation

- **ETR is often perceived as an additional tax levied over and above the already existing tax, thus adding burden on the economy and people's livelihoods.** To change this perception, ETR is being applied based on the revenue neutrality principle. The message that the reform does not lead to any additional tax burden on the overall economy as well as a potential of a double dividend (economic growth and employments, as well as reduced environmental damages) needs to be clearly communicated to the public from the beginning.
- **ETR is perceived as income regressive and thus affecting low-income households and individuals.** However, this is not inevitable. Through mitigation measures (such as "lifeline tariff" and progressive tax design) and compensatory measures (such as a well-targeted direct cash transfer) ETR can be designed and implemented in an equitable manner. For example, Singapore introduced a water conservation tax in 1997 in which a threshold for the minimum use of 40 cubic metres per month for households was established with a flat rate, while overuse above this threshold resulted in a progressive water tax increase.
- **ETR is perceived to damage the competitiveness of companies and the economy as a whole.** The perception as such is largely inflated: Empirical evidence from countries that have introduced ETR shows that overall competitiveness was not affected significantly. To the contrary, the ETR had a positive economic effect of increasing GDP, job creation and reducing fuel demand, as well as reducing carbon emissions. More details can be found in the case study: Europe's environmental tax and fiscal reform

Implementing strategies

Concerns over competitiveness and distributive impacts need to be actively tackled through a set of measures, and the benefits of ETR and EFR need to be clearly communicated to the public and businesses to to draw the required support to sustain the reforms.

- **Utilize special arrangements for energy-intensive industries**. Sectors with exhibit a high energy-intensity, high trade-intensity, a high share of costs as energy expenditures and a low ability to pass costs on to consumers are like to have more pronounced impacts on their competitiveness.[5] In cases of highly energy intensive industries, the use of energy is essential to the processes and therefore makes up a large portion of operating costs. This may include sectors such as aluminium, steel, cement, paper, glass, etc. Special arrangements such as tax rebates, sectoral exemptions, voluntary agreements, targeted subsidies for R&D, green job training and transition assistance can address competitiveness concerns and increase the political feasibility of ETR, as shown in the cases of European countries that have introduced ETR. The UK Climate Change Levy (CCL) and Climate Change Agreements (CCA) provide an example (refer to the case study on the United Kingdom's Climate Change Levy).

[4] Organisation for Economic Co-operation and Development, *The Political Economy of Environmentally Related Taxes* (Paris, 2006).

[5] Paul Ekins and Stefan Speck, *GFC Briefing Paper 7: Competitiveness and Environmental Tax Reform* (London, Green Fiscal Commission, 2010).

- **Design ETR in a revenue neutral way, and utilize part of the revenue in a way to offset the competitiveness impacts on industries.** The effect of revenue recycling on different sectors has to be closely studied from the design stage of ETR. In the case of Europe, this revenue recycling has played a critical role in compensating for the higher energy prices and bringing about a positive GDP gain of up to a 0.5 per cent.[6] For instance, reducing corporate taxes, as done in the case of the Netherlands as part of ETR, can partially or entirely offset increased energy costs especially for those firms with a low level of energy- or resource-intensity.
- **Gradually phase-in the reforms.** Gradually increasing tax rates over a set time period can ease the initial burden of compliance and provide financial flexibility to retool the production capacities. Relevant policy options include providing lead-in times, announcing the level and implementation date in advance and enacting a relevant law.
- **Ensure predictability and consistency of reforms.** Credible, clear and concrete future policy directions and goals within a firm legal and regulatory framework enables businesses to make long-term strategic and investment decisions.
- **Involve affected industries and other stakeholders in the design stage**. Widely consulting and involving industries and other stakeholders will make them not only effective partners but also genuine supporters for the reform measures. The stability and consistency of the ETR policies are shown to be positively related to firms' willingness to invest in low-carbon technology.
- **Introduce mitigation and compensatory measures to offset the income regressiveness effect of the reforms.** Studies indicates that well-targeted, coherent and transparent compensation measures that support real incomes of the poorest households tends to be more effective in mitigating the immediate negative impacts on low-income households than other measures.[7] Indonesia's direct cash transfer during the 2005 fuel subsidy reform is an example (refer to the case study on Indonesia's Bantuan Langsung Tunai cash transfer programme).
- **Phase out environmentally harmful subsidies and increase the share of subsidies for green transformation.** Redirect subsidies from environmentally harmful activities and products, such as pollution, carbon emissions, resource inefficiency, overdependence on non-renewable fossil fuels to more environment-friendly ones, such as renewable energy development.

[6] ibid.

[7] *Dana Krechowicz, The Effect of Carbon Pricing on Low-income Households, and its Potential Contribution to Poverty Reduction, Sustainable Prosperity* (Ottawa, University of Ottawa, 2011) available from http://www.sustainableprosperity.ca/article1398 (accessed 15 March 2012).

FACT SHEET

Extended producer responsibility

Key point

- ***Sharing or extending the responsibility for the treatment of used products to producers is one way to internalize the ecological costs of waste into the design and production of products.***

Extended producer responsibility explained

The extended producer responsibility requires producers to take certain physical or financial responsibility for the treatment of products at the end of their life cycle.

In a conventional approach, the production, consumption and treatment of waste are carried out separately by producers, consumers and governments. For some types of products, the amount of waste and the potential to reuse and recycle are profoundly designed into the production process. Producers thus can have a hand in designing goods and selecting materials in a way that prevents waste, reduces toxic materials and increases the recyclability of products from the beginning of a product's life cycle.

The types of waste that are best covered by the extended producer responsibility is still being tested and explored. In OECD countries, the extended producer responsibility has been applied to packaging waste, electronic and electrical equipment, batteries, bottles, paint cans, automobiles, waste oil, tyres and refrigerators.[1]

The scope of producers can range from brand owners to manufacturers, seller/vendors and importers, depending on the types of products and wastes. For some developing countries without a manufacturing industry, the main targets can be importers and sellers.

How it works

Producers can be assigned physical or financial responsibility with different scales. Setting (collection, recycling or recovery) targets upfront and matching the specific operating scheme with the types of waste are two key factors for success, with consideration given to national contexts, markets and policy priority. The scheme can manifest in several ways:

- **Mandated product "take-back"** requires producers and vendors to be responsible for the collection of products and packaging at the end of the useful live. Producers are responsible for setting up supportive system for collection, take-back and recycling (processing). Governments may require each producer to meet specific recycling or collecting rate targets. The scheme has been applied to automobiles, electric and electronic products and packaging.

- **Deposit and refund scheme** is a type of product take-back policy and refers to a payment (deposit) made by manufacturers and importers of certain products into a fund. Consumers are given a refund when returning the products to the dealer or treatment facilities after their use. The physical responsibility for operating these schemes is delegated to manufacturers of the products who need to set administrative arrangements with retailers at the onset of the programme. The scheme has been mostly used for beverages containers, with a few exceptions for the application to batteries, fluorescent light bulbs, tyres and shopping bags to some extent.

[1] Generally, the products or wastes with the following characteristics can be subject to the extended producer responsibility: the products with a potential to create massive volume of waste (packaging), waste groups requiring special attention due to the potential harmful environmental impacts (battery), or products to be difficult to reuse or recycle without engaging producers (ink cartridge).

- **Advanced disposal and recycling fee**[2] is a tax paid in advance by manufacturers to cover the cost of collection or recycling of a product. Fees may be assessed by weight or per unit of product sold. Although costs for processing waste are covered by producers through the scheme, a complementary system needs to be set up for the physical collection and recycling. This measure has covered product groups with longer life span, such as refrigerators or tyres.

The measures can be implemented on a voluntary basis – often via corporate social responsibility, on a mandatory basis or through the combination of both (such as negotiated agreements between governments and industries). For instance, Xerox is operating a cartridge take-back programme for copying machines. The used cartridge is collected, dissembled, treated and turned into resources for new products.[3]

Strengths with extended producer responsibility

- Improves resource efficiency by saving virgin material inputs and energy consumption.
- Reduces wastes to be land-filled, incinerated, and final disposal.
- Leads to environmental benefits via reduced pollution from production and waste treatment.
- Spurs innovation for more efficient production and packaging.
- Creates business opportunities for recycling industry.

Challenges with extended producer responsibility

- **Administrative costs for the operation and monitoring can be high** if a large number of parties, such as consumers, producers, importers, retailers and collectors, are engaged in the process of producing and taking back. A cost-benefits analysis is recommended.
- **The application of the full-scale EPR can be limited in countries that lack of institutional capacity** to operate a supportive scheme, such as waste-sorting system. Governments can start with selected measures, such as introducing a deposit and refund scheme for beverage containers, and expand the scope incrementally.

Implementing strategies

Set up a coordinating body: There needs to be a designated body setting up the framework, managing and monitoring the scheme, which includes the selection of the entitled businesses or product groups and the establishment of the recycling or collection targets.

Adjust the degree of responsibility according to the market readiness: The physical and financial responsibilities can be shared by the government if businesses are not ready to take over completely. For instance, municipal authorities can be in charge of setting up a waste-sorting, system such as installing recycling bins to alleviate the burden on businesses.

Supplement with incentives or disincentives: Although the primary purpose of the scheme is to transfer the responsibility of waste treatment to the producers, the successful implementing requires cooperation from other actors, such as distributors and consumers. For instance, if consumers keep disposing wastes without proper segregation, the collection will be extremely difficult. Governments can use a mix of instruments, including regulation (ban certain types of waste in landfills) and information dissemination (recycling labels attached to the products).

[2] In some cases, this policy may be changed from producer responsibility to consumer responsibility; the increased costs are transferred to consumers and the tax is displayed as a separate line item on the bill.

[3] Fuji Xerox website "About 'Reuse and Recycling'". Available from www.fujixerox.com/eng/company/ecology/office/reuse/index.html (accessed 1 March 2012).

Strengthen the capacity of recycling market/industry: The collection of recyclable waste has no point unless the existing recycling market can handle the collected material. In Germany, the initial target was set too high compared with the capacity to handle them, resulting in the dumping of the excess amount of secondary material into the international market at a low price.[4] The policy measures aimed at spurring innovation on recycling and related technologies can go hand in hand.

Examples

Japan: The Home Appliances Recycling Law requires the manufacturers and importers of air conditioners, televisions, electric refrigerators and electric washing machines to take back the end-of-life equipment and recycle it.

Australia: A National Used Tyres Product Stewardship Scheme has been set up to divert end-of-life tyres from landfills.[5]

[4] Organisation for Economic Co-operation and Development, *Extended Producer Responsibility: A Guidance Manual for Governments* (Paris, 2001, page 34).

[5] Commonwealth of Australia, website of Department of Sustainability, Environment, Water, Population and Communities "Product Stewardship for End-of-Life Tyres". Available from www.environment.gov.au/settlements/waste/tyres/index.html (accessed 17 November 2011).

Feed-in tariff

Key points

- ***A feed-in tariff is a widely used tool for developing the scale of renewable energy power for green growth.***
- ***A feed-in tariff can be adjusted to characteristics of the energy market, energy infrastructure and technological conditions of each country. This makes it a convenient tool for many countries.***
- ***A feed-in tariff has to be introduced carefully, especially in developing countries.***

Feed-in tariff explained

A feed-in tariff is an energy policy focused on supporting the development and dissemination of renewable power generation. In a feed-in tariff scheme, providers of energy from renewable sources, such as solar, wind or water, receive a price for what they produce based on the generation costs. This purchase guarantee is offered generally on a long-term basis, ranging from 5 to 20 years, but most commonly spanning 15–20 years.[1] The cost of the tariff payments are typically shared with the electricity consumers.

An inherent part of low carbon green growth is the transformation of the energy generation infrastructure away from the use of fossil resources, such as coal and oil, and towards renewable sources. A feed-in tariff is currently recognized to be the most effective policy to stimulate investments in renewable energies.[2] It has been responsible for 75 per cent of the global PV and 45 per cent of the global wind turbine deployment.[3]

Potential for change

In 2009, the global primary energy consumption amounted to about 11.16 billion tons of oil equivalent.[4] The share of the Asia-Pacific region in this global energy consumption has been rising steadily, accounting for 37 per cent in 2009.[5] By 2035, more than half of the global energy consumption will take place in developing and emerging economies in Asia alone (figure 1).[6] With the help of a feed-in tariff system for renewable energies, this rising energy demand could be met by an increasing number of renewable energy sources.

[1] Toby Couture, Karlynn Cory, Claire Kreycik and Emily Williams, *A Policymaker's Guide to Feed-in Tariff Policy Design* (Golden, CO, National Renewable Energy Laboratory, 2010). Available from www.aaec.arkansas.gov/Solutions/Documents/A%20Policymakers%20Guide%20to%20Feed-in%20Tariff%20Policy%20Design.pdf (accessed 09 February 2012).

[2] Mary Jean Bürer and Rolf Wüstenhagen, "Which renewable energy policy is a venture capitalist's best friend? Empirical evidence from a survey of international cleantech investors", *Energy Policy* (2009), vol.37, No. 12, pp. 4997-5006.

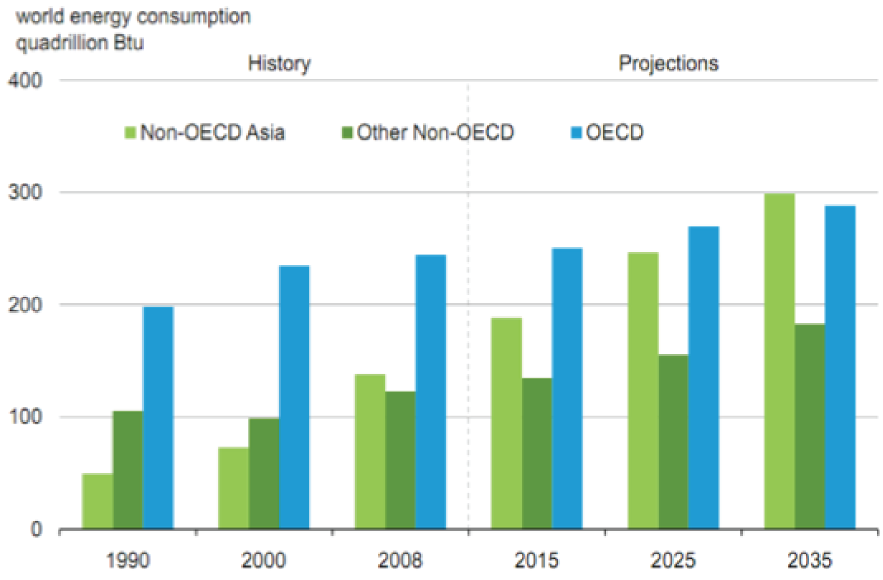
[3] Toby Couture, Karlynn Cory, Claire Kreycik and Emily Williams, *A Policymaker's Guide to Feed-in Tariff Policy Design* (Golden, CO, National Renewable Energy Laboratory, 2010). Available from www.aaec.arkansas.gov/Solutions/Documents/A%20Policymakers%20Guide%20to%20Feed-in%20Tariff%20Policy%20Design.pdf (accessed 09 February 2012).

[4] Beyond Petroleum, *BP Statistical Review of World Energy* (London, 2010). Available from www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2008/STAGING/local_assets/2010_downloads/statistical_review_of_world_energy_full_report_2010.pdf (accessed 10 February 2012).

[5] ibid.

[6] Energy Information Administration, *International Energy Outlook 2011*, (Washington, D.C., 2011). Available from www.eia.gov/pressroom/presentations/howard_09192011.pdf (accessed 15 February 2012).

Figure 1: Global energy consumption by subregion (1990–2035)



Source: Energy Information Administration, *International Energy Outlook 2011* (Washington, D.C., 2011). Available from www.eia.gov/pressroom/presentations/howard_09192011.pdf (accessed 15 February 2012).

Successful feed-in tariff policies typically include three components:[7] 1) guaranteed access to the grid; 2) stable, long-term purchase agreements (typically 15–20 years); 3) payment levels to the renewable energy producer based on the costs of renewable energy generation; the actual payment amount is usually differentiated based on technology type, project size, quality of the resource and/or other project-specific variables (table 1).

How it works

A well-designed feed-in tariff can be both cost-effective and cost-efficient. The calculation of payment rates varies from country to country, depending on the national electricity infrastructure, energy prices and overall competitiveness of renewable energy compared with conventional energy sources. There are several variables that governments and policymakers can adjust to suit their country-specific characteristics and needs. Table 1 refers to some of the most commonly considered variables in the design of a feed-in tariff payment structure, ranging from the most basic to more sophisticated design options. The wide range of options provides flexibility for countries characterized by different requirements and economic conditions. Developing countries could start with a relatively simple design, such as a technology-specific feed-in tariff that is based on power generation costs. Over time, with technological advancement and in consideration of the economies of scale, more sophisticated design options could be added.

[7] Toby Couture, Karlynn Cory, Claire Kreycik and Emily Williams, *A Policymaker's Guide to Feed-in Tariff Policy Design* (Golden, CO, National Renewable Energy Laboratory, 2010). Available from www.aaec.arkansas.gov/Solutions/Documents/A%20Policymakers%20Guide%20to%20Feed-in%20Tariff%20Policy%20Design.pdf (accessed 09 February 2012).

Table 1: A spectrum of feed-in tariff design, adjustments and implementing options

Feed-in tariff configuration factors	• **Eligibility** determines which entities can participate (citizens, corporations, non-profit organizations, government entities, etc.) and whether there are limitations on which project types can qualify (technology, project size, location and in-service date). • **Contract duration** defines the period in which the feed-in tariff payments are awarded. Contract periods generally range from 5 to 20 years, with the majority lasting 15–20 years. Longer contract periods help to reduce payments and ensure cost recovery. • **Grid access** calls for clear protocols for transmission and interconnection issues to ensure that renewable energy projects can be connected to the grid in a timely way. • **Purchase obligations** (used by several countries) require energy providers, load- n system operators to purchase the entire output from eligible projects. • **Capacities** determine whether there is a limit on the renewable energy feed-in tariff programme, either restricting the promoted quantity of renewable energy or the project size due to the technology type or the total programme expenditure. • **Comprehensive revision** of the policy should be made mandatory every two to four years, including the tariff structure and implementing options. • **Forecasting obligations** for the output of renewable energy generators could help utilities and system operators to balance the variable output from different sources and technologies into the grid. • **Funding the feed-in tariff policy** will depend on how the legislation is proposed. Costs could be added to the rate base or by using tax revenues, carbon auction revenues or cost sharing among the energy providers. In any case, the financing mechanism should be fair and transparent, including the distribution of the incremental costs of new renewable energy capacity (including grid integration and balancing costs).
Feed-in tariff level factors	• **Provide a reasonable return**: The optimal tariff level varies on a national scale, due to the fact that hurdle rates for investments are orientated on the respective bank rates in every country. The tariff level should allow a payback period shorter than the length of the agreement. For instance, in Australia, the tariff should provide between five and ten years' time to pay off the upfront investment. The tariff could be set as a fixed-price feed-in tariff payment (independent of the market price of electricity) or premium-price feed-in tariff payment (adding a premium tariff to the spot market of electricity). • **Configuration by technology**: Costs to generate electricity differ depending on the renewable energy source (solar, wind, hydropower, among others). Payments should be adjusted accordingly to enable diversity of renewable energy technologies. • **Incorporate innovation:** The tariff should be designed to encourage the proliferation of innovative technologies; for instance, technologies that preserve open spaces, such as photovoltaic solar panels on rooftops. • **Consider size and location**: A variety of project sizes and locations should be incorporated. For instance, tariffs for smaller projects are usually higher. Feed-in tariff should vary according to each country's unique energy pricing structure and capacities.

Feed-in tariff adjustment factors	• **Fixed adjustments**: The feed-in tariff for new projects often decrease each year to incentivise technology improvement (tariff degression). • **Regular adjustments:** To avoid excessive rents, a feed-in tariff can be scheduled for periodical adjustments to updated energy market and technology conditions (for example, Germany adjusts every four years). • **Inflation adjustments**: Technological investment is subject to commodity prices. A feed-in tariff should be adjusted to help cover volatile prices.

Source: Toby Couture, Karlynn Cory, Claire Kreycik and Emily Williams, *A Policymaker's Guide to Feed-in Tariff Policy Design* (Golden, CO, National Renewable Energy Laboratory, 2010). Available from www.aaec.arkansas.gov/Solutions/Documents/A%20Policymakers%20Guide%20to%20Feed-in%20Tariff%20Policy%20Design.pdf (accessed 09 February 2012).

Strengths with the feed-in tariff

- **Flexibility:** As one of the most widely used mechanisms to promote power generation from renewable energies, a feed-in tariff possesses great flexibility in its design. Eligibility, contract duration, purchase obligation and capacities can be defined individually by each government. Additionally, the tariff level can be specified according to national market conditions, including the option to particularly promote certain renewable energy technologies, innovations or regional renewable energy development. Thus it easily can be adapted to varying levels of economic development and diverse policy priorities.

- **Investor confidence:** Ensuring long-term investment security through a feed-in tariff promotes investments in renewable energy industries and encourages manufacturers to expand the time horizon applied to the planning of their ventures. A profitability guarantee provided via a feed-in tariff also constitutes a strong incentive for private R&D investments, leading to cost reductions in innovation and technology developments.

- **Efficiency:** The simplicity, stability and fairness of a feed-in tariff mechanism leads to low administration and transaction costs, making it the most efficient policy for promoting renewable energy sources.[8]

- **Increased competitiveness:** Appropriately designed, feed-in tariff will increase the number of players in renewable energy market, which in turn promotes the competitiveness of the market and boosts R&D and innovations.

- **Social impact:** Effective implementation of feed-in tariff mechanisms also benefits the society as a whole by creating jobs and reducing carbon emissions and their negative accompanying effects. In the long run, feed-in tariff can be understood as a key driver for (local) economic growth and green industries in particular.

- **Comparative advantage:** The price guarantee and long-term policy certainty offered by a feed-in tariff have propelled some countries to the forefront of the global renewable energy industry and has created countless economic opportunities in new and emerging sectors, especially in the European Union and in China.

[8] Intergovernmental Panel on Climate Change, *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation* (Cambridge, United Kingdom, Cambridge University Press, 2011). Available from http://srren.ipcc-wg3.de/report (accessed 10 February 2012).

Challenges to using a feed-in tariff

- **Finding the right tariff level:** The tariff must be set at a level that enables businesses opting for renewable energies to compete against providers of conventional fossil resource-based energies. Finding this level, however, is not a static process. It demands flexibility and good knowledge of the mechanics behind the energy market. If a feed-in tariff is set too low, renewable energy providers will fall victim to the well-known market disadvantages experienced in industries that try to incorporate environmental and social externalities, and their investment will have little chance to pay off. If the tariff is set too high, it may provide unwarranted profits to developers and incur disproportional costs for the reduction of green house gas emissions on society, possibly disadvantaging more efficient reduction measures. Additional to the correct calculation of the tariff level at the point of introduction, it should be adjusted periodically, following signals from the renewable energy market and technology innovation sector.

- **Capacity and cost control:** Because a feed-in tariff can provide a strong incentive for renewable energy producers and manufacturers, policymakers need to ensure that there is a means to control the overall capacities and costs of its implementation. They have to make sure that public resources are managed efficiently and are not diverted away from other more pressing development goals.

- **Grid access:** The feed-in tariff requires a guaranteed, non-discriminatory access to the grid for all renewable energy producers, including residential, commercial and industrial customers; federal, state and local government agencies; and non-profit organizations. The grid access guarantee is important for both small-scale and larger industrial developments, at both the transmission and distribution levels. This presents a challenge for the energy infrastructure, which may need to connect often remote renewable energy sources to the well-established grid that is usually concentrated in an urban area. In addition, fluctuations in energy quantity supplied by renewable sources can affect energy security. Moreover, the grid access guarantee might weaken the incentive to place renewable energy plants in the most cost-efficient areas.

Examples

Box 1: Feed-in tariffs in selected European countries

Germany: Feed-in tariff legislation resulted in renewable energy development in which both small and large providers receive guaranteed profits from investing in renewable energy technology. Germany enacted its Electricity Feed Act (Stromeinspeisungsgesetz) in 1991, followed by the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz) in 2000, which was renewed and updated in 2004 and 2009. Germany has since become the world's largest market in solar photovoltaic use (as of 2009) (figure 2).[9] Additional policies were applied to support further R&D investments and to ease access to capital. Policies also included stimulating heat and transport fuel markets by introducing investments grants and low-interest loans for renewable energy heat systems. As a result, the capacity of renewable energy has doubled since 2000 and has created about 280,000 new jobs in the renewable energy industry.[10] In fact, it has generated three times more jobs per megawatt of capacity than the coal-fired electricity industry.[11] This successful use of the feed-in tariff is expected to enable Germany to increase its targets of renewable electricity generation to 35 per cent of the total electricity by 2020 and to 80 per cent by 2050.[12]

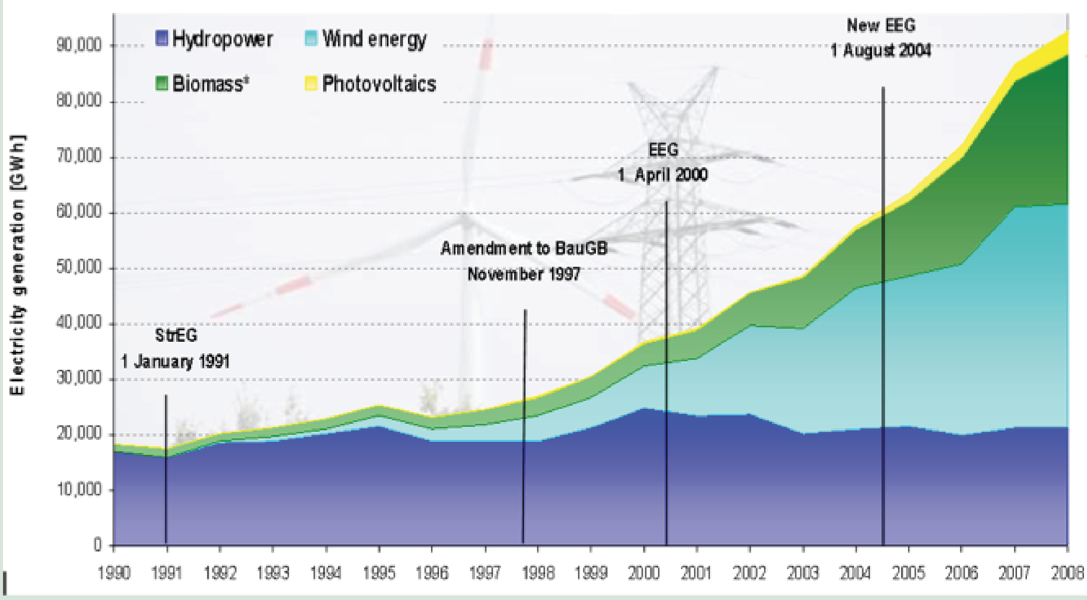
[9] Amber Sharick, *Renewable Energy Pricing: Context & the German Example* (Beijing, 2010). Available from www.cresp.org.cn/uploadfiles/1/1127/ms.amber_sharick.pdf (accessed 10 February 2012).

[10] ibid.

[11] United Nations Environment Programme, *Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World* (New York, 2008). Available from www.unep.org/labour_environment/PDFs/Greenjobs/UNEP-Green-Jobs-E-Bookp85-129-Part2section1.pdf (accessed 09 February 2012).

[12] Amber Sharick, *Renewable Energy Pricing: Context & the German Example* (Beijing, 2010). Available from www.cresp.org.cn/uploadfiles/1/1127/ms.amber_sharick.pdf (accessed 10 February 2012).

Figure 2: The development of feed-in tariffs and renewable energy in Germany



Source: Amber Sharick, *Renewable Energy Pricing: Context & the German Example* (Beijing, 2010). Available from www.cresp.org.cn/uploadfiles/1/1127/ms.amber_sharick.pdf (accessed 10 February 2012).

Spain: The feed-in tariff mechanism to stimulate the use of renewable energy was introduced in 1998. Due to the favourable payment levels adopted in the Royal Decree 661/2007, accompanied by long-term contracts (usually 25 years), the renewable energy industry has experienced an explosive growth. According to International Energy Agency estimates, 560 MW and 2,760 MW of solar photovoltaic capacity were added in 2007 and 2008, respectively.[13] Excessive remuneration for the photovoltaic installations, however, prompted the solar market to virtually ignite in 2008, resulting in a 500 per cent expansion.[14] This development quickly became unsustainable for the Spanish Government and led to a more specific law for solar technologies (Royal Decree 1578/2008). The new legislation included a cap on the photovoltaic capacity installed (500 MW in 2009–2010 and 400 MW in 2011–2012),[15] more restrictive requirements for renewable energy generators and differentiated feed-in tariff payments to achieve a better allocation of photovoltaic installations. A tariff adjustment mechanism was initiated to automatically correct the tariff according to the market development.

Application in developing countries

For developing countries, typically those featuring relatively non-liberalized power markets and fledgling levels of a renewable energy industry, one of the biggest challenges is securing sustainable funding mechanisms for a feed-in tariff. Although developing countries often possess a huge number of untapped renewable energy resources, the costs of promoting renewable energies via a feed-in tariff can be quite high because they lack sufficient grid infrastructure. Additionally, the opportunity costs for the public resources that flow into feed-in tariff financing are high in countries with pressing development issues, such as high poverty levels or unemployment rates, prevailing diseases or elevated child mortality rates.

To fill the financial void, developing countries can use revenues from international carbon trading schemes (such as through the Clean Development Mechanism) or regulate the number of eligible renewable energy projects to control the costs. In any case, they need to incorporate cost-controlling mechanisms from the beginning of the feed-in tariff application.

[13] Claire Kreycik, Toby Couture and Karlynn Cory, *Innovative Feed-In Tariff Designs that Limit Policy Costs* (Golden, Colorado, National Renewable Energy Laborator, 2011). Available from www.nrel.gov/docs/fy11osti/50225.pdf (accessed 09 February 2012).

[14] LeRoy Paddock and David Grinlinton, *Legal Framework for Solar Energy* (Washington D.C., George Washington University, 2009). Available from http://solar.gwu.edu/Research/GW%20Solar%20Legal%20Framework%20Report_March2010.pdf (accessed 09 February 2012).

[15] ibid.

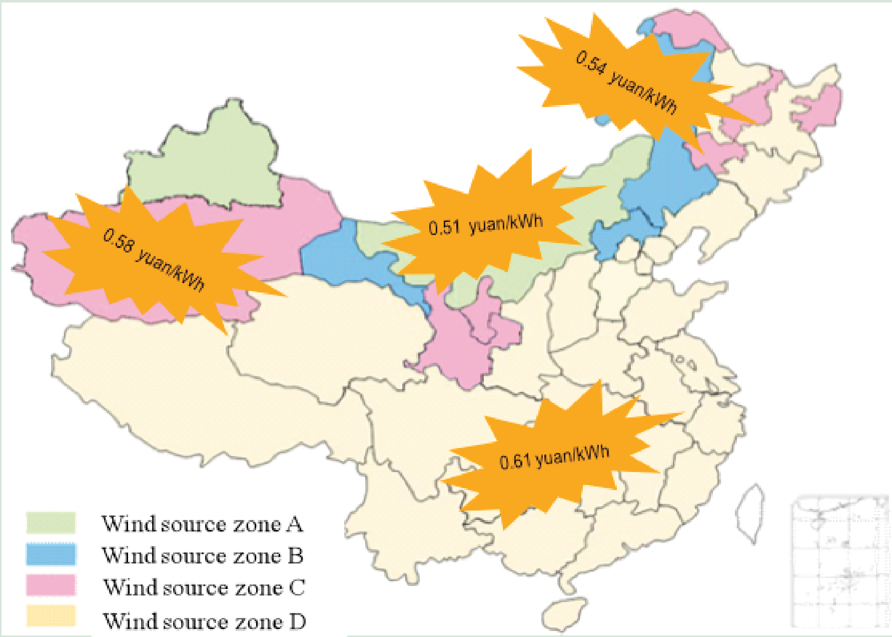
Box 2: Feed-in tariffs in selected countries in the Asia-Pacific region

Both industrialized and developing countries in the Asia-Pacific region are using a feed-in tariff in their policy framework, including Australia, China, India, Indonesia, Japan, Kazakhstan, Malaysia, Mongolia, Philippines, Republic of Korea, Sri-Lanka, Taiwan Province of China and Thailand.

Japan: The Government implemented an excess electricity purchase scheme under the electricity buyback programme in 2009 in which electricity utilities were required to pay 48 yen for excess electricity generated from photovoltaic sources over a guaranteed contract period of ten years.[16] Although the programme helped to promote electricity conservation, the Government recently enacted the Law on Special Measurement Concerning Procurement of Renewable Energy Sourced Electricity (August 2011), which includes a feed-in tariff mechanism. The scheme will start in July 2012 and utilities will have to buy electricity from photovoltaic, wind, biomass, geothermal and small hydropower generators. The goal is to increase the current 3 per cent of renewable energy share in Japan's power generation to 10 per cent by 2020.[17]

China: The Government inaugurated its feed-in tariff for wind power featuring varying tariff levels that were based on regional wind resource distribution in 2009 (figure 3). Since then, China has become the world's largest installer of wind energy plants.[18] The cumulative capacity of wind power installation reached 44.7 GW, which generated 50 TWh of green electricity in 2010[19] and covered about 1 per cent of the country's total electricity demand.[20] Although it may sound slight, this 1 per cent, or 50 TWh, is equal to the total annual amount of electricity produced in the whole of New Zealand.[21]

Figure 3: Feed-in tariffs for wind power in China



Source: Extracted from Liping Jiang et al., "Wind Energy in China", *IEEE Power & Energy Magazine* (2011), vol. 9, No. 6, pp. 36-46.

[16] Junko Edahiro, "Japan Begins Feed-in Tariff Scheme to Accelerate Renewable Energy Promotion", *Japan for Sustainability*, Newsletter No. 110, October 08, 2011.

[17] Japan Renewable Energy Policy Platform, *Renewables Japan Status Report 2010: Executive Summary* (Tokyo, 2010). Available from www.re-policy.jp/jrepp/JSR2010SMR20100427E.pdf (accessed 09 February 2012).

[18] Amber Sharick, *Renewable Energy Pricing: Context & the German Example* (Beijing, 2010). Available from www.cresp.org.cn/uploadfiles/1/1127/ms.amber_sharick.pdf (accessed 10 February 2012).

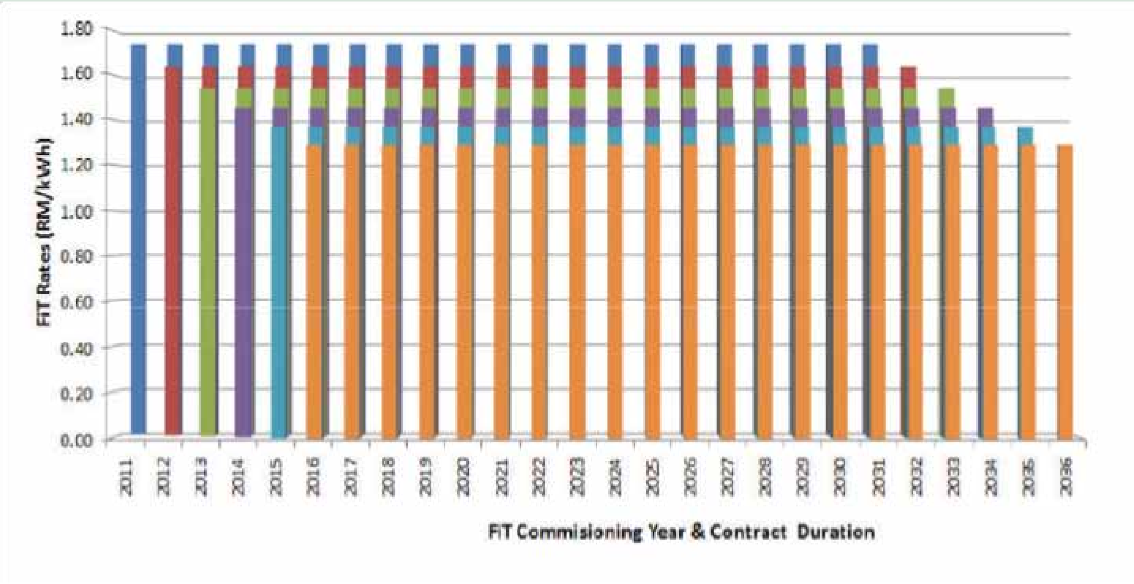
[19] Global Wind Energy Council, *Global Wind Report: Annual Market Update 2010 Wind report 2010* (Brussels, 2011). Available from www.indianwindpower.com/pdf/gwecReport_2010.pdf (accessed 10 February 2012).

[20] International Energy Agency and Energy Research Institute, *Technology Roadmap: China Wind Energy Development Roadmap 2050* (Beijing, the People's Republic of China, 2011). Available from www.iea.org/papers/roadmaps/china_wind.pdf (accessed 09 February 2012).

[21] Organisation for Economic Co-operation and Development website "Statistics from A to Z". Available from www.oecd.org/document/0,3746,en_2649_201185_46462759_1_1_1_1,00.html (accessed 1 March 2012).

Malaysia: In April 2011, the Government introduced an advanced renewable tariff system, which includes specific targets for each renewable energy technology. The scheme applies to renewable power plants generating up to 30 MW. The technologies included under the feed-in tariff mechanism are small-scale hydropower, biomass, biogas, waste and solar photovoltaic. The tariff payment rates include an automatic annual reduction that is based on the renewable energy source (figure 4) to stimulate rapid investment. It basically means that the sooner the renewable energy generators are connected to the grid, the higher the tariff payment will be that they receive. The plan is to expand the share of renewable energy to 5.5 per cent by 2015 and to 9 per cent by 2020.[22]

Figure 4: Renewable energy feed-in tariff degression in Malaysia



NOTE: The different colours indicate maximum tariff rates for contracts starting at different dates.

Source: David Jacobs, *FIT for Malaysia: Assessment of the Proposed Malaysian Feed-in Tariff in Comparison with International Best Practise* (Berlin, 2010).

Further reading

A Policymaker's Guide to Feed-in Tariff Policy Design, by Toby Couture, Karlynn Cory, Claire Kreycik and Emily Williams (Golden, CO, National Renewable Energy Laboratory, 2010). Available from www.aaec.arkansas.gov/Solutions/Documents/A%20Policymakers%20Guide%20to%20Feed-in%20Tariff%20Policy%20Design.pdf

Innovative Feed-In Tariff Designs that Limit Policy Costs, by Claire Kreycik, Toby Couture and Karlynn Cory (Golden, CO, National Renewable Energy Laboratory, 2011). Available from www.nrel.gov/docs/fy11osti/50225.pdf

Legal Framework for Solar Energy, by LeRoy Paddock and David Grinlinton (Washington, D.C., George Washington University, 2009). Available from http://solar.gwu.edu/Research/GW%20Solar%20Legal%20Framework%20Report_March2010.pdf

[22] David Jacobs, *FIT for Malaysia: Assessment of the proposed Malaysian Feed-in Tariff in Comparison with International Best Practise* (Berlin, 2010). Available from www.mbipv.net.my/dload/Jacobs+FIT_for_Malaysia+final.pdf (accessed 9 February 2012).

Geothermal energy

Geothermal energy explained

Geothermal energy is thermal energy generated from the Earth's crust. There are two types of uses of geothermal energy: electricity production and direct use for heat.

How it works

In the first case, geothermal energy drives a heat engine to produce electricity. Alternatively, the Earth's heat can be applied directly to provide heat for spaces and/or for industrial and agricultural processes. A geothermal heat pump (GHP), for instance, uses the moderate temperature difference in the ground to increase the efficiency of heating and cooling in buildings. Harnessing the Earth's thermal energy is easiest along the edges of tectonic plates where the crust naturally vents heat out through volcanic activity. However, new technology known as enhanced geothermal systems (EGS) is expanding the potential to use geothermal energy in other areas. EGS technology is capable of drilling and releasing geothermal energy from less permeable areas of the Earth's crust, also called the "hard rock".

Opportunities in Asia and the Pacific

- **Large potential along Ring of Fire islands:** The Earth's volcanic activity along the Ring of Fire island nations provides fertile ground for geothermal energy production in much of the region. A 1999 Geothermal Energy Association report listed 39 countries around the world that could be powered solely from geothermal energy, including seven countries in the region: Fiji, Indonesia, Papua New Guinea, Philippines, Solomon Islands, Tonga and Vanuatu.[1]
- **Broader capabilities in the region with the development of enhanced geothermal systems:** Further development of EGS technology could increase the potential for electricity production in the region greatly by making electricity production from geothermal plants more feasible and cost-effective outside of the Ring of Fire nations.[2]

Trends in development

The Asia-Pacific region accounts for a third of the world's geothermal electricity generation: Electricity production from geothermal only occurs in 24 countries worldwide, six of which are in Asia.[3] Across Asia, installed power capacity for geothermal energy reached 3,743 MW between 2008 and 2009.[4] These countries produced around 30 per cent of the world's geothermal electricity in 2009.[5]

Philippines is a regional and world leader in geothermal electricity: Philippines has the second-largest most installed geothermal capacity in the world, after the United States of America. In 2010, the 1,904 MW of installed

[1] Alison Holm and others, *Geothermal Energy: International Market Update* (Washington D.C., Geothermal Energy Association, 2010).

[2] ibid.

[3] It includes Philippines (1,904 MW), Indonesia (1,197 MW), Japan (536 MW), Russia (82 MW), China (24 MW) and Thailand (0.3 MW).

[4] Alison Holm and others, *Geothermal Energy: International Market Update* (Washington D.C., Geothermal Energy Association, 2010).

[5] International Energy Agency, *Statistics and Balances* (Paris, 2009). Available from www.iea.org/stats/index.asp (accessed 15 February 2012).

capacity on the islands was enough to supply around 17 per cent of the country's electricity needs in 2009, which was equivalent to 10,324 GWh.[6]

China leads in direct use applications: China is the world leader in direct use of geothermal energy, with 12,605 GWh in 2005.[7]

Strengths with geothermal energy

- **Steady supply:** Unlike wind and solar, electricity generated from geothermal is not intermittent, and it can be used to provide reliable base load power.
- **Scalability:** Geothermal can be used for various purposes at various scales, ranging from heating for individual households to powering an entire city.
- **Low operation costs of geothermal power:** Once constructed, geothermal power generation can be operated cost-effectively.

Challenges to using geothermal energy

- **High upfront capital and exploration costs:** Unfortunately, the high up-front costs of geothermal power due to the initial explorative drilling have slowed down the development of this highly reliable, long-term energy resource in Asia and the Pacific.[8] Despite having tapped less than half of the viable geothermal resources in the Philippines, for instance, geothermal electricity production in the Philippines has not significantly increased since the mid-1990s.
- **Limited areas for resource extraction without enhanced geothermal systems:** Geographical limitations to where geothermal energy can be harvested in a cost-efficient manner for electricity production will continue to limit development outside of the Ring of Fire countries.

Implementing strategies

Strengthen geothermal systems to extend capacity: Further development of EGS technology is supported by a number of OECD countries. Technology transfer, cooperation and financial incentives for domestic and international private investment will be important to ensure the development of geothermal energy production plants to meet the region's potential beyond the Ring of Fire.

[6] International Energy Agency website, "Electricity/Heat in Philippines in 2009". Available from www.iea.org/stats/electricitydata.asp?COUNTRY_CODE=PH (accessed 16 February 2012).

[7] R. Bertani, "Long-term projections of geothermal-electric development in the world", presented at the GeoTHERM Congress, Offenburg, Germany, 5-6 March, 2009. Available from www.iea-gia.org/documents/LongTermGeothermElecDevelopWorldBertanioffenburg23Feb09.pdf (accessed 26 September 2011).

[8] Z. Sarmiento and B. Steingrimsson, "Review on estimated power potential and realistic development of geothermal resources in leading geothermal countries", presented at the Short Course on Geothermal Development in Central America UNU-GTP, San Salvador, El Salvador, 25 November - 1 December, 2007. Available from www.os.is/gogn/unu-gtp-sc/UNU-GTP-SC-04-02.pdf (accessed 26 September 2011).

Green finance

Key points

- ***The primary role of governments is to encourage the flow of private finance in green growth through policies and financial instruments.***
- ***Policy frameworks should be predictable, stable and farsighted to encourage green investments.***
- ***Timing and strategy are crucial for the success of promoting policies.***

Green finance explained

There is no internationally agreed definition of green finance. The term describes a broad range of funding for environment-oriented technologies, projects, industries or businesses. A more narrow definition of green finance refers to environment-oriented financial products or services, such as loans, credit cards, insurances or bonds.[1] Green investing recognizes the value of the environment and its natural capital and seeks to improve human well-being and social equity while reducing environmental risks and improving ecological integrity.[2] Other terms used to describe green finance include "environmentally responsible investment" and "climate change investment".

How it works

Green industries and technologies are all at different levels of maturity, thus, requiring different levels of funding from different sources of capital. There are generally three sources: domestic public finance, international public finance and private sector finance. Domestic public finance refers to the direct funding by a government while international public finance refers to funding from international organizations and multilateral development banks; private sector finance consists of both domestic and international funding sources. Green financing can be packaged in different ways through various investment structures.

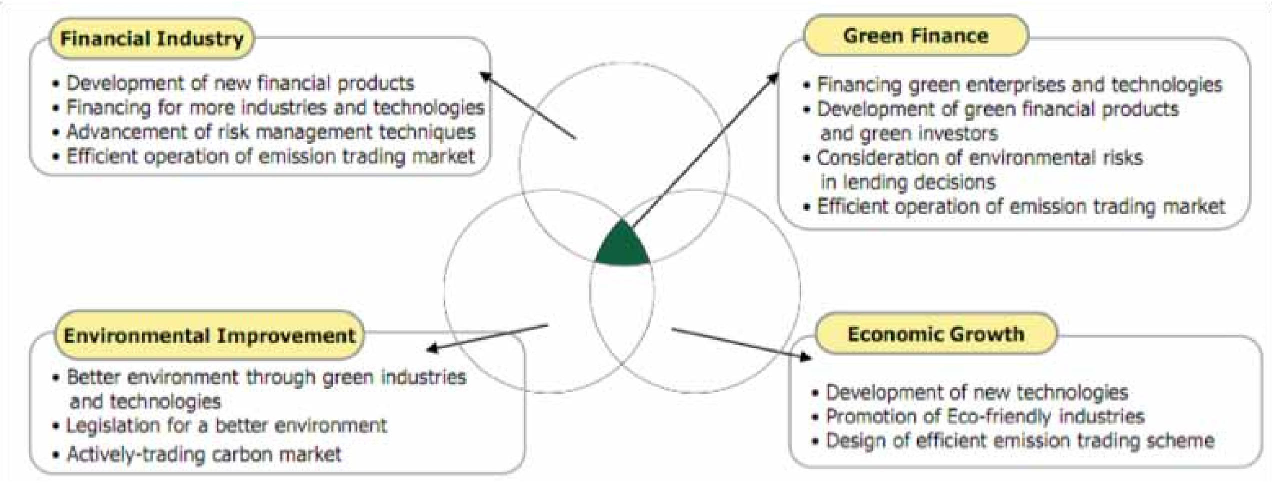
Green finance is a core part of low carbon green growth because it connects the financial industry, environmental improvement and economic growth (figure 1): "One missing link between 'knowing' and 'doing' in the transition to green industry is 'green finance'. All green industrial propositions cost money, and many green industry business models are more often than not untested or unconventional. Therefore, traditional finance may find it difficult or commercially unattractive to finance these green industrial propositions."[3]

[1] For more information on financial products and services, see United Nations Environment Programme Finance Initiative, *Green Financial Products and Services: Current Trends and Future Opportunities in North America* (Geneva, 2007). Available from www.unepfi.org/fileadmin/documents/greenprods_01.pdf (accessed 26 January 2012).

[2] United Nations Environment Programme, *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication* (Nairobi, 2011). Available from www.unep.org/greeneconomy/Portals/88/documents/ger/ger_final_dec_2011/Green%20EconomyReport_Final_Dec2011.pdf (accessed 26 January 2012).

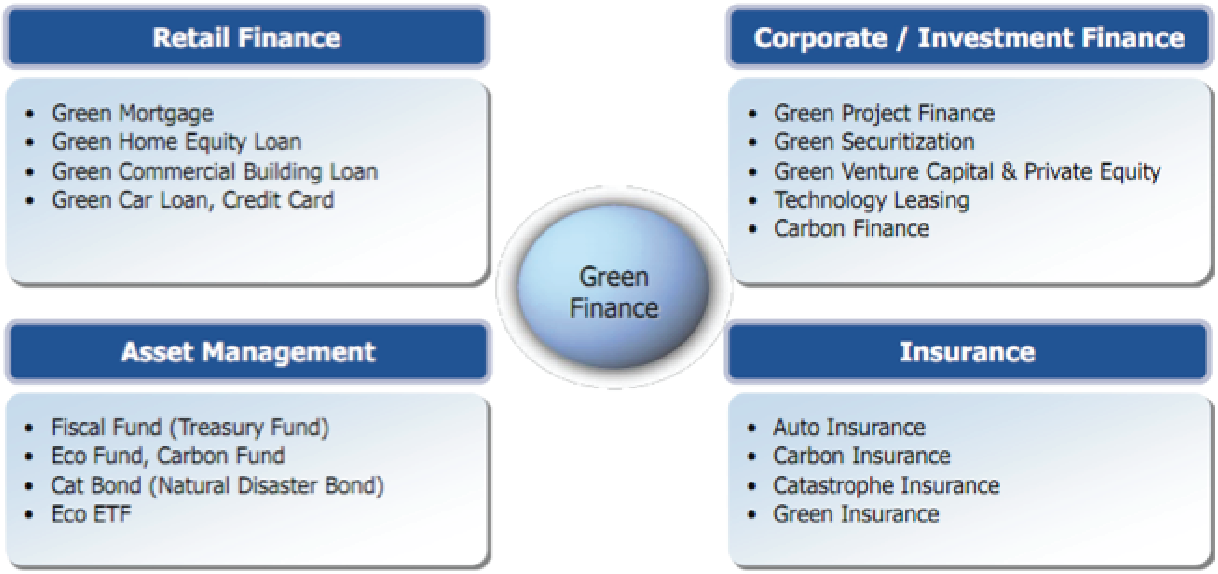
[3] Victor Zhikai Gao, *Green Finance for Green Industry and Green Economy* (Manila, 2009). Available from www.unido.org/fileadmin/user_media/UNIDO_Header_Site/Subsites/Green_Industry_Asia_Conference__Maanila_/Gao_pres.pdf (accessed 13 February 2012).

Figure 1: The green finance interface



Source: Jin Noh Hee, *Financial Strategy to Accelerate Innovation for Green Growth* (2010).

Figure 2: Green finance products



Source: Jin Noh Hee, *Financial Strategy to Accelerate Innovation for Green Growth* (2010).

Green finance spans many sectors and products (figure 2). Three categories for green finance are: infrastructure finance, financial assistance for industry or firms and financial markets. Green financing related to climate change includes mitigation and adaptation investments.

Many private investors perceive the risks of environmentally sustainable projects as not justified by the expected returns. Public financing mechanisms can tilt this balance in favour of perceived profitability; for example, by offering soft loans or guaranteeing loans from private banks. Public funding can help spur private investment. The United Nations Environment Programme estimates that US$10 billion of public funding for climate mitigation could leverage US$50–$150 billion of private investments.[4]

Even if public investment is small relative to private funds, it can catalyse corresponding private-sector activities. Direct government financing for green growth can also take place through sustainable public procurement and eco-efficient investment in public buildings and enterprises.

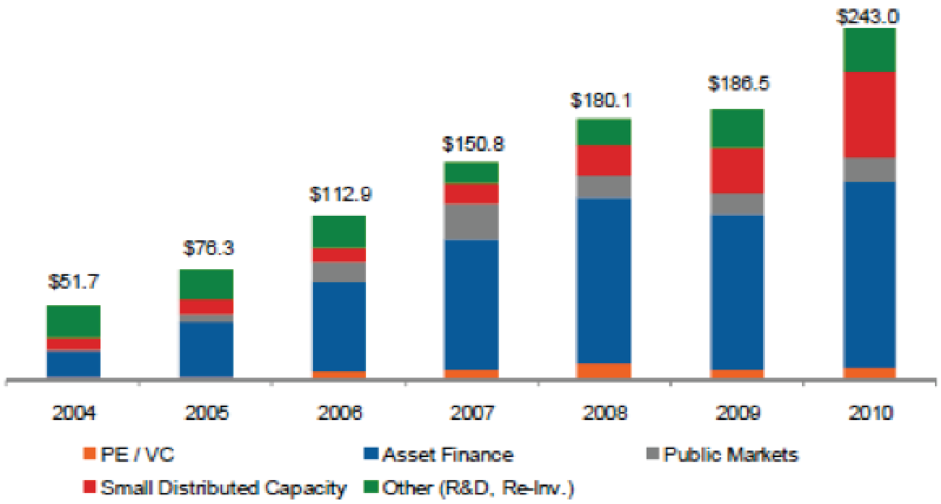
[4] United Nations Economic and Social Commission for Asia and the Pacific, Financing an Inclusive and Green Future: A Supportive Financial System and Green Growth for Achieving the Millennium Development Goals in Asia and the Pacific (Bangkok, 2010). Available from www.unescap.org/66/documents/Theme-Study/st-escap-2575.pdf (accessed 13 February 2012).

Generally, governments pursue the following objectives through green financing measures:[5]

- Establish and secure funding for green industries and green growth
- Support low carbon green growth by developing new financial products
- Attract private investments to build and sustain green infrastructure
- Strengthen corporate disclosure of green management practices and expand financial support for those businesses that apply them
- Set up markets for environmental goods and services, such as carbon markets featuring carbon credits.

If past trends can be taken as an indicator, then green investments possess great potential for growth in the future, especially for promoting clean energies (figure 3).

Figure 3: Total global investment in clean energy 2004–2010, including all asset classes (billions of US dollars)



Source: Deutsche Bank Climate Change Advisors, *Investing in Climate Change 2011* (2011).

Infrastructure finance

Much of the public investment in green growth relates to infrastructure. Governments of developing countries now have the opportunity to put infrastructure in place that will result in a better long-term management of resources, which will, in turn, channel private-sector capital into those investments. Infrastructure financing is generally project-based, with renewable energy and energy efficiency projects taking up the largest share of financing capital.[6]

Financial assistance for industry or firms

Some green industries need government financial assistance to mature or to become more competitive against well-established "brown" industries. Governments can give financial assistance to encourage businesses to invest in emerging green industries. They can also develop regulatory policy frameworks to help ease the access to financing from private investors or financial markets.

[5] Jin Noh Hee, *Financial Strategy to Accelerate Innovation for Green Growth* (Seoul, Korean Capital Market Institute, 2010). Available from www.oecd.org/dataoecd/4/4/45008807.pdf (accessed 13 February 2012).

[5] Deutsche Bank Climate Change Advisors, *Investing in Climate Change 2011* (Frankfurt, Deutsche Bank AG, 2011). Available from www.igcc.org.au/Resources/Documents/ExploringRiskAndReturn.pdf (accessed 13 February 2012).

Country experience: Geothermal investments in Indonesia

Indonesia houses 40 per cent of the world's known geothermal resources. Currently, it has 1.05 GW of geothermal capacity. The Government plans to add 9.5 GW of geothermal capacity by 2025, equivalent to about 33 per cent of the country's electricity demand. To increase private and international investment, the Indonesian Government announced a feed-in tariff for geothermal power and a 30 per cent net income tax reduction for six years for renewable energy. In addition, the Government created a US$400 million fund for the development of geothermal resources. Investment in geothermal projects in the country is estimated to amount to more than US$30 billion until 2025.[7]

Source: International Trade Administration, *Renewable Energy Market Assessment Report: Indonesia* (Washington, D.C., US Department of Commerce, 2010).

Promoting financial markets

Financial markets are an important source of green finance for publicly traded firms. Many institutional investors have adopted responsible investing, especially related to climate change, as part of their investment process.[8] Government support for environmental social governance schemes provides credibility to programmes, such as the Carbon Disclosure Project and eco-label initiatives, and encourages firms to become more environmentally responsible and thereby benefit from green financing schemes.

Box 1: Environmental social governance

Environmental social governance describes the environmental, social and corporate governance issues that investors consider in the context of their corporate behaviour. Although there is no definitive list of such issues, they typically display one or more of the following characteristics:

- Issues that have traditionally been considered non-financial or non-material
- A medium- or long-term horizon
- Qualitative objects that are readily quantifiable in monetary terms
- Externalities (costs borne by other firms or by society at large) not well captured by market mechanisms
- A changing regulatory or policy framework
- A public-concern focus

Source: United Nations Environment Programme and WBCSD, *Translating ESG into Sustainable Business Value* (Nairobi, 2010).

Institutional investors

Institutional investors often provide the largest source of funds for green investment. They are thought to control US$110 trillion in funds globally, including more than US$12 trillion from pension funds.[9] Generally, institutional investors have limited tolerance for risk, so they look for long-term policy stability in the countries where they aim to invest their money. Institutional investors invest in companies whose attitude to corporate social responsibility suggests that they have the potential for stable, long-term and sustainable growth. Additionally, they often take positions on the boards of larger companies to encourage them in this direction.

[7] Stuart Biggs, "Harnessing the heat of Indonesia's volcanoes", *Bloomberg Businessweek*, July 7, 2011. Available from www.businessweek.com/magazine/harnessing-the-heat-of-indonesias-volcanoes-07072011.html (accessed 16 February 2012).

[8] Deutsche Bank Climate Change Advisors, *Investing in Climate Change 2011* (Frankfurt, Deutsche Bank AG, 2011). Available from www.igcc.org.au/Resources/Documents/ExploringRiskAndReturn.pdf (accessed 13 February 2012).

[9] United Nations Economic and Social Commission for Asia and the Pacific, *Financing an Inclusive and Green Future: A Supportive Financial System and Green Growth for Achieving the Millennium Development Goals in Asia and the Pacific* (Bangkok, 2010). Available from www.unescap.org/66/documents/Theme-Study/st-escap-2575.pdf (accessed 13 February 2012).

Country experience: A carbon fund in Thailand

Thailand's market regulatory body, the Securities and Exchange Commission (SEC), approved the establishment of carbon credit funds in September 2011. The SEC also issued a set of guidelines for creating a carbon fund, aimed at asset management companies. The carbon funds can be used for investing in clean development mechanism projects and to buy carbon credits and carbon credit futures. The funds must invest at least 85 per cent of their net asset value in greenhouse gas reduction projects or carbon credits. In addition, investment in Thailand's carbon reduction projects must make up at least 65 per cent of the net asset value.[10] The carbon fund scheme provides an additional financing vehicle for institutional investors who are interested in supporting the reduction of emissions through certified emission reduction or voluntary emission reduction processes.

Source: Securities and Exchange Commission, *Request for Public Opinion Document on the Establishment and Management of Carbon Fund* (Bangkok, Government of Thailand, 2011).

Strengths of green finance

- **Promotes technology diffusion and eco-efficient infrastructure:** Investment in environmentally sound technologies, such as clean energy, may help bring down their costs and expedite wider technology diffusion. Developing countries can avoid the development model of "grow first, clean up later" because a great part of the green investment flows into infrastructure. This situation provides the opportunity for a country to leap ahead to eco-efficient infrastructure. The responsibility then falls on governments to develop infrastructure that will result in better long-term management of resources, which will in turn increase a country's competitiveness and channel private-sector capital into domestic green markets.

- **Creates comparative advantage:** Low carbon green growth may inevitably change from the current voluntary nature to a mandatory strategy in response to the rising pressures emanating from climate change and other environmental and economic crises. Expanding green finance today will mean a comparative advantage once environmental standards become stricter.

- **Adds value:** Businesses, organizations and corporations can add value to their portfolio by enhancing and publicizing their engagement in green finance. Thus they can give their business a green edge and thereby attract more environmentally conscious investors and clients alike.

- **Increases economic prospects:** Governments promoting green finance help buffer their societies against the time when resources become scarce by establishing and promoting domestic markets for alternative resources and technologies. They increase their economic prospects further by dipping into the new markets that possess great potential for employment generation. Because governments are primarily interested in maximizing the welfare of multiple generations, green financing mechanisms are particularly appealing in that they foster projects and developments that bear sustained benefits, especially in the medium and long terms.

Challenges to green finance

- **Present and projected Competitiveness:** Private investment in green growth in developing countries is constrained by both activity-specific and country-specific barriers that adversely affect the attractive ness of such investments, both in terms of investment returns and risk management. Increasing private investment in green growth will depend on the extent to which these investments become attractive relative to other opportunities, both domestically and internationally. Because international investors can look across different countries for opportunities, governments may need to implement a series of public interventions to make green investment opportunities more attractive.

[10] Securities and Exchange Commission, *Request for Public Opinion Document on the Establishment and Management of Carbon Fund* (Bangkok, Thailand, 2011).

- **Mispricing and no pricing of risks:** The overall investment and policy environment of a country contributes to its effectiveness in attracting private investors. The capital markets in some countries are not effective in pricing green growth-related risks. The extent to which the market misprices these risks or refuses to price them represents a barrier. In general, these risks include those associated with new technologies or processes that are not well understood and those related to the design, stability and transparency of domestic policies.

Country experience: Green Investment Bank in the United Kingdom

In 2010, the UK Government announced that it would create a Green Investment Bank that will invest in the green infrastructure projects that the market currently cannot adequately accommodate due to fear of the perceived associated risks. In March 2011, the UK Government published a report on several structures and models for a Green Investment Bank. The report notes that the UK Government committed 3 billion pounds in 2011 to fund the bank until 2015.[11] The Green Investment Bank will help accelerate additional investment in the green economy by complementing other green policies already set up by the Government. Investments will be made in various sectors, such as renewable energy, transport, waste and water. The Green Investment Bank aims to reach a "double bottom line of both achieving significant green impact and making financial return."[12] The institution is still in its preparation phase and will begin operating in April 2012.[13]

Source: House of Commons, European Scrutiny Committee, *Second Report of Session 2010–11* (2010).

- **Market distortions and shortcomings:** As long as subsidies for fossil fuels and the failure to internalize environmental externalities continue to distort the market price of energy, investment in green energy will have a hard time yielding attractive returns for investors. Adding to that is the limited number and diversity of green finance products and respective markets in which they can be traded.

- **Competing objectives:** While private investors aim to maximize the risk-adjusted returns for their investments, public green finance providers seek to achieve the highest possible environmental improvement and host-country policymakers are interested in achieving the best development prospects.[14]

- **Limited capital and limited awareness:** Many small- and medium-sized businesses are characterized by limited liquidity and access to capital, which hinders their participation in the green financing sector. The prevailing myopic time horizon of business strategies, which ignore benefits of green industries that lie in the far future, is another fundamental hurdle to private investments. Adding to that is the lack of experts who understand the complex relationship between environmental issues and financial markets.

- **Regulatory gaps:** Another barrier to the expansion of green finance is the gap in adequate regulatory and technical infrastructure to measure, assess and analyse green business strategies and financing.

[11] European Scrutiny Committee, *Second Report of Session 2010–11* (London, House of Commons, 2010). Available from www.publications.parliament.uk/pa/cm201011/cmselect/cmeuleg/428-ii/428ii.pdf (accessed 13 February 2012).

[12] Her Majesty's Government, *Update on the Design of the Green Investment Bank* (London, 2011). Available from www.bis.gov.uk/assets/biscore/business-sectors/docs/u/11-917-update-design-green-investment-bank.pdf (accessed 13 February 2012).

[13] Mark Kinver, "Clegg: UK Green Bank to Begin Investing in April 2012", *BBC News*, May 23, 2011. Available from www.bbc.co.uk/news/science-environment-13502121 (accessed 13 February 2012).

[14] United Nations High-Level Advisory Group on Climate Change Financing, *Work Stream 7 Paper: Public Interventions to Stimulate Private Investment in Adaptation and Mitigation* (2010). Available from www.un.org/wcm/webdav/site/climatechange/shared/Documents/AGF_reports/Work_Stream_7%20_Public_Private.pdf (accessed 13 February 2012).

Implementing strategies

Although there is no single best solution for the various situations and projects that demand green financing, there exist a number of interventions and measures that may be appropriate for common constraints and levels of development. In general, when businesses compare enabling environments for trade and investment, they look for: macroeconomic stability, potential for conflict and the degree of good governance, among other factors. Public interventions must address these topics and be applied in a manner that is transparent, long lasting and consistent if they want to stimulate private investment.

The following describes the various policy options that can improve the regulatory landscape to overcome investment challenges:

Information-building policy: Consumers, producers and investors all need to understand the positive economic and environmental effects of low carbon green growth. It is important they realize that this strategy poses an opportunity rather than a burden and that it will most likely transform from a voluntary path to a mandatory one in the long run. To improve the transparency needed for promoting a green financial market, impetus along the lines of corporate social responsibility needs to be expanded, such as the Carbon Disclosure Project or the UN Principles for Responsible Investment. It is also important to adopt stringent verification schemes for green technologies and green businesses to avoid confusion among consumers, to ensure that only those companies benefit from the green industry image that are truly part of it and to provide investors with the necessary information to make prudent investment choices.

Environmental regulations:[15] Environmental regulations include pollution standards and controls, public disclosure of information about environmental impacts, elimination of implicit subsidies for environmentally harmful or unsustainable growth (such as land use controls, building standards, land use planning, protection of natural buffer zones and water management and pricing) and improved sector governance and monitoring.

Markets for green finance products and environmental goods and services:[16] An often-cited example of a green market launched and developed by governments is the carbon market. In many countries so far, an emissions trading scheme was set up first; this included usually the enacting of legislation to govern membership, trading conditions and market surveillance for emissions trading. To ease the transition, governments can introduce pilot projects or voluntary trading schemes first and then slowly move to a mandatory trading system, encompassing lessons learned from the pilot phase, a legal base shift to "cap and trade" and the diversification of traded products.

Public financing: Because the cost of green investment projects, such as a renewable energy facility, is generally higher than conventional projects, governments should subsidize a portion in order to attract investors. Financing mechanisms include public competitive bidding, public procurement and public loans, grants or funds, like venture capital funds. In 2009, the carbon funds around the world held a total of US$16.1 billion in assets, which meant a 20 per cent increase compared with the previous year.[17]

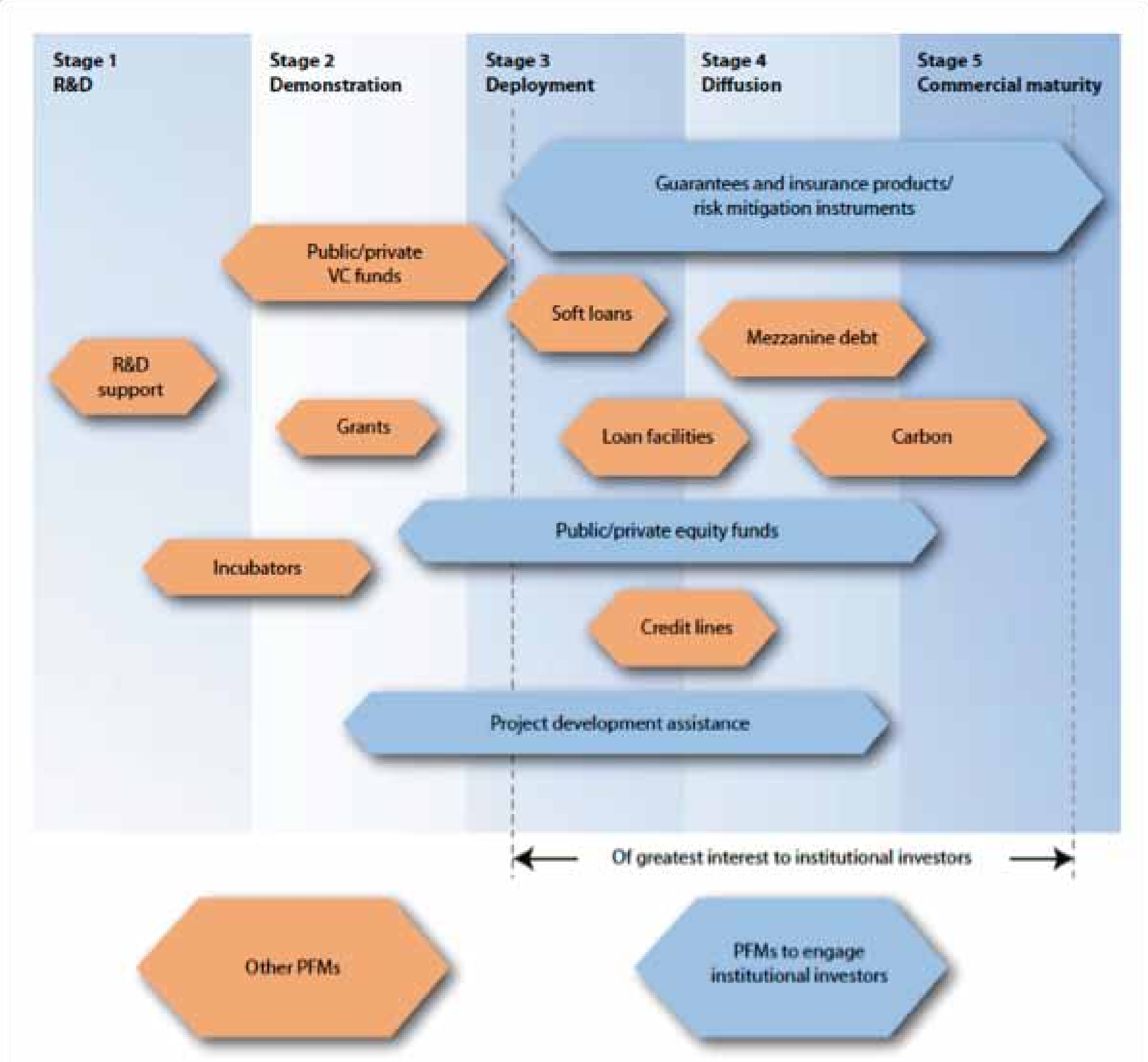
Government support targets only the early stages of development: Due to the risks associated with the use of new technologies and their relatively weak stance against the well-established brown technologies, which externalize environmental costs and profit from a fitting infrastructure system and well-developed supply chains, green businesses need government support, especially in the initial stages of their development. However, governments should aim to attract and empower other financial institutions to take over their role as active facilitators of green businesses once they enter a mature stage (figure 4).

[15] United Nations High-Level Advisory Group on Climate Change Financing, *Work Stream 7 Paper: Public Interventions to Stimulate Private Investment in Adaptation and Mitigation* (2010). Available from www.un.org/wcm/webdav/site/climatechange/shared/Documents/AGF_reports/Work_Stream_7%20_Public_Private.pdf (accessed 13 February 2012).

[16] Jin Noh Hee, *Financial Strategy to Accelerate Innovation for Green Growth* (Seoul, Korean Capital Market Institute, 2010). Available from www.oecd.org/dataoecd/4/4/45008807.pdf (accessed 13 February 2012).

[17] Orlando Fernández, *Carbon Funds at the Crossroads* (Practical Law Publishing Limited, 2010). Available from www.practicallaw.com/cs/Satellite?blobcol=urldata&blobheader=application%2Fpdf&blobkey=id&blobtable=MungoBlobs&blobwhere=1247280598680&ssbinary=true (accessed 13 February 2012).

Figure 4: Public financing mechanisms across the stages of technological development



Source: United Nations Environment Programme, *Renewable Energy Investing in Energy and Resource Efficiency* (Nairobi, 2011).

Green finance policy measures for Asia and the Pacific

The Korea Capital Market Institute has summarized appropriate policy measures for promoting the green financing sector in the Republic of Korea (table 1) – although these policy points are easily transferable to other countries in Asia and the Pacific that are pursuing low carbon green growth.

Table 1: Policy measures promoting the green finance sector

Policy measure	Description
Environmental requirements reflected in statutes for investment, lending, credit rating, accounting, etc.	• Require financial institutions to address environmental concerns: fiduciary and lender's liability on the environment • Reflect environmental factor in credit rating and accounting procedures
Corporate disclosure of environmental information	• Put environmental information as a requirement for listing and disclosure • Shift from voluntary to mandatory disclosure gradually o Finance institutions in industrialized countries already are required to disclose comprehensive environmental information pursuant to voluntary guidelines, such as the Global Reporting Initiative
Certification of green Technology, enterprise and industry to guide investment and lending	• Introduce green business certification programmes, which are specific to industry, technology, business type and size o Leading financial institutions, such as Goldman Sachs, rate environmental performance; for example, categorizing green and non-green businesses
Green indices	• Develop a green enterprise index to promote green investment • Develop a green (carbon) risk index to promote investment in green bonds o JPMorgan and Innovest co-developed the JPMorgan Environmental Index-Carbon Beta (JENI-Carbon Beta Index), the world's first bond index that reflects climate change risk of businesses
System for green information provision	• Build a mechanism to access essential green information o Information for financial institution's credit and investment decisions: license and approvals from the environment ministry and other authorities, regulatory compliance, green enterprise designation, participation in voluntary agreements, etc.
Green enterprise rating agency	• Promote green company rating agencies o Three major rating agencies that specialize in corporate environmental performance are Innovest (US), EIRIS (UK) and SAM (Switzerland)
Green financial professionals	• Train professionals for research, review and investment to provide green financial services o Introduce professional training programmes and promote expertise
Green financial consumer education	• Initiate public and consumer education to promote awareness of: o The need for green growth o Green bubbles, environmental risks and other issues
Conference on green finance in Asia	• Organize an annual conference on green finance in Asia o One example is the Conference on Sustainable, Responsible, Impact Investing in North America (also known as SRI in the Rockies)

Source: Jin Noh Hee, *Financial Strategy to Accelerate Innovation for Green Growth* (2010).

Further reading

An Inclusive and Green Future: A Supportive Financial System and Green Growth for Achieving the Millennium Development Goals in Asia and the Pacific (Bangkok, United Nations Economic and Social Commission for Asia and the Pacific, 2010). Available from www.unescap.org/66/documents/Theme-Study/st-escap-2575.pdf

Green Investing: Toward a Clean Energy Infrastructure (Geneva, World Economic Forum, 2009). Available from www.weforum.org/reports/green-investing-2009-towards-clean-energy-infrastructure

Translating ESG into Sustainable Business Value (Geneva, United Nations Environment Programme and World Business Council for Sustainable Development, 2010). Available from www.unepfi.org/fileadmin/documents/translatingESG.pdf

FACT SHEET

Green industry

Key points

- ***A green industry is the core driver of economic competitiveness and sustainable growth.***
- ***A system change approach is needed to green industries.***
- ***Greening an industry is not an ad hoc, straightforward process but is dynamic and enduring.***

Green industry explained

The United Nations Industrial Development Organization (UNIDO) defines the green industry vision as: "The potential for industries to decouple economic growth and revenues from excessive and increasing resource use and pollution. It foresees a world where industrial sectors minimize waste in every form, utilize renewable resources as input materials and fuels, and take every possible precaution to avoid harming workers, communities, climate, or the environment. Green industries will be creative and innovative, constantly developing new ways of improving their economic, environmental and social performance."[1]

A green industry is the concept of promoting sustainable consumption and production patterns in the manufacturing of products.[2] This involves both the greening of existing products and the creation of green industries that deliver environmental goods and services. A green industry requires manufacturers to accept responsibility for the environmental impacts of their product or service throughout its whole life cycle.

A green industry aims to:

- Improve the efficiency of conventional industries and supply chains
- Create new types of products, such as renewable energy, recycling technologies and organic food production
- Create environmental analysing and advisory services, such as an energy service company, which includes analysis and calculation of ecological footprints
- Create new types of services that are more ecologically friendly, such as ecotourism.

How it works

Greening of industries

All industries, regardless of the sector, size or location, continuously need to improve their environmental performance. This includes commitment to and actions aimed at reducing the environmental impacts of processes and products by using resources more efficiently, phasing out toxic substances, substituting fossil fuels with renewable energy sources, improving occupational health and safety at the worksite, taking increased producer responsibility and reducing the overall risks for the environment.

[1] United Nations Industrial Development Organization, *Green Industry: Policies for Supporting Green Industry* (Vienna, 2011).

[2] In the Report of the World Commission on Environment and Development: *Our Common Future* from the 1987 United Nations General Assembly, sustainable business has been addressed as a business that "meets the needs of the present world without compromising the ability of the future generations to meet their own needs".

Energy and resource efficiencies drive the greening of industries, which is a worthwhile pursuit for businesses because it reduces the cost of production as well as the cost of compliance with future environmental standards.[3]

Industrial ecology

The realization that industrial systems can mimic biological ecosystems – in that one organism's or business's waste is the source of food for another organism or business – has led to the concept of "industrial ecology". One of the strengths of industrial ecology is its "systematic view" of patterns of production, consumption and resource recovery. A basic principle is that a plan for greater resource efficiency and reduced pollution must be integrated across all resource flows, economic sectors, public and private activities and both the short- and long-term time horizons.[4]

How to green an industry

There are many practical approaches to greening an industry, such as:

- Circular economy
- Cleaner production
- Industrial symbiosis
- 3Rs – reduce, reuse and recycle

Country experience: Circular economy policy in China

China is implementing far-reaching policy measures to increase its resource efficiency. This includes the Resource Saving Initiative (2006–2010), which was introduced in the Eleventh Five-Year Plan for Strengthening the Vision of a Green China.

The circular economy policy was established in 2008 through the Circular Economy Promotion Law, which was intended to guide China's economic development in ways that conserve energy, water and materials and protect the environment. The Chinese Government believes development, based on the circular economy, will be essential for the country to sustain its fast-paced growth while mitigating negative ecological impacts and creating more job opportunities.

The circular economy approach integrates cleaner production and industrial ecology into a broader system that encompasses industrial companies, networks or chains of companies, eco-industrial parks and regional infrastructure to support resource efficiencies. The Chinese circular economy sets action targets on three levels:

1. **Company level:** The manager must seek much higher efficiency through the "reduce, reuse and recycle" approach to cleaner production.
2. **Industry level:** Reuse and recycle resources in industrial parks and in clustered or chained industries so that the resources circulate fully within the local production system.
3. **Regional level:** Integrate different production and consumption systems in a region so that resources circulate among industries and urban systems.

The circular economy law states that national, regional and local authorities and government institutions should be responsible for organizing, coordinating and regulating the circular economy initiatives.

The eleventh plan strongly advocated economic development that is in harmony with environmental and resource sustainability and social welfare across the country, including in the less developed western region of China. This economic and social development dimension of the circular economy policy was reaffirmed in the

[3] Pierre Desrochers, "Cities and industrial symbiosis: some historical perspectives and policy implications", *Journal of Industrial Ecology* (2001), vol. 5, No. 4.

[4] Asian Development Bank and Institute of Global Environmental Strategies, *Towards Resource-Efficient Economies in Asia and the Pacific: Reduce, Reuse and Recycle* (Manila, 2008). Available from www.adb.org/Documents/Papers/Resource-Efficient-Economies/Resource-Efficient-Economies.pdf (accessed 20 January 2011).

Twelfth Five-Year Plan (2011–2016). The National Development and Reform Commission selected more than 1,300 enterprises to join a pilot programme to promote circular economy strategies. At the end of 2011, the agency published a list of 60 companies that had successfully adopted circular economy practices and were promoted as models for other enterprises in China.[5]

Companies applying circular economy strategies

With the Government's strong backing, several companies have been testing the concept:

- Yanjing Beer Group, the world's eighth-largest and Beijing-based brewery, invested in several technologies to cut water and energy consumption in its facilities. This included installation of devices to trap heat and gases generated during the fermenting and brewing processes for use in other procedures and wastewater recycling for use in the cooling system.[6]

- Tangshan Iron & Steel, based in Tangshan City in Hebei Province, installed desulfurizing and dust-removal devices to reduce the air pollution its facilities generated. It also uses secondary energy and constructed a 300 million yuan wastewater treatment plant.[7] The facility is the largest in northern China. It treats urban wastewater for use in the steel manufacturing process and thus avoids the consumption of freshwater.

Source: Zengwei Yuan, Jun Bi and Yuichi Moriguichi, "The circular economy: A new development strategy in China", *Journal of Industrial Ecology* (2006), vol. 10, No. 1-2, pp. 4-7.

Box 1: Cleaner production

Cleaner production is a strategy for improving natural resource efficiency, reducing and eliminating wastes and pollution, and minimizing risks to human health. Cleaner production is achieved by applying know-how, improving technology and changing attitudes. It goes beyond pollution control and waste management by directly managing production processes and introducing environmental management systems. Recently, the concept of cleaner production expanded to include product life-cycle aspects, such as eco-design and consumption patterns.

The United Nations Environment Programme defines cleaner production as "the continuous application of an integrated preventive environmental strategy to processes and products to reduce risks to humans and the environment. For production processes, cleaner production includes conserving raw materials and energy, eliminating toxic raw materials and reducing the quantity and toxicity of all emissions and wastes before they leave a process. For products, the strategy focuses on reducing impacts along the entire life cycle of the product, from raw material extraction to the ultimate disposal of the product."[8] The goal of cleaner production is to avoid generating waste and to minimize the use of raw materials and energy.

Source: United Nations Environment Programme website "UN Clean Production Programmes". Available from www.cleanproduction.org/Steps.Process.UN.php (accessed 24 January 2012).

[5] The Central People's Government of the People's Republic of China, *Case Study for the Companies Who Initiate the Circular Economy in China* (Beijing, 2011).

[6] Kultida Samabuddhi, "A Circular Sustainability," *Bangkok Post*, August 15, 2011, sec. B9.

[7] ibid.

[8] United Nations Environment Programme website "UN Clean Production Programmes". Available from www.cleanproduction.org/Steps.Process.UN.php (accessed 24 January 2012).

Country experience: Eco-efficiency reaps huge profits in the Republic of Korea

In an eco-industrial park, the waste generated by one company is used as a resource for another (industrial symbiosis), leading to a clear business case for a green industry practice. The eco-industrial park in Gyeonggi Province in the Republic of Korea demonstrates how linking various actors can promote eco-efficiency and generate win-win situations. Following an initial government investment of 440 million won, the recovery of copper from wastewater as well as the reuse of the treated wastewater now generates an annual profit of 4.72 billion won.[9] In this arrangement, Hwabaek Engineering Co. Ltd recovers copper from wastewater produced by PCB company (Daeduk GDS Co. Ltd) and returns the treated water back to PCB before selling the recovered and refined copper.

Key to the success of the initiative was the strong role of the Government in setting up the enabling conditions. The legal framework Act to Promote an Environment-Friendly Industrial Structure implemented in 1995 was followed by a series of actions to transform industrial complexes into eco-industrial parks. Five pilot projects were launched with the purpose of developing an eco-industrial park model in the first phase (2005–2009). The second phase (2010–2014) is in line with the Government's low carbon, green growth five-year plan, in which the main focus is encouraging replication of good practices through a communication network. Eight eco-industrial parks now operate with support and coordination from the Ministry of Knowledge Economy. According to the Government, the annual resource savings is equivalent to 41.2 billion won. Additionally, the eco-efficiency in the parks avoids the annual generation of 37,000 tonnes of wastewater and 280,000 tonnes of CO_2.[10]

Source: Ministry of Knowledge Economy, Republic of Korea, "Outcomes and Future of Korea's Eco-Industrial Parks Optimizing Resource Efficiency", *News Release*, December 1, 2010.

Country experience: Reducing, reusing and recycling policy in Japan

The Government of Japan adopted a policy of reduce, reuse and recycle (3Rs) to create a sustainable society – one that achieves a balance between the economy and the environment. To reach that balance, the Government is moving from a sole focus on hazardous substance management towards a greening of the entire economy. The 3Rs policy promotes technological development in the areas of resource efficiency and waste recovery and recycling. Additionally, it fosters the development of new green products for both economic and employment growth. As a result, there have been substantial investments in developing energy-efficient home appliances, office equipment and recycling infrastructure.

What are the 3Rs?

The 3R philosophy centres on reducing waste and reusing and recycling resources and products. The amount of waste that is produced should be decreased, products or their parts should be used repeatedly and waste should enter the production cycle as a substitute for raw natural resources. By promoting the 3Rs, waste can be minimized in an efficient way, leading to the reduction of overall resource consumption.

A new approach to reduce waste is the "extended producer responsibility" in which manufacturers are held responsible, to a certain extent, for the adequate reuse, recycling and disposal of their discarded products. Japanese manufacturers are required to adopt the life-cycle assessment approach to minimize the negative impacts of their products on the environment throughout the lifespan of those products. This requirement has succeeded in encouraging manufacturers to develop products that are less likely to turn into waste, easy to reuse or recycle or have little impact on the environment when discarded.

Legal system for a material-cycle society

The Fundamental Law for Establishing a Sound Material-Cycle Society (2000) is the legal framework for promoting

[9] Ministry of Knowledge Economy of Republic of Korea, "Outcomes and Future of Korea's Eco-Industrial Parks Optimizing Resource Efficiency", *News Release*, December 1, 2010.

[10] ibid.

the 3Rs policy.[11] Additionally, the Law for Promotion of Effective Utilization of Resources (2001) was enacted to cover the production stage along with various laws regulating the collection and recycling of waste. The Waste Management and Public Cleansing Law (1970) covers waste management. The Law on Promoting Green Purchasing (more formally the Law Concerning the Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities, 2000) encourages the purchase of eco-friendly products by the State, institutions and local governments and promotes consumer demand for such products.

Source: Japan's Experience in Promotion of the 3Rs (Tokyo, Ministry of Environment, 2005).

Box 2: Clean coal technologies

The term clean coal technology refers to a suite of coal combustion, conversion and emission-reduction technologies. Clean coal technology increases coal use efficiency and reduces the environmental impacts that using coal causes. The different technologies involved are at various maturity and commercialization stages. Technologies such as low nitrogen oxide burners and flue gas desulfurization are important for reducing the emission of harmful gases associated with acid rain and are highly commercialized. Emerging technologies such as ultra-supercritical steam cycles and integrated gasification combined cycle are still in the demonstration phase.

Although emissions-control technologies continue to improve and new conversion technologies can achieve higher efficiencies, the technical risks, lack of operational experience and uncertainties over carbon pricing keep them from becoming cost competitive with traditional coal-fired electricity plants. While there is a clear theoretical limit for thermal conversion efficiency, excluding carbon capture and storage, it is not yet clear when and where the limits of emission control will be reached.

The selection of clean coal technology will depend on many factors, such as environmental standards, capital cost, operation and maintenance considerations and future carbon charges. The characteristics and quality of coal used can affect the conversion efficiency, capital cost and emission performance of a power plant, and thus plant developers must also take the long-term supply of coal into consideration. The need for flexibility to meet future environmental requirements (such as the ability to retrofit carbon capture and storage facilities to existing plants) may create a preference for technology that features the lowest cost in this respect. However, coal power plants will be expensive to retrofit regardless of the clean coal technology selection, and there are currently no commercially viable technologies that offer the necessary flexibility for a plant to be "capture-ready".

Source: Massachusetts Institute of Technology, *The Future of Coal Options for a Carbon-Constrained World* (Boston, MA, 2007).

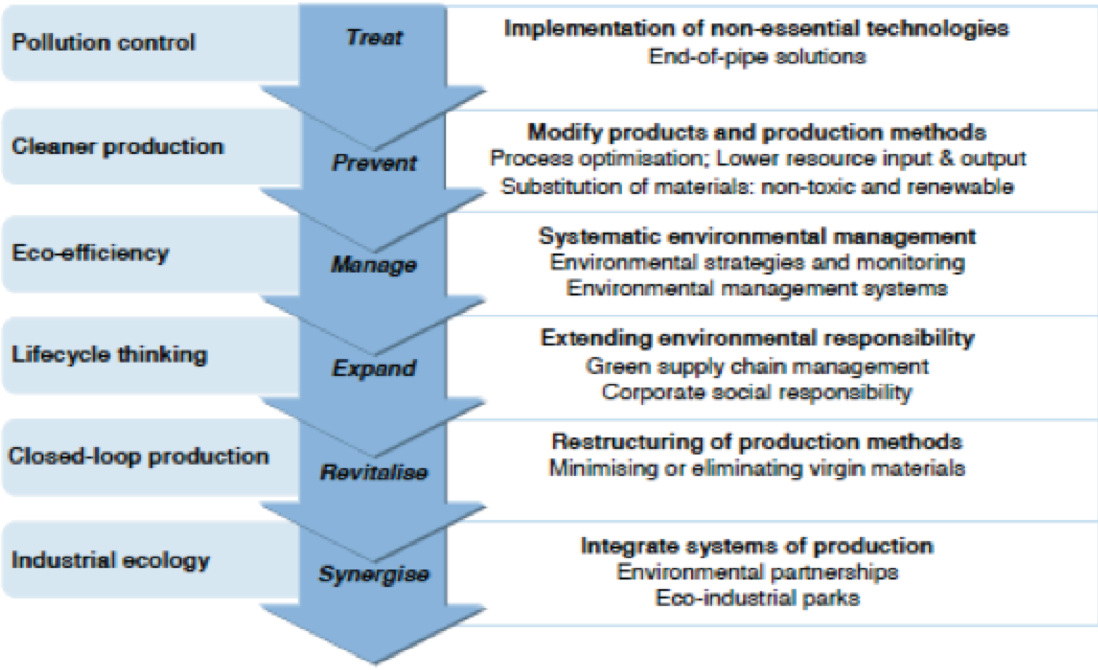
Creating green industries

Businesses that provide green goods and services encompass many sectors and products, including waste management, ecotourism, renewable energy and air pollution control. The segment also encompasses environmental and energy consultants in addition to the providers of integrated solutions, such as energy service companies.

Each country will need to create its own version of green industries. A ready-made solution, universally applicable, is not feasible due to each country's unique natural resources and economic, social and industrial circumstances. The energy supply infrastructure, demand patterns and government capacity also differ from country to country.

[11] Japan, *Japan's Experience in Promotion of the 3Rs* (Tokyo, Ministry of Environment, 2005). Available from www.env.go.jp/recycle/3r/en/approach/02.pdf (accessed 29 January 2012).

Figure 1: The evolution of greening industry concepts and practices



Source: Organisation for Economic Co-operation and Development, *Sustainable Manufacturing and Eco-Innovation: Framework, Practices and Measurement* (Paris, 2009). Available from www.oecd.org/dataoecd/15/58/43423689.pdf (accessed 5 March 2012).

Strengths with green industries[12]

Environmental

- Reduces energy consumption and increases energy-efficiency.
- Reduces water consumption and increases water-use efficiency.
- Minimizes waste due to the recycling of materials in which residues from one process or industry are re-sold as inputs to other industries.
- Reduces the total environmental costs from virgin mineral extraction.
- Encourages brownfield redevelopment, whereby eco-industrial developments are located in existing industrial areas and help facilitate a co-location and linking of businesses.

Economic

- Avoids the costs for waste disposal.
- Reduces the costs for raw material purchases.
- Reduces the costs for energy and water.
- Reduces costs through the sharing or centralizing of material managing services.

[12] R. J. Klee, *Eco-Industrial Development Primer* (Connecticut, 1999). Available from http://environment.research.yale.edu/documents/downloads/0-9/106eip-cels_exercise1.pdf (accessed 29 January 2012).

Challenges for green industries

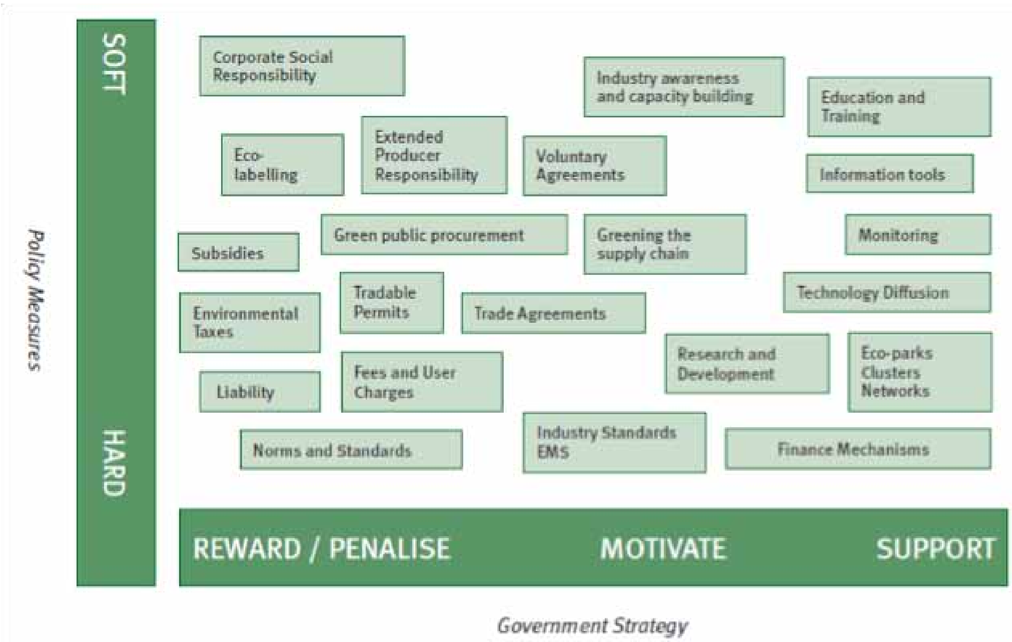
- Relatively low profitability compared with many conventional industries.
- Conflicts of interests between brown and green industries, such as in their attitudes towards cap and trade or carbon tax, prevents them from working together.
- Existing production and consumption patterns dominate throughout the whole manufacturing chain.
- Unclear policy signals and lack of commitment from the government, resulting in short-term policies only.
- Lack of data on green industry development, which makes it hard to assess respective trends, opportunities and barriers and then form effective policies.
- Short-sightedness of conventional business strategies, which ignore benefits in the far future.
- Greening of industries on a national level can induce disadvantages in international markets, which are still dominated by conventional products and production chains and not conditioned to strict environmental standards.

Implementing strategy

Long-term policy: Driving economic growth with green industries means to either increase competitiveness in international markets for green goods and services, such as ecotourism or organic products, increase productivity or create new industries through innovations. Green industry efforts need a long-term government policy that clearly signals to all businesses that a shift towards a low-carbon emitting, resource-efficient economy is obligatory. A long-term and stable government policy will draw private investment into the green industries. Further research that unravels the mechanics behind the fairly new green industries will help policymakers to promote the right strategies.

From a public policy perspective, the greening of industries cross-cuts a range of policy streams. These include industrial policy (such as technology development), environmental policy (such as resource conservation measures) and regional development policy (such as the provision of local infrastructures). Within this policy context, UNIDO has suggested a "policy matrix for the greening of the industries" (figure 2). In the matrix, "green industry policies" refer to the broad range of government interventions that directly or indirectly support the greening of industries.

Figure 2: Policy matrix for the greening of industries



Source: United Nations Industrial Development Organization, *Green Industry: Policies for Supporting Green Industry* (Vienna, 2011). Available from www.unido.org/fileadmin/user_media/Services/Green_Industry/web_policies_green_industry.pdf (accessed 5 March 2012).

Further reading

A Greener Footprint for Industry (Vienna, United Nations Industrial Development Organization, 2009). Available from www.unep.or.jp/ietc/spc/news-nov09/UNIDO_GreenIndustryConceptEbook.pdf

Are You a Green Leader? Business and Biodiversity: *Making the Case for a Lasting Solution* (Nairobi, United Nations Environment Programme, 2010). Available from www.unep.fr/scp/business/publications/pdf/Are_you_a_green_leader_final_publication.pdf

FACT SHEET

Green jobs

Key points

- ***Green jobs lead to a net gain in the number of employment opportunities, especially in developing countries.***

- ***Ensuring that the demand for quantity and quality of green employees can be met is a pressing policy task.***

- ***Governments have to ensure that the green industry sector matures fast and well enough to take over the role as facilitator of and investor in green jobs.***

Green jobs explained

A green job[1] is defined as a "position in agriculture, manufacturing, R&D, administrative and service activities aimed at alleviating the myriad environmental threats faced by humanity. Specifically, but not exclusively, this includes jobs that help to protect and restore ecosystems and biodiversity, reduce energy consumption, decarbonizes the economy, and minimize or altogether avoid the generation of all forms of waste and pollution."[2] A successful strategy to green the economy and create green jobs involves environmental and social full-cost pricing of energy and material inputs to discourage unsustainable patterns of production and consumption. The United Nations Environment Programme (UNEP) adds that a "green economy is an economy that values both nature and people and creates decent and adequately paid jobs."[3]

How it works

Governments should have a strong hand in creating a qualified workforce for green industries. UNEP and the International Labour Organization describe four ways in which employment will be affected as an economy moves towards a greener and more sustainable path:[4]

1) Additional jobs will be created, such as in the manufacturing of pollution-control devices, maintenance of renewable energy installations or management of green businesses.

2) Some existing employment in support of conventional growth patterns will be substituted by new "green" job possibilities, such as during the process of shifting from fossil fuels to renewable energy (figure 1), from truck manufacturing to rail car manufacturing or from land filling and waste incineration to recycling.

3) Certain jobs may be eliminated without direct replacement, such as when packaging materials are discouraged or banned and their production is discontinued.

4) Many existing professions (such as plumbers, electricians, metal workers and construction workers) will simply be transformed and redefined when day-to-day skill sets, work methods and their profiles transition to green jobs.

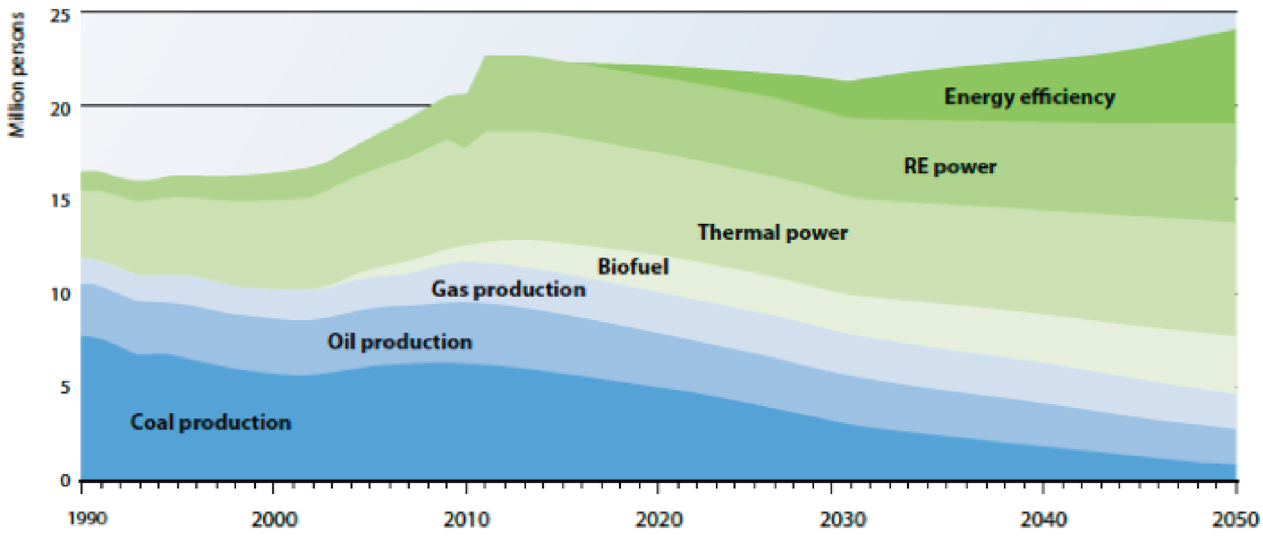
[1] The concept of "green job" derives from Green Jobs Initiative which was started jointly by United Nations Environment Programme, International Labour Organization and International Trade Union Confederation in 2007.

[2] United Nations Environment Programme, International Labour Organization, International Organization of Employers and International Trade Union Confederation, *Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World* (Nairobi, 2008). Available from www.unep.org/labour_environment/PDFs/Greenjobs/UNEP-Green-Jobs-Report.pdf (accessed 29 January 2012).

[3] ibid.

[4] ibid.

Figure 1: Estimated total employment in the energy sector and its disaggregation

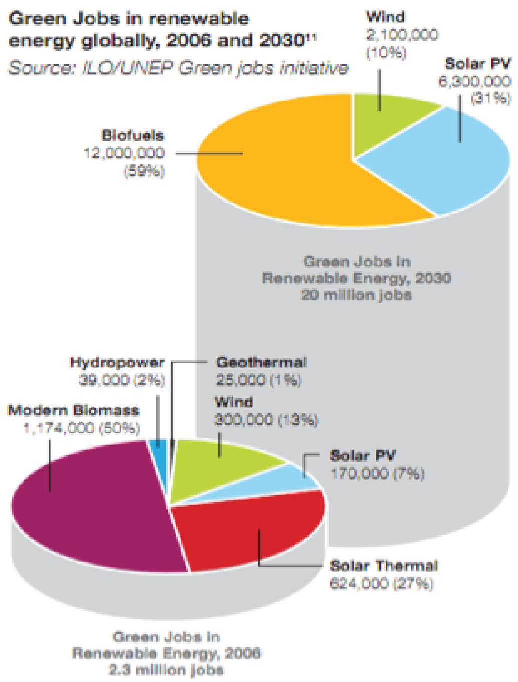


Source: United Nations Environment Programme, *Renewable Energy: Investing in Energy and Resource Efficiency* (Nairobi, 2011). Available from www.unep.org/greeneconomy/Portals/88/documents/ger/GER_6_RenewableEnergy.pdf (accessed 26 February 2012).

The utility sector provides the largest number of green jobs

The majority of green jobs will be created in utility sectors, principally in renewable energy (figure 2). Water and waste management (including recycling), construction and tourism will also gain significance as green employment sectors.[5]

Figure 2: Green jobs in renewable energy globally, 2006 and 2030



Source: AEA Technology and United Kingdom Department of International Development, *Green Jobs in a Low Carbon Economy* (London, 2011). Available from www.aeat.com/cms/assets/Uploads/DFID-Low-carbon-summary-sheets/DFID_low_carbon_development_green_jobs.pdf (accessed 15 February 2012).

[5] International Labour Organization, *Promoting Decent Work in a Green Economy*, ILO Background Note to Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication (Geneva, 2011). Available from www.ilo.org/wcmsp5/groups/public/@ed_emp/@emp_ent/documents/publication/wcms_152065.pdf (accessed 29 January 2012).

Several governments have acknowledged the potential job generation through green growth by inserting green components into the stimulus packages responding to the global economic crisis in 2008. The sectors that were typically included as green components were: construction and retrofitting of buildings; transport, especially mass transit and fuel-efficient cars; renewable energies, such as solar, wind and biomass; and environmental protection, such as waste management.

Table 1 below highlights green job industries, their progress to date and their estimated long-term job generation potential.

Table 1: Green job progress to date and future potential

Industry sector	Industry subsector	Green job progress to date	Long-term green job potential
Energy	Renewables	Good	Excellent
	Carbon capture and storage	None	Unknown
Industry	Steel	Fair	Fair
	Aluminium	Fair	Fair
	Cement	Fair	Fair
	Pulp and paper	Fair	Good
	Recycling	Good	Excellent
Transportation	Fuel-efficient cars	Limited	Good
	Mass transit	Limited	Excellent
	Rail	Negative	Excellent
	Aviation	Limited	Limited
Buildings	Green buildings	Limited	Excellent
	Retrofitting	Limited	Excellent
	Lighting	Good	Excellent
	Efficient equipment and appliances	Fair	Excellent
Agriculture	Small-scale sustainable farming	Negative	Excellent
	Organic farming	Limited	Good to excellent
	Environmental services	Limited	Unknown
Forestry	Reforestation/afforestation	Limited	Good
	Agroforestry	Limited	Good to excellent
	Sustainable forest management	Good	Excellent

Source: United Nations Environment Programme, International Labour Organization, International Organization of Employers and International Trade Union Confederation, *Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World* (Nairobi, 2008). Available from www.unep.org/labour_environment/PDFs/Greenjobs/UNEP-Green-Jobs-Report.pdf (accessed 29 January 2012).

Green jobs in the transport sector

Another segment that will offer an increasing number of green jobs in the future is transportation. Although the number and share of green jobs is currently quite low in most regions, the situation is likely to change significantly in some developing countries in the next few years due to the introduction of new regulations to produce more efficient and less-polluting cars. Thailand, for example, has launched a promising initiative to produce more fuel-efficient cars and seems to be on track to successfully green a good portion of its vehicle manufacturing workforce, counting 182,000 employees so far.[6]

Table 2: Green job estimates in vehicle manufacturing

	European Union	Japan	Republic of Korea	United States
Passenger car manufacturing workforce	2,000,000	952,000	247,000	1,095,000
Jobs in manufacturing green vehicles	150,000	62,000	10,000	13,000

Source: United Nations Environment Programme, International Labour Organization, International Organization of Employers and International Trade Union Confederation, *Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World* (Nairobi, 2008). Available from www.unep.org/labour_environment/PDFs/Greenjobs/UNEP-Green-Jobs-Report.pdf (accessed 29 January 2012).

An infrastructure alternative to the car industry that is more environment friendly and labour intensive is railway transportation. However, over the past few decades, many countries have experienced a constant decline in rail transport, both in operating rail lines and in expanding infrastructure, leading to a decrease in the attached workforce. Even in China, where the rail network grew by 24 per cent from 1992 to 2002, railway employment was cut from 3.4 million to 1.8 million jobs.[7] India's railway jobs declined from 1.7 million to 1.5 million[8] due to the closing down of local lines and the introduction of efficient automated operating schemes. A sustainable transport policy is needed to reverse this trend. A strategic policy that channels investment towards building and rebuilding railway networks and integrating high-speed inter-city lines with regional and local lines would lead to a substantial expansion of green jobs.

Green jobs in the building sector

Buildings use between 30 and 40 per cent of all primary energy resources and are responsible for about the same share of overall global greenhouse gas emissions and waste generation.[9] Energy-efficiency improvements throughout the life cycle of buildings, spanning from the design and construction of new buildings to the retrofitting and renovation of old buildings, provide major opportunities for employment.

The McKinsey Global Institute notes that the most cost-effective measures to reduce greenhouse gas emissions lie in the improvement of energy efficiency of buildings, including building insulation, lighting systems, air conditioning and water heating.[10] A vast number of jobs are likely to be created directly for the construction and retrofitting of green buildings and most of the construction jobs will be situated in developing countries. Achieving energy efficiency in the building sector requires enormous private and public investment. However, it can be done by using existing technology with little or no net cost, which means that the investments will primarily flow towards labour. This, in turn, connotes that greening buildings will create millions of jobs on a global scale.

[6] United Nations Environment Programme, International Labour Organization, International Organization of Employers and International Trade Union Confederation, *Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World* (Nairobi, 2008). Available from www.unep.org/labour_environment/PDFs/Greenjobs/UNEP-Green-Jobs-Report.pdf (accessed 29 January 2012).

[7] ibid.

[8] ibid.

[9] ibid.

[10] John Creyts, Anton Derkach, Scott Nyquist, Ken Ostrowski and Jack Stephenson, *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?*, U.S. Greenhouse Gas Abatement Mapping Initiative Executive Report (New York, McKinsey & Company, 2007). Available from www.c2es.org/docUploads/US_ghg_final_report.pdf (accessed 29 January 2012).

Strengths of green jobs[11]

- **Enhancing economic development in the long run:** The green job sectors have a greater multiplier effect on the economy than conventional employment segments because they feature the establishment of longer, more diversified supply chains, higher labour intensity and net-profit margins.

- **Triggering rural development and supporting poverty reduction:** Green jobs offer opportunities for employment in rural areas, especially in least developed countries. They often exploit local resources and try to build up or establish local training and manufacturing structures that are not dependent on dense urban supply chains and infrastructure. The installation and maintenance of small-scale renewable energy facilities, such as solar panels or wind energy generators for off-grid households in rural areas, is a good example. By providing employment opportunities, green jobs help to lift low-income workers, including an over-proportional share of women, out of poverty.

- **Providing more opportunities for education:** Many green sectors are just emerging and as a consequence, the workforce that supports them has to be created. This provides education and training opportunities for people with no or little formal education to date, even in remote areas, because employers will look for readily available workers within a small proximity to support their newly established green industry.

- **Reducing greenhouse gas emissions:** Due to the fact that most of the green jobs will be created in the renewable energy and energy-efficiency segments, their establishment will help governments to achieve their carbon emissions targets.

- **Improving environmental conditions:** Greening the job profiles in all sectors of the economy will help to disseminate the knowledge and application of sustainable practices and thereby lessen the adverse environmental impacts of these sectors while maintaining or even enhancing their economic output. In this way, green jobs in forestry and agriculture, for example, will not only contribute to environmental integrity but also strengthen food security.

- **Supporting long-term employment:** Green jobs are supporting a forward-looking industry that aims to sustain economic growth within ecological boundaries. Hence, they too are established with a long-term perspective and offer lasting, secure employment opportunities in a transitioning economy.

Challenges for green jobs

- **Transformation of conventional business mindsets:** In a period when crisis and unstable economic conditions are overshadowing the actions of big and small businesses alike, there seems to be no space left for taking a seemingly risky and unexplored green business approach into consideration. This is aggravated by the fact that green industries are often more labour-intensive than their conventional counterparts and go against the modern trend of expanding businesses but keeping the number of employees and real wages constant.[12]

- **Lack of appropriate education infrastructure:** There is a well-established, widespread and diversified education system in place for almost all conventional industries and jobs. However, the emerging demand for green employees might be confronted with a lack of adequately skilled workers in some regions and sectors, because there is no systematic education infrastructure in place for them yet.

[11] AEA Technology and United Kingdom Department of International Development, *Green Jobs in a Low Carbon Economy* (London, 2011). Available from www.aeat.com/cms/assets/Uploads/DFID-Low-carbon-summary-sheets/DFID_low_carbon_development_green_jobs.pdf (accessed 15 February 2012).

[12] International Labour Organization, *Global Employment Trends 2011: The Challenge of a Jobs Recovery* (Geneva, 2011). Available from www.ilo.org/wcmsp5/groups/public/@dgreports/@dcomm/@publ/documents/publication/wcms_150440.pdf (accessed 24 February 2012).

- **Limited labour demand and mobility:** The demand for and expansion of green jobs is relatively new, and although the range of employment opportunities in the green field is wide, the market for it is not yet fully developed. For the moment, green industry and businesses remain mostly small-sized and dispersed;[13] they are ideally based on local resources and regional supply chains. As a consequence, they do not adopt the same employment dimension as conventional business branches. Additionally, green job profiles are comparatively new and indistinct, which hampers the transfer and acknowledgement of green job qualifications across different geographic areas and businesses,[14] which restricts labour mobility of the green workforce.

- **Green industry sector hurdles:**[15] The obstacles to the development of the green industry as a whole also prevent the expansion of green jobs. These hurdles include lack of supporting regulations (policy hurdle), ministry authority overlap (institutional hurdle), infrastructure lock-in (technical hurdle), site-specific, dispersed nature of green industry hampering benefits from economies of scale (market hurdle), high initial capital costs for many green technology projects (economic hurdle) and lack of knowledge about new green technologies, alternative resources, equipment suppliers and potential financiers (information hurdle).

Implementing strategies

Institute policies to attract the business sector: Recent fiscal stimulus packages, like the Green New Deal, aim to create short-term impacts on employment[16] and accelerate the transition towards green growth (table 3). However, to achieve long-term job creation and to fulfil the projected potential for the number of green jobs (table 4), governments need private sector engagement. For this, they can issue fiscal stimuli (subsidies, direct payments or tax reductions), regulations (technology standards) or public financing mechanisms (green funds or loans with preferential interest rates).

[13] Asia Business Council, *Addressing Asia's New Green Jobs Challenge* (Hong Kong, 2009). Available from www.asiabusinesscouncil.org/docs/GreenJobs.pdf (accessed 23 February 2012).

[14] Australia, *Draft of the Energy White Paper: Strengthening the Foundations for Australia's Energy Future* (Canberra, Department of Resources, Energy and Tourism, 2011). Available from www.ret.gov.au/energy/Documents/ewp/draft-ewp-2011/Draft-EWP-chap8.pdf (accessed 23 February 2012).

[15] Waste Concern Consultants, *Assessment of Green Jobs* (Bangladesh, 2010). Available from www.wasteconcern.org/Publication/RE_Summary.pdf (accessed 17 February 2012).

[16] According to recent studies in the United States, federal and state efforts to stimulate creation of green jobs have largely failed due to overestimation of the green market (energy efficiency, installation of renewable etc.). For more information, see Aaron Glantz, "Number of Green Jobs Fails to Live Up to Promises", *New York Times*, August 18, 2011. Available from www.nytimes.com/2011/08/19/us/19bcgreen.html (accessed 19 February 2012).

Table 3: Estimate of the number of jobs in low-carbon sectors between 2008 and 2010

Source	Actual No. of jobs	Region examined	Time-frame	Sector/Other considerations
UNEP, ILO, IOE, ITUC (2008) Green Jobs: Towards decent work in a sustainable, low-carbon world	2,300,000	Worldwide	2008	Renewable energy sector (directly and indirectly through supplier industries)
Clean Edge, Clean Tech Job Trends 2010	300,000	Worldwide	2010	Solar
	500,000	Worldwide	2010	Wind
WWEA	550,000	Worldwide	2009	Wind Energy
Ren21	3,000,000	Worldwide	2009	Renewable energy sector
UNEP	1,500,000	China	End of 2009	Renewable energy sector
	300,000	*China*	*Incremental in 2009*	*Renewable energy sector*
	600,000	China	End of 2009	Solar thermal industry
	266,00	China	End of 2009	Biomass Energy
	55,000	China	End of 2009	Solar PV (installation & manufacturing)
	22,000	China	End of 2009	Wind power
Ren21	250,000	China	2009	Solar Hot Water
Ren21	700,000	Brazil	2009	Bio-ethanol
European Wind Energy Association	192,000	EU	2009	Wind
German Government Study	259,000	Germany	2006	Renewable energy sector direct and indirect jobs
Solar Foundation	100,000	US	End of 2010	Solar power
	50,000	US	End of 2009	Solar power
World Economic Forum	40,000	US	At June 2010	Bio-refinery industry
Renewable UK	9,200	UK	2010	Large-scale onshore and offshore wind

Source: Deutsche Bank Group, *Investing in Climate Change 2011* (Frankfurt, 2011). Available from www.igcc.org.au/Resources/Documents/ExploringRiskAndReturn.pdf (accessed 21 February 2012).

Table 4: Long-term green job potential

Source	Potential No. of jobs	Region examined	Time-frame	Sector/Other considerations
WWEA	1,000,000	Worldwide	2012	Wind Energy
UNEP, ILO, IOE, ITUC (2008) Green Jobs: Towards decent work in a sustainable, low-carbon world	12,000,000	Worldwide	2030	Biofuels-related agriculture & industry
	2,100,000	Worldwide	2030	Wind Energy
	6,300,000	Worldwide	2030	Solar PVs
World Economic Forum	800,000	US	2022	Commercialization of second and third generation biofuels
European Wind Energy Association	250,000	EU	2020	Wind
	88,000	EU	2015	Wind
	450,000	EU	2020	Wind - Cumulative
	23,000-60,000	UK	2020	Offshore wind
Anaerobic Digestion and Biogas Association	40,000	UK	2020	Biomass
Carbon Trust (2008)	40,000-70,000	UK	2020	Jobs created along the supply chain if 29 GW of offshore wind capacity is installed.

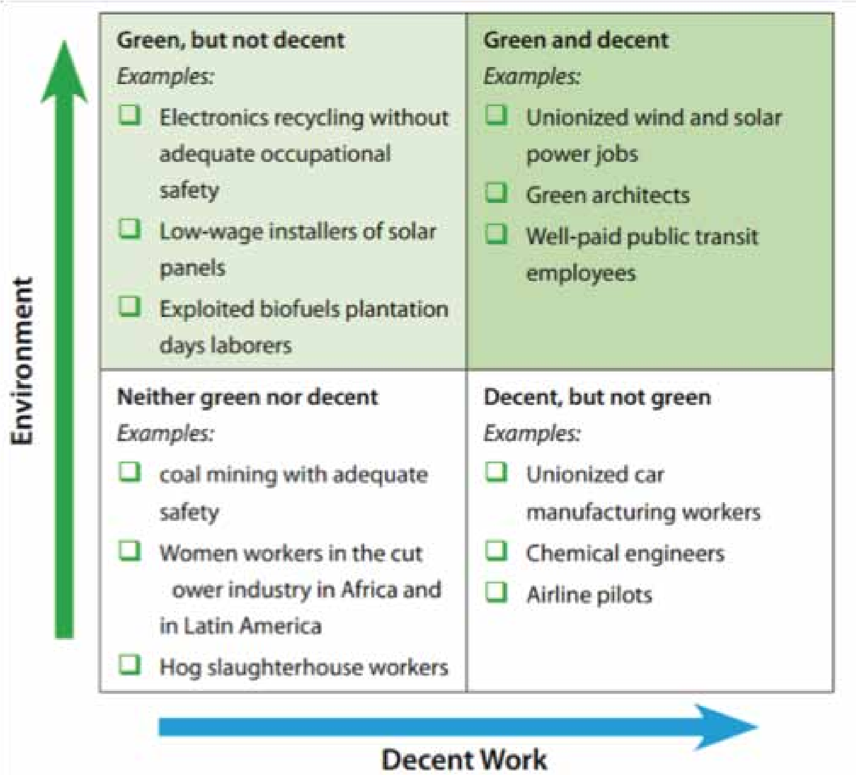
Source: Deutsche Bank Group, *Investing in Climate Change 2011* (Frankfurt am Main, 2011). Available from www.igcc.org.au/Resources/Documents/ExploringRiskAndReturn.pdf (accessed 21 February 2012).

Reallocate labour across sectors and provide job training: The OECD estimates that employment in renewable energy sectors will grow at the expense of employment in fossil fuels and coal mining industries.[17] Additionally, this reallocation of labour across sectors and enterprises and the incorporation and dissemination of new job characteristics and skill requirements are essential for the transition to a low-carbon economy. Governments need to support job training for acquiring new skills by setting up education and certification schemes, guide-lines and facilities.

[17] Organization for Economic Co-operation and Development, Interim Report of the Green Growth Strategy: *Implementing Our Commitment for a Sustainable Future*, Meeting of the OECD Council at Ministerial level (Paris, 2010). Available from www.oecd.org/dataoecd/42/46/45312720.pdf (accessed 29 January 2012).

Ensure green jobs are decent jobs: Green jobs should be decent jobs with adequate wages and close attention to safe working conditions, job security and workers' rights (for green and decent job examples, see figure 3). Likewise, the greening of the economy should contribute to poverty reduction. The transition to a green and low-carbon economy will also mean building the necessary capacities for both the public and private sectors. Governments can help by setting the agenda, mobilizing resources and developing adequate capacity-building programmes. In any case, they should ensure the decency and quality of green jobs by setting specific guidelines and ensuring that worker rights are protected.

Figure 3: Green and decent job scheme



Source: United Nations Environment Programme, International Labour Organization, International Organization of Employers and International Trade Union Confederation, *Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World* (Nairobi, 2008). Available from www.unep.org/labour_environment/PDFs/Greenjobs/UNEP-Green-Jobs-Report.pdf (accessed 29 January 2012).

Country experience: Green jobs in Asia

China: The renewable energy sector creates output worth US$17 billion and employs 1.5 million people, of which 600,000 are employed in making and installing solar thermal products, such as solar water heaters.[18] Recycling and waste management employs an estimated 10 million people.[19] The waste management sector is expected to grow rapidly due to the increasing urban population and industrialization.

Global Climate Network projections indicate that in 2020, the macro-economic restructuring of the Chinese economy will lead to 11.5 to 17 million fewer jobs in traditional sectors. However, the net effect of investment in renewable and clean energy, which will create approximately 6.5 to 7 million jobs, and the macro shift towards the services sector, which is likely to generate up to 20 million jobs, will bring about a net gain in jobs overall.[20]

India: According to India's Institute of Green Economy, an annual expenditure of US$1 million spent on sustainably managed forestry has the potential to create between 500 and 1,000 full-time jobs. India could also generate 900,000 jobs by 2025 in biomass gasification.[21] With 9 million households still depending on traditional cooking stoves, replacing them with recently developed biomass cooking technologies is projected to create 150,000 jobs.[22]

Sri Lanka: Since 2009, the Ministry of Environment has distributed Green Job Awards to individuals, teams and organizations in relation to their contribution in initiating, promoting and carrying out environment-friendly technologies or activities in the following areas: biodiversity and ecosystem conservation, agriculture and livestock, climate change and disaster management, transport, power and energy, industrial and enterprise development, waste management and pollution control, water resource management, soil conservation and land improvement, urban development and spatial planning and environmental education and campaigns.[23]

Further reading

Green Jobs and the Clean Energy Economy, by D. Engel and M. D. Kammen (Copenhagen, Copenhagen Climate Council, 2009). Available from http://rael.berkeley.edu/sites/default//files/old-site-files/TLS%20Four_May2209_1.pdf

Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World (Nairobi, United Nations Environment Programme, International Labour Organization, International Organization of Employers and International Trade Union Confederation, 2008). Available from www.unep.org/labour_environment/PDFs/Greenjobs/UNEP-Green-Jobs-Report.pdf

Promoting Decent Work in a Green Economy (Geneva, International Labour Organization, 2011). Available from www.ilo.org/wcmsp5/groups/public/@ed_emp/@emp_ent/documents/publication/wcms_152065.pdf

[18] Deutsche Bank Group, *Investing in Climate Change 2011* (Frankfurt, 2011). Available from www.igcc.org.au/Resources/Documents/ExploringRiskAndReturn.pdf (accessed 21 February 2012).

[19] United Nations Environment Programme, International Labour Organization, International Organization of Employers and International Trade Union Confederation, *Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World* (Nairobi, 2008). Available from www.unep.org/labour_environment/PDFs/Greenjobs/UNEP-Green-Jobs-Report.pdf (accessed 29 January 2012).

[20] Global Climate Network, *Low Carbon Jobs in an Interconnected World: Literature Review*, Global Climate Network Discussion Paper 3 (London, 2010). Available from www.globalclimatenetwork.info/uploadedFiles/globalclimatenetwork/low_carbon_jobs_lit_review.pdf (accessed 29 January 2012).

[21] United Nations Environment Programme, *Global Green New Deal: Policy Brief* (Geneva, 2009). Available from www.unep.org/pdf/A_Global_Green_New_Deal_Policy_Brief.pdf (accessed 14 February 2012).

[22] United Nations Environment Programme, International Labour Organization, International Organization of Employers and International Trade Union Confederation, *Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World* (Nairobi, 2008). Available from www.unep.org/labour_environment/PDFs/Greenjobs/UNEP-Green-Jobs-Report.pdf (accessed 29 January 2012).

[23] R.H.S. Samaratunga, "Green Job Awards: 2011", presented at the World Environment Day, 5 June, 2011. Available from www.environmentmin.gov.lk/temporary_files/add_copy_eng_final.pdf (accessed 29 January 2012).

FACT SHEET

Green marketing

Key points

- ***General guidelines are needed to regulate misleading claims.***
- ***Green marketing benefits businesses, consumers and society.***

Green marketing explained

Marketing is both a discipline and a set of practices to appeal to consumers and entails the operations organized around a product or service, from concept to sales and through the design, price setting, promotion and availability.

The term "green marketing" first surfaced in the late 1980s as an extension of what the American Marketing Association referred to in 1975 as "ecological marketing".[1] There is no single definition accepted universally, but in 1994 Polonsky stated: "Green or environmental marketing consists of all activities designed to generate and facilitate any exchanges intended to satisfy human needs or wants, such that the satisfaction of these needs and wants occurs, with minimal detrimental impact on the natural environment."[2]

The United Nations Environment Programme defines it as "a marketing which encompasses all communication operations undertaken to promote a product on the basis of its environmental properties or of its social qualities. It is about selling products on an ethical platform."[3] The distinctive features of green marketing are its commercial dimension coupled with the reference to the values of consumers who want to act in an environmentally conscious and socially responsible manner with the purchases they make.

Why companies are using green marketing

According to Polonsky's research on green marketing,[4] there are several reasons for companies to increase their exploitation of green marketing:

1. Company management perceives environmental marketing to be an opportunity that can be used to achieve their objectives.
2. Company management believes they have a moral obligation to be more socially responsible.
3. Governments are forcing companies to be more responsible.
4. Competitors' environmental activities pressure companies to change their environmental marketing activities.
5. Cost factors associated with waste disposal or reductions in material use forces companies to modify their behaviour.

[1] Sumy State University, *The International Student Conference: Economics for Ecology* (Sumy, Department of Economics of Sumy State University, 2007). Available from http://iscs.fem.sumdu.edu.ua/data/ISCS_Materials_2007.pdf (accessed 14 February 2012).

[2] Michael Jay Polonsky, "An introduction to green marketing", *Electronic Green Journal* (1994), vol. 1, No. 2. Available from http://ogma.newcastle.edu.au:8080/vital/access/manager/Repository/uon:3104 (accessed 26 January 2012).

[3] United Nations Environment Programme, *Sustainability Communications: A Toolkit for Marketing and Advertising Courses* (Nairobi, 2005). Available from www.unep.fr/shared/publications/pdf/DTIx0886xPA-EducationKitEN.pdf (accessed 26 January 2012).

[4] Michael Jay Polonsky, "An introduction to green marketing", *Electronic Green Journal* (1994), vol. 1, No. 2. Available from http://ogma.newcastle.edu.au:8080/vital/access/manager/Repository/uon:3104 (accessed 26 January 2012).

Marketing is a tool for the private sector

The private sector communicates in many ways to present and potential consumers. In this context, marketing is rooted very firmly in the fundamental logic of a company situated in a market economy. Polonsky's research implies that private companies are using green marketing as a means to gain competitive advantage over companies that do not offer an environment-friendly alternative product yet. The biggest green marketing advertising investments are in sectors that represent a large portion of the individual ecological footprint, such as food and transport.[5]

However, green marketing should not be confused with public service campaigns aimed at getting people to change habits and adapt a more environment-friendly lifestyle. In contrast, green marketing is about getting people to buy and to consume products that are "thought to be" better for the environment. From the consumer protection perspective, green marketing should focus on information disclosure and establishing transparency of business and production procedures.

Green consumerism (sustainable consumerism) is emerging

Green products are often some of the most expensive on the shelf. They can cost between 16 and 100 per cent more than conventional products.[6] Green products are typically more costly because the expenses for inputs, production processes or the specialized technology are higher. Another reason is that the transportation of these goods is more expensive because they are often produced and consumed in only small quantities. For most product categories, green goods and services do not even achieve a share of 1 per cent in overall sales.[7]

According to recent studies and analysis, there is huge doubt as to whether green consumerism exists or not. Based on an analysis of monthly sales from March 2006 to March 2011 for nearly 4,300 items in 22 categories, conducted by Sanford C. Bernstein & Co., the market share of green products generally was down from their respective peak year.[8] However, the downward trend may be temporary, according to a study by Ogilvy Earth, which shows that hidden underneath the current reduced sales of green products lay a strong demand base and potential for these goods. The study found that 77 per cent of the US Americans would like to consume in a more sustainable way, while 89 per cent of the Chinese citizens said that a green lifestyle is important to them.[9] L'Oreal USA and the marketing research company ORC International conducted a survey on green purchases in the United States and found that 43 per cent of the respondents would purchase environment-friendly or socially responsible products if offered at the same price as their usually purchased brands.[10] If given a choice between two equally performing products, 38 per cent of the respondents said they would choose the more eco-friendly option. These surveys underscore the importance of green marketing in raising consumer awareness.

[5] United Nations Environment Programme, *Sustainability Communications: A Toolkit for Marketing and Advertising Courses* (Nairobi, 2005). Available from www.unep.fr/shared/publications/pdf/DTIx0886xPA-EducationKitEN.pdf (accessed 26 January 2012).

[6] Graceann Bennett and Freya Williams, *Mainstream Green: Moving Sustainability from Niche to Normal* (Ogilvy & Mather, 2011). Available from http://assets.ogilvy.com/truffles_email/ogilvyearth/Mainstream_Green.pdf (accessed 26 January 2012).

[7] Joel Makower,"Green Marketing is Over. Let's Move On", *Green Biz*, May 16, 2011. Available from www.greenbiz.com/blog/2011/05/16/green-marketing-over-lets-move (accessed 26 January 2012).

[8] Stephanie Clifford and Andrew Martin, "As Consumers Cut Spending, 'Green' Products Lose Allure", *The New York Times*, April 21, 2011. Available from www.nytimes.com/2011/04/22/business/energy-environment/22green.html?_r=1&pagewanted=all (accessed 26 January 2012).

[9] Graceann Bennett and Freya Williams, *Mainstream Green: Moving Sustainability from Niche to Normal* (Ogilvy & Mather, 2011). Available from http://assets.ogilvy.com/truffles_email/ogilvyearth/Mainstream_Green.pdf (accessed 26 January 2012).

[10] Myriam Coneim, "Sustainable living survey fielded by L'Oréal USA reveals changes in attitudes, behavior and consumption are slow to come", *3BL Media*, April 20, 2011. Available from http://3blmedia.com/theCSRfeed/2011-Sustainable-Living-Survey-Fielded-LOr%C3%A9al-USA-Reveals-Changes-Attitudes-Behavior-and- (accessed 26 January 2012).

Strengths in green marketing

- **Business opportunity:** A majority of the population in countries of varying geographical and economic background want to consume in a more sustainable way.[11] Businesses can tap into this huge potential client base by stepping up their environmental performance and by communicating this change to their buyers. Organic food, beverages and supplements, for example, delivered revenues of US$51 billion in 2008 and are expected to grow by 12.8 per cent annually until 2015, reaching nearly US$105 billion.[12] In Asia, this growth is projected to reach an even higher rate of 20.6 per cent.
- **Environmentally conscious businesses:** In addition to improved profitability, which is a direct benefit for the business itself, green marketing can also benefit society by facilitating not only the communication about but also the use of green business practices. It can be assumed that companies engaging in environmental marketing activities actually have a high possibility to improve their behaviour, because to claim that their products are green they have to actually assess the product in a way that meets certain requirements to attain certified eco-labels.[13] They do not want to lose the trust of the environmentally conscious consumers they address.
- **Environmentally conscious consumers:** If conducted correctly and credibly, green marketing can enhance the quantity and quality of environmentally conscious consumerism. By pointing out the adverse effects of conventional business and production practices on the environment and introducing and informing about green alternatives, consumers are enabled to make a conscious choice with their purchases.
- **Business practice transparency:** Green marketing is a double-edged sword for businesses. On one hand, they can appeal to green consumers, but on the other they have to live up to the green reputation they try to establish. In this sense, green businesses are held accountable by both the government and society. To be certified by green labels, companies have to disclose information about their management and production practices that would normally not be accessible to the public. Hence, green marketing is a tool that also enhances business transparency.
- **Acceptance of environmental price internalization:** An inherent part of green marketing is to communicate why green products are priced differently than their conventional counterparts. The premium price is the reflection of the environmental costs that the resource extraction and processing incur, which is usually not reflected in the market price. This way, green marketing helps acclimate consumers to accept paying higher prices for products that actually integrate the environmental impacts they inflict into their prices.
- **Supply chain expansion:** Green marketing can give consumers an idea of what green products and their benefits are and can encourage them to look for more green purchase alternatives in their proximity. This helps to expand the supply chain of green products by raising the demand for regional supply networks.
- **Closing the product life cycle:** Green products, advertised via green marketing, do not only encompass new inventions but also recycled, refurbished and remanufactured goods. By communicating their alternatives, which often are cheaper than usual green products and are considered as waste in the conventional supply and consumption patterns, green marketing can contribute to opening consumers' minds to the options and thereby closing the product life cycle.

Challenges for green marketing

- **Vague credibility:** False or misleading green marketing claims made by businesses that do not undergo proper certification but still want to appeal to environmentally conscious consumers can damage the credibility of the whole sector. Consumers have a hard time distinguishing between simple green advertisements and valid, certified claims.

[11] Graceann Bennett and Freya Williams, *Mainstream Green: Moving Sustainability from Niche to Normal* (Ogilvy & Mather, 2011). Available from http://assets.ogilvy.com/truffles_email/ogilvyearth/Mainstream_Green.pdf (accessed 26 January 2012).

[12] *PR Newswire*, "Markets and Markets: Global Organic Food and Beverages Market Worth $104.50 Billion By 2015", February 24, 2011. Available from www.prnewswire.com/news-releases/marketsandmarkets-global-organic-food-and-beverages-market-worth--10450-billion-by-2015-116804058.html (accessed 16 February 2012).

[13] Michael Jay Polonsky, "An introduction to green marketing", *Electronic Green Journal* (1994), vol. 1, No. 2. Available from http://ogma.newcastle.edu.au:8080/vital/access/manager/Repository/uon:3104 (accessed 26 January 2012).

- **Deluding information:** Green marketing can lead to consumer awareness, but it also runs the risk of deluding consumers with erroneous information. There is always a danger that the marketing of these products or services may send a message that might lead to behavioural change with substantial adverse effect on the environment and society in the future (such as buying electric vehicles without considering how to dispose of old batteries in the future).
- **Gap between sustainable intention and behaviour:** Although most consumers might claim they are intending to follow a sustainable lifestyle or that they would want to buy green products, when it comes down to actually transforming these intentions into actions, only a fraction of people actually do it. A survey conducted by EcoAlign in the United States found that although 90 per cent of the American citizens were aware of the importance of eco-efficiency, only 3 per cent of them turned their computer off during the night.[14]
- **Price premium:** Consumers who are interested in making more sustainable purchases are often not willing to accept the comparatively high price of green products, resulting from the internalization of environmental costs. Only a very small fraction of the population is willing to compromise performance, quality or price in exchange for environmental performance in their purchasing decisions, diminishing the motivation for businesses to venture into green production and marketing.[15]
- **Information gap:** Despite the increasing consumer awareness of green purchasing alternatives, the number of people who are truly familiar with a wide range of green products or their benefits for the environment is still quite low. The US American environmental labelling programme, ENERGY STAR, for example, was only known to 56 per cent of American citizens some 12 years after its creation in 1992.[16]

Implementing strategies

Set legal constraints on green marketing. Governments can lead the private sector to better green marketing and ensure its credibility by providing guidelines or regulations for assessing products. Existing national and international regulations for marketing and advertisements mainly ensure honesty and transparency for protecting the safety of consumers. The idea of regulating marketing claims comes from consumer protection movements to govern certain production categories, such as organic products, or to regulate that a product accurately reflects the real qualities that it claims to possess. There are regulations dealing with misleading or deceitful advertising in all countries already, but only a few of them have set guidelines or regulations that deal with green marketing.

Country experience: Green guidelines in the United States

The US American Federal Trade Commission published the *Guides for the Use of Environmental Marketing Claims*, which outline general principles that should be applied to all environmental marketing claims.[17] It also provides guidance on specific green claims, such as biodegradable, compostable, recyclable, recycled content, refillable and ozone-safe. The guidelines include principles to avoid unqualified general claims that address environmental benefits, which might deceive consumers.

Use eco-labelling as a tool to foster consumer awareness. Since the United Nations Earth Summit in 1992, an international consensus has been generated to integrate environmental issues into manufacturing procedures and consumption patterns to achieve sustainable development. Although manufacturers apply eco-labels voluntarily, the practice links producers and consumers. Currently, both certified and private standardized eco-labels exist. Setting standards for eco-labelling is a new form of regulation of the market economy that remains voluntary in nature.[18]

[14] Graceann Bennett and Freya Williams, *Mainstream Green: Moving Sustainability from Niche to Normal* (Ogilvy & Mather, 2011). Available from http://assets.ogilvy.com/truffles_email/ogilvyearth/Mainstream_Green.pdf (accessed 26 January 2012).

[15] Lizhi Wang, Yihsu Chen, Guiping Hu, and Bopaya Bidanda, *Can Green Products Survive Market Competition?* (Merced, University of California, 2008). Available from http://faculty.ucmerced.edu/ychen/7Green.pdf (accessed 16 February 2012).

[16] ibid.

[17] United States of America, Federal Trade Commission website "Part 260: Guides for the Use of Environmental Marketing Claims". Available from http://www.ftc.gov/bcp/grnrule/guides980427.htm (accessed 16 February 2012).

[18] For more information, see FACT SHEET: Eco-labelling

Box 1: Ecological footprints

The ecological footprint is a way of measuring human pressure on the natural environment. Created by two researchers at the University of British Columbia in Vancouver,[19] the concept was quickly popularized by numerous environmental NGOs, such as the World Wildlife Fund.

The ecological footprint of a population is the biologically productive land and water areas required to produce the consumed resources and to assimilate the wastes generated by that population, using prevailing technology.[20] According to the WWF *Living Planet Report 2010*, humanity's global ecological footprint has more than doubled over the past 50 years.[21] It is now 50 per cent in excess of the biological capacity of the Earth. In Asia, the ecological footprint even tripled between 1961 and 2007.[22] *The Living Planet Report 2002* also noted profound inequalities between income groups: on average, the footprint per person is more than six times greater in high-income countries than in low-income ones.[23]

Box 2: Carbon footprints

A carbon footprint is often part of the ecological footprint. It is a measurement of the impact that human activities have on the environment, based on their greenhouse gas emissions, and is usually measured in tonnes of carbon dioxide equivalent (tCO_2e).[24] The term is used to address climate change and relates to the amount of greenhouse gases produced in daily activities through the burning of fossil fuels for electricity, heating, transportation, etc.

In the United Kingdom, The Carbon Trust introduced a CO_2 label in March 2007, in cooperation with the UK Department for Environment, Food and Rural Affairs and BSI British.[25] Companies that want to feature the label on their products have to calculate the carbon footprint of their goods according to the British Publicly Available Specification 2050 (PAS 2050).

Further reading

Sustainability Communications: A Toolkit for Marketing and Advertising Courses (Nairobi, United Nations Environment Programme, 2005). Available from www.unep.fr/shared/publications/pdf/DTIx0886xPA-EducationKitEN.pdf

Sustainable Consumption Facts and Trends: From a Business Perspective (Geneva, World Business Council for Sustainable Development, 2008). Available from www.fusbp.com/pdf/WBCSDSustainableConsumption.pdf

[19] Mathis Wackernagel and William Rees, *Our Ecological Footprint: Reducing Human Impact on the Earth* (Gabriola Island, New Society Publishers, 1996).

[20] World Wildlife Fund, United Nations Environment Programme World Conservation Monitoring Centre and Redefining Progress, *Living Planet Report 2002* (Gland, Switzerland, 2002). Available from www.wwf.se/source.php/1165540/Living%20planet%20report%202002.pdf (accessed 16 February 2012).

[21] World Wildlife Fund, Zoological Society of London and Global Footprint Network, *Living Planet Report 2010: Biodiversity, Biocapacity and Development* (Gland, Switzerland, 2010). Available from http://assets.wwf.org.uk/downloads/wwf_lpr2010_lr_1_.pdf (accessed 16 February 2012).

[22] World Wildlife Fund, China Council for International Cooperation on Environment and Development, Institute of Geographic Sciences and Natural Resources Research and Global Footprint Network, *China Ecological Footprint Report 2010: Biocapacity, Cities and Development* (Beijing, 2010). Available from www.wwf.or.jp/activities/lib/lpr/Chn_EF_Report2010EN.pdf (accessed 16 February 2012).

[23] World Wildlife Fund, United Nations Environment Programme World Conservation Monitoring Centre and Redefining Progress, *Living Planet Report 2002* (Gland, Switzerland, 2002). Available from www.wwf.se/source.php/1165540/Living%20planet%20report%202002.pdf (accessed 16 February 2012).

[24] Cerolyn Pertsova, ed., *Ecological Economics: Research Trends* (New York, Nova Science Publishers, 2007).

[25] Organisation for Economic Co-operation and Development, *Better Policies to Support Eco-Innovation* (Paris, 2011). Available from www.carbon-label.com/the-label/guide-to-the-carbon-reduction-label (accessed 16 February 2012).

Green New Deal

Key point

- ***The Green New Deal is not only a way to stimulate the economy but it can help shift society and industry to a greener way.***

Green New Deal explained

No general definition has been established for explaining what is meant by the Green New Deal, although it is commonly used.

In its 2007 *Green New Deal*[1] report, the UK-based New Economy Foundation outlined two primary elements: First, there is a structural transformation of the regulation of the national and international financial systems and major changes to the taxation system. Second, the Green New Deal promotes a sustained programme to invest in and deploy energy conservation and renewable energies, coupled with effective demand management. The Green New Deal will stabilize the current social system by generating "resilient low-carbon economies" that are "rich in jobs" and "based on independent sources of energy supply".

The United Nations Environment Programme (UNEP) first used the term "Global Green New Deal" in a 2009 report[2] referring to proposed economic stimulus packages in five areas to simultaneously accelerate tackling climate change, environmental degradation and poverty. The five areas entail: i) energy efficiency in old and new buildings, ii) renewable energy technologies, iii) sustainable transport technologies, iv) ecological infrastructure and v) sustainable agriculture.

Based on a Eurostat/OECD definition of eco-industries, the Wuppertal Institute defines the Green New Deal as "targeted state investment in activities which produce foods and services to measure, prevent, limit, minimize or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco-system. This includes innovation in cleaner technologies and products and services that reduce environmental risk and minimize pollution and resource use."[3]

Essentially, the Green New Deal can be seen as a package of policies to stimulate the economy and create jobs by investing in green projects in the sectors of energy efficiency, sustainable transport, waste management and recycling, and renewable energies. Because many of the economic stimulus packages have emerged as emergency solutions in response to the financial crisis, governments may find it a struggle to mobilize sufficient public funds to continue the programmes in the long run. The success of the Green New Deals depends directly on the ability of governments to link the temporarily introduced measures to the medium- and long-term policies for the transition towards a green economy.

How it works

Comparison of Green New Deal among countries

[1] The Green New Deal Group, *A Green New Deal: Joined-up policies to solve the triple crunch of the credit crisis, climate change and high oil prices* (London, new economics foundation, 2008). Available from www.neweconomics.org/sites/neweconomics.org/files/A_Green_New_Deal_1.pdf (accessed 26 January 2012).

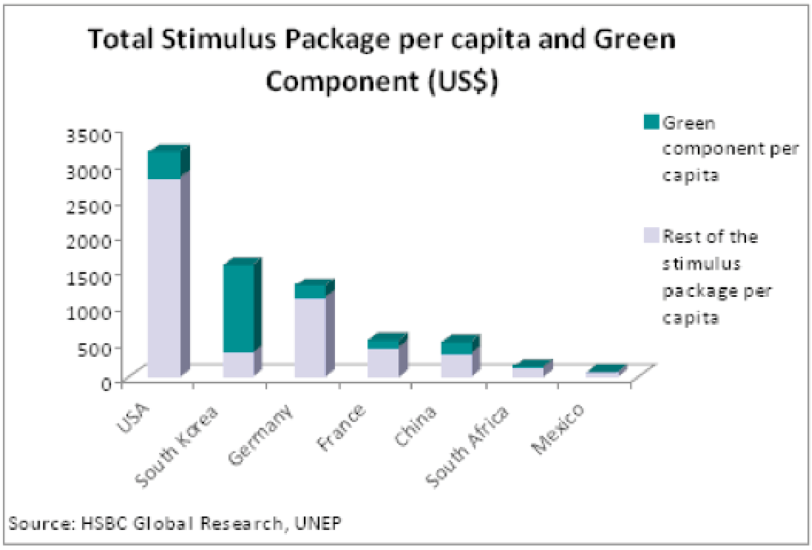
[2] United Nations Environment Programme (UNEP), *Global Green New Deal* (UNEP and Green Economy Initiative, 2009). Available from www.unep.org/pdf/G20_policy_brief_Final.pdf (accessed 29 January 2012).

[3] Wuppertal Institute for Climate, Environment and Energy, *A Green New Deal for Europe: Towards green modernization in the face of crisis* (Brussels, the Green European Foundation, aisbl GEI, 2009). Available from www.gef.eu/fileadmin/user_upload/GEF_GND_for_Europe_publication_web.pdf (accessed 29 January 2012).

Many industrialized countries as well as developing countries announced a Green New Deal plan in 2008 and 2009, after the severe global economic crisis. Most of the plans were part of each government's economic stimulus package, which mainly targeted infrastructure, energy and the water sector, with the anticipation of creating more jobs. The volume of each stimulus package launched varied from country to country; the largest was the United States, allocating the equivalent of 751 billion euros, which was 12 per cent of its GDP at that time, followed by China with 453 billion euros equivalent.[4]

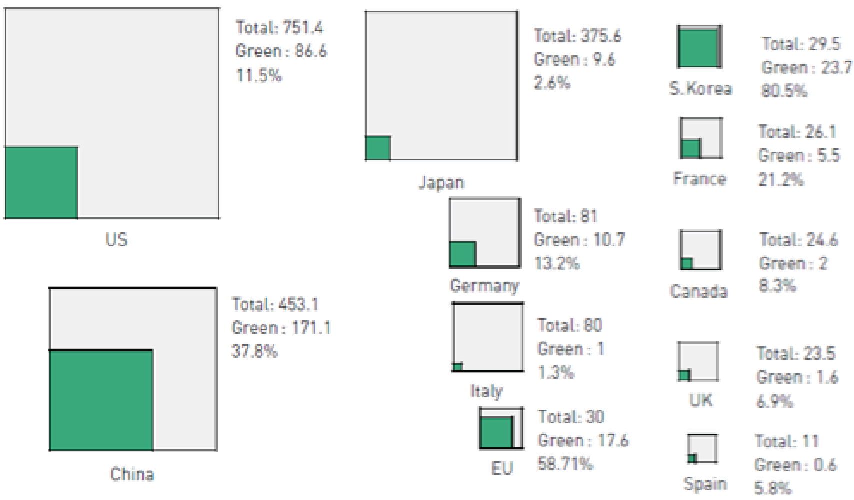
There were substantial differences among the countries in terms of expenditure per capita (figure 1). Although the United States had the largest stimulus package, the Republic of Korea invested more heavily in green components (figure 2). In the Korean case, a total of US$30.7 billion (about 80 per cent of the total stimulus package) was allocated to renewable energies, energy-efficient buildings, low-carbon vehicles and water and waste management.

Figure 1: Total stimulus package per capita and green component



Source: United Nations Environment Programme, *Global Green New Deal: Policy Brief* (Geneva, 2009).

Figure 2: Ratio of green stimulus of national recovery packages (euros)



Source: Wuppertal Institute for Climate, Environment and Energy, *A Green New Deal for Europe: Towards Green Modernization in the Face of Crisis* ((Brussels, the Green European Foundation-aisbl GEI, 2009).

[4] Wuppertal Institute for Climate, Environment and Energy, *A Green New Deal for Europe: Towards Green Modernization in the Face of Crisis* (Brussels, the Green European Foundation-aisbl GEI, 2009). Available from www.gef.eu/fileadmin/user_upload/GEF_GND_for_Europe_publication_web.pdf (accessed 29 January 2012).

Country experience: The Green New Deal in the Republic of Korea

The Republic of Korea remains classified as a developing country under the UNFCCC rules and thus is not required to have binding emission targets. But the Government plans to cap the country's emissions at 2005 levels over the first Kyoto period (2008–2012). The Government also plans to expand use of renewable energy from 5 per cent in 2011 to 11 per cent by 2030.

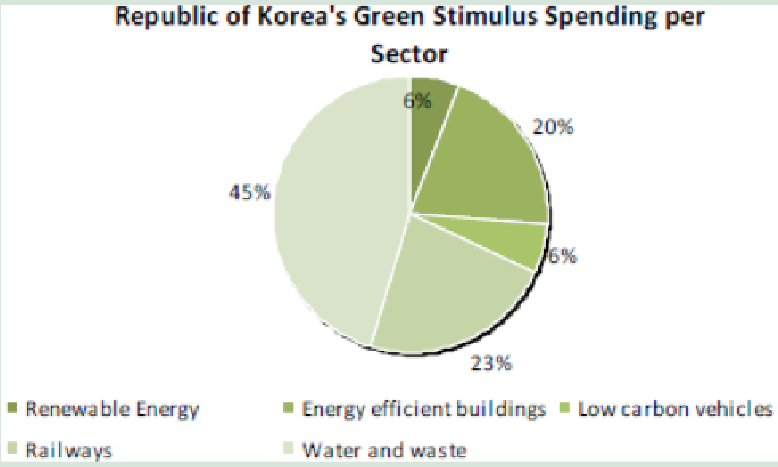
In January 2009, the Government launched its Green New Deal as a means of stimulating job creation and revitalizing the economy. The stimulus package of US$38.1 billion (equivalent to 4 per cent of GDP) covers the implementing period of 2009–2012. A total of US$30.7 billion (about 80 per cent of the total stimulus package) was allocated to environmental themes. The Green New Job Creation Plan, announced at the same time, is expected to create 960,000 jobs.

The plan has nine core projects organized in four themes:

- Conservation: green cars, clean energy and recycling
- Quality of life: green neighbourhoods and housing
- Environmental protection: revitalizing four major rivers and securing water resources
- Preparing for the future: IT infrastructure and green transport networks

The environment-related areas are renewable energy, energy-efficient buildings, low-carbon vehicles and water and waste management.

Figure 3: Breakdown of the Korean Green New Deal



Source: United Nations Environment Programme, *Global Green New Deal: Policy Brief* (Geneva, 2009).

Table 1, compiled by HSBC, explains the climate change investment stimulus plans in a range of countries.

Table 1: Green New Deal economic stimulus plans

A Climate of Recovery? The climate change investment dimension of economic stimulus plans

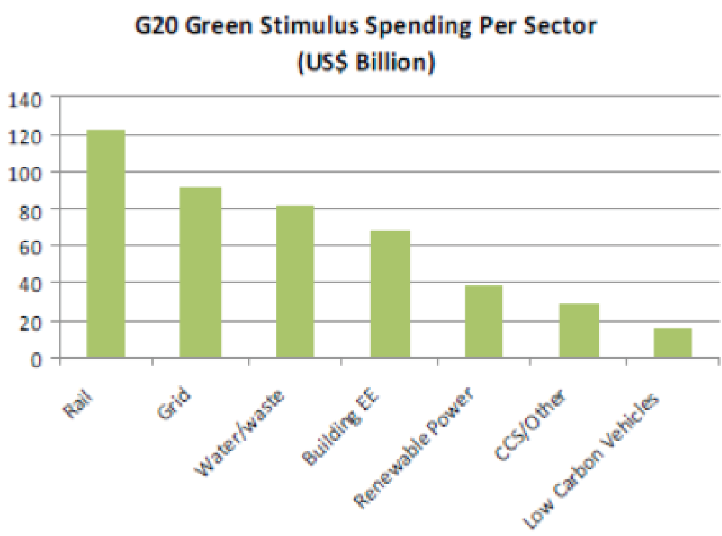
Country	Fund USDbn	Period Years	Green Fund USDbn	% Green Fund	Low-Carbon Power Renewable	Low-Carbon Power CCS/Other	Energy Efficiency (EE) Building EE	Energy Efficiency (EE) Lo C Vech+	Energy Efficiency (EE) Rail	Energy Efficiency (EE) Grid	Water/Waste
Asia Pacific											
Australia	26.7	2009-12	2.5	9.3%	-	-	2.48	-	-	-	-
China	586.1	2009-10	221.3	37.8%	-	-	-	1.50	98.65	70.00	51.15
India	13.7	2009	0.0	0.0%	-	-	-	-	-	-	-
Japan	485.9	2009 onwards	12.4	2.6%	-	-	12.43	-	-	-	-
South Korea	38.1	2009-12	30.7	80.5%	1.80	-	6.19	1.80	7.01	-	13.89
Thailand	3.3	2009	0.0	0.0%	-	-	-	-	-	-	-
Sub-total Asia Pacific	**1,153.8**	**0.0**	**266.9**	**23.1%**	**1.8**	**0.0**	**21.1**	**3.3**	**105.7**	**70.0**	**65.0**
Europe											
European Union	38.8*	2009-10	22.8	58.7%	0.65	12.49	2.85	1.94	-	4.85	-
Germany	104.8	2009-10	13.8	13.2%	-	-	10.39	0.69	2.75	-	-
France	33.7	2009-10	7.1	21.2%	0.87	-	0.83	-	1.31	4.13	-
Italy	103.5	2009 onwards	1.3	1.3%	-	-	-	-	1.32	-	-
Spain	14.2	2009	0.8	5.8%	-	-	-	-	-	-	0.83
United Kingdom	30.4	2009-12	2.1	6.9%	-	-	0.29	1.38	0.41	-	0.03
Other EU states	308.7	2009	6.2	2.0%	1.9	-	0.4	3.9	-	-	-
Sub-total Europe	**325.5**	**0**	**54.2**	**16.7%**	**3.5**	**12.5**	**14.7**	**7.9**	**5.8**	**9.0**	**0.9**
Americas											
Canada	31.8	2009-13	2.6	8.3%	-	1.08	0.24	-	0.39	0.79	0.13
Chile	4.0	2009	0.0	0.0%	-	-	-	-	-	-	-
US EESA	185.0**	10 Years	18.2	9.8%	10.25	2.60	3.34	0.76	0.33	0.92	-
US ARRA	787.0	10 Years	94.1	12.0%	22.53	3.95	27.40	4.00	9.59	11.00	15.58
Sub-total Americas	**1,007.8**		**114.9**	**11.4%**	**32.8**	**7.6**	**31.0**	**4.8**	**10.3**	**12.7**	**15.7**
Total	**2,796**		**436**	**15.6%**	**38.0**	**20.1**	**66.8**	**15.9**	**121.8**	**91.7**	**81.6**

(*Only EUR30bn from direct EU contribution considered for calculation as the rest (EUR170bn) is contributed by member states; **USD700bn under TARP not considered for calculation as the fund is mainly for bank bailouts not for fiscal stimulus) + Low Carbon Vehicles
Source: HSBC estimates

Source: HSBC Global Research, *A Climate for Recovery: The Colour of Stimulus Goes Green (London, 2009).*

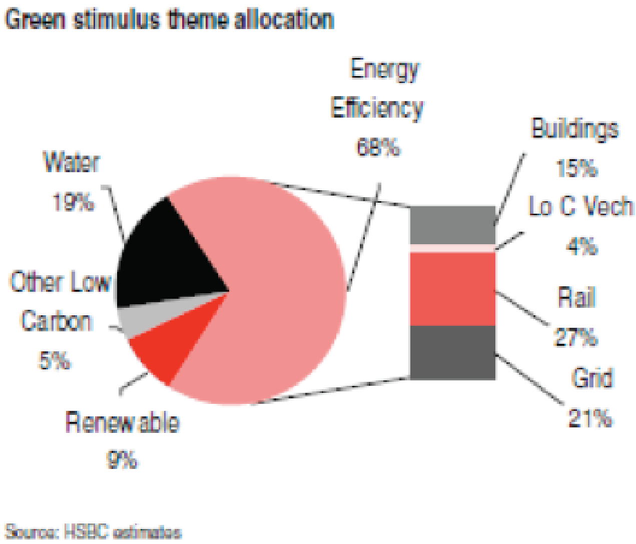
Regarding budget allocations, most governments set the core element of their future growth in energy efficiency with a large proportion (68 per cent) of their total stimulus packages. Because the primary purpose of a green stimulus package is to work hand-in-hand with job creation, energy efficiency measures related to green infrastructure, notably rail (27 per cent), grid (21 per cent) and buildings (15 per cent) were the main focus of allocations. The construction sector was the major beneficiary of each Green New Deal stimulus package, along with indirect effects on the operating sectors, such as railway, power and water utilities (figures 4 and 5).

Figure 4: G20 green stimulus spending by sector



Source: United Nations Environment Programme, *Global Green New Deal: Policy Brief* (Geneva, 2009).

Figure 5: Green stimulus theme allocation



Source: HSBC Global Research, *A Climate for Recovery: The Colour of Stimulus Goes Green* (London, 2009).

Implementing strategies

Need to change policy architecture: UNEP, in its *Global Green New Deal Report*[5] for the G20 Pittsburgh Summit in September 2009, notes that green investments contained in each national stimulus package need to be supported by a domestic framework to ensure they contribute to a long-term transition to a green economy. The report recommends six domestic policy reforms:

- Reduce perverse subsidies (such as subsidies on fossil fuels)
- Create positive incentives and appropriate taxes to reward more sustainable practices
- Improve land use and urban policy
- Develop integrated management of freshwater resources
- Introduce and improve environmental legislation and enforcement
- Implement systems for monitoring and accounting for the economic contributions made by green investments, such as environmental economic accounting.

Further reading

Global Green New Deal: Policy Brief (Geneva, United Nations Environment Programme, 2009). Available from www.unep.ch/etb/publications/Green%20Economy/UNEP%20Policy%20Brief%20Eng.pdf

A Global Green New Deal for Climate, Energy, and Development (New York, United Nations Department of Economic and Social Affairs, 2009). Available from www.un.org/esa/dsd/resources/res_pdfs/publications/sdt_cc/cc_global_green_new_deal.pdf

A Climate for Recovery: The Colour of Stimulus Goes Green (HSBC Global Research, 2009). Available from www.globaldashboard.org/wp-content/uploads/2009/HSBC_Green_New_Deal.pdf

[5] United Nations Environment Programme (UNEP), *Global Green New Deal: An Update for the G20 Pittsburgh Summit* (Geneva, 2009). Available from www.unep.org/pdf/G20_policy_brief_Final.pdf (accessed 29 January 2012).

Green public procurement

Key points

- ***Public sector purchasing is a powerful force that can influence markets for environment-friendly products and services and create markets for appropriate technologies and innovative solutions.***

- ***Poorly managed government spending is counterproductive to a green economy transition because it depletes environmental assets and diverts scarce financial resources.***

- ***Governments need to have a policy framework and matching procurement criteria so that government agencies follow green procurement standards.***

Green public procurement explained

Green procurement is the selection of products and services that minimize environmental impacts. Environmental considerations include, among other things, the reduction of pollution, improved energy and resource efficiency, reduction of waste and toxic and hazardous materials.[1]

According to *Procuring the Future*, "Sustainable public procurement is a process whereby public organizations meet their needs for goods, services, works and utilities in a way that achieves value for money on a whole life basis in terms of generating benefits not only to the organization but also to society and the economy while minimizing damage to the environment."[2] It incorporates social considerations in addition to environmental considerations. Social considerations can include equality, poverty eradication and employment conditions.

Public spending represents up to 30 per cent of national GDP and every purchase is an opportunity to drive markets towards innovation and sustainability.[3] Poorly managed government spending is counterproductive to a green economy transition because it depletes environmental assets and diverts scarce financial resources.

Green public procurement is an effective way to pursue social and environmental goals. In addition to creating demand for green goods and services, green procurement can increase the credibility of public authorities, particularly when encouraging industry and consumers to change their patterns of production and consumption.

Sustainable public procurement seeks to achieve the appropriate balance between the three pillars of sustainable development:[4]

[1] United Nations Department of Economic and Social Affairs, "Public Procurement as a Tool for Promoting More Sustainable Consumption and Production Patterns", *Sustainable Development Innovation Briefs*, August 2008. Available from http://esa.un.org/marrakechprocess/pdf/InnovationBriefs_no5.pdf (accessed 22 February 2012).

[2] United Kingdom, *Procuring the Future* (London, Department for Environment, Food and Rural Affairs, 2006). Available from www.defra.gov.uk/publications/files/pb11710-procuring-the-future-060607.pdf (accessed 25 February 2012). Definition adopted by the Task Force on Sustainable Public Procurement led by Switzerland (membership includes Switzerland, USA, UK, Norway, Philippines, Argentina, Ghana, Mexico, China, Czech Republic, State of Sao Paolo (Brazil), UNEP, IISD, International Labour Organization (ILO), European Commission (DG-Environment) and International Council for Local Environmental Initiatives (ICLEI)) and in the context of the Marrakech Process on Sustainable Production and consumption led by UNEP and UN DESA.

[3] United Nations Environment Programme, *Capacity Building for Sustainable Public Procurement* (Nairobi, 2011). Available from www.unep.fr/scp/procurement/docsres/ProjectInfo/ProjectBrochureEN.pdf (accessed 21 February 2012).

[4] United Nations Environment Programme, Division of Technology, Industry and Economics website "Sustainable Consumption and Production Branch". Available from www.unep.fr/scp/procurement/whatisspp/ (accessed 20 February 2012).

- **Economic factors** include the costs of products and services over their entire life cycle, such as: acquisition, maintenance, operations and end-of-life management costs (including waste disposal) in line with good financial management.
- **Social factors** include social justice and equity, safety and security, human rights and decent employment conditions.
- **Environmental factors** include emissions to air, land and water, climate change, biodiversity and natural resource use over a product's life cycle.

Strengths of green public procurement

- **Raising awareness:** Green public procurement can be a driving force to bring sustainable consumption to the attention of the public and entrepreneurs, which ultimately expands markets for green products.

- **Expanding green markets:** Through sustainable procurement, governments can set an example and deliver policy objectives. These signals allow companies to make long-term investments in innovation; thus, public procurement kick-starts markets for more innovative and environment-friendly products and services. It encourages producers to realize economies of scale and consumers to follow the government's lead, resulting in the wider commercialization of green goods and promoting conscious consumption.

- **Social, environmental and economic benefits:** Buying green and efficient products and services generates social, environmental and economic benefits, namely a reduced ecological footprint, enhanced innovation and competitiveness as well as an increased availability of green products and services.[5]

Country experience: Green procurement in Japan

To promote new technology in the market, governments should pursue green procurements in the initial stage of technology diffusion. Zero-emission electric vehicles, for example, are drawing attention because of the growing concerns about global warming and the climate. However, electric vehicles still represent only a niche market, primarily because of the difficulty to set up sufficient recharging infrastructure. Operating an electric vehicle requires periodical recharging, but recharging stations are typically not that plentiful in countries where the vehicles are available.

In Japan, the Nissan electric vehicle called "Leaf" is mostly sold to local governments rather than to regular customers. The lack of recharging station infrastructure makes customers reluctant to buy the cars. Nissan has only sold 13,600 cars around the world since they went on sale in December 2010.[6] There are now 619 recharging stations throughout Japan, with more than half installed in the company groups that promote electric vehicles, while the remainder are with local governments.

At the early stage of technology diffusion, it is important for a government to promote the technology by using its own procurement scheme. To stimulate the sales of the Leaf, the Nissan Motor Co. developed a charger for electric vehicles that is smaller, cheaper and easy to install. The newly developed quick-charging unit retains a high performance and will cost significantly less than US$13,000, while the base specification unit will cost less than half the price of the current unit, which is now on sale for US$19,000.[7] Nissan plans to install the new charging units at an increasing number of its dealerships nationwide and to introduce the new units at locations throughout Japan that draw large numbers of customers. This fact underscores the importance of the infrastructure availability at the time electric vehicles are introduced in the market.

[5] United Nations Environment Programme, *Capacity Building for Sustainable Public Procurement* (Nairobi, 2011). Available from www.unep.fr/scp/procurement/docsres/ProjectInfo/ProjectBrochureEN.pdf (accessed 21 February 2012).

[6] *The Economic Times*, "Nissan Develops Cheaper, Smaller Charger for EVs", September 12, 2011. Available from http://economictimes.indiatimes.com/news/international-business/nissan-develops-cheaper-smaller-charger-for-evs/articleshow/9954745.cms (accessed 20 February 2012).

[7] Green Car Congress website, "Nissan Develops New Quick Charger for Electric Vehicles" (12 September 2011). Available from www.greencarcongress.com/2011/09/nissancc-20110912.html (accessed 20 February 2012).

Box 1: Green public procurement laws in Asia

China: As of 2007, the central and provincial governments are required to prioritize environment-friendly products listed in a green product inventory. The list includes products that have been approved by the China Certification Committee for Environmental Labelling. Products must meet the environmental protection and energy saving standards set by the State Environmental Protection Administration to obtain the label.

Japan: The 2000 Law on Promoting Green Purchasing makes it compulsory for the Government to follow green procurement criteria while encouraging local authorities, private companies and individuals to make efforts for purchasing environmentally sound products and services. All state ministries, departments and agencies have to define procurement targets in every fiscal year and make the results of their green procurement efforts publicly available.

Republic of Korea: The Promotion of the Purchase of Environment-Friendly Products Act of 2005 requires public agencies at the national and local levels to publish and enact green procurement policies and implementing plans and to report the results.

Source: United Nations Department Economic and Social Affairs, "Public procurement as a tool for promoting more sustainable consumption and production patterns", *Sustainable Development Innovation Briefs*, Issue 5, August 2008. Available from http://esa.un.org/marrakechprocess/pdf/InnovationBriefs_no5.pdf (accessed 26 February 2012).

Challenges for green public procurement

- **High implementing costs:** Green products and services may have higher upfront costs than conventional products; thus procurement policies may need to be revised to permit the use of non-price criteria and to incorporate green criteria.

- **Lack of knowledge:** A major hurdle for the widespread use of green procurement practices is a lack of knowledge among officials on how to achieve it. Training on how to incorporate environmental criteria is crucial for acquiring green products and services.

- **Uncertainty regarding real environmental impacts of products:** Making the right choice for specific technologies and goods is particularly difficult in the context of immature technologies and has to be determined by comprehensive analysis.[8]

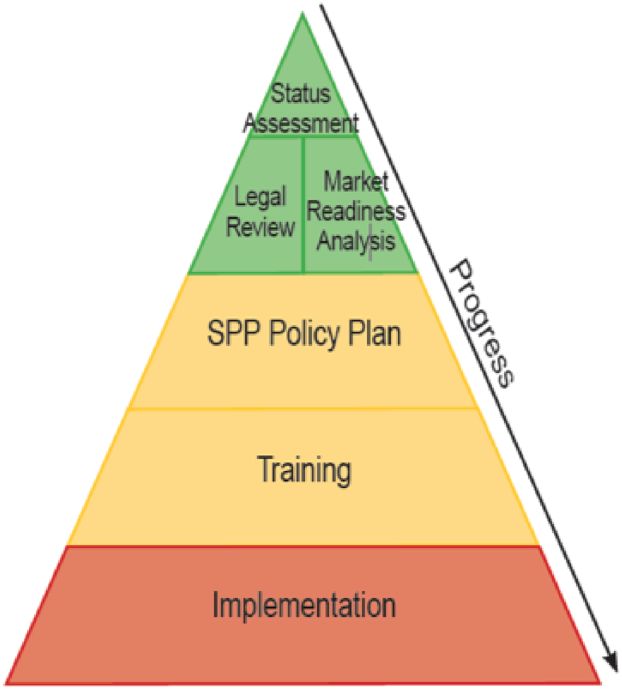
Implementing strategies

Take the step by step approach: The Marrakech Task Force developed a step-by-step approach that aims to encourage and assist public authorities to pursue green, or sustainable, public procurement. It is a flexible implementing strategy and takes into account the varying needs, priorities and legal frameworks present in different countries. Depicted in figure 1, the approach ideally starts from the top of the triangle and ends with the implementing of sustainable public procurement (SPP) in day-to-day procedures; the policy plan must receive inputs from a status assessment, a legal review and a market readiness review.[9]

[8] United Nations Environment Programme, *Enabling Conditions: Supporting the Transition to a Global Green Economy* (Nairobi, 2011). Available from www.unep.org/greeneconomy/Portals/88/documents/ger/GER_14_EnablingConditions.pdf (accessed 20 February 2012).

[9] Marrakech Task Force, *Marrakech Task Force on Sustainable Public Procurement* (Bern, 2011). Available from www.unep.fr/scp/procurement/docsres/ProjectInfo/MTF_Flyer_A4_Ansicht.pdf (accessed 21 February 2012).

Figure 1: Developing a green, or sustainable, public procurement scheme



Source: United Nations Environment Programme, *Capacity Building for Sustainable Public Procurement* (Nairobi, 2011). Available from www.unep.fr/scp/procurement/docsres/ProjectInfo/ProjectBrochureEN.pdf (accessed 21 February 2012).

Identify priority sectors for green, or sustainable, procurement: Prioritizing ensures that public procurement expenditures are not used in sectors in which there is little room for governments to influence the market or where governments cannot expect to find green or sustainable alternatives at a competitive price. Adequate means for this are market potential analyses, reviews of national procurement frameworks and procurement assessments.

Circumvent high implementing costs: To lower initial costs, governments embracing green procurement criteria should focus on goods and services that have a short payback time or high rate of return when their efficiency gains are factored in.[10] To overcome the hurdle of high investments, long-term leasing opportunities for equipment, which transfers the costs of maintenance and replacement back to suppliers, should be considered.

Mandate green public procurement: High-level political commitment makes a difference. Government leaders should make clear that green procurement is a priority through the help of a country-based green public procurement policy and action plan that includes a capacity-building programme so that agencies can set expectations for their procurement officers.

Clear criteria integrating social and environmental aspects for green, or sustainable, public procurement are needed. Procedures for selecting products and services and government-wide training and technical assistance for procurement officers will help encourage familiarity with green procurement practices.

[10] United Nations Environment Programme, *Enabling Conditions: Supporting the Transition to a Global Green Economy* (Nairobi, 2011). Available from www.unep.org/greeneconomy/Portals/88/documents/ger/GER_14_EnablingConditions.pdf (accessed 20 February 2012).

Further reading

Buying green! A Handbook on Environmental Public Procurement (Brussels, European Commission, 2004). Available from http://ec.europa.eu/environment/gpp/pdf/buying_green_handbook_en.pdf

Improving the Environmental Performance of Public Procurement: Report on Implementation of the Council Recommendation (Paris, Organisation for Economic Co-operation and Development, 2007). Available from www.oecd-ilibrary.org/docserver/download/fulltext/0207091ec001.pdf?expires=1329987595&id=id&accname=ocid49013645&checksum=D4C5EDF59BB6DF78D26AAB8889568160.

"Public Procurement as a Tool for Promoting More Sustainable Consumption and Production Patterns", *Sustainable Development Innovation Briefs*, Issue 5 (New York, United Nations Department of Economic and Social Affairs, 2008). Available from http://esa.un.org/marrakechprocess/pdf/InnovationBriefs_no5.pdf

FACT SHEET

Green technology

Key points

- ***Encouraging the diffusion of green technology requires a combination of voluntary approaches, government incentives and a comprehensive regulatory framework.***

- ***Policy signals stimulate private investments in R&D.***

- ***Least developed countries and small island developing states need special measures and support to promote green technologies.***

Green technology explained

There is no commonly accepted or internationally agreed definition of green technology. The term can be broadly defined as technology that has the potential to significantly improve environmental performance relative to other technology. It is related to the term "environmentally sound technology", which was adopted under the United Nations Conference on Environment and Development Agenda 21, although it is no longer widely used. Based on Agenda 21, environmentally sound technologies are geared to "protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they were substituted."[1] Other related terms for green technology include: climate-smart, climate-friendly and low-carbon technology.

How it works

In terms of pollution, green technology includes both process and product technologies that generate low or no waste and increase resource- and energy-efficiency. They also cover "end-of-the-pipe" technologies for treating pollution. Green technology does not only mean individual technologies but also systems, including know-how, procedures, goods and services and equipment, as well as organizational and managerial procedures.

Categories of green technology

Green technology covers a broad area of production and consumption technologies. The adoption and use of green technologies involves the use of environmental technologies for monitoring and assessment, pollution prevention and control, and remediation and restoration. Monitoring and assessment technologies are used to measure and track the condition of the environment, including the release of natural or anthropogenic materials of a harmful nature. Prevention technologies avoid the production of environmentally hazardous substances or alter human activities in ways that minimize damage to the environment; it encompasses product substitution or the redesign of an entire production process rather than using new pieces of equipment. Control technologies render hazardous substances harmless before they enter the environment. Remediation and restoration technologies embody methods designed to improve the condition of ecosystems, degraded through naturally induced or anthropogenic effects.[2]

[1] United Nations Department of Economic and Social Affairs, *Earth Summit Agenda 21: The United Nations Programme of Action from Rio* (Rio de Janeiro, 1992). Available from www.un.org/esa/dsd/agenda21 (accessed 31 January 2012).

[2] United Nations Environment Programme, *Environmentally Sound Technologies for Sustainable Development*, Revised Draft (Osaka, Division of Technology, Industry and Economics, 2003). Available from www.unep.or.jp/ietc/techtran/focus/sustdev_est_background.pdf (accessed 05 March 2012).

Sectors of green technology

- Agriculture
  - Organic agriculture
- Energy
  - Renewable energy technology
  - Efficiency technology
- Water and waste management
  - Recycling technology
  - Sewage treatment and solid waste management
  - Water purification
- Building
  - Sustainable building material
  - Building performance technology
- Transportation
  - Rail transport
  - Electric vehicle

Country experience: Green technology policy in Malaysia

In Malaysia, green technology has been recognized as a driver for future economic growth, energy security, climate change mitigation and adaptation. In April 2009, the Malaysian prime minister proclaimed his vision of a Green Malaysia and demonstrated his commitment to climate change mitigation and energy security by escalating the advancement of green technology through the creation of the Ministry of Energy, Green Technology and Water. The prime minister further enunciated his vision by developing Putrajaya and Cyberjava as pioneer townships in green technology that were to become a showcase for the development of other townships across the country.

The national green technology policy was developed in cooperation with all relevant parties to strengthen the institutional frameworks and policy coherence. The policy was designed to generate benefits in four areas: energy, environment, economy and social conditions. Progress will be monitored by a variety of indicators. Green technologies are to be developed in four core sectors: energy, buildings, water and waste management, and transport. Additionally, work is underway to develop a green technology roadmap for Malaysia.

Policies to strengthen institutional frameworks include: the formation of a Green Technology Council and a Cabinet Committee on Green Technology for high-level policy coordination among ministries, chaired by the prime minister; the establishment of a Malaysia Green Technology Agency to coordinate and oversee initiatives and programmes; a review of legal mechanisms and the creation of new legislation that is in line with national goals; and a revision of institutional clarity so that all agencies are aware of their roles and responsibilities.

Policies to encourage the growth of green technology sectors include: support for higher-learning and research institutions for R&D; increased foreign and domestic investment; establishment of a Green Technology Fund; feed-in tariffs legislation to support renewable energy in power generation; and the recognition of green products through standards, ratings and labelling programmes. Various industry programmes inform SMEs about new green technologies, strategic green technology hubs throughout the country, and funding mechanisms.

Other fiscal incentives for renewable energy include: "pioneer status", which provides exemptions from income tax (25 per cent from 2009 onwards) on 100 per cent of statutory incomes for ten years[3]; investment tax allowances on qualifying capital expenditure incurred within five years of the first expenditure; and import duty and sales tax exemptions for one year on imported machinery, equipment, materials, space parts and consumables that are used for renewable energy by both importers and third-party distributors.

[3] Kementerian Tenaga Teknologi Hijau Dan Air, *Incentive for Energy Efficiency and Renewable Energy in Malaysia* (Putrajaya, 2009). Available from http://seda.gov.my/pdf/PTM%20Incentives.pdf (accessed 31 January 2012).

Policies to improve human resource capacity include: several policies centre on training and education, such as financial and fiscal incentives for students pursuing studies in green technology disciplines at both the undergraduate and graduate levels; retraining and apprenticeship schemes for green jobs; a grading and certification mechanism for green technology-related skills; and brain gain programmes to strengthen local expertise.

Source: Kementerian Tenaga Teknologi Hijau Dan Air, "The national green technology policy", PowerPoint presentation (2010). Available from http://portal.ppj.gov.my/c/document_library/get_file?p_l_id=17335&folderId=27605&name=DLFE-4709.pdf (accessed 06 March 2012).

Box 1: Recent developments in eco-design in Europe

Eco-design, which is often referred to as cradle-to-cradle design (C2C), is a policy tool aimed at improving the environmental performance of products throughout their lifecycle by introducing specific requirements in their design stage. Eco-design can take a variety of forms, such as guidelines, checklists, indicators and life-cycle assessment. While eco-labelling helps to disclose information on the products in order to assist consumers in making informed decisions, eco-design, in contrast, directly influences the way the product is designed, manufactured, packaged, transported, used and disposed. Eco-design can play a critical role in greening markets by singling out inefficient products and pulling them out of the market.

In the European Union, concerted efforts are being made to establish and update eco-design through the Ecodesign Directive. The Ecodesign Directive sets minimum energy efficiency requirements and other environmental standards for 32 indicative product groups, including electronic appliances and office lighting, based on a life-cycle approach.[4] The implementing measures vary depending on the respective product groups. Nine new broad product groups may be added for the period 2012 to 2014, depending on their energy saving potential and market volume. These groups under consideration include windows, steam boilers (less than 50MW), power cables, enterprises servers, storage and ancillary equipment, and smart appliances/meters. According to the working plan, these priority product groups are estimated to achieve energy savings of 1,157 TWh per year by 2030.

Source: European Commission, *Communication from the Commission to the Council and the European Parliament: Establishment of the Working Plan for 2012-2014 under the Ecodesign Directive*, Draft (Brussels, 2012). Available from www.ebpg.bam.de/de/ebpg_medien/wp2_2011-12_wd_kom.pdf (accessed 06 March 2012).

Strengths from adopting green technology[5]

- **Ability to meet strict product specifications in foreign markets:** Manufacturers in developing countries typically need to meet stricter environmental requirements and specifications to export their products to industrialized countries than vice versa. The adoption of green technologies can help exporting companies to gain advantage and market share over competitors.

- **Reduction of input costs:** Green technology can improve production efficiency through the reduction of input costs, energy costs and operating and maintenance costs, which can improve a company's competitive position.

- **Environmental image:** Adopting green technology can improve a company's environmental reputation, which is crucial if other competitors and consumers are becoming more environmentally conscious.

[4] INFORSE-Europe website "ECO-Design for Energy Efficiency: Framework Directive with Implementation Measures" (July 2010). Available from www.inforse.dk/europe/eu_ecodesign.htm (accessed 16 January 2012).

[5] R. Luken and F. Van Rompaey, "Drivers for any barriers to environmentally sound technology adoption by manufacturing plants in nine developing countries", *Journal of Cleaner Production* (2008), vol.16, No.1, pp. 67-77.

- **Ability to meet stricter environmental regulations in the future:** Companies that invest in green technology are more likely to be better equipped and ready for stricter environmental regulations as well as product specifications that are expected to be imposed on them in the future.

Box 2: Transfer of green technologies

Technology transfer is not a passive, one-way process. To entice the transfer of green technologies from industrialized economies to the developing world, both supply and demand factors must be considered. On the supply side, investors and businesspeople who participate in the transfer of technology seek an enabling environment in recipient developing countries, specifically the capacity and infrastructure to support production and management and the regulations that encourage further development of green technology. On the demand side, there must be local demand (pull factors) in order for green technologies to be successfully absorbed.

If developing countries want to embrace sustainable strategies for green growth, they must nurture the transfer of green technologies by building technical capacity and by creating an institutional framework that enables them to absorb, adapt and improve the transferred components and systems.

Currently, most of the green technology transfer is happening in the biggest emerging economies, such as China, Brazil and India. But it is not entirely unidirectional. It also takes place between, within and across industrialized and developing countries in many ways. The most frequent transfer path is the straightforward buying and selling. Additionally, there are also in-licensing and out-licensing agreements regarding potential technologies and associated know-how and the creation of more sophisticated platforms aimed at developing, transferring and using technology, such as joint ventures, strategic alliances and R&D services. Another transfer path is the acquisition of knowledge of different technologies through specialized programmes, technical assistance, training and education.

Source: World Intellectual Property Organization, *World Intellectual Property Report 2011: The Changing Face of Innovation* (Geneva, 2011). Available from www.wipo.int/freepublications/en/intproperty/944/wipo_pub_944_2011.pdf (accessed 05 March 2012).

Challenges to green technology adoption

Generally, green technology is more expensive than the technology it aims to replace, because it accounts for the environmental costs that are externalized in many conventional production processes. Because it is relatively new, the associated development and training costs can make it even more costly in comparison with established technologies. The perceived benefits are also dependant on other factors such as supporting infrastructure, technology readiness, human resources capabilities and geographic elements. Hence, what could be a feasible green technology in one country or region may not be in another.

Adoption and circulation of these technologies can be constrained by a number of other barriers. Some may be institutional, such as the lack of an appropriate regulatory framework; others may be technological, financial, political, cultural or legal in nature.

From a company's perspective, the following are likely barriers to adopting green technologies:[6]

- High implementing costs
- Lack of information
- No known alternative chemical or raw material inputs
- No known alternative process technology
- Uncertainty about performance impacts
- Lack of human resources and skills.

[3] R. Luken and F. Van Rompaey, "Drivers for any barriers to environmentally sound technology adoption by manufacturing plants in nine developing countries", *Journal of Cleaner Production* (2008), vol.16, No.1, pp. 67-77.

Overcoming these barriers is a complex process because it can involve a large number of parties, ranging from government, private sector, and NGOs to financial, research and educational institutions. Promoting green growth requires identifying and removing these barriers that hinder the large-scale dissemination of clean technology to developing countries, especially to those countries with special needs, such as least developed countries and small island developing states.[7] Table 1 highlights motivating and influencing factors for adopting new technologies from the viewpoint of various parties.

Table 1: Motivation and influence for technology adoption

Stakeholders	Motivations	Areas of influence
Governments • National/federal • Regional/state/provincial • Local/municipal	• Development goals • Environmental goals • Competitive advantage • Security	• Taxation • Import/export • Innovation policies • Education and capacity-building • Regulatory programmes • Institutional development • Credit and investment
Private sector business • Transnational • National • Local/micro-enterprise (including producers and users)	• Profits • Return on investment • Market share • Competitive advantage	• Capital investment • Technology R&D/commercializing • Marketing • Skills/capabilities development • Acquisition of information • Technology transfer • Technology transfer pathways • Lending/credit policies(producers, financiers) • Technology selection (distributors, users)
International development institutions • Multilateral banks • Bilateral aid agencies • Other agencies (Global Environment Facility, World Trade Organization, United Nations, OECD)	• Basic and applied knowledge • Research • Teaching • Knowledge transfer • Perceived credibility	• Research and development • Technology commercializing • Technology transfer • Technology transfer pathways
Media/public groups • TV, radio, newspapers • Schools • Community groups • NGOs	• Information dissemination • Education • Awareness • Informed decisions • Collective welfare	• Promotion and advertising • Educational programmes • Community programmes • Lobbying for resources • Information dissemination
Individual consumers • Urban • Rural	• Survival • Quality of life • Information • Affordable solutions	• Purchase decisions • Information selection • Learning pathways • Application of knowledge

[7] United Nations Economic and Social Commission for Asia and the Pacific, *Financing an Inclusive and Green Future: A Supportive Financial System and Green Growth for Achieving the Millennium Development Goals in Asia and the Pacific* (Bangkok, 2010). Available from www.unescap.org/publications/detail.asp?id=1393 (accessed 31 January 2012).

Source: United Nations Environment Programme, *Environmentally Sound Technologies for Sustainable Development* (Osaka, Division of Technology, Industry and Economics, 2003). Available from www.unep.or.jp/ietc/techtran/focus/sustdev_est_background.pdf (accessed 6 March 2012).

Until fossil energy resources and GHG emissions are priced appropriately, marked by the point when distorting subsidies are removed and externalities are internalized, government policies will need to support R&D and the adoption of certain green technologies. Four policy measures that have proven successful in the Asia-Pacific region are: i) renewable energy targets and portfolio standards; ii) renewable energy certificates; iii) feed-in tariffs; and iv) green public procurement.[8]

Green technology – agriculture

Agriculture accounts for about 13–15 per cent of global greenhouse gas emissions.[9] Having a share in global GDP of only about 4 per cent, it is very greenhouse-gas intensive. Under a business-as-usual scenario, agricultural greenhouse gas emissions are predicted to rise by almost 40 per cent by 2030. Climate change could reduce total agriculture production in many developing countries by up to 50 per cent in the next few decades. At the same time, the population of the world is projected to nearly double, potentially creating tensions between food supply and demand.[10]

Green growth in agriculture is achieved through a shift to practices that take into account the regional environmental capacity, by promoting low-carbon production and carbon sequestration capacities. What is needed is a low-carbon life cycle, not only in terms of production but also encompassing distribution, processing and consumption.

Agriculture that pursues green growth can be characterized as green agriculture – although the term is not widely used. There are several green concept terms more commonly used in reference to agriculture. Sustainable agriculture is one such term. It integrates the three goals of sustainable development: environmental protection, economic profitability and social equity. Sustainable agriculture covers organic farming, low external-input agriculture, agro-ecological and bio-dynamic production systems, integrated livestock and crop farming systems and conservation tillage.

Organic agriculture

Organic agriculture, according to the Codex Alimentarius Commission, is "a holistic production management system that avoids use of synthetic fertilizer, pesticides and genetically modified organisms, minimizes pollution of air, soil and water and optimizes the health and productivity of interdependent communities of plants, animals and people."[11]

Box 3: Codex Alimentarius Commission

The Codex Alimentarius Commission, working under the Joint FAO/WHO Food Standards Programme, develops food standards, guidelines and codes of practice since its foundation in 1963 by FAO and WHO. The programme aims to protect the consumer health, promote fair trade practices and facilitate the coordination of all food standards work undertaken by international government and non-government organizations.

Source: World Health Organization and Food and Agriculture Organization, *Understanding the Codex Alimentarius*, third edition (Rome, 2006). Available from ftp://ftp.fao.org/codex/Publications/understanding/Understanding_EN.pdf (accessed 06 March 2012).

[8] Jeffrey Crawford, *Promoting Trade and Investment in Climate-Smart Goods, Services and Technologies in Asia and the Pacific* (Bangkok, UNESCAP, 2011).

[9] Ulrich Hoffmann, *Assuring Food Security in Developing Countries under the Challenges of Climate Change: Key Trade and Development Issues of a Fundamental Transformation of Agriculture* (Geneva, United Nations Conference on Trade and Development, 2011). Available from www.unctad.org/en/docs/osgdp20111_en.pdf (accessed 31 January 2012).

[10] ibid.

[11] Nadia El-Hage Scialabba and Maria Müller-Lindenlauf, "Organic agriculture and climate change", *Renewable Agriculture and Food Systems* (2010), vol. 25, No. 2, pp. 158-169. Available from www.redagres.org/Organic-agric.pdf (accessed 05 March 2012).

Organic agriculture consists of practices that increase resource efficiency by optimizing nutrient and energy flow while minimizing human health risks and environmental impact includes:

- Crop rotations
- Crop diversity
- Integrated livestock production
- Organic fertilizer
- Biological pest control.

Organic and biodynamic farming systems possess soils of higher biological, physical and, in many cases, chemical quality than that of conventional practices. When social and environmental costs are accounted for, the organic alternative can also be economically competitive. The market for global organic food and beverage is currently estimated at around US$51 billion and expected to reach US$104.5 billion by 2015.[12] Governments can support organic and sustainable agriculture by consolidating organic standards and setting up certification and regulatory mechanisms, technology packages and market networks.

Table 2: Environmental benefits and adaptation potential of organic agriculture

Objectives	Means	Impacts
• Alternative to industrial production inputs (mineral fertilizers and agro chemicals) to decrease pollution • *In situ* conservation and development of agro-biodiversity • Landscaping • Soil fertility	• Improvement of natural resources processes and environmental services (soil formation, predation) • Farm diversification (polycropping, agroforestry and integrated crop/livestock) and use of local varieties and breeds • Creation of micro-habitats (hedges), permanent vegetative cover and wildlife corridors • Nutrient management (rotations, corralling, cover crops and manuring)	• Reliance on local resources and independence from volatile prices of agriculture inputs (mineral fertilizers) that accompany fossil fuel hikes • Risk splitting (pests and diseases), enhanced use of nutrient and energy flows, resilience to climate variability and savings on capital-intensive seeds and breeds • Enhanced ecosystem balance (pest prevention), protection of wild biodiversity and better resistance to wind and heat waves • Increased yields, enhanced soil water retention/drainage (better response to droughts and floods), decreased irrigation needs and avoided land degradation

Source: Nadia El-Hage Scialabba and Maria Müller-Lindenlauf, "Organic agriculture and climate change", *Renewable Agriculture and Food Systems* (2010), vol. 25, No. 2, pp. 158-169. Available from www.redagres.org/Organic-agric.pdf (accessed 06 March 2012).

[12] *PRNewswire*, "MarketsandMarkets: Global Organic Food and Beverages Market Worth $104.50 Billion By 2015", February 24, 2011. Available from www.prnewswire.com/news-releases/marketsandmarkets-global-organic-food-and-beverages-market-worth--10450-billion-by-2015-116804058.html (accessed 31 January 2010).

Box 4: Climate-smart agriculture

FAO and the COP16 in 2010 have both recognized the future dilemma of feeding a climate-change ridden world whose population is ever-increasing. Thus, they emphasized the need to transform the agricultural sector from being part of the problem to being part of the solution, by making it 'climate smart'. Climate smart means agriculture that sustainably increases productivity and resilience against environmental pressures while at the same time reducing greenhouse gas emissions or removing them from the atmosphere. The FAO stresses that climate smart practices do not need to be newly invented in many cases, but that a variety of them already exists that could be widely instilled in developing countries, where food production is bound to change due to changing economic, environmental and social circumstances.[13]

Source: United Nations Economic and Social Commission for Asia and the Pacific, *The Role of Trade and Investment in the Context of Track 4 (Turning Green into a Business Opportunity) and Track 5 (Low Carbon Economics) of the LC GG Roadmap for the Asia-Pacific Region* (Bangkok, Trade and Investment Division, 2011).

Country experience: Roadmap for the agriculture sector in the Republic of Korea

The Korean Government has already started adapting its agriculture sector in the face of a changing climate. The adaptation strategy was charted in a roadmap for 2030 designed in three phases: short-term base build-up phase (2010–2013), mid-term take-off phase (2014–2019) and long-term settlement phase (2020–2030). Each phase covers seven categories, and a total of 19 adaptation measures listed below:

- **R&D** – breeding, production technology development, base technology development, resource management innovation and climate information system
- **Infrastructure management** – farmland management, agricultural water management and agricultural facility management
- **Economic means** – provision of grants
- **Legal and institutional improvement** – insurance system expansion, resource management system set-up and regional plans
- **Human resource training and education** – training, education and public relations
- **Monitoring** – assessment of adaptation and vulnerability
- **Technology and management applicable to farm households** – production technology management, soil management, water management and farm household finance management.

Not all the measures apply to all of the three phases, but many do. The three measures included in the infrastructure management category, constitute the main tasks in all phases. In the economic category, the low-carbon grant is critical in the base build-up phase but it should continue as well. In the legal and institutional improvement category, the agricultural disaster insurance system needs to be carried on continuously so that it can be established securely. Public relations and education should also be continued in order to establish a consensus on adaptation to climate change. In the monitoring category, the tasks for developing a model to make medium- and long-term forecasts of the world food demand and supply should also be kept up in each phase. And in the category of technology and management applicable to farm households, R&D programmes should be present in each phase to promote new, green technologies.

Source: Chang-Gil Kim, *The Impact of Climate Change on the Agricultural Sector: Implications of the Agro-Industry for Low Carbon, Green Growth Strategy and Roadmap for the East Asian Region*, Consultant Report (Bangkok, UNESCAP, 2011).

[13] The Food and Agriculture Organization of the UN (FAO, 2010) has a new report out on precisely this issue: "Climate-Smart" Agriculture: Policies, Practices and Financing for Food Security, Adaptation, and Mitigation.

Country experience: Countering climate change in the agriculture sector in China

The Chinese government's agricultural countermeasures against climate change are largely divided into greenhouse gas mitigation and adaptation.

The mitigation strategies entail:

- popularizing of low carbon-emitting, multi-harvesting rice varieties and half-drought type cultivation techniques;
- adopting efficient irrigation methods and soil-specific fertilization techniques;
- researching and developing high-quality ruminant breeding technology and stockbreeding management technologies;
- strengthening the management of animal excrement, wastewater and solid wastes;
- improving the efficiency of methane use; and controlling methane emissions.

Adaptation means entail:

- strengthening the measured forecast level for extreme meteorological disasters by supplementing the measured forecast emergency action mechanism, the multi-department decision-making mechanism and ensuring a comprehensive community-involvement mechanism in provisions against various disasters;
- establishing a meteorological disaster defence process (by 2010) that has an essential role in securing the society;
- improving the comprehensive measured forecast level, defence level and disaster-mitigation capacity to cope with extreme meteorological disasters;
- forming 24 million ha of new grassland and clearing 55 million ha of degraded, desertificated and/or alkali grasslands (by 2010) by strengthening farmland construction, cultivation system adjustments, resistant- variety selection and development, and biotechnology development.[14]

In terms of climate change adaptation policies, the Chinese Government has enacted the Agriculture Act, the Grassland Act, the Fisheries Act, the Land Management Act, an Ordinance on Emergency Measures Against Sudden Critical Animal Epidemic and an Ordinance on Pasture Fire Prevention. The Government has made efforts to supplement the political and regulatory system for the agricultural sector's adaptation to climate change. In addition, it has strengthened agricultural infrastructure, promoted the construction of farmland irrigation systems, expanded the irrigated agricultural area and improved irrigation efficiency. Additionally, the Government has popularized water-saving technology for hardy crops, enhanced the agricultural disaster prevention and reduction capacity, and developed crop varieties that can endure high temperature, blight and pests.

In the future, the Chinese Government will further popularize high-quality crop varieties and increase their coverage. Also, it will strengthen the prevention of critical animal epidemics.

Source: Chang-Gil Kim, *The Impact of Climate Change on the Agricultural Sector: Implications of the Agro-Industry for Low Carbon, Green Growth Strategy and Roadmap for the East Asian Region*, Consultant report (Bangkok, UNESCAP, 2011).

Green technology – energy

It is not just efficiency alone that advocates the use of green technology in the energy sector. Reduced costs, decreased environmental impacts, grid security and reliability are further benefits. Thus, new technologies should be carefully integrated into the system to complement existing infrastructure.

Solar

Currently, there are two main technologies for generating electricity using solar energy: photovoltaic (PV) and concentrated solar power (CSP). PV technology directly converts sunlight into electricity. CSP technology

[14] Chang-Gil Kim, *The Impact of Climate Change on the Agricultural Sector: Implications of the Agro-Industry for Low Carbon, Green Growth Strategy and Roadmap for the East Asian Region*, Consultant report (Bangkok, UNESCAP, 2011).

collects solar thermal energy by using mirrors to reflect and concentrate sunlight to produce heat or steam and convert it into electricity via a power generator.

PV technology can be further divided into two categories: crystalline silicon and thin-film module. Crystalline silicon was the first PV technology to be commercialized and still accounts for most of the global production.[15] Thin-film technology is generally less efficient than crystalline silicon but is also less expensive to manufacture. Due to the low-cost advantage, thin-film technology has been adopted in emerging economies and developing countries.

The PV industry's power plants are relatively easy to operate because the PV panels have no moving parts, thus requiring less maintenance than CSP power plants. But due to the low conversion efficiency of the photovoltaic cells, a large land area is needed for a high volume of electricity generation. On the plus side, the scalability of the PV module enables rooftop-mounted applications, which represents a big potential application area as well as a viable source for distributed electricity generation.

There are four types of CSP systems: linear concentrator, dish/engine, power tower and thermal storage. The concept for producing electricity is basically the same for all of them. They differ in their solar concentration configuration, tracking system, heat storage and efficiency. Smaller CSP systems can be used in distributed-generation applications to produce power on-site. But unlike the PV technology, the CSP systems are not easily scalable and are generally used in utility-scale applications. The heat generated from the CSP can be stored, so the produced electricity does not fluctuate as widely as with the PV system, thus it possesses an advantage in providing reliable power to utilities. Because CSP power plants commonly use steam to generate electricity and are water cooled, the availability of water resources can pose a constriction for their application.

The high cost and low-conversion efficiency are the main barriers to the wide use of solar power systems. Costs per unit of electricity generated from solar elements have remained relatively high in comparison to other renewable energy sources.[16] Fortunately, the manufacturing costs for the PV system decrease as the market for the technology expands. Moreover, the current research on increasing the efficiencies of both PV and CSP technologies aims to make the generating of solar power even more cost competitive.

Figure 1: Global cumulative installed solar power capacity, 2000–2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
China	19	30	45	55	64	68	80	100	145	373	893
APEC	38	43	49	57	66	80	112	170	466	718	1,191
Rest of the world	758	814	894	971	1,000	1,010	1,128	1,190	1,303	1,427	1,944
North America	146	177	222	287	379	496	645	856	1,205	1,744	2,727
Japan	318	452	637	860	1,132	1,422	1,708	1,919	2,149	2,632	3,622
EU	181	275	414	613	1,319	2,324	3,307	5,257	10,387	16,006	29,252
Total	**1,459**	**1,790**	**2,261**	**2,842**	**3,961**	**5,399**	**6,980**	**9,492**	**15,655**	**22,900**	**39,529**

Source: European Photovoltaic Industry Association, *Global Market Outlook for Photovoltaic until 2015* (Brussels, 2011). Available from www.epia.org/publications/photovoltaic-publications-global-market-outlook/global-market-outlook-for-photovoltaics-until-2015.html (accessed 06 March 2012).

[15] Andrew David, *U.S. Solar Photovoltaic (PV) Cell and Module Trade Overview* (Washington, D.C, United States International Trade Commission, 2011).

[16] Barry Rabe, *Race to the Top: the Expanding Role of U.S. State Renewable Portfolio Standards* (Michigan, Pew Center, 2006).

Country experience: Renewable energy in Thailand

In 2009, the Government of Thailand set the goal of generating 20 per cent of the country's energy from renewable sources by 2020. To achieve this, the Thailand's Ministry of Energy directed the Department of Alternative Energy Development and Efficiency to include a policy on alternative energy in the national agenda. The subsequently designed Alternative Energy Development Plan aims to generate 40,000 new jobs, reduce migration from rural to urban areas, decrease greenhouse gas emissions, save 460 billion baht per year in foreign currency reserves (value), currently spent to import fossil fuels, and generate up to 14 billion baht annual revenue from international carbon markets.[17]

The Alternative Energy Development Plan features provisions for the production and utilization of alternative energy in order to improve energy security. The Government will use a mix of market-based instruments as well as an oil fund to maintain energy prices at stable and affordable levels. Related policies included in the plan promote R&D of renewable energy from biofuels and co-generation from biomass and biogas, energy efficiency standards for electrical appliances and buildings, revision of existing obstructive legislation and updating of feed-in tariffs. The 8 baht added cost per kWh for solar energy, for example, may be reduced to 6.5 baht per kWh due to the reduction in the cost of solar technology.[18] Additionally, import duties on equipment for renewable energy will be waived and exemptions from corporate income tax for new investments and start-ups will be granted. Funding for new commercial alternative energy technologies will be encouraged by tax incentives and investments from a revolving fund.

In the long run, the alternative energy policy aims to expand the use of new green technologies, such as hydrogen and bio-hydrogenated diesel from palm oil, extend green city models to the communities in the country and encourage the export of biofuels and indigenous green technologies to the ASEAN region.

Table 3: Renewable energy potential for electricity generation in Thailand

Renewable energy type	Potential (MW)	Source
Solar	50,000	Urban areas; solar homes; majestic projects
Hydro	700	Micro-hydro; mini-hydro
Wind	1,600	Wind farms in southern Thailand
Biomass	4,400	Sugarcane and palm industries; biomass power plants; community power plants
Biogas	190	Livestock farms; Agro-industries

Source: Thailand, Thailand in the 2010's: *Thailand's Renewable Energy and its Energy Future: Opportunities & Challenges*, Final draft (Bangkok, Ministry of Energy, 2009). Available from www.nstda.or.th/attachments/7918_CASAVA-2.pdf (accessed 06 March 2012).

Wind

Wind power technology is one of the most mature renewable energy approaches. In 2010, for the first time ever, more new wind power capacity was installed in developing countries than in the traditional markets of the OECD.[19] The main barriers to wind power production are the intermittency of wind, location constraints and public resistance. Due to the irregularity of wind, a high penetration of wind power requires energy storage technology. Additionally, producing electricity from wind turbines requires non-turbulent wind (strong wind blowing

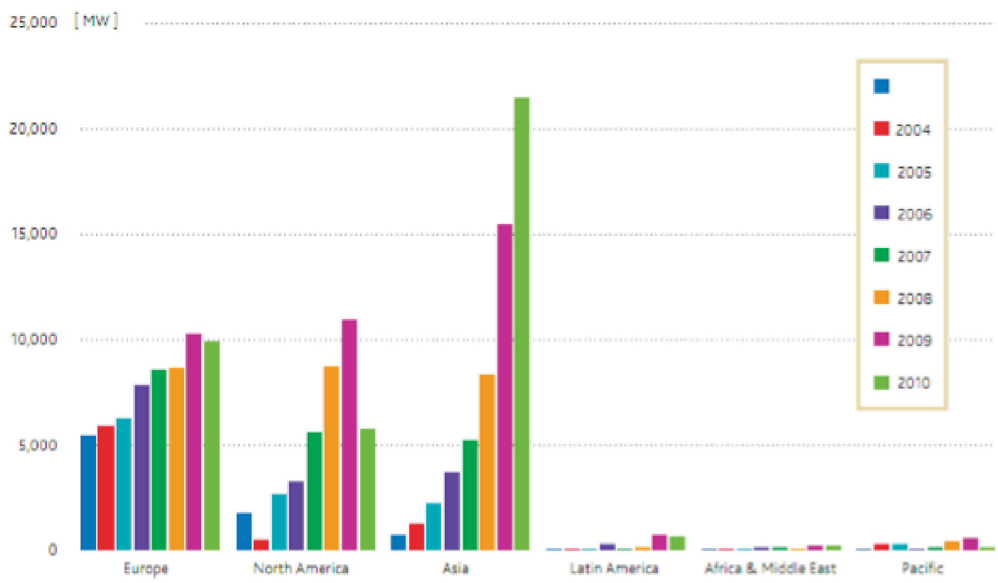
[18] *Bangkok Post*, "Subsidy Changes Leave Green Energy Future in Doubt", December 27, 2011.

[19] Global Wind Energy Council, *Global Wind Report: Annual Market Update 2010* (Brussels, 2011). Available from www.gwec.net/fileadmin/images/Publications/GWEC_annual_market_update_2010_-_2nd_edition_April_2011.pdf (accessed 06 March 2012).

with consistent force). Thus, available wind resources need to be the main consideration for the site selection of wind farms. However, some communities may be resistant to having a wind farm nearby due to aesthetic issues and the low-frequency noise of the windmills.

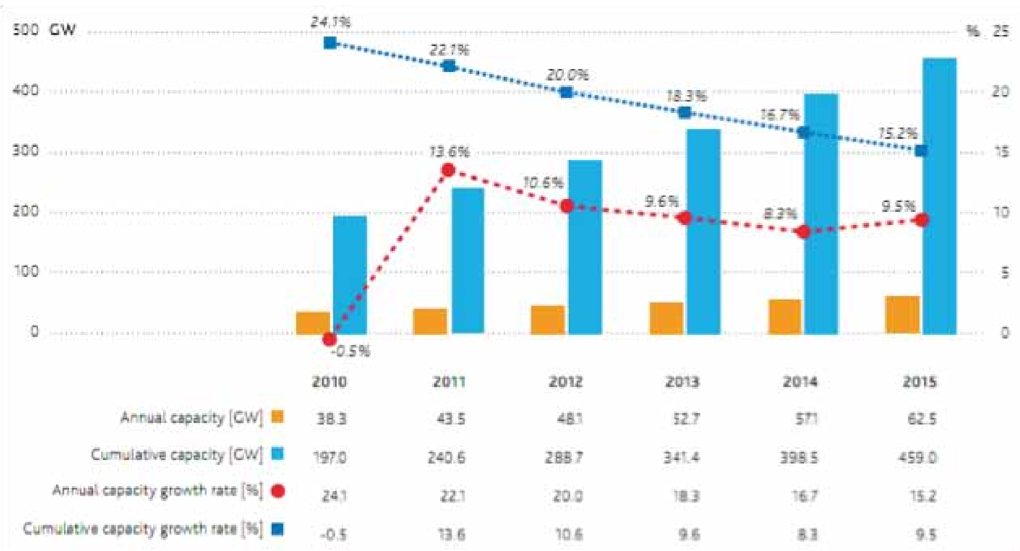
Offshore wind farms may attract less public resistance, but the entailed construction and operating costs are higher. The technological limitations of an offshore location, namely the need for submarine transmission lines, are additional obstacles. Offshore-wind generation has great potential due to better wind resources (stronger and more predictable) and easily available construction space, especially once the best sites for on-shore wind power generation are no longer available. Grid parity of wind-generated energy with natural gas and coal is predicted for 2025, if a carbon price of US$30 per tonne CO_2 emissions is introduced.[20]

Figure 2: Annual installed wind power capacity, by region, 2003–2010



Source: Global Wind Energy Council, *Global Wind Report: Annual Market Update 2010* (Brussels, 2011). Available from www.gwec.net/fileadmin/images/Publications/GWEC_annual_market_update_2010_-_2nd_edition_April_2011.pdf (accessed 06 March 2012).

Figure 3: Forecast for global wind market development, 2011–2015



Source: Global Wind Energy Council, *Global Wind Report: Annual Market Update 2010* (Brussels, 2011). Available from www.gwec.net/fileadmin/images/Publications/GWEC_annual_market_update_2010_-_2nd_edition_April_2011.pdf (accessed 06 March 2012).

[20] Exxon Mobil Corporation, The Outlook for Energy: A View to 2030 (Irving, Texas, 2009). Available from www.exxonmobil.com/Corporate/files/news_pub_eo_2009.pdf (accessed 18 January 2012).

Geothermal

Geothermal technology uses energy from the earth's crust to generate heat or electricity. The energy can be accessed by drilling wells into underground reservoirs to bring the hot geothermal fluid to the surface. The heat can then be converted into electricity or used directly in heating applications.

In the geothermal field, the term "energy conversion" refers to power-plant technology that converts the heat of geothermal fluids into electricity. There are three types of geothermal power plants currently in operation: dry (or direct) steam, flash steam and binary-cycle plant. The plant type depends on the specific location of the geothermal resource. Due to the variation in resources, such as composition, pressure and temperature of the geothermal fluid, geothermal power plants must be designed according to an assessment of the site-specific conditions in order to optimize the power generation efficiency. Unlike wind and solar power, electricity generated from geothermal sources is not intermittent, which means that it can provide reliable base-load power.

Box 5: Potential growth in geothermal power generation

The current global capacity of geothermal power is around 10.7 GW across 26 countries. Pike Research, a market research and consulting firm, has projected that the total worldwide geothermal power capacity could grow to 25.1 GW by 2020. The firm also estimated that there is a minimum of 190 GW of conventional geothermal resources around the globe that can be exploited using currently available technologies.

Source: Ecoseed website "Global Geothermal Capacity Can Hit 25.1 GW by 2020: Research" (30 September 2011). Available from www.ecoseed.org/geothermal/article/14-geothermal/11357-global-geothermal-capacity-can-hit-25-1-gw-by-2020-%E2%80%93-research (accessed 06 March 2012).

Table 4: Countries generating geothermal power in 2010

Country	Installed Capacity (MW)	Rank
United States	3,086	1
Philippines	1,904	2
Indonesia	1,197	3
Mexico	958	4
Italy	843	5
New Zealand	628	6
Iceland	575	7
Japan	536	8
El Salvador	204	9
Kenya	167	10
Costa Rica	166	11
Nicaragua	88	12
Russia	82	13
Turkey	82	14
Papua New Guinea	56	15
Guatemala	52	16
Portugal	29	17
China	24	18
France	16	19
Ethiopia	7.3	20
Germany	6.6	21
Austria	1.4	22
Australia	1.1	23
Thailand	0.3	24

Source: Alison Holm and others, *Geothermal Energy: International Market Update* (Geothermal Energy Association, 2010). Available from www.geo-energy.org/pdf/reports/gea_international_market_report_final_may_2010.pdf (accessed 06 March 2012).

The locations of geothermal power plants are mainly limited to areas with a hydrothermal resource and highly permeable rocks. Geothermal resources that are relatively dry, featuring rocks with low permeability and thereby insufficient water content, are undevelopable with current commercial geothermal technologies. However, enhanced geothermal system (EGS) (also hot dry rock, hot wet rock or hot fractured rock technology) is a technology being developed to use the resources that traditional geothermal technologies cannot exploit. EGS technology is under demonstration trials in several countries in the European Union.[21]

"Geothermal direct use" refers to the use of heat that comes directly from the geothermal source. In cold climates, water from a hydrothermal source is used for heating, such as in buildings, greenhouses and district heating. In warmer climates, geothermal heat has agricultural and industrial applications.

A geothermal heat pump (GHP) (also referred to as GeoExchange, earth-coupled, water-source and ground source heat pump) uses the moderate temperature of the ground to raise the efficiency of heating and cooling of buildings. The GHP application of geothermal energy is widespread in colder climates. However, the technology is fundamentally different from what is used for geothermal power generation and the market segment and applications are also different.

Fuel cells

Fuel cells convert the chemical energy contained in hydrogen to electricity and heat using an electrochemical process. Inside a fuel cell, hydrogen electrochemically merges with oxygen to create electricity, resulting in water and potentially useful heat as by-products. There are many types of fuel cells, though in general, they all share the same basic configuration, featuring two electrodes sandwiched around an electrolyte. The types of fuel cells are categorized by the electrolyte substance.

Power produced by a fuel cell depends on the fuel cell type, size, operating temperature and the gas supplied. Hydrogen is the most optimal fuel for use in fuel cells. However, other hydrogen-rich fuel sources, such as biogas from waste treatment and natural gas, which are rich in methane, can also be used as fuel. Fuel cells can be used for backup power, power for remote locations, distributed power generation and combined heat and power applications. To sustain electricity generation, though, the fuel needs to be supplied continuously; thus a reliable supply of gas or a bulk storage system is needed.

Because fuel cells do not use combustion, emissions are much lower, and conversion efficiency is higher than with conventional thermal power generation. A typical conventional combustion-based power plant has around 33–35 per cent efficiency, while fuel cell systems can generate electricity at efficiencies up to 60 per cent.[22]

Unfortunately, fuel cell technology has not advanced to the point where it can compete with conventional power generation. The two main barriers to the commercializing of fuel cells are cost and durability. Material and manufacturing costs for fuel cells are high compared to traditional combustion systems, and fuel cells have not demonstrated the needed system reliability and durability to compete with existing technologies.

Energy storage

Energy can be used more efficiently through the addition of short- and long-term energy storage, both on and off the grid. Thermal and electrical energy storage systems enable more efficient power generation by balancing fluctuating energy supply and demand. Thermal energy storage can also be used to reduce electricity consumption by increasing the efficiency of heating and cooling systems, while an electrical storage system can supply excess electricity, which is generated during periods of low consumption, to meet peak power demand.

Depending on the technology, energy can be stored as electrical, chemical, thermal or mechanical energy. Not all technologies are suitable for every application, however, mainly due to power output and storage capacity limitations. Identifying a suitable storage technology depends on several factors, such as storage capacity, charging and discharging power, efficiency, storage period, storage cycle and cost.

[21] International Energy Agency, *Technology Roadmap Geothermal Heat and Power* (Paris, 2011). Available from www.iea.org/papers/2011/Geothermal_Roadmap.pdf (accessed 10 January 2012).

[22] United States of America, *Hydrogen & Our Energy Future* (Washington, D.C., Department of Energy, 2009). Available from http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/hydrogenenergyfuture_web.pdf (accessed 10 January 2012).

"Grid energy storage" (also large-scale or utility-scale storage) refers to a grid-connected energy storage system. A high penetration of renewable energy sources will require major alterations to a power system's operation. Electricity from renewable energy sources (specifically wind and solar) are intermittent, which can lead to system instability and a mismatch in supply and demand. Thus, energy storage is essential to increase the penetration of renewable energy power generation as well as for the overall energy efficiency in the power generation sector.

The commercial readiness of energy storage varies according to the technology and application. Pumped storage is the most widespread system in use on power networks, representing about 3 per cent of the global generating capacity. Other storage technologies include compressed air energy storage (CAES), flywheels, lead-acid batteries, sodium sulphur batteries and capacitor systems.[23] Battery storage methods are suitable for small-scale applications, such as battery-backup systems for solar panel homes.

Smart grids

Smart grid technology consists of multiple components and systems. A smart grid basically describes the existing grid enriched by new networks of sensing, communication and control technologies. These networks are linked by universal standards and protocols that are constantly added and updated. The grid becomes "smarter" through the deployment of communication and control devices and through the integration of complex optimizing software enabled by advances in information technology. In simpler terms, a smart grid is made up of a series of smart devices connected over a network to computers that use the data provided by the devices to optimize the system.

Box 6: Potential growth in the smart meter market

The global number of smart meters installed is expected to reach 535 million units by 2015 and 963 million units by 2020.[24] The Asia-Pacific region is expected to be a major contributor to the growth in use, with China's state grid smart meter market alone valued at US$7.7 billion and a potential market of 300 million smart meter units. Currently, China has a smart meter base of around 70 million. The state grid is expected to install smart meters at a rate of 50 million to 60 million units per year through 2014.[25]

Source: *Metering International Magazine*, "Efficiency from metering to service solutions", Issue 3, 2011.

On the supply side, smart grids enable a high penetration of renewable energy sources through enhanced control of the fluctuations in the power supply. The supply of many renewable resources is intermittent, so utility services normally have a hard time integrating them into the system. What smart grid technology offers, is a system that can virtually go out and see what resources are available and dispatch them to the consumers. On the demand side, the deployment of a smart meter and smart appliances lets system operators as well as consumers know when demand for electricity is outstripping supply and thus curtails the use of electricity.

Smart grid technology is not yet commercially viable because the standards and protocols for the system integration are still under development. There are several smart grid pilot projects around the world. The biggest barrier to smart grid application may be the costs, as it will be expensive to implement smart grid technologies because old equipment and transmission infrastructure will need to be replaced and upgraded.

[23] Susan M. Schoenung and William V. Hassenzahl, *Long- vs. Short-Term Energy Storage Technologies Analysis* (Livermore, California, Sandia National Laboratories, 2003). Available from http://prod.sandia.gov/techlib/access-control.cgi/2003/032783.pdf (accessed 20 January 2012).

[24] *Metering International Magazine*, "Smart meter base to near 1 billion units globally by 2020", Issue 3, 2011.

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Hybrid energy system

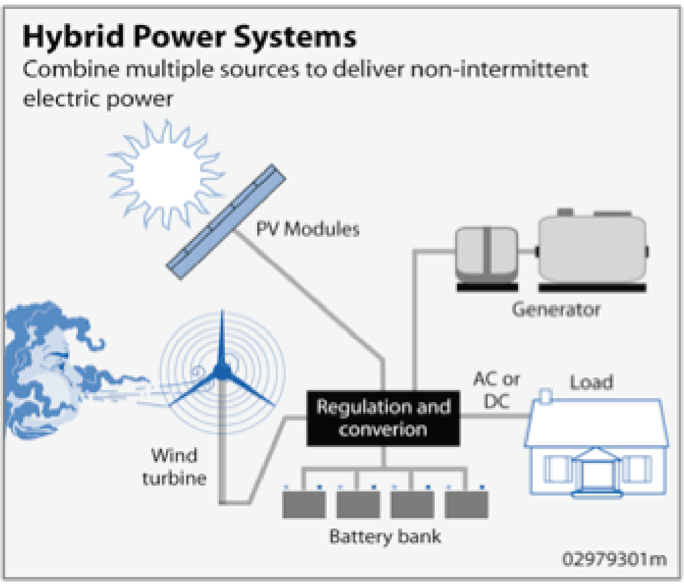
Key point

- ***Hybrid systems can increase the amount of dispatchable renewable energy generation as well as the reliability of rural energy access.***

Hybrid energy system explained

A hybrid energy system combines multiple types of energy generation and/or storage or uses two or more kinds of fuel to power a generator. A hybrid energy system is a valuable method in the transition away from fossil fuel-based economies. Particularly in the short term, while new technologies to better integrate renewable energy sources are still being developed, backing up renewable generation with conventional thermal electric production can actually help expand the use of renewable energy sources.

Figure 1: Hybrid power systems



Source: US Department of Energy, *Small "Hybrid" Solar and Wind Electric Systems* (Washington, D.C., US Government, 2011).

How it works

Hybrid energy systems can capitalize on existing energy infrastructure and add components to help reduce costs, environmental impacts and system disruptions. Planning a hybrid electricity system has a market focus rather than a technology focus: the priority is to choose a mix of energy technologies that is the most efficient and reliable way to meet users' needs.

Generally, at least one source of the fuel used to power a generator is renewable. Such a system is designed to increase the reliability (and thus usability) of renewable energy sources by providing redundant energy production from conventional sources or, more efficiently, by providing storage for electricity produced by intermittent sources.[1] Computer applications automatically increase or reduce conventional generation or battery usage as

[1] Gary D. Burch, "Hybrid renewable energy systems", presented at the United States Department of Energy Natural Gas and Renewable Energy Workshops, Golden, Colorado, 21 August, 2001. Available from www.netl.doe.gov/publications/proceedings/01/hybrids/Gary%20Burch%208.21.01.pdf (accessed 17 October 2011).

needed to respond to fluctuations in production from the renewable resources to maximize the amount of renewable energy in the system.[2]

An important issue in renewable energy development has been the inability to rely on intermittent renewable sources, such as wind and solar, for base load power. It is not economical to ramp up or reduce production at large conventional base load power plants; so even if wind or solar plants are producing enough electricity to supply both peaking and some base load demand, it does not generally offset fossil fuel-based or nuclear base load energy generation. Small, agile hybrid energy systems are one way to allow energy production from intermittent renewable sources into the grid more reliably. To respond accordingly to peaks and dips in renewable energy production, hybrid systems are best implemented on a small scale because small generators are more flexible. These agile systems can, when possible, be interconnected into the central grid system and function as small power plants.

Opportunities in Asia and the Pacific

- **Hybrid energy systems are particularly well suited for use in remote locations.** Hybrid systems can serve standalone mini-grids, thus avoiding costly transmission costs. The increased capability of integrating renewable energy production into the electricity mix reduces the costs of transporting fuel to remote areas.

- **Applicable for combined heat and power and district heating:** As technology systems that can be used for distributed generation, isolated grids or on-site application, hybrid energy systems are generally well suited for combined heat and power production or district heating.[3]

Strengths in using a hybrid system

- Hybrid systems can reduce reliance on fossil fuels and increase the share of renewable energy resources, including intermittent ones, thus increasing the eco-efficiency of energy production and energy security.
- Hybrid systems can reduce energy costs in the long run by offsetting fossil fuel use with renewable production.
- Setting up isolated grids can help provide modern energy access to remote areas and avoid the cost of expensive transmission and distribution lines from the central grid. Particularly in poor areas using diesel gensets, for which fuel price fluctuations can mean no electricity for a period of time, hybrid systems can help provide more reliable modern energy access.

Challenges to using a hybrid energy system

Financial

- The multiple components required to form a hybrid system generally make them expensive to build.[4]

Technical

- There is no single optimal hybrid energy system configuration. Rather, optimizing is based on the availability of renewable and non-renewable resources, on site-specific energy infrastructure, production costs and incentive policies. Planning a hybrid system thus necessitates an adequate study period for each proposed project site.

[2] J. F. Manwell, *"Hybrid energy systems" Encyclopedia of Energy* (2004), vol. 3, pp. 215-226. Available from http://resume.marcbrands.com/classfolder/45-859/https@blackboard.andrew.cmu.edu/courses/1/s04-45859/content/_185100_1/hybrid_systems_review.pdf (accessed 13 October 2011).
[3] J. F. Manwell, *"Hybrid energy systems" Encyclopedia of Energy* (2004), vol. 3, pp. 215-226. Available from http://resume.marcbrands.com/classfolder/45-859/https@blackboard.andrew.cmu.edu/courses/1/s04-45859/content/_185100_1/hybrid_systems_review.pdf (accessed 13 October 2011).
[4] J. F. Manwell, *"Hybrid energy systems" Encyclopedia of Energy* (2004), vol. 3, pp. 215-226. Available from http://resume.marcbrands.com/classfolder/45-859/https@blackboard.andrew.cmu.edu/courses/1/s04-45859/content/_185100_1/hybrid_systems_review.pdf (accessed 13 October 2011).

- Because many hybrid systems rely on the flexibility of small conventional power production facilities that can be dispatched as needed and/or on small storage devices to deal with intermittent renewable energy sources, these systems have limited scalability with the currently available technologies.
- Not all energy production and storage technologies that are potential hybrid system components are fully developed. It is risky to invest in long-term, expensive infrastructure that may improve significantly in the medium term.
- Implementing hybrid energy systems can create market opportunities for the deployment of energy technologies that are not yet mature.[5] If a particular technology, such as a new type of fuel cell, is not yet efficient or reliable enough to produce electricity in a stand-alone system, it may fit well as an additional component to a hybrid system in which other components can cover possible bumps in the production process.

Institutional

- Transmission interests and large electric utility interests may rely on political clout or financial assets to try to limit the expansion of hybrid energy systems development because they encourage more decentralized energy production.

Implementing strategies

Provide a net metering option in which a transmission grid encourages the development of hybrid energy systems, particularly in commercial applications: Net metering is a major financial incentive for small power producers because they can sell excess generation from renewable energy sources back to the grid at a retail – rather than wholesale – rate. Net metering requires advanced meters that communicate in real time. The production and use of smart meters is growing in China, and several ASEAN countries are beginning to follow suit. Although widespread use is a long-term vision, using smart meters with hybrid projects may provide a useful learning experience for utilities and power producers.

Introduce a feed-in tariff: Such an incentive can encourage the maximizing of renewable energy production in hybrid systems. The higher rate paid by the feed-in tariff is paid out relative to kWh of renewable production.

Subsidize the capital costs or provide soft loans for hybrid power systems to expand their use: For example, in India there is an upfront capital subsidy of up to 200,000 rupees (US$3,800) or 80 per cent of the project cost (whichever is the lower) for hybrid power projects built by community groups and government bodies. For private companies and individuals, the subsidy is lower – up to 125,000 rupees (US$2,400) or 50 per cent of the project cost. The highest subsidy, up to 240,000 rupees (US$4,600) or 90 per cent of the project cost, is allotted for non-electrified islands to promote electrification.[6] The low cap encourages small-scale development.[7]

Mobilize funding: Governments can seek out funding from the Clean Development. Mechanism under the Kyoto Protocol, rural development banks and other development organizations to upgrade diesel genset systems to hybrid systems or build new hybrid systems to provide modern energy access to rural areas.

Example

Koh Tao (island) in southern Thailand: the Provincial Electricity Authority (PEA) installed a hybrid wind-diesel energy system to increase power capacity and reliability and to reduce the long-term costs. The PEA had previ-ously relied on a diesel system that cost 6.5 million baht (US$200,000) in losses per year due to high fuel and fuel

[5] Gary D. Burch, "Hybrid renewable energy systems", presented at the United States Department of Energy Natural Gas and Renewable Energy Workshops (Golden, CO, 21 August 2001). Available from www.netl.doe.gov/publications/proceedings/01/hybrids/Gary%20Burch%208.21.01.pdf (accessed 17 October 2011).

[6] India, *Wind-solar Hybrid Systems* (New Delhi, Department of Science and Technology, 2005). Available from www.techno-preneur.net/technology/new-technologies/solar/wind-solar.htm (accessed 24 November 2011).

[7] Tata Energy Research Instiute and Agency for Environment and Energy Management, *Report on Utilisation of Hybrid Energy Services in Island and Rural Communities: Indian and European Scenario* (New Delhi and Paris, 2003). Available from http://insula.org/islandsonline/hybrid.pdf (accessed 24 November 2011).

transportation costs. Based on the wind resource, electricity infrastructure and geographic constraints, the PEA chose to install a 250kW wind turbine to reduce its heavy reliance on diesel.[8]

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[8] S. Saengsrithorn and P. Kitworawut, *The First Medium Wind/Diesel Pilot Project in Thailand* (Bangkok, World Energy, 2010). Available from www.worldenergy.org/documents/congresspapers/327.pdf (accessed 17 October 2011).

Hydropower

Hydropower explained

Hydropower harnesses the energy of moving water and converts it into mechanical or electric power for human consumption. The most well-known source of hydropower is the hydroelectric dam.

How it works

Damming relies on the potential energy of water held in a reservoir and its controlled outflow, which turns a turbine. Hydroelectric dams range in size from tiny systems with capacities of just a couple of kW to the largest electricity-producing plants in the world, with capacities well over 10 GW.

Energy can be harnessed anywhere water flows from a higher elevation (as in an artificial reservoir) to a lower elevation. Developments in "run-of-the-river" power station technology are making the capture and conversion of hydropower into hydroelectricity from undammed running water more efficient. Similar technologies are being refined to more efficiently harness marine power from ocean waves and tidal streams. Pumped-storage hydro systems, on the other hand, have more control over the flow of the water through the turbine and therefore make this type of hydroelectric power one of the most reliable sources of base load power. In these systems, however, power must be used to pump water back up into the higher-level reservoir.

Opportunities in Asia and the Pacific

- **Most untapped potential in the world:** A 2007 survey of energy resources by the World Energy Council led to the conclusion that the technically exploitable capability of hydropower in Asia and Oceania is an estimated 5,712 TWh – well over the capacity of any other region. Of that, more than 3,500 TWh was deemed economically feasible, although the reliability of measurements of potential generation from hydropower has been questioned.[1]

Trends in development

World's largest producer of hydropower: In 2009, the Asia-Pacific region accounted for 415 GW, or nearly 5 per cent, of cumulative installed hydropower capacity – more than any other region. With relative efficiency losses, these plants contributed almost 4 per cent of all hydroelectric production in that year.[2]

Largest source of renewable power in the region: Hydroelectric power totalled 861,850 GWh of electricity generation in Asia, representing around 15 per cent of the region's production. Excluding China (one of the world's leading hydropower producers), hydroelectric projects still fill a substantial portion (almost 16 per cent) of Asia's electricity supply.[3]

China: Beyond large hydro development, such as the famous Three Gorges Dam project, China has focused resources on small hydro projects, particularly for rural electrification. At the end of 2007, China boasted 47,380MW of small hydro capacity at 50,000 systems.[4] The country leads the world in small hydro power generation.

[1] World Energy Council, *2010 Survey of Energy Resources* (London, 2010).

[2] A. Kumar and others, "Hydropower", in O. Edenhofer and others, eds., *Renewable Energy Sources and Climate Change Mitigation: Special Report of Intergovernmental Panel on Climate Change* (New York, Cambridge University Press, 2011).

[3] International Energy Agency, Statistics and Balances (Paris, 2009). Available from www.iea.org/stats/index.asp (16 February 2012).

[4] United Nations Food and Agriculture Organization Water Development and Management Unit (FAOWater), "Hydropower resource assessment of Africa", presented at the Miniterial Conference on Water for Agriculture and Energy in Africa: the Challenges of Climate Change, Sirte, Libyan Arab Jamahiriya, 15-17 December 2008. Available from www.sirtewaterandenergy.org/docs/2009/Sirte_2008_BAK_3.pdf (accessed 25 October 2011).

Strengths with hydropower

- **Variable size to meet utility or decentralized power needs:** The large absolute size of Asia's hydropower potential does not mean that all hydropower projects must be large. Hydropower production offers great flexibility in size and can be used for large base load power plants or small, decentralized electricity generation. Micro and small-scale hydropower systems are the cheapest renewable energy options and can be important reliable components in mini-grid projects for rural electrification.[5]
- **Use of pumped-storage hydropower to integrate other renewable energy into the grid:** Due to their large energy storage capacity and reliability, pumped-storage hydro projects are a valuable way to smooth the generation from intermittent renewable energy sources such as wind and solar.

Challenges to using hydropower

- **Land use and water use issues:** Large hydropower systems often require significant alterations to the river bed and surrounding region, which can create social and environmental pressures. Thus not all hydro power is sustainable. Often hydro projects are written off as unsustainable, based on their size alone. It is important to classify projects as sustainable or unsustainable by basing them on concrete measurements and criteria.
- **Potential transboundary conflicts:** In many areas, water resources cross national borders. Damming of rivers for hydropower projects may impact water resources in other countries. Water use issues gain a level of complexity when disputes arise between water resource users in two or more countries.[6]
- **Adapting to changing climates and water scarcity:** Changes in rainfall patterns as a result of changing climate can impact hydropower resources and the generation potential. Reduced water flows in many rivers will be the primary cause of reduced power generation. Erratic and more intense rainfall can lead to increased soil erosion; the increased sediment in water flows can reduce hydropower generation capacities and make operations and maintenance more complex and expensive.[7] Some areas are projected to see increased hydropower potential, but more intense rainfall could lead to flash flooding and landslides, which could threaten hydropower infrastructure and generation.[8]
- **Community dissent:** Large-scale land use changes can also lead to community objection to new hydro power projects.

Implementing strategies

Impose sustainability criteria for hydro projects: Standardized environmental and social sustainability criteria for hydroelectric plants at a national level can help stimulate the development of hydro projects, including large hydro projects. Such criteria may gauge: water-quality impacts, impacts on water flow and other water users, fish passage possibilities, ongoing environmental and social management programmes in place, impacts on human settlements and the degree of inclusion of local communities in the development process.[9] Projects that do not meet the set criteria should not be classified as renewable or sustainable energy projects and should not profit from policies in place to foster such developments.

[5] Alliance for Rural Electrification, *Hybrid Mini-Grids for Rural Electrification* (Brussels, 2011).

[6] Lars Christian Moller, *Transboundary River Conflicts over Hydropower and Irrigation: Can Multilateral Development Banks Help?* CREDIT Research Paper (Nottingham, United Kingdom, University of Nottingham, 2005). Available from www.nottingham.ac.uk/credit/documents/papers/05-09.pdf (accessed 30 November 2011).

[7] Government of Bhutan, *Securing the Natural Freshwater Systems of the Bhutan Himalayas: Climate Change and Adaptation Measures on Water Resources in Bhutan* (2011). Available from www.bhutanclimatesummit.org.bt/paper/Water_Paper_Bhutan.pdf (accessed 30 November 2011).

[8] Intergovernmental Panel on Climate Change, *Climate Change and Water* (Geneva, 2008).

[9] International Energy Agency Hydropower, *Update of Recommendations for Hydropower and the Environment* (Paris, 2010). Available from www.ieahydro.org/uploads/files/finalannexxii_task2_briefingdocument_oct2010.pdf (accessed 30 November 2011).

FACT SHEET

Integrated land use and transport planning

Key points

- ***It is imperative to build cities that cater to the mobility needs of people – not cars.***
- ***How people travel and how goods are transported are heavily influenced by what kind of urban structure is in place. Integrating decisions on land use with those for transport is of vital importance to ensure the move towards more sustainable cities.***
- ***New neighbourhoods should be built around a public transport corridor to minimize reliance on cars.***

Integrated land use and transport planning explained

This measure generally concerns the development of a master plan and an associated institutional structure that allows for issues of urban land use to be strategically linked to how the transport network is designed. The overall goal is to ensure that development of land (both new and regenerated) is conducted with the consideration of its transport-generating impacts, and minimise any potential problems in advance. More specifically, it aims to ensure that public transport, cycling and walking facilities are existent or newly provided at potential origins and destinations, such as shopping facilities, schools, hospitals, residential areas and commercial centres.

How it works

Emphasis can be placed on transit-oriented development principles as follows:

Increases density along with mass transit corridors: This may involve increasing density standards and possible land uses along major routes, restricting development from taking place at a specified distance from major transit arteries, and creating incentives for development at recognized nodes, whether they be major intersections or mass-transit hubs (such as aligning centres of mixed use with mass transit corridors).

Coordinates the routes of various public transports to ensure wide coverage.

Improves pedestrian access: This includes convenient pedestrian connections to transit and between buildings, as well as outward-oriented buildings which serve as destinations for pedestrians; creating walkable streets; incorporating parking garages and cycling facilities into public transit stations

Strengths in integrating land use with transport planning

- Creates opportunities for economic development and job creation through business opportunities in the mass transit network, as well as access to local employees.
- Reduces the private vehicle trips and traffic congestion, resulting in a more pleasant environment.
- Reduces energy consumption and carbon emissions via reduced private vehicle trips.
- Increases density and convenient access to mass transit allows for public transport to become profitable.

Challenges to integrating land use with transport planning

- **Lack of institutional integration:** One government department is in charge of land use planning while

another has responsibility for transport and no structure for collaborating.
- **Lack of land rights, regulation and planning laws:** Private developers are free to develop land in ways that are not suited to sustainable forms of transport.
- **Lack of a long-term strategy:** Ad hoc planning and development takes place without concern for the long-term viability of the city and its transport system.

Weakness

The concept may be difficult to apply into the cities already developed with dependence on private cars (strong resistances from car users, difficulty in redirecting already existing paths serving private cars).

Implementing strategies

Establish a coordinating body at the local level that links plans on transport with those on land use and formulates integrated master plans.

Strengthen land rights, regulation and planning laws to ensure that private developments are done in ways to support sustainable forms of transport.

Provide financial incentives, such as value capture with developers.

Examples

Curitiba, Brazil: Curitiba, Brazil has successfully implemented a widely used, yet low-cost, transportation system that connects districts throughout the city

Sweden: Shopping malls cannot be building without proving accessible by public transport.

Japan: Suburban towns and cities are often built around railway corridors, allowing the public to access the city centre by rail.

Further reading

How Land Use Affects Transport by Todd Litman and Rowan Steele (Victoria, Australia, Victoria Transport Policy Institute, 2011). Available from www.vtpi.org/landtravel.pdf

FACT SHEET

Integrated resource recovery centre

Key points

- ***Waste can be turned into valuable resources.***
- ***Setting up a system for the collection and treatment of waste is an enabling condition for recovering the resource potential of waste.***

Integrated resource recovery centre explained

An integrated resource recovery centres (IRRC) is a decentralized community-based centre specializing in waste treatment. Attractive features of an IRRC are the close involvement of the surrounding communities and the small scale of the facility.

How it works

An IRRC carries out three primary activities:

- **Collection of segregated waste:** Most centres provide daily door-to-door collection service from neighbourhoods and charge a monthly waste collection fee. Waste can be also collected from local authorities or private companies.
- **Processing of waste:** Waste is sorted a second time at the centre. A major portion of the incoming waste is organic and about 70–80 per cent can be composted. The recyclable material is stored and in some cases processed. The 5–10 of waste that is rejected is sent to a landfill.
- **Selling resources produced from the waste:** Compost is sold in bulk to farmers, fertilizer companies and to local authorities who use it for parks and green spaces. The IRRC is encouraged to focus on bulk buyers and buyers with their own distribution networks to reduce the cost of transportation and packaging. The recyclable material is also sold in bulk.

The IRRCs can incorporate various components for treating wastes:

- **Compost enrichment:** An IRRC can produce different types of fertilizer for specific soil and crops by varying quantities of nitrogen, phosphorus and potassium and other nutrients that are added to the compost.
- **Biogas plant:** Fish and animal waste can be made into biogas using a digester installed within the premises. The produced biogas can be used for cooking and generating electricity.
- **Recyclable management:** Inorganic waste, including plastics and metals, are sorted, cleaned and compacted before it is sold to bulk buyers.
- **Used cooking oil recycling unit:** Used cooking oil can be converted into biodiesel.

Strengths of an integrated resource recovery centre

- **Offers an inexpensive option:** IRRCs can be built and operated at low costs by using limited mechanical technology. Using technology that requires little energy keeps operation costs low and equipment breakdowns are minimal. Simpler technology is also more labour intensive, therefore it creates more job opportunities for the poor.
- **Reduces landfill content:** By limiting the amount of waste going to dumpsites, the IRRCs also help the

environment. This process addresses the problem of used cooking oil being disposed of into the drainage systems of many developing cities.

- **Provides safer employment:** IRRCs directly benefit the urban poor, providing waste pickers with better, more stable incomes and safer working conditions.
- **Promotes recycling to produce healthier material:** Organic fertilizer or biodiesel are environment friendly.

Challenges to setting up an integrated resource recovery centre

- Potential resistance from informal workers making money out of the current waste treatment system.

Implementing strategies

Designate a focal point to operate and manage the centres: An IRRC can be initiated and operated by municipalities, private-sector enterprises and civil society organizations, or a combination of all three through different partnership models. The capacity to process waste can vary from 2 to 20 tonnes per day. An IRRC can be established within neighbourhoods, in several areas in one city or in the outskirts of a city.

Ensure financial viability of the operation: Income streams can include collection fees from serviced households, sale of compost and recyclable material and income from carbon financing. To ensure profitability, an IRRC must formulate a business plan before starting any work. The business plan must ensure that the products cater to the demands of the local agricultural sector and that the source of revenue, including carbon credits, and running costs are identified and estimated as accurately as possible.

Inform and engage people from the community: The value added and the purpose of recycling need to be communicated to the public for higher uptake. Training households to separate their waste into organic and inorganic fractions helps increase the value of what is recycled for safer and easier collecting and sorting at the IRRC. With carefully sorted organic waste, an IRRC uses an aerated box method to produce good-quality compost.

Further reading

Integrated Resource Recovery Centres (Bangkok, UNESCAP, 2010).

Integrated water resource management

Key point

- ***Fragmented policies and uncoordinated governance lead to poor services and inefficient resource uses, which are major challenges in water infrastructure in Asian and Pacific countries. Adopting an integrated water resource management approach in designing and managing water infrastructure helps to overcome such problems.***

Integrated water resource management explained

According to the Global Water Partnership (2000), integrated water resources management is a process for coordinating the development and management of water, land and related resources in a way that maximizes economic and social welfare equitably, without compromising the sustainability of vital ecosystems and the environment.[1]

How it works

The main objectives of integrated management are to overcome sector-based policy fragmentation and inefficient governance structures and thus achieve more compact water infrastructure in an ecologically and economically efficient manner. This may still require several other policies, but they are aware of each other and connected through a managing system.

The particularly critical objectives are: 1) integrating water resource provision and the wastewater treatment system, 2) optimizing water infrastructure and 3) promoting an environment-friendly water cycle system. Circumstances affect the specific policies. The content and extent of integration depends on the stage of socioeconomic development, geographic features, institutional capacity, financial constraints and public acceptance in a country. Because integrated water resource management is not a concrete blueprint – it is a philosophical concept – policymakers need to consider what should be included and to what extent integration should be conducted.

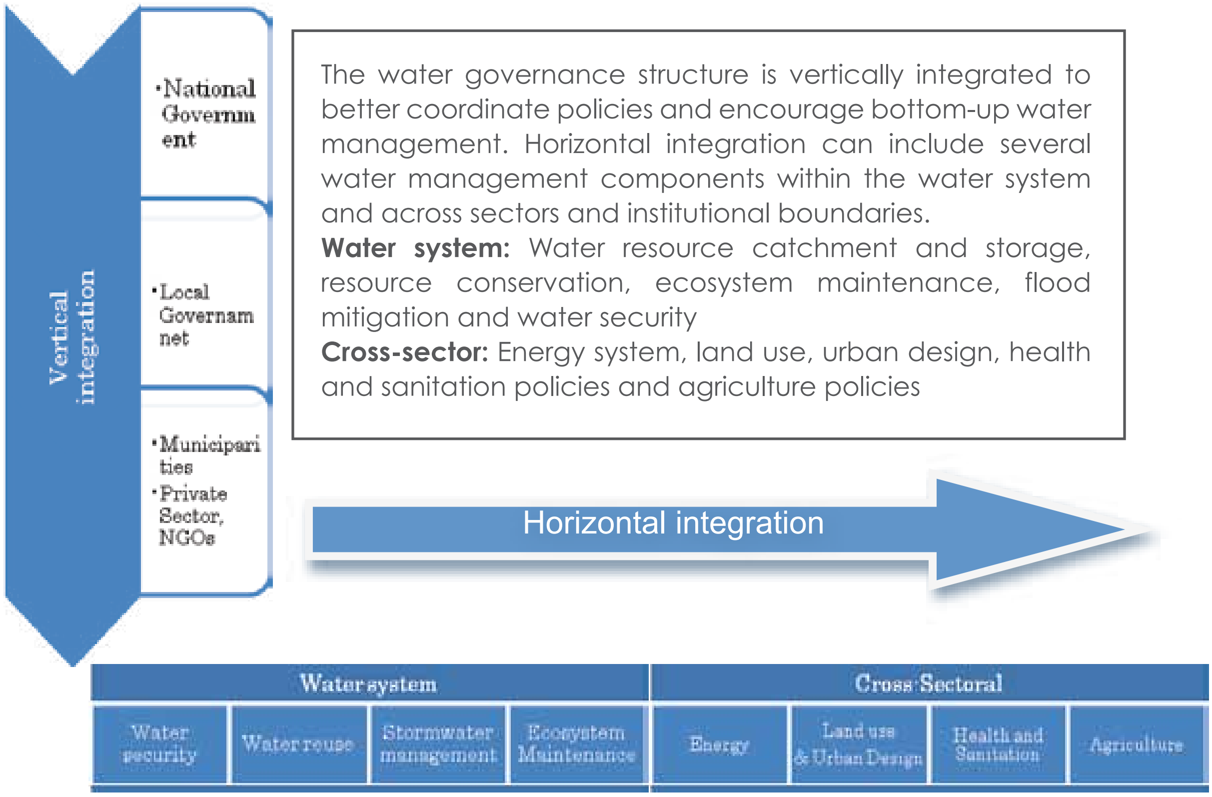
Minimizing the water demand is the first and the most effective step to significantly reduce wastewater treatment needs. Other critical sustaining issues are water resource conservation, ecosystem maintenance, disaster risk reduction, stormwater management and effective land use.

As the following diagram indicates, integration can takes place vertically and horizontally. Vertical integration refers to the coordination of governance structures, which includes agencies from the central to local government, municipalities and communities. Horizontal integration refers to a sector-based coordination within the water system and across several sectors, such as health, agriculture and energy.[2]

[1] Global Water Partnership, Technical Advisory Committee, *Integrated Water Resources Management*, TAC Background Papers No. 4 (Stockholm, 2000). Available from www.unep.org/civil_society/GCSF8/pdfs/IWRM_water_efficiency_eng.pdf(accessed 2 February 2012).

[2] United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), *The Guidelines for Establishing of the National Strategies for Eco-Efficient Water Infrastructure Development* (Bangkok, UNESCAP and Korea International Cooperation Agency (KOICA), 2011).

Figure 1: Vertical and horizontal integration directions of water resource management



Strengths from integrating water resource management

- **Economic:** The fragmentation and overlapping of policies and systems inefficiently consumes extra costs. Fragmentation between the water supply system and the wastewater treatment system results in requiring more energy costs to piped water resources. Integrating their management cuts costs. Additionally, it is a valuable way to manage water-related disaster risks, such as floods and drought, and can possibly reduce economic losses caused by such disasters.
- **Environmental:** The integration of policies and systems enables water infrastructure to be built or adjusted to be more compact and eco-efficient. This brings several environmental benefits, such as water resource conservation and natural hydrological cycle maintenance. It also significantly reduces energy use in the provision of water and thus reduces CO_2 emissions.
- **Social:** Water policy is particularly correlated with health, gender and agriculture issues in developing countries. An integrated management perspective helps to implement cross-cutting policies. Additionally, because this approach entails the transfer of responsibility and ownership of water resource management from public bodies to communities, it strengthens communities and social capital.

Challenges to integrating water resource management

- **Lack of consideration to local context:** There is no one-size-fits-all blueprint for integrated management. Translating the concept into operations that are appropriate for local contexts requires adaptive work among policymakers. Integration that lacks adequate insight into the local context results in failure.
- **Lack of institutional capacity and arrangement:** Successful integration depends on a balance between management capacity and the level of integration. Lack of institutional capacity can be a major hurdle to integrate several sector-based policies with different interests and views regarding water resources. Lack of a regulatory framework and financial support also leads to unfavourable outcomes.
- **Conflicts:** People's interests and views in water resources vary and are relative to how and where they use the water resources. Upstream and downstream users have different demands in water quality and quantity. This conflict of interests can also emerge in cross-sector collaboration. Thus, any policy integration without adequate consideration to the different interests across sectors and institutions can heighten conflicts in water resource management.

Implementing strategies

Consider context specificity and decide the policy orientation of water infrastructure: To effectively apply the concept of integrated water resource management into policy actions, implementing strategies need to include context-specific consideration, institutional capacity, a regulatory framework and stakeholders' participation. While the basic principles underlying integrated water resource management may be commonly applicable, policymakers need to consider appropriate components and the level of integration.

Build up institutional capacity: Capacity building is needed at different levels of government to achieve vertical integration. In addition, the institutional arrangement is another factor for integration. In particular, a regulatory framework should be harmonized across sectors.

Require inclusive participation: One of the key principles of integrated water resource management is that the traditional top-down approach should be supplemented by bottom-up efforts. Thus, it is significant to integrate and harmonize various views and interests. The sustainable water integrated management and governance project conducted in Baguio City in Philippines is a good example of encouraging various parties' participation. Throughout the project, a total of 22 local water dialogues took place, with 805 participants, including local government representatives, private sector individuals, NGO staff, journalists and village leaders to overcome water system fragmentation.[3] This multiparty approach was emphasized during the project so that everyone could clearly identify their role in a sustainable water system.

Develop a mechanism for coordinating activities and mitigating conflicts: Setting a guideline and creating a central committee are possible options for coordinating the interests of diverse actors and to encourage their participation in the decision-making process. For instance, the Republic of Korea enacted a basic water law and established a National Water Council, with an attempt to set up comprehensive institutional and regulatory frameworks for the nation's water resource management.

Look carefully at local contexts, different actors' interests and institutional capacity: Principles of integrated water resource management provide the policy directions. However, sufficient adaptive work is required for integration and thus it is important for policymakers to recognize that consolidating government organizations or sectors do not automatically lead to successful results. They need to also consider the local context, capacity and different points of views and objectives.

Further reading

Integrated Water Resources Management, Technical Advisory Committee Background Paper No. 4, (Stockholm, Global Water Partnership,2000). Available from www.gwp.org/The-Challenge/What-is-IWRM/.

Integrated Water Resources Management (IWRM) and Water Efficiency Plans by 2005: Why, What and How? Technical Advisory Committee Background Paper No. 10. (Stockholm, Global Water Partnership, 2004). Available from http://cap-net.org/sites/cap-net.org/files/TEC%2010.pdf.

The Dublin Principles for Water as Reflectedin a Comparative Assessment of Institutionaland Legal Arrangements for Integrated WaterResources Management, Technical Advisory Committee Background Paper No.3.(Stockholm, Global Water Partnership,1999).Available from www.cawater-info.net/bk/iwrm/pdf/tec_paper3_e.pdf.

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[3] United Nations Economic and Social Commission for Asia and the Pacific, *Pro-poor Water and Wastewater Management in Small Towns: Integrated Water Management in Baguio City,Philippines* (Bangkok, 2007). Available from www.unescap.org/pdd/prs/ProjectActivities/Ongoing/Water/Baguio/Baguio_MR.pdf(accessed 2 February 2012).

FACT SHEET

Intercity high-speed railway systems

High-speed railway explained

Definitions of a high-speed railway system vary, but a common one is a rail system designed for maximum train speeds that exceed 200 km per hour for upgraded tracks and 250 km per hour for new tracks. High-speed rail is generally used for intercity transport rather than urban transport.

Performance, evaluated

Capacity	Approximately 1,000 persons per vehicle. Double-decker trains increase the capacity but also increase drag, and thus increase the amount of energy needed.
Geographical range	There is no limit in expanding the line, as long as the demand is high. Generally, high-speed rail can compete with airplane trips of 300–600 km and car trips of up to 300 km.[1]
Implementing cost	Infrastructure costs are highly variable and very dependent on a number of site-specific factors. Excluding planning fees, the cost can range from 9 million to 40 million euros per kilometre in Europe. There is an additional 30,000 euros per kilometre in track maintenance costs as well as 77,000–145,000 euros per seat in rolling stock (train) operations and maintenance costs.[2] Costs in Asia are likely somewhat lower due to lower construction and labour costs.
Payback period	The length of the payback period depends not only on the cost of the project but also on ridership per year and the level of passenger charges. European studies have shown break-even ridership to be 3 million to 17 million passengers per year.[3] Most systems take in more revenue than annual operating costs but do not come close to recouping the infrastructure investment costs.
Example	Shinkansen in Japan, High-speed rail in China, Korean Train eXpress in Republic of Korea

Strengths of the high-speed railway

- Long-term and durable infrastructure
- High carrying capacity
- Relatively safe (fewer traffic casualties compared to road-based transport)
- Efficient land use (road-based transport occupies more space with multiple lanes and parking lots)
- Faster, more reliable transportation times

[1] Gines De Rus, "The economic effects of high-speed rail investment", Discussion paper No. 2008-16 prepared for the Round Table on Airline Competition, Systems of Airports and Intermodal Connections, Paris, 2-3 October 2008. Available from www.internationaltransportforum.org/jtrc/discussionpapers/dp200816.pdf (accessed 21 February, 2012).

[2] ibid.

[3] Chris Nash, "Enhancing the Cost Benefit Analysis of High Speed Rail", *California Connect*, February 22, 2011. Available from http://californiaconnect.com/research/view/enhancing-the-cost-benefit-analysis-of-high-speed-rail (accessed 26 September 2011).

If designed well, high-speed railway systems contribute towards:

- Improved air quality and lower greenhouse gas emissions[4]
- Economic growth and increased employment

Challenges to using high-speed railway

- Estimating annual ridership during feasibility stage analysis (and thus returns, including greenhouse gas reduction) can be difficult, especially when developments in other transportation modes (air and auto mobile) are uncertain
- High investment costs for buying the needed land and building the lines and trains
- Long period of construction time and for reaping payback

Limitations

- High-speed rail lines, once built, are very inflexible. Corridors to be developed must be heavily studied to determine if the return is likely to be eco-efficient.
- Increasing train speed requires considerably more electricity. If power is sourced from polluting technologies and/or if load factors are low, high-speed rail can actually exacerbate rather than mitigate greenhouse gas emissions.
- The possible positive ecological impacts are largely dependent on a modal shift – more passengers must choose high-speed rail links over driving or flying.
- To maintain the high speed and financial viability of the system, the service should be supplemented with intermodal transport that will improve the connectivity and sense of door-to-door service.
- Construction on soft ground is technically difficult. The difficult terrain and travel through high-density cities are the main reasons for the higher construction costs.

Implementing strategies

- **Financial support from public sector:** Securing and allocating government revenue for high-speed rail investments over multiple years is a necessary first step to allow for the required years of planning and construction of a new high-speed rail project. Long-term revenue could come from a transportation tax.[5] Publically chartered infrastructure corporations can foster public-private partnerships and alleviate planning difficulties for lines that cross administrative boundaries of provinces or even national borders.[6] A high-speed railway should be promoted alongside renewable energy-promoting policies in order to have positive climate change mitigation impacts.
- **Coordination with feeder transportation:** Because a high-speed railway is usually operated for passenger transport, the service should be linked to other more flexible feeder transportation in order to improve the connectivity.
- **Strategic design of networks:** Because demand for rail services needs to be quite high for investment in high-speed rail to be worthwhile, it is significantly important that a high-speed rail system be used to link sizeable population centres that expecting increased travel capacity between them

[4] To be environmentally beneficial, a high-speed railway system must capture the market share of passengers who would otherwise use cars or airplanes. The final environmental impact depends on (inter alia): Load factor (CO_2 emissions per passenger mile decrease as passengers increase); Electricity CO_2 factor (generation mix and associated emissions); Changes in competing modes (emissions for air and road transportation).

[5] Petra Todorovich, Daniel Schned and Robert Lane, High-Speed Rail: International Lessons for U.S. Policy Makers (Cambridge, MA, Lincoln Institute of Land Policy, 2011).

[6] Petra Todorovich, Daniel Schned and Robert Lane, *High-Speed Rail: International Lessons for U.S. Policy Makers* (Cambridge, MA, Lincoln Institute of Land Policy, 2011). Available from www.lincolninst.edu/pubs/download.asp?doc_id=1268&pub_id=1948 (accessed 26 September 2011).

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High Speed Rail, by International Union of Railways (Paris, 2010b). Available from www.uic.org/download.php/publication/521E.pdf

Intracity bus rapid transit and trolley buses

Guangzhou, China
Photo: Ko Sakamoto

Bus rapid transit and trolley buses explained

Bus rapid transit (BRT) is a mass transit system using designated right-of-way lanes. BRT systems offer similar performance and speed of service as metro systems but use buses rather than rail vehicle technology. BRT is one way to improve the quality of operating conventional buses.

Performance, evaluated

Capacity	High (20,000 to 35,000 people per hour per direction)
Geographical range	Low to high (from up to 5km to beyond 20 km)
Implementing cost	Medium (up to 1 million USD per km)
Payback period	Low to medium (within 5 to 10 years)
Applicable city size	Medium and large (from 500,000 to more than 5 million inhabitants)
Applicable stage of development	Least developed, developing and developed countries
Examples	• Guangzhou, China, which now boasts one of the world's largest BRT systems, carrying 800,000 people daily • Ahmedabad, India, which was financed partly by a national grant and is one of the largest in India • Bogotá, Columbia • Sao Paulo and Curitiba, Brazil

Strengths of bus rapid transit

- Lower implementing costs than other forms of mass transit. An LRT typically costs four times more and an MRT is ten times more per kilometre.[1]
- Provides greater operating flexibility in accommodating future growth of the city more quickly and at less cost than metro or rail systems.
- Popular with all income groups and profitable at relatively low fares.

[1] World Resource Institute, Embarq website *"What is Bus Rapid Transit?"* Available from www.embarq.org/en/node/28 (accessed on 16 November 2011).

- Provides a higher speed service due to segregation from the main traffic. Developments such as signal prioritizing and interchanges that improve speed and capacity can be added on a staged basis.
- Reduces the level of pollutants and noise levels.
- Supports more sustainable urban form through the densification of major corridors.

Challenges to using bus rapid transit

- Lack of political support.
- Limited technical and institutional capacity to support development.
- Lack of knowledge and understanding of the benefits of BRT schemes among policymakers.
- Strong lobbying pressure from taxi and paratransit operators.[2]

Limitations

- Requires separate lanes that need to be effectively enforced.
- Some locations physically do not permit a full separate lane for a BRT system.

Implementing strategies

- Highlight that the political rewards for those that commit to a BRT system can be high.[3]
- Develop an urban transport agency responsible for the formalisation and regulation of the service.
- Review the financial models of cities that have successfully introduced a BRT system.
- Consider engaging the private sector in the development and operation of services with specific performance based indicators such as environmental performance of vehicle used, safety, and punctuality.
- Consider international sources of funding to support the construction and operation.

Further reading

Bus Rapid Transit Planning Guide, by Institute for Transportation and Development Policy (New York, 2010). Available from www.itdp.org/index.php/microsite/brt_planning_guide/

Sourcebook Module 3a: Mass Transit Options, by L. Wright and K. Fjellstrom (Eschborn, GTZ (GIZ), 2004).

[2] Paratransit is an alternative mode of flexible passenger transportation that does not follow fixed routes or schedules.

[3] Lloyd Wright, *Sourcebook Module 3b: Bus Rapid Transit* (Eschborn, GIZ, 2005b).

FACT SHEET

Intracity conventional buses

Jakarta, Indonesia
Photo: Ko Sakamoto

Conventional buses explained

Traditionally bus services have been provided by the public sector. However, numerous private bus operators have appeared in cities in developing countries often operating on routes duplicating public sector routes, using small vehicles and refusing to carry exempt or reduced fare passengers.

Performance, evaluated

Capacity	Low to high (from up to 1,000 people to beyond 10,000 people per direction per hour), Overall capacity depends on operating patterns.
Geographical range	Medium (up to 20 km)
Implementing cost	Low (up to US$100,000 per km excluding cost of road building)
Payback period	Low (within 5 years)
Applicable city size[1]	Small, medium and large (from 500,000 to more than 5 million inhabitants)
Applicable stage of development	Least developed, developing and developed countries
Examples	Bus franchising in Hong Kong, China[2] and Santiago, Chile[3]

Strengths of conventional buses

- **Flexible:** Compared with fixed-track systems, such as the LRT and MRT, bus routes can be redesigned relatively easily to adapt to new patterns of demand.
- **Accessible:** Services are generally cheap and thus accessible to poorer urban residents.
- **Supports other public transport modes:** If integrated effectively, bus services can provide a valuable feeder service to other modes of public transport, such as light and heavy rail and waterborne modes.

[1] Note that there is no standard definition of small, medium and large sized cities. In this study, thresholds used in Asian Development Bank (2008), *Managing Asian Cities* are simplified into three categories. The ADB study is available from www.adb.org/Documents/Studies/Managing-Asian-Cities/mac-report.pdf (accessed 22 January 2012).

[2] Richard Meakin, *Sourcebook Module 3c: Bus Regulation and Planning* (Eschborn, GIZ, 2004b).

[3] Ken Gwilliam, "Bus franchising in developing countries: Some recent World Bank experience", PowerPoint presentation, 2005. Available from http://siteresources.worldbank.org/INTURBANTRANSPORT/Resources/340136-1120662668760/gwilliam.pdf (accessed on 16 November 2011).

Challenges to using bus rapid transit

- In some countries, bus service is largely provided by private bus operators without coordinating with other modes of transport and outside the control of the local authorities. These operators are often informal in nature and undermine the quality of bus services (reliability, punctuality, comfort) as well as road safety (due to lack of driver training) and air quality (due to lack of vehicle maintenance and renewal). This practice has endured for decades due to:
- Lack of political commitment for full regulatory reform
- Lack of government subsidies required for state-owned operations that operate at a loss[4]
- Lack of financial incentives to improve vehicle quality
- Fragmented ownership, which is common because no one operator has responsibility for the effective operation of a route

Limitations

Heavy congestion in many developing cities has a negative impact on service quality, reliability, energy consumption, economy and overall profitability.

Implementing strategies

Improving the quality of bus services is important to attract more people. The government's role is critical for establishing a framework in which public and private players contribute in a more effective way to a sustainable urban transport system. Such a framework should include the following strategic elements:

- **An administrative body** (such as local transport authority) to manage the urban transport network, planning routes, and fare structures for bus services in close coordination with other modes (such as LRT and MRT).
- **An appropriate regulatory arrangement for operators**, such as franchises for securing service on key routes that are issued through competitive tendering.[5]
- **Vigilant regulation of the performance of private operators**, including service frequency, safety, vehicle environmental performance and punctuality, possibly through performance-based contracts.
- **Carefully planned subsidies**, so that they are targeted specifically at disadvantaged groups (such as through discounted travel cards) as opposed to a more generic subsidy for the whole sector.

Further reading

Bus Franchising in Developing Countries: Some Recent World Bank Experiences, by G. William (Washington, D.C., 2005).

Sourcebook Module 3c: Bus Regulation and Planning, by R. Meakin (Eschborn, GTZ (GIZ), 2004).

[4] Richard Meakin, *Sourcebook Module 3c: Bus Regulation and Planning* (Eschborn, GIZ, 2004b).

[5] Ken Gwilliam, "Bus franchising in developing countries: Some recent World Bank experience", PowerPoint presentation, 2005. Available from http://siteresources.worldbank.org/INTURBANTRANSPORT/Resources/340136-1120662668760/gwilliam.pdf (accessed on 16 November 2011).

FACT SHEET

Intracity heavy rail and metro systems

Bangkok
Photo: Ko Sakamoto

Heavy rail and metro system explained

Metropolitan railways are urban, electric transport systems with high capacity and a high frequency of service. Metros are totally independent from other traffic, road or pedestrians. They are consequently designed in tunnel, viaducts or on surface level but with physical separation. In Asia, metro systems are being developed or expanded in many developing cities including Bangkok, New Delhi and Singapore.

Performance, evaluated

Capacity	High: Approximately 1,000 persons per vehicle, with peak capacity at 45,000 people per hour per direction and typical capacity between 20,000 and 30,000.[1]
Geographical range	Medium to high (from up to 20 km to beyond 20 km)
Implementing cost	High: dependency upon a number of factors, such as management and organizational structure and the land and labour costs. Costs run about US$55 million to $207 million per kilometre.
Payback period	High (more than 10 years)
Applicable city size	Large (more than 5 million inhabitants)
Applicable stage of development	Developing and developed, Appropriate generally in cities with more than 5 million inhabitants or linear spatial development and with at least US$18,000 per capita annual income.[2]
Examples	• Metropolitan rapid transit in Bangkok, Thailand • Star metro in Kuala Lumpur, Malaysia

Strengths of bus rapid transit

- High carrying capacity.
- High frequency and reliability of service – more than 700,000 trips per day.

[1] German Agency for International Cooperation (GIZ) website "International Fuel Prices". Available from www.gtz.de/en/themen/29957.htm (accessed 22 February 2012).

[2] Lloyd Wright and K. Fjellstrom, *Sourcebook Module 3a: Mass Transit Options* (Eschborn, Germany, GIZ, 2004).

- Lowest energy use and CO_2 emission per person per kilometre of the mass transport options.
- Major transit interchanges along the route can catalyse high-density development, if managed effectively.

Challenges to using bus rapid transit

- Lengthy construction times.
- A high level of investment is needed for the required infrastructure.
- High level of skill required for maintenance and operation.
- Requires exclusive right-of-way status.[3]
- Construction on steep gradients is technically and financially difficult.

Limitations

Due to the high capital and operational costs, rail-based systems are most appropriate in cities with a large population, where passenger capacities are expected to exceed 25,000 passengers per direction per hour.

Implementing strategies

Secure financial resources for the initial costs: Land value taxes or long-term loans from bilateral and multilateral development banks (such as Asian Development Bank) help to secure capital.

Designate an institutional body with professional expertise: The body should be responsible for setting fares and for ensuring that the timetable is integrated with other transport services in urban areas.[4]

Plan to meet financial sustainability of the operation: Financial viability of the operation can be secured through increased ridership. The measures include densification of land use around stations, effective integration with existing transport modes and policies that can stimulate feeder services and good interchange facilities between modes; the development of complementary mass transit systems.[5]

Further reading

Sourcebook Module 3a: Mass Transit Options, by L. Wright and K. Fjellstrom (Eschborn, GTZ (GIZ), 2004).

[3] German Agency for International Cooperation (GIZ) website "International Fuel Prices". Available from www.gtz.de/en/themen/29957.htm (accessed 22 February 2012).

[4] Lloyd Wright and K. Fjellstrom, *Sourcebook Module 3a: Mass Transit Options* (Eschborn, Germany, GIZ, 2004).

[5] German Agency for International Cooperation (GIZ) website "International Fuel Prices". Available from www.gtz.de/en/themen/29957.htm (accessed 22 February 2012).

FACT SHEET

Intracity light rail

Seville, Spain
Photo: Ko Sakamoto

Intracity light rail explained

Light rail transit (LRT) is an electric rail form of transport for urban centres that range from a conventional on-street tramway to segregated rapid transit systems. Light rail systems bridge the gap between conventional bus services and urban heavy rail or underground metro railways. Light rail systems have only been implemented in relatively wealthy developing cities. Recent examples include the elevated Putra and monorail system in Kuala Lumpur.[1]

Performance, evaluated

Capacity	High: 170 persons per six-axle tram and 250–350 per multi-articulated light rail vehicle; approximately 12,000 passengers per direction per hour.
Geographical range	Low to high (from up to 5km to beyond 20 km)
Implementing cost	High (above 1 million USD per km): The cost varies, based on a number of factors, including the extent of grade separation, geological conditions and the price of labour and materials.[2] The capital costs of a light rail system in the United States, for example are on average US$21.6 million per km.
Payback period	Medium to high (within 10 or more than 10 years)
Applicable city size	Medium and large (from 500,000 to more than 5 million inhabitants)
Applicable stage of development	Developing and developed countries
Examples	• Putra light rail in Kuala Lumpur, Malaysia • LRT and urban revitalization in Japanese cities (Hiroshima) • Large-scale LRT in more than 20 French cities

Strengths of bus rapid transit

- Flexible and expandable compared with the heavy and metro railways.
- Intermediate capacity, between metro and bus and applicable to a range of passenger capacities and city sizes. It offers a sound solution for small cities, even those where passenger demand is fewer than

[1] Lloyd Wright and K. Fjellstrom, *Sourcebook Module 3a: Mass Transit Options* (Eschborn, Germany, GIZ, 2004).

[2] ibid.

3,000 passengers per hour per direction.[3] LRT is also applicable to larger cities, making the approach very flexible to a range of circumstances.
- Effective at supporting a modal shift from cars, if well designed.
- Positive impact on the development of land at interchange points.
- Produces no tailpipe emissions.[4]

Challenges to using bus rapid transit

- Potential resistance from private vehicle users.
- High levels of initial investment required. In most cases subsidies from local government are required.
- Implementation is institutionally demanding, especially for countries where there is often a fragmented institutional set-up.

Limitations

- Requires the provision and enforcement of a segregated lane.
- Costs may limit the geographical extent of the service.
- Construction on steep gradients is technically and financially difficult.

Implementing strategies

Highlight the benefits of an LRT: to help secure the buy-in of senior politicians; for example, that it supports the development of the city and a modal shift from private vehicles.

Consider setting up a central body: responsible for the operations, maintenance and administration of urban transport and ensure that there is a team with dedicated responsibility for the LRT.

Consider sources of funding to support implementation and operation.

BOX 1: Success factors for implementing the LRT in France

The LRT has proven to be particularly successful in France and is changing the face of its cities. By 2005, more than 20 cities had introduced or were planning an LRT. The success factors include:
Adoption of an integrated approach to transport and urban regeneration. The French approach looked to return the streets to the people instead of the motor car. French cities combined the introduction of a tramline with making city centres more amenable to pedestrians, the reorganization of the local road network and a restructuring of the underlying bus network to support – and not compete with – the tramway.
A local business tax covering the cost of implementation. Since the early 1980s, businesses have been required to pay a local transport tax, known as the Versement Transport, which provides a constant and reliable source of funding.
Dedicated right of way. Dedicated lands for the light rail lanes provided some separation from normal road traffic and helped to improve the operational reliability and increase average speeds.
Technological advancements supporting an effective service. Technological solutions have enabled vehicles to be matched with local requirements, including seating arrangements, on-board facilities and the driver's cab and control panel.

Further reading

"Light rail transport is changing the face of French cities", by M. Knutton, *International Railway Journal* (2005).

Sourcebook Module 3a: Mass Transit Options, by L. Wright and K. Fjellstrom (Eschborn, GTZ (GIZ), 2004).

[3] Mike Knutton, "Light rail transport is changing the face of French cities", *International Railway Journal* (2005) March. Available from http://findarticles.com/p/articles/mi_m0BQQ/is_3_45/ai_n13502068/ (accessed 22 February 2012).
[4] Lloyd Wright and K. Fjellstrom, *Sourcebook Module 3a: Mass Transit Options* (Eschborn, Germany, GIZ, 2004).

Low-carbon development plan

Key points

- ***A low-carbon development plan guides countries down a path towards low carbon green growth.***
- ***National short- to long-term targets, goals and policies on low carbon green growth send signals of credibility and reliability, which in turn attracts investment and promotes technology innovations, improves energy efficiency, encourages cleaner energy sources and creates jobs and business opportunities.***

Low-carbon development planning explained

Low-carbon development plans also can be called green growth plans, climate change plans and strategies or low-emission development strategies (LEDS). For some countries, low-carbon growth plans can take the form of national economic and social development plans. Although the terminology may differ, the objective and purpose of these plans and strategies are the same – they are intended to provide countries with a national strategy steeped in vision and replete with goals, targets and specific short- and long-term actions for overcoming the resource constraints and reducing greenhouse gas emissions in a way that also grows the economy. It requires an integrated and comprehensive planning process for combining development and climate priorities that enable countries to shift to a low-carbon development trajectory. Such strategies improve energy, resource, carbon and economic efficiencies.

Various organizations have their own characterization of what constitutes a low-carbon development plan. The OECD describes it as "forward-looking, climate-friendly growth strategies that can highlight a country's priority actions for climate mitigation and adaptation, and a country's role in the global effort against climate change."[1] The Project Catalyst states that "the plan is based on the unique socio-economic and development priorities of the country and includes both a vision for tomorrow and a plan of action for today."[2]

How it works

Although the components of a low-carbon development plan will differ due to the country context and its development priorities, these plans may consider inclusion of the following elements:[3]

- vision – a long-term and shared vision is required to guide policies over the long run and to gather actors around a common purpose
- assessments – this may include greenhouse gas inventories and projections to understand which are the major emitting sectors, vulnerability assessments to understand what would be the impacts of climate change and mitigation potential and costs

[1] Christa Clapp, Gregory Briner and Katia Karousakis, *Low-Emission Development Strategies (LED): Technical, Institutional and Policy Lessons* (Paris, International Energy Agency and OECD, 2010), p.11. Available from www.oecd.org/dataoecd/32/58/46553489.pdf (accessed 22 August 2011).

[2] Project Catalyst, *Low Carbon Growth Plans - Advancing Good Practices, Working Draft* (San Francisco, ClimateWorks Foundation, 2009), p. 6. Available from www.projectcatalyst.info/images/3.%20Low%20carbon%20growth%20planning/Publications/Advancing%20good%20practice/090805%20Project%20Catalyst%20-%20LCGP%20paper%20-%20normal%20view%20-%20Ver%202.0.pdf

[3] Extracted from Christa Clapp, Gregory Briner and Katia Karousakis, *Low-Emission Development Strategies (LED): Technical, Institutional and Policy Lessons* (Paris, IEA and OECD, 2010), p.12. Available from www.oecd.org/dataoecd/32/58/46553489.pdf (accessed 22 August 2011).

- short- to long-term targets and goals (economy-wide or sector specific)
- policy measures
- specific programmes and projects
- implementing plans
- funding mechanisms
- investment plans
- institutional capacity and coordinating mechanisms
- monitoring and evaluation plans.

Box 1: Low-emission development strategies and UNFCCC negotiations

The term "low-emissions development strategies" was first introduced in the United Nations Framework Convention on Climate Change negotiations in April 2008 in the context of a shared vision to ensure ambitious collective action on climate change.[4] Since then, governments, through the Copenhagen Accord, have recognized that "low-emission development strategies are indispensible to sustainable development".[5] The Cancun outcomes of the UNFCCC Conference of Parties 16 in 2010 encouraged "developing countries to develop low carbon development strategies or plans in the context of sustainable development"[6] as part of their national mitigation action. Now even developing countries are preparing low-emissions development strategies as part of their national climate change strategies, national development plans or national vision.

Some developing countries have raised concern that low-emissions development strategies, in particular nationally appropriate mitigation actions (NAMAs), may be a precondition for receiving financial support from donors. Low-emissions development strategies should be considered as a long-term planning exercise that integrates low-carbon issues, including climate change, sustainable development and economic priorities in a comprehensive manner, without undermining existing development efforts. As the Republic of Korea's Five-Year Green Growth Strategy and Action Plan shows, low-carbon efforts are considered to be a basis for an opportunity for achieving further growth.

Strengths in low-carbon planning

- **Achieves efficiency:** The value added of low-carbon development plan is that it can combine national economic development and climate change planning into a more integrated, comprehensive, consistent and coordinated approach that harnesses synergies, minimizes duplication and avoids trade-offs between strategies and plans.

- **Encourages investors:** Low-carbon development strategies can provide important signals to the private sector on the direction for future investments, research and development. A long-term strategy is particularly important for promoting technological innovations and deployment of low-carbon technologies that require considerable lead time for R&D and commercializing. It is also important for guiding infrastructure development, which also requires long-term planning but, once built, creates path dependency.

- **Connects with NAMAs:** Low-carbon development strategies can be beneficial for prioritizing nationally appropriate mitigation actions, which are voluntary mitigation action proposals from developing countries to the UNFCCC for reducing CO_2 emissions.

[4] ibid.

[5] United Nations Framework Convention on Climate Change, *Report of the Conference of the Parties on Its Fifteenth Session, held in Copenhagen from 7-19 December 2009, Addendum.. . Part Two: Action taken by the Conference of the Parties at its fifteenth session. Decision 2/CP.15 Copenhagen Accord*, (FCCC/CP/2009/11/Add.1, Decision 2/CP.15), p. 6. Available from http://unfccc.int/resource/docs/2009/cop15/eng/11a01.pdf (accessed 23 August 2011).

[6] ibid., p.11.

Challenges to low-carbon planning

- **Political commitment:** Leadership and political commitment from the highest level is the most important factor for countries to jump-start the process towards a low-carbon development path. The role of high-level political commitment is crucial in light of other urgent development challenges that are high priorities on the political agenda.

- **Institutional capacity:** Low-carbon development requires focused efforts with multiple issues. Unless there is coordination, cooperation and consensus across ministries that go beyond the conventional compartmentalized and fragmented approach, the effectiveness and efficiency of development efforts will be undermined. Establishing a new mechanism or strengthening existing mechanisms to carry out integrated and comprehensive planning and to support low-carbon development can expedite the process.

- **Financing:** For many countries, the financing issues are one of the most difficult challenges, both in terms of generating and allocating domestic sources as well as finding funding opportunities internationally. Within the current financial crisis, developing countries require strategic planning on financing and technical cooperation. Low-carbon development plans can be a tool for assessing and identifying financing priorities and the required sources of funding.

  These plans can help developing countries focus on how to market the best-bet low-carbon programmes and projects to international donors. Projects and programmes reflecting predictable and credible short- to long-term targets, goals and strategies may be more attractive to donors in terms of providing funding. At the same time, to support the actions of the plans, governments can also consider how to generate funds domestically and how to invite private investment, depending on their country perspective.

  In their planning, governments will need to consider how to allocate investment in a variety of areas, including science and technology, R&D, energy, eco-efficient infrastructure, green business, education and human resource development. Public funds need to be allocated today in areas where benefits can be derived in the longer term, such as low-carbon technologies that require long-term investment from the R&D stage to commercialization.

- **Human resource capacity:** Skill and knowledge level to implement policy measures is a common hurdle for developing countries. Required skills training and education must be integrated into national low-carbon development strategies and action plans as well as into education policies. Without a sufficient and capable human resource base, it will be difficult for countries to make a transition to a low carbon development path.

- **Information and advocacy:** Governments need to lead on expanding public knowledge and providing appropriate information on the benefits as well as the associated burdens of low-carbon development. Unless information dissemination and advocacy is fully carried out, it will be difficult to gain understanding and long-term support from the public. Awareness raising must also be extended to government ministries and political leaders.

Implementing strategy[7]

The process for developing and implementing a low-carbon development plan requires many steps and the involvement of many actors. There is no set format, thus governments should decide what are the most appropriate steps and issues to cover based on the country context and priorities. The following outlines some of the general steps.

The first step involves agreeing on a vision, common understanding of the objectives of a low-carbon development plan and who needs to be part of the transition. The scope (economy-wide or sector specific) and the level of ambition should be discussed. Based on this common understanding, planning efforts can be directed

[7] Based on Christa Clapp, Gregory Briner and Katia Karousakis, *Low-Emission Development Strategies (LED): Technical, Institutional and Policy Lessons* (Paris, IEA and OECD, 2010), pp.6-10. Available from www.oecd.org/dataoecd/32/58/46553489.pdf (accessed 22 August 2011).

towards developing a national vision and then setting and aligning sustainable development and climate change goals. The time horizon should also be considered for achieving targets and goals. The planning process should start by building on past reports and strategies, assessing current trends through analyses of appropriate and reliable data and ensuring coherence among various existing plans.

The second step requires establishing the institutional framework that allows inter-ministerial participation across sectors, such as finance, energy, industry, environment, technology, transport, forestry and water as well as civil society and the private sector. As in China, Indonesia and the Republic of Korea, an inter-ministerial mechanism can be situated within the office of the prime minister or the president or chaired by the head of State, which will encourage effectiveness and efficiency in the planning and implementing processes. In some cases, such an inter-ministerial mechanism is set up during the initial stages of this exercise to handle the coordination of the planning process.

The third step is to develop the policies. This includes macroeconomic modelling and scenario (emissions) exercises (developing baselines and scenarios) to locate barriers, set targets, prioritize policy measures and fix the time period. The key work in this exercise is data collection and the production of credible data, which are vital for assessing the trends. For instance, policymakers can use existing data collection systems, such as greenhouse gas inventories and scenarios, to identify the level of greenhouse gas emissions, heavy emissions sectors, future emissions projections, mitigation potential and costs and vulnerabilities to inform their policymaking.

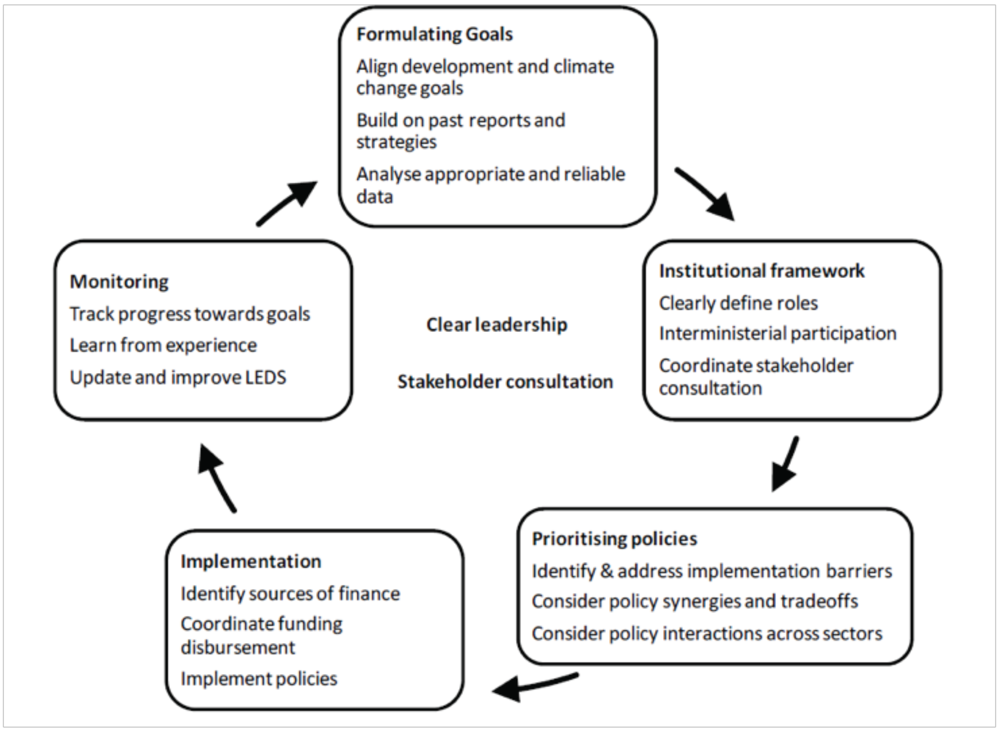
The fourth step entails the constructing of an implementing plan that enunciates clear roles and responsibilities of ministries and sectors and the level of funding that will be required for all expected activities.

Next, a finance or investment plan to support the policies and actions should incorporate information on how to generate funds domestically and through external sources as well as how to distribute the funds.

Finally, although it's not really a step but a recurring process, the low-carbon development plan needs to periodically incorporate lessons learned and adjustments due to changing circumstances. A dedicated mechanism that tracks the progress and the level of carbon emissions will be needed.

The following diagram outlines the general process for formulating a low-carbon development plan.

Diagram 1: Planning cycle of a low-carbon development plan (low-emissions development strategies, or LEDS)



Source: Christa Clapp, Gregory Briner and Katia Karousakis, *Low-Emission Development Strategies (LED): Technical, Institutional and Policy Lessons* (Paris, IEA and OECD, 2010). Available from www.oecd.org/dataoecd/32/58/46553489.pdf (accessed 22 August 2011).

Trends in development

Some countries have already developed low-carbon or low-emissions development plans. The following table provides a list of such plans and strategies from around the world, with many more expected. Some countries have even developed sector-based plans to support national low-carbon development or national climate change plans. For instance, in 2010 the Indonesian Government introduced the Indonesia Climate Change Sectoral Roadmap to guide the central and local governments in the planning and implementing of low-carbon development plans for the next 20 years.

Table 1: Selected national low-carbon development and climate change plans

Country	Date	Low-carbon Development Plans
Bangladesh	September 2008	Bangladesh Climate Change Strategy and Action Plan
Brazil	December 2008	National Plan on Climate Change
Cambodia	December 2009	Green Growth Roadmap
China	June 2007 March 2011	National Climate Change Programme Twelfth Five-Year Economic and Social Development Plan
European Commission	August 2011	A Roadmap for Moving to a Competitive Low carbon Economy in 2050
Guyana	May 2009	Transforming Guyana's Economy While Combating Climate Change
India	July 2008	National Action Plan on Climate Change
Indonesia	November 2007	National Action Plan Addressing Climate Change
Japan	July 2008	Action Plan for Achieving a Low carbon Society New Growth Strategy (Basic Policies)
Kazakhstan	September 2010	Zhasyl Damu-Green Development Strategy
Mexico	May 2007 August 2009	National Strategy on Climate Change Special Programme on Climate Change
South Africa	July 2009	Long-Term Mitigation Scenarios Climate Change Policy Framework
Republic of Korea	July 2009	Five-Year Low Carbon, Green Growth Strategy and Action Plan
United Kingdom	July 2009	The UK Low carbon Transition Plan

Source: Table developed based on Project Catalyst, *Low Carbon Growth Plans - Advancing Good Practices*, Working Draft (San Francisco, ClimateWorks Foundation, 2009).

Further reading

Low-Emission Development Strategies (LED) Technical, Institutional and Policy Lessons, by Christina Clapp, Gregory Briner and Katia Karousakis (Paris, International Energy Agency and OECD, 2010). Available from www.oecd.org/dataoecd/32/58/46553489.pdf

Low carbon Growth Plans - Advancing Good Practice, Working Draft (San Francisco, Project Catalyst, 2009). Available from www.project-catalyst.info/images/3.%20Low%20carbon%20growth%20planning /Publications/Advancing%20good%20practice/090805%20Project%20Catalyst%20-%20LCGP%20paper%20-%20 normal%20view%20-%20Ver%202.0.pdf

FACT SHEET

Nationally appropriate mitigation action and measurement, reporting and verification

Key points

- ***Due to the flexible and broad concept of nationally appropriate mitigation action (NAMA), developing countries can pursue projects according to their national preferences and priorities.***

- ***Through a NAMA, governments of developing countries can demonstrate and receive international recognition for their mitigation actions.***

NAMA and MRV explained

The concept of nationally appropriate mitigation action (NAMA) was introduced in the Bali Action Plan at the United Nations Framework Convention on Climate Change Conference of Parties (COP) 13 in 2007 in Bali, Indonesia.

Paragraph 1 (b) (II)[1] calls for "Nationally appropriate mitigation actions by developing country Parties in the context of sustainable development, supported and enabled by technology, financing, and capacity-building, in a measurable, reportable and verifiable manner." NAMAs are subject for review by an internationally agreed measurement, reporting and verification (MRV) system on their impacts, including emissions reductions, and on the international support that was provided.

How it works

The general idea is that through nationally appropriate mitigation action, developing countries will voluntarily reduce their CO_2 emissions (deviations relative to business-as-usual emissions in 2020). NAMAs are one method to allow countries to plan and pursue low carbon green growth contrary to following the carbon-intensive growth patterns of industrialized countries.

Since 2010, 44 NAMA proposals have been submitted by developing countries for inclusion in the Appendix II of the Copenhagen Accord.[2] Many developing countries have indicated in their submissions that the NAMAs are conditional on receiving support from the international community. The content of those NAMAs are diverse, ranging from targets and goals for reducing carbon emissions to specific sector-based actions that lead to carbon reductions, such as in energy, energy efficiency, agriculture, forestry, construction and transport sectors. Table 1 at the end of the fact sheet provides details of the NAMAs submitted to the UNFCCC from countries in the Asia-Pacific region.

[1] The Bali Action Plan was the outcome document of the UNFCCC COP 13 in Bali, Indonesia, in 2007. It is a comprehensive plan outlining specific actions to reach an agreement on a post 2012 framework for reducing global greenhouse gas emissions, based on four pillars: mitigation, adaptation, technology and finance.

[2] United Nations Framework Convention on Climate Change website "Appendix II: Nationally Appropriate Mitigation Actions of Developing Country Parties". Available from http://unfccc.int/meetings/cop_15/copenhagen_accord/items/5265.php (accessed 15 January 2012).

Box 1: Nationally appropriate mitigation actions in the transport sector

NAMAs in the transport sector can be considered as an upgrade of the Clean Development Mechanism. CO_2 emissions from the transport sector account for 23 per cent of the total energy emissions at the global level. The emissions in this sector are expected to increase by 120 per cent from 2000 levels by 2050.[3] Although the transport sector offers great mitigation potential, it has had challenges in developing CDM projects. Only 26 of 43 developing countries included mitigation in the transport sector as part of their NAMA submission to the Copenhagen Accord.[4] For instance, Mexico listed the development of a public transport system and the use of cleaner vehicles for public buses. Indonesia proposed a BRT system in 11 cities.[5] Although the classification of NAMAs is still under negotiation, the transport sector can provide a window of opportunity for discussing credible NAMAs.

No agreement yet on what qualifies as a NAMA

There is still no consensus regarding what "nationally appropriate mitigation action" will entail, such as the coverage (by sector or economy-wide), the overall institutional framework or the regulatory frameworks that need to be in place. The concept opens the window of opportunity for developing countries to propose, publicize and be recognized internationally for their own voluntary actions that are based on their country context. Although there is no agreement on what can qualify as a NAMA yet, it may include the introduction of policy measures, regulations, standards, targets, incentives and programmes that lead to reductions in greenhouse gas emissions at the national level.[6]

Many types of nationally appropriate mitigation actions have been proposed, which can be broken down to three general categories:[7]

1) **Unilateral NAMA** (unconditioned and domestic): Mitigation actions undertaken by developing countries without assistance from developed countries.
2) **Supported NAMA** (international, bilateral and conditional): Mitigation actions that are undertaken by a developing country with financial and/or technological support provided by industrialized countries.[8]
3) **Credited NAMA** (market-based): Mitigation actions undertaken in a developing country that can generate carbon credits by reducing CO_2 emissions. The excess credits generated against the baseline (business-as-usual levels) can be traded and sold in the international carbon market.

The MRV system and registry

As an outcome of the UNFCCC negotiations in 2010 in Cancun, a registry will be established to match the NAMAs with support from industrialized countries and a fund will be created to finance mitigation and adaptation action in developing countries.

[3] KPMG, "Sharing Knowledge on the Transport Industry", *Issues Monitor*, vol. 3, May 2009. Available from www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/Issues-monitor-transport/Documents/Issues-Monitor-Transport-May-2009-vol3.pdf (accessed 19 March 2012).

[4] Anne Binsted, Adam Davies and Holger Dalkmann, *Copenhagen Accord NAMA Submissions: Implications for the Transport Sector* (Deutsche Gesellschaft für Internationale Zusammenarbeit, Transport Research Laboratory, Institute for Transportation and Development Policy, International Association of Public Transport and Veolia Transdev, 2010). Available from www.transport2012.org/bridging/ressources/files/1/913,828,NAMA_submissions_Summary_030810.pdf (accessed 19 March 2012).

[5] Bridging the Gap Initiative website "Delegates from Mexico, Columbia, Indonesia and UNESCAP Discuss Transport NAMAs at BtG Event". Available from www.transport2012.org/transport-climate-change-news/2011-04-09,transportnamas-bkk.htm (accessed 30 April 2011).

[6] Center for Clean Air Policy, *Nationally Appropriate Mitigation Action by Developing Countries: Architecture and Key Issues* (Washington, D.C., 2009). Available from www.ccap.org/docs/resources/823/NAMAs%20by%20Developing%20Countries%20-%20Architecture%20and%20Key%20Issues.pdf (accessed 15 January 2012).

[7] ibid.

[8] For instance, the Green Climate Fund was launched at the UNFCCC COP 17 in Durban to support mitigation and adaptation efforts in developing countries. The Fund operates independently under the guidance of the UNFCCC COP. Developed countries are to provide financing worth US$100 billion to this fund by 2020.

A MRV system to track the progress of emissions and emissions reductions, commitments and mitigation actions will be established through national communications, biennial update reports and International Consultation and Analysis.[9] Deliberations during the COP 17 in Durban resulted in an agreement on more regular reporting requirements for developing countries; they will have to submit information on the status of their mitigation and adaptation efforts through their national communications every four years. Additionally, developing countries will be required to submit a biennial update report that includes greenhouse gas emissions inventories, the description of their mitigation policies and information on the international support that is required and received by them. The first reports are to be submitted in December 2014, which will be followed by a review process through International Consultation and Analysis (ICA).

The idea for a domestic MRV system in developing countries is intended to track the progress of emission reductions, promote transparency of the financial flows and the deployment of technological support that are provided to a specific NAMA. It can also help build trust among developing and industrialized countries, provide recognition both for developing countries for their mitigation action and industrialized countries for their international support, identify areas to improve action and enable opportunities for learning and sharing experiences.

Where there is international support, including support from industrialized countries, the MRV results recorded in the registry by developing countries will be crucial for ensuring accountability and transparency to countries or organizations providing the financial, technological or capacity building support.

The greenhouse gas inventory, which is part of the national communications, will be the basis to measure and assess the emissions, emissions reduction and the enhancement of carbon sinks.

Strengths with NAMAs and MRVs

- **Provides developing countries a strategic instrument:** Developing countries can position nationally appropriate mitigation action to showcase their best-bet mitigation options that reduce significant levels of greenhouse gas emissions while receiving technical and financial assistance from international funding sources and donors. NAMAs can be the basis for countries to achieve low-carbon development goals.

- **Facilitates external assistance to developing countries to address capacity building issues:** The nature of the capacity-building support that is required will differ from country to country, depending on the capacity and context. Some developing countries need help to improve their planning and implementing skills, including the prioritizing of NAMAs as well as drafting a policy framework and initiating institutional development. Some countries require support for setting up the basic institutional infrastructure. This may include establishing a MRV system for collecting, measuring, analysing and recording data. Other areas may entail strengthening of existing systems, such as greenhouse gas inventories and training of relevant staff on how to use equipment to measure and analyse greenhouse gas emissions.

- **Helps coordinate the multi-sector response to improve the impact of national mitigation actions:** Only specific ministries have been involved in responding to climate change issues generally. Depending on the coverage, NAMAs can open opportunities for ministries traditionally not involved in climate change mitigation actions, such as transport, construction and planning. In anticipation of large funding and technology transfer support, NAMAs can be a highly political process. Thus, if an efficient coordinating mechanism is in place, it can enable an effective multi-sector response at the national level.

  A central coordinating body can be responsible for developing the overall NAMA framework, aligning it with low-carbon development strategies. It can also develop national MRV strategies and install the required institutions and mechanisms, such as the NAMA registry. It can oversee a variety of issues and actions, such as data collection, planning, design, packaging of actions, marketing, attracting resources and technology and setting up or strengthening national data collection and analysis systems.

[9] Steve Winkelman, Ned Helme, Stacey Davis, Mark Houdashelt, Chuck Kooshian, Diana Movius and Anmol Vanamali, *MRV for NAMAs: Tracking Progress while Promoting Sustainable Development*, Discussion draft (Washington, D.C., Center for Clean Air Policy, 2011). Available from www.ccap.org/docs/resources/1029/MRV%20for%20NAMAs%2011-30-11.pdf (accessed 19 March 2012).

- **Opens opportunities for the business sector to engage in NAMA projects:** Because NAMAs are diverse in nature and cover many sectors, they can create new business opportunities for the private sector through the implementation of projects and programmes.

Challenges to NAMAs and the MRV

- **Weak institutional capacity:** Existing government institutions may not have the appropriate capacity to coordinate a multi-sector response involving several ministries, such as transport, energy, housing and construction, in the planning process of NAMAs. Additionally, existing institutions may not have the expertise to develop a strategy nor have the appropriate infrastructure to implement NAMAs or the MRV system.

- **Difficulties in attracting finance:** Developing countries may lack the capacity to strategically prioritize and market NAMAs to attract international support and private sector investment. In terms of mobilizing private sector financing, there may also be regulatory obstacles that hinder private sector investment, both domestically and internationally. Adding to that are obstacles to developing public-private partnerships or a lack of incentives for the private sector in the form of loan guarantees, tax incentives or seed money.[10]

- **Lack of technical expertise:** There may be a lack of technical expertise to manage the NAMA and MRV process. This includes the process of developing policy frameworks, carrying out accurate and reliable data collection and analysis for development of statistical data and conducting technical research, project development and management.

- **Lack of awareness of NAMA opportunities within the private sector:** Because the details of what will qualify as a NAMA and how the proposals will be operationalized are still being worked out at the international level, the private sector may not be aware of the potential business opportunities.

Implementing strategies

Create a national policy framework: A national policy framework, ideally in the form of low-carbon development plans, can provide the basis for planning, developing and implementing NAMAs. The low-carbon development strategy can be useful to ensure consistency and links between the individual NAMAs, to plan a number of NAMAs across sectors to achieve the established national emissions reduction targets and goals and to provide guidance in line with national development priorities.[11] Additionally, a NAMA framework and a national MRV strategy also will need to be developed.

Establish and strengthen legal and financial governance structures and institutions to support the long-term sustainability of mitigation policies and actions.

Dedicate a coordinating mechanism or strengthen an existing mechanism to facilitate a multi-sector response at the national level, such as a national NAMA coordinating committee.

Build up capacities and awareness at the national level, especially within ministries not traditionally involved with climate change mitigation actions but regarded as relevant for developing sector-specific NAMAs. Building the institutional, financial and human capacities and skills should also be directed towards the private sector and NAMA project developers through workshops and information campaigns, followed by support for innovative financing schemes and incentives, including private sector investment financing.

[10] KPMG, *Financing Low-Carbon Investment in Developing Countries: Public-Private Partnerships for Implementation of Nationally Appropriate Mitigation Actions* (London, 2010), p. 4. Available from www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/Pages/Financing-low-carbon-investment-in-developing-countries.aspx (accessed 30 August 2011).

[11] Center for Clean Air Policy, *Nationally Appropriate Mitigation Actions by Developing Countries: Architecture and Key Issues* (Washington D.C., 2009). Available from www.ccap.org/docs/resources/823/NAMAs%20by%20Developing%20Countries%20-%20Architecture%20and%20Key%20Issues.pdf (accessed 15 January 2012).

Set up the internationally agreed system to measure, report and verify the greenhouse gas reductions resulting from the implementation of NAMAs. The greenhouse gas inventory is an instrument in the MRV process to assess the actual emission reductions compared with the business-as-usual projections. Developing countries have already established inventories through the reporting requirements under the UNFCCC in their National Communications. However, developing countries may need to strengthen the existing national frameworks and mechanisms for data collection, measurement, analysis and monitoring to better carry out the NAMAs and ensure accountability and transparency of their mitigation actions.

Create enabling conditions for investment: Although NAMAs are to be supported with international assistance, the financing gap will need to be covered through private sector investments as well as from domestic public financing sources. Governments will need to arrange enabling conditions for private sector funding by removing legal and fiscal barriers, including lowering the debt cost through public guarantee mechanisms, the introduction of feed-in tariffs and providing measures for lowering the risks for investors.[12] Regulatory barriers that impede public-private partnerships will also need to be reviewed.

Box 2: J-MRV introduced by the Japan Bank International Cooperation

Some countries are going ahead to introduce their own measurement, reporting and verifying system. The Japan Bank International Cooperation is introducing the J-MRV, a simple, practical and internationally accepted framework of MRV to promote international projects reconciling greenhouse gas reductions and economic development. It is intended to accelerate low-carbon investment through the measurement of greenhouse gas reductions by the projects. The J-MRV will be used to provide an appropriate investment climate and advanced measurement methodology to trigger public-private financing in developing countries through projects that use the most appropriate and commercially viable technologies. The J-MRV will be applied to projects financed under the Global Action for Reconciling Economic Growth and Environmental Preservation (GREEN)[13] initiative.

Source: Japan Bank for International Cooperation website "Guidelines for Measurement, Reporting and Verification of GHG Emission Reductions in JBIC's GREEN (the "J-MRV Guidelines")". Available from www.jbic.go.jp/en/about/environment/j-mrv/index.html (accessed 19 March 2012).

Further reading

Financing Low-Carbon Investment in Developing Countries: Public-Private Partnerships for Implementation of Nationally Appropriate Mitigation Actions (London, KPMG, 2010).

"How to Get Nationally Appropriate Mitigation Actions (NAMAs) to Work", *Policy Update*, Issue 11, by Martina Jung, Katja Eisbrenner and Niklas Hohne (Köln, Germany, ECOFYS, 2010).

Nationally Appropriate Mitigation Action by Developing Countries: Architecture and Key Issues (Washington, D.C., Center for Clean Air Policy, 2009).

[12] KPMG, *Financing Low-Carbon Investment in Developing Countries: Public-Private Partnerships for Implementation of Nationally Appropriate Mitigation Actions* (London, 2010), p. 4. Available from www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/Pages/Financing-low-carbon-investment-in-developing-countries.aspx (accessed 30 August 2011).

[13] GREEN was initiated in March 2010 with a fund of US$4 billion (over a period of three years), catering to government and financial institution lending. Eligibility criteria are 1) climate change policy of the host country, 2) technology to be used and 3) reduction amount measured by the J-MRV.

Table 1: NAMAs submitted to the UNFCCC, by developing countries in the Asia-Pacific region, as of January 2012

Country (date)	Nationally appropriate mitigation actions
Afghanistan[(a)] (22 March 2010)	i) Prepare the Initial National Communication, which will include specific mitigation strategies and activities appropriate for the national context ii) Complete the national greenhouse gas inventory
Armenia[(a)] (29 January 2010)	Implement the National Programme on Energy Saving and Renewable Energy of the Republic of Armenia (2007) • Increase the energy production, based on renewable energy sources • Modernize thermal power plants • Improve energy efficiency in all sectors of the economy • Improve energy efficiency in buildings and construction • Decrease loss in methane flow in gas transportation and gas delivery systems • Expand electrical transport and increase the natural gas share in motor transport's fuel supply • Decrease methane emissions from solid municipal waste and waste water • Restore degraded forests, afforestation and reduce the volume of deforestation, sustains oil CO_2 content and ensure its increase
Bhutan[(a)] (5 February 2010)	i) Ensure that emissions continue to stay below sequestration capacity ii) Declaration of the Kingdom of Bhutan – Land of Gross Happiness to Save our Planet
China[(a)] (28 January 2010)	i) Lower carbon dioxide emissions per unit of GDP by 40–45% by 2020, compared to the 2005 level ii) Increase the share of non-fossil fuels in primary energy consumption to around 15% by 2020 iii) Increase forest coverage by 40 million hectares and forest stock volume by 1.3 billion cubic metres by 2020, from the 2005 levels
Georgia[(a)] (1 February 2010)	i) Achieve a measurable, reportable and verifiable deviation from the baseline (below business-as-usual levels) supported and enabled by technology and capacity building ii) Establish the baseline or reference case against which the action shall be measured, reported and verified iii) Support the Clean Development Mechanism as one of the most important means for further cooperation in the field of NAMAs because of its potential to lead to significant investments, better environmental performance, job creation and poverty alleviation iv) Develop a low-carbon growth plan and low-carbon strategy, in particular through the use of renewable energy investments and global cooperation
India[(a)(b)] (30 January 2010)	i) Reduce the emissions intensity of GDP by 20–25% by 2020, from the 2005 level ii) Target generating 20,000 MW of solar power by 2020
Indonesia[(a)] (30 January 2010)	i) Reduce emissions by 26% by 2020 through: • Sustainable peat land management • Reduction in rate of deforestation and land degradation • Development of carbon sequestration projects in forestry and

	agriculture • Promotion of energy efficiency • Development of alternative and renewable energy sources • Reduction in solid and liquid waste • Shifting to low-emission transportation mode
Iran[(b)] (Durban Conference 2011)	Fifth Five-Year Development Plan (2011–2016) i) Raise power plant efficiency to 43% ii) Reduce electric power network losses to 1% iii) Achieve 27.5% growth in hydropower, 90.2% growth in wind power iv) Establish energy labelling v) Extend flare gas recovery plans in oil and gas industry up to 99% vi) Increase carbon sequestration in rangelands by 2% annually vii) Increase forest protection factor from 40% to 90% viii) Increase per capita forest coverage from 1,700 to 2,500 square metres
Kazakhstan[(b)(c)] (7 November 2011 and 27 January 2010)	i) 15% emission reduction until 2020 and 25% until 2050, based on 1992 levels
Republic of Korea[(a)] (25 January 2010)	i) Reduce national greenhouse gas emissions by 30% from the business-as-usual emissions by 2020
Lao People's Democratic Republic[(b)] (Durban Conference 2011)	i) Reduce the vulnerability from natural disasters ii) Increase the use of renewable energy iii) Mitigate emissions from the transport sector iv) Achieve 70% forestry cover by 2020 v) Reduce emissions from deforestation and forest degradation
Malaysia[(b)] (Durban Conference 2011)	i) Reduce emission intensity of GDP by 40% by 2020 from 2005 levels
Maldives[(a)] (29 January 2010)	i) Target carbon neutrality by 2020
Marshall Islands[(a)] (27 January 2010)	i) National Energy Policy and Energy Action Plan 2009: 40% reduction of CO_2 emissions by 2020 from 2009 levels
Mongolia[(a)]	i) Energy supply: • Increase renewable options: • Photovoltaic and solar heating: implement pilot research projects in the areas along the railways and consider PVs in the Mongolian Gobi desert and steppe areas in the future • Provide wind power generators and wind farms for remote areas and nomadic families • Hydropower Plants: the 220 MW Egiin Gol hydroelectric power generation project • Improve coal quality through coal beneficiation (included in the Mongolian Environmental Action Plan) and coal briquetting • Improve efficiency of heating boilers, household stoves and furnaces and CHP plant • Increase the use of electricity from grid for individual households in cities ii) Building – Building Energy Efficiency Improvement • Improve district heating system in buildings

	• Install heat and hot water meters in apartments • Make insulation improvements for existing buildings and implement new energy efficient standards for new buildings • improve lighting efficiency in buildings iii) Industry – Energy Efficiency Improvement in Industry • Improve housekeeping practices of Mongolian industries through energy use management • Implement motor efficiency improvements • Introduce dry-processing in cement industry iv) Transport • Use more fuel efficient vehicles: introduce used vehicle import standards and vehicle registration tax v) Agriculture • Mongol Livestock Programme: limit the increase of the total number of livestock by increasing the productivity of each type of animal, especially cattle vi) Forestry • Improve forest management: options are natural regeneration, plantation forestry, agro-forestry, shelter belts and bioelectricity • Reduce emissions from deforestation and forest degradation and enhance forest carbon stocks
Papua New Guinea[(a)] (2 February 2010)	i) Decrease greenhouse gas emissions by at least 50% by 2030 (75% of target achievement through own capacities, rest is subject to support) ii) Achieve carbon neutrality before 2050
Singapore[(a)] (28 January 2010)	i) Reduce greenhouse gas emissions by 16% by 2020 from business-as-usual levels (Sustainable Singapore Blueprint in April 2009), contingent on a legally binding global agreement in which all countries implement their commitments in good faith
Sri Lanka[(b)] (Durban Conference 2011)	i) Deyata Sevana Programme: annual event of planting 2.1 million trees in one day, which started in 2010
Tajikistan[(a)] (10 February 2011)	i) Inventory greenhouse gas emissions ii) Improve energy efficient technologies in buildings and construction iii) Support adaption and mitigation measures and projects on capacity building and technology transfer iv) Develop low-carbon growth through the introduction of renewable energy sources
Thailand[(b)] (Durban Conference 2011)	i) Reduce energy intensity by 20% by 2020 ii) Replace 25% of fossil fuel energy generation by green energy within 10 years iii) 20-year energy conservation plan (2011–2030), 10-year renewable and alternative energy development plan (2012–2021): expected reduction of 205 million tonnes of CO_2
Timor-Leste[(b)] (Durban Conference 2011)	i) Achieve 50% energy production from renewable sources by 2015

(a)UNFCCC website "Copenhagen Accord Appendix II". Available from http://unfccc.int/meetings/cop_15/copenhagen_accord/items/5265.php (accessed 26 February 2012).
(b)UNFCCC website "Durban Conference Statements". Available from http://unfccc.int/meetings/durban_nov_2011/statements/items/6584.php (accessed 26 February 2012).
(c) UNFCCC website "Appendix I: Quantified Economy-Wide Emissions Targets for 2020". Available from http://unfccc.int/meetings/copenhagen_dec_2009/items/5264.php (accessed 26 February 2012).
* Kazakhstan is a Party included in Annex I for the purposes of the Kyoto Protocol in accordance with Article 1, paragraph 7, of the Protocol, but Kazakhstan is not a Party included in Annex I for the purposes of the Convention.

Ocean energy

Ocean energy explained

There are four sources of ocean energy: waves, tides, osmotic and thermal energy – all of which can be converted into electrical energy.

How it works

Waves: Wave energy can be harnessed and converted into electrical energy at onshore or offshore sites through a number of technological mechanisms. Onshore or coastal sites extract power from breaking waves. Deep-water sites have three to eight times as much wave power as coastal sites and are more efficient in electrical energy conversion; however, the transmission and maintenance costs increase the further the installation is offshore.[1]

Tides: The daily variation in tides can be converted into electrical energy in coastal areas. There must be a difference of at least 5 metres between the high tides and low tides to harness energy from them. The significantly higher density of seawater allows ocean currents to carry much more energy than air, making tidal technology more productive than wind power plants, even when ocean currents are slower than wind speeds. Turbines, which resemble wind turbines, can be placed offshore once water depths are 20–30 metres. Other options to harness tidal energy are more environmentally invasive, such as dams and tidal fences, both of which can interfere with sea life and silt flows.[2]

Osmotic: When salt water from the ocean meets freshwater, there is a pressure differential created because salt from the seawater wants to move into the freshwater. As it does so, energy is released. Capturing and converting this energy is the goal of osmotic ocean energy production.

Thermal: Some 70 per cent of the Earth is covered by oceans, making them the world's largest solar collector. Ocean thermal energy conversion (OTEC) relies on temperature differences between sun-warmed water near the ocean's surface and colder waters in the deep ocean to produce steam to power a turbine and then condense it back into liquid. A difference of 20 degrees is needed, making OTEC power production most viable in tropical coastal zones.[3]

Opportunities in Asia and the Pacific

- Sites for all types of ocean power are limited geographically.
- Sites for all types of ocean power are limited geographically. Areas for tidal power are limited in the Asia-Pacific region, with the greatest potential north of Australia, around New Zealand and off the coast of northern China to the Republic of Korea and southern Japan. Wave power potential is highest around Japan, Indonesia's Sumatra and Java islands and off the southern coast of Australia, extending east to New Zealand.[4]

[1] California Energy Commission website "Ocean Energy" (17 February, 2011). Available from www.energy.ca.gov/oceanenergy/index.html (accessed 30 November 2011).

[2] United States of America, Department of Energy website *"Ocean Tidal Power"* in Energy Savers. Available from www.energysavers.gov/renewable_energy/ocean/index.cfm/mytopic=50008 (accessed 30 November 2011).

[3] United States of America, Department of Energy website "Ocean Thermal Energy Conversion" in Energy Savers. Available from www.energysavers.gov/renewable_energy/ocean/index.cfm/mytopic=50010 (accessed 30 November 2011).

[4] Per Christer Lund, *Energy from Wind and Ocean: A North East Asia Study* (Tokyo, Innovation Norway, 2010). Available from http://neec.no/uploads/windocean.pdf (accessed 30 November 2011).

- Wave energy has a potential to replace carbon-intensive power systems based on diesel, especially in remote coastal areas or small islands.[5]

Trends in development

Early stage development: There is little existing ocean energy development worldwide and in the Asia-Pacific region. Wave power is in a demonstration phase, and mostly small scale. A few large-scale tidal barrage developments have been in place for decades, given their similarities to hydroelectric technology for damming rivers, but there has not been widespread development. Thermal and osmotic energy conversion systems are still being researched.[6]

Republic of Korea leading tidal development: Between 2007 and 2009, four plans for large-scale tidal power plants were announced in the Republic of Korea, each escalating in size – up to the 1,320 MW Incheon Bay project.[7] The Sihwa Lake Tidal Power Station went online in August 2011, becoming the world's largest tidal power plant, with a capacity of 254 MW. To drive development, the Republic of Korea has set a specific feed-in tariff for tidal power. Public and private funding for further R&D has increased significantly, amounting to 13 billion euros in 2010.[8]

Strengths with ocean energy

- **Relatively steady supply:** Compared with solar and wind energy, the ocean energy is a more reliable source of energy, with support from technology advancements.
- **Vast potential:** Although the development of ocean energy technologies is still in a nascent stage, a theoretical potential for ocean energy (7,400 EJ per year) is huge enough to accommodate the energy needs of current and future generations.[9]
- **Job creation potential:** Researchers for a European Ocean Energy Association report estimated that 10–20 jobs per MW of ocean energy could be created in coastal regions with good ocean energy resources.[10]

Challenges to using ocean energy[11]

- High capital costs prove to be a major hurdle to development. In addition to the development of under water transmission, most coastal regions lack high-voltage transmission lines and would need significant transmission upgrades to move power to the load centres.
- Low-profile installations may present a hazard to shipping navigation and fishing, creating conflict with other economic uses of the water. Ocean front views may be disturbed by onshore or near-shore installations (such as tidal dams), leading to reduced tourism or real estate values along the coast.

[5] Hans Christian Soerensen and Alla Weinstein, "Ocean energy: Position paper for IPCC", Keynote paper presented at the IPCC Scoping Conference on Renewable Energy, Lübeck, Germany, 20-25 January 2008. Available from www.eu-oea.com/euoea/files/ccLibraryFiles/Filename/000000000400/Ocean_Energy_IPCC_final.pdf (accessed 30 November 2011).

[6] European Commission Research and Innovation website "Technical Background". Available from http://ec.europa.eu/research/energy/eu/research/ocean/background/index_en.htm (accessed 30 November 2011).

[7] Per Christer Lund, *Energy from Wind and Ocean: A North East Asia Study* (Tokyo, Innovation Norway, 2010). Available from http://neec.no/uploads/windocean.pdf (accessed 30 November 2011).

[8] International Energy Agency, Ocean Energy Systems, *Annual Report 2010: Implementing Agreement on Ocean Energy Systems* (Lisbon, 2010). Available from www.iea-oceans.org/_fich/6/2010_Annual_Report.pdf (accessed 30 November 2011).

[9] Intergovernmental Panel on Climate Change, *Special Report on Renewable Energy Sources and Climate Change Mitigation* (Geneva, 2011)

[10] Hans Christian Soerensen and Alla Weinstein, "Ocean energy: Position paper for IPCC", Keynote paper presented at the IPCC Scoping Conference on Renewable Energy, Lübeck, Germany, 20-25 January 2008. Available from www.eu-oea.com/euoea/files/ccLibraryFiles/Filename/000000000400/Ocean_Energy_IPCC_final.pdf (accessed 30 November 2011).

[11] ibid.

- Installations, particularly those near the coastline, can create environmental hazards for sea life, especially those that migrate to and from the shore. With proper sitting, impacts can be minimal. Installations can also impede the flow of sediments, causing unnatural silt build-ups, which affect ocean life.
- For conversion systems that rely on the use of hydraulic fluids, there is a threat of spills or leaks if the equipment is faulty and cannot withstand ocean waves or storms.

Implementing strategies

Fund R&D: Most ocean energy technologies are either approaching or currently in a demonstration phase. Promoting further R&D by offering public funds or creating an enticing environment for private funds is important for future development.

Increase awareness: Cultivating public awareness and the awareness of policymakers to the various sources of ocean energy is important because the ocean has been overlooked in much of the literature and current policies on renewable energy.[12] To increase awareness, the quality and access to data on ocean energy resources must also be improved.[13]

Rely on feed-in tariffs: For countries with good ocean energy resources, setting a specific feed-in tariff for the various kinds of available ocean energy can promote targeted development.[14]

[12] ibid.

[13] David Leary and Miguel Esteban, "Climate change and renewable energy from the ocean and tides: Calming the sea of regulatory uncertainty", *International Journal of Marine and Coastal Law* (2009), 24. Available from http://agc-wopac.agc.gov.my/e-docs/Journal/0000014590.pdf (accessed 30 November 2011).

[14] ibid.

Low Carbon Green Growth Roadmap for Asia and the Pacific

FACT SHEET

Passive houses

Key point

- ***A passive house saves significant amount of energy, improve interior comfort and bolsters greater resilience towards oil price rises.***

Passive house explained

The passive house is more than just a low-energy building, which does not require mechanical heating or cooling. Passive design is a bundle of design principles aiming to reduce the heating, cooling and dehumidification load via the building envelope such as roofs, walls, windows and floors. The concept can be applied for both new and retrofitted construction projects in residential, public and commercial buildings.

According to the Passive House Institute, such a design provides the following distinctive performance:

- A passive house requires less than 15 kWh per (square metre per year) for heating or cooling (living spaces).
- The heating and cooling load is limited to a maximum of 10 W per square metre and primary energy use may not exceed 120 kWh per (m^2a).
- A passive house must be airtight, with air change rates limited to n50 = 0.6 per hour.
- In warmer climates and/or during summer months, excessive temperatures may not occur more than 10 per cent of the time.

How it works

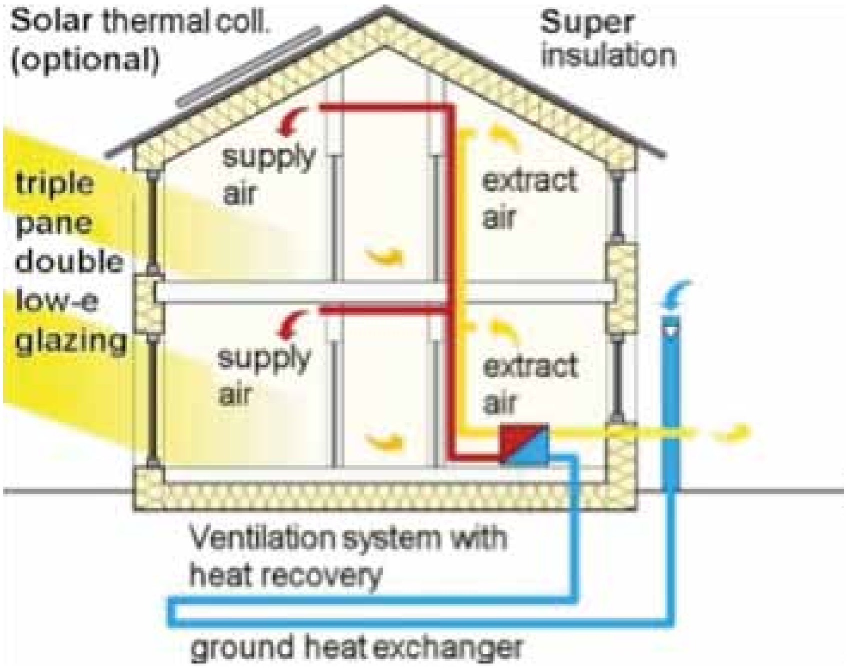
Vast energy savings in passive houses can be achieved via building orientation and energy-efficient building envelopes, such as insulation, glazing and a quality ventilation system. The style of buildings, material to be used and specific technologies vary according to the climate zone, level of market development and design and construction culture and practices.

In cold climates, for example, passive houses use solar passive designs, insulation, heat recovery and highly insulated windows. In hot climates, solar protection is emphasized, such as shading devices, proper size and quality of windows and a building's thermal mass (to avoid the penetration of heat into the building during the daytime when the ambient temperature rises).

The following are regarded as essential for all climates (figure 1):

- **Insulation:** Strengthening the insulation of the building envelope is critical in controlling heat gains and losses, such as with thermal bridge-free design, airtight construction and highly insulated windows. The level of insulation and types of insulation measures will differ from region to region.
- **Thermal bridge-free design:** The heat loss at thermal bridges, such as edges, corners, connections and penetrations, is generally high. The passive house is designed to avoid thermal bridges. Better insulation can make up for thermal bridges and allow for a good energy balance.
- **Good-quality ventilation:** Fresh air is not merely a matter of comfort but a necessity for healthy living. To ensure that closed doors do not hinder the flow of air, appropriate air transfer openings are installed above door frames. A heat recovery-ventilation system may be used to transport heat during the cold season, cool air during the hot periods and dry air to dehumidify, if necessary.

Figure 1: How a passive house works



Source: Wolfgang Feist, *What is a Passive House?* (Darmstadt, Germany, 2010). Available from www.passiv.de/07_eng/PHI/Flyer_quality_assurance.pdf (accessed 24 February 2008).

Trends in development

Passive solar houses are found mostly in Europe. There have been initiatives to establish standards and certifications, such as the Passive House Standard by the International Passive House Association and the Passive House Certificate for Old Buildings by the Passive House Institute. The European Parliament proposed that all buildings meet passive house standards of airtightness and energy efficiency by 2011. The passive house concept is gaining popularity in the Canada, the United States and some Asian countries as a result of the growing demand for greenhouse gas emissions reduction, long-term energy savings and good indoor air quality.

Conferences of interest on passive house design:

- Sixteenth annual International Passive House Conference, organized by the Passive House Institute, in Hanover, Germany in March 2012. (www.passivhaustagung.de/sechzehnte/Englisch/index_eng.php).
- Sixth annual North American Passive House Conference, organized by the Passive House Institute in October 2011 (www.passivehouse.us/phc2011).
- Fourth Nordic Passive House Conference, organized by the VTT Technical Research Centre of Finland in October 2011 in Helsinki (www.phn11.fi/phn11-home/phn11.html).

Strengths of a passive house

- **Saves energy and bolsters greater resilience towards oil price rises:** On average, passive house dwellings, which are built with airtight insulation that maximizes the use of natural heating systems such as the sun, achieve an energy savings of 90 per cent when compared with existing houses and more than 75 per cent when compared with average new construction.[1] In terms of heating oil, passive houses use far less than typical low-energy buildings.
- **Improves comfort:** Passive buildings provide a higher degree of comfort during both hot and cold months by controlling heat gains and losses as well as the humidity. Such buildings also enable air to flow constantly throughout the house and to stay fresh.

[1] International Passive House Association, *Active for More Comfort: The Passive House* (Darmstadt, Germany, 2010). Available from www.passivhaustagung.de/Passive_House_E/passivehouse.html (accessed 12 December 2011).

Challenges with a passive house

- **Upfront additional investment costs compared with standard houses:** In Germany where passive house design is popular, the additional expense derived from such a concept is 3–8 per cent higher than standard houses. Investments made in the designing and the higher-quality building components are largely offset by avoiding the need for investment in expensive heating, cooling and lighting systems. The upfront investment, however, is likely to be higher in developing countries where the concept and thus manufacturers of necessary components remain undeveloped.[2]
- **Lack of awareness of the concept and benefits:** The passive house is quite unknown to the public in general and to policymakers in particular. Thus accurate information on the actual costs and benefits are often lacking, which is prerequisite for considering and promoting the concept.
- **Immature market:** The construction or building industry in the region is not evolving or developing fast enough to accommodate many new technologies. The components or materials required for the passive house are not readily available or are expensive.

Considerations for replicating

Take an incremental approach: Increasing the minimum energy performance of buildings via building codes could be a useful priority during the market transformation, especially in least developed countries in the region.

Invests in research and development: Because the passive house is not a specific design technique but a design principle, constructing passive houses does not necessarily have to rely on modern technologies developed in European countries. Countries in the region can revisit their traditional and vernacular designs, such as design principles applied for tropical architecture that inspire lower resource consumption of buildings.

Institutionalize standards or certificates: Similar to the initiative in Europe, there is a need to introduce passive house standards in line with the climatic zone and to conduct sensitizing campaigns and capacity-building programmes for all parties associated with the building sector.

Further reading

Passive Houses Solutions, Working Paper for the Promotion of European Passive Houses Project, by the European Commission under the Intelligent Energy Europe Programme (Brussels, 2006).

Passive House Institute website: www.passiv.de.
International Passive House Association website: www.passivehouse-international.org.

[2] Passipedia website "Affordability". Available from http://passipedia.passiv.de/passipedia_en/basics/affordability (accessed 30 January 2011).

Policy options to improve the quality of public transport

- **Preserve road space and give priority to eco-efficient modes of transport:** A certain amount of road space should be allocated specifically for public transport and non-motorized transport, such as bus lanes and cycle lanes. This allows for increased frequency, faster speeds, fewer delays and better reliability of public transport. Safety is also improved because the interaction with the general traffic is reduced. Signalling and junction design should allow public transport to gain priority over private cars.

Dedicated bus lanes reduce delays to public transport in Jakarta, Indonesia
Photo: Ko Sakamoto

- **Integrate various modes of transport:** It is important to consider how the different modes of public transport can be integrated to improve connectivity and convenience. An extensive network should cover a spectrum of services from local services (typically catered by conventional buses, taxis and bicycles) to intrazone travel (typically catered by express buses, BRT and rail-based public transport systems). Conventional bus services, taxis and public bicycles can act as feeders to mass transit, including BRT, light rail and metro systems. Competition should not be between different modes of public transport but rather between the private car network and the public transport network.

Integration of public transport modes as seen in Madrid, Spain
Photo: Ko Sakamoto

- **Diversify the public transport service (in terms of speed, price, etc.) tailored to different needs:** The diversification of public transport service can attract more passengers whose demands vary. For example, putting in place express buses or rails in addition to the existing network can provide the types of service in terms of speed and price that accommodate various demands.

- **Design good-quality public transport infrastructure:** Infrastructure for public transport, such as bus, train and metro stations, should be designed and constructed in a way that enables easy access to all users, including those with mobility impairments, and to improve the convenience of transit between different modes. Ensuring good design standards from the outset also reduces further expenditures in the future, considering that retrofitting or redesigning old infrastructure is often more costly and technically difficult. In the context of climate change, it is also important that infrastructure is designed and built with resilience against extreme weather events (such as flooding) as well as likely changes to the physical environment (such as sea level rises).

Japanese multi-modal stations: Nishitetsu Tenjin station in Fukuoka City in which the second floor is used as the railway station while the third floor is a bus terminal and the fourth floor is a parking area.

Japanese multi-modal station for bus and train in Toyama City (Iwasehama station)

- **Maintain infrastructure and vehicles:** Both infrastructure and vehicles need to be appropriately maintained so that cleanliness, comfort and safety are reliable features. Maintenance is crucial to safeguard that the large capital investments made in transport infrastructure and vehicles are maximized and not squandered. Budgeting for transport projects should ensure that maintenance costs are factored in from the beginning and made available on schedule.

- **Provide information to the public:** The benefits of using public transport, including financial savings to households, improved health and lower burden to the environment, need to be communicated to the public through targeted campaigns. Additionally, information technology that improves the reliability and convenience of public transport and non-motorized transport systems should be employed, such as real-time information systems that let riders know what to expect.

Real-time public transport information
in Guangzhou, China
Photo: Ko Sakamoto

- **Make it affordable and provide incentives for the uptake of public transport:** Public transport fares should be set at rates that allow all members of society to use it. Conversely, the price of using private cars should be higher than that of using public transport, such as through congestion charging and high parking fees. In addition, fare systems between different modes of public transport should be integrated for users' convenience. In Bogota, Colombia, people can travel the whole city via public transportation with a single fare system. In Seoul, Republic of Korea, every public transport including bus, metro, airport limousine and local feeder buses installed the electronic fare system so that people can transfer from one to the other mode using the same multi-transport card (called 'smart card') at a discounted rate. The same system has been expanded into the neighbouring province.

FACT SHEET

Preservation of open and green spaces

Key points

- ***The city can be a more liveable place via enhanced walkability, environmental resilience and attractive natural surroundings.***

- ***Open and green spaces are vital in balancing out increasing urban density and ecological sustainability of cities.***

Open and green spaces explained

Urban green and open spaces can take a variety of forms, including parks, playing fields playgrounds, walkable squares and plazas and natural capital, such as wetlands, forestry and lakes. Building rooftops also serve as urban green spaces when land available for park is scarce.

How it works

Conserving and investing in natural capital inherent in cities such as wetland, park, forestry and lake can be turned into the place of leisure for the citizens, serving various purposes such as reduction of heat island effect or potential flooding. Although higher density and mixed-use policies are encouraged, they should be accompanied with the development of city parks, plazas, and the preservation of surrounding natural environments in order to improve the liveability. Parks and plazas with attractive landscaping, water features, or even entertainment venues help to significantly improve the appearance of an urban development or neighbourhood and even create a greater sense of security.

BOX: Selective green street design measures

Green street programmes include such strategies as the installation of swales, permeable paving and increasing the number of trees.

- Swales (vegetated open channels) can be designed to accept runoff and increase infiltration. These may be as simple as integrating grassy areas to capture water, or more complex forms that include amended soils, gravel storage areas, diverse thick vegetation and bio-retention soils. Additional bio-retention technologies can be provided in tree boxes, planter boxes, and curb retention.
- One of the most common and applicable technologies is permeable paving, which comes in a number of forms including permeable concrete, permeable asphalt, permeable interlocking concrete pavers, and grid pavers. Some systems may be modular and available for retrofit. All of these systems provide structural support, storm runoff, and assist in the removal of pollutants.
- Another accompanying strategy is to increase pavement albedo (reflectivity) to further reduce the heat island effect. Many cities have formal programs to develop and maintain sidewalk trees and tree boxes in the urban environment. The benefits of street trees include reducing the heat island effect and reducing storm water runoff, as well as the accompanying aesthetic improvements.

Strengths with open and green spaces

- **Increases environmental resilience:** Natural landscapes provide valuable ecosystem services to urban environments including clean air, storm-water management, and carbon sequestration. In Garland, Texas, tree canopies in the city saved up to US$38 million by avoiding the construction of artificial infra structure for storm water retention.[1]
- **Reduces heat island effect:** increased urban vegetation and mature tree canopies contribute to the mitigation of the urban heat island effect by reducing the air temperature.
- **Enhances walkability:** Street trees, swales, and planters create an additional barrier between moving vehicles and the pedestrian, creating a higher level of safety and increased walkability.
- **Increases property value and business opportunities:** Parks and open areas can serve as gathering places, and contribute to the vitality and attractiveness of a community. New business such as leisure and tourism can thrive cantering around green spaces.

Challenges to preserving open and green spaces

- **Land is often scarce, expensive and difficult to obtain from existing communities.**
- **Conserving parks and green spaces is not a policy priority:** Cities often do not make an adequate commitment of finances and resources that it does to buildings, roads and other infrastructure.

Implementing strategies

Careful examination and planning: To develop open space within an urban area, careful analysis of the existing land use must be conducted. Recognizing abandoned properties and brownfield sites as well as undesirable industries or other land uses and determining if these properties are accessible and suitable for green space is a key process.

Set up or designate an institution for continuous management and maintenance of public spaces.

Provide for a dedicated source of funding to support the continued improvements and maintenance of public green spaces: Develop a strong marketing campaign to inform residents and visitors of the public assets and encourage their use.

Examples

Singapore's Active, Beautiful and Clean (ABC) Waters Programme: Water infrastructure management has been integrated as part of the planning and design of the city so that local communities can enjoy the waterways as engaging features in their urban landscape. In 2009, a set of ABC water design guidelines have been issued, to provide reference to developers and industry professionals on how to implement environmentally sustainable green features or ABC Waters design features in their developments.[2]

Further reading

Parks, People, and Places: Making Parks Accessible to the Community, by Deborah L. Myerson, ULI Community Catalyst Report Number 4, (Washington, D.C., ULI Urban Land Institute, 2006).

[1] American Forests. *Local Ecosystem Analysis Garland Texas: Calculating the Value of Nature* (Washington D.C., 2000). Available from www.americanforests.org/downloads/rea/AF_Garland.pdf (accessed 22 February, 2012).

[2] Lai Choo Malone Lee, *Active, Beautiful, and Clean Waters Programme in Singapore: Water Resource Management and Ecological Conservation*, Case Study for Eco-Efficient and Sustainable Urban Infrastructure Development in Asia and Latin America Project (Bangkok, UNESCAP and UNECLAC, 2009).

REDD and REDD+

Key point

- ***REDD+ is a proposed policy mechanism for a post Kyoto 2012 Climate Change Agreement.***

REDD and REDD+ explained

REDD is the abbreviation for "reducing emissions from deforestation and forest degradation", followed by REDD+, with the "plus" referring to "the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries".

Greenhouse gas emissions due to deforestation and forest degradation are the second-largest sector source of greenhouse gas emissions behind only the energy sector and ahead of the transport sector. Reducing deforestation would thus significantly reduce greenhouse gas emissions; and it would provide important secondary benefits, such as protecting biodiversity and producing rainfall.

REDD+ is seen as complement to land use, land use change and forestry projects that also targets developing nations for reductions in greenhouse gas emissions. At its most basic level, REDD+ can be perceived as a payment for ecosystems services scheme. REDD+ provides developing nations an economic alternative to the more destructive use of forest lands thereby providing developing nations and their people a financial incentive to keep their forests intact.[1]

How it works

Greenhouse gas emissions due to deforestation and forest degradation account for nearly 20 per cent of global greenhouse gas emissions. It is for this reason, REDD+ is considered as a necessary part of any climate change mitigation actions.

REDD+ is a proposed policy mechanism currently under discussion within the UNFCCC Conference of Parties (COP) for reducing emissions from deforestation and forest degradation as well as to foster conservation, sustainable management of forests and enhancement of forest carbon stocks in developing nations. Beyond the environmental benefits of maintaining forests, REDD+ is seen as a mechanism for directing funds from the North to the South to help expand low-carbon development and poverty reduction.

The roots of REDD were laid in the land use, land use change and forestry framework, but REDD was excluded from the Kyoto Protocol because there were policy and methodology issues that were considered too difficult to solve at the time.[2] The avoided deforestation proposal was formally introduced and taken up as an agenda item in 2005 at COP 11 in Montreal.

At COP 13 under the Bali Action Plan, it was decided that REDD is to be included in a post-2012 framework and the details were to be decided during the COP 15 in Copenhagen. Subsequent to Bali, a number of proposals about the design of a REDD mechanism were proposed to the UNFCCC by the governments of both industrialized and developing countries as well as NGOs.

[1] *The Economist*, "Better REDD than dead: Tropical forests' best hope", September 23, 2010. Available from www.economist.com/node/17062737 (accessed 26 January 2012).

[2] Mark Belton, "REDD progress at Copenhagen", *Policy Quarterly* (2010), vol. 6, No. 2, pp. 8-10. Available from ips.ac.nz/publications/files/fca25b2faa5.pdf (accessed 26 January 2012).

BOX: UN-REDD Programme

The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries was launched in September 2008 to assist developing countries prepare and implement national REDD+ strategies. It builds on the convening power and expertise of the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP). The programme currently supports REDD+ readiness activities in 42 partner countries across Africa, Asia, the Pacific and Latin America.[3]

There are many contentious issues that a REDD+ framework must address. The way these issues are handled significantly shapes the way REDD+ works.

Deforestation and forest degradation

Deforestation and forest degradation may occur as a result of agricultural expansion, conversion to pastureland, infrastructure development, destructive logging and fires.[4] Deforestation and forest degradation emit greenhouses gases in two ways: 1) it removes plants that have the ability to sequester carbon dioxide, and 2) it releases CO_2 from the combustion of any of the harvested wood. Additional emissions, though, can occur in a number of other ways.

Trees and vegetation are not the only part of forests that store carbon. In fact, a greater proportion of carbon – more than 80 per cent – is stored as "soil carbon" rather than in vegetation.[5] Soil carbon is decaying plant and animal matter at various stages of decomposition in up to a metre of soil.[6] When organic matter decays, it releases CO_2 and CH_4 (methane), two primary greenhouse gases.[7] Human activities, such as tilling and deforestation, reduce the physical protection that soil has against decomposition and results in an increased rate at which greenhouse gases are released into the atmosphere.[8] Felling and burning (a common practice for clearing land) combust soil carbon, releasing it into the atmosphere as CO_2. Forests also provide secondary benefits beyond the reduction of greenhouse gas emissions, including protecting the ecosystem biodiversity, producing rainfall and cooling the Earth's surface.

Land use, land use change and forestry

In 1997, under the Kyoto Protocol, the United Nations Framework Convention on Climate Change (UNFCCC) recognized emissions and emission reductions (or "carbon stock changes") as a result of land use, land use change and forestry activities. The UNFCCC categorizes these activities as "a major sector of greenhouse gas emissions".[9] In accordance with the Kyoto Protocol, industrialized nations (those listed in Annex I of the UNFCCC) must report carbon stock changes resulting from afforestation, reforestation and deforestation and may choose to report carbon stock changes resulting from forest management, cropland management, grazing land management and re-vegetation.[10,11]

[3] United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries website "About the UN-REDD Programme". Available from www.un-redd.org/AboutUNREDDProgramme/tabid/583/Default.aspx (accessed 27 March 2012).

[4] ibid.

[5] The Intergovernmental Panel on Climate Change, *IPCC Special Report: Land Use, Land Use Change and Forestry – Summary for Policymakers* (World Meteorological Organization and United Nations Environment Programme, 2000). Available from www.ipcc.ch/pdf/special-reports/spm/srl-en.pdf (accessed 26 January 2012).

[6] The Commonwealth Scientific and Industrial Research Organisation website "Soil Carbon: The Basics" (14 October 2011). Available from www.csiro.au/resources/soil-carbon.html (accessed 26 January 2012).

[7] The United Nations Framework Convention on Climate Change website "Reducing Emissions from Deforestation in Developing Countries" (2012). Available from http://unfccc.int/methods_and_science/lulucf/items/4123.php (accessed 26 January 2012).

[8] W. M. Post and K. C. Kwon, "Soil carbon sequestration and land-use change: Processes and potential", *Global Change Biology* (2000), vol.6, pp. 317–328. Available from www.esd.ornl.gov/~wmp/PUBS/post_kwon.pdf (accessed 26 January 2012).

[9] The United Nations Framework Convention on Climate Change website "Glossary of Climate Change Acronyms" (2012). Available from http://unfccc.int/essential_background/glossary/items/3666.php#L (accessed 26 January 2012).

[10] United Nations Environment Programme GRID-Arendal website "Environmental Knowledge for Change: Opportunities and Challenges" (2011). Available from www.grida.no/publications/rr/natural-fix/page/3728.aspx (accessed 26 January 2012).

[11] The United Nations Framework Convention on Climate Change website "LULUCF under the Kyoto Protocol" (2012). Available from http://unfccc.int/methods_and_science/lulucf/items/4129.php (accessed 26 January 2012).

Specifics regarding the Kyoto Protocol were adopted under the Marrakesh Accords in 2001. Under those Accords, Annex I countries are allowed to gain credit for emission reductions from only reforestation and afforestation projects under Clean Development Mechanism (CDM) projects. Under Joint Implementation, Annex I countries can gain credit for projects from reforestation and afforestation as well as avoided deforestation and forest management. The commonly cited reason for only including reforestation and afforestation in CDM projects has been that questions remain over the issue of "leakage" – that reducing emissions from a project were merely increasing emissions elsewhere outside of the project boundary.[12]

Despite the opportunity for industrialized countries to gain credits for reforestation and afforestation projects in developing countries via the CDM, the use of the mechanism has been limited. As of August 2011, only 28 forestry CDM projects were registered (with two additional projects requesting registration) of a total of 3,347 registered CDM projects.[13] Researchers have cited the main hurdles to forestry CDM projects as financial constraints (cash flow and the immediacy of returns, securing financing and profitability) as well as constraints associated with knowledge, skills and other social factors (lack of knowledge of the CDM registration process, the need for coordinating a large number of local actors and the need for strong governance).[14]

The land use, land use change and forestry framework has been subject to criticism. Commonly cited are the restrictive rules involved with land use, land use change and forestry projects, the lack of involvement with developing nations, complex monitoring and reporting requirements, incomplete coverage of carbon sources and sinks and that emission reductions from forestry were not included in original country targets but can be used to meet them (although industrialized countries can only include land use, land use change and forestry projects to offset 1 per cent of their base year emissions). Due to these various constraints and criticisms, there is little international policy currently supporting forestry carbon projects.

How does REDD+ differ from the land use, land use change and forestry framework?

First, REDD+ is to be exclusively a mechanism for projects in developing nations.[15] The land use, land use change and forestry framework focuses on increasing the carbon held in forests and allows only for afforestation and reforestation projects through CDM. REDD is mostly focused towards avoiding carbon emissions from: 1) deforestation and 2) forest degradation, both of which are not currently allowed in the CDM. At the twenty-ninth meeting of the UNFCCC Subsidiary Body for Scientific and Technological Advice in Poznan, Poland in 2008, the avoided carbon emissions from: 3) conservation of forest carbon stocks, 4) sustainable management of forests and 5) the improvement of forest carbon stocks were given the same level of priority as deforestation and forest degradation. This has since been referred to as REDD+.

Timeline of REDD+[16]

11 December 1997 – Kyoto Protocol adopted and includes land use, land use change and forestry as a sector of emissions.

October/November 2001 – Marrakesh Accords (UNFCCC COP 7) specifies the nature of land use, land use change and forestry.

December 2005 – Avoided deforestation is proposed and accepted as an agenda item at the UNFCCC COP 11 in Montréal by the governments of Papua New Guinea and Costa Rica.[17]

[12] Romain Pirard, *Reducing Emissions from Deforestation and Degradation in Non-Annex 1 Countries* (London, The Climate Group, 2008). Available from www.theclimategroup.org/_assets/files/Reducing-Emissions-from-Deforestation.pdf (accessed 26 January 2012).

[13] The United Nations Framework Convention on Climate Change website "Project Search" (2012). Available from http://cdm.unfccc.int/Projects/projsearch.html (accessed 26 January 2012).

[14] Sebastian Thomas and others,,"Why are there so few afforestation and reforestation Clean Development Mechanism Projects", *Land Use Policy* (2010), vol. 27, No. 3, pp.880–887. Available from www.sciencedirect.com/science/article/pii/S026483770900204X (accessed 26 January 2012).

[15] Climate Action Network Australia, Count Down to Copenhagen: LULUCF and REDD, CANA International Climate Summary Sheet No. 6 (Sydney, 2009). Available from www.cana.net.au/sites/default/files/CANASummary6_LULUCF_REDD_060809.pdf (accessed 27 March 2012).

[16] Also see timeline in Carbon Planet, *Carbon Planet White Paper: the History of REDD* (Adelaide, 2009). Available from http://unfccc.int/files/methods_science/redd/application/pdf/the_history_of_redd_carbon_planet.pdf (accessed 26 January 2012).

[17] The United Nations Framework Convention on Climate Change website "REDD: Background" (2012). Available from http://unfccc.int/methods_science/redd/items/4547.php (accessed 26 January 2012).

December 2007 – The Bali Action Plan was adopted at the UNFCCC COP 13, setting a two-year timeframe to discuss the REDD framework.

December 2008 – Introduction of REDD+ at Poznan SBSTA 29 of the UNFCCC COP 14.

December 2009 – Industrialized countries pledge an additional US$30 billion between 2010 and 2012 to developing nations and a goal of US$100 billion per year by 2020 as part of the Copenhagen Accords (COP 15), with part of the funding to go towards REDD+.

December 2010 –The Cancun Agreements (UNFCCC COP 16) provided guidance to entities and countries assisting the REDD+ readiness process (the "fast-start period until 2012), on the phased approach and on requirements for developing countries, such as the national plans, national reference emission levels, transparent national forest monitoring systems and a safeguard compliance system.[18] Agreement was also made on the creation of a Green Climate Fund.

December 2011 – During UNFCCC COP 17 in Durban, countries agreed to a second commitment period of the Kyoto Protocol post 2012. The Clean Development Mechanism and the Joint Implementation will be operational in the second period.[19]

Design issues and challenges for REDD+

There are several important and contentious issues that the REDD+ framework must address. These issues are still being debated, and the actual design of REDD+ has yet to be determined. The following descriptions of the design issues capture only the basics of what are very complicated issues. Each option to address these issues has strengths and weaknesses and offers varying levels of benefits to the numerous actors involved.[20]

Scope – Scope can refer to a number of issues:

a. **Activities included** – One issue of scope is to determine the type of activities that would be considered in a REDD+ framework; deforestation, forest degradation, conservation of forest carbon stocks, sustainable management of forests, enhancement of carbon stocks or a combination of them.

b. **National-based policy versus project-based policy** – Should REDD+ be instituted as a national-based policy or as a project-based policy? This is important because it also affects a number of other design issues regarding permanence and leakage. Some proposals have incorporated aspects of both.
   i. A national-based policy would require participating countries to account for all their forestry emissions. A benefit of this type of policy is that it accounts for in-country leakage. A disadvantage is that it may create bureaucratic procedures that discourages outside investors.
   ii. A project-based policy would resemble the current CDM system. It would be easier to implement and attract more private investment, but it may be difficult to account for leakage.

Reference level or baseline – This is the benchmark that future emissions will be compared with to determine whether and how much emissions reduction has occurred. There are several options for how to calculate a baseline. One option is a historical baseline; for example, if a country deforested 1 million hectare of forests every year between 1990 and 2005, any rate of deforestation less than 1 million hectare would be considered an emissions reduction. A severe limitation in this type of system is that it does not account for changes in behaviour over time. Another option is a projected baseline that aims to predict changes in deforestation rates through modelling, which is still imprecise and based on numerous assumptions.

Financing – Several financing options have been suggested. One option is a market-based mechanism that would trade certified emission reductions (CERs) similar to the Clean Development Mechanism in an "offsets" market in which industrialized nations can purchase emission credits to offset their emissions and thus meet their respective emissions reduction commitments. Additionally, an auction process (or a market link) has been proposed as well as a voluntary approach involving a fund.

[18] World Resources Institute website "The REDD+ Decision in Cancun" (20 December 2010). Available from www.wri.org/stories/2010/12/redd-decision-cancun (accessed 6 March 2012).

[19] World Resources Institute website "A Look Back on the Durban Talks" (23 February 2012). Available from http://insights.wri.org/news/2012/02/look-back-durban-climate-talks (accessed 6 March 2012).

[20] Carbon Planet, *Carbon Planet White Paper: The History of REDD* (Adelaide, 2009). Available from http://unfccc.int/files/methods_science/redd/application/pdf/the_history_of_redd_carbon_planet.pdf (accessed 26 January 2012).

Distribution of revenues – An important issue to address is where the money goes. There are some countries that are highly forested yet have low rates of deforestation. Under an emissions reduction scheme, they would not receive financial benefits for keeping their forests intact. At a more local level, the revenues a country receives must also be distributed to the people in a transparent and equitable manner.

Human rights issues – A large portion of lands that will be targeted by REDD+ will likely be lands of indigenous people and other communities. Many of the world's poorest people, including indigenous people, live in forests and depend on them for their food and livelihoods. As inhabitants, these people have an important role in preserving and protecting the forest ecosystems. The rights of indigenous people to free, prior and informed consent is internationally recognized, and a REDD+ framework must uphold their rights, as with any citizen, to self-determination, culture and livelihoods.[21, 22]

Leakage – Leakage is the concept that a project's activities may result in greenhouse gas emissions increases or decreases outside of the project boundary. This may be a factor in any type of greenhouse gas mitigation project; but in the context of REDD+, the concern is negative leakage – that decreased deforestation in a project area would result in increased deforestation in another area.

Permanence – There are questions regarding the longevity of carbon reductions via REDD+ activities. Emissions reductions one year can be rapidly undone the next as a result of fire, pest outbreak and change in management, among other things. Some argue this is a greater concern for REDD+ than with fossil fuels, but others say that the same is true for both: emissions reductions from fossil fuel use can also be undone rapidly.

Monitoring, reporting and verification – The ability to verify the results of projects is imperative in REDD+ but measuring the amount of carbon stored in forests is difficult and imprecise. Although the technical capability and expertise to measure deforestation has become sufficient in recent years, there are still concerns as to how cost-effective these monitoring programmes can be.

Offsets versus reductions for industrialized countries – There is considerable opposition to REDD+ on the basis that it is another method by which industrialized nations can continue to pollute while not decreasing their own emissions and rather offsetting them. These critics argue that emission reductions must also come from the developed countries and cannot only come via offsets.

Current and ongoing REDD+ activities

Although the REDD+ framework is still being discussed and has not yet been ratified, work has already started, with initiatives to help prepare countries for when it begins:

Norway – Norway has taken a leading role in supporting REDD+ initiatives. Norway provided the initial US$52 million funding to start the UN-REDD Programme for developing countries. In addition, Norway has worked with the governments of Brazil, Guyana and Tanzania in different capacities, providing funding and capacity building.

Indonesia – Norway has committed up to US$1 billion of forest aid over the next seven to eight years (depending on performance) to Indonesia to reduce greenhouse gas emissions from deforestation and forest degradation. A first payment of US$30 million was paid in August 2010. Notable is that this is not an offsets project because it

[21] The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries, *Perspectives on REDD+* (Geneva, Food and Agriculture Organization of the United Nations, United Nations Development Programme and United Nations Environment Programme, 2010) Available from www.unredd.org/NewsCentre/Perspectives_on_REDD+/tabid/6594/Default.aspx (accessed 26 January 2012).

[22] Kingdom of Norway, Ministry of the Environment website "The Government of Norway's International Climate and Forest Initiative". Available from www.regjeringen.no/en/dep/md/Selectedtopics/climate/thegovernment-of-norways-international-/why-a-climate-and-forest-initiative.html?id=547202#The%20UN%20system (accessed 26 January 2012).

[23] Amantha Perera, "Jakarta Must Set Up Forest Bodies to Unblock Aid: Norway", *AltertNet*, August 1, 2011. Available from www.trust.org/alertnet/news/jakarta-must-set-up-forest-bodies-to-unblock-aid-norway (accessed 26 January 2012).

[24] Royal Norwegian Embassy in Jakarta website "Norway-Indonesia REDD+ Partnership: Frequently Asked Questions" (31 May 2010). Available from www.norway.or.id/Norway_in_Indonesia/Environment/-FAQ-Norway-Indonesia-REDD-Partnership-/ (accessed 27 March 2012).

will not count towards Norway's greenhouse gas reduction commitments. Any reductions will be additional to Norway's commitments.[24]

Forest Carbon Partnership Facility – The Facility is a global partnership helping to prepare countries for future REDD+ activities. The Facility oversees two funds, a Readiness Fund and a Carbon Fund, which are under the trusteeship of the World Bank. The two funds total US$447 million currently under management. Up to US$3.6 million can be provided to partner countries as readiness grants for helping countries in their preparatory work.[25]

Brazil's Amazon Fund[26] – In July 2008, Brazil's president at the time, Luiz Inácio Lula da Silva, launched the Amazon Fund to raise and collect donations for non-reimbursable investments that promote the preservation of forests in the Amazon biome. Non-reimbursable investments means that no credits for emission reductions are generated, and donors to the Amazon Fund are not able to count emission reductions generated by the Amazon Fund towards their emissions reduction targets.

The Fund is not a programme of the federal Government. It is governed by multiple actors divided into a number of groups. It is mainly governed by two committees, the Steering Committee (COFA) and the Technical Committee (CTFA). The COFA is made up of representatives from the federal and state governments as well as civil society and is responsible for posting guidelines and monitoring results. The CTFA consists of six authoritative technical and scientific experts appointed by the Ministry of Environment who certify the emissions figures from deforestation.

Funds are managed by the Brazilian National Development Bank, which retains 3 per cent of donations to cover the management costs. The Brazilian bank is responsible for the assessment of the preliminary applications.

The Amazon Fund received an initial pledge from the Government of Norway for up to US$1 billion by 2015, based on performance. Of that US$1 billion, the Amazon Fund had received US$110 million as of September 2011. The Amazon Fund received its second donation from the Government of Germany through the German Development Bank (KfW), which committed to giving US$27.8 million. Not all of the funds must stay in Brazil – up to 20 per cent may be used in other tropical countries.

The Amazon Fund works in a project-based manner: Project applications may be submitted to the Brazilian National Development Bank for consideration by government (federal, state or local bodies), NGOs, private companies, universities, etc. By decree, the Amazon Fund supports projects that fall into the following scopes:

- Management of public forests and protected areas
- Control, monitoring and environmental inspection
- Sustainable forest management
- Economic activities developed through the sustainable use of the forest
- Ecological and economic zoning, land-use planning and land-title regularization
- Conservation and sustainable use of biodiversity
- Recovery of deforested areas.

As of 15 September 2011, 59 projects had been submitted to the Amazon Fund and are active. Of them, 15 projects are in the initial stages of being "submitted"; 25 projects are "under analysis"; and 19 projects are in the final stage of being "approved."

The Amazon Fund is noted for several strengths and weaknesses.[27] The Fund has not yet raised additional funds beyond Norway and Germany's donations. It originally aimed to target 50 per cent of its funding towards scientific research and innovation but has not found a way to achieve this. In addition, funding has not been reaching grass-roots organizations. Many have questioned the lack of transparency of the Brazilian National Development

[25] The Forest Carbon Partnership Facility website "About FCPF: Introduction". Available from www.forestcarbonpartnership.org/fcp/node/12 (accessed 26 January 2012).

[26] Amazon Fund website "Frequent Asked Questions". Available from www.amazonfund.gov.br/FundoAmazonia/fam/site_en/Topo/FAQ/ (accessed 26 January 2012).

[27] Simon Zadek, Maya Forstater and Fernanda Polacow, "The Amazon Fund: Radical Simplicity and Bold Ambition – Insights for Building National Institutions for Low Carbon Development", Working Paper (Buenos Aires, Avina Foundation, 2010). Available from www.eurocapacity.org/finance/documents/Amazon_Fund_working_paper.pdf (accessed 26 January 2012).

Bank and the Fund as well as the lack of a grievance mechanism. Some critics suggest that the Brazilian bank is understaffed for such a project and that this will limit its ability to visit and reach communities to build local capacity and communication.

On the other hand, the Amazon Fund represents an early experiment for what a national climate fund could resemble. It has been cited for its quick development and its break from convention in terms of the configuration of governance and control mechanism. The Fund is also cited for its low-cost management through the arrangement with the Brazilian National Development Bank.

The medium- to long-term outlook of the Amazon Fund is unclear. The Brazilian Government had stated a need for US$1 billion a year of international contributions and a goal of US$20 billion by 2021. Some have questioned its medium- to long-term strategic approach, or rather, that it is lacking.

Viet Nam – In 2009, Viet Nam became one of nine UN-REDD Programme pilot countries. Approximately 40 per cent of Viet Nam is covered by forests, which sustain great biodiversity. US$4.38 million has been approved for planning and implementing national-level activities.[28, 29]

Further reading

The Little REDD+ Book: An Updated Guide to Governmental and Non-Governmental Proposals for Reducing Emissions from Deforestation and Degradation, by C. Parker and others (Oxford, Global Canopy Programme, 2009). Available from www.globalcanopy.org/materials/little-redd-book.

[28] United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries, "Reports & analysis: US$4.38 million UN-REDD+ Viet Nam programme launched", *Newsletter*, Issue 2, September 2009. Available from www.unredd.org/NewsCentre/Newsletterhome/US438millionUNREDDVietNamProgrammelaunche/tabid/1469/language/en-US/Default.aspx (accessed 26 January 2012).

[29] The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries website "Viet Nam" (2009). Available from www.unredd.org/UNREDDProgramme/CountryActions/VietNam/tabid/1025/language/en-US/Default.aspx (accessed 26 January 2012).

FACT SHEET

Renewable energy

Key points

- ***Promoting renewable energies is integral to low carbon green growth.***
- ***Policymakers should work towards boosting the competitiveness of renewable energy.***
- ***There is no blueprint for the right combination of renewable energy policies. Good practice measures should be watched closely and applied to national strategies when feasible.***

Renewable energy explained

Renewable energy derives from natural resources that have the capacity to replenish themselves over a relatively short period of time and can be regarded as infinite. Conventional energy sources, on the other hand, such as coal, natural gas or oil, restore themselves so slowly that their quantity and availability is limited for anthropogenic use. Examples of renewable energy sources include the sun, wind, moving water, biomass (including organic waste) and heat contained in the Earth's crust.

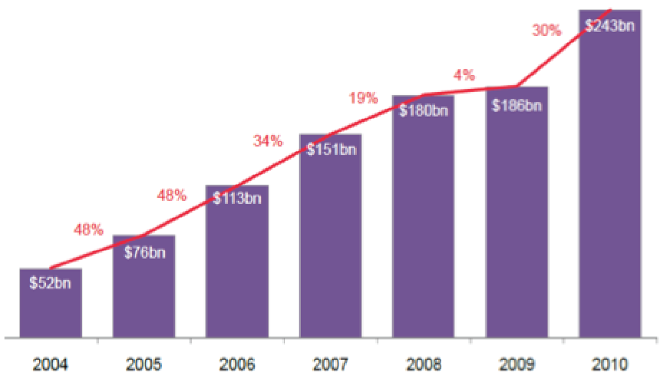
Renewable energy is also known as green energy because it does not produce toxins or pollutants that are harmful to the environment in the same quantity or quality in which non-renewable energy does. And it can counterbalance the carbon emissions created during energy production, transformation and distribution processes.

How it works

Renewable energy market share

Renewable sources supplied an estimated 16 per cent of global final energy consumption in 2009 and close to 20 per cent of the world's power supply by end 2010.[1] Despite the recession, total global investment in renewable energy reached a record high in 2010, amounting to US$243 billion (figure 1).[2] The scale of the renewable energy market has expanded over the past decade, thanks to its considerable potential (table 1).

Figure 1: Global total new investment in clean energy



Source: Bloomberg New Energy Finance, *Bloomberg New Energy Finance Summit: Results Book 2011* (London, 2011).

[1] Renewable Energy Policy Network for the 21st Century (REN21), *Renewable energy 2011: Global Status Report* (Paris, REN21, 2011).Available from www.ren21.net/Portals/97/documents/GSR/REN21_GSR2011.pdf (accessed 10 February 2012).

[2] Bloomberg New Energy Finance, *Bloomberg New Energy Finance Summit: Results Book 2011* (London, 2011). Available from www.bnefsummit.com/images/file-upload/Reports2011/Summit_2011_Results_Book.pdf (accessed 10 February 2012).

Table 1: Existing global capacity of solar PV and wind power, 1996–2010

Existing global capacity of solar PV				Existing global capacity of wind power			
Year	GW	Year	GW	Year	GW	Year	GW
1996	0.7	2004	3.9	1996	6.1	2004	47.6
1997	0.8	2005	5.4	1997	7.6	2005	59.3
1998	0.9	2006	7.0	1998	10.0	2006	74.6
1999	1.2	2007	9.5	1999	13.5	2007	94.0
2000	1.4	2008	16.0	2000	17.4	2008	121.0
2001	1.8	2009	23.0	2001	24.2	2009	159.0
2002	2.2	2010	40.0	2002	31.3	2010	198.0
2003	2.8			2003	39.4		

Source: Renewable Energy Policy Network for the 21st Century (REN21), *Renewable energy 2011: Global Status Report* (Paris, REN21, 2011).

The potential of renewable energy sources in meeting energy demands varies, depending on local and regional conditions, such as source endowments, climatic conditions and the price of energy. Site-specific analysis is always required to determine the technical and economic feasibility of renewable energy generation. The following table provides a general overview of selected renewable sources.

Table 2: Overview of the renewable energy sources

Renewable energy resource	Market readiness	Strengths	Weaknesses	Areas for R&D	Challenges
Solar	High cost of power from photovoltaic cells and concentrated solar power is a challenge, but significant cost reductions are possible Low-temperature solar thermal technology (such as solar water heaters) is market ready	Scalable and modular, highly compatible with distributed generation Wide geographic range, including in urban settings Large potential	Intermittent power generation and seasonal fluctuations	Efficiency increases and cost reductions to make photovoltaic cells generation cost-competitive Storage	High capital requirements Land-use issues for large solar power plants
Wind	Large-scale onshore development at prime wind sites can compete with conventional power	Scalable Highly compatible with distributed generation	Intermittent power generation and seasonal fluctuations	Improvements to reliability and storage as well as cost reduction through innovation Offshore turbine technology, especially for deep water applications	High capital requirements Site-specific modelling and assessments needed

Bioenergy	First-generation biofuels characterized by mature markets, technology Upgrades to existing conventional thermal power plants can allow for co-firing with solid biomass or liquid biofuel	Large amount of biomass resources from agricultural, forestry and municipal wastes Possible waste management co-benefit Compatible with distributed generation	Burning of biomass still generates greenhouse gas and local air pollution, some types more than others Limited distance from biomass resources required for economic viability	More efficient densification processes Efficient production and use of second- and third-generation biofuels	Land-use issues for energy crops Need targeted policies to support only “beneficial biomass” use
Geothermal	Conventional systems are commercially ready	Large potential in Ring of Fire countries Steady supply	Highly limited geographical availability of sites for conventional geothermal	Enhanced geothermal systems Better materials to deal with high acidity and other extreme	High capital requirements Site exploration required
Hydropower	Conventional systems are market ready and provide low-cost power Micro and small-scale hydro systems are the cheapest renewable energy	Storage possibilities Steady supply Scalable and compatible with distributed generation	Sites limited to where there is adequate water flow	Efficiency, lower requirements for flow speeds of run-of-river systems	Large-scale land- and water-use issues, high capital requirements and community dissent for large hydro
Ocean	Tidal dams are commercially ready; other technologies still in research and demonstration phases	Relatively steady supply (though with some peak times, such as with tides) Low operation costs	Sites limited by a number of geographic factors; may interfere with other economic uses of ocean, sea life and sediment flows	Much R&D is still needed for most ocean power technologies	High capital requirements Immature technologies Lack of specific resource data Insufficient transmission capacity from coastal areas to load centres

Renewable energies in developing countries

In 2011, developing countries represented more than half of the 118 countries that had established renewable energy targets and support policies.[3] Investments of developing countries in renewable energy companies, utility-scale renewable energy generation and biofuel projects exceeded those of industrialized countries for the first time in 2010.[4] Because most of the future growth in energy demand is expected to occur in developing

[3] Renewable Energy Policy Network for the 21st Century (REN21), *Renewable energy 2011: Global Status Report* (Paris, REN21, 2011). Available from www.ren21.net/Portals/97/documents/GSR/REN21_GSR2011.pdf (accessed 10 February 2012).

[4] ibid.

countries, this trend helps to reduce the negative environmental impact of those countries' present and projected rapid economic growth.

Policy goals

Policies for promoting renewable energy exist in different shapes and combinations, depending on the national energy market conditions. Essentially, governments try to achieve the following goals:

- Reduce market barriers for the relatively new renewable energy technologies
- Create energy market and infrastructure conditions in which renewable energy products can compete with the currently dominating fossil fuels
- Price the resource scarcity of conventional energy sources and thereby prepare for the time when their stocks are running low
- Reduce the vulnerability to energy price volatility
- Decrease impacts on environmental and human health
- Explore the industrial renewable energy market that features huge future growth prospects and employment capacities
- Balance the social, environmental and economic costs of conventional energies with renewable energy.

Strengths in using renewable energy

- **Supporting domestic energy security:** Because the energy demand from the Asia-Pacific region is strong, renewable energy is a cost-effective way to increase the domestic green energy supply and to reduce the dependence on fossil fuel imports and thus the exposure to energy price volatility.
- **Mitigating climate change:** Renewable energy can help countries reduce their carbon emissions. Renewable energy facilities support climate change mitigation and combat climate-induced consequences on agriculture, erosion and extreme hydrological events.[5]
- **Promoting regional development and industries in rural areas:** The renewable energy industry creates significant regional benefits through economic development that is based on the creation of employment using local resources in a new green industry with enormous export potential. The development of a domestic market and industries can attract numerous green financial investments, which benefit adjacent businesses and thus raise the living standard in a region.[6] Considering that natural resources and the space needed for renewable energy generation are often abundant in rural areas, it offers one of the rare opportunities for economic development there.
- **Improving economic competitiveness:** In addition to creating jobs, renewable energy can improve the economic competitiveness of a region by providing the chance to become part of the green industry sector, whose popularity and demand is rising steadily, and by stabilizing long-term energy prices.
- **Preserving air quality:** The avoidance or reduction of sulphur and nitrogen oxide emissions, released during the combustion process in conventional energy generation, enhances the quality of air.[7]
- **Opportunity for developing countries:** Renewable energy can directly contribute to poverty alleviation by providing the energy needed for creating businesses and employment in areas not connected to the grid. Producing renewable energy locally can offer a viable alternative for the 1.3 billion people around the world who don't have access to grid electricity.[8] Even though they are typically very poor, these people have to pay far more for lighting than people in industrialized countries because they use inefficient kerosene lamps. Solar power, for example, costs half as much as lighting with kerosene.[9] Renewable energy impacts poverty by supplying energy for cooking, space heating, lighting and even the operation of schools in remote areas. In developing countries that do not have extensive electricity grids, pipelines or other energy infrastructure, renewable energy technologies can be the most cost-effective option for electrifying remote villages.

[5] William Moomaw and Francis Yamba, *Renewable Energy and Climate Change* (Cambridge, 2011). Available from http://srren.ipcc-wg3.de/report/IPCC_SRREN_Ch01.pdf (accessed 9 February 2012).

[6] Union of Concerned Scientists, *Benefits of Renewable Energy Use* (Cambridge, 2005). Available from www.ucsusa.org/clean_energy/technology_and_impacts/impacts/public-benefits-of-renewable.html (accessed 9 February 2012).

[7] United States Environmental Protection Agency, Office of Air and Radiation, *The Benefits and Costs of the Clean Air Act from 1990 to 2020: Final Report* (Washington, 2011). Available from www.epa.gov/air/sect812/feb11/fullreport.pdf (accessed 9 February 2012).

[8] Kevin Bullis, "In the Developing World, Solar Is Cheaper than Fossil Fuels", in *Technology Review* (27 January 2012). Available from www.technologyreview.com/energy/39544/?p1=MstCom (accessed on 14 February 2012).

[9] ibid.

Challenges to using renewable energy

- **Costs and pricing:** Both implicit and explicit subsidies for fossil fuels distort the market conditions and investment decisions, thereby handicapping their renewable energy competitors. The prevailing blindness of conventional markets to environmental costs encourages the subsidies. And yet, because renewable energy accounts for the environmental impacts that conventional energy sources usually externalize, they have a hard time competing with the low market price of fossil resource-based power. Additionally, renewable energy investments require larger amounts of financing than conventional energy sources due to the high initial capital costs. Thus the hurdle rate for renewable energy projects is higher, and capital markets can demand a premium lending rate for financing these projects because more capital is being risked upfront than in conventional energy projects. Periodic fluctuations of oil and gas prices change the opportunity costs for renewable energy projects and directly influence investment motivation.
- **Legislation:** Generally, renewable energy producers encounter a variety of legal hurdles, owing to the fact that the policy field is relatively new and often works on a trial-and-error basis. Because of the newness, renewable energy policies are subject to constant changes, and investments are often held back because governments don't provide the necessary policy stability that can guarantee long-term profit. Although independent renewable energy producers suffer from a lack of legal frameworks, other renewable energy entities are impaired by planning restrictions that are too stringent to foster innovative technologies or business strategies.
- **Infrastructure:** Renewable energy producers must compete against technologies that rest on well-established infrastructure, designed to suit their special characteristics. The difficulties in predicting the exact production quantities from renewable energy sources makes it hard to weave these technologies into a grid that is designed to calculate and deliver the exact amount of electricity that is consumed at any given point in time. Natural processes bring about these fluctuations in production capacities for renewable energy; further research and technological advancement are needed to match conventional grid characteristics and novel renewable energy generation.
- **Information:** The information infrastructure of renewable energy is also lagging. The lack of technical skills, commercial skills and sufficient information about the benefits, risks and implementation of renewable energy projects hinders the uptake of this relatively new technology.
- **Market performance:** Power project developers have difficulties obtaining sufficient bank financing due to the prevailing uncertainties of long-term power purchase agreements of energy utilities. Because the innovation adoption lifecycle of renewable energy technologies has not reached the early majority stage yet, the lack of perceived technology performance raises the required rate of return and restrains access to capital.
- **Suitability of technologies:** Although renewable energy offers considerable improvement in environmental integrity compared with conventional energy sources, it also impacts the environment. Hydroelectric power generation, for example, often entails flooding of huge terrestrial ecosystems while the electricity production from biomass entails sulphur dioxide emissions.[10] The applicability of renewable energy technologies depends on the availability of capital, equipment and know-how as well as resource and space accessibility. The most suitable renewable energy mix, incurring the least costs on society and the environment, differs from country to country, and national strategies are limited in their transferability.

Implementing strategies

Setting a national target for renewable energy

Almost half of the countries in the world have proposed a renewable energy target to meet the green energy demand and mitigate climate change (table 3). The targets are typically guided by obligations to international agreements, vulnerability to the negative effects of climate change and the national capacities for the promotion and deployment of renewable energy. Quantitative goals are most commonly set for the share of renewable energy in electricity production, primary consumption or final consumption. Other aims may target the

[10] Bent Sorensen, *Renewable Energy: Its Physics, Engineering, Environmental Impacts, Economics & Planning* (Oxford, Academic Press, 2011).

share of renewable energy in the energy supply for different industrial sectors or define ratios for specific renewable technologies (table 4).

Table 3: Existing national shares of and targets for primary and final energy from renewable sources

Country/region		Existing share (2008/2009)	Future target	Existing share (2009)	Future target
		Primary energy		Final energy	
EU-27		8.2%		11.6%	20% by 2020
	Germany	8.9%		9.7%	18% by 2020 30% by 2030 45% by 2040 60% by 2050
	France	7.5%		12%	23% by 2020
	UK	3.1%		2.9%	15% by 2020
	Sweden	32%		50%	50% by 2020
China[11]				9.1%	15% by 2020
Fiji					100% by 2013
Indonesia		5%	17% by 2025		
Japan		6%	10% by 2020		
Republic of Korea		2.5%	4.3% by 2015 6.1% by 2020 11% by 2030		
Thailand		6.4%	20% by 2022		
Tonga					100% by 2013
Viet Nam			5% by 2020 8% by 2025 11% by 2050		

Source: Renewable Energy Policy Network for the 21st Century (REN21), *Renewable energy 2011: Global Status Report* (Paris, REN21, 2011).

Table 4: Other national renewable energy targets

Country/region	Target sector	Targets
EU-27	Transport	All 27 EU countries are required to meet 10% of final energy consumption in the transport sector with renewable energy by 2020
Australia	Renewable generation	Additional 45 TWh per year from large-scale renewable sources Power sources by 2020 (equal to 20% of generating capacity)
Bangladesh	Rural off grid solar	2.5 million units by 2015
Cambodia	Renewable generation	15% of rural electricity supply from solar and small hydro by 2015
India	Renewable capacity Wind Small hydro (< 25 MW) Biomass cogeneration Waste-to-energy Solar hot water Solar PV Rural lighting systems	78.7 GW added in 2007–2012 10.5 GW added in 2007–2012 1,400 MW added in 2007–2012 1,700 MW added in 2007–2012 0.4 GW added in 2007–2012 10.5 GWth by 2017; 14 GWth by 2022 12 GW by 2022 20 million by 2020
Malaysia	Renewable capacity	3,000 MW of new renewable energy by 2020, including 1,250 MW of solar PV and 1,065 MW from biomass
Nepal	Solar Wind Rural	3 MW by 2012/2013 1 MW by 2012/2013 7% from renewable energy
Pakistan	Renewable capacity	5% by 2030

[11] China's target changed in 2007 from a 15 per cent share of primary energy from renewable energy to a 15 per cent share of final energy from renewable energy and nuclear power combined.

Philippines	Renewable capacity Transport biodiesel Biomass power	10.6 GW by 2030; 4.5 GW added in 2003–2013 1,885 million litres annually by 2030 76 MW by 2010; 94 MW by 2015; 267 MW by 2030
Singapore	Solar hot water	0.035 GWth by 2012
Sri Lanka	Rural off-grid households served by renewable energy	6% by 2010; 10% by 2016

Source: Renewable Energy Policy Network for the 21st Century (REN21), *Renewable energy 2011: Global Status Report* (Paris, REN21, 2011).

Establishing a policy framework

To achieve national targets, to promote an increased share of power generation from renewable energies and to develop a sustainable renewable energy industry, there are primarily three policy options to rely on:

Regulatory policies
Regulatory policies ensure that renewable energy is treated with the significance in the energy and transport markets that it deserves, corresponding to its importance in achieving low carbon green growth. The policies should open the grid to renewable energy, guarantee a competitive price or ensure a specific market share of renewable energy. This can be managed with a variety of instruments:

- **Feed-in tariff:** Also known as a fixed-price policy because a government defines a fixed tariff for renewable energy electricity. Grid companies are required to purchase all renewable energy power generated by the power companies. The feed-in tariff can promote specific technologies, project locations or project sizes. Businesses appear to prefer the feed-in tariff and its derivatives because they are more effective than other policy options.[12]
- **Renewable portfolio standards:** Quota obligation policies, also known as renewable portfolio standards,[13] establish a target on the share of electricity from renewable energy sources by a certain date.
- **Renewable energy certificates:**[14] Renewable energy certificates are granted for the production of green energy and can be traded on the market and are commonly used with a renewable energy quota. They establish economic efficiency by enabling those businesses that can produce renewable energy with the least cost to sell a "certificate" to businesses that would have to pay high up-front infrastructure investments to achieve their quota.
- **Net metering:** Net metering describes a system in which solar panels and other small-scale renewable energy generators are connected to a public utility power grid. Only the net difference between electricity consumption and production by the client is accredited or bought by the grid at a price that depends on the retail electricity price.

BOX 1: Comparing feed-in tariffs and renewable portfolio standards, renewable energy certificates and net metering

Although the regulatory policies are not mutually exclusive, there are considerable differences in their impact on technology development, small-scale producers, renewable energy price levels and implementing costs. There are several reasons that make feed-in tariffs more attractive than the portfolio standards:[15]

1. Uncertainties originating from electricity and certificate price fluctuations discourage investment because they increase the cost of capital together with the investment risk.

[12] Mary Jean Bürer and Rolf Wüstenhagen, "Which renewable energy policy is a venture capitalist's best friend? Empirical evidence from a survey of international clean tech investors", in *Energy Policy* (2009), Vol.37, No. 12, pp. 4997-5006.

[13] For instance, quota obligation policies are called Renewable Electricity Standard in India, Renewable Obligations in the United Kingdom and Renewable Energy Targets in Australia.

[14] Ed Holt and Lori Bird, Emerging Markets for Renewable Energy Certificates: Opportunities and Challenges (Golden, National Renewable Energy Laboratory, 2005). Available from http://apps3.eere.energy.gov/greenpower/resources/pdfs/37388.pdf (accessed on 10 February).

[15] Intergovernmental Panel on Climate Change, Special Report on *Renewable Energy Sources and Climate Change Mitigation* (Cambridge, 2011). Available from http://srren.ipcc-wg3.de/report/IPCC_SRREN_Full_Report.pdf (accessed 09 February 2012).

2. Renewable portfolio standards are weak mechanisms to encourage technological and geographic diversity. A feed-in tariff offers a more suitable mechanism to promote specific technologies, locations or project sizes because they can adjust to those factors more flexibly and project conductors are incentivized to go beyond end-of pipe solutions to maximize their revenue.
3. The transaction cost of the portfolio standards could discriminate small-scale renewable energy producers while the feed-in tariff can even benefit those businesses and thereby help to diversify the renewable energy market and drive competitiveness.

Another common policy for renewable energy deployment is net metering. Similar to the feed-in tariff, it enables small-scale renewable energy generators to sell the produced electricity to the grid. However, it differs in several ways:

1. In the net metering system the power producer receives revenue, depending on the retail electricity price, without any long-term guarantee. It does not provide any certainty regarding that rate and thus there is little investment security.
2. Net metering does not give any incentives to enhance the capacity of a renewable energy project. A feed-in tariff is seen as an investment, and the system is sized to maximize the return.
3. The net metering system suffers from a lack of transparency because producers are not able to determine either the total generation of renewable energy from their system or their total consumption.

Source: National Renewable Energy Laboratory, *Feed-in Tariff Policy: Design, Implementation and RPS Policy Interactions* (Golden, CO, 2009).

Fiscal incentives

Fiscal incentives look to reduce the costs of renewable energy projects or at improving the relative competitiveness of renewable energy technologies.

- **Subsidies:** Governments can subsidize different economic variables via investment subsidies or capital subsidies, output subsidies or consumer (user) subsidies.[16]
- **Tax incentives:** To enable businesses to bridge the time and price gap of relatively expensive renewable energy investments, governments can grant tax reductions, such as annual income or fixed-assets tax decreases for investors or producers of renewable energy, or tax exemptions for the purchase of renewable energy technologies.
- **Energy production payment:** Governments pay per unit of produced renewable energy.

Public financing

Public financing is used to muster up the necessary capital for the renewable energy sector, either by providing funding for renewable energy projects or by awarding contracts:

- **Public competitive bidding:** Renewable energy projects are tendered by a government and a bidding process is used to choose investors. Power companies sign a power purchase agreement with the successful bidder within a specified period and all electricity is purchased at the bidding price. The competitive tender process can either commit successful bidders to deliver power at the price offered in their proposal or set the price for all successful bidders according to the highest accepted bid.[17]
- **Public renewable energy fund, loans or grants:** Due to the limited access to finance, especially for small and medium-sized enterprises, public funds, loans with favourable interest rates, grants and other financing options can be a viable mean to bridge this deficiency.
- **Public procurement:** Governments can step in and set a good example by installing renewable energy facilities in and around government buildings and public places or by covering their energy demand with renewable energy.

[16] International Energy Agency, Organization of the Petroleum Exporting Countries, Organisation for Economic Co-Operation and Development and World Bank, Analysis of the Scope of Energy Subsidies and Suggestions for the G-20 Initiative (Toronto, 2010). Available from www.oecd.org/dataoecd/55/5/45575666.pdf (accessed 10 February 2012).

[17] Renewable Energy Task Team, *Renewable Portfolio Standard Implementation: Working Group Report* (Ontario, 2003). Available from www.owa.ca/assets/files/publications/rett.pdf (accessed 10 February 2012).

Varying national strategies for renewable energy promotion

Most policymakers will adopt at least one of the policy options outlined here or rely on a few of them. The decision of which policy mix should be applied depends heavily on national conditions and varies from country to country (table 5). Countries with a similar energy market and infrastructure conditions can benefit from each other's experience, failures and successes.

Table 5: Renewable energy support policies of countries in Asia and the Pacific

	Regulatory policies						Fiscal incentives				Public financing	
	Feed-in tariff (incl. premium payment)	Electric utility quota obligation/ RPS	Net metering	Biofuels obligation/mandate	Heat obligation/ mandate	Tradable renewable energy certificates	Capital subsidy, grant or rebate	Investment or production tax credits	Reductions in sales, energy, CO_2, VAT or other taxes	Energy production payment	Public investment, loans or grants	Public competitive bidding
HIGH-INCOME COUNTRIES												
Australia	▲			▲		●	●				●	
Japan	●	●	●			●	●				●	
Singapore											●	
Republic of Korea[18]		●		●		●	●	●	●		●	
UPPER-MIDDLE INCOME COUNTRIES												
Iran								●		●		
Kazakhstan	●					●						
Malaysia	●										●	
LOWER-MIDDLE INCOME COUNTRIES												
China	●	●		●	●		●			●	●	●
India	●	●		●		●	●	●	●		●	●
Indonesia	●						●	●	●		●	●
Marshall Islands									●			
Mongolia	●											●
Pakistan			●				▲				●	
Philippines	●	●	●	●			●	●	●	●	●	●
Sri Lanka	●											
Thailand	●			●							●	
Viet Nam							●	●	●			
LOW-INCOME COUNTRIES												
Bangladesh							●				●	
Kyrgyzstan		●					●		●			
Nepal							●	●	●		●	●

▲ = Some states/provinces within these countries have state/provincial-level policies, but there is no national level policy.

Source: Renewable Energy Policy Network for the 21st Century (REN21), *Renewable energy 2011: Global Status Report* (Paris, REN21, 2011).

[18] In the Republic of Korea, the current feed-in tariff will be replaced by a PS policy in 2012.

Further reading

Energy Outlook for Asia and the Pacific (Manila, Asian Development Bank, 2009).

Energy Technology Perspectives (Paris, International Energy Agency, 2010).

Renewable energy 2011: Global Status Report (Paris, Renewable Energy Policy Network for the 21st Century, 2011). Paris. Available from www.ren21.net/Portals/97/documents/GSR/REN21_GSR2011.pdf

Special Report on Renewable Energy Sources and Climate Change Mitigation: Summary for Policy Makers (Geneva, Intergovernmental Panel on Climate Change, 2011).

World Energy Outlook 2011 (Paris, International Energy Agency, 2011).

FACT SHEET

Research and development and technological innovation

Key points

- ***Technological innovation and its deployment will be central pillars that enable countries to achieve low carbon green growth.***

- ***Developing and deploying innovative technologies that enhance energy efficiency and promote the use of new energy sources will be essential to overcome current energy challenges and to achieve a low-carbon development path.***

- ***Governments must take the lead by developing a national framework on R&D, institutions and financing that creates an enabling environment for technological innovation to flourish.***

R&D and technological innovation explained

Research and development (R&D) is the process of discovering new technologies that can change and improve the way we live, produce and consume or fine-tuning what is already in the works. Recent examples of technological breakthroughs that have brought transformative changes to our society are the Internet and the associated information and communication technologies. Technological innovation is especially critical for solving environmental challenges.

But innovation does not occur in a vacuum. The innovation chain must be supported by government policies, financing, institutions and the participation of the business sector, academia and civil society. At the same time it must be sensitive to the demands and needs of society. In terms of low carbon green growth, innovations should contribute to promoting the eco-efficiency and the development efforts of countries.

How they works

The role of technology

Low-carbon technology is a major driver in enabling countries to reduce their carbon emissions, stabilize atmospheric greenhouse gas concentrations, limit the temperature increase to less than 2° C and make the transition to low carbon green growth. Without the development, deployment and commercialization of such technologies, it will be difficult for countries to cut the greenhouse gas emissions to reach the global target of halving CO_2 emissions by 2050. Although technological breakthroughs will be crucial for reducing CO_2 emissions, for some developing countries, innovative indigenous applications of existing technologies may be more relevant due to their social and economic conditions. Some of the areas in which technological innovation will need to take place are in the power sector, transport, buildings and industry. For instance, carbon capture and storage technologies are projected to contribute 20 per cent of the global emission reductions by 2050.[1] Nonetheless, in developing countries, governments will need to drive the introduction of low-carbon technologies under a long-term vision.

The role of national policy frameworks to promote technological innovations

Governments will be critical for developing a comprehensive national policy framework and sector-based policy frameworks (technology, energy, innovation, industry, climate change mitigation and adaptation) that

[1] Shane Tomlinson, *Breaking the Climate Deadlock: Technology for a Low Carbon Future* (London, The Office of Tony Blair and The Climate Group, 2009). Available from www.theclimategroup.org/_assets/files/Technology_for_a_low_carbon_future_full_report.pdf (accessed 28 July 2011).

embrace a mix of policy measures or regulations that create enabling conditions and a level competing field for low-carbon technologies. These national frameworks can map out technological priorities and identify the level and types of government support in consideration of the national context, including investment and incentive schemes that are required for these technologies along the innovation chain, such as R&D in the commercialization phase.

Another important area in terms of partnerships is identifying how governments can work together with the private sector so that technologies can avoid being trapped in the "valley of death".[2] Depending on the country context, these issues can also be addressed through sector policies, such as national industrial policies. In some countries, technology roadmaps are developed to specify the time-bound actions and steps that need to be taken by the government, research institutions and the private sector.

National policy frameworks are also important to define the role of government support and to allow the government to close the time and cost gaps, especially in terms of basic research as well as for those technologies at the early stages of development that require huge amounts of upfront investments and financial risks that the private sector is not able to support.

Low-carbon technologies and the innovation chain

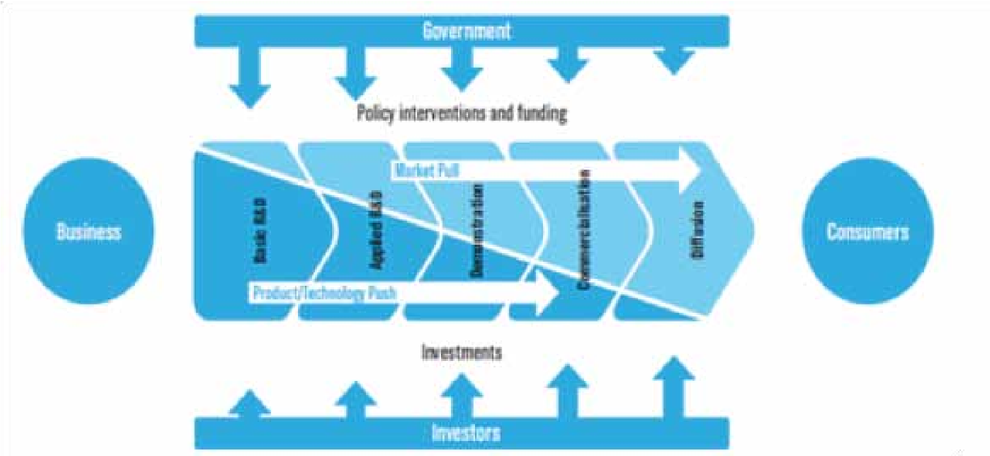
There is no one technology that will be the silver bullet for reducing CO_2 emissions and for achieving low carbon green growth. A combination of technological options will need to be introduced in various sectors. Not only should efforts be directed towards developing breakthrough technologies but also towards making incremental improvements to existing technologies, such as improving energy efficiency or undertaking innovations on application and use.

Many low-carbon technologies are in different stages of development within the innovation chain. Accordingly, the support that is required by the government will differ, depending on the stages and maturity of the respective technologies. Figure 1 depicts the five stages of the innovation chain: basic R&D, applied R&D, demonstration, commercialization and diffusion.

In the early stages of technological development, governments will have a bigger responsibility in terms of prioritizing, implementing policy measures and providing financial support for the technology options. In these early stages, government support is crucial, especially in filling the cost and time gaps, because the investment volume is huge and the returns are long term. For the private sector, the investment risks are too high at this stage. In the later stages of the innovation chain in which the technologies are more mature and close to commercialization, the private sector will have greater involvement. Government-funded R&D should also support or stimulate efforts by the private sector.

[2] "Valley of death" refers to the phase in the R&D chain in which technologies do not successfully reach the commercialization stage because they lacked support and investment (public funding, private investment or public-private partnerships) in the demonstration and deployment stages.

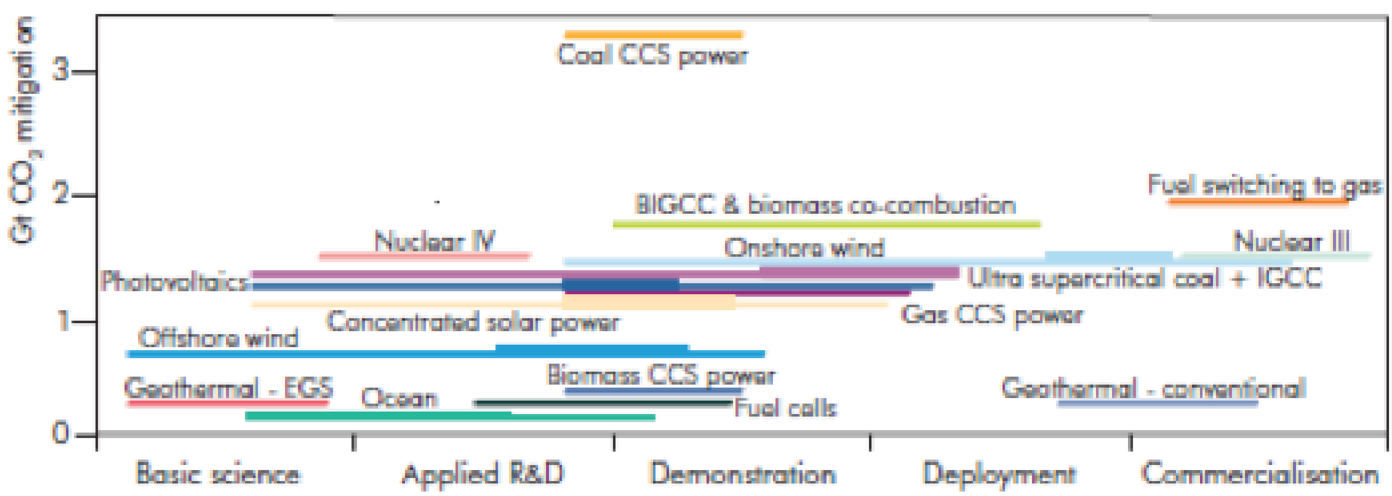
Figure 1: Innovation chain



Source: Shane Tomlinson, *Breaking the Deadlock: Technology for a Low Carbon Future* (London, the Office of Tony Blair and the Climate Group, 2009). Available from www.theclimategroup.org/_assets/files/Technology_for_a_low_carbon_future_full_report.pdf (accessed 28 July 2011).

Some of the biggest advances in low-carbon technologies have been in the area of renewable energy. Some that are near maturity are wind, solar PV and biofuels, which are in the technology demonstration and deployment phases. Figure 2 depicts the development stages of power-generating technologies along the innovation chain. To reach the deployment and commercialization stages requires market pull. Some of the emerging technologies that require the technology push under government-driven policy interventions and financing include carbon capture and storage (CCS), smart grids and hydrogen fuel cells. In addition to government support during the technology push phase, further assistance will be required in the commercialization and diffusion stages. Some technologies, however, may never reach the commercialization phase due to lack of support and investment (public funding and private investment) in the demonstration and deployment stages (valley of death).

Figure 2: Near-term development priorities for power-generating technologies



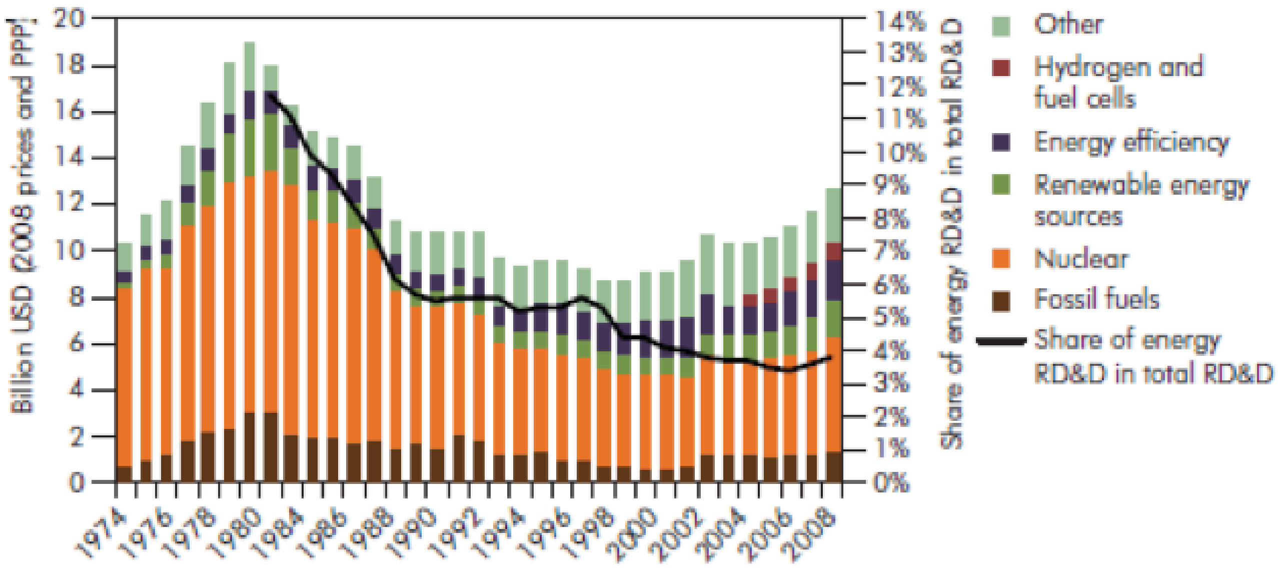
Notes: 1) Near-term indicates the next 10 to 15 years; 2) CO2 emission mitigation as laid out in the International Energy Agency's BLUE Map scenario relative to the baseline scenario
Source: International Energy Agency, *Energy Technology Perspective 2008* (Paris, 2008). Available from www.iea.org/w/bookshop/add.aspx?id=330 (accessed 15 February 2012).

The trends in public energy-related R&D

Governments have to take the upper hand in expediting public R&D through policies and financing schemes for accelerating low-carbon technological innovation. Funding towards public R&D has been allocated to a variety of parties, including public research institutes, laboratories and universities. Many of the breakthrough technologies, such as the Apollo space and nuclear energy programmes, have been government driven, particularly in the United States. Europe, Republic of Korea, Japan and more recently China have also concentrated efforts on public R&D for developing technologies for specific objectives.

There has been a decline in public energy-related R&D budgets in the 1990s (US$19 billion in 1980 to US$8 billion in 1997) in the International Energy Agency member countries in response to the difficulties of the nuclear industries and the decline of oil prices from 1985 to 2002.[3] However, since 1998, there is an evident upward trend in government expenditures on energy research, development and demonstration; in 2008, expenditure was around US$12 billion.[4] The share of energy research, development and demonstration in total RD&D, which had been declining in IEA member countries, appears to be on the rise again since 2006.[5]

Figure 3: Government RD&D expenditure in IEA member countries, 1974–2008



Note: PPP = purchasing power parity.

Source: International Energy Agency, *Energy Technology Perspective 2010* (Paris, 2010). Available from www.iea.org/Textbase/nppdf/free/2010/etp2010_part2.pdf (accessed 15 February 2012).

Figure 4 depicts that the share of government R&D devoted to improving environmental challenges is also low compared to total government budget for R&D. This indicates there is still a large need for governments to strengthen and invest in R&D efforts to address the environmental challenges that have the potential to hamper economic growth.[6]

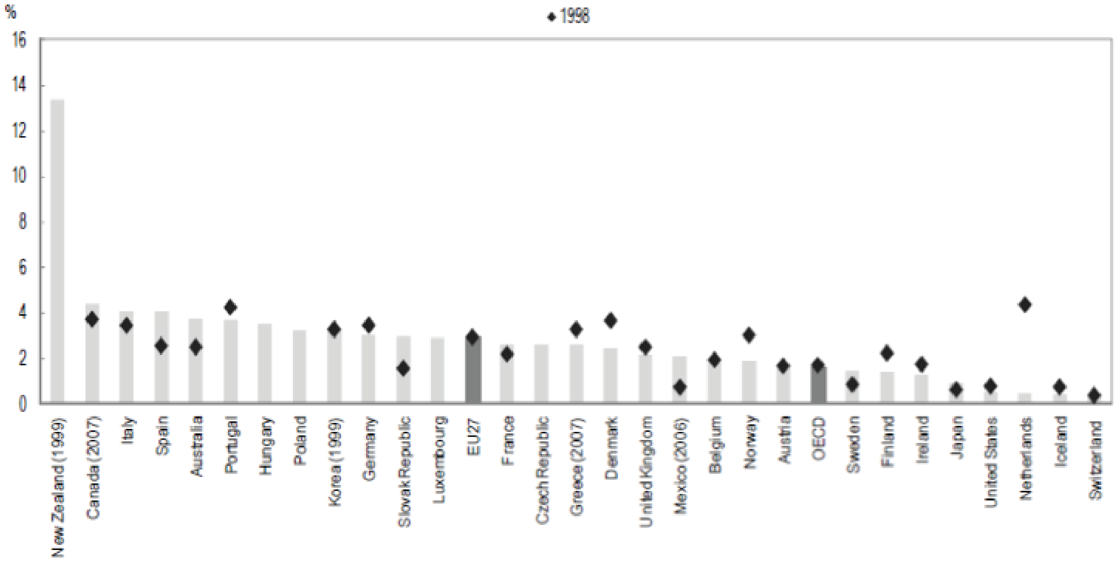
[3] International Energy Agency, *Energy Technology Perspective 2010* (Paris, 2010). Available from www.iea.org/Textbase/nppdf/free/2010/etp2010_part2.pdf (accessed 15 February 2012).

[4] ibid.

[5] ibid.

[6] Organization for Economic Co-operation and Development, *Green Growth Studies: Fostering Innovation for Green Growth* (Paris, 2011). Available from www.oecd-ilibrary.org/science-and-technology/fostering-innovation-for-green-growth_9789264119925-en (accessed 15 February 2012).

Figure 4: Government budget devoted to control and care for the environment, 1998–2008



Source: Organization for Economic Co-operation and Development, *Green Growth Studies: Fostering Innovation for Green Growth* (Paris, 2011). Available from www.oecd-ilibrary.org/science-and-technology/fostering-innovation-for-green-growth_9789264119925-en (accessed 15 February 2012).

In recent years, developing countries have also been active in spurring their own energy-related technology innovations – thus going against conventional thinking that technology is developed elsewhere and merely transferred to developing countries.[7] For example, according to the United Nations Department of Economic and Social Affairs, the combined energy R&D budget of Brazil, China, India, Mexico, Russian Federation and South Africa was about US$19 billion (in PPP terms), which was higher than the total public energy R&D budget of all of the IEA countries (estimated at US$12.7 billion in PPP terms) (table 1).

Table 1: Public and private spending on energy-related RD&D in selected emerging economies and the United States, 2004–2008a

Millions of 2008 US$ at PPP	**Fossil (including CCS)**	**Nuclear (including fusion)**	**Electricity, transmission, distribution and storage**	**Renewable energy sources**	**Energy efficiency**	**Energy technologies (unspecified)**	**Total**
China	7 044	19	--	--	161	5 885	**14 772**
Brazil	1 246	8[b]	122[b]	46[b]	46[b]	196	**1 664**
Russian Federation	430	--	22[b]	14[b]	25[b]	553	**1 045**
India	800	965[b]	35[b]	57[b]	--	--	**1 857**
Mexico	140	32[b]	79[b]	--	263[c]	19[c]	**534**
South Africa	164	164	26[c]	7[c]	--	9[b]	**370**
Subtotal	**9 624**	**>1 187**	**>285**	**>124**	**>497**	**>6 662**	**>18 580**
United States	1 821	804	319[b]	699[b]	525[b]	2510	**6 678**

a: Most recent year available.
b: Government only.
c: Private sector only.
Source: United Nations Department of Economic and Social Affairs, *World Economic and Social Survey 2011: The Great Green Technological Transformation* (New York, 2011). Available from www.un.org/en/development/desa/policy/wess/wess_current/2011wess.pdf (accessed 19 March 2012).

[7] United Nations Department of Economic and Social Affairs, *World Economic and Social Survey 2011: The Great Green Technological Transformation* (New York, 2011). Available from www.un.org/en/development/desa/policy/wess/wess_current/2011wess.pdf (accessed 19 March 2012).

Strengths of promoting R&D and technological innovation

- **Addresses environmental challenges.** Technological innovation of low-carbon technologies, including breakthrough technologies, can provide cost-effective solutions for addressing environmental challenges. At the same time, it can also address development goals and improve the quality of life by improving access to energy and safe drinking water, including for the rural poor.
- **Drives economic growth.** New technologies can lead to the creation of new business and investment opportunities and generate employment opportunities. With the increasing resource constraints and volatile fossil fuel prices impacting energy security issues, it is assumed that there will be higher demand for low-carbon technologies, products and services.
- **Strengthens national technology and innovation capacities.** Governments need to establish and strengthen the national innovation and science and technology base, including the institutionalization of national innovation systems and the human resource base. In the long term, this can lead to better capabilities to undertake innovations beyond technology transfer and adoption. Strengthening the innovation systems also means strengthening school curricula, especially in the areas of math and science, as well as setting up university courses that boost the knowledge base and the skills that are necessary to establish a capable workforce.
- **Strengthens indigenous innovation capacity for developing technologies applicable to the local context.** Technology transfer may strengthen the general technological absorption and application capacity, which can induce the expansion of the indigenous innovation capacity required to meet local conditions and needs.

Box 1: Grameen Shakti and promoting innovation at the local level

The Grameen Shakti, a subsidiary organization of the Grameen Bank, installed over 100,000 solar home systems under a programme of the Infrastructure Development Company Limited (a financial institution set up by the Government of Bangladesh), financed by the World Bank. Initially, all components of the solar home system were imported. Today, most of the components of the system are produced domestically. As a result of conducting their own indigenous research and development, Grameen Shakti has been successful in domestically producing 70 per cent of the compartments, excluding only the solar panels and batteries.[8] This has helped to save costs and to produce innovative technologies based on local needs, thus creating new business opportunities.[9] In addition, the deep-cycle batteries are now produced domestically by Rahimafrooz Renewable Energy Ltd (formerly Rahimafooz Batteries).[10] Recently, Rahimafrooz set up a solar panel assembly plant in Bangladesh with technical support from a company overseas.[11] The solar photovoltaic panels and tube lights are still imported.

Challenges for promoting R&D and technological innovation

- **Absence of national frameworks that promote R&D and technological innovation.** Without a national innovation or industrial strategy, there are no clear short- to long-term policy and price signals for raising the demand for green technology and motivating investors to make the necessary investment decisions.

[8] Dipal Chandra Barua, "Grameen Shakti (energy): Innovative use of micro-credit, market & social forces, government policy to bringing green energy & business opportunities to the rural areas in Bangladesh". PowerPoint presentation at the ESCAP Third Green Growth Policy Dialogue: The Greening of Business and the Environment as a Business Opportunity, Bangkok, 5-7 June 2007. Available from www.greengrowth.org/download/green-business-pub/The_Policy_Dialogue/Programme/Day1/Topic3/Mr_Dipal_Chandra_Barua.pdf (accessed 25 July 2011).

[9] United Nations Department of Economic and Social Affairs, *World Economic and Social Survey 2011: The Great Green Technological Transformation* (New York, 2011). Available from www.un.org/en/development/desa/policy/wess/wess_current/2011wess.pdf (accessed 19 March 2012).

[10] ibid.

[11] Sohel Parvez, "Rahimafrooz to Set Up Solar Panel Assembling Plant", *The Daily Star*, June 24, 2009. Available from www.thedailystar.net/newDesign/news-details.php?nid=93896 (accessed 2 March 2012).

- **Lack of demand for low-carbon technologies due to market failures.** Market failures that do not incorporate the environmental externalities will not provide the necessary incentives for private sector and consumers to shift their preference towards developing, adopting and purchasing green technology, products and services.
- **Lack of finance directed towards funding national R&D efforts.** R&D efforts for low-carbon technologies require huge investments and the current levels of public financing are not sufficient, even in industrialized countries. According to the International Energy Agency, there is a shortfall of about US$40–$90 billion in public sector low-carbon energy technology spending (currently, it is about US$10 billion) to achieve the goal of 50 per cent CO_2 emissions reduction by 2050.[12]
- **Lack of innovation capacity.** Developing countries lack the human resources and public institutional capacity to undertake R&D for low-carbon technologies. This is also the case for private companies, including small and medium-sized companies.
- **Regulatory barriers for enabling technological transfer to developing countries.** Developing countries may lack appropriate trade and investment policies, intellectual property rights and enforcement measures.

Implementing strategies

Set national goals: Governments need to set national innovation and science and technology targets and goals in national economic and development plans or in low-carbon development plans, which can be further elaborated in specific national energy strategies, climate change strategies, national environment strategies, national science, technology, innovation and R&D strategies, national educational strategies or technology roadmaps. The key is consistency among the various plans and strategies. There must also be consistency among the various sector policy frameworks.

Construct long-, medium- and short-term innovation policies within a national development framework: Governments can take a number of approaches to strengthen the R&D phase that is targeted towards the development of low-carbon technology development through clear and consistent strategies and policy direction. The role of the public-private sector partnerships can also be incorporated into these policy frameworks. The national policy must attempt to minimize uncertainty so that the private sector can complement or prepare to take part in certain stages of the innovation chain, for instance in the later stages of the innovation chain. Such efforts of the government and private sector may lead to creating new growth engines that can generate business opportunities and employment.

Develop an investment plan: Governments need to develop an investment plan and roadmaps with clearly defined outputs to accompany the national policy frameworks. In particular, specifications have to be given for the public financial support that will be extended by the government for specific interventions and actions along the innovation chain. R&D strategies and innovation programmes should also be designed with consideration of how to coordinate and complement the efforts and investments of the private sector.

Select strategic and core technologies and provide concentrated government support: Some countries may choose to identify and concentrate on a technological priority area for creating future niche and competitive markets. Although there are different views on such policy approaches, many countries have taken this track as part of their industrial and technological strategies, such as the Republic of Korea, China and Japan. These policies have allowed technological advancements that have led to the strengthening of their national competitiveness.

Some analysts believe that "picking winners" may distort the market. Thus a broad array of technologies, to the greatest extent possible, can be selected for support as part of achieving national goals. For some developing countries, experiences from East Asia may not be relevant at this time of their development stage. In such cases, countries can concentrate on how to adopt and improve existing technologies and develop the pathways for

[12] Organization for Economic Co-operation and Development, *Green Growth Studies: Fostering Innovation for Green Growth* (Paris, 2011). Available from www.oecd-ilibrary.org/science-and-technology/fostering-innovation-for-green-growth_9789264119925-en (accessed 15 February 2012).

deployment and commercialization, which in the future may eventually reduce costs in renewable energy, energy efficiency and associated infrastructure, based on the country context and demands.

National frameworks for R&D and technology innovation in the Asia-Pacific region

In China, the R&D and innovation goals and targets have been incorporated into the National Plan for Economic and Social Development and more detailed and long-term goals have been woven into China's medium- and long-term science and technology plans (box 3). In the Republic of Korea, the Five-Year Green Growth Plan provides R&D policy direction and goals. More focused policies and investment plans were included in the Republic of Korea's Green Technology R&D Plan (box 4).

Box 2: China's R&D strategies within its national policy frameworks

In China, the Twelfth Five-Year Plan (2011–2015) set short-term targets as part of its innovation policies, which included R&D expenditure to account for 2.2 per cent of GDP and for the research pace to hit a level of 3.3 patents per 10,000 inhabitants by 2015.[13] Along with these targets, there are policies to support, strengthen and promote seven strategic and emerging industries: i) energy saving and environmental protection, ii) next-generation information technology, iii) biotechnology, iv) high-end manufacturing, v) new energy, vi) new materials and vii) clean energy vehicles.

Such innovation strategies coupled with industrial policies and investments constitute the basis for developing a new growth engine by developing and deploying green technologies as well as greening the existing industries, all of which will help China transition towards a low-carbon economy.[14]

The Chinese Science and Technology National Plan released in 2006 (15-year plan) provides medium-term policy direction on the quality and quantity of China's R&D and innovation efforts up to 2020. This plan reflects the Chinese Government's determination to become an innovative nation by 2020 and a world leader in the science and technology field by 2050. The plan specifies four targets: i) invest 2.5 per cent of GDP in R&D, ii) reduce China's dependence on foreign technologies to 30 per cent, iii) increase the contribution of technology to economic growth to 60 per cent and iv) rank in the world's top-five countries in patents granted and citations used in international science papers. The plan also enumerates five strategic focuses that include develop technology in energy, water resources and environmental protection and strengthen R&D in basic science and in cutting-edge technology.[15]

Polices to stimulate private sector R&D and investment from the Chinese medium- to long-term science and technology plan (2006)[16]

Preferential tax treatment

- Accelerate implementation of consumption VAT to allow for capital expenditure deduction
- Accelerate depreciation of R&D apparatus and facilities
- Increase deduction of R&D expenses from taxable income
- Offer favourable tax policies, including favourable taxation terms for venture capital to promote the development of new products, technologies and high-tech enterprises
- Offer preferential tax policies for R&D-focused small and medium-sized enterprises
- Support the establishment of overseas R&D centres.

[13] The number of invention patents per 10,000 inhabitants here refers to the granted domestic patents, not the total. It indicates the patent values and nation's market controlling capacity. State Intellectual Property Office of China, "*What is the meaning of '3.3'?*", May 13, 2011 [in Chinese]. Available from www.sipo.gov.cn/mtjj/2011/201105/t20110513_604228.html (accessed 1 March 2012).

[14] Deborah Seligsohn and Angel Hsu, "How Does China's 12 Year Five-Year Plan Address Energy and the Environment?", *Climate, Energy & Transport News of World Resource Institute*, March 7, 2011. Available from www.wri.org/stories/2011/03/how-does-chinas-twelfth-five-year-plan-address-energy-and-environment (accessed 1 September 2011).

[15] Xiamei Tan and Zhao Gang, "An Emerging Revolution: Clean Technology Research, Development and Innovation in China", WRI Working Paper, p.6 (Washington D.C., 2009). Available from pdf.wri.org/working_papers/an_emerging_revolution.pdf (accessed 19 July 2011).

[16] ibid., p.6.

Favourable financing polices

- Provide loans to R&D-focused enterprises, and finance their import and exports
- Encourage commercial banks to provide loans based on government guarantees and discounted interest rates
- Encourage venture capital investment with government funding and commercial loans
- Create favourable environment for R&D enterprises to go public in overseas stock exchanges
- Establish technology-oriented financing platforms
- Provide special funding for the absorption, digestion and re-innovation of imported technologies.

Government procurement policies

- Require local governments to purchase domestically innovated products and technologies
- Extend financial support to enterprises that purchase domestically innovated products and technologies
- Establish technical standards through government purchases of domestically innovated products and technologies.

Source: Xiamei Tan and Zhao Gang, "An Emerging Revolution: Clean Technology Research, Development and Innovation in China", World Resources Institute Working Paper (Washington, D.C., 2009). Available from pdf.wri.org/working_papers/an_emerging_revolution.pdf (accessed 19 July 2011).

Box 3: Republic of Korea's R&D strategies within its national policy frameworks

One of the three major policy objectives in the Republic of Korea's Five-Year Green Growth Plan[17] is "creating new engines for economic growth", which is accompanied by four policy directions: i) develop green technologies, ii) green existing industries and promote green industries, iii) advance the industrial structure and iv) engineer a structural basis for the green economy.

Specific policies on R&D have been incorporated for the development of green technologies, which entail such goals as expanding green R&D investment, establishing an effective green R&D system, boosting green technology transfer and commercialization, expanding green R&D infrastructure, vitalizing international cooperation for green R&D and promoting green technology industries as new growth engines. In line with the Five-Year Green Growth Plan, a Green Technology R&D Plan[18] was developed in 2009 to assess government-driven R&D and develop investment plans for relevant ministries that include the Ministry of Knowledge and Economy, Ministry of Land, Transport and Maritime Affairs, the Ministry of Food, Agriculture, Forestry and Fisheries and the Ministry of Health and Welfare. The funds allocated for green technology R&D have been growing over the past few years, with more than 70 per cent now allotted to 27 core technologies.

Table 2: Republic of Korea's Investment plan for green technology R&D (unit: trillion won)

Year	2008	2009	2010	2011	2012
Green technology R&D	1.4	1.9	2.2	2.5	2.8
27 core technology R&D (portion in overall green technology, %)	1.0 (71.7)	1.4 (72)	1.7 (77.3)	2.0 (80)	2.3 (82)

Source: Republic of Korea, *National Green Technology R&D Plan* (Seoul, National Science & Technology Commission, 2009).

[17] Republic of Korea, *National Strategy for Green Growth and Five-Year Plan* (Seoul, Presidential Committee on Green Growth, 2009). Available from www.greengrowth.go.kr/?page_id=2450 (accessed 10 August 2011).

[18] Republic of Korea, *National Green Technology R & D Plan* (Seoul, National Science & Technology Commission, 2009).

Investment plans and financing policies to support the innovation chain

National policy must be supported by sufficient public funds to achieve national innovation goals. Public funds will need to be allocated for R&D as well as for implementing a mix of incentives and regulatory policies that will boost the innovation, deployment and commercialization stages of the innovation chain. Many governments put together an investment plan to budget and map out how government funds will be allocated and dispersed to support specific policy goals and measures.

Specific government intervention and support along the innovation chain will be needed early on for funding R&D programmes, demonstration projects and then scaling up what works best. During the later stages of the innovation chain, such as in the technological diffusion and deployment phases, the private sector may require support to minimize its risks and to stimulate private sector investment.

Box 4: Selected economic and financing policies to stimulate innovation

On the supply push side:
- Direct R&D funding for various organizations and institutions specializing in research, such as public research organizations, universities and the private sector
- Tax incentives and subsidies to promote R&D in the private sector
- Financing arrangements, such as preferential or concessional loans and guarantees.

On the market pull side to influence consumers and purchasing decisions:
- Government procurement to create or support a market for specific technologies
- Regulations and standards
- Tax incentives and subsidies.

Countries such as China, as previously pointed out, have developed a medium- to long-term science and technology plan outlining the specific policy measures and programmes to achieve its targets as well as in the five-year plans for economic and social development. The plan also indicates the specific incentives and financial and procurement measures to support private sector innovation efforts and domestically innovated products.

There are several bilateral and multilateral financing funds targeted towards technology transfers that developing countries can access, such as the Special Climate Change Fund and the Clean Development Mechanism under the UNFCCC and the Climate Investment Fund under the World Bank (box 6).

Box 5: Multilateral financing mechanisms

For developing countries, financial support can be accessed through multilateral and bilateral funds intended for the demonstration, deployment and transfer of low-carbon technologies. There is, for example, the Special Climate Change Fund under the UNFCCC, which is operated by the Global Environment Facility and was established in 2001 to support, including, adaptation and technology transfer projects and programmes. The technology transfer programme focuses on "the transfer of environmentally sustainable technologies, concentrating on, but not limited to, technologies to reduce emissions or atmospheric concentrations of greenhouse gases, in line with the recommendations from the national communications, technology assessments (TNAs) and other relevant information".[19] Activities such as implementing the results of technology needs assessments, dissemination of technology information, capacity building for technology transfer and facilitating enabling environments can be supported through the fund.

[19] The Global Environment Facility, *Accessing Resources Under the Special Climate Change Fund* (Washington, D.C., 2011). Available from www.thegef.org/gef/sites/thegef.org/files/publication/23470_SCCF.pdf (accessed 12 March 2012).

The other funding mechanisms are the Clean Technology Fund (CTF)[20] and the Strategic Climate Fund under the World Bank's Climate Investment Fund. The CTF promotes scaled-up financing for demonstration, deployment and transfer of low-carbon technologies with significant potential for long-term greenhouse gas emissions savings. The CTF finances programmes in 12 countries and one region. The focal areas of work are the power sector, transport sector and energy efficiency. The Strategic Climate Fund is an overarching framework to support three targeted programmes: the Forest Investment Programme, the Pilot Programme for Climate Resilience and the Programme for Scaling-up Renewable Energy in Low-Income Countries, with dedicated funding to pilot new approaches that have the potential for scaling up transformational action aimed at a specific climate change challenge or sector-based responses.

Institutional mechanisms

Many countries have established a dedicated agency or ministry that is responsible for overseeing the development of policies. Such a body ensures that there is policy coherence among the various sector-based policies, ministries and agencies, such as the ministry or agency of science and technology and the ministries for industry, education and finance. R&D programmes require inter-ministerial and cross-sector coordination and collaboration across ministries and research institutes, and thus a funding agency is an effective way to ensure consistency.

An inter-ministerial mechanism can affect how well policies are developed, implemented and monitored. They must be entrusted with a certain degree of authority and responsibility. Cross-ministerial coordination may encounter challenges. Depending on the economic and political circumstances, policy directions need to be reviewed and adjusted accordingly. The institutional arrangements will determine how public funds are secured and allocated throughout the innovation chain. The capacity of inter-ministerial mechanisms to resolve these challenging tasks will be crucial for a successful implementation of programmes that will lead to the achievement of national goals and targets.

In terms of publicly funded innovation programmes at the national level, a national innovation system or centre can prove to be a powerful institution, building the foundation and knowledge base for R&D and innovations as well as promoting the deployment and commercialization of low-carbon technologies.

Box 6: The National Innovation Agency of Thailand

Thailand's National Innovation Agency (NIA) was established by the Ministry of Science and Technology in 2003 by combining two funds, the Innovation Development Fund and the Revolving Fund of Research and Technology Development. It is an independent organization under the supervision of the National Innovation Board.

The NIA works to accelerate national innovation capacity, promote an innovation culture, create awareness of innovation at all levels (in industry, organizations and the public sector) and develop the National Innovation Ecosystem. The NIA is a central unit that coordinates networking of different organizations from a variety of fields. It mainly focuses on using knowledge management to achieve innovation, which can be a driving force towards improving the quality of life and the national competitiveness.

Over the past few years, the NIA has tried to build a system that can promote national innovation systems by providing both technical and financial support. From 2006 to 2010, the NIA invested in a total of 520 innovation projects.[21] It has established two development programmes, a strategic innovation programme focusing on bioplastics and the organic agriculture industry and the sector-industry innovation programme focusing on bio-business, eco-industry and design and solutions.

Sources: Thailand, National Innovation Agency website "About NIA" (2010). Available from www.nia.or.th/en/index.php?page=aboutus_background (accessed 12 February 2012); and Thailand, National Innovation Agency website "NIA Perspective" (2010). Available from www.nia.or.th/2009/publicmedia/downloads/NIA_Per_10.pdf (accessed 12 February 2012).

[20] The Climate Investment Funds website *"Clean Technology Fund"*. Available from www.climateinvestmentfunds.org/cif/node/2 (accessed 12 March 2011).

[21] Thailand, National Innovation Agency website "NIA Perspective" (2010). Available from www.nia.or.th/2009/publicmedia/downloads/NIA_Per_10.pdf (accessed 9 February 2012).

Public-private partnerships

Partnership building with the private sector will be integral to the technological development and commercialization stages, especially in creating new markets and ensuring an enabling business environment for technology deployment.

Some R&D programmes are products of partnerships among the public and private sectors. Governments need to take up projects that are high risk and require large investment over the long term, which may be difficult for the private sector to embrace alone. Public-private partnerships can reduce the risks and make the hurdles seem feasible.

Partnerships with the private sector can include:

- Collaborative research, joint conferences and seminars and policies that encourage the mobility of researchers between the public and private sectors.[22]
- Cooperative R&D agreements that allow government entities to work with the private sector, academia and other organizations.
- Industry consortia, in which businesses work together with funding and support provided by the government, which may reduce R&D costs and increase R&D efficiency.[23]

Box 7: Shanghai International Business Incubator

With approval of China's Ministry of Science and Technology, the Shanghai International Business Incubator (SHIBI) was established in 1997. Following the organization model of One Incubator, Several Bases, the SHIBI built six incubation bases (research centres), including a headquarters in the Shanghai Technology Innovation Center.

The SHIBI provides an innovative environment and services for domestic and overseas small and medium-sized businesses and functions as a unit that coordinates national and international organizations. To promote international exchange and cooperation, it organizes training programmes and information exchange sessions and works closely with many organizations within and outside of China, including in France, Japan, Republic of Korea, Russian Federation and the United Kingdom. It has helped Chinese students to establish their own technology business by sharing information and experiences with international enterprises, institutions, R&D centres and companies. It plans to continue offering workshops and seminars for information consultation, matching of partners, market reviews and new technological product distribution and thus stokes technological cooperation between China, other Asian countries and the rest of the world.

Sources: Wang Rong, *Shanghai Hi-tech Business Incubator Network: Networking, Internalization and Professionalization* (Shanghai, Shanghai Technology Innovation Center, undated). Available from www.aspa.or.kr/files/webzinevol.10_050907/050907_ASPA%20paper15_eg.htm (accessed 12 February 2012); and Shanghai Technology Innovation Center website "About SHIB" (2005). Available from www.incubator.sh.cn/en/aboutshibi.asp (accessed 12 February 2012).

Box 8: The Innovation Centre for Micro, Small and Medium Enterprises, Indonesia

Although micro, small and medium-sized enterprises (MSME) in Indonesia have made a significant contribution to the country's economic development, they lack modernized technology, facilities and management skills. To address these issues and propose solutions for a better future, the MSME Innovation Center was established in 2008 by decrees from the president and the coordinator minister for economics; it is an initiative with the Agency for Assessment and Application of Technology.

[22] United Nations Department of Economic and Social Affairs, *World Economic and Social Survey 2011: The Great Green Technological Transformation* (New York, United Nations, 2011). Available from www.un.org/en/development/desa/policy/wess/wess_current/2011wess.pdf (accessed 19 March 2012).

[23] United Nations Department of Economic and Social Affairs, *Climate Change: Technology Development and Technology Transfer.* Background paper prepared for the Beijing High-level Conference on Climate Change: Technology Development and Technology Transfer, Beijing, 7 - 8 November 2008. Available from www.un.org/esa/sustdev/sdissues/energy/op/beijing_hlccc_nov08/back_paper.pdf (accessed 2 March 2012).

The MSME Innovation Centre was set up to strengthen existing enterprises and generate new enterprises that are more competitive in process, products and services.

The MSME Innovation Centre functions as a platform for coordinating and creating synergies among the three components of innovation: research institutes, industry and government (including organizations). The Innovation Centre works with all major research, developmental and educational institutions that provide assistance in the areas of technology, capacity development, business network development and access to finance or markets. The centre facilitates the sharing of information among research institutions, industry and policymakers.

Sources: Utama H. Padmadinata, "The Importance of SME Innovation Center in Indonesia SME Condition in Indonesia", *APEC SME Briefing*, December 21, 2007. Available from www.apec-smeic.org/newsletter/newsletter_read.jsp?SEQ=387 (accessed 12 February 2012); and Organisation for Economic Co-operation and Development, *SMEs, Entrepreneurship and Innovation*, OECD Studies on SMEs and Entrepreneurship Series (Paris, 2010). Available www.keepeek.com/Digital-Asset-Management/oecd/industry-and-services/smes-entrepreneurship-and-innovation_9789264080355-en (accessed 12 February 2012).

Complementary measures

Complementary measures can assist in securing public finances to stimulate green innovation, including R&D. Environmental taxes, carbon pricing and the phasing out of perverse subsidies can spur innovation efforts and create new markets, but it also enables governments to generate funds that can be redirected to support innovation efforts. Without the introduction of such policy measures, existing brown technologies and infrastructure will be locked in because it will be more costly to invest in and introduce green innovations. Such market mechanisms as cap-and-trade schemes not only encourage the private sector to invest in low-carbon innovation and infrastructure, but it generates capital for further innovation efforts.

For innovation to flourish, other complementary measures require investment in human resources development and strengthening academic institutions and their research efforts, which is the basic foundation for reinforcing the national capacity in terms of knowledge and technical skills. Without the availability of capable human resources, challenges will arise in managing and operating the green technologies – let alone carrying out innovative research.

Box 9: The new growth strategy and science and technology policies in Japan

In December 2009, the Basic Policies of the New Growth Strategy of Japan was approved by the cabinet. In June 2010, the cabinet then approved a more detailed document, the New Growth Strategy Blueprint for Revitalizing the Economy. It provides measures for pursuing a strong economy, fiscal budget and social welfare system, with a target of boosting growth of more than 2 per cent on average and reducing the unemployment rate to 3 per cent by 2020. To achieve these goals, the strategy identifies seven focus areas (green innovation, life innovation, Asian economy, tourism and regional development, science and technology and ICT, human resources and employment and financial sector) and proposes 21 projects. One of the seven focal areas is the "Strategy for becoming an environment and energy power through green innovation", which puts the innovation of green technologies at the heart of the country's growth strategy. Specific policies to back up the strategy include promoting renewable energy use, technological development and innovation, energy-saving and energy-efficiency products, low-carbon investments and green tax reform. The environment and energy priority areas alone are expected to create new environment-related markets worth more than 50 trillion yen and 1.4 new environment-related jobs by 2020 and reduce 1.3 billion tonnes of CO_2 equivalent by using Japanese private sector technology.

The science and technology focus area is considered as a "platform for supporting growth" to push Japan forward as a world leader in green innovations by 2020. Proposals include increasing the number of universities and research institutions, providing support to technological innovation, including R&D, to small- and medium-sized enterprises and increase public- and private-sector investment in R&D to more than 4 per cent of GDP.

Based on the New Growth Strategy and the Blueprint Strategy, the cabinet approved the Fourth Science and Technology Basic Plan in August 2011. One of its pillars aims to strengthen green innovation in order to "realize the world's most advanced low-carbon society by identifying trends in de-fossil fuel that many countries are developing competitively as a key to future growth. Such promotion is expected to facilitate further innovation of environmental/energy technologies, in which Japan has strengths, and promote the reform of social systems and institutions."[24]

The earthquake and tsunami disaster of March 2011 greatly impacted the Japanese economy, sending the country into further recession. The environmental disaster of the Fukushima nuclear plant forced the Government to review and revise its growth strategy as well as the national energy strategy. As a result, in December 2011 the cabinet approved the Basic Strategy for Rebirth of Japan, which is a roadmap to recovery from the aftermath of the earthquake to revitalize the economy towards economic growth in the short term. To create new industries and markets in response to a changing environment, the short-term high-priority projects include removing barriers to green growth and conducting joint R&D research through partnerships. A new medium- to long-term strategy on energy and the environment will also be developed as one of the central drivers for growth and will be based on the new science and technology frameworks and global warming countermeasures. Regarding international cooperation, Japan will encourage the dissemination of Japanese low-carbon technologies. In 2012, the Government will further develop the Strategy for Rebirth of Japan, providing medium- to long-term specifics.

Sources: Japan, *The New Growth Strategy* (Basic Policies) Toward a Radiant Japan (Tokyo, Ministry of Economy, Trade and Industry, 2009). Available from www.meti.go.jp/english/policy/economy/growth/report20091230.pdf (accessed 1 March 2012); Japan; *The New Growth Strategy Blueprint for Revitalizing Japan* (Tokyo, Ministry of Economy, Trade and Industry, 2010). Available from www.meti.go.jp/english/policy/economy/growth/report20091230.pdf (accessed 1 March 2012); Japan, *Japan's Science and Technology Basic Policy Report* (Tokyo, Council for Science and Technology Policy, 2010), p.6. Available from www8.cao.go.jp/cstp/english/basic/4th-BasicPolicy.pdf (accessed 1 March 2012); and Japan, Strategy for Rebirth of Japan, Cabinet decision, December 24, 2011. Available from www.npu.go.jp/policy/pdf/20120127/20120127_en1.pdf (accessed 13 February 2012).

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World Economic and Social Survey 2011: The Great Green Technological Transformation (New York, United Nations Department of Economic and Social Affairs, 2011). Available from www.un.org/en/development/desa/policy/wess/wess_current/2011wess.pdf

[24] Japan, *Japan's Science and Technology Basic Policy Report* (Tokyo, Council for Science and Technology Policy, 2010), p.6. Available from www8.cao.go.jp/cstp/english/basic/4th-BasicPolicy.pdf (accessed 1 March 2012).

FACT SHEET

Restricting licence plates

Key points

- ***Directly limiting the number of vehicles permitted can be one effective precautionary measure to discourage private vehicle use.***

- ***Developing countries in the region have a fast-closing window of opportunity to curb the demand for private car ownership, which is relatively low, but rapidly increasing.***

Restricting licence plates explained

Restricting licence plates limits the absolute number of vehicles to be sold and owned within a city and thus is one way to directly control city traffic.

How it works

Typically, a cap is placed on the number of vehicle licence plates that are issued within a time frame (such as one month), without which cars cannot be sold, owned and used legitimately. As in the case of Shanghai and Singapore, vehicle licence plates are auctioned on the market, often fetching very high prices that reflect their scarcity. Anyone wanting to own a car must purchase a licence plate from the market.

Steps for implementing

- Set a quota on the (increase in the) number of cars allowed in a specific period, such as one year.
- Put in place a mechanism to distribute the licence plates allowed under the quota (such as an auctioning system).
- Monitor the car ownership and revise the number of cars allowed.

Strengths in restricting licence plates

- By limiting the absolute number of cars, the strain of ever-increasing car ownership in the form of new road construction and parking space provision is reduced. Congestion, air pollution, noise and many other costs of private cars are also reduced from the business-as-usual level.
- People are encouraged to shift to non-motorized or public transport. Research has shown that a person owning a car is less likely to use public or non-motorized transport, all else being equal. Hence, managing car ownership is likely to favour public transport patronage and contribute to the development of transit-oriented city development. Public transport will benefit from reduced traffic in that it allows increased speed capacity.

Challenges to restricting licence plates

- Opposition by the motoring lobbyists, who face a reduction in the sale of new cars.
- Opposition by existing and future car owners.
- Motorists with banned plate numbers will drive around the restricted zones, which will increase the travel distance.

Implementing strategies

Address public opposition through better awareness and communication.

Improve the provisions for alternative transport such as non-motorized transport and public transport, which will encourage the modal shift.

Institute a robust enforcement system to address violations.

Implement in conjunction with other strategies to better mitigate congestion and pollution.[1]

Examples

Shanghai, China: Licence plates for cars registered within the city are auctioned. The average price for a licence plate in recent years has exceeded US$6,000. The revenues are used to support public transport, including the construction of subway lines and providing subsidies for buses and ferry services.

Singapore: The city-state long implemented a wide range of measures to discourage car ownership, including a vehicle quota that allows for a controlled rate of increase in the vehicle population (1.5 per cent in fiscal year 2009–2010).[2]

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[1] Cambridge Systematics, Inc., *Congestion Mitigation Commission Technical Analysis: License Plate Rationing Evaluation*, Technical memorandum prepared for New York City Department of Transportation (2007). Available from www.dot.ny.gov/programs/repository/Tech per cent20Memo per cent20on per cent20License per cent20Plate per cent20Rationing.pdf (accessed 9 December 2011).

[2] LTA website "Vehicle Quota System". Available from www.lta.gov.sg/corp_info/doc/COE_Quota_Allocation_RV.pdf (accessed 26 February 2012).

Reusing and recycling water

Key point

- ***Reusing water by matching the quantity and quality of water with intended purposes can reduce the withdrawal of freshwater and reduce wastewater.***

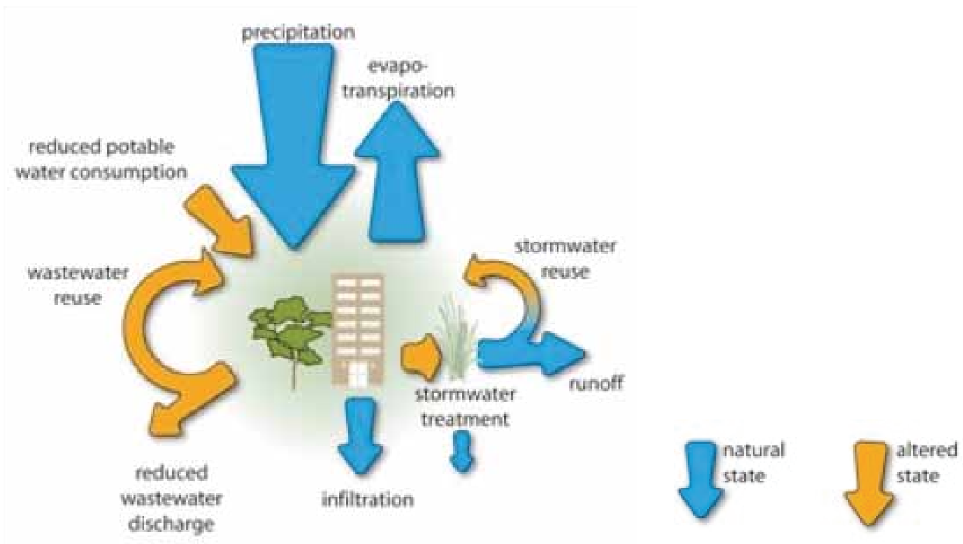
Reuse and recycling explained

The water cycle refers to the continuous movement of water on, above and below the Earth's surface.[1] The water cycle is a crucial function of the ecosystem; in the natural hydrological cycle, the Earth reclaims water over a long period of time. Promoting a water cycling system in an urban setting refers to harmonizing human activities with several processes of the natural water cycle, including efficient water reuse.

How it works

Water reuse can do two things: 1) minimize freshwater demand and 2) reduce wastewater treatment needs. As a result, water reuse minimizes new water extraction and wastewater effluent, thus enabling the continuous cycle of water in an urban setting. By minimizing new water inflow and wastewater effluent, water reuse makes the urban water cycle more compact and sustainable. Figure 1 shows how water reuse manipulates the directions of unfavourable water flows and creates a cycle of water in urban setting.

Figure 1: Sustainable urban water cycle through water reuse



Source: Healthy Waterways website,"What is water sensitive urban design?"(2011).Available from http://waterbydesign.com.au/whatiswsud/(accessed 2 February 2012).

The basic principle of water reuse is to reduce the inefficient mismatch between available water resources and the specific purposes of water use. Although freshwater sources are becoming scarce, it is also true that precious

[1] US Geological Survey website "Water Cycle" (27 December 2011). Available from http://ga.water.usgs.gov/edu/watercycle.html(accessed 2 February 2012).

freshwater is inefficiently used for non-potable purposes, such as irrigation. A 1958 UN Economic and Social Council resolution stated, "No higher quality of water, unless there is surplus of it, should be used for a purpose that can tolerate a lower grade."[2] To avoid the inefficient use of precious water sources, an eco-efficient water system allocates water types to appropriate purposes.

The sources and uses of reclaimed water are dependent on contexts. Thus treatment technologies need to be selected in relation to the sources and purposes of use. Examples of treatment technologies include membranes, wet lands, sand filters and waste-stabilizing ponds. The purposes of use also vary, depending on the quality of reclaimed water and local needs. While a potable use of reclaimed water is practised in some cities, non-potable uses, such as irrigation, toilet flushing and fire fighting, are more common. Context-specific matching of water sources, technologies and specific uses are critical elements of a water reuse policy.

Strengths in reusing and recycling water

- **Economic:** Developing new freshwater sources requires capture, conveyance and piping costs. Wastewater treatment and discharge are also an economic burden for public authorities. In particular, energy is a hidden cost in freshwater provision and wastewater treatment. Water reuse can cut this cost; household and community water reuse significantly reduces energy costs for water transmission.
- **Urban water cycle and ecosystem maintenance:** Water reuse reduces unnecessary new freshwater extraction and wastewater generation by correcting unfavourable water flows and promoting a sustainable cycle of water in an urban setting.
- **Environmental resilience:** A resilient water system helps communities cope with environmental shocks, such as water scarcity, floods and drought. Reclaimed water can be a dependable alternative source of water and improve water security in the face of climatic variability.

Challenges to reusing and recycling water

- **Public acceptance barriers regarding health issues:** The most critical hurdle for water reuse is fears and uncertainties about the health risks, which can severely affect public acceptance. This then impedes the implementing of policies. Unfavourable and uncoordinated regulatory framework can increase such fears and uncertainties.
- **Technical barriers:** Wastewater treatment for reuse requires such technologies as a membrane and a wetland. Insufficient technical capacity can hinder the installation and maintenance of the wastewater treatment systems. Although high-tech treatment generally produces high-quality reclaimed water, it is not easily a viable option in developing countries.
- **Financial barriers:** Initial costs to install wastewater treatment technologies can be expensive, thus making a reuse system unaffordable for households. The unfavourable pricing of freshwater can be a significant hurdle to promote water reuse. If freshwater pricing is too low, it does not drive people to reuse water.

Implementing strategies

Develop a favourable regulatory framework to overcome health risks and secure public acceptance: An extensive public awareness campaign will minimize the health risks of water reuse and make the practice socially acceptable. It requires cross-sector collaboration and harmony with agricultural and health policies. Raising public awareness and thus public comfort is the make-or-break necessity.

Match technologies with local contexts and purposes of water reuse: To determine the level of technology to use, the quality and quantity of wastewater needs to be balanced against the purposes for reusing. Building up capacities, from national government down to communities is necessary for installing and maintaining the treatment technologies.

[2] United Nations Economic and Social Commission for Asia and the Pacific, *Genetic Guideline to an Eco-efficient Approach to Water Infrastructure Development* (Bangkok. UNESCAP and KOICA, 2011).

Offer favourable financial support: To overcome financial constraints, cooperation with the private sector is necessary: financial support, such as subsidies, microfinance and leasing, supports the distributed application of water reuse systems. With initial installation costs relatively high, community ownership may be a viable option. Additionally, policymakers will need to set a price for freshwater and wastewater treatment at a level that promotes water reuse.

Maintain a good overview of the whole system: Because the basic principle of water reuse is to overcome an inefficient mismatch of water sources and uses, a careful balancing act is required to match available water sources with specific needs and with the appropriate quality and technology. Policymakers need to look at the whole water system. And they need to see that water reuse is critical to integrating and optimizing a water system; it affects both the inflow of freshwater and the wastewater effluent in the urban water cycle.

Examples

Greywater[3] reuse with planted filter (wetland), Kathmandu Valley, Nepal[4]: In the Kathmandu valley, household wastewater ran into and polluted the rivers due to the inadequate reach of the centralized wastewater treatment system. There was a significant deficit in water demand[5] due to the use of freshwater for non-potable purposes, such as irrigation, washing cars and flushing toilets. To overcome the problem, a wetland system (planted filter) was tested to prove the efficiency of greywater reuse (wastewater generated from such domestic activities as laundry, dishwashing and bathing). The project led to a savings of 500 litres of potable water a day per household and US$40 reduction in household expenditure for the year. Based on this calculation, the initial cost of the system could be paid back within ten years. The project proved that the system contributes to relieving water demand deficit, particularly in regions where urban space for planted filters was available and could cover the initial costs.

Turning used water into safe potable water, NEWater in Singapore[6]: Singapore has significantly depended on imported water from Malaysia for decades. But when one of its water treaties with Malaysia expired in 2011 and water demands were expected to rise to 400 million gallons a day by 2012 (from 300million in 2008), the Government began looking for other options. It latched onto recycling to build more resilient water security in an eco-efficient manner. NEWater is the brand name for reclaimed water produced by Singapore's Public Utilities Board. More specifically, it is treated wastewater (sewage) that has been purified using dual-membrane (via microfiltration and reverse osmosis) and ultraviolet technologies, in addition to conventional water treatment processes. The quality of NEWater consistently exceeds the requirements set by the US Environmental Protection Agency and the World Health Organization guidelines and is cleaner than the other sources of Singapore's water.[7] There are 5 NEWater plants in Singapore that now meet 30 per cent of Singapore’s total water demand. By 2060, NEWater is projected to provide half of Singapore’s water demand.[8]

Further reading

Urban Water CycleProcesses And Interactions: Technical Documents, IHP-VI Technical Document in Hydrology No. 78, by J. Marsalek and others (Paris, UNESCO, 2006). Available from www.infoandina.org/system/files/recursos/urban_water_cycle.pdf.

Genetic Guideline to an Eco-Efficient Approach to Water Infrastructure Development (UNESCAP and KOICA, 2011).

[3] Greywater is household wastewater from domestic activity, such as laundry, dishwashing and bathing.

[4] A. Morel and *S. Diener Greywater Management In Low And Middle-Income Countries, Review of Different Treatment Systems for Households or Neighbourhoods*, Sandec Report No. 14/06 (Dubendorf, Switzerland, Swiss Federal Institute of Aquatic Science and Technology, 2006). Available from www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=947 (accessed 22 February 2012).

[5] According to A. Morel and S. Diener, the water demand in Kathmandu is about 150 million litres per day, with 90 million litres available.

[6] Cezar Tigno, *Country Water Action: Singapore NEWater: From Sewage to Safe* (Manila, Asian Development Bank, 2008). Available from www.adb.org/Water/Actions/sin/NEWater-Sewage-Safe.asp (accessed 2 February 2012).

[7] Singapore, Public Utilities Board website “Membrane Technology” (28 December 2011). Available from www.pub.gov.sg/research/Key_Projects/Pages/MembraneTechnology.aspx (accessed 2 February 2012).

[8] Singapore, Public Utilities Board website “NEWater”(28 December 2011). Available from www.pub.gov.sg/about/historyfuture/Pages/NEWater.aspx (accessed 2 February 2012).

Low Carbon Green Growth Roadmap for Asia and the Pacific

FACT SHEET

Smart grid

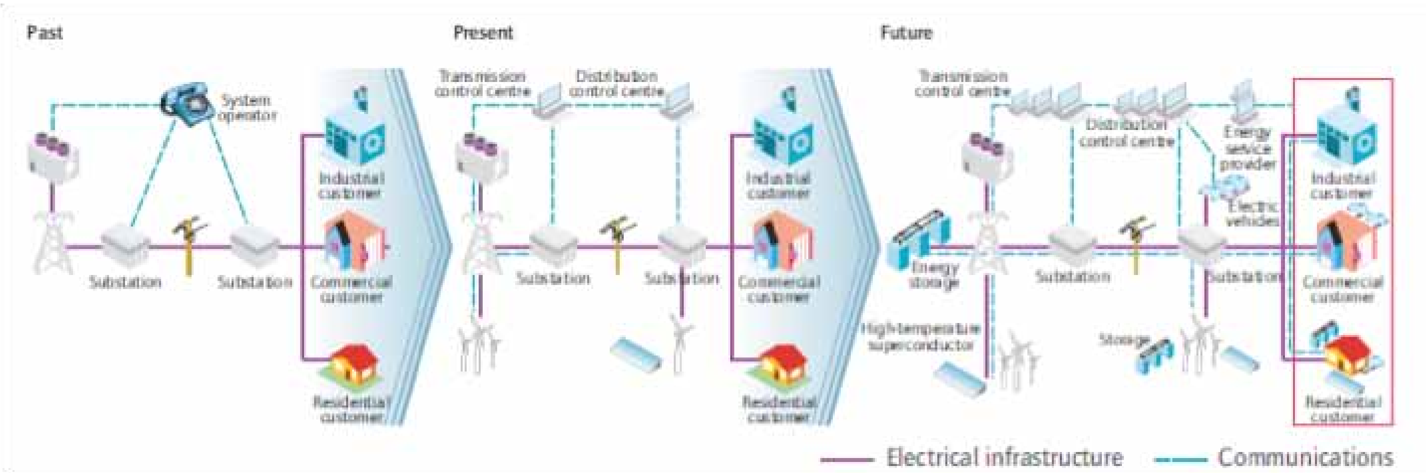
Key point

- ***The smart grid allows small- and medium-scale suppliers and individuals to generate and distribute power in addition to the conventional utility companies.***

Smart grid explained

The smart grid, according to *Technology Roadmap: Smart Grids*, is "an electricity network that uses digital and other advanced technologies to monitor and manage the transport of electricity from all generation sources to meet the varying electricity demands of end-users."[1] The smart grid coordinates the needs and capabilities of all energy producers, grid operators, end users and electricity market providers to control all parts of the system as efficiently as possible, minimizing costs and environmental impacts while maximizing system reliability, resilience and stability.[2]

Figure 1: Smarter electricity system



Source: International Energy Agency, *Technology Roadmap: Smart Grids* (Paris, 2011). Available from www.iea.org/papers/2011/smartgrids_roadmap.pdf (accessed 3 October 2011).

The technologies associated with the smart grid serve to deliver power from producers to end users. Although many of the individual technologies are mature, further experience is required to integrate all the technologies into one comprehensive smart grid system through their application in a large-scale demonstration project. The individual technology areas that make up the smart grid's hardware, systems and software include wide-area monitoring and control, information and communication technology integration, renewable and distributed generation integration, transmission enhancement, distribution grid management, advance metering, energy storage systems, electric vehicle charging infrastructure and customer side systems. They are used to assist in managing electricity consumption at the industrial and commercial levels and include smart appliances, routers, in-home displays and energy management systems.[3]

[1] International Energy Agency, *Technology Roadmap: Smart Grids* (Paris, 2011). Available from www.iea.org/papers/2011/smartgrids_roadmap.pdf (accessed 3 October 2011).

[2] ibid.

[3] ibid.

Infrastructure has a long life span which can be more than 30 to 50 years. Once an infrastructure is developed, in general, it is locked in. Thus, the design and construction of new infrastructure should take into account the eco-efficient technological innovations, such as smart grid technology, and lifestyle changes that will take place over the next 30 to 50 years.

Strengths of the smart grid

- **Provides potential for large scale deployment and distribution of locally generated renewable energy:** Volatile fuel prices and growing demands for energy will make countries look for renewable energy sources. But existing conventional electricity infrastructure, as it is, will not be able to accommodate the deployment of new sources of energy. However, smart grid technologies can maximize the use of existing electricity infrastructure through improved monitoring and management systems, while more energy-efficient infrastructure is strategically deployed.[4]
- **Provides the opportunity for the wide-scale introduction of electric vehicles and plug-in hybrid electric vehicles:** Smart grids allow cars to be charged when demand is low or during certain times of the day when renewable energy production is high (for instance, solar energy production is high during the day time). Smart grids also enable electric vehicles to be charged at a residence or at a designated charging station.
- **Provides resilience to disturbances, attacks and natural disasters:** Not only can smart grids ensure the supply of a reliable, stable and better quality of energy, it can also be programmed to supply energy during emergency situations from its energy storage facilities.[5] The batteries of electric vehicles also store energy and feed energy back into the grid during times of emergencies, such as black outs and natural disasters.[6]
- **Encapsulates central and localized power distribution:** One of the primary benefits of the smart grid is the way it transforms the power supply and distribution system from a centralized one to a less centralized one, enabling small-scale suppliers and individuals, or "prosumers", to generate and distribute energy alongside conventional utility companies.
- **Lowers utility use and bills and enables informed participation by customers:** The real-time, two-way digital communication channels (supply and demand control) made possible through the smart meter and information and communication technology allow consumers to control and manage the way they use energy. This directly impacts the users' utility bills. For instance, the smart electrical appliances connected to the smart meter can be switched on and off according to the electricity demand at a certain time. This also allows consumers to choose the type of energy they want to use, such as solar, geothermal or wind energy. It additionally enables utility operators to manage the supply, such as during peak hours.
- **Promotes energy and operating efficiency:** There is tremendous capacity to reduce the energy losses experienced in the transmission and distribution system. Because the energy generation, distribution and consumption can be managed better through a smart grid, it improves energy efficiency.[7] It also helps countries save money that can be redirected, for instance, to social programmes, such as job creation, health care and education. For example, in the United States, the interruption of power and blackouts cost the nation US$150 billion annually.[8]
- **Creates new opportunities for technology development in electrical appliances, energy products and energy services:** According to the International Energy Agency, while technological advancement in smart grid technology is progressing, there are still many technologies that have not reached maturity. This includes electric vehicle charging infrastructure and renewable and distributed generation integration, which include battery storage technology.[9]

[4] ibid.

[5] ibid.

[6] ibid.

[7] According to the ESCAP *Guideline for Strengthening Energy Efficiency Planning and Management in Asia and the Pacific*, less than 5 per cent of the energy in fossil fuels is delivered as lighting service and 60 per cent of the energy in the fossil fuel is lost because the power plant is constrained by the second law of thermodynamics.

[8] United States of America, *The Smart Grid: An Introduction* (Washington, D.C., Department of Energy, 2008). Available from http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/DOE_SG_Book_Single_Pages%281%29.pdf (accessed 12 March 2012).

[9] International Energy Agency, *Technology Roadmap: Smart Grids* (Paris, 2011). Available from www.iea.org/papers/2011/smartgrids_roadmap.pdf (accessed 3 October 2011).

- **Improves the climate change mitigation potential:** The development of a smart grid can be a major driver for countries to achieve the global goal of 50 per cent CO_2 emission reduction by 2050. According to the International Energy Agency's, Energy Technology Perspective 2010 BLUE map scenario, smart grids have the potential to contribute directly and indirectly to reducing between 0.9 and 2.2 gigatonnes of CO_2 annually by 2050, compared with the baseline scenario.[10] This is because it will facilitate the introduction of renewable energy and increase energy efficiency leading to energy security and new opportunities for economic development.

Challenges to introducing the smart grid

- **Lack of policy and market uncertainty:** The various technologies and infrastructure comprising the smart grid system require different levels of investment according to the maturity of the individual technologies, and the application of these technologies in demonstration projects requires even greater levels of investment. Thus, investors need policy and market certainty to make long-term investment plans.
- **Regulation barriers:** The electricity sector, especially the transmission and distribution systems, is generally a monopoly.[11] However, smart grids enable a wide variety of parties, including individuals and small to medium-sized entities, to enter the market. These include entities for renewable energy production. Regulatory barriers need to be removed and incentives schemes need to be provided to facilitate these new entrants.
- **Lack of investment towards research, development and demonstration:** In addition to investment in R&D for smart technologies that are still in the developing stage, it is equally important to undertake large-scale demonstration projects of the smart grid to test the application of technologies, infrastructure and services as a total system. The International Energy Agency estimates that current public research, development and deployment spending on smart grids is US$539 million annually. However, according to the International Energy Agency's BLUE map scenario, investments need to reach US$5.6 billion to US$11.2 billion annually to halve CO_2 emissions by 2050 compared to 2007 levels.[12] Thus, governments will need to lead and provide sufficient public funds to support this research, development and deployment process. At the same time, governments need to form partnerships and also attract investments from the private sector.
- **Lack of human resources:** To prepare for the large-scale deployment of a smart grid, appropriate training to build the capacity in human resources will be required. Without an able workforce with the appropriate skills and knowledge, smart grids will not be deployed and operated effectively.

Implementing strategies

Integrate smart grid strategies into national policy frameworks: Smart grid development will require strong government commitment and national vision. Short-, medium- and long-term goals and targets need to be set and integrated into national sector policies for science and technology, ICT, infrastructure, energy, innovation, finance, industry and climate change, just to name a few. Because of the smart grid's capacity for energy efficiency, the goals and targets for its development should also be integrated into national energy and energy efficiency policy frameworks.

Develop national smart grid roadmaps, which are crucial for planning and implementing smart grid technologies: A national smart grid vision needs to be formed by the government – stating what is to be achieved and how the technologies should be used. A matching investment plan and timeline of activities, such as government-supported demonstration activities, need to be devised. This process will contribute to creating an enabling policy environment. The development of the smart grid system also requires collaboration with and investment from the private sector and other partners. It will be important to have a plan that maps out how all actors will be engaged.

[10] International Energy Agency, *Energy Technology Perspectives 2010: Scenarios & Strategies to 2050* (Paris, 2010). Available from www.iea.org/Textbase/nppdf/free/2010/etp2010_part1.pdf (accessed 1 March 2012).

[11] ibid.

[12] International Energy Agency, *Energy Technology Perspectives 2010: Scenarios & Strategies to 2050* (Paris, 2010). Available from www.iea.org/Textbase/nppdf/free/2010/etp2010_part2.pdf (accessed 1 March 2012).

Ensure that regulations and standards enforce quality control and uniformity among the different technologies and infrastructure: Governments should take the lead in creating standards that ensure quality control and uniformity among the technologies and infrastructure as one system. The standards should be compatible with the existing infrastructure.

The introduction of the smart grid also involves the transformation of the market. Regulatory changes need to ensure that all actors involved in electricity generation, transmission and distribution as well as the consumers will benefit and share the cost burden – with consideration of the distributional and equity issues. For instance, a policy option may be the application of a dynamic pricing scheme involving smart metering,[13] although there has been controversy over this scheme in some parts of the world, including health and data privacy issues.

Regulatory barriers associated with smart grid technology and infrastructure must be removed from the current electricity system. New regulations must promote the market entrance of medium- and small-scale electricity generators and “prosumers”.

Other regulatory issues include assessing and then enabling the appropriate level of investments that will be required to support infrastructure development. The regulatory environment will need to be attractive enough to draw investment and generate returns on that investment. Because ICT will be the central tool for operating the smart grid, regulatory changes will be necessary to ensure cyber security. Lastly, the technology development will herald in the need for new regulator options.[14]

Financing smart grids

Public funding will be crucial for smart grid development at the national level. Governments will need to provide credible and stable signals through medium- to long-term policy frameworks to invigorate private sector confidence, which leads to investment. At the same time, governments will need to couple innovative financing schemes and incentives focused on the private sector, such as a feed-in tariff, to increase the share of renewable energy sources, which will be a vital component for smart grid efficiency. Such incentives as tax rebates, loan guarantees and low interest loans can spur investment. Incentives must also be extended to consumers because they will bear the financial cost for new technologies and appliances.

Opportunities in Asia and the Pacific

Although the electrification coverage has improved in developing countries, many still do not have adequate power infrastructure nor enjoy a stable energy supply. Further investment is required to improve their energy supply, including the infrastructure needed to access energy. The introduction of a smart grid system may be progressive at this time for many developing countries, but they can proceed with the construction of the power infrastructure now, keeping in mind the possibilities of smart grid technology integration in the future once there is more experience with large-scale projects in industrialized countries. At the least, the smart grid system can be deployed as an option for rural electrification by adopting small remote systems that are not connected to the centralized electricity infrastructure but can provide electricity to households and communities. At a later stage, community grids can be connected to the national system.[15]

Trends in smart grid development

The following table highlights the current status of smart grid systems in four of the eleven countries in the Asia-Pacific region that have either a demonstration smart grid system or are deploying a system: Australia, China, Japan and the Republic of Korea. (Elsewhere, Brazil, France, Germany, Italy, Spain, the United Kingdom and the United States have also introduced this system.)

[13] The smart metering allows a two-way flow of information between the customers and utilities on the electricity price as well as the time and amount of the electricity consumption.

[14] International Energy Agency, *Technology Roadmap: Smart Grids* (Paris, 2011). Available from www.iea.org/Papers/2011/SmartGrids_roadmap.pdf (accessed 3 October 2011).

[15] ibid.

Table 1: Selected national smart grid demonstration and deployment efforts in Asia and the Pacific

Australia	The Australian Government announced an A$100 million *Smart Grid, Smart City* initiative in 2009 to deliver a commercial-scale smart grid demonstration project.
China	The Chinese Government developed a large, long-term stimulus plan to invest in water systems, rural infrastructure and power grids, including a substantial investment in smart grids. Smart grids are seen as a way to reduce energy consumption, increase the efficiency of the electricity network and mange electricity generation from renewable technologies. China's State Grid Corporation outlined plans in 2010 for a pilot smart grid programme that maps out deployment to 2030. Smart grid investments will reach at least US$96 billion by 2020.
Japan	The Federation of the Electric Companies of Japan is developing a smart grid that incorporates solar power generation by 2020, with government investment of more than US$100 million. The Government announced a national smart metering initiative, and large utilities have announced smart grid programmes.
Republic of Korea	The Korean Government launched a 64.5 billion won approx. US$ 57.8 million pilot programme on Jeju Island in partnership with the industry sector. The pilot programme consists of a fully integrated smart grid system for 6,000 households, wind farms and four distributional lines. The Government announced plans to implement smart grids nationwide by 2030.

Source: Extracted from the International Energy Agency, *Technology Roadmap: Smart Grids* (Paris, 2011). Available from www.iea.org/Papers/2011/SmartGrids_roadmap.pdf (accessed 3 October 2011).

Further reading

Technology Roadmap: Smart Grids (Paris, International Energy Agency, 2011). Available from www.iea.org/papers/2011/smartgrids_roadmap.pdf

Solar energy

Solar energy explained

Solar power is the conversion of radiant light and heat from the sun into electricity, either directly, using photovoltaic (PV) cells, or indirectly, using concentrated solar power (CSP).

How it works

In solar PV cells, semiconducting materials (traditionally crystalline silicon) knock free the electrons in absorbed sunlight and the current of free electrons then moves in a single direction. Many cells are connected in an array and the aggregate flow of electrons is converted into usable electric current.

CSP uses mirrors and/or lenses to focus sunlight into a contained liquid, which creates steam capable of turning a turbine as well as providing heat for combined heat and power (CHP). Similar technologies, broadly called low-temperature solar thermal, can be used to heat water to provide hot water onsite or to concentrate solar energy into a cooking container to heat food.

Opportunities in Asia and the Pacific

India's National Solar Mission: As part of its National Action Plan on Climate Change, the Government of India enacted a number of policies to drastically increase solar PV and CSP production to 22,000 MW by 2022. The goal is to achieve national grid parity by 2022, and KPMG International analysis projects that grid parity across India could be achieved between 2017 and 2020.[1]

China leading the world in PV manufacturing: Chinese manufacturing accounts for more than one third of worldwide PV cell production, more than any other country. Although nearly 11,000 MW of PV panels were produced in China in 2010, followed by Japan with 2,200 MW, only 8 per cent remained in the country for domestic use. To generate domestic demand for its solar manufacturing, the Government initiated the national Golden Sun Programme that subsidizes half the costs for the capital investment and grid connection for a solar project, with the purpose of expanding 1,000 MW of domestic installation per year starting from 2012.[2]

PV costs approaching grid parity: Significant reductions in PV manufacturing costs, primarily from Chinese production, are quickly pushing solar PV power towards grid parity. The Energy Research Institute, a think tank supported by China's National Development and Reform Commission, projects that grid parity for solar PV in China could be reached by 2015.[3]

Trends in development

In 2009, solar PV provided just 4,205 GWh, or 0.06 per cent of the electricity supply across the region. CSP plants have been even slower to take off, with just 4 GWh of electricity production in 2009, all generated in Australia.[4] Passive and off-grid use of solar energy is difficult to gauge for the region.

[1] KPMG International, *The Rising Sun: A Point of View on the Solar Energy Sector in India* (Delhi, India, 2011). Available from www.kpmg.com/IN/en/IssuesAndInsights/ThoughtLeadership/The_Rising_Sun_full.pdf (accessed 10 October 2011).

[2] Earth Policy Institute website, "Solar Power: Solar PV Break Records". Available from www.earth-policy.org/indicators/C47 (accessed 15 February 2012).

[3] F. Wong and R. Lian, "China to Double Solar Capacity by Year End: Report", *Reuters*, 12 August 2011. Available from www.reuters.com/article/2011/08/13/us-china-solar-idUSTRE77C0AR20110813 (accessed 14 October 2011).

[4] Aggregation of 2009 renewable energy generation data from IEA for Asia, excluding China, and OECD Asia and Oceania. International Energy Agency (IEA), *Statistics and Balances* (Paris, IEA and OECD, 2009). Available from www.iea.org/stats/index.asp (accessed 15 February 2012).

Strengths with solar energy

- **Easy access:** A major advantage of solar energy is that solar radiation resources are fairly uniform across sub-regions; thus the resources and energy production capability are not as site-specific as it is for wind, hydro or geothermal sources. Solar PV modules are inherently scalable, broadening their potential for deployment at many levels.
- **Increased access to modern energy:** Off-grid solar thermal, solar home systems and solar-powered mini-grids have a great potential to increase access to electricity in rural Asia and the Pacific. Small solar thermal can offset traditional biomass cooking and heating and thus reduce indoor air pollution and associated health impacts. Appliance-based PV systems can help provide basic services, such as clean water and lighting to rural homes.[5]
- **Job creation:** A study from the (American) University of Berkeley's Renewable and Appropriate Energy Laboratory found that solar PV creates more jobs per unit of electricity output than any other form of electricity generation. The study report notes that the highly distributed nature of solar PV installations may lead to its considerably higher job multiplier.[6]

Challenges to using solar energy

- **Intermittent power generation and seasonal fluctuations:** Energy production from solar PV is limited to daylight hours. Currently available battery storage technologies are not cheap or efficient enough for utility-scale deployment. CSP plants have some storage capacity and can enhance this capacity with additional thermal storage infrastructure to hold heat excess in molten salts to be used to generate electricity during periods of cloud cover or even at night.

- **High costs and low efficiencies:** A major challenge for grid-connected solar energy development is the high cost of power. Investment costs are dropping with developments in thin-film solar modules, which rely on less expensive semiconducting materials than the traditional crystalline silicon. However, the panels' low conversion rates (from solar to electrical energy) are currently keeping the cost of electricity high, relative to other sources of power in many Asian markets.

Implementing strategies

Hybrid systems to help circumvent intermittency issues and storage deficiencies: By offsetting the need for some diesel fuel imports to remote locations, solar-diesel hybrid mini-grids can actually increase the reliability of access to electricity for users who may not always be able to afford diesel fuel when prices jump. Pairing solar generators with pumped storage hydro-electric plants may be another way to increase the input of solar energy into the grid.

Support of research and development to bring down costs: Investment in solar energy research can help bring down manufacturing costs and increase conversion efficiency of both PV and CSP technologies. Although generally less efficient than the older crystalline silicon solar cells, thin-film technology, in particular, presents great scope for deployment in emerging economies and developing countries. They are less expensive to manufacture than crystalline silicon cells, and they have no moving parts, lowering maintenance servicing and costs relative to solar thermal plants.

Increasing grid flexibility: In the long run, increasing the flexibility of the grid to accommodate solar variability will be important to allow even more solar energy to feed into the grid. Such measures include expansion of the supply market to smooth regional supply fluctuations, electricity demand management, smart metering and enhanced distributed energy storage (electric vehicle batteries). Although these are long-term measures, they have long lead times, and planning and investment are needed in the immediate term.[7]

[5] International Energy Agency, *Energy Poverty: How to Make Modern Energy Access Universal* (Paris, OECD/IEA, 2010a)

[6] M. Wei, S. Patadia and D.M. Kammen, "Putting renewable energy and energy efficiency to work: How many jobs can the clean energy industry generate in the US?", *Energy Policy* (2010) vol. 38, pp. 919–931. Available from http://rael.berkeley.edu/sites/default/files/WeiPatadiaKammen_CleanEnergyJobs_EPolicy2010.pdf (accessed 14 October 2011).

[7] International Energy Agency, *Technology Roadmap: Solar Photovoltaic Energy* (Paris, IEA and OECD, 2010b).

FACT SHEET

Subsidy reforms

Key points

- ***Subsidies are an important fiscal instrument that governments use to stimulate certain vital sectors of the economy, but they can distort markets, harm the environment and inhibit the adoption of more advantageous alternatives.***

- ***Subsidies can be reformed through an environmental fiscal reform, which will redirect the allocated funds into investment towards increased resource efficiency, eco-efficiency innovation and poverty reduction.***

Subsidy reform explained

The Organisation for Economic and Co-operation and Development defines a subsidy as "a measure that keeps prices for consumers below market levels, or keeps prices for producers above market levels or that reduces costs for both producers and consumers by giving direct or indirect support."[1]

A subsidy may constitute direct or indirect grants or payments as well as pricing, tax or regulatory policies that are preferential to particular economic activities. Some subsidies are very evident, such as government payments to assist a business or industry, but other advantages that governments provide to producers or consumers can also be considered subsidies.[2] These government actions can include tax policies (special exemptions, allowances, deductions and credits), regulations, research and development, direct government market activities, government services (maintaining public ports and highways) and disbursements (such as grants).

The share of fuel subsides differ from country to country. In developing countries, fuel subsidies to households tend to constitute a large portion of government spending. As of 2009, 22 per cent of government expenditures in Malaysia for example were subsidies, with petrol subsidies alone taking up 12 per cent.[3]

Environmental fiscal reforms (EFR) can help governments phase out certain subsidies, particularly the ones that result in higher degrees of consumption or production of environmentally harmful products and services. The phase-out can in turn increase resource efficiency of the economy, which can further be augmented by redirecting the generated budget revenues (liquidity) to environmentally beneficial and green growth stimulating activities as well as to creating social benefits and increased employment.

How it works

Governments usually initiate subsidy reforms in times when the costs of certain vital natural resources, such as fossil fuels, rise to the extent that subsidizing their use becomes unfeasible. There are some important questions and steps to be considered when initiating the subsidy review, which should include a thorough analysis of whether subsidies benefit the most disadvantaged as intended, what market distortions need to be corrected, impact of the subsidy phase-out on the disadvantaged and on the key sectors of the economy, compensatory measures and garnering public support.

Review of direct benefits of subsidies

[1] Organization for Economic Co-operation and Development, *Improving the Environment Through Reducing Subsidies* (Paris, 1998).

[2] There are more than 250 measures that support fossil fuel production and use in OECD countries, according to the Organisation for Economic Co-operation and Development, *Inventory of Estimated Budgetary Support and Tax Expenditures for Fossil Fuels* (Paris, 2012).

[3] Munan Heidi, Foo Yuk Yee, *Malaysia*. (New York, Benchmark Books, 2001) pp. 28, 36–37.

Some subsidies are designed and implemented with a primary objective of alleviating poverty and enhance the livelihoods of the low-income households and individuals by easing their access basic utilities to ensure the minimum standards of their living. For instance, kerosene, electricity and fertilizer subsidies are intended to benefit poor households.

In reality, however, the effects of some of the subsidies are suboptimum, and they may be a costly and inefficient way to achieve such goals, often resulting in environmental costs that negate their supposed benefits. For instance, the rural poor in many a developing countries largely lack access to the centralized modern energy supply; subsidies on water prices or chemical fertilizers for agriculture often tend to benefit large corporate farming rather than small farmers as intended.

Based on a recent International Energy Agency (IEA) study of selected economies, only 8 per cent of fossil fuel subsidies in 2010 actually benefited the poorest 20 per cent of the population.[4] The top 20 per cent of households received on average approximately 42 per cent of the total energy subsidies.[5] An International Monetary Fund study (2010) found that as much as 80 per cent of the benefits of the gasoline subsidies worldwide went to the richest 40 per cent of households.[6]

A similar pattern was found in many countries in the region. In Indonesia, for example, more than 70 per cent of fossil fuel subsidies directly benefited the 40 per cent top-income households, while to the most disadvantaged, constituting 40 per cent of the lowest-income households, only 14 per cent of the subsidies distribution could be attributed. The subsidies stimulated robust use of private vehicles and much less was attributed to lowering the price of kerosene used in poor households.[7] The studies also reveal that fossil fuel subsidies have had a strong impact on widening the gap between rich and poor.

Review of costs and market distortion implications of subsidies

Subsidies often stimulate higher degrees of consumption or production of environmentally harmful products and services than would occur in their absence, causing damage not only to the environment but to the economy as well. Specifically, they can result in the overuse of fossil fuels and extraction of natural resources at levels that are not sustainable and consequently substantial increase of pollution, harmful emissions and waste.[8]

In the current pricing mechanism, the costs for abatement of these environmentally harmful and undesirable activities are not being fully internalized in the production costs and remain unaccounted. The higher costs of the environmental damages are eventually paid by the end consumer.

One such review of the market distortions caused by subsidies (favouring fossil fuel-based energy production processes) shows considerable impact on the competiveness of renewable energy systems. The IEA estimates that in 2010, worldwide fossil fuel subsidies reached US$409 billion, representing a significant portion of the GDP – often averaged to 1–2 per cent of the GDP (PPP) and resulted in stimulating the consumption and production of fossil fuels. Alarmingly, fossil fuel subsidies are expected to grow to US$660 billion by 2020, equivalent to 0.7 per cent of global GDP.

Renewable energy production, however, receives only US$66 billion of such subsidies in the form of incentives, tax breaks and rebates, which are not enough to reduce their costs and stimulate wider use.[9] This constitutes a missed economic opportunity, especially for developing countries in the Asia-Pacific region.

[4] International Energy Agency, *World Energy Outlook 2011* (Paris, 2011). The findings are based on a survey of 11 countries including Angola, Bangladesh, China, India, Indonesia, Pakistan, Philippines, South Africa, Sri Lanka, Thailand and Viet Nam. The survey does not include subsidies specifically allocated to extend access to basic energy services.

[5] Ramón E. López, Vinod Thomas, and Yan Wang, *The Effects of Fiscal Policies on the Quality of Growth* (Washington, D.C., The World Bank, 2010), p. 9.

[6] David Coady and others, Petroleum Product Subsidies: Costly, *Inequitable and Rising* (Washington, D.C., International Monetary Fund, 2010).

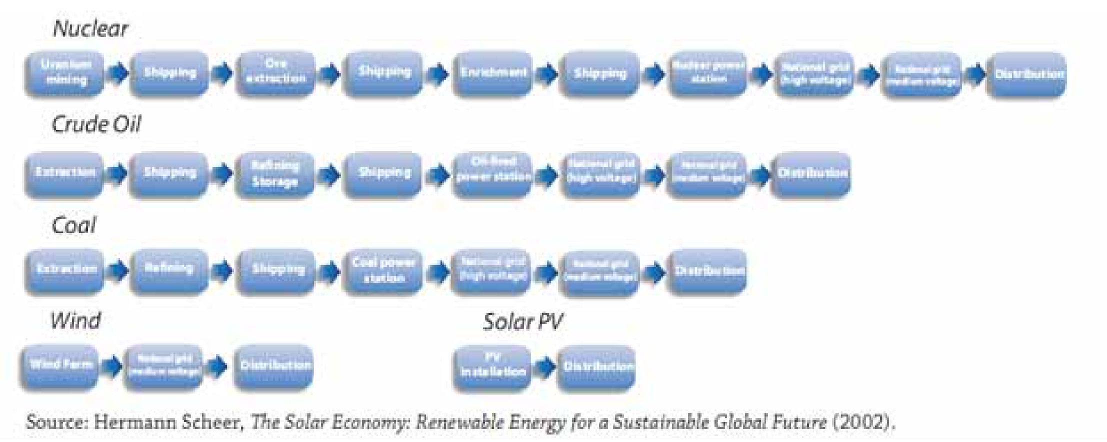
[7] Republic of Indonesia, Effectiveness of Unconditional Cash Transfer of 2008 (Jakarta, Deparemen Sosial, Ministry of Social Welfare 2008), p.15 from A. A. Yusuf and B. P. Resosudarmo, "Mitigating distributional impact of fuel pricing reform: The Indonesian experience", *ASEAN Economic Bulletin* (2008), vol. 25, no. 1, pp. 32–47, a modelling shows that richer households tend to experience a greater increase in consumer prices and bigger fall in their income as a result of reductions in fuel subsidies.

[8] These result in losses to the GDP.

[9] International Energy Agency, *World Energy Outlook* (Paris, IEA and OECD, 2010g).

In the case of China, for example, which has emerged as the world's producer of solar photovoltaic (PV) systems, 95 per cent of this production in 2007 was for export.[10] Currently shrinking European markets are creating an oversupply of PV solar systems and a considerable price drop, by 30–40 per cent. Boosting local consumption of such solar systems would create the desired economy of scale to make prices competitive with those of conventional energy production systems. Solar energy systems, for example, tend to create faster investment returns because of lower risks in a short supply chain, as illustrated in the following figure.

Figure 1: Comparison of supply chains for electricity supply for different energy sources



Source: Hermann Scheer, *The Solar Economy: Renewable Energy for a Sustainable Global Future* (London, Earthscan Publications Ltd., 2002).

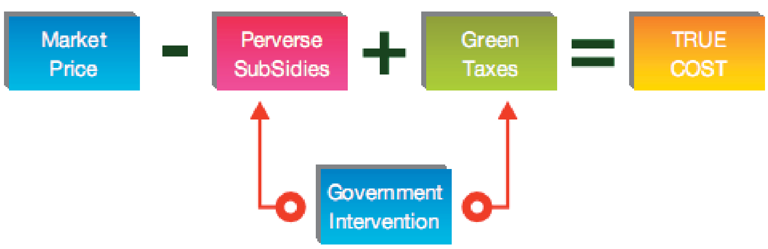
Additional expected benefits would include reduction and elimination of budgetary losses from subsidizing traditional energy production facilities, new green jobs, improved domestic energy and environmental security, increased investments in green technologies and innovation, and economic growth

Strengths of subsidy reform

Subsidy reform as part of the environmental fiscal reform in the context of low carbon green growth is comprised of two parts: 1) **Phasing out environmentally harmful subsides**, and; 2) **Increasing subsides for energy efficiency, clean and renewable energies and other activities related to the greening of the economy.**

Key benefits of subsidy reforms include following:

- **Provides excellent opportunity to correct market failure:** Redirecting subsidies from environmentally harmful activities and products, such as pollution, carbon emissions, resource inefficiency, overdependence on non-renewable fossil fuels to more environment-friendly ones (such as renewable and other clean and efficient energy sources), constitute an important part of the EFR. The following simplified diagram illustrates the process.



[10] Based on data for exports and imports in 2007.

- **Creates significant resource efficiency gains:** Removing fossil fuel subsidies, which lock countries into an inefficient infrastructure development pattern for long periods of time, would considerably reduce the consumption of these resources, would contribute heavily towards reducing carbon emissions and would create additional incentives for investments in renewable energy infrastructure. The Potential of carbon emission reduction through robust renewable energy subsidy policies are estimated to be 3.4-3.5 Gt by the year 2035 compared with the average emission level in 2009, yielding fossil-fuel import savings of US$350 billion globally.[11]

- **Generates revenue to finance green growth:** Removing environmentally harmful subsidies can potentially create substantial budgetary room for investments on renewable and other alternative energies as well as green technologies. A recent study by the McKinsey Global Institute finds that yearly $260 to $360 billion (about 60-90 per cent of the current fossil fuel subsidies) would be sufficient over the next two decades in financing to achieve a 450 ppm pathway by shifting from high-carbon to low-carbon powered economy through renewable energies, more extended use of biofuels in road transport and other carbon emission reduction measures. The same paper indicates that ensuring the minimum energy access for all (by providing 250 to 500 kilowatt hours per person per year) would require about $50 billion a year during the same period, which accounts for only 12 per cent of the current fossil fuel subsidies[12]. The process of greening an economy is expected to generate more employment ("green jobs"), spur innovations as well as improving domestic energy and environmental security.

BOX 1: Emissions reductions attributed to removal of fossil fuel subsidies

An IEA study indicates that global greenhouse gas emissions would be reduced by 8 per cent compared with business-as-usual levels in 2050 if all 37 countries in the IEA subsidy database (36 countries plus Uzbekistan) phased out fossil fuel subsidies between 2013 and 2020.[13] Analysis by the OECD also suggests that phasing out fossil fuel subsidies by 2020 could reduce greenhouse gases by more than 15 per cent in 2050 in India and more than 5 per cent in China.[14]

Challenges to subsidy reform

- **Income regressive impacts.** Subsidy reform may lead to negative impacts on the livelihoods of the population with lowest income and means, which will weaken the legitimacy and sustainability of the reform. Reforms need to be gradual in pace and to address the distributional impacts, based on a careful assessment of economic and social impacts, and supported with rigorous public information campaigns for securing public understanding, support and political feasibility.

- **Lack of supporting regulatory measures.** Subsidy reforms need to be gradually put in place while firmly based on a rigorous impact analysis and enforced in tandem with supportive policy and regulatory measures that will allow compensation of possible direct and sudden impacts on the industrial competitiveness and on the livelihoods of the poor.

[11] Organisation for Economic Co-operation and Development, Farmland Conversion – *The Spatial Implications of Agricultural and Land-use Policies* (Paris, 2009c). (Paris, International Energy Agency and OECD, 2011).

[12] Mckinsey Global Institute, Mckinsey Sustainability & Resource Productivity Practice, Resource Revolution: Meeting the world's energy, materials, food and water needs. November 2011.

[13] J. Burniaux and J. Chateau, "Mitigation Potential of Removing Fossil Fuel Subsidies: A General Equilibrium Assessment", OECD Economics Department Working Papers, No. 853 (Paris, OECD Publishing, 2011). Available from http://dx.doi.org/10.1787/5kgdx1jr2plp-en (accessed 17 March 2012).

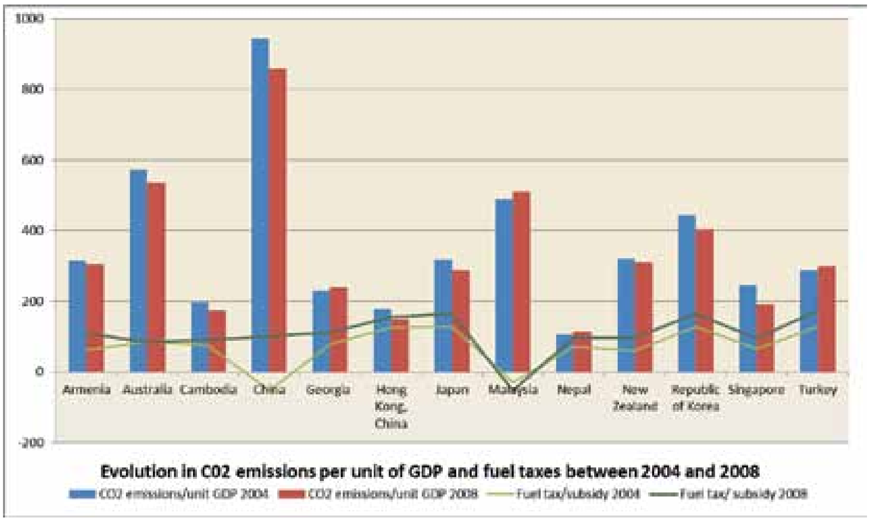
[14] Organisation for Economic Co-operation and Development, *Interim Report of the Green Growth Strategy: Implementing our commitment for a sustainable future* (Paris, 2010).

Recent Initiatives in developing countries in the Asia-Pacific region

Countries are beginning to understand that reforming environmentally harmful subsidies is a critical step toward a greener economy. In 2009, the G-20 agreed to gradually phase out fossil fuel subsidies. In Asia and the Pacific region, countries are also moving toward phasing out fossil fuel subsidies.

Between 2004 and 2008, many governments in the region decided to shift from fuel subsidies to fuel taxes as a strategy to address the impact of rising fuel prices. Such EFR policies have resulted in increased budget liquidity and may have contributed to reducing CO_2 emissions per unit of GDP (figure 2).

Figure 2: Evolution in C02 emissions per unit of GDP and fuel taxes in selected countries in the Asia-Pacific region, 2004–2008



Source: Based on data from the German International Development Agency (GIZ), *International Fuel Prices 2009* (Berlin, 2009).

Policymakers in **Indonesia** started a reform of the fossil fuel subsidies; in 2005, concern over the increasing pressure that fuel subsidies were placing on the state budget led the Government to increase fuel prices in March and then again in October by an average of 29 per cent and 114 per cent, respectively. This reduced the state budget deficit by US$4.5 billion in 2005 and US$10 billion in 2006.[15] The potential negative impact of the reform on the poor was mitigated through a **direct cash transfer programme**, which reached 19.2 million households and cost around US$2.3 billion, less than a quarter of the savings in 2006 alone.[16]

The **Malaysian** Government also introduced reforms of energy subsidies in 2008, shifting to cash rebates, windfall taxes and expansion of the social safety net. This came after expenditure on electricity and petroleum subsidies grew to US$14 billion, or approximately 4 per cent of GDP, during the period of rising oil prices in the late 2000s. Further cuts to gasoline, diesel and LPG subsidies were made in July 2010.

Similarly, lawmakers in the **Islamic Republic of Iran** introduced in 2010 the **Targeted Subsidy Reform Act**, which resulted in a twenty-fold increase in domestic energy and agricultural prices. The reform resulted in savings of US$50–$60 billion in one year. Half of this amount was redistributed to households, while US$10–$15 billion was advanced to enterprises to finance investment in restructuring aimed at reducing energy intensity.[17]

[15] Robert Bacon and Masami Kojima, *Coping with Higher Oil Prices* (Washington, D.C., The World Bank, 2006).

[16] ibid.

[17] Dominique Guillaume, Roman Zytek and Mohammad Reza Farzin, "Iran: The Chronicles of the Subsidy Reform", IMF Working paper WP/11/167 (Washington, D.C., International Monetary Fund, 2011).

Box 2: Current status of Indonesia's fuel subsidy reform

Indonesia's Medium-Term Plan in 2010 pledged to a reduced spending on energy subsidies by 40% by 2013 and eliminates subsidies by 2014 In February 2011, however, Indonesia postponed a restriction on subsidies for fuel for private cars, a move that could end up costing the Government 6 trillion rupiah.[18] This measure was initiated to substantiate the pledge of the Government to eliminate fossil fuel subsidies in the medium term and completely eliminate them by 2014. The path to zero subsidies has not been without its bumps.

Even the restriction was considered ineffective to some because it was limited in scope; motorcycles were to be exempt from the subsidy cut, even though there are approximately ten times as many motorcycles as there are cars in Indonesia.[19] A recent trend of increasing oil price strengthens a perverse incentive to sell fuels subsidized by the Government to industries and other illegal channels: in 2011, this portion reportedly reached between 10 and 15 per cent.[20] In December 2011, the quota of subsidized fuels reportedly would increase by between 500,000 and 1,000,000 kilolitres.[21]

In addition, the electricity subsidy increased from 65.6 rupiah to 91 trillion rupiah (as of January 2012). Due in part to the subsidized and state controlled price of electricity, the state utility PLN has had difficulty in increasing energy infrastructure and supplying electricity to meet the increasing need. This problem, analysts find, threatens to slow Indonesia's economic growth.[22] A concern is raised that in the projected steady increase of oil prices, the current practice of fuel and energy subsidies in Indonesia is likely to further weaken fiscal conditions of the Government while diverting public expenditure from areas requiring more investment, such as health, education and infrastructure building.

[18] Rangga D. Fadillah and Esther Samboh, "15 Per cent of Subsidized Fuel Sold to Industries", *The Jakarta Post*, May 31 2011. Available from www.thejakartapost.com/news/2011/05/31/15-percent-subsidized-fuel-sold-industries.html (accessed 17 March 2012).

[19] Francis Kan, "Analysis: Power Woes Could Trip Indonesia's Economic Surge", *Reuters*, 22 December 2011. Available from www.reuters.com/article/2011/12/23/us-indonesia-energy-bottlenecks-idUSTRE7BM06F20111223 (accessed 17 March 2012).

[20] Rangga D. Fadillah and Esther Samboh, "15 Per cent of Subsidized Fuel Sold to Industries", *The Jakarta Post*, May 31 2011. Available from www.thejakartapost.com/news/2011/05/31/15-percent-subsidized-fuel-sold-industries.html (accessed 17 March 2012).

[21] *The Jakarta Post* , "Govt to Add to Subsidized Fuel by Up To 1m kl", 15 December 2011. Available from www.thejakartapost.com/news/2011/12/15/govt-add-subsidized-fuel-1m-kl.html (accessed 17 March 2012).

[22] Francis Kan, "Analysis: Power Woes Could Trip Indonesia's Economic Surge", *Reuters*, 22 December 2011. Available from www.reuters.com/article/2011/12/23/us-indonesia-energy-bottlenecks-idUSTRE7BM06F20111223 (accessed 17 March 2012).

Tropical architecture

Key point

- ***With the increasing annual cooling load associated with needs for air-conditioning in tropical climates, tropical architecture is finding renewed emphasis.***

Tropical architecture explained

Tropical architecture can be regarded as a type of green building applicable specifically for tropical climates, using design to optimally reduce buildings' energy consumption, particularly the cooling load.

Tropical architecture is not a new concept. Countries in the Asia-Pacific region have adopted vernacular designs adapting to their climatic needs over many centuries. For instance, a high ceiling demonstrates an understanding of the stack effect. Malay homes install a large roof overhang and the West Indians use verandas to reduce solar gains. These design solutions allow windows to remain open for natural ventilation in a building during rainy season. Samoans long ago did not install walls to allow free-flow breezes. Malayan homes' plentiful windows aim to maximize cross-ventilation.

How it works

Tropical architecture works to achieve thermal comfort through the use of design elements, such as sunshades, cavity walls, light shelves, overhangs, roof and wall insulation and even shading from trees.[1] The design principles of tropical architecture include: regional evaluation; climatic elements; site selection; sol-air orientation; solar control on the environment and building; forms, wind effects and air flow patterns; thermal effects of materials; and heliothermic planning.[2] In addition, maximum cross ventilation, natural lighting, louvers and natural materials are key elements for optimizing natural ventilation to cool tropical buildings.

An example of tropical architecture: Golconde in Pondicherry, South India[3]

Golconde in Pondicherry, South India is a multi-storey dormitory built from 1936 to 1942 and based on design principles of simplicity, economy, directness and closeness to nature. The building is an interesting example of how vernacular design can be integrated into modern tropical architecture. The Golconde's specific design features include:

- **Rooms separated from the corridor by sliding doors:** This allows air to circulate freely when the doors are open. Staggered slats allow for ventilation even when the doors are closed. The topmost part of all the doors has a skylight with a sliding glass pane that also allows for air movement.
- **Room walls finished with eggshells:** The walls aid in the natural lighting because they reflect more light and the rooms are better illuminated with the natural light. Unlike with concrete walls, there is less heat in the room.
- **Double-thick roof made of precast curved cement concrete tiles:** The convection of air keeps the roof and the top-floor rooms as cool as the lower floors.

[1] Amado de Jesus, "Green Architrends: Tropical Architecture", *Philippine Daily Inquirer*, September 16 2011. Available from http://business.inquirer.net/19613/tropical-architecture (accessed 6 December 2011).

[2] Victor Olgyay, *Design with Climate: Bioclimatic Approach to Architectural Regionalism* (Princeton, New Jersey, Princeton University Press, 1963).

[3] This section is based on documents stored in the Archives of Sri Aurobindo Ashram and displayed at an Exhibition on Golconde in Pondcherry in October 2011.

- **Large operable horizontal louvers:** The entire building on both the north and south sides is equipped with large operable horizontal louvers that protect from sunlight, wind and rain while allowing for natural ventilation. By avoiding direct sunlight, the building allows rooms to remain cool without the need for mechanical ventilation.

- **Landscaping with surrounding garden:** Trees, grass and shallow pools are used to create a cooling effect. High walls around the property are installed to avoid the heat island effect from non-shaded areas.

Considerations for replicating

The challenge of introducing tropical architecture is to adapt it to the modern lifestyle – the transformation of local cultures to the modern city. While it is possible to retain enough of the vernacular lifestyle for residential designs, other types of buildings, such as offices and shopping centres, have generally not done so. There is growing interest in developing modern tropical architecture in urbanized countries like Malaysia and Singapore. Modern architecture aligned with existing technologies includes: the angle of the inclination of the roof when using tile roof covering materials, long overhangs, the use of a ventilation crusade to reduce the humidity and hot air temperatures and the correct direction of the orientation of the building.[4]

Further reading

Tropical Architecture website: http://tropical-architecture.blogspot.com/2011/07/modern-tropical-architecture.html

United Nations Educational, Scientific and Cultural Organization website "Australia": www.unesco.org/en/unitwin/access-by-region/asia-and-the-pacific/australia/unesco-chair-in-tropical-architecture-14

[4] Tropical Architecture website: http://tropical-architecture.blogspot.com/2011/07/modern-tropical-architecture.html (accessed 10 December 2011).

FACT SHEET

Vehicle and fuel taxes plus the removal of car-oriented subsidies

Key point

- ***By internalizing the external costs of purchasing and using private cars, such as congestion and degraded air quality, the overall demand for private cars can be discouraged.***

Vehicle and fuel taxes explained

Historically, vehicles and fuels have been favoured in financial terms through subsidies and tax breaks, thereby reducing incentives to move towards eco-efficient transport patterns. It is imperative that such financial preferences be removed and that vehicles and fuels are priced in ways that reflect their costs to society and the environment.

How it works

Taxes on or subsidies for vehicles and fuels are often applied at the national level and are often designed to promote (either intentionally or otherwise) the use of private cars. This trend can be revered as follows:

Fuel subsidies, which are commonly applied in countries in the Asia-Pacific region, should be removed and instead fuels should be taxed.

The sale and ownership of vehicles should be taxed (such as purchase tax and annual registration tax) and subsidies removed. Value-added taxes (VAT) vary according to the specification of cars and can be regarded as a purchase tax. Many European countries have a special car purchase tax in addition to VAT.

Although the tax on fuel has more direct impacts on the use of vehicle, vehicle-related taxes affect the vehicle choice consumers make when buying (such as fuel efficiency technology and size of engine). Following practice in such countries as the France, Germany, Japan, Spain and the United Kingdom, the tax on vehicles could be made to reflect their environmental performance so that those cars with less fuel consumption would be made cheaper compared with those that are fuel inefficient.

Strengths in taxing vehicle and fuel and removing subsidies

- Taxes on fuels and vehicles are relatively easier to administer and enforce compared with more localized charges, such as for parking and congestion.
- Transaction costs (the costs associated with their collection) are relatively low.
- These taxes have the ability to raise a significant amount of revenue, which could be invested in public transport improvements.

Challenges to removing subsidies and raising taxes on vehicles and fuel

- Opposition from industry, particularly the motoring lobby.
- Opposition from consumers, who perceive an increase in the cost of transport.

Implementing strategies

Remove subsidies gradually to mitigate any large price changes within a short period. Targeted subsidies (in the form of cash pay-outs) can be provided to the most vulnerable members of society who may be affected by a rise in the fuel price.

Use the revenue from the higher level of tax to finance alternative, eco-efficient transport, such as the construction of public or non-motorized transport infrastructure and the operation of public transport.

Link the level of vehicle tax to the environmental performance of a vehicle so that higher-polluting vehicles will be taxed at a higher rate.

Examples

Indonesia: Efforts have been made to reduce the level of fuel subsidies, coupled with measures to reduce public opposition, including the cash transfer to the urban poor.

Ghana and other African countries: Revenues from fuel taxes are being used to maintain road infrastructure in a consistent manner.

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The Effects of Fossil-Fuel Subsidy Reform: A Review of Modelling and Empirical Studies, by Jennifer Ellis (Geneva, International Institute for Sustainable Development, 2010). Available from
www.globalsubsidies.org/files/assets/effects_ffs.pdf

Walkability

Key point

- ***By reducing dependency on the car and promoting walkability, the city can become more liveable, with less congestion, air pollution, noise, vibration and severance brought by heavy traffic.***

Walkability explained

Walking is the most important form of human transportation. The way we design cities can greatly influence the way people move for decade to come. Cities should be planned and designed to encourage people to walk more rather than using private vehicles. Planners should focus on the overall pedestrian experience when designing the layout and character of urban street and infrastructure.

How it works

Street design and urban environments can better serve for pedestrian by improving safety, comfort, and attractiveness for all users, including pedestrians, cyclists, motorists and public transport users of all ages and abilities. Overall walkability of cities can be improved by the following measures:

- **The development of car-free areas:** Car-free areas can take many shapes and forms, depending on the context of the city. Approaches could range from the traffic calming of a single street (via the introduction of speed bumps or chicanes) to a totally car-free city.[1] The development of car-free areas within a city is relatively easier to enforce than, say, parking regulations because entry points into the zone can be secured against violating traffic – as opposed to policing a whole area. The technological requirements are also lower, compared with, say, congestion charging.
- **Walkable street design:** The development of pedestrian-friendly streets requires serious consideration of a number of factors early in the planning process. For instance, cellular development concepts that locate a variety of important destinations within close proximity including schools, grocery and retail stores, office buildings would encourage people to walk more. Key elements include: safety features such as increased lighting, reduced vehicle speeds and effective traffic signals and crosswalks; efficient street networks that allow for greater route choice; convenient access to mass transit options; installing clear and direct signage; widening of streets for people instead of widening for cars; creating space for urban greenery, such as street trees, seating areas and shelter to more effectively accommodate pedestrians.

Strengths in walkability

- **Reduces carbon emissions, air pollution, noise and congestions** via reduced dependency on private cars.
- **Enhances liveability** via increased a sense of community and health benefits.
- **Increases land and property values.** Businesses benefit from a higher level of footfall.

Challenges to expanding walkability

- **Planning culture that prioritizes the movement of cars rather than people.**
- **Attitudes:** Business owners likely will fear a reduced level of commercial activity, and individuals will perceive the car as more convenient than walking

[1] Lloyd Wright, *Car-Free Development* (Eschborn, GTZ, 2005). Available from www.sutp.org (accessed 27 February 2012).

Implementing strategies

Develop an integrated transport and land use master plan: Incorporate provisions for car-free areas, especially for central shopping and business districts, with walkable streets and restricted parking space in downtown areas.

Ensure appropriate analysis involving many actors and outreach/marketing on the benefits of the scheme: The added business benefits (more footfall) and improved accessibility (shorter journeys) have to be impressed upon communities.

Engage a skilled project team: Proper design includes operational plans, conceptual designs and detailed engineering designs.

Examples

- **Car-free residential area in Vauban-Freiburg, Germany**
- **Traffic-calmed residential blocks in Guangzhou, China**
- **Abu Dhabi urban street manual, United Arab Emirates:**[2] The Abu Dhabi Urban Planning Council created the Urban Street Design Manual in 2010 to guide the designers in creating walkable streets and pedestrian-friendly environments. The manual applies to all streets in the emirate, including those parts scheduled for urbanization by 2030 as well as streets to be retrofitted.

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[2] Abu Dhabi Urban Planning Council, *Abu Dhabi Urban Street Design Manual* (Abu Dhabi, 2010). Available from www.upc.gov.ae/template/upc/pdf/Street%20Design%20Manual%20English%20(small)%20FINAL.pdf (accessed 27 February 2012).

Wind energy

Wind energy explained

Wind energy is the kinetic energy of air in motion.

How it works

Differences in air temperature caused by energy from the sun's rays create air flows, and kinetic energy from this wind can be captured by wind turbines. Wind turbines essentially function like a fan in reverse: blades are propelled by natural wind flow and the energy is consolidated through a series of gears to turn a generator and produce electrical energy. Turbines range widely in physical size and energy production capacity. Smaller turbines can function efficiently at lower wind speeds; however, they cannot produce electricity at the utility-scale. Large wind farms can be located on land or offshore.

Opportunities in Asia and the Pacific

Best wind speeds for utility-scale development in Eastern Asia: The greatest potential for large-scale wind energy development lies along the coast in East Asia including China, Japan, Republic of Korea and Taiwan Province of China, in coastal Oceania and parts of the Pacific.[1] Wind speeds in northern China and Mongolia as well as parts of western China and India are high. But these areas are often far from load centres, unlike the coastal resources.

Offshore wind potential along Eastern seaboard: Some of the best wind speeds are offshore. Unfortunately, offshore installations cost as much as double the onshore wind farms due to the added cost of building foundations and transmission lines in water.[2] Better wind speeds and higher production capabilities of offshore turbines may absorb the cost difference over time.

Trends in development

As of 2010, there were 60.7 GW of installed wind power capacity in Asia and the Pacific.[3] This represents only a small share of the electricity generation mix in most markets – in 2009, wind power accounted for 0.7 percent of total electricity generation across the region.[4]

Asia leading the world in growth: Growth in wind energy development is increasing more steadily in Asia than in any other continent. Installed capacity in Asia grew by more than 50 per cent each year from 2008 to 2010. Indeed, nearly 55 per cent of the worldwide wind capacity installed in 2010 was installed in Asia, elevating the continent to second place for total installed capacity, at 31 per cent.[5] The Global Wind Energy Council projects that Asia will overtake Europe for most installed capacity by 2015, when the continent is projected to have more than 180 GW of installed capacity.[6]

1 C. L. Archer and M. Z. Jacobsen, "Evaluation of global wind power", *Journal of Geophysical Research* (2005) vol.110, D12110.

2 Soren Krohn, ed., *The Economics of Wind Energy* (Brussels, European Wind Energy Association, 2009).

3 Global Wind Energy Council, *Global Wind Report: Annual Market Update 2010* (Brussels, 2011).

4 Aggregation of 2009 wind energy generation data from International Energy Agency for Asia excluding China, China, and OECD Asia and Oceania. *Statistics and Balances* (Paris, IEA, 2009).Available from www.iea.org/stats/index.asp (accessed 15 February 2012).

5 World Wind Energy Association, *World Wind Energy Report 2011* (Bonn, 2011).

6 Global Wind Energy Council, *Global Wind Report: Annual Market Update 2010* (Brussels, 2011).

China leading the way: Growth in Asia is in large part due to extensive wind farm development in China in recent years. At the end of 2010, total (cumulative) installed wind energy capacity in Asia was 61.2 GW, of which 44.7 GW, or 73 per cent, was in China.[7]

Strengths with wind energy

- **Scalability:** There is no technical barrier to build wind power at various scales. Countries can choose the size of wind power according to their needs as well as climatic and geographic contexts.
- **Wider potential for small-scale wind:** Wind energy production at smaller scales (with smaller turbines) has lower required wind speeds and thus more potential across the region.
- **Compatibility with existing grids powered by diesel:** Small-scale production could feed into hybrid mini-grids for rural electrification, with the potential to offset diesel- or biomass-burning generators when the wind is blowing. Feeding local wind energy into the mini-grid not only reduces environmental impact of a rural electrification scheme but also cuts long-term costs and increases reliability by reducing dependence on diesel.[8]

Challenges to using wind energy

- **High upfront planning and capital costs:** Investment costs for feasibility planning, turbine equipment and interconnection remain a large barrier for both large- and small-scale wind developments.
- **Site-specific modelling and assessments needed:** Ecologically sound and economically efficient locations for wind farms require extensive environmental assessments and wind resource modelling, adding to the time and cost of development.
- **Intermittent power generation and seasonal fluctuations:** Electricity production from wind energy is not easily dispatched. Currently available battery storage technologies are not cheap or efficient enough for utility-scale deployment. The variability of generation currently inhibits the amount of wind energy that can be fed into the grid.
- **Land-use decisions:** The best onshore wind resource is often along mountain ridge tops. In Asia and the Pacific, these areas tend to be heavily forested. Some forest would need to be cleared for access roads and construction; but the remaining tree cover surrounding turbines would decrease the wind power plant's efficiency.[9] In some communities, proposed wind power plants have been met with local resistance due to concerns about aesthetic and low-frequency noise issues.

Implementing strategies

Focus on small-scale and mini-grids: Feed-in tariffs, mandatory interconnections for small wind instalments and financial support mechanisms for off-grid and mini-grid-connected wind projects can help promote efficient wind energy development while also expanding rural electrification in a low-carbon way.

Pair wind with other renewable energies: Technological development to couple wind energy production facilities with pumped-storage hydroelectric plants could provide a means of storing intermittent energy production from wind.[10]

[7] World Wind Energy Association, *World Wind Energy Report 2011* (Bonn, 2011).

[8] Alliance for Rural Electrification, *Hybrid Mini-Grids for Rural Electrification* (Brussels, 2011).

[9] True Wind Solutions, LLC, *Wind Energy Resource Atlas of Southeast Asia*, Paper for World Bank Asia Alternative Energy Program (Albany, New York, 2001). Available from http://siteresources.worldbank.org/EXTEAPASTAE/Resources/wind_atlas_complete.pdf (accessed 26 September 2011).

[10] C. Bueno and J.A. Carta, "Wind powered pumped hydro storage systems, a means of increasing the penetration of renewable energy in the Canary Islands", *Renewable and Sustainable Energy Reviews* (2006) 10, pp. 312–340.

Consider a regional super-grid: Regional cooperation and investment in a super-grid of high-voltage direct current (HVDC) cables can help integrate more wind energy into the electricity market. Seasonal fluctuations can be minimized by connecting wind power plants in both the northern and southern hemisphere into a regional super-grid.[11] Installation of a super-grid with new HVDC cables would also minimize transmission losses.

Create interconnection requirements: Requiring grid operators to off-take electricity produced by wind power and standardizing the requirements (technical and financial) for interconnection to the grid are important regulatory moves to create incentives.

[11] Mikiyasua Nakayama, "Transboundary super grid as a long-term solution for energy security and general security", Powerpoint Presentation at the USJI Seminar on the Great East Japan Earthquake: Lessons for Japan's Energy Policy, Infrastructure Development, and Media Coverage, Washington D.C., 21 July 2011. Available from www.us-jpri.org/en/reports/seminar/nakayama20110721.pdf (accessed 18 November 2011).

FACT SHEET

Zero-energy buildings

Key points

- ***Zero-energy buildings enable building owners to be isolated from fluctuating energy prices through the on- or off-grid renewable energy supply.***

- ***Zero-energy buildings help reduce peak electrical demand by self-supplying energy demands on site.***

- ***Zero-energy buildings should go hand in hand with the transformation of energy infrastructure and market.***

Zero-energy buildings explained

A zero-energy building (ZEB), which is an autonomous building energy option, is defined as a building that produces as much energy as it uses from renewable energy sources at the site. Zero-energy buildings can exchange energy with the power grid as long as the net energy balance is zero on an annual basis.[1]

In terms of the thermal energy transfer and storage, zero-energy buildings can achieve annual energy consumption levels down to 0 kWh per square metre through the use of renewable energy sources, which compares favourably with the passive house energy criteria per square metre. Energy plus houses, in contrast with both the passive houses and zero-energy buildings, focus on producing more energy per year than they consume, which can lead to an annual energy performance of -25 kWh per square metre.

How it works

Zero-energy buildings can be achieved by incorporating energy efficiency measures and on-site renewable energy generation technologies.[2]

- Energy efficiency measures include: creating a high-performance building envelope, installing energy-efficient appliances and lights, increasing the use of passive solar cooling and heating techniques and installing high-efficiency mechanical systems that match the lower energy requirements of the home.
- On-site renewable energy generation systems can be available within a building's footprint by using PVs, solar hot water and wind located on the building or at the site by means of PVs, solar hot water, low-impact hydro and wind located on-site not on the building.

Trends in development

Installing renewable energy generation system at buildings is not a choice but a must for some countries in their building energy policy. The European Union released an ambitious plan in 2009 that requires all buildings built after December 2018 to produce their own energy onsite – via solar panels or heat pumps, for example.[3]

[1] American Society of Heating, Refrigerating and Air-Conditioning Engineers, ASHRAE Vision 2020: *Producing Net Zero Energy Buildings Providing Tools by 2020 that Enable The Building Community to Produce Market-Viable NZEBs by 2030* (Atlanta, Georgia, 2008).

[2] Canada Mortgage and Housing Corporation, "Approaching net-zero energy in existing housing" *Research Highlights*, June 2008.

[3] The plan is an amendment to the 2002 Energy Performance of Buildings Directive. European Parliament, "All New Buildings to Be Zero Energy from 2019," *Press release*, 31 March 2009. Available from www.europarl.europa.eu/sides/getDoc.do?language=en&type=IM-PRESS&reference=20090330IPR52892 (accessed 13 January 2012).

The specific definition of a zero-energy building varies, depending on the region and on the perspective adopted for analysis, such as site energy, source energy, energy costs or emissions from energy uses. Because the definition can have a large impact on the design, international initiatives are looking to harmonize the concept and to promote it. The International Energy Agency's Net Zero Energy Buildings initiative is one such example.

Examples

Zero-energy building is still in the conceptual stage in the Asia-Pacific region. A few pilot projects have been applied to public buildings, such as research institutes, for demonstration purpose.

Sustainable Energy Technology Center in China: Sustainable Energy Technology Center at the University of Nottingham Ningbo is the first zero-energy building established in 2008. The building is designed to minimize its environmental impact by generating energy from renewable sources on site, storing rainwater and re-using grey water where appropriate. The building does not require conventional heating or cooling systems, and residual energy requirements are met by renewable sources, including wind turbines, a PV array roof, solar-powered chillers, ground source heat pumps, sterling engines and weather stations. The building will reduce energy consumption by an estimated 448.9 tonnes and carbon emissions by 1,081.8 tonnes over the next 25 years.[4]

Pusat Tenaga Malaysia's Zero Energy Office (ZEO) Building: PTM, as a showcase for sustainable and green buildings, emphasizes energy efficient features, including 100 per cent daylight, efficient lighting fixtures, floor slab cooling and double-glazed windows. With the installation of 92 kWp BIPV systems, the PTM ZEO building has been designed to be a super-energy-efficient building, using only 286 kWh per day and thus leading to energy savings of 576,000 kWh per year and mitigating 350 tonnes of CO_2 per year.[5]

National Institution of Environmental Research in Republic of Korea: Recognizing that greenhouse gas emissions in buildings account for 20 per cent of the total emissions in the Republic of Korea, the Government is pursuing various initiatives to reduce emissions in the building sector. To demonstrate zero-energy technologies, the National Institution of Environmental Research, with government funding, constructed a carbon-zero building. The project took three years to complete (2008–2010), at a cost of US$3,000 per square metre. Its expected benefits in terms of energy saving and carbon reduction are US$93,577 of annual budget saving through energy reductions and 100 tonnes per year of CO2 emissions. The total annual energy consumption in the carbon-zero building amounts to 123.8kWh per square metre. The technologies applied in the building include 30 energy consumption reduction technologies, 18 energy efficiency technologies, and 13 new and renewable energy technologies.[6]

Strengths with a zero-energy building

- **Saves energy:** With site energy savings ranging from 25 to 68 per cent, compared with conventional buildings,[7] zero-energy buildings can radically reduce or eliminate utility costs.
- **Increases thermal comfort:** The uniform interior temperatures and enhanced indoor air quality and occupant health create soothing environments.
- **Reduces air pollution and greenhouse gas emissions**
- **Creates jobs:** Constructing zero-energy buildings can generate local jobs by increasing demand in the renewable energy market, which is a critical task for many countries.
- **Increases housing value:** Due to a demand that is higher than the available supply, the resale value of zero-energy buildings is generally higher than for conventional properties, especially in times of high energy prices.

[4] Alex Pasternak, "China's First Zero-Emissions Building: Ningbo's Sustainable Energy Technology Center", *Treehugger*, September 25, 2008. Available from www.treehugger.com/files/2008/09/china-first-zero-emission-building-ningbo.php (accessed 23 October 2011).

[5] Pusat Tanaga Malaysia, "KTAK low energy office (LEO) building & PTM-zero energy office (ZEO) building", PowerPoint presentation, 20 February, 2008. Available from www.uniten.edu.my/newhome/uploaded/coe/arsepe/2008/UNITEN%20ARSEPE%2008%20L24.pdf (accessed 23 October, 2011).

[6] National Institution of Environment Research, *Carbon Zero Building* (Incheon, Republic of Korea, 2010).

[7] American Society of Heating, Refrigerating and Air-Conditioning Engineers, *ASHRAE Vision 2020: Producing Net Zero Energy Buildings Providing Tools by 2020 that Enable The Building Community to Produce Market-Viable NZEBs by 2030* (Atlanta, Georgia, 2008).

Considerations for replicating

Special attention is required for setting up the enabling condition allowing the generation and penetration of renewable energy from buildings. For instance, provision of the feed-in tariff help individual power generators to enter the market by lowering the market entry barrier. In addition, building regulations such as development permit and building permit need to be reformed in a way to allow the generation of renewable energy, for instance, by adjusting land-use by laws, roof loading, and mechanical fastening of solar systems.

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Zero and Net-Zero Energy Buildings + Homes, by Building Design Construction Network (Arlington Heights, Illinois, 2011).

Zero Energy Buildings: A Critical Look at the Definition, by P. Torcellini, S. Pless, M. Deru and D. Crawley (Golden, Colorado, National Renewable Energy Laboratory, 2006

CASE STUDY

Taking a bold stand on pollution
Australia's carbon pricing scheme

Key points

- ***Australia, one of the world's biggest polluters, passes legislation to change its habits, starting with the charging of fees to industries that contribute to the abundance of emissions.***
- ***The scheme gives industries time to acclimate to the new system and to start planning ways to reduce their pollution.***

There was a problem…

Contributing 1.5 per cent of the world's greenhouse gas emissions due to its heavy dependence on coal for electricity generation (about 80 per cent),[1] Australia is considered one of the worst per-capita polluters in the world. Considering that the country is expected to produce an estimated 690 million metric tons of carbon dioxide equivalent by 2020 – representing a 24 per cent increase from its 2000 emissions if the current business-as-usual economic pattern continues – the Government recognized that the "clean up later" time had arrived. Reducing Australia's greenhouse gas emissions became increasingly critical for the Government.[2]

What was done?

To move towards a low-carbon economy, the country passed legislation to introduce a carbon pricing scheme in February 2011.

A two-stage system

The carbon pricing mechanism is composed of an initial three years' carbon tax, starting from July 2012 and switching to a market-based emission trading scheme thereafter. For the fixed price period of the initial three years, the scheme will affect 500 of Australia's biggest polluting companies, which generate more than 25,000 tons of carbon dioxide each year.[3] Activities such as burning of fossil fuel for electricity generation and transportation, heavy industries (such as steel making or concrete), mining industries (such as coal and liquefied natural gas mining) and waste management will be liable under the scheme.

The price will start at A$23 per ton as of 1 July 2012.[4] In each of the next two years, it will rise by 2.5 per cent in real terms, assuming inflation of 2.5 per cent a year.[5] This will give industries time to acclimate to the new system and start planning ways to reduce their pollution. In the flexible price period, starting from July 2015, the carbon price will be set by the market.

[1] *Reuters*, "Australia Passes Forest, Farm Offsets Scheme", August 22, 2011. Available from www.energy-enviro.fi/index.php?PAGE=2&NODE_ID=4&ID=3767 (accessed 8 November 2011); and *The Economist*, "Pushing for a carbon tax in Australia: An expensive gamble", July 14, 2011. Available from www.economist.com/node/18959030 (accessed 8 November 2011).

[2] Balazs Koranyi, "Australia Plans Carbon Tax from 2012: Report", *Reuters*, February 11, 2011. Available from www.reuters.com/article/2011/02/12/us-australia-emissions-idUSTRE71B0DZ20110212 (accessed 8 November 2011).

[3] Commonwealth of Australia, *Securing a Clean Energy Future: The Australian Government's Climate Change Plan* (Canberra, Australian Government, 2011). Available from www.cleanenergyfuture.gov.au/wp-content/uploads/2011/07/Consolidated-Final.pdf (accessed 5 January 2012).

[4] Australian Government website "Clean Energy Future: Carbon Price" (2012), Available from www.cleanenergyfuture.gov.au/clean-energy-future/carbon-price/#content01 (accessed 17 February 2012).

[5] Commonwealth of Australia, *Securing a Clean Energy Future: The Australian Government's Climate Change Plan* (Canberra, Australian Government, 2011). Available from www.cleanenergyfuture.gov.au/wp-content/uploads/2011/07/Consolidated-Final.pdf (accessed 5 January 2012).

Recycling revenue for mitigating distributional impacts, job creation and investing in clean energy and climate change programmes

The revenue from the carbon tax will be recycled by the Government in three main areas:

- Assist households (50 per cent of the revenue)
- Support jobs and enhance competitiveness
- Invest in clean energy and climate change programmes (40 per cent).[6]

With the scheme, household spending will increase by an estimated A$9.90 a week on average, including electricity and gas bills. Households will receive, however, an average of A$10.10 a week in assistance through tax cuts, an increase in pensions or family payments, particularly focusing on pensioners and low- and middle-income households.[7] A Jobs and Competitiveness Programme will receive A$1.3 billion in assistance. About A$10 billion will also be invested over five years in wind, solar and other reusable energy sources; and A$1.2 billion will be used for a Clean Technology Programme to improve energy efficiency and support research.

A separate arrangement for the agriculture industry

Agriculture is not included in the scheme, but the Clean Energy Future's Land Sector Package will allocate A$1.7 billion across a range programmes and measures, including the Carbon Farming Futures, which incorporates research, deployment and outreach into new methods and technologies for land management for carbon farming. It also includes the Biodiversity Fund, the Indigenous Carbon Farming Fund, the Regional Natural Resource Management Planning for Climate Change Fund, the Carbon Farming Skills programme, the Carbon Farming Initiative Non-Kyoto Carbon Fund and the establishment of a Land Sector Carbon and Biodiversity Board to provide expert advice on the implementation of these measures.

The entire package is "about creating new opportunities for land managers to enhance productivity, gain economic benefits and help the environment by reducing greenhouse gas emissions. Actions to reduce greenhouse gas emissions or increase carbon storage can also increase the land sector's resilience to climate change, protect Australia's natural environment and improve long-term farm productivity."[8]

Management and monitoring by multiple independent authorities

To make the carbon pricing scheme efficient, different roles have been assigned to multiple authorities, including independent entities: the Government and the parliament will be responsible for making major policy decisions that require the balancing of economic, social and environmental factors. The Climate Change Authority will review pollution caps, the future trajectory of Australia's pollution levels and the overall performance. It will also track Australia's progress towards meeting its targets for reducing carbon pollution. The Clean Energy Regulator will administer elements of the carbon pricing mechanism. The Productive Commission will also review industry assistance and the impact of the carbon price on industry and continue reporting on actions by other countries to reduce carbon pollution.

Expected outcomes

From this scheme, Australia expects to reduce its carbon emissions by 159 million tons by 2020, which would be 5 per cent below the 2000 levels, and by 80 per cent of their 2000 levels by 2050.[9] During the same period, the share of large-scale renewable energy (excluding hydropower) is expected to expand by 18 times; including hydropower, 40 per cent of the electricity generation would be covered by renewable energy.

[6] *The Economist*, "Pushing for a carbon tax in Australia: An expensive gamble", July 14, 2011. Available from www.economist.com/node/18959030 (accessed 8 November 2011).

[7] *Commonwealth of Australia, An Overview of the Clean Energy Legislative Package* (Canberra, Australian Government, 2011). Available from www.cleanenergyfuture.gov.au/wp-content/uploads/2011/11/CEF-overview-20111109.pdf (accessed 5 January 2012).

[8] Commonwealth of Australia, Department of Agriculture, Fisheries and Forestry website "Carbon Farming Futures" (15 November, 2012). Available from www.daff.gov.au/climatechange/carbonfarmingfutures (accessed 20 February 2012).

[9] Commonwealth of Australia, *Securing a Clean Energy Future: The Australian Government's Climate Change Plan* (Canberra, Australian Government, 2011). Available from www.cleanenergyfuture.gov.au/wp-content/uploads/2011/07/Consolidated-Final.pdf (accessed 5 January 2012).

Double dividend

An economic dividend is also expected: By 2050, the country should experience an increase in gross national income per person, by about A$30,000 in today's dollar terms.[10] In addition, 1.6 million jobs are expected to be created by 2020 due to carbon pricing.[11]

[10] ibid.

[11] ibid.

CASE STUDY

A paradigm shift in managing water supplies
Australia's water-sensitive urban design

Key points

- ***Rapid urban development and population increase changes the natural water cycle and depletes water resources.***
- ***The current heavy reliance on a large-scale water system may not be suitable to meet increasing demand in urban areas because of its impact on the natural hydrological cycle and energy consumption.***
- ***To overcome this challenge, it is necessary to integrate an eco-efficiency perspective into urban planning by diversifying the urban water system into eco-efficient localized systems.***

There was a problem...

Australia is subject to climate variability and experiences reoccurring floods, droughts and water scarcity. Water resource management is a significant challenge for urban planning in Australian cities. Rapid urban development has expanded the impacts on the ecosystem and changed the natural water cycle. The rapid population growth will inevitably increase the stress on water resources. Additionally, newly developed settlements are increasingly remote from the conventional centralized system and require more transmission costs.

What was done?

A guideline for water-sensitive urban design was created in Western Australia in 1994 and became significant for national water management.[1] The National Water Commission refers to this approach as capable of ensuring "that urban water management is sensitive to natural hydrological and ecological cycles. It integrates urban planning with the management, protection and conservation of the urban water cycle."[2] By managing the urban water cycle, the sensitive urban design concept maximizes the value of water-related services while minimizing the impacts of urban development on the ecosystem.

Local authorities adopted the concept, and capacity-building projects were instigated at different levels, including among policymakers and politicians. The concept encourages integrating several water management systems, such as rainwater tanks and gravel recharge trenches, into urban design: Urban landscapes and buildings are designed in relation to minimizing their impact on the ecosystem.[3] Integrating eco-efficient water cycle management with urban design also helps to achieve significant energy conservation and socio-economic cost cuts.

The project of Figtree Place located in Hamilton, an inner suburb in New South Wales, is an example of how water-sensitive urban design promotes an eco-efficient way of water management. By installing rainwater tanks, gravel recharge trenches and a central infiltration basin at the Hamilton bus station, 60 per cent of fresh water use was reduced, while the quality of rainwater maintained was acceptable for hot water clothes washing, toilet flushing and other non-potable uses.[4]

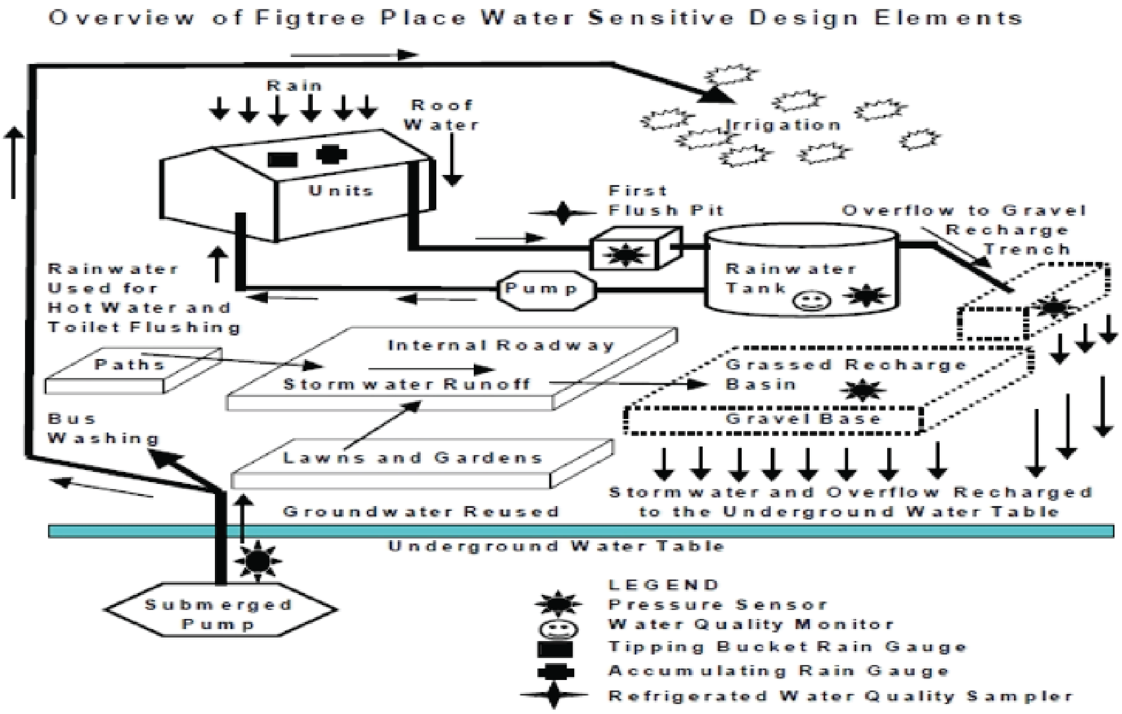
[1] United Nations Economic and Social Commission for Asia and the Pacific, *Generic Guideline to an Eco-efficient Approach to Water Infrastructure Development* (Bangkok, UNESCAP and KOICA, 2011).

[2] Australian Government, National Water Commission website "Water Sensitive Urban Design" (13 December 2011). Available from http://nwc.gov.au/urban/more/water-sensitive-urban-design (accessed 2 February 2012).

[3] "Integrated Water Cycle Management" (IWCM) developed from a number of water management approaches, including water-sensitive urban design. It is a multi-objective approach to achieve the sustainable use of water resources.

[4] United Nations Economic and Social Commission for Asia and the Pacific, *Generic Guideline to an Eco-efficient Approach to Water Infrastructure Development* (Bangkok, UNESCAP and KOICA, 2011).

Figure 1: Figtree Place water-sensitive design concept



Source: Peter J. Coombes, John R. Argue and George Kuczera, "Figtree place: A case study in water sensitive urban development", *Urban Water* (2000), vol. 1, No. 4, pp. 335-343.

Considerations for replicating

Asian and Pacific countries are experiencing tremendous urbanizing while maintaining the conventional forms of managing their water supplies. The water-sensitive urban design in Australia represents a paradigm shift in water management, from reliance on the centralized system to more optimal water infrastructure. By integrating various aspects of water cycle management into urban planning and designing, multiple benefits can be obtained, such as reduction in freshwater demands and minimizing the discharge of wastewater.

Further reading

Generic Guidelines to an Eco-Efficient Approach to Water Infrastructure Development (UNESCAP, 2011).

"Water Sensitive Urban Design"(Australian National Water Commission website). Available from www.nwc.gov.au/urban-water/more-about-urban-water/water-sensitive-urban-design

Water Sensitive Urban Design in the Australian Context, synthesis of a conference in 30–31 August 2000, Melbourne, Australia, Technical Report 01/7 by Sara D. Lloyd (2001). Available from www.catchment.crc.org.au/pdfs/technical200107.pdf

CASE STUDY

Rising above the congestion
Bangkok, Thailand's mass transit system

Key point

- ***The role of government is critical in ensuring that public-private partnership is in line with the goals of public transport – economic efficiency, ecological resilience and social inclusiveness.***

There was a problem…

For two decades, Bangkok's traffic congestion was legendary – and growing worse. The impact on the city's GDP was considerable. With high-rise development on the horizon that would bring more people into the city, moving people around without a car became an imperative.

What was done?

The city planners opted for an elevated metropolitan rail system – the Bangkok Mass Transit System (BTS). The BTS opened in December 1999 with two lines and 23 stations. Operated by the Bangkok Mass Transit System Public Company (BTSC), the BTS covers much of the central business district. The two intersecting lines now total 55 kilometres and have added seven stations. The BTS has considerably helped ease Bangkok's traffic congestion and provides an environment-friendly transportation alternative. Each train carries more than 10,000 passengers per day – a similar number of people would induce the trips of 800 motorized vehicles on the road. In March 2011, the system averaged 505,000 daily riders and is growing steadily.

Public-private partnership

Bangkok's government, the Bangkok Metropolitan Authority (BMA), signed a 30-year mixed build-operate-transfer concession with the BTSC, ending December 2029, although it is renewable for ten years. The BMA awarded the BTS concession under authority from Thailand's Ministry of Interior.

- The BTSC, a special-purpose private company, is responsible for 100 per cent of the design, financing, construction, operation and management of the capital asset and service.[1] The total project cost of the initial 23 km system was approximately 55 billion Thai baht (US$1.3 billion), up from an initial 32 billion baht due to currency depreciation.[2] There are no revenue sharing or concession fees for the BMA. However, the BTSC must ensure adequate levels of safety in construction and operations.
- The public sector is responsible for providing right-of-ways, monitoring construction and operations as well as approving fare increases. The concession contract provided for fare increases every 18 months, with the increase in consumer price index. There were also concession provisions for increases in the event of exceptional circumstances, including major changes in foreign exchange rates.

[1] Martin Spicer, "BTS skytrain case study: The experience of Bangkok's first private mass-transit concession", PowerPoint presentation at the World Bank Transport Learning Week 2006, Washington, D.C., 3 April, 2006. Available from http://siteresources.worldbank.org/INTTRANSPORT/Resources/336291-1152796664200/2749337-1153152935396/spicer-c4-btsc-case-study.pdf (accessed 16 November 2011).

[2] Prako Chirakiti, "Public and private partnership in Bangkok", Powerpoint presentation. Available from www.citynet-ap.org/images/uploads/resources/2_DrPrakob.pdf (accessed 16 November 2011); Poona Antaseeda and Krissana Parnsoonthorn, "They said pigs would never fly", *1999 Economic Review: Year-End*, 1999. Available from www.bangkokpost.com/99year-end/13transport.htm (accessed 16 November 2011).

Lessons learned

The BTS, which is designed, constructed and operated entirely by a private company, displays several benefits of private operation. First, the private operation enables efficiency of expenditure and the maximizing of revenue and profit. For instance, the BTSC recorded its first profit in 2009 with the completion of restructuring the BTS, which cost 67 billion baht in late 2008. The BTSC is currently covering operating costs, with revenue from the mass transit system, media (advertising in and on the train and stations), rental property and other service business. The biggest portion of the BTS revenue contribution comes from the mass transit fares (65 per cent) and the media business (23 per cent). It also promotes maintaining high-quality service and creative marketing for additional revenue.

Private operation has its risks. Because the responsibility for the costly investment is solely left to the BTSC, it is difficult to expect an extensive BTS network, which is socially and ecologically desirable but may not be commercially viable. In addition, the lack of coordination with other municipal transportation services limits overall transportation efficiency. There is a lack of physical and fare integration with most of the other urban transportation methods (bus, subway and boat).

Considerations for replicating

Because private interests often differ from public interests they are more short-sighted and usually do not factor in social and ecological costs as well as the benefits. Governments need to make sure that these factors are considered in infrastructure projects when engaging the private sector. In the case of Bangkok's BTS, this was done through monitoring mechanisms for construction and maintenance and by restricting ticket price increases. Although this approach may guarantee economic efficiency, more public guidance may be needed to establish a transport system that also reaps the most benefits for society and the environment.

Further reading

A Tale of Three Cities: Urban Rail Concessions in Bangkok, Kuala Lumpur and Manila, by World Bank (Washington, D.C., 2004).

Bangkok's Mass Transit: Planning, Design, Financing, Development: The "Mega Projects" Update 2002–2009, by J.M. Cobb (Bangkok, TransGate International Development Consultants, 2009). Available from www.bangkoktransport.net.

CASE STUDY

Controlling millions of vehicles
Beijing, China's traffic policy package

Key point

- ***Beijing city government takes six steps to control private vehicle use and improve public transport.***

There was a big problem…

Due to fast economic growth and the increasing number of residents, Beijing now suffers from massive traffic congestion. In 2009, the net increase of vehicles reached 515,000 in the city, close to the 580,000 total vehicle population in Hong Kong, China. The Beijing government estimated that the vehicle population exceeded 4.7 million in 2010, with an average daily gain of about 2,000 vehicles.[1]

What was done?

In December 2010, the Beijing government instituted a combination of policy measures to control private vehicle use and improve public transport. This involved a six-step plan, with 28 specific measures aimed at controlling the motorized vehicles (in line with the national Twelfth Five-Year Plan). The city planned to use both regulatory and economic instruments to control the number of motorized vehicles and to reduce the traffic volume.

Control of license plates: Beijing introduced a quota system for license plates to regulate the increasing number of private cars. Under the quota system, only 240,000 license plates were issued through a lottery system in 2011, compared with 700,000 the previous year. The license plates will be issued only for permanent residents of Beijing.

Odd-even license plate system: Additionally, the Beijing government imposed an odd-even license plate system to reduce the number of the cars on the roads during special events and extreme weather conditions. The system allows cars to drive on alternate days, based on the license plate number. This measure is already in place a few other cities around the world, such as Bogota and Mexico City. However, the scheme is a temporary solution because it encourages owners to buy a second car.

Traffic restriction for non-residents to Beijing for peak hours: Cars registered outside of Beijing will not be allowed into the city during peak hours. Check points are set up to prevent motorists to enter the fifth ring road from 7 a.m. to 9 a.m. and from 5 p.m. to 8 p.m. This encourages people to commute by train or bus to the city.

Control of the number of official vehicles:[2] The Beijing municipal government launched a special campaign to restrict official motor vehicles, which covers various organizations, political advisory bodies, government-funded institutions among others. The growth in official vehicles is also one of the reasons for the traffic congestion – they contribute 15 per cent of the city's car ownership. Restrictions will be applied on the purchase and operation of official vehicles.

Increasing parking fees: Since 2002, the Beijing government gradually increased parking fees to discourage vehicle use. Parking fees in non-residential areas have increased to discourage driving to work. Based on the level of congestion, the non-residential areas have been divided into three zones. The parking fees were raised from 2 yuan to 10 yuan in April 2010; the fee is also as high as 15 yuan in the highly congested zones.[3]

[1] Chen Xing, "Beijing's Plan to Steer Clear of Traffic Jams", *China Daily*, December 14 2010. Available from www.chinadaily.com.cn/china/2010-12/14/content_11696079.htm (accessed 26 February 2012).

[2] Guanqung Wang, "China Launches Special Campaign to Restrict Use of Official Vehicles", *Xinhua*, May 31 2011. Available from www.gov.cn/english/2011-05/31/content_1874275.htm (accessed 26 February 2012).

[3] Ye Xin, "Beijing's Car Owners Switch to Bikes as Parking Fees Rise", *People's Daily Online*, April 15, 2011. Available from http://english.people.com.cn/90001/90776/90882/7351622.html (accessed 26 February 2012).

Preliminary results

The initial traffic-control measures have started to have an impact, reports the Beijing Municipal Commission of Transport:

- The average travel speed for motorized vehicles has increased to 28 km per hour during morning peak hours.[4]
- There was about a 4 per cent increase in public transport passengers (January–March 2011), compared with the same period of 2010 (January–March)[5].
- The average daily rail passengers increased to 21 per cent (January–March 2011), compared with the same period of 2010 (January–March).[6]
- Daily parking fee of up to 60 yuan and an increase in gasoline prices led motorists to commute by bicycle to work.[7]

Future plan

The Beijing government announced in September 2011 that it will impose congestion charges for specific zones to ease traffic.[8] The specific details are not yet released. Further to the measures already introduced, this is expected to limit private vehicle use and encourage the uptake of public transport.

[4] Jia Xu, "Beijing Traffic Congestion Eases", *China Daily*, April 18 2011. Available from www.chinadaily.com.cn/2011-04/18/content_12345368.htm (accessed 26 February 2012).

[5] People's Daily Online, "Beijing's Congestion Control Measures Pay Off", April 18 2011. Available from http://english.peopledaily.com.cn/90001/98649/7353674.html (accessed 26 February 2012).

[6] ibid.

[7] Ye Xin, "Beijing's Car Owners Switch to Bikes as Parking Fees Rise", *People's Daily Online*, April 15, 2011. Available from http://english.people.com.cn/90001/90776/90882/7351622.html (accessed 26 February 2012).

[8] Sabrina Mao, Terril Yue Jones and Ken Wills, "Now Beijing Plans Congestion Fee to Ease Traffic", *Reuters*, September 2 2011. Available from www.reuters.com/article/2011/09/02/us-china-traffic-beijing-idUSTRE78119I20110902 (accessed 26 February 2012).

CASE STUDY

A president prioritizes a different future
Brazil's National Plan on Climate Change and Law

Key point

- ***Political leadership is what it takes to make the necessary changes within policies, plans, laws and institutions.***

There was a problem…

According to Brazil's second National Inventory of Greenhouse Gas Emissions, the country's greenhouse gas emissions increased by approximately 60 per cent between 1990 and 2005 – from 1.4 gigatons to 2.192 gigatons of equivalent carbon dioxide (CO_2e).[1] The majority of the emissions derive from land and forestry use change, which accounted for 61 per cent of total emissions during that time period. Emissions from industry and waste treatment were, respectively, 3 per cent and 2 per cent of the national total.[2]

What was done?

Under the United Nations Framework Convention on Climate Change (UNFCCC), cutting greenhouse gas emissions is voluntary for developing countries. To curb the rate of deforestation of the Amazon forest and CO2 emissions generated from it in Brazil, the president demanded national plans and policies, backed by legislation, that established institutional mechanisms and innovative financial mechanisms with international support.

In April 2007, the president made the preparation of a climate change plan a national priority. In November 2007, the Government created the Inter-Ministerial Committee on Climate Change to develop, monitor and evaluate the National Plan on Climate Change. This Committee is coordinated by the Office of the President and consists of 17 federal bodies and ministries and the Brazilian Forum on Climate Change.

National Climate Change Plan

In December 2008, the Government launched the National Climate Change Plan. The plan seeks to reduce greenhouse gas emissions mainly through mitigation and adaptation efforts, promotion of renewable energy, reducing deforestation and loss of forests and R&D.[3] The plan includes such targets as:

- Increasing recycling of urban waste by 20 per cent by 2015
- Reducing the annual rate of deforestation by 80 per cent by 2020
- Increasing domestic consumption of ethanol by 11 per cent per year by 2020
- Increasing the contribution of co-generation electrical energy, especially of sugarcane biogases, to 11.4 per cent of the total supply of electricity in the country by 2030.[4]

National reduction targets

In December 2009, following a presidential decree, the National Policy on Climate Change was adopted. With this law, Brazil legally established its voluntary national reduction target of 36.1–38.9 per cent of projected emissions by 2020, compared with the 2000 levels. It also laid out sector-based reduction targets (which were absent

[1] Federative Republic of Brazil, *Emissions Inventory* (Cancun, Mexico, Ministry of Environment, 2010). Available from www.brasil.gov.br/cop-english/overview/what-brazil-is-doing/emissions-inventory (accessed 25 January 2012).

[2] ibid.

[3] Federative Republic of Brazil, *National Climate Change Plan* (Cancun, Mexico, Ministry of Environment, 2010). Available from www.brasil.gov.br/cop-english/overview/what-brazil-is-doing/national-climate-change-plan (accessed 25 January 2012).

[4] ibid.

in the national plan) including in deforestation, agriculture and livestock, energy and the forested charcoal in the steel sector. The law also requires mitigation actions to be quantifiable and verifiable.

Twelve sector-based policies were developed and implemented in 2011 to achieve these targets on an economy-wide scale.[5] Incentives and financing mechanisms were also put in place to support actions. Additional reduction targets are planned to be based on the second Brazilian Greenhouse Gas Emissions Inventory, which was finalized in 2010 and covers the period from 1990 to 2005.[6]

Financing law

In 2009, the National Fund on Climate Change Law was created to finance climate change mitigation and adaptation activities of the national plan. The fund was officially established in 2010 and supports adaptation, combating desertification, education, training, REDD+, technology development, public policy development, sustainable production chains and payment for environmental services activities. Of the $226 million reais budget, the state-owned Brazilian Development Bank manages $200 million reais, for covering repayable loans and financing production areas.[7] The Ministry of the Environment manages the remaining $26 million reais, which supports research projects, climate change impact studies and other activities.[8] The revenue mainly derives from a special levy on the profits from oil production.

Amazon Fund

In 2008, the Amazon Fund was created (by decree) through a pledge of donation of US$1 billion from the Norwegian Government that is to be distributed across a period of eight years.[9] The money is to finance non-reimbursable activities and projects aimed at preventing, monitoring and combating deforestation and promoting conservation and the sustainable use of the Amazon forest. The Government is also open to other international contributions to the fund. The Brazilian Development Bank manages the fund and issues certificates that certify emissions reductions (the reductions are certified by the Technical Committee of the Amazon Fund, whose members the Ministry of the Environment appoints) achieved through use of financial contributions from the fund. According to the Amazon Fund website, these certificates are "nominal, non-transferable and do not generate rights or credits of any nature".[10] Up to 20 per cent of the fund can be used to establish systems to monitor and control deforestation in areas other than the Amazon and in other tropical countries.[11] Currently, 15 projects are being financed from this fund, amounting to US$120 million, to reduce deforestation and to promote the sustainable use of forests in the Amazon region.[12]

Results

Brazil's rate of deforestation is estimated to have slowed in recent years as a result of the prioritized national efforts tackling forest degradation.[13] In 2011, it achieved a reduction of 66 per cent compared with the average deforestation rate between 1996 and 2005, which is the lowest rate since its monitoring system was put in place in 1988. The actual reductions amounted to a little more than 6,000 square kilometres. During its peak, deforestation reached 27,000 square kilometres.[14]

[5] Federative Republic of Brazil, "New Decree Details Brazil's National Policy on Climate Change", *Press release*, December 15, 2010. Available from www.brasil.gov.br/news/history/2010/12/10/new-decree-details-brazil2019s-national-policy-on-climate-change (accessed 25 January 2012).

[6] World Resources Institute, "Brazil's Global Warming Agenda", *News*, March 1, 2010. Available from www.wri.org/stories/2010/03/brazils-global-warming-agenda (accessed 25 January 2012).

[7] Federative Republic of Brazil, *"Climate Fund and Amazon Fund", website (2010)*. Available from www.brasil.gov.br/cop-english/overview/what-brazil-is-doing/climate-fund-and-amazon-fund (accessed 25 January 2012).

[8] ibid.

[9] Amazon Fund website "Donations". Available from www.amazonfund.gov.br/FundoAmazonia/fam/site_en/Esquerdo/doacoes/ (accessed 25 January 2012).

[10] ibid.

[11] ibid.

[12] Federal Republic of Brazil, "Official Statement of Minister of the Environment of Brazil, Dr. Izabella Teixeira", statement presented at the high-level segment of the 17th session of the Conference of the Parties to the UNFCCC, Durban, 8 December 2011. Available from http://unfccc.int/files/meetings/durban_nov_2011/statements/application/pdf/111208_cop17_hls_brazil.pdf (accessed 13 February 2012).

[13] ibid.

[14] ibid.

CASE STUDY

Pooling water systems in a small developing island
Cebu City, Philippines' integrated stormwater management

Key point

- ***Combining policy planning for stormwater management, rainwater harvesting and wastewater treatment is a valuable option for developing eco-efficient water infrastructure to tackle such problems as water shortage, floods and public health concerns – in unison.***

There was a problem…

Due to rapid urbanization and the depletion of water resources, the water system in Cebu City in central Philippines was confronted with a quiet crisis: 1) over-extraction of aquifers, 2) increasing water demand, 3) lack of rainwater storage, 4) discharge of untreated wastewater and 5) lack of effective flood management.[1]

The fragmentation of water resource management by sectors was a main cause of the problems, along with the weak enforcement of environmental policies and regulations. Compounding the situation, there was low public awareness and a low level of concern.

What was done?

To overcome the challenges, integrating the water resource management became an essential policy direction. To demonstrate the effectiveness of integrated water management, UNESCAP and the Department of Science and Technology Regional Office No.7 (DOST7) initiated a pilot project in Cebu City on integrated stormwater management. Through the following steps, it sought to reduce the impact of stormwater on the ecosystem and promote the reuse of wastewater:

- After computer simulation modelling, several components were installed in a facility in the heart of DOST7: rainwater collection, primary rainwater treatment, a micro-membrane filtration system, an integrated rainwater administration system, rainwater drainage against emergencies and a reuse water treatment system.
- Local government officials received capacity training on planning and management of the integrated approach and the stormwater recycling system as they implemented the pilot project.
- Site visits to the facility raised public awareness.
- Information technology was installed that facilitated the simulation modelling, rainfall data analysis and the monitoring and controlling systems in remote areas.

Results

- After the integrated stormwater management facility was installed, it achieved a reduction of 75 per cent in dependence on water coming from the Metro Cebu Water District.[2]
- The facility could manage floods in the DOST7 district.
- Treatment of greywater met the requirements of the clean water law.

[1] Rene Burt N. Llanto and Juan Edgar C. Osorio,"Eco-efficient water infrastructure development in the Philippines:Integrated storm water management in Cebu", paper presented at Third Regional Workshop on Eco-Efficient Water Infrastructure in Asia, Bangkok, 23-25 November, 2010. Available fromwww.unescap.org/esd/Energy-Security-and-Water-Resources/water/projects/eewi/workshop/3rd/documents/Presentation/Session%203-part2/Llanto-DOST.pdf(accessed 2 February 2012).

[2] United Nations Economic and Social Commission for Asia and the Pacific, Executive Summary of a Project on Integrated Stormwater Management System in Cebu, the Philippines (Bangkok, 2011).

- The facility became a valuable visual tool to raise public awareness regarding rainwater, stormwater and wastewater management.

Benefits

The facility became a model of integrated stormwater management and generated major benefits:

- Cost savings from the control of stormwater and flood damage, the reduction of unnecessary investment in overlapping systems, the reduction of freshwater demand and the reduction of piping energy
- The conservation of water resources and the ecosystem
- The increased motivation among public officials to incorporate an eco-efficiency perspective into the water system.

Considerations for replicating

The pilot project on integrated stormwater management proved that the basic concept of integration can be replicated in a developing country setting and in small islands. Despite its relatively abundant rainfall, Philippine communities suffer from water stresses. Ensuring a sustainable clean water supply has been one of the most urgent challenges because population growth, urbanization and economic development have increased the pressure on the water resources. The results of the project illustrate the possibility of integrating several water systems and overcoming various water-related problems.

Further reading

Executive Summary of a Project on Integrated Stormwater Management System in Cebu, the Philippines (UNESCAP, 2011).

CASE STUDY

Voluntarily confronting the largest sources of emissions
China's carbon trade

Key point

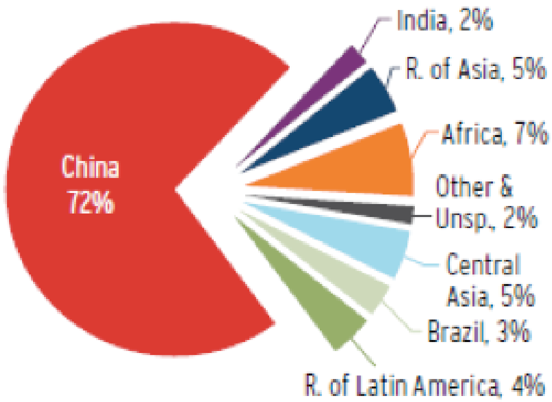
- ***China is the world's largest carbon dioxide emitter and Clean Development Mechanism host. Although still in the initial stage, the Chinese Government is setting up a carbon trade system to achieve its mitigation targets cost-effectively.***

There was a problem…

Along with its increased energy consumption, the greenhouse gas emissions in China have attracted tremendous concern from the world community. The total amount of carbon dioxide emissions in China increased by 9.1 per cent from its 2008 levels and exceeds 7 billion tonnes today, making China the world's largest greenhouse gas emitter.[1]

At the same time, China has become the largest Clean Development Mechanism host and maintained its overall dominance with a 72 per cent share of the market in 2009, even under the influence of an economic downturn (figure 1). China's contribution created a carbon market of US$2 billion accumulatively and helped to reduce its carbon dioxide emissions.[2]

Figure 1: The market share of Clean Development Mechanism projects in 2009



Source: Alexandre Kossoy and Philippe Ambrosi, *State and Trends of the Carbon Market 2010* (The World Bank, 2010). Available from http://publications.worldbank.org/index.php?main_page=product_info&cPath=0&products_id=24243(accessed 26 January 2012).

[1] BP p.l.c., *BP Statistical Review of World Energy* (London, 2010). Available from www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2008/STAGING/local_assets/2010_downloads/statistical_review_of_world_energy_full_report_2010.pdf (accessed 26 January 2012).

[2] Alexandre Kossoy and Philippe Ambrosi, *State and Trends of the Carbon Market 2010* (The World Bank, 2010). Available from http://publications.worldbank.org/index.php?main_page=product_info&cPath=0&products_id=24243(accessed 26 January 2012).

What was done?

In March 2011, China released its Twelfth Five-Year Plan for National Economic and Social Development (2011-2015), which formally stated that China is planning to set up a carbon trade market, step by step, over the next five years.[3]

China will introduce a carbon trade system that helps to:

- Secure the economic growth while controlling carbon dioxide emissions
- Achieve the national mitigation target cost-effectively.

Setting national targets

For the carbon trade market, a national target was set in the Twelfth Five-Year Plan. Additionally, a set of national targets related to the carbon trade were established for both the short and long terms and could be a compelling force or catalyst for the Chinese carbon trade market (table 1).

Table 1: The national targets related to carbon trade in China

	Name	Targets
Short-term	Twelfth Five-Year Plan on National Economic and Social Development(2011–2015)	Steadily set up the carbon trade market and accelerate the implementing of pilot projects of low-carbon cities.
	Twelfth Five-Year Plan on National Economic and Social Development(2011–2015)	Reduce the carbon intensity (carbon dioxide emission per unit GDP) by 17 per cent in 2011–2015.
	Twelfth Five-Year Plan on National Economic and Social Development(2011–2015)	Reduce the energy intensity (energy consumption per unit GDP) by 16 per cent in 2011–2015.
	Twelfth Five-Year Plan on National Economic and Social Development(2011–2015)	At least 11.4 per cent of primary consumption to come from non-fossil fuel by 2015.
Long-term	Mitigation target	Reduce the carbon intensity(carbon dioxide emission per unit GDP) by 40–45 per cent of 2005 levels by 2020
	Renewable energy target	At least 15 per cent of the primary consumption will come from non-fossil fuel by 2020

Source: People's Republic of China, *The Twelfth Five-Year Plan for National Economic and Social Development: 2011–2015* (Beijing, The State Council, 2010). Available from www.gov.cn/2011lh/content_1825838.htm (accessed 26 January 2012)[in Chinese].

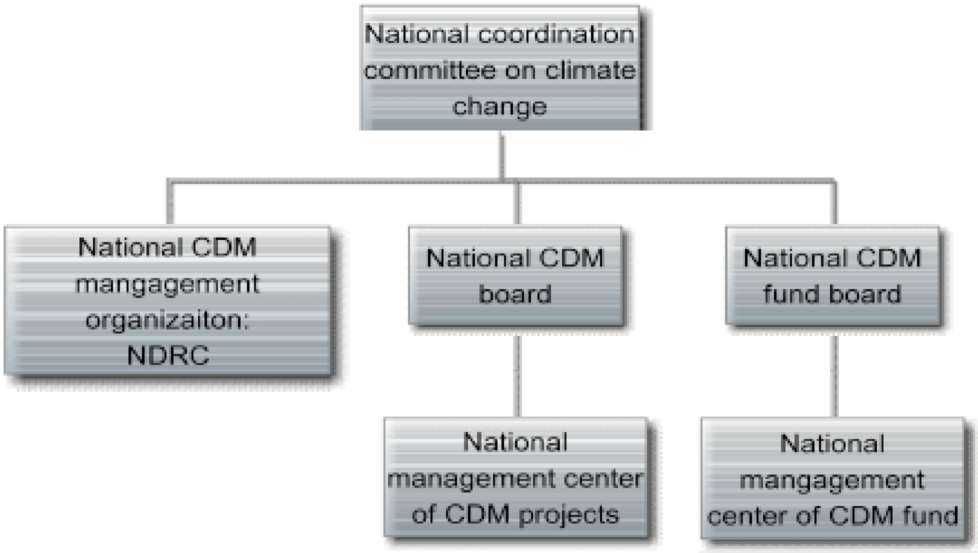
Encouraging Clean Development Mechanism projects

The National Coordination Committee on Climate Change supervises the Clean Development Mechanism trading, nearly representing the entire carbon trade in China now (figure 2).[4]

[3] People's Republic of China, *The Twelfth Five-Year Plan for National Economic and Social Development: 2011–2015* (Beijing, The State Council, 2010). Available from www.gov.cn/2011lh/content_1825838.htm (accessed 26 January 2012) [in Chinese].

[4] People's Republic of China, *The Management Methods of CDM Projects*, Amendment (Beijing, National Development and Reform Commission, 2011). Available from http://cdm.ccchina.gov.cn/WebSite/CDM/UpFile/File2692.pdf (accessed 26 January 2012) [in Chinese].

Figure 2: National coordination for managing Clean Development Mechanism in China



Source: ESCAP adapted from National Development and Reform Commission of the People's Republic of China.

There are four priority fields for Clean Development Mechanism projects, ranging from renewable energy and energy efficiency to alternatives of methane and fuels. These fields were favoured in the application of domestic projects (table 2).

Table 2: The preference fields of Clean Development Mechanism projects in China

Fields	Contents
New and renewable energy	Wind power, hydro power, biomass and solar PV stations
Energy efficiency	Power generation from waste gas and heat
Alternatives of CH_4	Coal bed methane
Alternatives of fuel	Natural gas

Source: People's Republic of China, The Management Methods of CDM Projects, Amendment (Beijing, National Development and Reform Commission, 2011). Available from http://cdm.ccchina.gov.cn/WebSite/CDM/UpFile/File2692.pdf (accessed 26 January 2012) [in Chinese].

Financing

A national Clean Development Mechanism fund was established to dole out grants that support policy research, academic activities, international cooperation and education activities on climate change as well as green investments, including equity investments, loans and financing guarantees.[5]

Setting up national carbon exchange centres

Three voluntary environmental exchange centres were established in Beijing, Tianjin and Shanghai in 2008 through private sector collaborations, with approval from the municipal governments. These are pilots for testing the use of domestic emission trading as a tool to support the climate change mitigation strategy (table 3).

[5] ibid.

Table3: The three primary carbon exchange centres in China

Name	Founding date	Description
China Beijing Environmental Exchange (CBEEX)	5 August 2008	• The China Beijing Environmental Exchange provides a market platform for trading various environmental commodities. • The CBEEX also facilitates CDM transactions and is generating market demand for voluntary emissions reduction.
Tianjin Climate Exchange (TCX)	26 September 2008	• The Tianjin Climate Exchange is China's first integrated exchange for the trading of environmental financial instruments. • Its focus is similar to the CBEEX but it also promotes energy efficiency through intensity-based emissions trading, particularly for heating suppliers. • The first sale was in February 2010. After the pilot phase, the Tianjin plan may be extended to cover all public, commercial and residential buildings and their heating suppliers.
Shanghai Environment Energy Exchange (SEEE)	5 August 2008	• The Shanghai Environment Energy Exchange provides a platform for trading asset rights, creditors' rights, stock rights and intellectual property rights, focusing on the environment and energy. • It is exploring a new market mechanism aligned with the requirements of the Clean Development Mechanism. • The exchange is intended to reduce transaction costs and bring more transparency to certified emissions reduction pricing.

Source: Alexandre Kossoy and Philippe Ambrosi, *State and Trends of the Carbon Market 2010* (The World Bank, 2010). Available from http://publications.worldbank.org/index.php?main_page=product_info&cPath=0&products_id=24243(accessed 26 January 2012).

Creating the voluntary emissions reduction market

As a non-Annex I country of the Kyoto Protocol, China has no mandatory emission reduction obligation, which means that the voluntary emissions reduction market might be important to establish a strong demand for the domestic carbon market.

For the voluntary reduction market, the China Beijing Environmental Exchange is developing a "Panda Standard" for domestic greenhouse gas offset assets in the agriculture and forestry sectors, with social co-benefits (figure 3).[6]

According to the Panda Standard website, "The China Beijing Environment Exchange (CBEEX) and Blue Next founded the Panda Standard as the first Chinese domestic voluntary carbon standard, designed to provide transparency and credibility in the nascent Chinese carbon market" and to advance the Government's poverty alleviation objectives by encouraging investments in the rural economy. The Panda Standard supports the Government's commitment to reduce the greenhouse gas emissions intensity of its economy, help develop national capacity in domestic voluntary carbon markets, and promote agriculture, forestry and other land use greenhouse gas offset projects "with significant poverty alleviation benefit."[7]

The Panda Standard version 1.0 was launched at the Conference of Parties 15 in Copenhagen in December 2009. It describes the overall organization of the Panda Standard Association and the core procedures of its project certification scheme, which aim at providing transparency and credibility in the Chinese carbon market.

[6] The Panda Standard website "What is the Panda Standard?" (2010). Available from www.pandastandard.org/standard/standard.html (accessed 26 January 2012).

[7] ibid.

Figure 3: The first pilot voluntary emissions reduction project of Panda Standard

Carbon Credits Transaction Certificate

碳减排量交易证明书

兹此证明，方兴地产（中国）有限公司于2011年3月29日通过北京环境交易所购买16,800吨产自云南西双版纳竹林碳汇项目的熊猫标准自愿减排量。

This is to certify that on March 29th 2011,Franshion Properties (China) Limited has purchased, through China Beijing Environment Exchange, 16,800 tonnes of Panda Standard VERs from Yunnan Xishuangbanna Bamboo Reforestation Project.

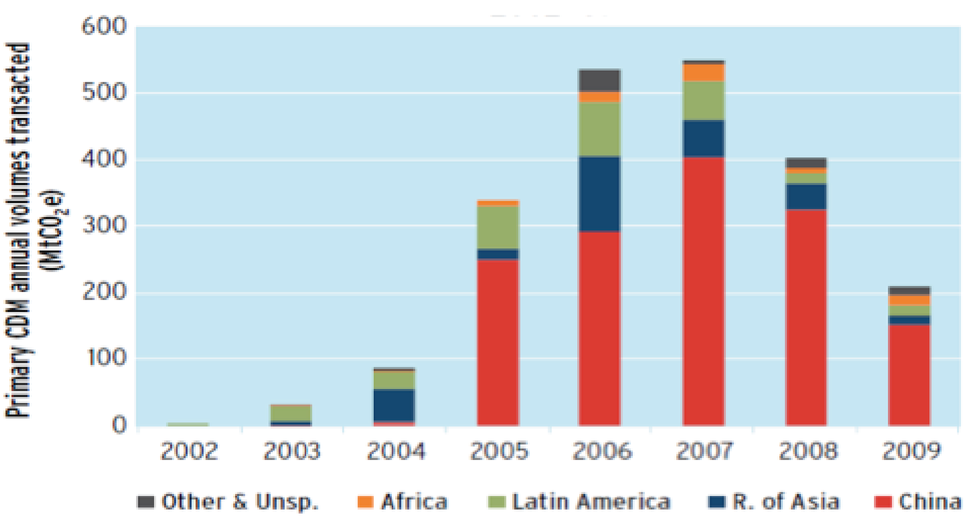
北京环境交易所
China Beijing Environment Exchange
2011年03月29日

Source: China Beijing Environment Exchange, *China's First Voluntary Emissions Reduction Standard to Achieve the First Transaction* (Beijing, 2011). Available from www.cbeex.com.cn/article/xwbd/201103/20110300029728.shtml (accessed 26 January 2012).

Results

According to World Bank data, China has become the world's largest Clean Development Mechanism host since 2005, with a market share of more than 50 per cent(figure 4).

Figure 4: The development of Clean Development Mechanism in the world since 2002



Source: Alexandre Kossoy and Philippe Ambrosi, *State and Trends of the Carbon Market 2010* (The World Bank, 2010). Available from http://publications.worldbank.org/index.php?main_page=product_info&cPath=0&products_id=24243(accessed 26 January 2012).

By the end of July 2011, China had approved 3,154 Clean Development Mechanism projects, mainly in new energy and renewable energy, energy conservation and energy efficiency. Among them, 1,560 projects successfully registered with the United Nations Clean Development Mechanism Executive Board, accounting for 45.7 per cent of the total registered projects. The certified emission reductions issued was about 328 million tons of carbon dioxide equivalent, nearly 63.84 per cent of the world's total issued emissions reductions.[8]

[8] People's Republic of China, The Central People's Government website "White Paper: China's Policies and Actions on Climate Change" (2011). Available from www.gov.cn/jrzg/2011-11/22/content_2000047.htm (accessed 15 March 2012) [Chinese language website].

CASE STUDY

100 cities working to become low-carbon habitats
China's low-carbon city project

Key point

- ***The principle of eco-efficiency – producing more while consuming less and polluting less – has been mainstreamed into the development of cities in China to manage the crisis of rapid urbanization and promote long-term growth.***

There was a problem…

The migration of Chinese people from remote provinces and villages to cities began in the 1980s. Since then, the urbanizing process has provided millions of workers who helped buttress the fast economic growth. Hardly surprising however, the urbanizing process also moved new challenges such as resource shortages and environmental deterioration into all the cities, from small up to Beijing and Shanghai and especially as migration sped up in the mid-1990s. As of 2009, the energy intensity of the Chinese urban centres was 2.75 times the world average[1] and was expected to be higher in the coming decades. Shifting the direction of the city development for eco-efficiency was imperative for the survival of cities.

What was done?

In July 2010, the Government's National Development and Reform Commission launched a pilot project to construct low-carbon cities in five provinces (Guangdong, Liaoning, Hubei, Shanxi and Yunnan) and eight cities (Tianjin, Chongqing, Shenzhen, Xiamen, Hangzhou, Nanchang, Guiyang and Baoding (figure 1)). The good practices pursued through the pilot projects are intended to be applied to other Chinese cities after the project.

Figure 1: China's five low-carbon pilot provinces and eight cities

Source: ESCAP, based on the source from the National Development and Reform Commission, China

[1] The National Bureau of Statistics of China, *China Statistics Yearbook 2010*. Available from www.stats.gov.cn/tjsj/ndsj/2010/indexch.htm (accessed 18 July 2011).

The heavy burden on resources had forced many cities to rethink their urban plans even before the government introduced its national response. In scattered corners, urban planners began promoting low-carbon directions for their cities or at least adaptation responses to climate change issues. For instance, city planners in Baoding, Hebei Province, released a development plan for a low-carbon city in December 2008. Urban planners in Tianjin municipality announced their plan to address climate change in March 2010.[2] Currently, nearly 100 other cities are also willing to construct low-carbon environments.

The plan's purpose is to encourage cities to find new strategies for economic growth and improving people's quality of life. The plan requires the following:[3]

- **Creating a low-carbon development plan.** The plan integrates the adjustment of the industrial structures, the optimizing of the energy structures, improving energy saving and efficiency and increasing the carbon sink.
- **Setting supportive policies for low-carbon green growth**. Market mechanisms are encouraged to achieve the greenhouse gas emission-control targets. Promoting of green building and public transport are part of them.
- **Establishing a low-carbon industrial system:** This includes green innovation and R&D, installation of low-carbon technologies into industrial process, nurturing green business in energy efficiency and renewable energy sectors.
- **Establishing a greenhouse gas emission statistics and management system.** Data collection and accounting system need to be set up along with strengthening the skills of staff to proficiently manage it.
- **Advocating lifestyle and consuming patterns of low carbon green growth.** Education and advertising campaigns on the imperative of low-carbon lifestyles that target both policymakers and the general public are required.

Results

Given the pressure as well as incentives from national government, many cities had begun moving towards eco-city development even before the project. The pilot project to construct low-carbon cities in the selective areas thus became a good opportunity for the participating cities to showcase their achievements in a spotlight that had not been there before.

Still, whether due to previously set regional targets relating to carbon and energy intensity or greater impetus through the low-carbon city project, as the following table explains, many changes are taking place with industrial structures, building energy codes, heavier promotion of public transport, ecologically efficient vehicles and non-motorized transport and increases in renewable energy generation and use.

Table 1: Targets, programmes and activities for low-carbon environments, by city

City	Target	Major programmes	Activities
Tianjin	By 2015, the carbon intensity, compared with 2010, reduced by 15.5 per cent By 2015, the energy intensity, compared with 2010, reduced by 15 per cent By 2015, the proportion of forest cover increased to 23 per cent or more	Combating Climate Change Plan	Sino-Singapore Tianjin Eco-city, a collaboration with Singapore and Japan to build a model low-carbon city.
Chongqing	By 2015, the carbon intensity dropped to less than 1.15 ton per 10,000 yuan GDP By 2015, non-fossil energy accounts for more than 30 per cent of total energy consumption By 2015, the proportion of forest cover increased to 38 per cent or more		Accelerating the development of low-carbon transport, green buildings and green energy

[2] TThe Climate Group, *The Clean Revolution in China: Cities* (London, 2010).

[3] People's Republic of China, National Development and Reform Commission website "The Notice of the Development of Low Carbon and Low Carbon City Pilot" (2010). Available from www.sdpc.gov.cn/zcfb/zcfbtz/2010tz/t20100810_365264.htm (accessed 18 July 2011) [Chinese language website].

Shenzhen, Guangdong Province!		Shenzhen: Medium- and Long- Term Low-Carbon Development Plan (2011–2012) Shenzhen 2010 Energy-Saving Emission-Reduction Work Plan Action Plan for Speeding up the Elimination of the Outdated Industrial Capacity in Guangdong	Low-carbon Development Promotion Law in special economic zones and a national model low-carbon city
Xiamen, Fujian Province	By 2020, the carbon intensity, compared with 2005, reduced by 60 per cent By 2020,the total amount of carbon dioxide emission less than 68.64 million tons	The Outline of Building a Low-Carbon City in Xiamen	Strictly control the greenhouse gas emissions from the transportation, residential buildings, public buildings and manufacturing
Hangzhou, Zhejiang Province!		Opinions on Constructing a Low-Carbon City in Hangzhou	Plan to build a six-in-one low-carbon city: the low-carbon economy, low-carbon architecture, low-carbon transportation, low-carbon lifestyle, low-carbon environment and low-carbon society
Nanchang, Jiangxi Province	By 2015, the carbon intensity decreased by 38 per cent, compared with 2005 By 2015,non-fossil energy accounts for more than 7 per cent of total energy consumption By 2015, the proportion of forest cover increased to 23 per cent or more	Nanchang: An Action Plan for Promoting the Low-Carbon Economy and Building a Low-Carbon City Jiangxi: 2010 Contingency Plan for Energy Conservation and Emission Reduction Monitoring and Early Warning System	The first regional carbon emission and energy-consuming monitoring system and carbon emission publishing system in People's Republic of China
Guiyang, Fujian Province	By 2020, the energy intensity lower than 1.3–1.4 tons of standard coal, down by 40 per cent compared with 2005 By 2020, the carbon intensity decreased from 3.77 ton per 10,000 yuan GDP in 2005, to 2.07–2.24 ton per 10,000 yuan GDP	Action Plan for Low-Carbon Development in Guiyang (outline) 2010–2020	Exploring and developing a carbon emission trade system under the current conditions (trial operation)
Baoding, Hebei Province	By 2020, the carbon intensity (carbon dioxide emission per unit GDP), compared with 2010, reduced by 35 per cent By 2020, the carbon dioxide emission below 5.5 ton per person	Implementing Suggestions on Building Low-Carbon City in Baoding Opinions on Constructing Baoding as a Solar City	Focusing on creating the "Chinese electricity valley" and "solar city"

Source: The Climate Group, *China Clean Revolution Report III: Low Carbon Development in Cities* (London, 2010). Available from www.theclimategroup.org.cn/publications/2010-12-Chinas_Clean_Revolution3.pdf [In Chinese language]; Clean Air Initiative in Asia Centre (CAI-Asia Centre), *Low Carbon Cities and Development Plan-8 Pilot Cities* (Dalian, 2011).

Lessons learned

Low-carbon city development should be pursued in accordance with a broader national framework aimed at low carbon green growth. Even though the pilot project to build low-carbon cities became a trigger to encourage city planners to come up with action plans for low-carbon development, there were national energy intensity targets impressing upon city governments for change. The energy-intensity reduction targets established at the municipal level are based on the national goals set under the Twelfth Five-Year Plan (2011–2015), which was the initial motivation on most cities to improve their energy efficiency in production and consumption.

Providing incentives is critical to attract cities to follow through on complementary policies. Many Chinese cites regard the participation in the project as an opportunity to nurture a greener economic engine due to the various programmes offering support. For instance, the Promoting New Energy Automotive Industry Development Policy, introduced by the Ministry of Industry and Information Technology, facilitates the development of local low-carbon businesses. In Guangdong Province, special funds have been established for helping low-carbon industries development. Under the Demonstration and Popularization Project of Renewable-Energy

Building Application, participating cities are granted around US$70 million from the central Government.

Designating a coordinating body to guide the low-carbon city projects can better assist local government to handle cross-sector issues. The pilot project involved many supplementary policies across sectors, including those that related to the national emissions reductions targets and those looking to boost green business. Management of the eco-city project was delegated to the National Development and Reform Commission, which has responsibility for integrated national socio-economic planning and producing the Five-Year Plans.

Further reading

China Clean Revolution Report III: Low Carbon Development in Cities (New York, The Climate Group, 2010). Available from www.theclimategroup.org.cn/publications/2010-12-Chinas_Clean_Revolution3_Summary.pdf

CASE STUDY

Lighting up remote corners
China's mini-grids for rural electrification

Key point

- ***China's rural electrification programme demonstrates that improving energy efficiency and energy access can work in tandem with promoting the renewable industry with the right policy mix.***

There was a problem…

China has been working steadily toward rural electrification for decades, with a number of government initiatives. In 2008, however, there were still an estimated two million households, or nine to ten million people, primarily in villages and farming areas in western China, lacking electricity, according to the National Energy Administration.[1] Chinese western provinces are characterized by dispersed rural settlements. Remaining villages without electricity are far from load centres and from existing electricity generation and transmission infrastructure.

What was done?

The Township Electrification Programme from 2001 to 2005 focused on electrifying the remote villages with a particular emphasis on sustainability with distributed generation from renewable sources. Although renewable energy had been a focus of the Brightness Programme since the late 1990s, the Township Electrification Programme marked the first time that the Chinese Government focused on 100 per cent renewable energy systems for village power. Of the 1,065 villages selected for the programme, 688 were to be electrified with PV-battery mini-grids and 377 with small-scale hydro mini-grids.[2] The most recent initiative, the Village Electrification Programme (2005–2010), looked to expand on the Township Electrification Programme's success by electrifying 20,000 villages with renewable sources.

Results

- **Increased electricity access in western provinces:** Through the Township Electrification Programme, 721 PV and PV or wind hybrid systems and 146 small hydropower stations were built, providing electricity to 1.3 million people.[3]
- **Electricity for basic services but not productive uses:** The village power systems were built to provide electricity for lighting and television in hopes of improving people's quality of life and economic development. Lighting helps young students have more time to study. However, productive uses to generate income would demand too much capacity from the small battery system, so they were discouraged, despite the income generation potential.[4]
- **Stimulated solar PV production:** Government funding of PV-only systems for rural electrification delivered a strong signal to the country's domestic industry that PV is an important piece of China's energy future.[5]

[1] A. Niez, *Comparative Study on Rural Electrification Policies in Emerging Economies: Keys to Successful Policies* (Paris, International Energy Agency and OECD, 2010).

[2] Renewable Energy and Energy Efficiency Partnership and United Nations Industrial Development Organization, *Sustainable Energy Regulation and Policymaking Training Manual* (Vienna, 2007). Available from www.unido.org/fileadmin/media/documents/pdf/training_manual_on_sustainable_energy_regulation_and_policymaking_for_Africa.pdf (accessed 20 October 2011).

[3] Alexandra Niez, *Comparative Study on Rural Electrification Policies in Emerging Economies: Keys to Successful Policies* (Paris, International Energy Agency and OECD, 2010).

[4] ibid.

Lessons learned

A site-specific cost-benefit analysis is required: Renewable energy-based village mini-grids were more economically viable due to the comparatively high costs of extending the transmission grid to remote, low load areas. Other countries in the region need to assess the comparative benefits and costs of decentralized rural electrification versus grid extension; more densely populated countries or areas may find the higher-quality service from central grid connection to be worth the investment in the grid extension.

Success factors

Public financing: The Township Electrification Programme was fully government financed, with US$293 million coming from the central Government and US$437 million from the provincial governments. The townships included in the programme spanned 11 provinces with different levels of development. The central Government analysed the social and economic development of the provinces to determine the percentage of matching funds – for example, the Government supplied 100 per cent of funding for projects in Tibet while it covered only 50 per cent of costs in Sichuan Province.[6]

Government-led implementing: The National Development and Reform Commission (NDRC, formerly the State Development Planning Commission) was in charge of running the Township and Village Electrification Programmes. Giving the top-level management to the NDRC highlighted the broader goals of the programmes, which were to not just increase access to electricity but to reduce poverty and further other development objectives. However, the array of government agencies involved sometimes contributed to inefficiencies.

Site assessment of energy resources: Conducting a site assessment of renewable energy resources for each village was an important early step to designing a suitable system capable of providing reliable access to electricity to the target population. The villages in western China and islands off the eastern coast, although difficult and expensive to reach by grid extension, are also generally rich in at least one renewable energy resource. High solar insolation, good wind speeds and/or proximity to rivers with substantial heads were imperative enabling conditions; biomass resources could also fuel a mini-grid generator in other regions.

Preference for local production: Even in cases of bilateral partnerships with OECD countries that produce the technology, an effort was still made to localize the manufacturing. System integrators responsible for design, installation, operation and maintenance were selected through a competitive domestic bidding process.[7]

Focus on capacity building: About US$100 million of the Township Electrification Programme's budget was dedicated to training and institutional development.[8] The Government, in partnership with the US National Renewable Energy Laboratory, the German Society for Technical Cooperation (GTZ, now GIZ) and UNDP trained 135 local trainers and 115 backbone service engineers. The local trainers then prepared 1,400 village operators to work at the township level. Due to the dispersal of the villages in the Village Electrification Programme, an additional 40,000 village operators were expected to be trained.[9] In addition to operation and maintenance, operators were also trained on how to teach smart practices in electricity use to help manage power demand effectively.

[5] Renewable Energy and Energy Efficiency Partnership and United Nations Industrial Development Organization, *Sustainable Energy Regulation and Policymaking Training Manual* (Vienna, 2007). Available from www.unido.org/fileadmin/media/documents/pdf/training_manual_on_sustainable_energy_regulation_and_policymaking_for_Africa.pdf (accessed 20 October 2011).

[6] ibid.

[7] ibid.

[8] H. Gao, Z. Wang and Y.Q. Zhao, *Renewable Energy Options in Improving the Life of Western Rural Poor Population in China, in Renewable Energy Technologies* (Roskilde, Denmark, Global Network on Energy for Sustainable Development, 2005). Available from www.gnesd.org/Downloadables/RETs/ERI%20RETs%20final%20version.pdf (accessed 21 October 2011).

[9] J. Ku, D. Lew and S. Ma, "Sending electricity to the townships" *Renewable Energy World* (2003), Sep-Oct, pp. 56-67. Available from http://frankhaugwitz.com/doks/general/2003_05_China_RE_SDDX_REW_Debra_Lew.pdf (accessed 25 October 2011).

Considerations for replicating

Ability to pay: Although capital costs of renewable energy equipment and installation were mostly covered by government subsidies, it was important to gauge the ability, willingness and reliability of customers to make payments to cover operational costs.

Supply and demand balancing: After estimating the overall ability to pay for electricity, an additional intricacy was the gauging of potential levels of use at various prices per unit of electricity. Pricing too low could lead to excessive demand, whereas pricing too high could lead to non-payment or non-use. Lack of information about electricity supply could also lead to misuse.

Operations and maintenance know-how: Although China is a leader in renewable energy technologies, particularly PV and small hydro systems, most of the enterprises involved in those industries are based in the developed eastern part of the country. System integrators who designed a particular mini-grid system are only responsible for three years of operating and maintenance.[10] Beyond the length of that initial contract, local technicians capable of operating and maintaining the mini-grids to maximize efficiency would be required.

Further reading

Comparative Study on Rural Electrification Policies in Emerging Economies: Keys to Successful Policies, by Alexandra Niez, (Paris, International Energy Agency and OECD, 2010).

[10] H. Gao, Z. Wang and Y.Q. Zhao, *Renewable Energy Options in Improving the Life of Western Rural Poor Population in China, in Renewable Energy Technologies* (Roskilde, Denmark, Global Network on Energy for Sustainable Development, 2005). Available from www.gnesd.org/Downloadables/RETs/ERI%20RETs%20final%20version.pdf (accessed 21 October 2011).

Controlling massive energy consumption
China's mitigation targets

Key point

- ***During the past five years, China began to set up targets for controlling its energy consumption and thus reduce its carbon dioxide emission – while pursuing efficient development. Administrative and market-oriented policies were adopted, including national targets, influential projects and the optimizing of the industrial structure – all of which are likely applicable in other Asian countries.***

There was a problem…

China was consuming more and more energy to fuel its rapid economic growth. In 2004, its energy consumption reached 2.3 billion tons of coal equivalent, nearly 2.3 times higher than in 1990, making China the world's second-largest energy consumer. This led to both public and government concern about the country's future energy supply and security.[1]

Because nearly 90 per cent of its primary energy derives from coal and crude oil, China's increasing energy consumption also brought serious environmental problems. For example, according to International Energy Agency statistics, China became the world's largest emitter of carbon dioxide in 2007, and its carbon dioxide emissions rose to 65 billion tons, accounting for 22 per cent of global emissions in 2008.[2]

Compared with its energy consumption and carbon dioxide emissions, China's energy intensity was still relatively low. The energy intensity was 8.3 tons of coal equivalent per US$10,000 in 2004 and 7.7 tons of coal equivalent per US$10,000 in 2008, which was equivalent to 2.75 times the world average, 3.9 times the United States average, 5.2 times the German average and 7.8 times Japan's average.[3]

What was done?

In March 2006, China released its Eleventh Five-Year Plan on National Economic and Social Development and its Eleventh Five-Year Plan on Energy that proposed to reduce energy consumption per unit of GDP by 20 per cent and to cut down major pollutants by 10 per cent by the end of 2010.[4] At the same time, a well-designed operational mechanism involving different levels of actors was set up; target-oriented and market-oriented policy options were adopted to achieve the goals of the plan.

For the operational level, a five-tier "top-to-bottom" mechanism was established:[5]

- **Topmost level:** In June 2007, the State Council set up a Leading Group of National Response to Climate Change and Energy Saving, which is in charge of solving the most important issues related to energy saving and coordinating the different interests among provinces and organizations.

[1] People's Republic of China, National Bureau of Statistics website "China Statistics 2006" (2006). Available from www.stats.gov.cn/tjsj/ndsj/2006/indexch.htm (accessed 26 January 2012).

[2] International Energy Agency, *CO_2 Emissions from Fuel Combustion: Highlights 2011 ed.* (Paris, 2011). Available from www.iea.org/co2highlights/CO_2highlights.pdf (accessed 26 January 2012).

[3] BP p.l.c., *BP Statistical Review of World Energy June 2010* (London, 2010). Available from www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2008/STAGING/local_assets/2010_downloads/statistical_review_of_world_energy_full_report_2010.pdf (accessed 26 January 2012).

[4] People's Republic of China, *National Eleventh Five-Year Plan of Energy* (Beijing, National Development and Reform Commission, 2007). Available from http://nyj.ndrc.gov.cn/zywx/P020070410416322295969.pdf (accessed 24 February 2012) [In Chinese].

[5] People's Republic of China, Central People's Government website "China's National Plan to Address Climate Change" (2007), Available from www.gov.cn/gongbao/content/2007/content_678918.htm (accessed 22 February 2012) [Chinese language website].

- **National level:** Departments, such as the National Development and Reform Commission, the Department of Finance and the National Energy Administration, were in charge of proposing the overall implementing strategy and operating plans, drafting national policies, and monitoring and evaluating the energy-saving programmes.
- **Provincial level:** The provincial governments were responsible for executing the plans and policies generated by the top two levels. Additionally, they were responsible for setting and reaching local targets (through work plans, local standards and regulations and local financial funds).
- **Business enterprise level:** The enterprises were obligated to accept the targets set by the government. Both the government and the public monitored their compliance. Incentives and financial supports were available to help them adopt advanced technologies.
- **Public level:** The public was encouraged to participate in various forms of energy-saving promotions, such as the National Action of Energy-Saving, the annual National Energy Conservation Publicity Week and the World Environment Day.

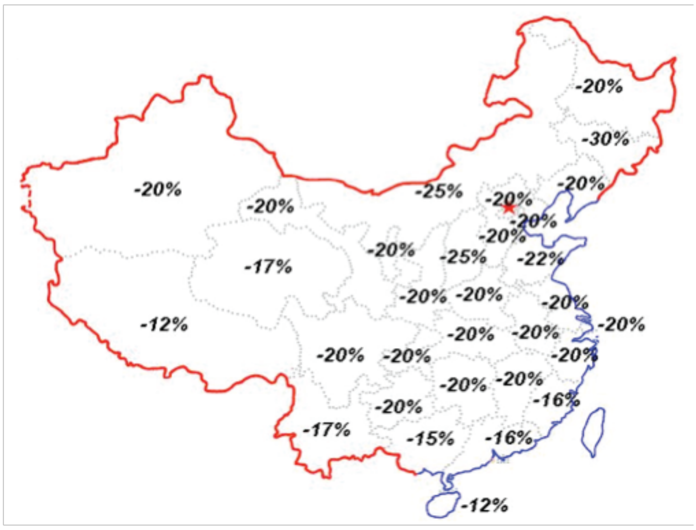
Administrative methods and market-oriented policies were adopted because the Chinese Government thought the combination of both would better facilitate the participation of all actors. At the provincial and enterprise levels, administrative policy options dominated.

Target responsibility allocated to provincial governments and enterprises

The targets of energy intensity and pollutant emission reduction were broken down into subtargets that were then assigned to provincial governments, thousands of intensive energy-consuming enterprises and five major power generating companies.

1) **Provincial targets:** In September 2006, the State Council approved the 20 per cent energy-saving target among provinces and cities; 31 provinces, autonomous regions and municipalities had their own sub-targets (figure 1), and the provincial government was expected to form local policies and regulations to achieve those targets.[6]
2) **Enterprise targets:** A national energy conservation campaign among thousands of corporations was launched in 2006. The central Government selected 1,008 high energy-consuming enterprises, which account for one third of China's energy consumption, to participate. The Government and the energy companies signed statutory goals addressing energy-saving responsibility. The project was expected to save at least 100 million tons of coal equivalent by 2010.[7]

Figure 1: The subtargets for each of China's 31 provinces, autonomous regions and municipalities



Source: National Development and Reform Commission, China

[6] The subtargets of 31 provinces in the Plan for Energy Consumption Per Unit of GDP Reduction Target During the Eleventh Five-Year Plan of the National Development and Reform Commission in People's Republic of China. Available from www.sdpc.gov.cn/zcfb/zcfbqt/qt2006/W020061106586300315301.doc (accessed 24 February 2012).

[7] People's Republic of China, *The Implementation Plan of Energy Conservation Action of 1000 Enterprises* (Beijing, National Development and Reform Commission, 2006). Available from www.ndrc.gov.cn/zcfb/zcfbtz/tz2006/W020060414514022692980.doc (accessed 24 February 2012).

Application of an evaluation and penalty system

In accordance with the objectives and responsibility, an evaluation and penalty system was set up to ensure that the subtargets would be achieved. It included statistical measures, rewards and penalties that would be imposed on the provincial governments, enterprises and power-generating companies. The State Council issued a statistical monitoring and evaluation framework in 2007.[8]

1) The provincial government was responsible for evaluating and examining onsite energy reduction target responsibility each year; the assessment results were to be announced to the public.
2) Some quantitative methods were applied to the evaluation, and an index system with various quantitative indicators for energy efficiency goals was created to monitor the subtargets; both the penalty and incentive mechanisms were applied according to the evaluation results.

Improving the legal system

Since 2007, China has passed the revised Energy Conservation Law, the Circular Economy Promotion Law, the Renewable Energy Law (Amendment) and a series of energy laws and regulations. In addition, 27 mandatory national standards for energy consumption, 41 mandatory energy-efficiency standards for major end-use products and 24 pollutant discharge standards have been posted.

Optimizing the industrial structure

In recent years, the focus of China's overall industrial policy centred on adjustments that promote a low-input, low-consumption, low-emission and high-efficiency model of development. The current industrial policy looks to regulate the high energy-consuming high-tech industries and service sectors. Many companies with high energy consumption and emissions have been forced to close, while new up-to-standard factories have been built. For example, during the period of 2006–2010, more than 70GW of inefficient small thermal-power units were shut down.

1) Supporting policies were introduced to promote the use of energy-efficient products, such as LED products.
2) Supporting policies were introduced for raising energy management contracts. In April 2010, the Government issued policies to accelerate the application of the energy management contracts to promote the energy service industry.

Implementing a set of energy-saving projects

At least 215 billion yuan from the central government funds were invested to support energy-saving projects in energy subsectors, such as an urban sewage treatment and associated pipeline network construction project, a project focusing on water pollution control and capacity-building projects for energy saving. The projects attracted nearly 1,600 billion yuan of social investments and brought about savings of 340 million tons of coal equivalent per year by their completion.

Creating a sustainable energy conservation industry

1) The development of an energy-saving manufacturing industry and the promotion of advanced energy-saving technologies and products created a market for domestic manufacturers. In recent years, about 14 billion yuan from central financial subsidies were provided to promote 360 million energy-saving lamps, more than 2,000 million energy-efficient air conditioners and 20 million energy-efficient cars and motors, which contributed to the creation of a substantial market for domestic producers.
2) Energy-saving service has become a new industry in parts of China. Many social institutions and companies are engaged in energy-efficiency projects.

[8] People's Republic of China, Central People's Government website "China's National Plan to Address Climate Change" (2007), Available from www.gov.cn/gongbao/content/2007/content_678918.htm (accessed 22 February 2012) [Chinese language website].

Establishing the monitoring system

The provincial and local governments were in charge of monitoring the 1,008 enterprises participating in the energy conservation projects. As a result, in 2008, 19 provincial-level Energy Conservation Supervision Centres were established in China.

The Government also provided financial support to create a sustainable energy conservation industry to help expand the economy. Central investment and polices, based on market prices, taxes, funding support and other measures, were introduced to strengthen the energy conservation industry:

Price policy: To optimize energy prices, the Government applied differential pricing policies, such as decreasing the electricity price of small thermal power to restrict high-carbon production plants and offering feed-in tariffs to biomass and wind power to encourage green power.

Fiscal policy: Between 2006 and 2010, the Government established several special financial funds to support energy conservation in industry, construction and transportation and in other emission reduction projects in various fields, including:[9]

- **Special funds for energy conservation:** From 2007 to 2009, the Government allocated approximately 105 billion yuan (US$15 billion).
- T**he fiscal policy supports the Ten Key Energy Conservation Projects in the Eleventh Five-Year Plan**. In 2007, the Government promulgated the Interim Measures of the Financial Incentives Fund Management to Energy-Saving Technological Transformations and provided appropriate support awards, entailing incentive payments for the projects.
- **Financing was provided to support energy-efficiency projects for buildings:** In 2006, the Ministry of Finance and the Ministry of Construction established a renewable energy demonstration project that targeted buildings and provided funding to encourage the use of renewable energy in the construction field, shallow geothermal energy and other renewable energy sources.
- **Tax policy:** The Government issued a series of conducive tax policies, including consumption tax, VAT, resource tax, income tax, export tax rebates and property tax, to promote energy conservation. In 2007, China reduced the export tax of nearly 3,000 low-carbon goods, accounting for 37 per cent of the total goods.

Results

After five years, the Government nearly achieved its targets. By then, it established a comprehensive framework for energy conservation (including an organizational platform and mechanism, policies and action plans).

In 2006–2009, the energy consumption per unit of GDP declined by 13.2 per cent, saving about 450 million tons of coal equivalent, while sulphur dioxide emissions reduced by 13.14 per cent. The total energy consumption per unit of GDP fell by an estimated 19 per cent by 2010.[10]

[9] People's Republic of China, *White Paper: China's Policies and Actions on Climate Change* (Beijing, State Council, 2011).

[10] National Bureau of Statistics of China, *China Statistics Yearbook 2010* (Beijing, 2010). Available from: www.stats.gov.cn/tjsj/ndsj/2010/indexch.htm (accessed 24 February 2012) [In Chinese].

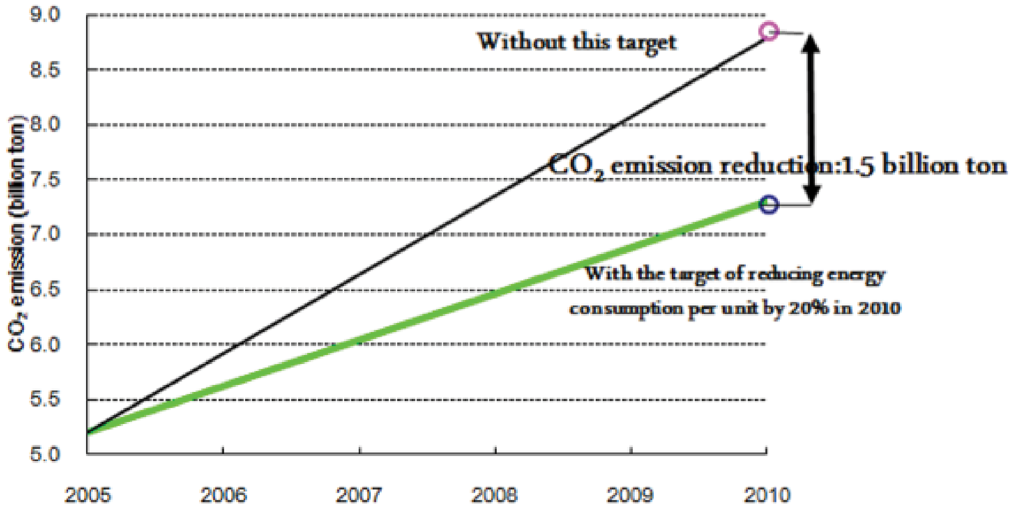
Table 1: Energy intensity decreased between 2005 and 2009 (reference year: 2005)

	2005	2006	2009
Apparent GDP (billion yuan)	18,493.7	21,634.4	34,050.6
Constant price GDP (billion yuan)	18,493.7	20,838.1	28,480.7
Gross primary energy consumption (million tons of coal equivalent)	2,359.97	2,586.76	3,066.47
Energy intensity (unit tons of coal equivalent per 10,000 yuan)	1.277	1.241	1.077

Source: National Bureau of Statistics of China, *China Statistics Yearbook 2010* (Beijing, 2010). Available from: www.stats.gov.cn/tjsj/ndsj/2010/indexch.htm (accessed 24 February 2012) [In Chinese].

For energy consumption, at least 500 million tons of coal equivalent were saved between 2006 and 2010, which means a reduction of 1.5 billion tons of carbon dioxide emissions (figure 2).[11]

Figure 2: The contribution of energy conservation to the reduction of carbon dioxide emissions in 2006–2010



Source: Figure developed by author based on BP p.l.c., *BP Statistical Review of World Energy June 2010* (London, 2010); International Energy Agency, *CO2 Emissions from Fuel Combustion: Highlights* (Paris, 2011).

In 2009, China announced that it would reduce its carbon intensity (carbon dioxide emissions per unit of GDP) by 40–45 per cent by 2020, from its 2005 levels. This would include reducing the carbon intensity by 17 per cent and its energy intensity (energy consumption per unit GDP) by 16 per cent by 2015, according to the Twelfth Five-Year Plan (2010).[12]

Lessons learned

Administrative measures combined with market-oriented policy methods were adopted in China to achieve an energy-saving target throughout society and made a significant contribution. For countries that need to limit their increasing energy consumption, the China experience offers useful lessons:

- Set up a national target and strategy for achieving it.
- Establish a "top-down" group to implement the target.
- Break down the overall target into subtargets.

[11] People's Republic of China, *White Paper: China's Policies and Actions on Climate Change* (Beijing, State Council, 2011).

[12] People's Republic of China, *The Twelfth Five-Year Plan for National Economic and Social Development: 2011–2015* (Beijing, State Council, 2010). Available from www.gov.cn/2011lh/content_1825838.htm (accessed 26 January 2012).

- Improve the legal system, including laws and regulations.
- Implement a set of key energy-saving projects.
- Establish a monitoring system.
- Institutionalize the participation of businesses and the public.

Considerations for replicating

For most Asian countries, implementing the necessary and/or useful administrative measures may encounter political challenge. In China, market-oriented policies were adopted to tap the market potential without affecting economic development by:

1) Creating a sustainable energy conservation industry by:
    - o encouraging advanced energy-saving technologies and products
    - o introducing energy savings certification and trading.
2) Supporting the sustainable energy conservation industry by introducing:
    - o price policy
    - o fiscal supporting policy
    - o tax policy.

Guiding the shift to a new economic system
China's National Development and Reform Commission

Key point

- ***The National Development and Reform Commission in China is an example of a well-performing inter-ministerial organization that could be a model for other developing countries to adapt for implementing green growth policies.***

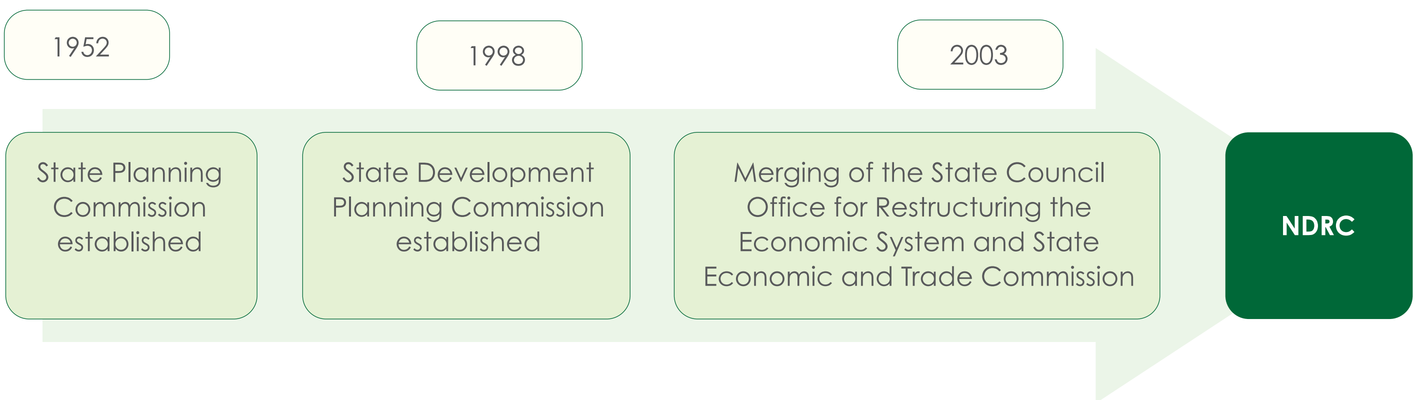
There was an institutional gap…

The State Planning Commission was established in 1952 as a central economic planning and management agency. However, the transition of the Chinese economy from a command system to the socialist market economy system in the late 1990s called for establishing an institution to coordinate between the macroeconomic and microeconomic affairs, to create a competitive but fair market environment and to draft national development strategies for adapting to the new economic system.[1]

What was done?

In 1998, the National Development and Reform Commission[2] was launched as the government agency devoted to generating economic and social policies while maintaining a balance between economic arrogation and economic restructuring. With supervision from the State Council, the National Development and Reform Commission has 26 functional departments, bureaus and offices.

Figure 1: Historical development of the NDRC



Source: People's Republic of China, National Development and Reform Commission official website "Brief Introduction of the NDRC". Available from http://en.ndrc.gov.cn/brief/default.htm (accessed 15 March 2012).

The major functions of the National Development and Reform Commission:

- Establish and implement national economic and social development strategies, long-term and annual plans, and industrial and price policies

[1] *China Daily*, "National Development and Reform Commission", November 16, 2006. Available from www.chinadaily.com.cn/bizchina/2006-11/16/content_734828.htm (accessed 27 February 2012).

[2] People's Republic of China, National Development and Reform Commission website "Main Functions of the NDRC". Available from http://en.ndrc.gov.cn/mfndrc/default.htm (accessed 4 October 2011).

- Monitor and adjust the performance of the national economy, maintain the balance of economic aggregates and optimize major economic structures
- Examine and approve major construction projects
- Guide and promote the restructuring of the economic system
- Perform strategic readjustments, upgrade industrial structures, coordinate the development of agriculture and the rural economy and guide the industrial development
- Establish energy sector development plans and manage the national oil reserve
- Promote the sustainable development strategy, including social development and coordination of regional development.

Results

The National Development and Reform Commission is treated as a "super ministry" due to its broad scope of authority over national medium- to long-term economic plans, approving foreign investment projects and coordinating and monitoring various other economic development policies. The National Development and Reform Commission developed the Twelfth Five-Year Plan (announced in March 2011), which leans heavily towards environmentally sustainable growth as well as equitable wealth distribution and increasing domestic consumption.

CASE STUDY

Shifting from quantity to quality of growth
China's Plan for National Economic and Social Development

Key point

- ***China's Twelfth Five-Year Plan for National Economic and Social Development (2011–2015) is a good example of how a country's national development plan can incorporate low-carbon growth strategies – achieving low-carbon goals as an engine for pursuing economic growth.***

What was done?[1]

The Twelfth Five-Year Plan was formed by the National Development and Reform Commission (NDRC) and endorsed by the National People's Congress in March 2011. The NDRC is implementing the plan and monitoring the progress.

In comparison with the previous Five-Year Plan, the current plan has made a dramatic shift from pursuing only greater economic growth to pursuing higher quality of growth that tackles growing concerns over the increasing income disparities within the population and among regions and providing better social and welfare services and a better living environment. One of the new features of the Plan is the concept of "inclusive growth."[2]

The plan places more emphasis on tackling and improving various environmental issues, such as climate change, pollution and energy security. It also stresses strengthening the associated industrial sectors as the foundations for pursuing further growth, which is why it is characterized as a green or low carbon development plan.

The Government has committed to the concept of low carbon green growth by establishing targets to improve energy consumption and reduce carbon emissions and the share of fossil fuel supply. In addition, new energy (nuclear, wind and solar), energy conservation and environmental protection, biotechnology, new materials (rare earths and high-end semiconductors), next-generation information technology, high-end equipment manufacturing (aerospace and telecom equipment) and clean energy vehicles have been designated as the plan's seven strategic industrial sectors.[3] These new sectors will be strengthened through industrial policy interventions and support for R&D efforts and technological innovations.

The Government has set annual targets through yearly government work reports that feed into achieving the targets and goals of the Five-Year Plan. Sector-based, provincial and city-level plans that reflect the national goals and targets of the Five-Year Plan are being developed. In addition, the targets that were set from 2011-2015 in the Five-Year Plan are interim targets that feed into longer-term targets, such as the reduction of carbon intensity by 40-45 per cent by 2020.

The Five-Year Plan's environment-related targets cover:

Climate and energy targets
- Reduce 16 per cent in energy consumption per unit of GDP from 2010 levels by 2015 (energy intensity)
- Reduce 17 per cent in CO_2 emissions per unit of GDP from 2010 levels by 2015 (carbon intensity)
- Non-fossil fuel to account for 11.4 per cent of the primary energy consumption from 2010 levels by 2015.

[1] Shasha Deng, "Key Targets of China's Twelfth Five-Year Plan", *Xinhua*, March 5, 2011. Available from http://news.xinhuanet.com/english2010/china/2011-03/05/c_13762230.htm (accessed 1 September 2011).
[2] KPMG China, *China's Twelfth Five-Year Plan: Overview* (Beijing, 2011). Available from www.kpmg.com/cn/en/IssuesAndInsights/ArticlesPublications/Documents/China-12th-Five-Year-Plan-Overview-201104.pdf (accessed 1 September 2011).
[3] ibid.

Forestry targets

- Increase forest coverage rate to rise to 21.66 per cent and forest stock to increase to 600 million cubic metres.

Water targets

- Reduce water consumption per unit of value-added industrial output by 30 per cent.

Science and technology targets

- Expenditure on R&D to account for 2.2 per cent GDP
- Increase the number of patents to 3.3 patents per 10,000 inhabitants by 2015.[4]

Pollution targets[5]

- Reduce chemical oxygen demand and sulphur dioxide (SO_2) by 8 per cent each
- Reduce nitrogen oxide and ammonia nitrogen by 10 per cent each
- Motor vehicle emissions standards for cities.

Climate change related[6]

- Inventory- improved system for monitoring greenhouse gas emissions
- Gradually introduce the establishing a carbon trade market.

Energy efficiency[7]

- Promote energy efficiency in industry and in new as well as in existing buildings
- A new programme under the introduction of 1,000 Enterprise Programme.

Industry[8]

- Develop seven priority industries contributing to economic growth, such as energy saving and environmental protection, new energy and clean energy vehicles.

Transport[9]

- 35,000 km of high-speed rail that connects cities with populations over 500,000
- Improve subway and light rail coverage in cities with existing transportation systems, build new systems in at least nine cities and make plans for at least six cities.

Circular economy

- Promote waste water and solid waste treatment
- Promote reuse and recycle.

The great challenge for China now will be achieving the ambitious goals and targets. The Government has demonstrated that with political commitment from the highest level, national plan and a systematic way of implementing policies nationwide (from the national to local levels) it can move to a low carbon development path.

[4] The number of invention patents per 10,000 inhabitants here refers to the granted domestic patents, not the total. It indicates the patent values and nation's market controlling capacity. State Intellectual Property Office of China, *"What is the meaning of '3.3'?"*, 13 May, 2011 [in Chinese]. Available from www.sipo.gov.cn/mtjj/2011/201105/t20110513_604228.html (accessed 1 March 2012).

[5] KPMG China, *China's Twelfth Five-Year Plan: Overview* (Beijing, 2011). Available from www.kpmg.com/cn/en/IssuesAndInsights/ArticlesPublications/Documents/China-12th-Five-Year-Plan-Overview-201104.pdf (accessed 1 September 2011).

[6] Joanna Lewis, *Energy and Climate Goals of China's Twelfth Five Year Plan* (Arlington, V.A., Center for Climate and Energy Solutions, 2011). Available from www.pewclimate.org/docUploads/energy-climate-goals-china-twelfth-five-year-plan.pdf (accessed 1 September 2011).

[7] D. Seligsohn and A. Hsu, "How Does China's 12 Year Five-Year Plan Address Energy and the Environment?",*News of Climate, Energy & Transport, World Resource Institute*, March 7, 2011. Available from www.wri.org/stories/2011/03/how-does-chinas-12th-five-year-plan-address-energy-and-environment (accessed 1 September 2011).

[8] KPMG China, *China's Twelfth Five-Year Plan: Overview* (Beijing, 2011). Available from www.kpmg.com/cn/en/IssuesAndInsights/ArticlesPublications/Documents/China-12th-Five-Year-Plan-Overview-201104.pdf (accessed 1 September 2011).

[9] D. Seligsohn and A. Hsu, "How Does China's 12 Year Five-Year Plan Address Energy and the Environment?",*News of Climate, Energy & Transport, World Resource Institute*, March 7, 2011. Available from www.wri.org/stories/2011/03/how-does-chinas-12th-five-year-plan-address-energy-and-environment (accessed 1 September 2011).

Considerations for replicating

Achieving goals and targets requires supplementing how-to plans. For example, to better implement the Twelfth Five-Year Plan's goals and targets for reducing energy consumption and carbon emissions, the national and provincial governments and industry administrators will also adopt special plans and measures, such as the Non-ferrous Twelfth Five-Year Special Plan, the Industrial Transformation and Upgrading Special Plan (2011–2015), the Twelfth Five-Year Plan of Jiangxi Province and Information and Industry Development Plan in Jiangxi Province (2011–2015). A monitoring and review process is required at all levels of government and of different organizations in the form of periodic assessment reports.[10] Based on the assessments, the Government will set or modify annual targets. The Government will also introduce various measures and programmes to incentivize the public and local authorities to help fulfil the goals and targets.

[10] APCO Worldwide, *China's 12th Five-Year Plan: How it actually works and what's in store for the next five years* (Beijing, 2010). Available from www.apcoworldwide.com/content/pdfs/chinas_12th_five-year_plan.pdf (accessed 1 March 2012).

CASE STUDY

Measuring eco-efficiency triggers a green transformation
China's Resource and Environment Performance Index

Key points

- ***China recognized the imperative of improving its eco-efficiency and decoupling economic growth from its intensive coal and fossil-fuel consumption pattern.***

- ***The Government's goal is to develop a Resource Efficient and Environment-Friendly Society. Through the Resource and Environment Performance Index, the progress is monitored and evaluated.***

There was an alarm…

For the past two decades, a rapid expansion of energy- and resource-intensive heavy industry fuelled China's economic growth – from 37 per cent of GPD in 1990 to 45.9 per cent in 2004. China's energy and resource demand has visibly risen in parallel, and by 2010 the country had become the world's second biggest energy consumer and CO_2 emitter. The resource- and energy-intensive production and consumption of that speedy growth also has resulted in significant social and economic costs. China is losing 4.3 per cent of its GDP to health costs related to air and water pollution and 1.5 per cent from the non-health impacts of pollution. The value of the negative externalities associated with coal production and consumption were estimated to be as much as 1.7 trillion yuan in 2007, accounting for 7.1 per cent of China's GDP in that year.[1]

The concern about China's growth pattern led to warnings that unless a shift is made from the high input, high consumption, high pollution, low-output and low-efficiency growth model, the economy would overheat and could threaten the long-term economic development.

What was done?

The Government sought to drive a paradigm shift towards resource and energy efficiency to sustain the growth and development while responding to the shared responsibility of the global community in tackling the climate and ecological challenges. To make this shift, the Government introduced the concept of a Resource Efficient and Environment-Friendly (REEF) Society – a term adopted by the Chinese Academy of Science – and integrated it into the Eleventh Five-Year Plan for National Economic and Social Development (2006–2010).

A comprehensive framework for both the macro and micro levels

Building a REEF society requires "real protection and rational use of various sources, raising the utilization efficiency of resources in all areas of production, construction, distribution and consumption and in all aspects of economic and social development so as to achieve the maximum economic and social benefits with as little consumption of resources as possible".[2] A REEF society, also called an energy- and resource-saving society, has two primary aspects: i) a range of integrated means to rationally relocate, recycle and reuse resources in a highly efficient manner and ii) minimizing pollutant generation and other environmental impacts of production and consumption.

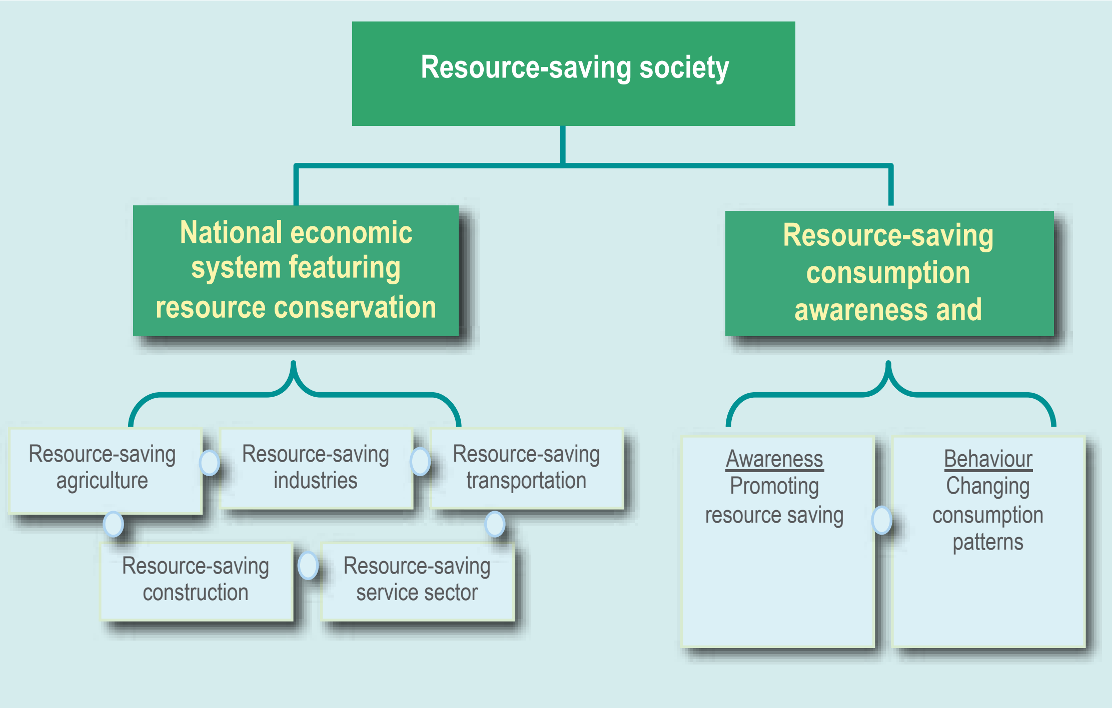
The core values of a REEF society are resource and energy efficiency, pollutant discharge reduction and environmentally sound treatment of waste, prioritizing the saving of energy, land and water resources. Based on the

[1] Mao Yushi, "The True Cost of Coal" (Greenpeace, China Sustainable Energy Program, WWF, 2008). Available from http://act.greenpeace.org.cn/coal/report/TCOC-Final-EN.pdf (accessed 23 November 2011).

[2] Wen Jiabao, "Give Full Attention, Strengthen Leadership and Accelerate the Building of an REEF Society (温家宝:高度重☒ 加强☒☒ 加快建☒☒☒型社会) (Xinhua News Agency, 2005). Available from http://news.xinhuanet.com/newscenter/2005-07/03/content_3169936.htm. (accessed 9 February 2012) (Originally in Chinese language).

macro framework, policy instruments and strategies were developed at the micro level, including various institutional arrangements, structural adjustments and technological innovations.[3]

Figure 1: Basic structure of REEF – the essential elements of a resource-saving society



Resource and Environment Performance Index: Measuring eco-efficiency

The REEF initiative stemmed from alarming research findings that indicated China's resource and environmental performance was significantly behind most industrialized countries. Developed by the Chinese Academy of Science, the Resource and Environment Performance Index (REPI) is a relative indicator that reflects a country's (or a region's) level of resource use, or eco-efficiency, by quantifying resource consumption and pollutant emissions per unit of GDP (box 1). REPI was developed to reflect, monitor and assess the progress of the installation of a REEF society at international, regional and industrial levels.[4]

BOX 1: The Resource and Environment Performance Index[5]

$$REPI_j = \frac{1}{n} \sum_{i}^{n} w_i \frac{g_j / x_{ij}}{G_0 / X_{i0}}$$

Wi = The weight of resource consumption or pollutant discharge performance of resource i
Xij =The total quantity of resource consumption or pollutant discharge of resource i in province (or region) j
gj = The GDP (total) in province (or region) j
Xio = The total quantity of resource consumption or pollutant discharge of i in the country
Go = GDP of the country
g/x and G/X = The intensity of resource consumption or pollutant discharge that results in each province (or region) (g/x) and the whole country (G/X)
n: the number of types of consumed resources or pollutants discharged

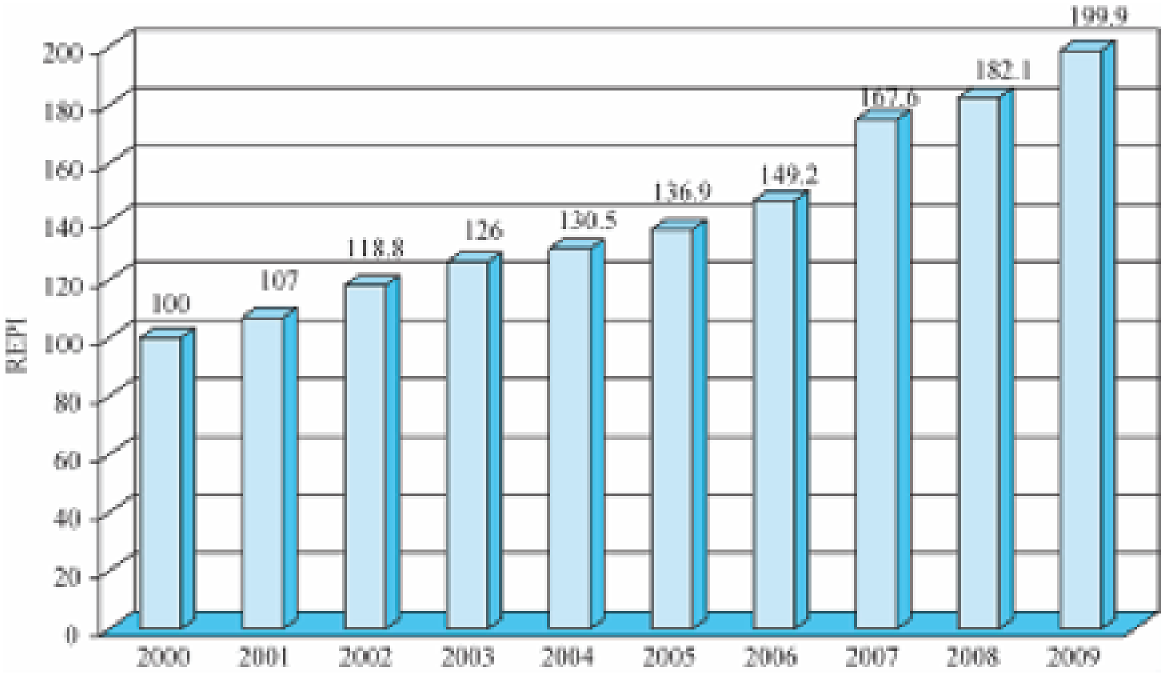
* The larger the number, the higher the REPI, and the poorer the performance of the country or the province (or region). For simplification, it is assumed that the weight of all resources and pollutant discharge results is identical.

Source: The information extracted from Chinese Academy of Science, *China Sustainable Development Strategy Report 2011: Greening the Economic Transformation*

REPI findings – Wide discrepancies among countries and among regions within China

REPI calculations found that the country's ranking has steadily declined since the 1980s, by an annual average decrease of 4.9 per cent. Between 1980 and 2003, the country steadily reduced both pollutant emissions (SO_2 and CO_2) and resource consumption. This is partly a reflection of the economic restructuring and technological advances.[6] However, resource consumption levels and pollutant emissions surged again, beginning in 2003, due largely to growth in the highly resource-intensive heavy chemical industry.

Figure 2: Changing trends of the REPI, 2000–2009



Source: *China Sustainable Development Report 2001 and China Sustainable Development Report 2011*, original in Chinese)

A 2003 REPI study calculated the resource-efficiency performance of 59 countries, based on the consumption of five key resources (non-renewable energy, freshwater, cement, non-ferrous metals and finished steel). China's low performance ranking alarmed the Government (54th using GDP at purchasing power parity and 56th for GDP at market rates), which initiated the revision of the existing pattern of growth. The findings also revealed that China's energy intensity had exceeded that of industrialized countries by 120 per cent. The comparisons among countries indicated that, in general, a country at the lower level of development tends to have a low level of resource efficiency and environmental performance than more advanced ones.

Comparison among different regions within China also indicated a significant disparity, with western China following a more resource-intensive pattern of growth than the eastern side.

[3] For more details of the policy measures, see ESCAP, *Eco-efficiency: A Practical Path to Sustainable Development* (2007) pp. 53-55

[4] Room for further improvement of the REPI exists: Challenges in determining the kind and weight of resource and pollutant to be included in the measurement, integrating REPI in the Government's decision-making and policy process at all levels, as well as quantifying the contribution of structural adjustments, technical innovation to resource and environmental performance are examples. See: Shaofeng Chen and Yi Wang, *REPI-Based Evaluation for Resource-Efficient and Environment-Friendly Society in China* (Institute of Policy and Management Science, Chinese Academy of Sciences, Beijing). Available from www.greengrowth.org/download/GGPD_CD_resources_for_website/SECTION_III_%20H_.pdf [Accessed 8 March 2012].

[5] Chinese Academy of Science, China Sustainable Development Strategy Report 2011: Greening the Economic Transformation (CAS Sustainable Development Strategy Study Group, February 2011, original text in Chinese). The definition of REPI has been modified. For the original version of the formula, see *CAS Sustainable Development Strategy Report, 2006*.

[6] More recently, the Chinese Academy of Science produced China's performance of REPI until 2010. See: *Chinese Academy of Science, China Sustainable Development Report 2001 and China Sustainable Development Report 2012*. Full text of the reports is not available online.

Results

With the integration of the goal of a REEF society and introduction of the REPI in its Eleventh Five-Year Plan, the Government initiated strategic adjustments for its new economic structure and transformation into more sustainable and greener growth. A recent assessment by the Chinese Academy of Science concluded that through the Eleventh Five-Year Plan, China succeeded in integrating green and low-carbon policies into the country's development and growth by significantly raising the awareness of both the Government and society. The nationwide efforts of energy-saving measures have led to visible results: In the first four years of the Eleventh Five-Year Plan, the country overachieved its intended target of energy savings by one third.[7]

Continuation and deepening of eco-efficient economy in the Twelfth Five-Year Plan

The Academy of Science studies generated a sobering realization that China's extensive GDP growth was at the expense of poor environmental and resource-efficient performance and that a better REPI level was impossible to reach by following the resource- and energy intensive industrialization path.[8]

Carrying on from the previous plan for economic development, the Twelfth Five-Year Plan (2011–2015) emphasizes "higher-quality growth" and "inclusive growth". As well, the Government prudently opted to slow growth to a 7 per cent to enable quality and sustainable economic growth.[9]

Reducing emissions by increasing energy efficiency is a major focus, and new regulations, preferential and industrial policies have been adapted to support the implementation. This includes binding targets on important pollutants, such as nitrogen oxide and ammonia nitrogen, to improve the air and water quality. The Government is now heavily promoting the "circular economy" (recycling) as an important strategy for national and social development. Recycling in production, circulation and consumption is to be speeded up across the country to improve the efficiency of China's resources output ratio.

Among the seven priority sectors targeted for improvement in the Twelfth Five-Year Plan, three of them align specifically the theme of sustainable growth: energy savings and environmental protection, new energy technologies and clean energy vehicles.[10]

To improve the resource and environmental performance, the plan also fosters a decrease of energy intensity per GDP by 17 per cent and reduced carbon intensity for 2020 by 40 per cent from the 2005 levels. This goal is to be achieved through the restructuring of the coal industry and the steady replacement of renewable energy, which will also help to mitigate the environmental impact generated by the rising energy demand. The plan highlights anticipated investments in clean coal technologies, such as hydropower, solar and wind capacities, and the building of 200,000 kilometre-long high voltage power lines for transmitting the renewable energy from the point of generation to grid centres.

[7] See Chinese Academy of Science, *China Sustainable Development Strategy Report 2011: Greening the Economic Transformation* (CAS Sustainable Development Strategy Study Group, February 2011). Available from www.world-governance.org/IMG/pdf_Wang_Yi_-_China_Sustainable_Development_Strategy_Report_2011.pdf (accessed 9 March 2012)

[8] Shaofeng Chen and Yi Wang, *Section III H: REPI-Based Evaluation for Resource-efficient and Environment-friendly Society in China* (United Nations Economic and Social Commission for Asia and the Pacific, 2007). Available from www.greengrowth.org/download/GGPD_CD_resources_for_website/SECTION_III_%20H_.pdf (accessed 9 March 2012).

[9] New Zealand Trade and Enterprise, *Report On the 12th Five Year Plan* (Auckland, 2011). Available from www.nzte.govt.nz/features-commentary/In-Brief/Documents/China%27s%20%20Five-Year%20Plan%202011-2015.pdf (accessed 9 March 2012).

[10] KMPG China, *China's 12th Five-Year Plan: Overview* (Beijing, 2011). Available from www.kpmg.com/CN/en/IssuesAndInsights/ArticlesPublications/Publicationseries/5-years-plan/Documents/China-12th-Five-Year-Plan-Overview-201104.pdf (accessed 9 March 2012).

Further reading

China Sustainable Development Strategy Report 2011: Greening the Economic Transformation (Chinese Academy of Science, Sustainable Development Strategy Group, February 2011), Available from www.world-governance.org/IMG/pdf_Wang_Yi_-_China_Sustainable_Development_Strategy_Report_2011.pdf

Eco-efficiency: A Practical Path to Sustainable Development (UNESCAP, 2007)

Report On the 12th Five Year Plan (Auckland, New Zealand Trade and Enterprise, 2011). Available from www.nzte.govt.nz/features-commentary/In-Brief/Documents/China%27s%20%20Five-Year%20Plan%202011-2015.pdf

Shaofeng Chen & Yi Wang, *REPI-Based Evaluation for Resource-Efficient and Environment-Friendly Society in China*. Institute of Policy and Management Science, Chinese Academy of Sciences (Beijing 100080, P.R. China) Available from www.greengrowth.org/download/GGPD_CD_resources_for_website/SECTION_III_%20H_.pdf

CASE STUDY

Finding a green engine for economic growth
China's renewable energy policies

Key points

- ***China's renewable energy industry has been elevated to an engine for economic growth, encompassing growing international competitiveness for the accelerating number of domestic renewable energy companies.***
- ***In China, demand for wind power increased thanks to clear national targets and flexible strategic policies, including concession projects at the early stages and a feed-in tariff at a later stage.***
- ***China's focus on developing a domestic industry and a domestic market for wind power vaulted it in the position of world leader in wind power installations, bringing about the creation of hundreds of thousands of green jobs.***

There was an ambition…

In September 2009 the Government declared its intention to supply 15 per cent of its primary energy demand with power from non-fossil fuels by 2020[1] to ensure energy security and to reduce carbon dioxide emissions. To achieve this goal, the policymakers looked at lessons learned from the renewable energy developments in the European Union and the United States and decided to speed up especially its domestic wind power generation through a variety of policies, but most prominently the Renewable Energy Law enacted in 2006. Renewable energy supplied about 9 per cent of the country's energy demand in 2010,[2] barely missing the intended 10 per cent goal proclaimed in 2007[3] but strengthening the policymakers' confidence in meeting the 2020 goal.

What was done?

Setting up public tendering for concession projects

The first wind policies issued in the 1990s did not generate much impact, neither on the market nor on the industry, due to the comparatively high market price for wind electricity at that time and a lack of incentives. By 2003, the total capacity of China's wind turbines amounted to little more than 0.56 GW[4], accounting for only 0.15 per cent of the total Chinese energy capacity.[5]

To increase the wind power supply, the Government turned to a market-oriented policy for wind power concession projects in 2003 that also addressed commercial wind farms. The National Development and Reform Commission (NDRC) managed the concession projects, for which investors were selected via public tendering. The generated wind electricity was purchased through a bidding process by provincial grid companies. With this new approach, a stable domestic market began to build.

[1] Embassy of the People's Republic of China in the Republic of Botswana website "Recharging China: Clean Energy Dream?" Available from http://bw.china-embassy.org/eng/xwdt/t755048.htm (accessed 22 February 2012).

[2] Renewable Energy Policy Network for the 21st Century, *Renewables 2011: Global Status Report* (Paris, 2011). Available from www.ren21.net/Portals/97/documents/GSR/REN21_GSR2011.pdf (accessed 26 February 2012).

[3] Chew Chong Siang, *China's Medium to Long-Term Renewable Energy Development Plan* (Tokyo, Institute of Energy Economics Japan, 2007). Available from http://eneken.ieej.or.jp/en/data/pdf/383.pdf (accessed 27 February 2012).

[4] Global Wind Energy Council website "PR China". Available from www.gwec.net/index.php?id=125 (accessed 27 February 2012).

[5] Calculated using data from Asia Pacific Energy Research Center, *Energy in China: Transportation, Electric Power and Fuel Markets* (Tokyo, Institute of Energy Economics Japan, 2004). Available from www.ieej.or.jp/aperc/pdf/CHINA_COMBINED_DRAFT.pdf (accessed 27 February 2012).

Protecting and promoting domestic industries

The concession projects that had started in 2003 required that at least 70 per cent of all wind turbines are purchased domestically and that all wind turbines are assembled within China;[6] these requirements greatly influenced the market, attracting foreign investments in Chinese facilities and increasing the number of newly established local wind turbine manufactures.[7] China was able to overtake the United States of America as the greatest investor in clean energy sectors in 2009, despite abolishing the local purchasing requirements in the same year. Investments amounted to approximately US$34.6 billion[8] and exhibited the advanced stage of maturity of the renewable energy segment in China.

Drafting binding regulations

The Government adopted the National Renewable Energy Law in 2005, which took effect a year later and included two important regulations:[9] Wind power projects larger than 50 MW must be approved by the central Government while provincial governments approve all others; and the grid must purchase all the electricity generated from wind sources at a preferable price while the extra expenditure is shared by all electricity consumers in the country.

In 2007, the Government announced a national plan for renewable energy development, followed by the Twelfth Five-Year Plan for Renewable Energy in 2008 that set a medium- to long-term target for each renewable energy technology and a short-term target for wind power, aiming at a wind power capacity of 10 GW by 2010.[10]

Strengthening government support with other policies and incentives

Equally influential in the industry's development process has been the 2005 Guiding Catalogue for the Renewable Energy Industry, which contained additional mandating and incentivizing policies. A series of economic policies was introduced, such as the reduction of import duties and VAT for wind electricity selling. This was followed by a system to standardize the industry (figure 1).

[6] Dewey & LeBoeuf LLP, *China's Promotion of the Renewable Electric Power Equipment Industry: Hydro, Wind, Solar, Biomass* (New York, National Foreign Trade Council, 2010). Available from www.nftc.org/default/Press%20Release/2010/China%20Renewable%20Energy.pdf (accessed 24 February 2012).

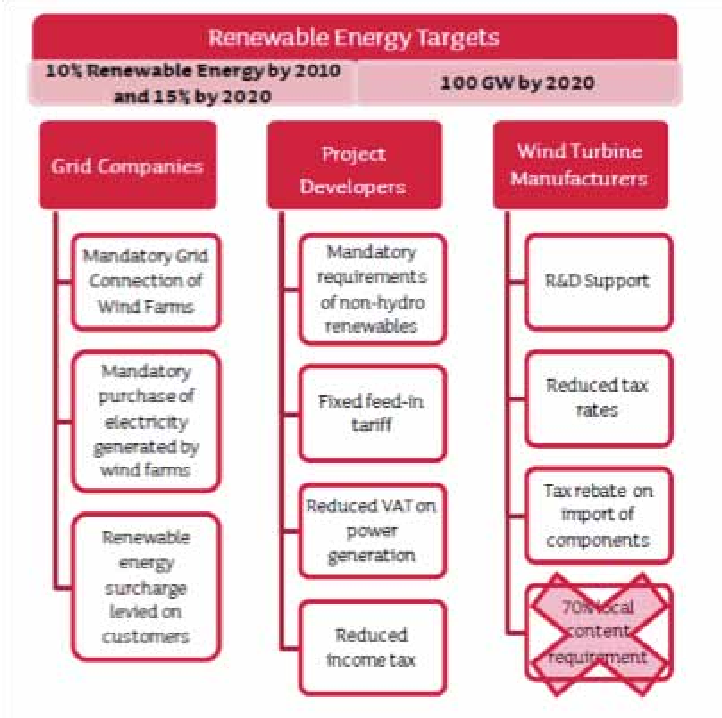
[7] *Power-technology.com digital magazine*, "Snapshot: Renewable Energy: China's Imbalanced Trade", May 18, 2011. Available from www.power-technology.com/features/feature119046/ (accessed 27 February 2012).

[8] ibid.

[9] Christian Nagstrup, "Year of the tiger: A turning point for Vestas in China?", PowerPoint presentation, 11 February 2011. Available from www.emu.dk/gym/hhx/vk/uvm/fagkons/2011/YearoftheTigerVestasFeb11.pdf (accessed 27 February 2012).

[10] China Wind Power Center website "National Policy". Available from www.cwpc.cn/cwpc/en/node/658 (accessed 27 February 2012).

Figure 1: Overview over renewable energy targets and policies, China



Source: Christian Nagstrup, "Year of the tiger: A turning point for Vestas in China?", PowerPoint presentation, 11 February 2011. Available from www.emu.dk/gym/hhx/vk/uvm/fagkons/2011/YearoftheTigerVestasFeb11.pdf (accessed 27 February 2012).

The National Development and Reform Commission together with the Ministry of Finance issued the Suggestions on Promoting Wind Power Industry in November 2006, which provided six areas of support for the wind industry: investigation and evaluation of national wind energy resources; establishment of national wind power standards together with a testing and certification system; capacity building for advanced wind power technology; domestic production of wind power equipment; grid planning and technical studies on wind power; and construction and management of wind farms.

Shifting to a feed-in tariff

After five years of tendering for wind power concession projects, China switched to a feed-in tariff in 2009, which had a stabilizing and maturing impact on the domestic market. The annual newly installed wind power capacity reached 13.6 GW in 2009 and 16.5 GW in 2010.[11]

Results

China's total energy supply from renewable energy demonstrated an average annual growth rate of about 12 per cent between 2000 and 2010 and substituted 293 million tonnes of coal equivalents by the end of that period. China became the world's biggest wind-using country in 2010[12] when its market share reached 21.8 per cent for cumulative installations and 46.1 per cent for new wind power installations. By that time, the wind power industry entailed about 260,000 jobs.

Other renewable energy sectors grew as well, such as solar PV, solar water heater or biomass (table 1). The production of photovoltaic cells, for example, reached 8 GW in 2010, and the annual growth rate consistently

[11] Global Wind Power Energy Council website "PR China". Available from www.gwec.net/index.php?id=125 (accessed 27 February 2012).

[12] Global Wind Energy Council, *Global Wind Report: Annual Market Update 2010* (Brussels, 2011). Available from www.gwec.net/fileadmin/images/Publications/GWEC_annual_market_update_2010_-_2nd_edition_April_2011.pdf (accessed 27 February 2012).

exceeded 100 per cent in the preceding five years.[13] Its global market share reached nearly 50 per cent, and approximately 93 per cent of the cells were exported to the European Union and other countries.

Renewable energy strengthened the Chinese economy

In 2010, the total amount of GDP produced by the renewable energy industry was close to 417 billion yuan (US$63 billion), accounting for 1 per cent of the total GDP (table 1). Additionally, the growth in renewable energies created more than 4 million jobs in China by 2010.

Table 1: The GDP contribution and job creation of the Chinese renewable energy sector (excluding hydropower), 2010

	GDP contribution (billion yuan)	GDP contribution (billion US$)	Employment (millions)	Installed capacity (GW)
Wind power industry	100	15	0.26	31.07
Solar PV industry	150	23	0.30	0.83
Solar water heater industry!	70	11	3.00	20.16
Biomass industry	97	15	0.79	6.69
Total	**417**	**63**	**4.35**	**58.75**

Source: ESCAP based on data from the National Development and Reform Commission, China

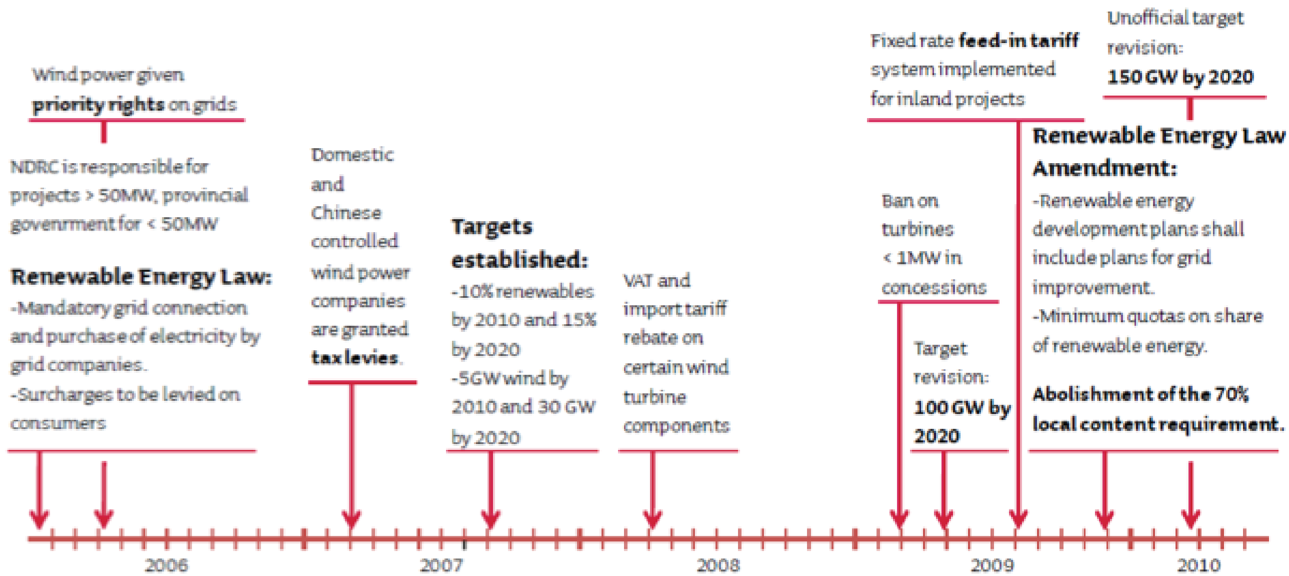
Lesson learned

Strong but flexible regulations are the best facilitator for renewable energies: A low carbon development path that fosters renewable energy needs a set of supporting laws. The Government provided a legal basis in the form of the Renewable Energy Law in 2006, for example, which evened the ground for the renewable energy sector. The regulations are not perceived as sufficient yet. The certification system for energy-saving products, established by the Energy Conservation Law in 2008, did not bring about the desired results because of inconsistencies between different certification standards and the lack of economic incentives.[14] However, the reason why the Chinese renewable energy sector has been growing successfully and why the policy gaps are probably not long-lasting hurdles to its development is the consistent optimizing process the Government exerts on its energy policies. China's renewable energy policies have been revised constantly since the first regulating attempts in the 1990s. Ineffective laws were amended and new regulations were added to the policy mix whenever the wind industry or other renewable industries started to stray from the national goals (figure 2).

[13] SEMI PV Group, SEMI China PV Advisory Committee and China PV Industry Alliance, *China's Solar Future: A Recommended China PV Policy Roadmap 2.0* (Beijing, 2011). Available from www.semi.org.cn/solarconchina/mail/2012/2011China_White_Paper_FINAL.pdf (accessed 27 February 2012).

[14] Economic and Social Commission for Asia and the Pacific, *Low-carbon Development Path for Asia and the Pacific: Challenges and Opportunities for the Energy Sector*, ESCAP Energy Resources Development Series No. 41 (Bangkok, 2010). Available from www.unescap.org/esd/publications/energy/Series/2010/Series-No-41.pdf (accessed 27 February 2012).

Figure 2: Timeline of major legislative changes within the wind-power sector in China (2006-2010)



Source: Christian Nagstrup, "Year of the tiger: A turning point for Vestas in China?", PowerPoint presentation, 11 February 2011. Available from www.emu.dk/gym/hhx/vk/uvm/fagkons/2011/YearoftheTigerVestasFeb11.pdf (accessed 27 February 2012).

Success factors

Since the early 2000s, China has aligned its national renewable energy policies with three core principles that have contributed significantly to the current prosperity of the renewable energy sector:

Building up a national producer and consumer base: Strengthening domestic markets in relation to both supply with and demand for renewable energy and related technology is crucial for long-term business development. Initially, the Government imported wind turbines and other key parts but later initiated support for building a domestic industry.

Protecting green technology markets in the early development stages: Vulnerable new technology markets, especially in emerging and developing economies facing global competition from industrialized nations, need to be protected during the initial market introduction phase. Policymakers implemented domestic purchasing and production requirements, which were abolished once the wind industry was strong enough to face global competition.

Setting ambitious but achievable goals: Policymakers did not lose sight of their initial intention to introduce renewable energy regulations and tried to set renewable energy goals as high as the Chinese capacities permitted. When the first wind power goal of installing 5 GW by 2010 was achieved ahead of time, the policymakers decided to raise the bar and changed it to 10 GW.[15]

Considerations for replicating

The Government's energy policies strongly affected China's energy development. As a result, it brought the goal of domestic energy security and increased renewable energy technology exports nearer. The Chinese renewable energy strategy and its success may be unique in some respects. Not many countries feature such an extensive and rapidly growing energy demand that eases the entrance of new companies into the market. Additionally, China's wind resources are abundant and space for their installation is readily available in rural areas. Although the scale of China's success might be unique, the mechanisms behind reaching the Chinese renewable energy goals, which were outlined above, can be replicated in other countries.

[15] Ni Chunchun, *China's Wind Power Generation Policy and Market Developments* (Tokyo, Institute of Energy Economics Japan, 2008). Available from http://eneken.ieej.or.jp/en/data/pdf/465.pdf (accessed 27 February 2012).

CASE STUDY

Shifting people out of cars
Curitiba, Brazil's transport and zoning policies

Key points

- ***The bus rapid transit system, first introduced in the Curitiba, has been replicated across the world as a successful mode of public transport.***

- ***Transport systems can be used to direct where city growth takes place rather than reacting to unmanaged growth.***

There was a problem…

From the 1950s to the 1980s, cities across Brazil experienced rapid growth with the migration of people from rural to urban areas as a result of agricultural mechanization. Curitiba, the capital of Paraná State, experienced some of the largest growth, with its population increasing at an estimated 5.7 per cent per year. The uncontrolled population growth provoked the need for more effective city planning.

What was done?

The city constructed a consolidated public transportation system to move people easily throughout the metropolitan area and its surrounding municipalities. The city planners recognized that a transportation system would serve as the foundation for development and growth of the city. The city planned the transit system with the intent of dictating growth in the city rather than allowing the rapidly growing population to create inefficient growth.

Progress over the decades started with:

- **Master plan allowing for integrated urban planning with transport:** In 1966, the city planners developed a master plan that established guidelines to restructure the city's development to accommodate urban expansion. The Curitiba Master Plan, adopted in 1968, focused on strict controls on urban sprawl, a reduction of downtown traffic, preservation of the city's historic district and a convenient and affordable public transit system. The plan included new road design to minimize traffic and a series of landscaped parks. In the 1970s, the city implemented zoning laws to direct linear growth by attracting residential and commercial density along a mass transit system.

- **Good quality mass transit system:** Curitiba became the first city to implement the bus rapid transit system.
  1) Extensive networks of routes serving varying purposes: Curitiba's transportation system is made up of three complementary levels of service that include feeder lines, express lines and inter-district routes. The feeder lines pass through outlying neighbourhoods, making the system easily accessible to lower- density areas. The feeder lines connect with the express system along the structural corridors. The express system operates like a surface subway system, transporting large numbers of passengers to locations along the structural corridors. Finally, the inter-district routes allow passengers to connect to the axis of the express lines without going into the city.
  2) Fare system: The Integrated Transport Network allows transit between any points in the city by paying just one fare. A single fare covers the whole city, encouraging the use of public transportation.
  3) Quality infrastructure: The physical stocks, such as buses and stations, are designed for users' convenience; for instance, by setting up shelters in conjunction to the bus stations and by upgrading to extra-wide doors of the buses for speedy loading.

- **Support for social welfare programmes:** Curitiba also faced dilemmas with what to do with the buses that could no longer run on the transit system. Because the system relies heavily on buses, their average life is only about 3.5 years. Today, "retired" buses are used as mobile job training centres, schools, health clinics, soup kitchens and food markets.

Results

Today, Curitiba is considered one of the best examples of urban planning worldwide.

- **Increased modal share of public transport:** An effective and well-planned bus transit system has helped to significantly decrease the dependence of residents on driving, resulting in lower carbon emissions. About 85 per cent of Curitiba's population uses the BRT system.
- **Financial viability of the operation:** The BRT operates without financial support from the government. Revenue from the relatively high ridership is sufficient to cover the operation and maintenance costs.

Success factors

- **Leadership of a mayor with a clear vision:** The Curitiba mayor at the time of the over-urbanizing crisis of the late 1960s was Jaime Lerner, an urban planner as well as an architect, who had a vision and commitment for the sustainable future of the city. He pushed forward policy packages that promoted the BRT system and incorporated other measures such as car-free districts. With his zeal, the benefits of those policies were vastly communicated to win over public support.

- **Financial support from the central Government for the initial capital investment:** Upfront investments were partly covered through a 15-year loan from the central Government; the local budget and revenues from a local fuel tax and road-use pricing were channelled to cover the remainder.

- **Clearly divided role between government and the private sector:** The BRT operation system in Curitiba is based on an innovative public-private partnership model. Although the city government decides the routes, plans the schedule, constructs the roads and provides the infrastructure, such as bus ways and stations, private companies take responsibility for the operation, daily maintenance and fare collection.

- **The operation is monitored and regulated by the city government to maintain a certain quality:** The bus performances are monitored by a public entity; if they fail to meet the service requirements, which are shown by parameters in the contract, they are fined. In addition, the private bus operators are paid by the kilometres they serve or the type of service they offer rather than by the number of passengers. This ensures that all routes, which are socially and ecologically desirable, are evenly operated.

Further reading

Eco2 Cities: Ecological Cities as Economic Cities, by Hiroaki Suzuki and others (Washington D.C., World Bank, 2010). Available from http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1270074782769/Eco2_Cities_Book.pdf

CASE STUDY

Wind Power takes flight in Denmark
Denmark's renewable energy policies

Key points

- ***From the initial start-up, to diffusion and up-scaling, the effective Danish policy mix implemented over the last two decades illustrates the importance of a timely and appropriate policy intervention in promoting renewable energy industries.***

- ***Community support is also important for technology dissemination.***

There was a strong wind…

Although rich in natural resources,[1] Denmark was heavily reliant on imported fossil fuel until the 1970s. After the oil crisis in the mid-1970s, the Government decided to focus on wind power and combined heat and power. In 1986, the nuclear disaster in Chernobyl made the option of nuclear power generation politically unfeasible.[2]

What was done?

To satisfy the strong energy demand, the Danish Government subsidized research and development on biomass, combined heat and power and photovoltaic and wind turbines and supported the associated emerging technologies through a package of policies. Denmark was one of the first countries to invest in wind turbines as part of a national policy, which eventually enabled it to become a global leader in wind power technology.

Packaging and sequencing policies promoting wind power

1) **Financial and technical support from the Government at the initial stage**. In 1978, the Government established a test station for wind turbines at the Riso National Laboratory. The Government then granted investment support for building and exporting wind turbines, initially at 40 per cent of the investment cost; but it was gradually reduced until 1989, when the support scheme was cancelled. Even with the financial support, only a few wind turbines were built in this period (figure 1).

2) **Setting targets.** In 1981, the Government launched its first energy plan, which included a goal of 1,000 MW of wind power by the year 2000. In *Energy 21*, the Danish Government's Action Plan for Energy[3] (published in 1999), the goal was to install 5,500 MW of electricity supply from wind turbines by 2030.

3) **Wind power increases only after the introduction of a feed-in tariff.** Wind turbine installation increased from 1984 to 2001, when the Government's support changed to a feed-in tariff,[4] with ensured grid connection. The Government mandated the utility sector to purchase wind energy at a preferential price and guaranteed wind power generators a fixed price of 70–85 per cent of the local retail price of electricity, excluding taxes. Although the energy tax had been introduced in 1981, in 1992 a carbon tax was added.[5] This made renewable energy more economically viable compared with fossil fuel.

[1] The degree of self-sufficiency rose from 5 per cent in 1980 to 145 per cent in 2002. Denmark is the third-largest oil producer (started producing net surplus of oil since 1993) in Western Europe and is dependent on domestic oil and natural gas for its primary energy supply.

[2] There are still no nuclear power plants in Denmark.

[3] Svend Auken, *Energy 21: the Danish Government's Action Plan for Energy* (1996). Available from http://193.88.185.141/Graphics/publikationer/energipolitik_uk/e21uk/index.htm (accessed 22 January 2012).

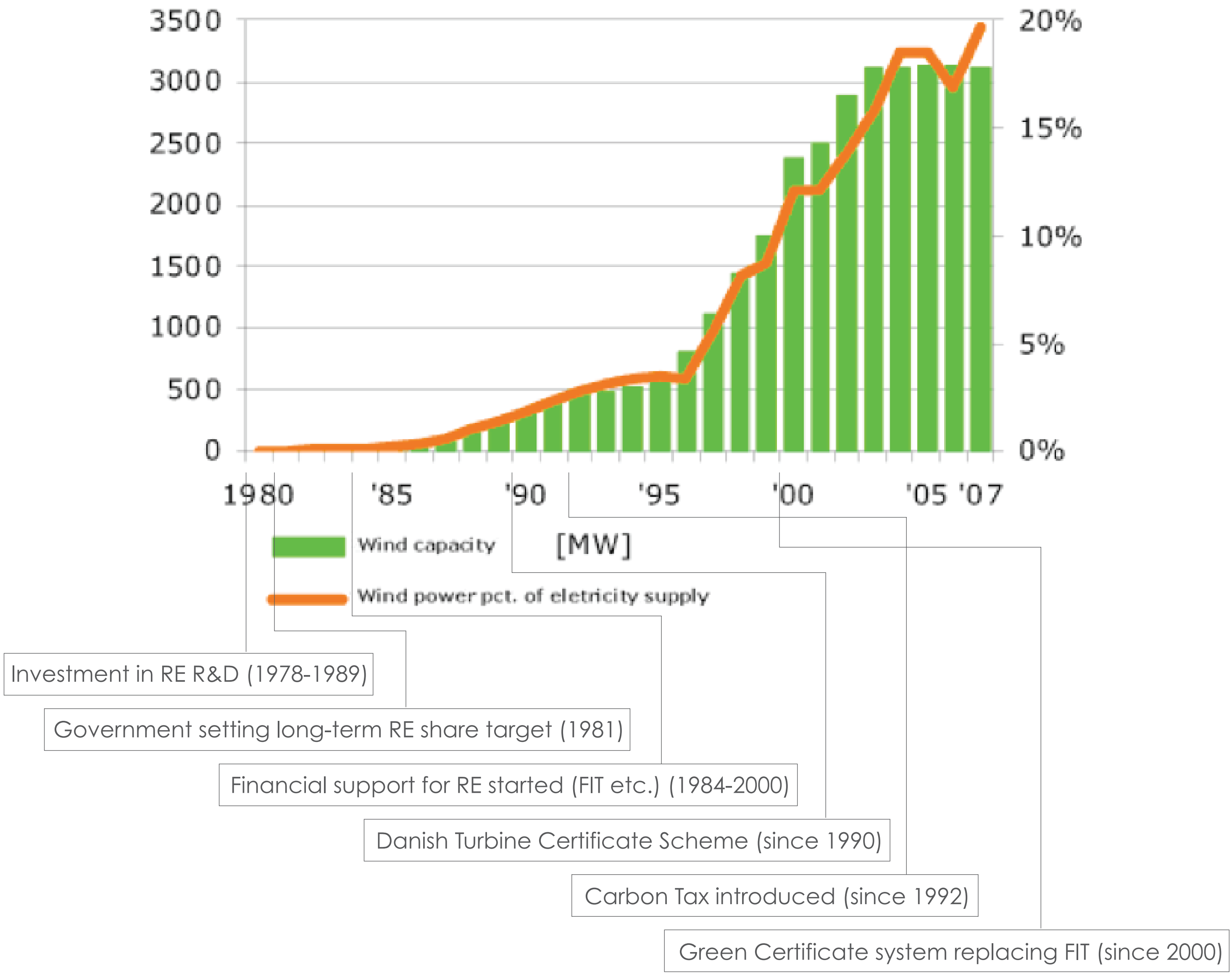
[4] Danish Energy Authority, *Cost of the Public Service Obligation for Environmentally Benign Production of Electricity* (Copenhagen, 2009).

[5] Stefan Speck and Jirina Jilkova, *Design of Environmental Tax Reforms in Europe* (2009).

4) **Technology standards ensure quality.** Since 1990, Denmark's design, manufacture and installation of wind turbines, onshore as well as offshore, have been subject to the Danish Wind Turbine Certification Scheme, established by the Danish Energy Agency to ensure that safety, energy and quality-related requirements are followed.

5) **Green certificates supersede the feed-in tariff.** In 2000, the Government replaced the feed-in tariff with a system of green certificates[6] to encourage expansion of the renewable energy sector. The certificates are issued to producers of renewable electricity who can then trade them at a premium with anyone who wants to purchase renewable energy or who has an obligation to do so.

Figure 1: Danish wind capacity development and renewable wind energy policy introduction



NOTE: The graph has been modified by the author by marking the date and name of policy interventions.
Source: Danish Energy Agency, *Energy Statistics 2010* (Copenhagen, 2011). Available from www.ens.dk/en-US/Info/FactsAndFigures/Energy_statistics_and_indicators/Annual%20Statistics/Documents/Energy%20Statistics%202010.pdf (accessed 30 January 2011).

[6] Ole Odgaard, *The Green Electricity Market in Denmark: Quotas, Certificates and International Trade* (Copenhagen, 2000). Available from http://unfccc.int/files/meetings/workshops/other_meetings/application/pdf/dnkoo.pdf (accessed 21 January 2012).

Community profiting critical

Community support for wind energy has been remarkable. Local cooperatives have installed more than 80 per cent of the wind turbines in Denmark. With a high fixed price for electricity generated from wind power, many communities regarded wind turbines as profitable investments. Some sought creative partnering, such as the Middelgrunden Wind Turbine Cooperative, an offshore wind turbine jointly owned by a local cooperative, the local utility (Copenhagen Energy[7]) and the Danish Wind Turbine Owners' Association.[8]

Results

Denmark has been self-sufficient in energy since 1997.[9] Though rich in natural resources, it was one of the first countries to invest in wind turbines as a national policy in the 1970s. The field of wind power technology developed very quickly, starting in the 1980s, and accelerated over the next 10–15 years. In 2008, wind power supplied almost 20 per cent of the Danish electricity consumption, compared with an average of 2.4 per cent in Europe.[10] As of May 2010, 5,052 wind turbines had been installed that generated a wind power capacity of 3,752 MW,[11] with offshore wind power accounting for 720 MW.

Today, the wind power industry is a significant driver of Denmark's economic growth and competitiveness, enjoying a global market share of 40 per cent.[12] As of 2010, the exports of the wind energy industry accounted for 8.5 per cent of the total Danish exports, up from 7.2 per cent in 2008.[13] The success of the Danish wind power industry can be attributed to systematic and effective policy interventions over the past three decades in support of wind and other renewable energy-related industries.

Lessons learned

Governments need to be a driving force to move producer and consumer interests to green technology. The successful take off of the Danish wind power industry since the mid-1980s was the result of the Government's consistent support of and investment in wind power technology since the 1970s. The ensuing sequencing of policies bridged the time gap between paying the initial investment costs for and reaping the benefits of the green industries. It is essential for governments to help jump start a new green industry if they want it to take the lead in a specific field.

Ad hoc investments will not build up a green industry; governments need to provide long-term policies to assure investors. Green technologies take time to finesse. Experiences show that ad hoc investments, focusing on short-time profits without any a long-term vision and consistent policy framework, may even postpone the developing momentum of green technologies.

Policies need to be customized to the type of technology and energy. Although wind power featured the most successful technology development, the Danish Government also supported other technologies in the 1970s and crafted specific policy support for each of them. Technology-specific policy measures are necessary due to the different factors involved in their innovation and dissemination processes. As the technology develops, policies also need to be updated accordingly to remain in line with the level of innovation. For example, the

[7] For more information see Middelgrunden website. Available from www.middelgrunden.dk/middelgrunden/?q=en (accessed 05 March 2012).

[8] For more information see Danish Wind Turbine Owners' Association website. Available from www.dkvind.dk/eng/index.htm (accessed 05 March 2012).

[9] Danish Energy Authority in the Danish Ministry of Economic and Business Affairs, *Energy in Denmark* (Copenhagen, 2003).

[10] Danish Wind Industry Association. Available from www.vindselskab.dk/composite-1457.htm (accessed 24 May 2011).

[11] Global Wind Energy Council, *Global Wind Report: Annual Market Update 2010* (Brussels, 2011). Available from www.gwec.net/fileadmin/documents/Publications/Global_Wind_2007_report/GWEC%20Global%20Wind%20Report%202010%20low%20res.pdf (accessed 20 January 2012).

[12] Danish Wind Industry Association. Available from www.vindselskab.dk/composite-1457.htm (accessed 24 May 2011).

[13] *Danish Wind Industry Association News*, "New all-time record in exports", 4 April 2004. Available from www.windpower.org/en/news/news.html#719 (accessed 21 February 2012).

solutions to a specific problem related to the circulation of new technology (acquiring financial resources, distance to market, strength of the network grid and international playing field) differ with the type of technology addressed.

Success factors

Sequencing and packaging of public R&D support, long-term plans and financial scheme. The Danish Government's intervention was essential for the wind power industry's success, specifically:

- Research and development funding at the initial stage
- Long-term commitment to specific and ambitious renewable energy targets
- Financial support (feed-in tariff, etc.) to ensure that targets are reached
- Access to transmission infrastructure at the initial stage and strategic expansion of infrastructure
- Streamlined planning and procedures for obtaining permits.

Consideration for replicating

To promote the installation of offshore wind power, many countries are using the feed-in tariff example that Denmark set, such as Germany, Japan, Netherlands and the United Kingdom. Whether the feed-in tariff alone is sufficient to support technology development and to stimulate the market or whether it needs to be combined with other complementary policies, as in the case of Denmark, is a consideration for policymakers looking at the specific context and conditions in their country.

Box : The success of Vestas Wind Systems A/S

More than 200 Danish companies are associated with the wind power generation in Denmark, featuring a unique component supply chain (including metal processers, sensor and controlling systems, platforms and foundations). Due to the continuous entry of new businesses into the wind energy market, the Danish market share has been decreasing. Some companies, though, have managed to remain soaring, such as Vesta Wind Systems A/S. It is one of the world's leading manufacturers of large-scale and offshore wind turbines, with a global share of 16 per cent; it installed and delivered 5,842 MW in 2010.[14] Vestas has installed more than 43,000 wind turbines in 66 countries on six continents. It is currently developing 6 MW class wind turbines, which will be more economical for generating electricity. Vestas pioneered the development and installation of the first-ever offshore wind turbines in Sweden in 1990. The company employed a total of 21,600 people in 2009, more than 500 of them top engineers posted around the world.[15]

Source: Vestas, *Full Year 2010 and Guidance for 2011: Operating in a Market in Recovery* (Copenhagen, 2010). Available from www.vestas.com/Admin/Public/DWSDownload.aspx?File=%2fFiles%2fFiler%2fEN%2fInvestor%2fFinancial_presentations%2f2010%2f2010_AR_PRES_UK.pdf (accessed 18 January 2012).

Further reading

See the website of the Danish Energy Agency. Available from www.ens.dk.

See the website of Vestas Wind Systems A/S. Available from www.vestas.com.

[14] Vestas, *Full Year 2010 and Guidance for 2011: Operating in a Market in Recovery* (2010). Available from www.vestas.com/Admin/Public/DWSDownload.aspx?File=%2fFiles%2fFiler%2fEN%2fInvestor%2fFinancial_presentations%2f2010%2f2010_AR_PRES_UK.pdf (accessed 18 January 2012).

[15] ibid.

CASE STUDY

Gauging the double dividend success
Europe's environmental tax and fiscal reforms

Key points

- ***Recent modelling exercises carried out on the potential impacts of environmental tax and fiscal reforms in European countries indicate they have yielded both a weak and strong double dividend.***
- ***With more effective tax rates and more vigorous revenue recycling including investments on greening the economy, the reforms are expected to yield a stronger double dividend.***

There was a curiosity…

After decades of years of instigating environmental tax reform (ETR) and environmental fiscal reform (EFR), some countries in Europe illustrate good practices of green economic transformation. Although none of the countries has embraced full-scale green growth across their economic system (by encompassing entire sectors and levels of society), their environmental tax and fiscal reforms appeared instrumental in achieving their environmental and economic objectives. There was interest in confirming with empirical evidence the efficacy and central role of the ETR and EFR in yielding a double dividend.

What was done?

Several assessments of ETR and EFR impacts in European countries were conducted:

Evidence of a double dividend

Under the financial support from the European Union's Sixth Framework Programme for Research and Technological Development (EU-FP6), a COMETR project was conducted from December 2004 to May 2007 in coordination with the National Environmental Research Institute of the University of Aarhus (Denmark) and five other partners.[1] This Specific Targeted Research Project (STREP) aimed to improve the understanding of the environmental and economic implications of an ETR. As a part of the project, a macro-economic analysis was conducted on the basis of the E3ME model[2] of the economic forecasting consultancy group Cambridge Econometrics to assess the competitiveness effects of the environmental tax reforms of some of the individual member states that implemented ETR (Denmark, Finland, Germany, Netherlands, Slovenia, Sweden and the United Kingdom).[3]

Over the period of 1994–2012, 25 countries that were European Union members as of 2006 plus Norway and Switzerland were included in the exercise. The baseline case with six western European countries (plus Slovenia, which has restructured its energy taxation as a new EU member state to include a carbon component), that have been introducing ETR, was compared with the counterfactual reference case, specifically with the situation of non-introduction of ETR for the same period.

[1] Including: Cambridge Econometrics (UK), Economic and Social Research Institute (Ireland), Institute for Economic and Environmental Policy, University of Economics Prague (Czech Republic), Policy Studies Institute (United Kingdom) and Vienna Institute for International Economic Studies (Austria).

[2] E3ME is a dynamic estimated time-series cross-section model of Western Europe covering the EU 25 member states and Norway and Switzerland. For more details of the E3ME and the COMETR, see: Terry Barker and others, an Energy–Environment–Economy Model for Europe: A Non–Technical Description, COMETR DL 4.1, E3ME 4 (CE, 2005).

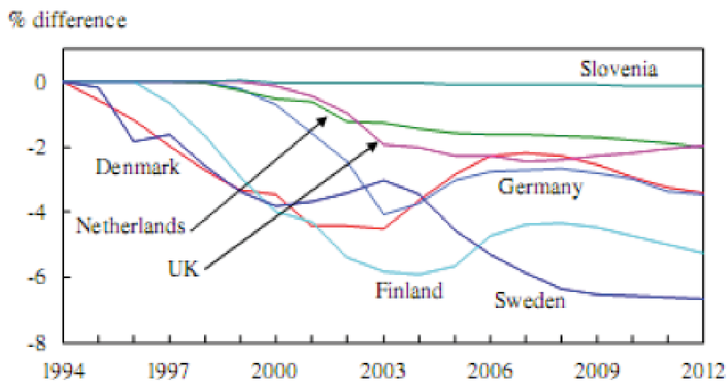
[3] Competitiveness Effects of Environmental Tax Reforms Project website: www2.dmu.dk/COMETR/ (accessed 15 March 2012).

The assessment produced the following major findings:[4]

- The Western European countries that have implemented an ETR show a reduction in fuel demand and all of them achieved an even higher level of carbon emissions reduction (see figure 1), with Finland and Sweden yielding the largest scale of carbon emissions reduction, with the highest rates of environmental taxes.
- Generally, the effect of ETR on economic activities will be positive in most countries, whose level varying dependent on how the revenues from the environmental taxes are recycled. Six of the ETR countries (Denmark, Finland, Germany, Netherlands, Sweden and the United Kingdom) could depict GDP increases as a result of the ETR, with varying pace and degrees.
- Impact on the overall price level change turned out to be lower than it was suspected. Revenue recycling had a hand in it because the reduction in employers' social security contributions may have had deflationary effects, such as in Germany.

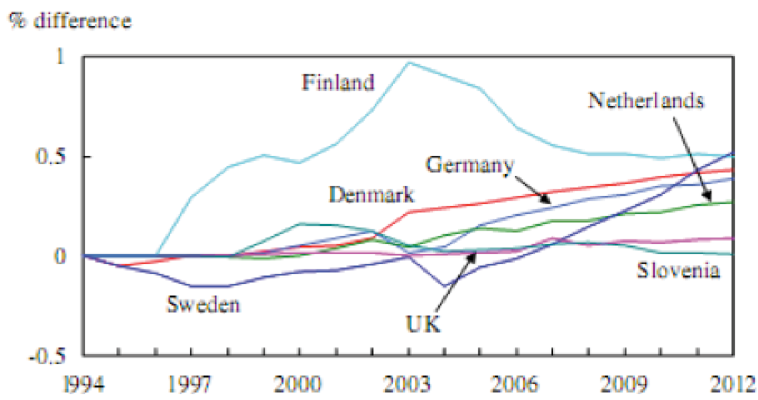
With revenue recycling as an essential factor, the ETR in Europe has generated small double dividend effects in every country, with GDP increase by up to 5 per cent compared with the reference case (the business-as-usual case without introduction of ETR, see figure 2).

Figure 1: Effects of environmental tax reform on greenhouse gas emissions



Note(s) : % difference is the difference between the base case and the counterfactual reference case.
Source(s) : CE.

Figure 2: Effects of environmental tax reform on GDP



Note(s) : % difference is the difference between the base case and the counterfactual reference case.
Source(s) : CE.

Source: Cambridge Econometrics, *The Effects of Environmental Tax Reform on International Competitiveness in the European Union: Modelling in E3ME* (Cambridge, 2006).

[4] Paul Ekins, "The effects of ETR on competitiveness: Modelling with E3ME", in *Competitiveness Effects of Environmental Tax Reform* (COMETR), Final Report to the European Commission, DG Research and DG Taxation and Customs Union (Roskilde, Denmark, National Environmental Research Institute, Economic and Social Research Institute, Institute for Economic and Environmental Policy, Policy Studies Institute and Vienna Institute for International Economics Studies, 2007). Available from www2.dmu.dk/cometr/COMETR_Summary_Report.pdf (accessed 9 October 2011).

Productivity and environmental tax reform in Europe project (petrE): Assessing productivity impacts of ETR and EFR

Another modelling exercise conducted as part of the Creating Sustainable Growth in Europe programme of the Anglo-German Foundation for the Study of Industrial Society shows that more vigorous implementation of ETR in Europe may lead to potentially higher yields of a double dividend in implementing countries while increasing the environmental benefits in the rest of the world.

The findings of two modelling exercises, the E3ME (of Cambridge Econometrics) and the GINFORS (another dynamic model with global coverage, performed by the Gesellschaft für Wirtschaftliche Strukturforschung (GWS)), arrived at a similar conclusion: In a scenario in which ETR is introduced in EU countries with revenue recycling to meet unilateral 30 per cent EU 2020 greenhouse gas reduction targets and with a high level of energy prices due to higher tax levies, greenhouse gas reduction targets can be reached with only small influence on the GDP (with slightly positive GDP increase in E3ME and slightly negative in GINFORS calculations).

At the same time, both of the modelling exercises estimate a plausible decrease of labour productivity due to the structural shift from energy-intensive to labour-intensive industries, in regard to all studied countries having increased employment.[5] Both modelling exercises also indicate an increase in resource productivity. (See the Table 1 below.)

In country-specific levels, impacts on CO_2 emissions tend to vary depending on each country's characteristics on the level of energy use, fuel mix and ease of fuel mix switching, economic structure and sectoral composition of energy demand, social system and reactions to labour cost changes, only to mention a few of possible impact factors. The carbon price effect on end users' price of electricity will also depend on the country's energy mix of electricity supply.

Table 1: European Union countries (EU-27) productivity: percentage deviations against respective baselines in 2020, GINFORS

Scenario	Material Productivity	Energy Productivity	Labour Productivity	Carbon Productivity
S1H	0.91	6.04	–0.93	8.59
S2H	0.84	7.15	–0.71	8.99
S3H	1.78	15.48	–2.61	21.35
S1L	1.97	12.21	–3.02	17.17

Source: Paul Ekins, *Resource Productivity, Environmental Tax Reform and Sustainable Growth in Europe* (London, Anglo-German Foundation for the Study of Industrial Society, 2009). Available from http://www.petre.org.uk/pdf/FinRepFin.pdf (accessed 14 March 2012).

The listed scenarios above were modelled by GINFORS and depict the situation with a more substantial tax shift at the European level, referring to baseline situations with low (BL) and high (BH) international energy prices. The S2H scenario is calculated additionally with an implicated proportion of revenues being spent on eco-innovation measures such as investing on low-carbon technologies and S3H with the regard to meet the higher 2020 greenhouse gases reduction targets (30 per cent emissions reduction by 2020, with 20 per cent from the S1H, S2H and S1L scenarios).[6] In all scenarios, with varying degrees, material, energy and carbon productivity will improve compared with the baseline scenarios.

The global implication of the bigger scale of ETR in European countries in the scenarios tend to have sizable positive environmental benefits, with 5.3 per cent projected reductions of the global material extraction and 15.6 per cent reduction of the global energy-related CO_2 emissions.

[6] Paul Ekins, *Resource Productivity, Environmental Tax Reform and Sustainable Growth in Europe* (London, Anglo-German Foundation for the Study of Industrial Society, 2009). Available from http://www.petre.org.uk/pdf/FinRepFin.pdf (accessed 14 March 2012).

[7] UK Green Fiscal Reform, *The Case for Green Fiscal Reform* (London, 2009). Available from http://www.greenfiscalcommission.org.uk/images/uploads/GFC_FinalReport.pdf (accessed 14 March 2012).

UK green fiscal reform: Potential of double dividend

The Green Fiscal Commission, an independent institution, was established in 2007 and ran its course to October 2009 in order to assess the potential impact of a large-scale ETR in the United Kingdom, with a hypothesis of doubling or tripling the share of environmental tax revenues out of the total revenue (from current level of about 7 per cent to 15–20 per cent).

The Green Fiscal Commission final report[7] concludes that a large-scale tax shift would be economically sensible and environmentally effective if implemented with appropriate complementary measures. According to the report, an increase in energy prices is the only economic change that will directly promote greater energy efficiency, increased investment in renewable energy and reduced energy demand without damaging the economy, if the UK carbon-reduction target for 2020 is to be met.

Table 2: Economic, social and environmental impacts of green fiscal reform in the United Kingdom

Impacts	Green fiscal reform modelling
Economic	1. Impact on GDP is negligible (for example, a reduction of 0.6–0.7% by 2020, a reduction in the economic growth rate of around 0.07%). 2. Investing 10% of the environmental tax revenues in energy-efficient homes and cars and offshore wind electricity increases the generation of electricity from renewable sources to 26–29% by 2020 and further reduced carbon emissions through efficient cars and homes.
Social	3. Reduced costs of labour result in about 455,000 additional jobs by 2020.
Environmental	4. UK meets greenhouse gas emissions reduction targets for 2020 (a minimum of 34% reduction from 1990 levels).

In summary, the combination of a large-scale ETR that is based on the revenue neutrality principle (as in the case of the United Kingdom with a reduction of labour tax or business tax for industrial competitiveness) with a more stringent revenue recycling measures through a robust EFR and with the investment in greening industries and eco-innovative measures are expected to yield a stronger double dividend.

Further reading

Competitiveness Effects of Environmental Tax Reform (COMETR), Final Report to the European Commission, DG Research and DG Taxation and Customs Union (Roskilde, Denmark, National Environmental Research Institute, Economic and Social Research Institute, Institute for Economic and Environmental Policy, Policy Studies Institute and Vienna Institute for International Economics Studies, 2007).

Resource Productivity, Environmental Tax Reform and Sustainable Growth in Europe, by Paul Ekins (London, Anglo-German Foundation for the Study of Industrial Society, 2009).

The Case for Green Fiscal Reform (London, UK Green Fiscal Reform, 2009).

The Effects of Environmental Tax Reform on International Competitiveness in the European Union: Modelling with E3ME, by Terry Barker and others, in *Carbon-Energy Taxation: Lessons from Europe* (Oxford, Oxford University Press, 2009).

"The effects of ETR on competitiveness: Modelling with E3ME", by Paul Ekins in *Competitiveness Effects of Environmental Tax Reform* (COMETR), Final Report to the European Commission, DG Research and DG Taxation and Customs Union (Roskilde, Denmark, National Environmental Research Institute, Economic and Social Research Institute, Institute for Economic and Environmental Policy, Policy Studies Institute and Vienna Institute for International Economics Studies, 2007).

CASE STUDY

Multinational pioneers learn by doing
European Union's Emissions Trading System

Key points

- ***As the world's largest carbon trading market, the European Union's Emissions Trading System provides valuable lessons for adopting and developing carbon pricing mechanisms.***
- ***The phased approach enabled time to integrate lessons from the pilot phase into subsequent phases.***

There was a need…

As agreed in the Copenhagen Accord in 2009, limiting the global temperature rise to 2 ° C or less, relative to the pre-industrial level, by 2050, is necessary to limit the dangerous anthropogenic interference with the climate system. According to the International Energy Agency modelling,[1] a reduction of more than 50 per cent of global greenhouse gas emissions from the baseline is required to achieve this goal. Thus drastic policy changes, especially in the power sector, were – and remain – imperative.

What was done?

The concept of a European cap-and-trade scheme emerged as an ambitious policy experiment to lead a global effort through the use of market forces to reduce harmful emissions by achieving its 2020 greenhouse gas reduction goal (by 20 per cent from the level of 1990).[2]

The European Emissions Trading System (EU ETS) became a mandatory cap-and-trade scheme for large emitters in countries under the Agreement on the European Economic Area, in which each participating member State was expected to develop a national allocation plan (NAP) that then had to be approved by the European Commission. NAPs contain information about the total quantity and distribution of allowances that a member State intends to issue, based on objective and transparent criteria provided in the guidelines.

Carbon pricing mechanisms, such as emissions trading schemes and carbon taxes, are gaining momentum as an essential and necessary means to drive carbon reductions with the required rapidity.

The ETS framework, based on a 2003 European Commission directive, fixed an upper limit ("cap") on the maximum emission of carbon dioxide from factories, power plants and other installations covered under the scheme. Under this ceiling, every tonne of "permitted" CO_2 receives an emission allowance (European Union allowance, or EUA), also known as the "authorization to emit".

The total emissions of a country are thus converted to an equivalent amount of allowances, which are then distributed to the facilities affected by the scheme, based on their historical emission baseline. These allocated allowances (permits) cover their actual emissions and "allow" entities to release a specific amount of greenhouse gases. To emit more than the allocated allowance threshold, additional permission can be purchased from other entities (businesses, organizations, etc.) that have emitted less than their allocated allowance. Carbon emission allowances can be sold and purchased to meet the entities' respective assigned carbon emissions reduction quota.

[1] International Energy Agency, *World Energy Outlook 2009* (Paris, OECD and IEA, 2009). Available from www.iea.org/weo/2009.asp (accessed 26 March 2012).

[2] In 2010, EU agreed to increase this cut to 30 per cent under the condition that "other major emitters agree to take on their fair share of a global reduction effort". See European Union, "Climate Change: European Union Notifies EU Emission Reduction Targets Following Copenhagen Accord", *Press release*, 28 January 2010. Available from http://europa.eu/rapid/pressReleasesAction.do?reference=IP/10/97 (accessed 24 March 2012).

How allowances are traded

The trading process is handled through a national emissions trading registry that needs to send each transaction proposal to the central hub of the Secretariat of the United Nations Framework Convention on Climate Change (International Transaction Log, or ITL). Approval is given by the ITL, based on the compliance with the rules agreed under the Kyoto Protocol.[3]

The first national registries were set up in early 2005 to launch the operation of the EU ETS; there are now 30 registries, including the three non-European Union countries that joined the scheme in 2008 – Iceland, Liechtenstein and Norway.[4] Any individual or organization operating an installation under the ETS obligation is required to open an Operator Holding Account within the national trading registry, which officially records all EU emission allowances. This online database enables participants to trade their allowances and record allowance allocations, their movement between accounts and annual verified emissions.

The trade of allowances can be conducted through direct trading between businesses, through such intermediaries as banks, brokers and specialist traders and by joining an exchange that lists carbon allowance products or EU member State auctions.

The revision of the ETS Directive in 2009 resulted in the creation of a centralized European Union registry, managed by the European Commission. This single registry, including all national registries, is used now by more than 25,000 end users (operators and traders)[5] and is subject to the European Union Transaction Log (EUTL), which took over the role of the ITL for keeping track of ownership of allowances in the EU ETS.[6]

The step-by-step approach: From voluntary trial and pilot phase to Kyoto and post-Kyoto phase

A voluntary phase was introduced in Denmark and the United Kingdom in 2002. A pilot phase (Phase I) followed, from 2005 to 2007, before the full-scale second phase (Phase II, also called the Kyoto Phase) was launched, from 2008 to 2012.

The voluntary trial phase (starting in 2002)

The voluntary trading scheme was the world's first multi-industry carbon trading system and allowed governments and the private sector to gain experience with auctioning and trading allowances. The 34 recruited UK participants received a share of an incentive fund in exchange for their willingness to reduce their emissions.[7] Each participant agreed to hold sufficient allowances to cover their actual emissions and to take part in a scheme that followed an annually resetting cap. It was up to the participants to decide in which way they would meet the requirements: reducing emissions and thereby releasing allowances or covering an excess of emissions by buying allowances from other participants.[8]

[3] European Commission website "Climate Action: Registries" (30 January 2012). Available from http://ec.europa.eu/clima/policies/ets/registries_en.htm (accessed 1 March 2012); United Nations Convention on Climate Change website "International Transaction Log" (2012). Available from http://unfccc.int/kyoto_protocol/registry_systems/itl/items/4065.php (accessed 5 March 2012).

[4] European Commission website "Climate Action Registries". Available from http://ec.europa.eu/clima/policies/ets/registries_en.htm (accessed 13 April 2011); European Commission website "EU ETS Registries". Available from http://ec.europa.eu/clima/policies/ets/allocation/2008/documentation_en.htm (accessed 5 March 2012). Iceland, Environment Agency "Registry System". Available from www.ust.is/the-environment-agency-of-iceland/eu-ets/registry-system (accessed 20 March 2012).

[5] ibid.

[6] European Commission website "Climate Action: Registries" (30 January 2012). Available from http://ec.europa.eu/clima/policies/ets/registries_en.htm (accessed 1 March 2012).

[7] To initiate the Scheme, Department for Environment, Food and Rural Affairs (DEFRA) held an auction on 11-12 March 2002 and agreed to pay successful bidders incentives worth £215 million, over the five years from 2002 to 2006, in exchange for delivering emissions reductions. United Kingdom of Great Britain and Northern Ireland, *The UK Emissions Trading Scheme: A New Way to Combat Climate Change* (London, National Audit Office, 2004). Available from www.nao.org.uk/publications/0304/uk_emissions_trading_scheme.aspx (accessed 1 March 2012).

[8] United Kingdom, The UK Emissions Trading Scheme, A New Way to Combat Climate Change (London, National Audit Office, 2004). Available from: www.nao.org.uk/publications/0304/uk_emissions_trading_scheme.aspx (accessed 1 March 2012)

Consequently, the participants took advantage of the incentive for reducing their emissions to invest specifically in greenhouse gas reduction measures and efficient facilities. The experience gained in the voluntary trial phase helped policymakers to determine pricing strategies, establish emission trading brokerage businesses and learn about negotiating issues as well as the auctioning process. In Denmark, eight companies (with historical emissions greater than 100,000 tonnes of CO_2 per year from combined heat and power generation) participated in the initial trading scheme, with a 2003 target of reducing CO_2 emissions by up to 60 per cent of the historic level (between 1994 and 1998). Revenues from penalties for non-compliance were to be spent on additional energy-saving measures.[9]

The pilot phase (2005–2007): A learning-by-doing exercise

Integrating a pilot phase into a new emissions trading scheme is an important element for the scheme's development. When the EU ETS opened up its pilot phase operations in January 2005, market participants were already in place thanks to the prior launch of the UK Emissions Trading Scheme. Despite the potential of emissions trading to cover many sectors of the economy and all six greenhouse gases regulated by the Kyoto Protocol (CO_2, methane, nitrous oxide, hydrofluorocarbon, perfluorocarbon and sulphur hexafluoride), the pilot phase began with a limited scope of coverage: CO_2 emissions from large emitters in the power and heat generation industry and in defined energy-intensive industrial sectors (combustion plants, oil refineries, coke ovens, iron and steel plants and factories making cement, glass, lime, ceramics, pulp and paper).[10] About 2.2 billion tonnes of CO_2 allowances were issued annually in the pilot phase.[11]

The cap was set very moderately to enable a smoother entry into the scheme, considering that there was not enough time for the participants to make significant preparations. The allowances for this phase were distributed according to the national allocation plans, mostly for free and based on previously estimated emission levels ("grandfathered"[12]). This historic emission data was rather inaccurate and problematic because it was largely dependent upon the reports and the industry projections made by the businesses themselves. The businesses tended to "overstate" their past and expected future emissions.[13] In result, this induced an over-allocation of allowances and a biased evaluation of the factual emission reductions achieved through the ETS.

The inventories during that first phase revealed that real emissions were below the projected business-as-usual scenario. Due to oversupply, the allowance price fell close to zero and the scheme consequently offered no incentive for abatement anymore, hindering the efficient commencement of the financial regulation and carbon reduction measure. During that time, the oil and natural gas prices fluctuated, which affected also the allowance price.[14] As a consequence of these previously supposed difficulties, the amount and composition of EUAs applied in Phase I was not transferred to Phase II.

Fifteen EU member States participated in the pilot phase. Its launch helped to identify difficulties in the operation and the impacts on the economy, which were taken into account before recommending new regulations for the design of the scheme in Phases II and III. Key components of the required infrastructure for ETS, including emission data monitoring, national registries and inventories were established during this phase.

[9] Sven Bode, "Emission trading schemes in Europe: Linking the EU emission trading scheme with national programmes" in Bernd Hansjürgens, ed., *Emissions Trading for Climate Policy: US and European Perspectives* (Cambridge, Cambridge University Press, 2005).

[10] Global Carbon webiste "EU ETS" (2007). Available from: www.global-carbon.com/en/services/euets.html (accessed 1 March 2012).

[11] Frank J. Convery, "Reflections on the European Union emissions trading scheme (EU ETS): What can we learn?", presented at the Informational Board Workshop on Policy Tools for the AB 32 Scoping Plan of the Air Resources Board, Sacramento, California, 28 May 2008. Available from www.arb.ca.gov/cc/scopingplan/meetings/5_28notice/presentations/convery_whitepaper_5_28.pdf (accessed 1 March 2012).

[12] Allocation method under which the government would give (not sell) allowances to entities based on their historic production, emission or consumption levels. See Clean Air-Cool Planet website "Glossary of Terms" (2012). Available from www.cleanair-coolplanet.org/cpc/glossary_cpc.php (accessed 1 March 2012).

[13] In order to receive more Phase I allowances (and consequently, to receive more Phase II allowances, because the Phase II allowance was based on the emissions performance during Phase I).

[14] Larry Parker, *Climate Change and the EU Emissions Trading Scheme (ETS): Looking to 2020* (Washington, D.C., Congressional Research Service, 2010).

Table 1: Summary results for Phase I of the EU ETS

	2005	2006	2007	Total phase I
Price (time average)	€18.40	€18.05	€0.72	€12.39
Trading volume[a]	262 Mt	817 Mt	1 364 Mt	2 443 Mt
Trading value[a]	€5.4 billion	€14.6 billion	€28 billion	€48 billion
Allocation	2 099 Mt	2 072 Mt	2 079 Mt	6 250 Mt
Emissions	2 010 Mt	2 031 Mt	2 041 Mt	6 081 Mt
Surplus (volume)	89 Mt	41 Mt	39 Mt	168 Mt
Surplus (%)	4.22%	1.98%	1.85%	2.69%

[a] OTC (Over-the-Counter) and exchange trading for phase I and II, but excluding bilateral trades

Source: Beat Hintermann, "The price of carbon: Allowance price development in the EU ETS", Dissertation, University of Maryland, August 2009.

Kyoto phase (2008–2012)

Phase II of EU ETS integrated project-based flexible mechanisms of the Kyoto Protocol.[15] The so-called "linking directive" enabled participants to purchase a certain amount of Kyoto certificates (including for certified emission reductions and emissions reduction units) from flexible mechanism projects in developing countries to meet the EU emissions targets.[16]

The Kyoto flexible mechanisms are:

- **International Emissions Trading (IET):** (under Article 17 of the Kyoto Protocol) specifies that Annex I (industrialized) countries are allowed to trade assigned amount units (AAUs) with each other.
- **Joint Implementation projects (JI):** (under Article 6 of the Kyoto Protocol) an Annex I country A or an authorized institution participates in an emission-reducing project in another Annex I country B. Country A receives a certain amount of the emissions reduction units (ERUs).
- **Clean Development Mechanism (CDM):** (under Article 12 of the Kyoto Protocol) allows Annex I countries to purchase emissions reduction certificates (certified emissions reduction, or CERs) through projects in non-Annex I countries (developing country). This promotes the technology transfer and enables implementing emissions reduction projects in developing countries.[17]

In the second and the third phase, the introduction of banking for further carbon offsetting ("offset credit")[18] has been arranged to facilitate compliance with the targets. The offset possibility may provide (dis)incentives for more attractive investment options (cost-wise) in developing countries outside the European Union and thus discourage the trading of allowances within Europe.

[15] ibid.

[16] United Kingdom of Great Britain and Northern Ireland, Department of Energy and Climate Change website "EU ETS Legislation". Available from www.decc.gov.uk/en/content/cms/emissions/eu_ets/legislation/legislation.aspx (accessed 22 March 2012).

[17] For more details of IET, JI and CDM, see Kommunalkredit Public Consulting website "Flexible Mechanisms". Available from www.ji-cdm-austria.at/en/portal/kyotoandclimatechange/kyotoprotocol/flexiblemechanisms/ (accessed 2 March 2012).

[18] "Offset credit" is credits for emissions reduction undertaken elsewhere via the Kyoto Protocol's Clean Development Mechanism and Joint Implementation. International Energy Agency, *Reviewing Existing and Proposed Emissions Trading Systems* (Paris, OECD and IEA, 2010). Available from www.iea.org/papers/2010/ets_paper2010.pdf (accessed 5 March 2012).

Post-Kyoto phase (2013—2020)[19]

The upcoming Phase III aims to substantially revamp the EU ETS to improve its efficiency while clearing some of the problems that surfaced in the previous phases. To prevent oversupply and support more effective carbon reduction across the continent, the third phase is introducing a series of more rigorous measures, with a centralized and harmonized management of the whole system:

- A more ambitious EU-wide cap on emissions (aiming to deliver two thirds of the unilateral 20 per cent emissions reduction target on 1990 levels by 2020), with a strictly defined amount of allowances allocated to each EU member State.[20]
- Auctioning as a preferred mode of allocation, such as rising to 20–100 per cent (depending on the sector)[21] in the starting year, with ongoing annual increase (from 3 per cent in Phases I and II). Although a common auction platform will be appointed according to the auctioning regulation, individual member States will be allowed to opt out to establish their own national auction platform.
- Introducing aviation into ETS (which obliges member States to auction 15 per cent of aviation allowances by the end of 2012).

The allocation of allowances will be more centralized by the European Commission with the harmonization of auctioning processes, allocation and treatment rules across the EU member States. Allowances will be distributed to member States based on historical emission data, with extra allowances granted to lower-income member States for more balanced competition conditions; and the power sector will be fully auctioned to address the issue of windfall profits.[22]

Table 1: Overview of the trading scheme stages

Phase	Countries involved	Sectors included	Name	Gases covered
Voluntary trial phase[a] 2002–2006 2001–2003	United Kingdom and Denmark	Any company or public body, electricity generators excluded Only electricity generators	UK Emissions Trading System Denmark Greenhouse Gas Trading Scheme[23]	All six greenhouse gases
Phase I (pilot phase)[b] 2005–2007	15 EU member States	Combustion installations with more than 20 MW, oil refineries, coke ovens, iron and steel works, mineral, pulp and paper industry, electricity generators included	European Union Trading System	Only carbon dioxide
Phase II (Kyoto phase) [c] 2008–2012	30 countries (27 EU member States plus Norway, Iceland, Lichtenstein)	Combustion installations with more than 20 MW, oil refineries, coke ovens, iron and steel works, mineral, pulp and paper industry, electricity generators, aviation (2012)	European Union Trading System	Only carbon dioxide
Phase III (post-Kyoto phase) 2013–2020	30 countries (27 EU member States plus Norway, Iceland, Lichtenstein)	Combustion installations greater than 20 MW, oil refineries, coke ovens, iron and steel works, mineral, pulp and paper industry, electricity generators included, petrochemicals, ammonia and aluminium industries	European Union Trading System	To be extended to other greenhouse gases produced by processes already covered by the system.[24]

a Compiled from United Kingdom of Great Britain and Northern Ireland, *The UK Emissions Trading Scheme: A New Way To Combat Climate Change* (London, National Audit Office, 2004). Available from www.nao.org.uk/publications/0304/uk_emissions_trading_scheme.aspx (accessed 1 March 2012).

b Committee on Climate Change, *Building a Low-Carbon Economy: the UK's Contribution to Tackling Climate Change* (London, The Stationary Office, 2008). Available from www.theccc.org.uk/pdf/TSO-ClimateChange.pdf (accessed 4 March 2012).
c The Pew Research Center on Global Climate Change, *The European Union Emissions Trading Scheme (EU ETS): Insights and Opportunities* (Arlington, VA., 2008). Available from www.c2es.org/docUploads/EU-ETS%20White%20Paper.pdf (accessed 29 February 2012).

Results so far (Phases I and II)

The EU ETS has grown to be the world's largest greenhouse gas market with more than 11,000 participating facilities in 27 EU member States. It covers 45 per cent of Europe's CO_2 emissions (as of 2010), holds a market value of more than US$118 billion as of 2009, and 6,326 Mt CO_2 equivalent of allowances are being traded.[25] With 10 per cent of the global carbon emissions share, the ETS is expected to be a reference point for other countries when designing emissions trading schemes.

Assessments of the impacts of EU ETS have been contentious and unclear, largely due to the data uncertainties as well as emission projection uncertainties. The forecasting of the economic growth and (thus the baseline of the business-as-usual situation) were reportedly inflated. With this background, reading the reported emission reductions requires caution:

- A 2–5 per cent emissions reduction was achieved during the pilot phase (Phase I, 2005–2007)[26] and between 2007 and 2009, carbon emissions declined by 13.79 per cent[27]
- Average annual emissions per installation were reduced by more than 17,000 tonnes CO_2 equivalent (8.3 per cent reduction) compared to 2005 level, being as much as 7,500 tonnes of hard coal burned less per installation.[28]
- With the EU ETS, about 45 per cent of total CO_2 emissions were being capped at a level consistent with the adopted climate change targets.[29]

Whether the EU ETS can initiate a fuel switch from coal to natural gas in significant scale is yet to be seen. However, other unanticipated emission reduction strategies have already emerged, including infra-fuel substitution (brown to hard coal) in Germany and improved CO_2 efficiency in the United Kingdom.[30]

[19] United Kingdom of Great Britain and Northern Ireland, Department of Energy and Climate Change website "EU ETS Phase III (2013-2020)" (2012). Available from www.decc.gov.uk/en/content/cms/emissions/eu_ets/phase_iii/phase_iii.aspx (accessed 1 March 2012).

[20] The total allocation of allowances should not exceed the actual emissions because issuing too many allowances reduces the incentive for businesses to cut back their emissions.

[21] For more details, see box 1 in the fact sheet on cap-and-trade schemes in the Roadmap.

[22] The price of EUAs was passed on fully in the final price of electricity, providing significant windfall gains to fossil generators. See a memorandum submitted by David Newbery of Electric Policy Research Group, University of Cambridge to the Environmental Audit Committee – "Written Evidence: The Role of Carbon Markets in Preventing Dangerous Climate Change". Available from www.publications.parliament.uk/pa/cm200910/cmselect/cmenvaud/290/290we33.htm (accessed 1 March 2012).

[24] New sector activities and gases of Phase 3 include the release of: 1) carbon dioxide from the production of bulk organic chemicals, non-ferrous metals and gypsum related activities; 2) releases of perfluorocarbons and carbon dioxide from the primary aluminium sector; and 3) releases of carbon dioxide and nitrous oxide from the production of nitric, adipic, glyoxal and glyoxylic acid. See United Kingdom of Great Britain and Northern Ireland, Environment Agency website "Phase III 2013 to 2020" (30 January 2012). Available from www.environment-agency.gov.uk/business/topics/pollution/113457.aspx (accessed 1 March 2012).

[25] International Energy Agency, Reviewing Existing and Proposed Emissoins Trading Schemes (Paris, 2010). Available from: www.iea.org/papers/2010.pdf (accessed 5 March 2012)

[26] A. D. Ellerman and others, *Pricing Carbon: The European Union Emissions Trading Scheme* (Cambridge, Cambridge University Press, 2010).

[27] International Emissions Trading Association, *UK Parliamentary Inquiry into the EU ETS* (London, 2011). Available from www.ieta.org/assets/PositionPapers/ieta%20response%20uk%20ets%20inquiry_14-8-11.pdf (accessed 5 March 2012). One should note the external factors during the same period, such as of industrial restructuring, financial crisis and other external factors on the emission reduction results.

[28] Findings of a statistical analysis published by the European Commission on the basis of data from the Community Independent Transaction Log (CITL). European Commission and Climate Action, *The EU ETS Is Delivering Emission Cuts* (Brussels, 2011). Available from http://ec.europa.eu/clima/publications/docs/factsheet_ets_emissions_en.pdf (accessed 1 March 2012).

[29] International Emissions Trading Association, *UK Parliamentary Inquiry into the EU ETS* (London, 2011). Available from www.ieta.org/assets/PositionPapers/ieta%20response%20uk%20ets%20inquiry_14-8-11.pdf (accessed 5 March 2012).

[30] Frank Convery, Denny Ellerman and Christian De Perthuis, *The European Carbon Market In Action: Lessons From The First Trading Period* (Dublin, 2008). Available from www.cdcclimat.com/IMG/pdf/ENG_The_European_carbon_market_in_action_ExecSummary.pdf (accessed 1 March 2012).

There has been negative impact on industrial competitiveness: "windfall" profits in the power industry were largely due to lacking regulations in this sector, but also oversupply, free allowance allocation and arbitrary choice of baseline years referring to emission reduction targets as well as market restructuring and high fossil fuel prices. No empirical evidence so far indicates any market share loss in the non-power sector (including cement, refining, steel and aluminium). This implies that with more stringent controls in the future, the longer-term negative impact on competitiveness could be less.[31]

Lessons from the pilot phase[31]

The EU ETS has pioneered a truly multinational emissions trading system. Several years' piloting experience has yielded valuable lessons, which are reflected in the next phases, such as more stringent caps and harmonized regulations.

Lessons from the pilot phase:

- **Preparation needs time.** Governments and businesses require time to adopt a learning-by-doing approach until the system matures enough to demonstrate effectiveness and efficiency in reducing CO_2 emissions. The European market developed strongly in terms of traded volumes and market infrastructure in the pilot period, which indicates that not all the infrastructure has to be in place from the beginning as long as the rules of the system allow room for improvement.
- **Accurate data makes a difference.** Inaccurate data on emissions of participating entities leads to discrepancies in the calculation of allotted allowances, with the consequence of a possible over allocation of allowances that induces a lower price or even a price crash of emission allowances.[33]
- **Free allocations require fair rules of distribution among recipients to achieve emissions reduction targets.** Giving emission permits for free may create a disincentive for businesses to reduce their greenhouse gas emissions, an effect that can be alleviated if permits are auctioned.[34] Revenues from auctions can be used for research and development of low-carbon technology or to cut distortionary taxes, which would improve the efficiency of the overall cap policy.[35]
- **Government decisions influence the market design and implementation.** Initially the allowances were grandfathered and the cap was set low due to the "learning-by-doing" nature of the pilot phase. The EU ETS is gradually shifting towards an auctioning system and is also adjusting the emission reduction targets for different sectors covered by the ETS.
- **Strong and stable price signals are necessary to create certainty.** Investment and operational choices are highly influenced by the efficiency of the scheme, which is determined by price stability.
- **Harmonizing allocation rules and implementing stricter caps.** Emission caps need to be stringent to drive significant reductions in emissions.
- **Market oversight and monitoring of compliance have to be managed through annual reporting and independent verification systems.** National authorities should oversee the trading in options and futures, spot trade on exchanges and over-the-counter, being largely unregulated. Measures like integrating allowance trading into general regulations of energy markets and penalties of not compliance of set caps to emissions should be considered.[36]

[31] ibid.

[32] ibid.

[33] As shown in the year 2007, when the carbon price in EU EUS fell almost to zero.

[34] Cameron Hepburn, "Regulation by prices, quantities, or both: A review of instrument choice", *Oxford Review of Economic Policy* (2006), vol. 22, No. 2, pp. 226-247. Available from http://economics.ouls.ox.ac.uk/12828/1/hepburn%2520(2006,%2520oxrep)%2520regulation%2520by%2520p%2520or%2520q.pdf (accessed 1 March 2012).

[35] B. S. Fisher, "An economic assessment of policy instruments for combating climate change" in James P. Bruce, Hoesung Lee and Erik F. Haites, eds., *Climate Change 1995: Economic and Social Dimensions of Climate Change*, Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge, Cambridge University Press, 1996). Available from www.ipcc.ch/ipccreports/sar/wg_III/ipcc_sar_wg_III_full_report.pdf (accessed 1 March 2012).

[36] International Emissions Trading Association, *UK Parliamentary Inquiry into the EU ETS* (London, 2011). Available from http://www.ieta.org/assets/PositionPapers/ieta%20response%20uk%20ets%20inquiry_14-8-11.pdf (accessed 5 March 2012).

[37] For more details on the carbon leakage problem, see the fact sheet on cap-and-trade schemes in this Roadmap.

Challenges remain in several areas: First, addressing the problem of carbon leakage requires a broader (global) level of legally binding framework and institutions for emissions reduction. Measures should be established to prevent an increase in CO_2 emissions outside the countries through the possible re-allocation of carbon emissions to regions with less stringent mitigation rules.[36] The regulations and the allowance rates need to be more stringent to induce behaviour change and industrial restructuring. Linking and harmonizing among (existing) emission trading schemes is expected to enhance enforcement and can also strengthen price recovery by adding liquidity, thus resulting in more efficient outcomes.

Ensuring the transparent and accountable management of the system is also required to prevent fraud cases (such as online theft and VAT fraud, and potential risks of insider trading or market manipulation, as shown in the case of the financial markets) through enhanced security of the registry and explicit market oversight.

Green technology grows rural roots in least developed countries

Cooking with the sun in Cambodia

To find truly suitable green technologies for rural communities, a survey was conducted among 97 households in Cambodia's Takeo Province. Based on the findings that almost three quarters of them still rely on firewood for cooking,[1] the ASEM SMEs Eco-Innovation Center, an organization that builds green innovation bridges between small- and medium-enterprises in Asia and Europe, set up a project in which locals were trained on how to manufacture and maintain solar cookers. The project was sponsored by the Small and Medium Business Administration of the Republic of Korea and linked with the Global Green Growth Institute country programme to encourage small and medium-sized commercial ventures for selling solar cookers. Villagers were given entrepreneur training and assistance in setting up businesses that ideally would lead to more diverse technologies, such as solar panels, in sunlight-affluent Cambodia.

Solar lantern rental system shines many lights in Lao People's Democratic Republic[2]

A large proportion of the population of Lao People's Democratic Republic lives in remote rural areas without access to the public electricity grid. For them, kerosene lamps are the only option available to light up their darkness, even though many studies have shown that kerosene fuels have detrimental environmental, economic and health impacts.

In pockets across the region are tiny attempts to provide villagers without electricity safer options than kerosene. One seemingly bright prospect, solar lighting systems, has not been very successful in some countries because of poor quality equipment or battery failures as a result of inappropriate use and irregular charging. Thus Sunlabob Ltd., a commercial company based in the Lao People's Democratic Republic, set out to transcend those difficulties and prove that solar power could sustainably light up rural lives. Sunlabob developed an innovative approach for providing fee-based services for charging solar lanterns: They use a village-based charging station, which is powered by a photovoltaic array and managed by community technicians. Fees are applied to the service delivery, including the use of the lanterns, which is reasonable and lower than the cost of kerosene.

As part of the approach, a Village Energy Committee is usually established to manage, coordinate and oversee the process of collective decision-making. Sunlabob experts train the village technicians, who are assigned to charge the lanterns, operate the solar charging stations, collect fees and maintain the system.

The approach has been successfully replicated in Afghanistan, Cambodia and Uganda.[3] In 2010, as part of the regional green growth capacity development pilot for Cambodia, solar lantern rental systems were set up in two floating villages in the Thonle Sap district, in Siem Reap Province, replicating the Lao model with assistance from ESCAP and Sunlabob. During prolonged heavy flooding in 2011, villagers stranded in their homes used the solar lanterns for charging phones and other emergency needs. The service lit up the lives so successfully, more villagers are demanding the solar lantern service and the Government is looking for ways to finance expanded coverage.

[1] Kim Da-ye, "Appropriate tech more than foreign aid tool", *Korea Times*, 28 November, 2011. Available from www.koreatimes.co.kr/www/news/special/2011/11/182_99623.html (accessed 25 January 2012).

[2] United Nations Economic and Social Commission for Asia and the Pacific , *Green Growth Capacity Development Programme* (2011). Available from www.greengrowth.org\capacity_development\capacity.html (accessed 25 January 2012).

[3] United Nations Economic and Social Commission for Asia and the Pacific, *Financing an Inclusive and Green Future: A Supportive Financial System and Green Growth for Achieving the Millennium Development Goals in Asia and the Pacific* (Bangkok, 2010). Available from www.unescap.org/66/documents/Theme-Study/st-escap-2575.pdf (accessed 30 January 2012).

Human and animal waste fuel improved quality of life in Samoa

Relying on blueprints of bio-digester technologies from Thailand and Viet Nam, the Falelauniu community of the Faleata district of Samoa created a clean bio gas by capturing the methane from a mixture of human sanitation effluents and animal waste. Introduced to the community through the Youth with a Mission NGO, the low-tech and low-cost technological approach of bio-mimicry has put vital livelihood services, like lighting, heating and access to cooking fuel, within the reach of poor community dwellers. Additionally, residue from the bio-digesters was discovered to boost organic agriculture. As a result, households are now making considerable savings on their energy bills and food products while increasing their incomes by selling excess produce.

The pilot project set up a training and demonstration centre in the Falelauniu community and encouraged young people to acquire the skills needed to bio-digest while generating employment through a community-based cooperative that sold the gas. Now the centre provides similar fee-based technical services to other communities replicating the pro-poor green business model.[4] The pilot project has been replicated successfully in Fiji and Vanuatu, with other Pacific countries, such as Tonga, considering it.

[4] United Nations Economic and Social Commission for Asia and the Pacific, *Sustainable Infrastructure: Biogas in Samoa* (2010). Available from www.unescap.org/EPOC/pdf/Examples-of-Green-Growth-in-the-Pacific.pdf (accessed 20 January 2012).

CASE STUDY

High-quality investment matters
Guangzhou, China's bus rapid transit system

Key points

- ***Bus rapid transit can be a cost-effective mode of public transport for cities experiencing congestion, given the high carrying capacity, compared with conventional buses, and the smaller upfront investment needed, compared with the rail-based transport.***

- ***Although the government's ability to overcome public resistance was critical to jump-start change in Guangzhou, investment in a high-quality BRT system enabled the operation of financially viable services by attracting passengers with the increased speed, convenience and connectivity.***

There was a problem…

Guangzhou is one of the fastest-growing cities in the world. Rapid motorization had taken place in the city for three decades, leading to congestion and an unhealthy environment.

What was done?

In 2010, Guangzhou began a scheme to improve both public transport and the local environment and reduce the level of greenhouse gas emissions from the transport sector. A key part of this package was the development of a bus rapid transit (BRT) network.

The city's BRT system was launched in February 2010. Working with the Guangzhou Municipal Engineering Design and Research Institute, the international Institute for Transportation and Development Policy (ITDP) led the design and planning of the project.[1] The ITDP works with cities worldwide to bring about sustainable transport solutions that cut greenhouse gas emissions, reduce poverty and improve the quality of urban life.

The infrastructure costs for the following components were US$4.4 million per kilometre and were financed by the Government:

- **Quality infrastructure:** Sensitively designed infrastructure enables efficient transit between different modes of transport and easy access to all citizens. The scheme is the first in China to include bicycle parking at the stations and to include direct tunnels between the metro and BRT stations. Platforms are at grade with the bus floor, ensuring easy access for mobility-impaired passengers.
- **Integrated fare system:** The BRT and metro fare systems are integrated, which helps ensure a seamless transition between the two modes.
- **Synergies with the non-motorized transport (bicycle):** To further support the uptake of non-motorized transport, new bicycle lanes were developed that run parallel to the BRT stations. A bike-sharing scheme was launched in June 2010, with 1,000 bikes initially.[2]
- **Supplementary measures aimed at improving liveability and environmental resilience:** As part of the integrated process, polluted waterways were reclaimed as public space. Tree-lined bicycle lanes were developed that immensely improved the look and feel of the environment.

[1] Claudia Gunter, "Guangzhou Opens Asia's Highest Capacity BRT System" *Newsletter of Institute for Transportation and Development Policy*, March 5, 2010. Available from www.itdp.org/index.php/news/detail/guangzhou_opens_highest_capacity_brt/ (accessed 16 November 2011).

[2] ibid.

Results

- **Integrated transport network:** The BRT system is well integrated with other public transport modes, including bike sharing and the metro railway system. The system won the 2011 Sustainable Transport Award from ITDP.
- **Increased ridership in public transport:** It currently carries 26,900 passengers per direction per hour, with a daily ridership level of roughly 800,000, supporting a modal shift of 10-15 per cent from private vehicles.
- **CO_2 emission reduction:** It is estimated that the scheme has reduced CO_2 emissions by approximately 20,000 tonnes a year.[3]
- **Time saving:** The BRT is estimated to have saved 30 million passenger hours in the city in its first year.
- **New employment and business opportunity:** Guangzhou's BRT opened up a range of employment and business opportunities for people who were previously restricted by the time and cost required to move along the Zhongshan Avenue corridor.

Lesson learned

Investment in the improvement of the quality of the BRT system led to the long-term financial sustainability of the operation. The high-quality service is expected to cover all operating costs, including bus depreciation and the installation, operation and maintenance of the fare-collection system.

Success factors

- **Political leadership:** There was significant opposition to the introduction of the scheme from car owners[4] and the media. But that was met with strong and unwavering political support for the scheme from the city mayor. In addition, all provincial and city officials have ridden and endorsed the system.[5]
- **Clearly defined responsibilities:** The new BRT scheme was to be integrated with improvements to non-motorized transport and the metro, so there was a need to ensure clearly defined responsibility and effective communication. The BRT system is regulated by the Public Transport Management Office (planning) and the BRT Management Co. (control).[6] The BRT Management Company oversees the private companies that are responsible for the operations.[7]
- **Appropriate regulatory arrangement for operators:** There are seven operating companies in three large corporate groups that are responsible for managing the operation of the service. This makes some aspects of regulation more complicated but helps to ensure a good service by providing regulators with more options. Bus operators are paid per kilometre rather than per passenger.

Considerations for replicating

Countries with a lack of planning and design capacity may resort to the support from an international organization or research institute. Guangzhou turned to the Institute for Transportation and Development Policy to help ensure the ongoing sustainability of its vision and system. Minor route changes and the gradual introduction of express routes and larger buses will result in significant operational improvements to ensure increasing passenger demand continues to be met.[8]

[3] Sabiq Rahim, "Chinese Cities Find Bus Only Lanes an Alternative to Cars and Subways", *The New York Times*, July 16, 2010. Available from www.nytimes.com/cwire/2010/07/16/16climatewire-chinese-cities-find-bus-only-lanes-an-altern-10489.html (accessed 16 November 2011).

[4] ibid.

[5] Megan McConville, "Guangzhou's BRT: Revolutionizing Perceptions of Bus Travel in China", *The City Fix*, April 1, 2010. Available from http://thecityfix.com/guangzhous-brt-revolutionizing-perceptions-of-bus-travel-in-china (accessed 16 November 2011).

[6] Claudia Gunter, "Guangzhou Opens Asia's Highest Capacity BRT System" *Newsletter of Institute for Transportation and Development Policy*, March 5, 2010. Available from www.itdp.org/index.php/news/detail/guangzhou_opens_highest_capacity_brt/ (accessed 16 November 2011).

[7] ibid.

[8] Megan McConville, "Guangzhou's BRT: Revolutionizing Perceptions of Bus Travel in China", *The City Fix*, April 1, 2010. Available from http://thecityfix.com/guangzhous-brt-revolutionizing-perceptions-of-bus-travel-in-china (accessed 16 November 2011).

Further reading

Options for Financing Bus Rapid Transit in China, by W. Hook, K. Fjellstrom and O. Diaz (New York, The Institute for Transportation and Development Policy, 2006). Available from www.itdp.org/documents/China per cent20BRT per cent20Financing, per cent20Final.pdf

CASE STUDY

Looking to the sun for revolutionary economic growth
India's Solar Mission

Key point

- ***Solar energy industry is seen as capable of providing India with the same revolutionary growth that the IT industry brought.***

There was a problem…

India's energy policy had reached a critical point, with energy demand rising while the supply of domestic conventional fuels tapers and the need for imported fuel grows.[1]

What was done?

The Government launched the Jawaharlal Nehru National Solar Mission, also known as Solar India, in late 2009 to achieve grid parity and generate 20,000 MW of grid-connected and 2,000 MW of off-grid solar energy by 2022. It is part of the National Action Plan on Climate Change, which was released by the Prime Minister's Council on Climate Change in 2008 and includes seven other missions.[2]

The Ministry of Environment and Forests, the Ministry of Power, the Ministry for New and Renewable Energy, the Ministry of Agriculture, the Ministry of Science and Technology and the Ministry of Water Resources are involved in the missions, and each is tasked with coordinating one or more of the strategies.

How it works

An autonomous Solar Mission authority within the Ministry for New and Renewable Energy oversees the Solar Mission. A package of policies was designed to encourage not only new solar energy generation but also technological and human resource development. The policies specifically target the building of a manufacturing and innovation base for solar thermal and photovoltaic industries in India. A solar energy industry is seen as capable of ushering in the same revolutionary growth in India that the IT industry brought. Similar to the "Indian Silicon Valleys" that the IT boom spawned, solar energy research and manufacturing companies could cluster in "Solar Valleys" to spur business opportunities and innovation.[3] Although the Government plans to create at least 100,000 jobs by the end of 2022, KPMG India (business advisers) projects that 600,000 jobs in utility-scale, rooftop and agricultural solar (water) pumpsets could be created in the Solar Mission's final phase, with a further potential of 420,000 jobs in solar water heating.[4]

[1] KPMG India, *The Rising Sun: A Point of View on the Solar Energy Sector in India* (Mumbai, 2011). Available from www.kpmg.com/IN/en/IssuesAndInsights/ThoughtLeadership/The_Rising_Sun_full.pdf (accessed 10 October 2011).

[2] The National Plan on Climate Change identified national "multi-prolonged, long-term and integrated strategies" for achieving national climate change goals until a time horizon of 2017. These strategies are referred to as "missions". In addition to the Solar Mission, the other seven missions are the National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a Green India, National Mission for Sustainable Agriculture and National Mission on Strategic Knowledge for Climate Change.

[3] Sujay Mehdudia, "Manmohan launches 'Solar India'" *The Hindu*, 11 January 2010. Available from www.thehindu.com/news/national/article78775.ece (accessed 14 February 2012).

[4] KPMG India, *The Rising Sun: A Point of View on the Solar Energy Sector in India* (Mumbai, 2011). Available from www.kpmg.com/IN/en/IssuesAndInsights/ThoughtLeadership/The_Rising_Sun_full.pdf (accessed 10 October 2011).

The Solar Mission was designed with three phases, with the following cumulative targets:

Phase	Grid-connected power, incl. rooftop	Off-grid applications	Solar collector area
Phase 1 (2010–2013)	1,100 MW (of which 500 MW solar thermal)	200 MW	7 million sq m
Phase 2 (2013–2017)	4,000–10,000 MW	1,000 MW	15 million sq m
Phase 3 (2017–2022)	20,000 MW	2,000 MW	20 million sq m

KPMG India also projects that when grid parity is reached, solar energy generation could offset 30.8 million tons of CO2 emissions – roughly 1 per cent of the overall Indian emissions or 2.2 per cent of emissions from the electricity sector. In just two years after grid parity, solar installations are expected to take off and could reduce CO2 emissions by 95 million tons (over 6 per cent of emissions from the electricity sector).

A core component of the Solar Mission policy framework is the feed-in tariff, launched in 2009 and amended to differentiate between solar thermal and solar photovoltaic installations; it set specific rates for those technologies to better drive development and innovation in each industry. Rates are fixed for 25-year power purchase agreements and will be reviewed and revised annually. The power purchase agreements are signed with NTPC Vidyut Vyapar Nigam, a wholly owned subsidiary of India's largest state-owned power generating company, under the Ministry of Power. NTPC Vidyut Vyapar Nigam will bundle the solar energy with cheaper unallocated coal-based generation to sell the power back to distribution utilities at more affordable prices.

The Solar Mission also benefits from existing renewable purchase obligations (India's state-level renewable energy standards) as well as a new national system of tradable renewable energy credits, which increases flexibility in renewable energy investments.

Objectives of the Solar Mission:

1) **Provide a policy framework that promotes the deployment of grid-connected and off-grid solar energy generation by the private sector.**
2) **Achieve grid parity by 2022.** The three-phase plan aims to facilitate solar energy production with government incentives so that grid parity is reached by 2022.
3) **Create jobs.** To ramp up solar development, as many as 1 million new jobs could be created in the industry in the next ten years.[5]
4) **Build knowledge and a skilled workforce.** Developing the solar industry in India requires not only technological development but also human resource development, thus education is an important component of the Solar Mission.
5) **Become a leader in solar technology, particularly solar thermal, and become an exporter of this technology.**
6) **Develop off-grid solar energy installations.** Providing heat and electricity to remote rural areas and poor urban districts via off-grid solar installations can improve people's health and quality of life.

Results

The Government pledged US$900 million to the first phase of the Solar Mission. Some funds will be used to buy solar energy and feed it back into the grid, providing secure power purchase agreements to help accelerate the nascent solar market in the first three years. The solar generation is bundled with conventional thermal power to reduce the cost before it is sold back to utilities at a competitive price. Reductions of import duties and excise taxes on solar technology components have been instituted to cut production costs until domestic supply chains can be developed.

[5] ibid.

These financial mechanisms, along with the policy certainty provided by the 2022 goal, have provided the favourable conditions necessary to drive solar development. The first batch of bidding for 704 MW of power purchase agreements in 2010 was oversubscribed, with proposals from solar start-ups as well as experienced independent power producers.

Although project developers have proposed thousands of MW of projects, there is a noted lack in manufacturing and development experience, particularly in concentrated solar power (CSP).[6] Of the 470 MW of CSP projects allocated in 2010, none of the developers had any experience with concentrated solar power,[7] and there was no domestic manufacturing of CSP components at the outset of the Solar Mission.[8] With more solar development on the horizon, a number of universities have instituted new departments and programmes to train a new generation of labour to meet the growing needs of the solar industry.

[6] Republic of India, *Jawaharlal Nehru National Solar Mission, Building Solar India: Guidelines for Selection of New Grid Connected Solar Power Projects* (New Delhi, Ministry of New and Renewable Energy, 2010). Available from http://pib.nic.in/archieve/others/2010/jul/jnnsm.pdf (accessed 10 October 2011).

[7] Karl-Erik Stromsta, "India unveils 37 national solar mission project winners", *Recharge News*, December 15, 2010. Available from www.rechargenews.com/energy/solar/article239515.ece (accessed 10 October 2011).

[8] Republic of India, *Jawaharlal Nehru National Solar Mission: Towards Building Solar India* (New Delhi, Government of India, 2010). Available from http://india.gov.in/allimpfrms/alldocs/15657.pdf (accessed 10 October 2011).

CASE STUDY

Easing the impact of subsidy reform
Indonesia's Bantuan Langsung Tunai cash transfer programme

Key points

- ***After realizing that fossil fuel subsidies are financially untenable, inequitable and environmentally harmful, the Indonesian Government launched a series of fossil fuel subsidy reforms over several years, with the goal of phasing them out.***

- ***In combination with a direct cash transfer, Indonesia's subsidy reform mitigated potential negative impacts on the poor as well as increased political feasibility of the reform and promoted fairness and equity of the policy scheme.***

There was a problem…

With a rapid rise in the world oil price and increasing demand for energy to meet its need for growth, Indonesia became a net oil importer for the first time in 2004. At the same time, budgetary pressure of continuing fossil fuel subsidies increased.[1] The fuel subsidies in Indonesia were found to be inequitable: By 2005 the top 40 per cent of households received 70 per cent of the subsidies while the bottom 40 per cent benefited only from 15 per cent of the subsidies.[2] Thus there was evidence that the fuel subsidies were regressive because they represented less than 0.5 per cent of poor household incomes as opposed to more than 1.5 per cent for the most affluent household incomes.[3]

What was done?

The Government launched a subsidy reform in 2005 to phase out fossil fuel subsidies, with the aim of diversifying its energy mix, securing energy access for continuing economic development and reducing dependence on oil imports.

In 2005, concern over the increasing pressure that fuel subsidies were placing on the state budget led the Government to increase fuel prices in March and then again in October by an average of 29 per cent and 114 per cent, respectively, reducing the Indonesian state budget deficit by US$4.5 billion in 2005 and US$10 billion in 2006.[4]

According to the 2007 national action plan for addressing climate change, gradually phasing out fossil fuel subsidies will promote low-carbon economic growth with less environmental impact while increasing the competitiveness of alternative energy sources.

[1] Between 2001 and 2008, fuel subsidies ranged from 10 to 28 percent of the national budget. Christopher Beaton and Lucky Lontoh, *Lessons Learned from Indonesia's Attempts to Reform Fossil-Fuel Subsidies*, Trade, Investment and Climate Change Series (Manitoba, Canada, International Institute of Sustainable Development, 2010). Available from www.iisd.org/pdf/2010/lessons_indonesia_fossil_fuel_reform.pdf (assessed 12 September 2011).

[2] Annabelle Mourougane, "Phasing Out Energy Subsidies in Indonesia", OECD Economics Department Working Paper No. 808 (Paris, Organisation for Economic Co-operation and Development, 2010). Available from www.oecd-ilibrary.org/economics/phasing-out-energy-subsidies-in-indonesia_5km5xvc9c46k-en (accessed 5 October 2011); Christopher Beaton and Lucky Lontoh, Lessons Learned from Indonesia's Attempts to Reform Fossil-Fuel Subsidies, Trade, Investment and Climate Change Series (Manitoba, Canada, International Institute of Sustainable Development, 2010). Available from www.iisd.org/pdf/2010/lessons_indonesia_fossil_fuel_reform.pdf (assessed 12 September 2011).

[3] Annabelle Mourougane, "Phasing Out Energy Subsidies in Indonesia", OECD Economics Department Working Paper No. 808 (Paris, Organisation for Economic Co-operation and Development, 2010). Available from www.oecd-ilibrary.org/economics/phasing-out-energy-subsidies-in-indonesia_5km5xvc9c46k-en (accessed 5 October 2011).

[4] K. Bacon and M. Kojima, *Coping with Higher Oil Prices* (Washington D.C., the World Bank, 2006).

Along with the other G20 nations, Indonesia has pledged to eliminate fossil fuel subsidies in the medium term. The Government's stated intention was to completely eliminate fossil fuel subsidies by 2014.

Direct cash transfer initiative cushioned impacts on 19.2 million households

To mitigate the impact of the reform on the poor, the Government introduced an unconditional cash transfer programme called Bantuan Langsung Tunai (BLT). The direct cash transfer has an advantage of easily targeting a specific group and its costs, usually known with certainty. Approximately 19.2 million low-income households (whose per capita expenditure is 175,000 rupiah or less (around US$17.50 per month)) were given the equivalent of US$10 a month over a six-month period.[5]

According to ASEAN estimates, the BLT programme cost around a quarter of the 2006 savings, at around US$2.3 billion, excluding organizational and administrative costs of targeting and distribution of the aid.

Payment methods

Because many recipients did not have an identification card, a bank account or a valid address, a face-to-face cash distribution method was largely used to maximize the access for the poor without the need for registration or using bank accounts. This led to high transportation and maintenance costs.[6]

Other welfare-support measures to increase the overall effectiveness of BLT

The BLT was accompanied by a number of other short-term welfare-support measures:[7]

- Free health care at local clinics, free outpatient visits and inpatient services (US$230 million)
- School operating assistance programme (US$1.2 billion)
- Rural infrastructure support project (US$60.82 million, including a loan of US$50 million)

Results

Reduced fiscal deficits: The reduction of fossil fuel subsidies reportedly saved US$4.5 billion in 2005 and US$10 billion in 2006.[8]

Reduced poverty rate: According to government research, the BLT programme was expected to significantly contribute to the compensation of the drastic rise in poor households' living costs due to higher fossil fuel prices and even to offset poverty rates in rural areas. Although different modelling simulations provide various outcomes, according to Statistics Indonesia, the number of people living below the poverty line decreased to 16.58 per cent in March 2007, from 16.66 per cent in 2005. Another estimate indicates that without the programme, the fuel price increase could have raised the poverty rate up to 22 per cent.[9]

The BLT programme affected differently the welfare of rural poor and urban poor populations, because the latter is more dependent on oil consumption for a higher use of kerosene fuels for cooking or fuel-related commodities such as transportation. More effective policy design should consider the different consumption patterns of low-income household groups.

[5] ibid.

[6] Muliadi Widjaja, *An Economic and Social Review on Indonesian Direct Cash Transfer Program to Poor Families Year 2005* (Jakarta, Institute for Economic and Social Research University of Indonesia, 2011). Available from www.welfareacademy.org/pubs/international/policy_exchanges/asp_papers/widjaja.pdf (accessed 5 October 2011).

[7] Christopher Beaton and Lucky Lontoh, *Lessons Learned from Indonesia's Attempts to Reform Fossil-Fuel Subsidies*, Trade, Investment and Climate Change Series (Manitoba, Canada, International Institute of Sustainable Development, 2010). Available from www.iisd.org/pdf/2010/lessons_indonesia_fossil_fuel_reform.pdf (assessed 12 September 2011).

[8] ibid. p.23

[9] ibid.; Muliadi Widjaja, *An Economic and Social Review on Indonesian Direct Cash Transfer Program to Poor Families Year 2005* (Jakarta, Institute for Economic and Social Research University of Indonesia, 2011). Available from www.welfareacademy.org/pubs/international/policy_exchanges/asp_papers/widjaja.pdf (accessed 5 October 2011).

Reduced political opposition: One study indicates that compared with the previous fuel price rises in 1998 and 2003, the intervention in 2005 was met with a relatively low level of opposition thanks to the cash transfer programme and other supporting measures.[10] The BLT, as one of the most high-profile welfare-support schemes applied during the reform, was credited for effectively cushioning the poor from an economic shock and raising awareness about social and economic benefits of the subsidy reform.

High level of public satisfaction: Independent research indicates that, on average, BLT recipients reported a relatively high level of satisfaction with the accuracy of targeted groups, the efficient distribution manner and the frequency as well as the quantity of payments.[11]

Efficient cash spending by the recipients: A field survey indicates that contrary to the criticism on the programme that money would be spent on activities not related to welfare increase, such as drinking or gambling, more than 90 per cent of recipients claimed to have spent the extra income on rice, followed by kerosene expenditures, private debt, health- and education costs.[12]

Current status of Indonesia's fuel subsidy reform

The path to zero-subsidies has not been without its bumps. In February 2011, the Indonesian Government postponed a restriction on subsidies for fuel for private cars, a move that could end up costing 6 trillion rupiah.[13] In addition, the electricity subsidy increased from 65.6 trillion to 91 trillion rupiah. Due in part to the subsidized and state controlled price of electricity, the state utility PLN has had difficulty in increasing energy infrastructure and supplying electricity to meet increasing need. This problem, analysts find, threatens to slow Indonesia's economic growth.[14] In December 2011, it was reported that the quota of subsidized fuels would increase by between 500,000 and 1,000,000 kilolitres.[15]

Lessons learned

Ensure penetration to the beneficiaries through effective means of distribution: The existence of large informal economy in many developing countries may pose a challenge because many people who would otherwise be eligible for the programme may be discouraged from registering for the direct cash transfer. In the case of Indonesia, the face-to-face cash distribution was found to be effective, but at the same time it induced extra transport costs and other opportunity costs – and still remained limited in accessing the poor in remote areas. Further research on implementing strategies to extend the benefits to all of the eligible groups would be desirable.

[10] Christopher Beaton and Lucky Lontoh, *Lessons Learned from Indonesia's Attempts to Reform Fossil-Fuel Subsidies*, Trade, Investment and Climate Change Series (Manitoba, Canada, International Institute of Sustainable Development, 2010). Available from www.iisd.org/pdf/2010/lessons_indonesia_fossil_fuel_reform.pdf (assessed 12 September 2011).

[11] Christopher Beaton and Lucky Lontoh, *Lessons Learned from Indonesia's Attempts to Reform Fossil-Fuel Subsidies*, Trade, Investment and Climate Change Series (Manitoba, Canada, International Institute of Sustainable Development, 2010). Available from www.iisd.org/pdf/2010/lessons_indonesia_fossil_fuel_reform.pdf (assessed 12 September 2011); SMERU Research Institute, *A Rapid Appraisal of the Implementation of the 2005 Direct Cash Transfer Program in Indonesia: A Case Study in Five Kabupaten/Kota* (Jakarta, 2006). Available from www.smeru.or.id/report/research/blt/slt_eng.pdf (assessed 15 November 2011).

[12] An economic and social review on Indonesian direct cash transfer program to poor families year 2005, Muliadi Widjaja, *An Economic and Social Review on Indonesian Direct Cash Transfer Program to Poor Families Year 2005* (Jakarta, Institute for Economic and Social Research University of Indonesia, 2011). Available from www.welfareacademy.org/pubs/international/policy_exchanges/asp_papers/widjaja.pdf (accessed 5 October 2011),.p. 8.

[13] Rangga D. Fadillah and Esther Samboh, "15 Percent of Subsidized Fuel Sold to Industries", *The Jakarta Post*, March 15 2012. Available from www.thejakartapost.com/news/2011/05/31/15-percent-subsidized-fuel-sold-industries.html (accessed 15 March 2012).

[14] Francis Kan, "Analysis: Power woes could trip Indonesia's economic surge", Reuters, December 22 2011. Available from www.reuters.com/article/2011/12/23/us-indonesia-energy-bottlenecks-idUSTRE7BM06F20111223 (accessed 15 March 2012).

[15] *The Jakarta Post*, "Govt to Add to Subsidized Fuel by Up To 1m kl", December 15 2011. Available from www.thejakartapost.com/news/2011/12/15/govt-add-subsidized-fuel-1m-kl.html (accessed 15 March 2012).

Considerations for replicating

Targeting the right group of beneficiaries

Identifying eligible groups should be reliable and transparent: Eligible families were determined by the Central Board of Statistics, or Badan Pusat Statistik (BPS), then field-checked by post office staff and village officers and verified by poverty indicators, which include the consideration of consumption habits, level of education and assets.[16] Only poor households with a per capita expenditure of 175,000 rupiah or less (around US$17.50 per month) qualified.

Strengthening the eligibility testing system through reliable socio-economic data and training mechanisms may increase legitimacy and transparency of the targeting approach. The lack of a reliable database may create a potential for undercoverage and overcompensation, thereby limiting the effectiveness and fairness of the programme.

Gaining public support

An effective information campaign can help garner public support: The BLT was accompanied by an awareness-raising campaign, including newspaper reports, TV talk shows, village notice boards and the distribution of pamphlets and brochures as well as information on the back of the identification card needed for payments.[17]

Effective modes of communicating the economic and social costs of the existing subsidies as well as the benefits of the reform to the public may differ depending on a country's unique social and political context. Strategies should be tailored to country-specific factors. For example, studies indicate that a permanent and independent institution that investigates and communicates the benefits of a reform may be more credible and effective in harvesting public support than ad hoc working groups or commissions.[18] A good case in point is the Productivity Commission in Australia, which consistently publishes subsidy reports and also raises public awareness about the subsidy reform through media.[19]

A transparent decision-making structure is crucial for credibility: A transparent and coherent governance structure that provides clear implementing guidelines and effectively oversees relevant municipalities is essential in increasing credibility and political acceptability of the scheme. In 2009, for example, the Indonesian Government created a National Energy Council (Dewan Energi Nasional) to analyse energy-policy issues and monitor the cross-sector policies.[20] The council consists of members of different ministries and the industry as well as academics.

Structural poverty alleviation measures should be set in place in the long-term: While effective in the short-term, a direct cash transfer should not be considered as a replacement for broader, longer-term structural mechanisms to alleviate poverty, such as investing in public infrastructure or education.

Subsidy reforms need to be ongoing: There is ample room for further reforms in subsidy measures. In 2010, the Government joined the G20 pledge to phase out subsidies for fossil fuels and announced plans to eliminate them by 2014 while steadily reducing total energy subsidies (including fossil fuels, electricity and biofuel subsidies) by 10–15 per cent on average per year during the period 2011–2014. These welcome initiatives may be complemented by detailed timelines and concrete action plans in the near future.

[16] There is criticism that without reliable household income data, the BPS officers rely only on physical assessments such as quality of house or the judgment of the village officers, leading to public dissatisfaction.

[17] Christopher Beaton and Lucky Lontoh, *Lessons Learned from Indonesia's Attempts to Reform Fossil-Fuel Subsidies*, Trade, Investment and Climate Change Series (Manitoba, Canada, International Institute of Sustainable Development, 2010). Available from www.iisd.org/pdf/2010/lessons_indonesia_fossil_fuel_reform.pdf (assessed 12 September 2011)

[18] Annabelle Mourougane, "Phasing Out Energy Subsidies in Indonesia", OECD Economics Department Working Paper No. 808 (Paris, Organisation for Economic Co-operation and Development, 2010). Available from www.oecd-ilibrary.org/economics/phasing-out-energy-subsidies-in-indonesia_5km5xvc9c46k-en (accessed 5 October 2011)

[19] ibid.

[20] ibid.

Further reading

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"Phasing Out Energy Subsidies in Indonesia", by A. Mourougane, OECD Economics Department Working Papers No. 808 (Paris, Organisation for Economic Co-operation and Development, 2010). Available from www.oecd-ilibrary.org/docserver/download/fulltext/5km5xvc9c46k.pdf?expires=1329276590&id=id&accname=guest&checksum=17A36E350F6C9FC78C7EAF0B2F8A1EC0

The Effect of Fiscal Policies on the Quality of Growth, by Ramón E. López, Vinod Thomas and Wang Yan (Washington, D.C., The World Bank, 2010). Available from http://siteresources.worldbank.org/INTOED/Resources/EB9_web.pdf

CASE STUDY

Rural villages generate hydropower and income
Indonesia's micro hydropower projects

Key point

- ***The potential of micro hydropower generation can be tapped through financial and regulatory policies as well as by innovative community-based participation.***

There was a problem…

Around 100 million Indonesians in rural areas still live without electricity. And yet, despite there being a large potential for the generation of electricity from hydropower in Indonesia, the actual production remains marginal, amounting to about 5 per cent for large-scale hydropower plants (4,264 MW of production of a total 75,670 MW of projected capacity).[1] Only 17 per cent of micro hydropower generation has been developed of the 500 MW of potential capacity.[2] When hydropower appeared on the high-hopes horizon, it quickly came up against financial and regulatory obstacles as well as the overpowering competitive forces of the state-owned electricity company.

What was done?

In the 1990s, a young woman and social justice activist working with poor communities in West Java, Tri Mumpuni, started a business group NGO that has built community-run hydropower plants. The NGO, IBEKA, also known as People Centered Business and Economic Institute, works in rural areas with village communities to adopt people-centred economic systems, with an emphasis on energy and electricity services. IBEKA advocates community ownership for each micro hydropower system.

When a village asks for a micro hydropower (MHP) project, a public meeting is organized to identify the poorest group in the community. The people with no land, capital, employment and education are prioritized for inclusion in the project. A community cooperative typically is set up. Some projects are co-managed with private investors, while others have become fully owned by the community. IBEKA trains the community members to manage the system technically and financially. Before the system is up and running, IBEKA helps them plan the funding of the system, organize construction and maintenance, and set priorities for the generated revenue. After the MHP system is built, the community begins to receive a gross monthly income of approximately 31 million rupiah (US$3,300). The revenue is divided equally with the business partner, if there is one, after deducting for the cost of operating and maintenance. The remaining funds are then used for scholarships, an emergency health fund, a health facility and seed money for farmers.[3]

Institutionalizing the on- and off-grid connection to take on market forces

Once the state-owned and subsidized electricity company, PLN, entered the market, many of the operations found it difficult to survive. Mumpuni lobbied the Government for three years with three successive energy ministers to allow small electricity producers to sell back to the grid. As a result of Tri Mumpuni's persistent campaigns and lobbying for changes in state policy, new regulations supportive of micro hydropower were issued by the Ministry of Energy and Mineral Resources. The regulations made it mandatory for the state-owned utility to buy all small-scale power. In 2004, the state utility was also mandated to buy all medium-voltage co-generated power

[1] International Trade Administration, *World Factsheet: Hydropower Market in Indonesia* (Washington, D.C., Department of Commerce, 2010). Available from http://ita.doc.gov/td/energy/Indonesia%20Renewable%20Energy%20Assessment%20(FINAL).pdf (accessed 27 January 2012).

[2] ibid.

[3] ASHOKA, "Tri Mumpuni". Available from www.ashoka.org/node/3870 (accessed 20 February 2012).

as well.[4] This now requires that PLN purchases energy generated by the community projects and other renewable energy-based electricity sources by providing tariff mechanisms under power purchasing agreements.[5]

Under the IBEKA project, MHP plants with more than 2 MW of generation capacity can link the generated electricity to the central grid and gain revenue through the feed-in tariff.[6] Simultaneously, smaller off-grid plants, up to 0.5 MW, help to increase local productivity in such areas as agribusiness.[7]

An attractive business model

The business model has attracted private investment. Additionally, IBEKA finances its projects through different schemes, but mostly through grants from international donors, corporate social responsibility programmes of large corporations and funding organizations.

Mumpuni developed a pro-poor public-private partnership model for rural electrification and approached UNESCAP for equity funding. With this model, IBEKA has made joint ventures between community cooperatives and private investors feasible. IBEKA also established a centre of excellence for people to learn about micro hydropower systems for rural development. Through training programmes, IBEKA helps to educate many local government officials as well as other interested institutions within the Asia-Pacific region.

Results

IBEKA has built 60 community-run hydropower plants with 5–250 kW capacity so far that have provided electricity to 500,000 people in rural Indonesia. Tri Mumpuni and IBEKA are currently working on developing a plastic turbine for use in compact hydropower plants situated along rivers. Villagers are participating fully in the planning, construction and maintenance of the facilities in a cooperative manner. Most future plants will generate 5–60 kW, but some will have the capacity to produce up to half a megawatt.[8]

Success factors

The great potential in hydropower generation remained untapped for a long time in Indonesia, largely due to the lack of legal and financial institutions. Aware of this gap, ensuing campaigns and lobbying sought binding and enabling government regulations in parallel with a grass-roots movement propelled by local populations. The effective and simultaneous combination of bottom-up and top-down approaches was pivotal for the success.

Considerations for replicating

All regulatory barriers must to be removed to successfully develop community-run micro hydropower plants as a local business.[9] Simultaneously, empowerment and capacity building of community members to generate their command and ownership of the projects is necessary.

[4] ibid.

[5] Jon Respati, "Small hydro in Indonesia: finding the right price", *RESPECTS Renewable Energy Review*, October 2010. Available from http://respectsmagazine.com/format/respects3rd-edition.pdf (accessed on 5 January 2012).

[6] In 2009 a new regulation was issued which graded the proposed PLN purchasing price relative to regional electricity costs and needs.

[7] Siemens Stiftung and Ashoka, "Siemens Stiftung and Ashoka encourage entrepreneurs developing technologies for human needs: Investment profiles of participating social entrepreneurs" (2011). Available from www.siemens-stiftung.org/fileadmin/user_upload/gesellschaft_technik/Ashoka_Investment_final.pdf (accessed 5 January 2012).

[8] Nikesh Thapaliya, "Definition of social entrepreneurship: Tri Mumpuni", *Youth Leader Positive Action Magazine*, September 2011. Available from www.asia.youth-leader.org/?p=3457 (accessed on 22 November 2011).

[9] ibid.

CASE STUDY

Cutting emissions without hurting the economy
Indonesia's National Development Planning Agency

There was concern and then a pledge…

Policymakers in the Indonesian Government had read the research and knew that the country's vulnerability to climate change could not be underplayed. They recognized the country could experience significant losses. At first they imagined and then they felt the impact of the issues – prolonged drought, flooding and increased frequency of extreme weather events. They realized that Indonesia's rich biodiversity was at risk.[1] While attending the G20 Summit in the United States in 2009, President Susilo Bambang Yudhoyono pledged an emissions reduction target of 26 per cent by 2020. He also said it could rise to 41 per cent with international assistance.

What was done?

The Government's National Development Planning Agency (BAPPENAS, Badan Perencanaan Pembangunan Nasional) worked to mainstream climate change adaptation and mitigation needs into a Medium-Term Development Plan 2010–2014. This included a Climate Change Sectoral Roadmap (2010) that outlines the strategic vision that emphasizes the challenges emerging in the forestry, energy, industry, transport, agriculture, coastal areas, water, waste and health sectors. The Roadmap was created through rigorous analysis and vulnerability assessments and includes capacity-building and response strategies as well as financial assessments.[2]

BAPPENAS was established in 2002 by presidential decree. Under the Secretary of BAPPENAS, there are nine deputy ministers in charge of specific areas: human resources and culture; politics, law, defence and security; poverty, employment and small and medium enterprises; economic affairs; natural resources and environment; facilities and infrastructure; regional development and autonomy; financing for development; and performance evaluation of development. Additionally, there are two centres (development, education and training, and data and information) as well as a directorate for inspections.

Based on the National State Guidelines, BAPPENAS has developed a long-term development plan (2005–2025), with five-year mid-term plans, each with development priorities. The current midterm plan spans from 2010 to 2014 and aims to 1) promote the quality of human resources, 2) develop science and technology and 3) strengthen economic competitiveness.[3]

The main tasks include:[4]

- **Macro-economic development:** Reform and restructure the economy and finances through sound fiscal and monetary policies in cooperation with international institutions, such as International Monetary Fund.
- **Infrastructure development:** Improve transportation facilities, irrigation, energy infrastructure as well as the development of tourism, post and telecommunication services.
- **Human resources development:** Build up capacities through the development of various social aspects, such as health, social welfare and education.

[1] See the *Indonesia Climate Change Sectoral Roadmap*, Foreword remarks by Armida S. Alisjahbana, Minister for National Development Planning/Head of National Development Planning Agency (Jakarta, BAPPENAS, 2010).

[2] U. Hayati Triastuti, "Development planning toward green economy: policy initiatives", presented at the National Workshop on Mobilizing the Public and Private Sector of Indonesia towards a Resource Efficient and Green Economy, Jakarta, Indonesia, 23 September, 2010.

[3] World Bank, *Country Brief of Indonesia*. Available from http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/INDONESIAEXTN/0,print:Y~isCURL:Y~menuPK:287081~pagePK:141132~piPK:141107~theSitePK:226309,00.html (accessed 5 October 2011).

[4] Republic of Indonesia official web portal "State Ministry of National Development Planning / BAPPENAS". Available from www.indonesia.go.id/en/ministries/ministers/state-minister-for-chairperson-of-the-national-development-planning-agency/1646-profile/277-kementerian-perencanaan-pembangunan-nasional.html (accessed 5 October 2011).

- **Regional development:** Harmonize national and regional growth by taking account of areas that are underdeveloped, densely and sparsely populated or isolated.

Results

In February 2012, the Government declared confidence that achieving the emissions reduction of 26 per cent would not harm the economy. The 2020 emission reduction targets five main sectors, namely forestry and peat-lands, agriculture, energy and transportation, industry, and waste management with 50 main activities and 73 supporting activities that will be carried out by 20 ministries and other government institutions.[5]

[5] Elly Burhaini Faizal, "Plan laid out; Indonesia upbeat about its 2020 emission target", The Jarkata Post, 31 October 2011 (Jakarta).

CASE STUDY

Weaning a country from oil dependence
Indonesia's renewable energy policy

Key point

- ***Setting targets for renewable energy and percentage ceilings for coal, natural gas and oil can cut the share of energy from oil.***

There was a shortcoming…

Indonesia has seen its oil production stagnate, and withdrew its membership from OPEC as it became a net importer of oil.[1] To reduce the need to increase energy subsidies due to the unstable price of oil, the Government decided to reduce its heavy reliance on power production from oil.[2]

Based on a 2006 presidential decree, the Indonesian Government committed itself to increasing the share of renewable energy to cover 15 per cent of the primary energy supply by 2025, up from 4.3 per cent in 2005.[3] The targets from the decree were translated into the Energy Law of 2007. As of 2010, renewable energy, including hydropower, still made up less than 5 per cent of Indonesia's primary energy mix.[4]

What was done?

Because of its resource richness, the Indonesian Government in the 2006 decree placed prominence on developing biofuels and geothermal energy. Specifically, 5 per cent of the total primary energy supply should come from geothermal and 5 per cent from biofuels by 2025.

The targets include quotas for renewable energy and percentage ceilings for coal, natural gas and oil in the energy mix – most notably to cut the share of energy from oil by more than 60 per cent.

In addition to developing renewable resources and moving away from oil dependency, the Indonesian energy policy also has an eye on increasing electrification, from 64 per cent of households in 2009 to 95 per cent by 2025.[5]

[1] United States of America, *Renewable Energy Market Assessment Report: Indonesia* (Washington, D.C., International Trade Administration, 2010). Available from http://ita.doc.gov/td/energy/Indonesia%20Renewable%20Energy%20Assessment%20(FINAL).pdf (accessed 9 November 2011)

[2] *Asian Legal Business*, "A Closer Look at the Power Sector in Indonesia: The Latest Initiatives", May 6, 2010. Available from http://asia.legalbusinessonline.com/industryupdates/indonesia-soemadipradja-taher/a-closer-look-at-the-power-sector-in-indonesia-the-latest-initiatives/45834 (accessed 9 November 2011).

[3] International Energy Agency, *Electricity/Heat in Indonesia in 2008* (Paris, 2011). Available from www.iea.org/stats/electricitydata.asp?COUNTRY_CODE=ID (accessed 7 November 2011); and International Energy Agency, Renewables and Waste in Indonesia in 2008 (Paris, 2011). Available from www.iea.org/stats/renewdata.asp?COUNTRY_CODE=ID (accessed 7 November 2011).

[4] Director General of New and Renewable Energy and Energy Conservation, "Towards sustainable energy supply: Indonesia's energy vision 25/25", Power point presentation presented at the Renewable Energy Conference: Green Supply for Growing Demand, Jakarta, 24 October 2011. Available from http://indonesien.ahk.de/fileadmin/ahk_indonesien/PAST_EVENTS/RENERGY2011/MONDAY/1_-_Ministry_of_energy_and_mineral_resources.pdf (accessed 9 November 2011).

[5] Montty Girianna, "Renewable energy and energy efficiency in Indonesia", paper presented at ADB Workshop on Climate Change and Energy, Bangkok, Thailand, 26–27 March, 2009. Available from www.adb.org/documents/events/2009/Climate-Change-Energy-Workshop/Renewable-Energy-Girianna.pdf (accessed 9 November 2011).

Institutions and energy market governance

The Indonesian electricity sector is undergoing a slow liberalizing process. Generation, transmission and distribution of electricity have primarily been handled by a single state-owned limited liability company, PLN (Perusahaan Listrik Negara). With reforms that began in 1992 and until 2009, independent power producers and cooperatives were also involved in generation; but PLN was the sole buyer and seller of electricity on the grid. In September 2009, Indonesia's new Electricity Law opened up an opportunity for regional and local governments, cooperatives and private entities to generate and sell power to PLN and also to receive licenses to distribute electricity directly to end users – although PLN maintains a "right of first priority" in the market.[6]

The Government sets the retail price of power, which is only about half the cost of PLN production. The difference is subsidized by the Government.[7] Energy regulatory policies, including electricity tariffs, are set by the Directorate-General of Electricity and Energy Utilisation within the Ministry of Energy and Mineral Resources. The Ministry of Finance must allocate subsidies and loans, and the Ministry of State-Owned Enterprises must approve the PLN budget and management.

The Government's National Development Planning Agency (BAPPENAS) inputs a broader planning perspective to energy development.[8] In relation to the development of renewable energy resources, above all geothermal and biomass resources, the Ministry of Forests and the Ministry of Agriculture hold respective roles in formulating policies supportive of renewable energy resource development. In 2007, a National Energy Council was established to create a new national energy policy and master plan and coordinate policies between the two ministries.[9]

In 2010, the Directorate-General for New and Renewable Energy and Energy Conservation was established under the Ministry of Energy and Mineral Resources to promote demand-side energy management (conservation) and sustainable supply-side energy management (diversification away from fossil fuel sources).

Local and regional governments are also increasingly involved in the energy market as suppliers and regulators.

Pricing and required energy purchase from small community plants

Renewable energy pricing: Ministerial decrees from the Ministry of Energy and Mineral Resources set pricing for electricity generation from renewable sources, including hydropower, biomass, municipal waste and geothermal. Tariffs are specific to: 1) source of power; 2) geographical location, with more remote islands having higher tariffs and 3) voltage levels, with low voltage (less than 10 kV) grid power receiving higher tariffs than medium voltage.

Fast-track Crash Programme: To stimulate the expansion of electricity generating capacity in the near-term to meet the growing demand and to shift from the use of fossil fuel, the Government set up a two-phase Crash Programme. The first track programme (2006 to 2013) is focusing on coal and natural gas power plant development, and the second track programme (2009 to 2014) has emphasized geothermal and hydropower projects. Of the 10,147 MW of allocated projects in the second track, over 60 per cent will be renewable energy projects, with geothermal projects accounting for 3,977 MW and hydro for 1,198 MW.[10]

[6] Renewable Energy and Energy Efficiency Partnership website "Policy DB Details: Indonesia (2010)". Available from www.reeep.org/index.php?id=9353&text=policy&special=viewitem&cid=32 (accessed 8 November 2011).

[7] Montty Girianna, "Renewable energy and energy efficiency in Indonesia", paper presented at ADB Workshop on Climate Change and Energy, Bangkok, Thailand, 26–27 March, 2009. Available from www.adb.org/documents/events/2009/Climate-Change-Energy-Workshop/Renewable-Energy-Girianna.pdf (accessed 9 November 2011).

[8] For information, refer to the case study, "Indonesia's National Development Planning Agency".

[9] Renewable Energy and Energy Efficiency Partnership website "Policy DB Details: Indonesia (2010)". Available from www.reeep.org/index.php?id=9353&text=policy&special=viewitem&cid=32 (accessed 8 November 2011).

[10] ibid.

Power purchase obligation: Since 2009, PLN is required to offtake electricity from small-scale (up to 10 MW capacity) renewable energy power plants developed by independent power producers, including cooperatives or local communities and private businesses.[11] In addition to the power purchase requirement for small renewable energy plants, there is a stipulated offtake requirement for geothermal energy.

Energy self-sufficient villages: Since 2005, the Government has shifted support away from diesel generator sets for rural electrification. The goal of the Energy Self-Sufficient Villages programme, launched in 2007, is to release villages from dependency on oil imports for energy by using local renewable resources. From 2007 to 2009, 2,000 villages were selected to be part of the programme; half were to be electrified by biomass and the other half by other renewable energy sources. Given the focus on biomass resources, the Ministry of Agriculture had an important role in the programme, alongside the Ministry of Energy and Natural Resources. By presidential decree, the Ministry of Manpower and Transmigration, the Ministry of Home Affairs, the State Ministry of Less Developed Regions, the State Ministry of State Enterprises and the Ministry of Fisheries and Marine Affairs are also involved.[12]

Financing

The lack of available financing is one of the biggest barriers to renewable energy development in Indonesia. The following touches on options to cope with the financing difficulties:

- **Subsidy reform:** High subsidies for fossil fuel production and for electricity consumption have distorted the Indonesian energy market. In 2011, energy subsidies were raised to over US$22 billion to help cover increases in oil prices. However, less than 2 per cent of energy subsidies were targeted at promoting renewable energies, leaving a large chunk of the government budget that could be shifted gradually towards renewable energy development.[13]

  Development of geothermal energy is expected to create cost savings to the Government by offsetting fossil fuel generation and thereby reducing required subsidy levels. In the majority of regional grids, the power purchase cost for geothermal electricity is lower than current electricity production costs – in many cases, the cost of geothermal is less than half.[14]

- **Private capital:** The lack of capital is the primary motive for opening up the energy market to regional and local governments, cooperatives and private entities. More than 75 per cent of the geothermal projects listed in phase two of the Crash Programme will be developed by independent power producers. Policies such as renewable energy pricing and power purchase obligations are intended to make a lucrative market for private developers and private equity; however, other regulatory policies must make financial incentives more robust and reliable.

- **Foreign and international development aid:** Many projects are developed with the support of foreign governments and international organizations. For instance, the Dutch Government provides a financing mechanism and technical assistance to the programme on biogas. Another example is the Integrated Micro-hydro Development Programme, which is funded by the Global Environment Fund (through UNDP)

[11] Director General of New and Renewable Energy and Energy Conservation, "Towards sustainable energy supply: Indonesia's energy vision 25/25", Power point presentation presented at the Renewable Energy Conference: Green Supply for Growing Demand, Jakarta, 24 October 2011. Available from http://indonesien.ahk.de/fileadmin/ahk_indonesien/PAST_EVENTS/RENERGY2011/MONDAY/1_-_Ministry_of_energy_and_mineral_resources.pdf (accessed 9 November 2011).

[12] Indonesian Center for Agriculture Socio Economic and Policy Studies website "Energy Self-Sufficiency Village". Available from http://pse.litbang.deptan.go.id/eng/index.php?option=com_content&task=view&id=236&Itemid=157 (accessed 9 November 2011).

[13] R. D. Fadillah, "Govt Considers New Renewable Energy Policy", *The Jakarta Post*, October 18, 2011. Available from www.thejakartapost.com/news/2011/10/18/govt-considers-new-renewable-energy-policy.html (accessed 10 November 2011).

[14] Director General of New and Renewable Energy and Energy Conservation, "Towards sustainable energy supply: Indonesia's energy vision 25/25", Power point presentation presented at the Renewable Energy Conference: Green Supply for Growing Demand, Jakarta, 24 October 2011. Available from http://indonesien.ahk.de/fileadmin/ahk_indonesien/PAST_EVENTS/RENERGY2011/MONDAY/1_-_Ministry_of_energy_and_mineral_resources.pdf (accessed 9 November 2011).

and aims to remove barriers to micro-hydropower use.[15] On a broader scale, the World Bank announced in 2010 that it would channel US$400 million from its Climate Investment Funds to support geothermal energy development in Indonesia.[16] The Clean Development Mechanism under the Kyoto Protocol provides another important financing mechanism for renewable energy project development.

Lesson learned

Renewable energy policies can secure benefits far beyond the energy and environment scope: The initial intent of the Indonesian Government for promoting renewable energies was to reduce the dependency on oil imports. However, the policies and programmes put in place for that purpose led to many other benefits for the Indonesian population. The liberalizing of the energy market enabled independent producers to enter the market, rural residents were given the chance to switch to self-sufficient local power generation and the Government could alter its burden from fossil fuel subsidies.

Considerations for replicating

The Indonesian example shows that in addition to setting a national target and a competitive price for renewable energy there is much more to consider when initiating a sensible shift towards clean energies that can reap benefits for businesses, the people and the environment. Other governments that want to achieve this shift will have to restructure their energy market, mobilize ministries beyond the usual environment and energy scope, pay special attention to the impacts of the policies on rural and poor residents, ensure that the programmes do not exceed domestic fiscal capacities and make use of foreign and international funds that support renewable energy projects.

[15] Republic of Indonesia, Ministry of Energy and Mineral Resources, "Updates on renewable energy development program in Indonesia", PowerPoint presentation at Expert Group Meeting on New Renewable Energy Technology, Honolulu, 30 March – 3 April 2009. Available from www.egnret.ewg.apec.org/meetings/egnret32/Indonesia%20RE%20priorities.pdf (accessed 9 November 2011).

[16] United States of America, *Renewable Energy Market Assessment Report: Indonesia* (Washington, D.C., International Trade Administration, Department of Commerce, 2010). Available from www.ita.doc.gov/td/energy/Indonesia%20Renewable%20Energy%20Assessment%20(FINAL).pdf (accessed 8 November 2011).

CASE STUDY

Daring to remove the subsidies
Islamic Republic of Iran's subsidy reforms

Key points

- ***The Islamic Republic of Iran reduced its food and energy subsidies – the first drastic and comprehensive energy subsidy reform of a major oil-exporting country – which led to substantial increases in domestic energy and agricultural prices.***

- ***The Government managed the reform without major resistance or economic disturbance due to careful preparation, pricing policies and a cash transfer mechanism for certain households.***

There was a problem…

With its traditional dependence on the oil export revenue (accounting for about 65 per cent of its fiscal revenues), the policymakers in the Islamic Republic of Iran used to set domestic energy prices high enough to cover the production costs. However, when the international oil price began to rise in 2001 and the global recession came up in 2007 and 2008, a sharp fall occurred in the oil export and consequently, soaring international oil prices rapidly widened the gap between the domestic energy price and the global market price. Around the same time, the Islamic Republic of Iran became one of the world's most energy-intensive countries due to the cheap national energy price related overconsumption, maintained by the high level of energy subsidy.[1]

The artificially low energy price led to a rapid increase in domestic energy consumption mainly in the non-production sector (with an eight-fold increase in energy consumption while there was a less than three-fold population increase between 1971 and 2012[3]). As of 2008, the domestic gasoline price in the country was one twentieth of the international price (US$0.10 per liter compared with around US$2 per liter internationally) – a reform of the energy subsidies became urgently necessary.

The need for reforming the energy price for a more stable economy was also strongly felt in the economic sanctions afflicted on the country that restricted the country's oil and natural gas export potential drastically.

What was done?

The timing and measures of the reform were carefully calculated and adjusted through repeated consultations to ensure the preparedness of all related sectors. The preparation included the banking system to tackle possible massive cash withdrawal of the cash transferred, in case of any public panic and a fuel management system that ensured the timely distribution of compensation to households prior to the price rise to avoid a hit on the household welfare. The president announcement of the drastic energy price reform in an evening televised broadcast and other mass media in December 2010 was followed by a systematic information and communication campaign through the government machinery, ministers and senior officials.

The primary challenge was making the drastic energy price reform acceptable to the public without severely hurting people's welfare and to move the business sector to acceptance and a positive response to the reform. In combination with a rise of the price for liquid fuels and a new level set for the natural gas-, electricity- and

[1] D. Guillaume, R. Zytek and M. R. Farzin, "Iran: The Chronicles of the Subsidy Reform", IMF Working Paper WP/11/167 (Washington, D.C., International Monetary fund, 2011). Available from www.imf.org/external/pubs/ft/wp/2011/wp11167.pdf (accessed 22 February 2012).

[2] M. Massarrat, "Iran's energy policy: Current dilemmas and perspective for a sustainable energy policy", *International Journal of Environmental Science & Technology* (2004), vol. 1, No. 3, pp. 233-245. Available from www.ceers.org/ijest/issues/full/v1/n3/103010.pdf (accessed 22 February 2012).

[3] ibid.

water tariffs, the Government introduced cash-compensation measures to ease the immediate impact of the sudden energy price rise. As a result, the feared public panic did not occur (few incidences of mass cash withdrawal were reported). Within ten days of the reform announcement, all households in the country reportedly began receiving a supplementary "targeted subsidy" that amounted to US$4 per month, payable for two months in advance.

Major businesses (including major car producers in the country) were encouraged and also volunteering to control the rise of the price of their products. The Government imposed the price controls in major commodities to mitigate the immediate direct impacts, particularly on low-income households. As a result, exaggerated levels of price increases were mitigated through various policy measures, and there were additional compensatory measures addressed to the most affected groups of the population during the reform introduction.

Figure 1: Changed prices of commodities after the subsidy reform

Commodity	Price before increase	Price after increase	Initial* change in consumption	Explanation
Gasoline	10 cents/liter, 40 cents/liter (beyond the quota of 60 liters/month)	40 cents/liter; 70 cents/liter (beyond the quota of 60 liters/month)	-5%	Taxis, ambulances, and other public service cars received a higher quota
Gas oil	1.5 cents/liter	15 cents/liter, 35 cents/liter on the open market	-29%	Vehicles active in public transportation will receive an extra quota
Natural gas	1-1.3 cents/m^3 for households and 0.5 cents/m^3 for power plants	On average 7 cents/m^3 for households and industry and 8 cents/m^3 for power plants	-6.5%	Prices vary according to the regional climate and level of consumption
LPG	Free (only a small fee for testing the cylinders)	10 cents/liter	N/A	
CNG	4 cents/m^3	30 cents/m^3	N/A	
Fuel oil	1 cent/liter	20 cents/liter	N/A	
Kerosene	1.5 cents/liter	10 cents/liter	N/A	
Electricity	On average 1.7 cents/kWh for households	On average 4.5 cents/kWh for households and 4 cents/kWh for industry	-11%	Prices vary according to the regional climate and level of consumption
Bread	Less than 1 cent/Kg of wheat flour	28 cents/Kg of wheat flour		
Water	9 cents/ m^3 for households	25 cents/ m^3 for households	-5%	

* The statistics are based on official statements for the first ten days following price changes

Source: Turquoise Partners, *Iran Investment Monthly*, January 2011. Available from www.turquoisepartners.com/iraninvestment/IIM-Jan11.pdf (accessed 15 March 2012).

The additional disposable income is likely to be used for other goods and services, which will increase the general welfare of people (with about US$30 billion in annual compensatory payments directly paid to the population and 50 per cent of the revenue collected to individual households[4]). Another 30 per cent of the revenue collected will be allocated to business enterprises for adopting new, energy-saving technologies and efforts to improve energy and overall efficiency.

These simple but highly visible compensatory measures are expected to improve social equity and provide the Government with powerful leverage to increase public acceptance.[5]

Impacts so far and expected future results

Immediate impacts of the reform were felt from the beginning. The consumption of diesel fuel, gasoline, fuel oil and kerosene has reportedly dropped by an average of 38 per cent.[6] As of January 2012, approximately US$5.3 billion in fuel consumption reportedly had been saved through the subsidy reform.[7] Local media reported the soaring demand for energy saving equipment (such as energy-saving lamps and insulating glass). The Government has introduced financial incentives for special utilities to boost green technologies, such as double-glazed windows, UPVC, thermal brick frames, thermal insulation materials and thermostatic valves.

The revenues raised through the reform (about US$60 billion annually) are to be used to reduce energy waste and regulate consumption. At the same time, potential savings from the reduced domestic consumption are expected to significantly increase quantities of crude oil and refined products for export purpose, which will additionally increase the Islamic Republic of Iran's economic dividend. To safeguard the reform for the long term, it will be important to maintain macroeconomic stability and to ensure that the reform induces corporate restructuring measures towards greener production that focuses on higher energy efficiency.[8]

[4] Originally the government intended to provide aid to the bottom two income groups of the households (except for the top income group). However, due to the incomplete and inaccurate data on the household incomes as well as the public's reluctance to reveal their real incomes, the government relaxed the measures . As a result, in 2011 as high as 90% of the Iranian population ended up filing for the compensations. Semira N. Nikou, *The Subsidies Conundrum* (Washington D.C., United States Institute of Peace). Available from http://iranprimer.usip.org/sites/iranprimer.usip.org/files/The%20Subsidies%20Conundrum.pdf (accessed 2 December 2011).

[5] D. Guillaume, R. Zytek and M. R. Farzin, "Iran: The Chronicles of the Subsidy Reform", IMF Working Paper WP/11/167 (Washington, D.C., International Monetary fund, 2011). Available from www.imf.org/external/pubs/ft/wp/2011/wp11167.pdf (accessed 22 February 2012).

[6] *Tehran Bureau*, "Petroleum Product Usage Plummets Post-Subsidy Paring" 29 December 2010. Available from www.pbs.org/wgbh/pages/frontline/tehranbureau/2010/12/petroleum-product-usage-plummets-post-subsidy-paring.html (accessed 13 March 2012).

[7] *Tehran Times*, "Subsidy Reform Plan Saves Iran $5.3b in Fuel Consumption", 11 January 2012. Available from http://tehrantimes.com/economy-and-business/94462-subsidy-reform-plan-saves-iran-53b-in-fuel-consumption (accessed 13 March 2012).

[8] D. Guillaume, R. Zytek and M. R. Farzin, "Iran: The Chronicles of the Subsidy Reform", IMF Working Paper WP/11/167 (Washington, D.C., International Monetary fund, 2011). Available from www.imf.org/external/pubs/ft/wp/2011/wp11167.pdf (accessed 22 February 2012).

CASE STUDY

Stimulating consumer interest in businesses that go green
Japan's Green Power Certificate scheme

Key points

- ***Japan's Green Power Certificate is a successful scheme to publicize, attract and monitor individual and corporate efforts for environmental protection in the renewable energy sector.***

- ***Launched and managed by a private business but with certification from a public facility, the scheme emphasizes the supporting role of governments in influencing corporate and private behaviour.***

There was an ambition…

The Japanese Green Power Certificate scheme was introduced by the Japan Natural Energy Company Ltd in 2000 and is the first scheme of its kind initiated by a private business in the country.[1] Customers in the private sector can purchase green power by paying a premium price in exchange for the guarantee that this energy is better for the environment than conventional alternatives. The Green Energy Certification Center is an individual and neutral body, which certifies green electricity generated at a power plant that meets the renewable energy criteria.

The Certificate of Green Power is used to widely publicize the increased use of renewable energy and is part of the corporate social responsibility strategy in the private sector. It was established to achieve the following four goals:[2]

- Enable customers who are not able to have their own green power plant or green heat source to gain proof that the electricity or heat they use is generated from renewable energy sources.
- Make achievements of environmental protection endeavours quantifiable and measurable, including energy conservation (fossil fuel savings) and CO_2 (greenhouse gas) emission reductions.
- Provide incentives for generators to construct new green power plants, which is currently still expensive compared to already established conventional energy or heating sources.
- Accelerate and increase the demand for green power.

What was done?

A Green Power Certification scheme was instigated to encourage the private sector and its consumers to use renewable energy and recognize their efforts in protecting the environment. It is a voluntary measure that is coupled to the quantity of consumed energy from renewable sources.[3] Initially based on electricity from qualified generation technologies, such as solar, wind, geothermal, biomass and hydropower, the scope of the Green Power Certification scheme was expanded to cover heat in 2008 to broaden the use of renewable energies.

Businesses can profit by adding the Green Power Certificates to their portfolio and thus attract environmentally conscious investors and customers. They are simultaneously counterbalancing the emissions during their production processes by using emissions-free electricity (in line with corporate social responsibility). Businesses and individuals alike can acquire a guarantee that the electricity they use stems from renewable sources, which

[1] Green Energy Certification Center website "How GECCJ Was Established". Available from http://eneken.ieej.or.jp/greenpower/eng/01-2.htm (accessed 24 February 2012).

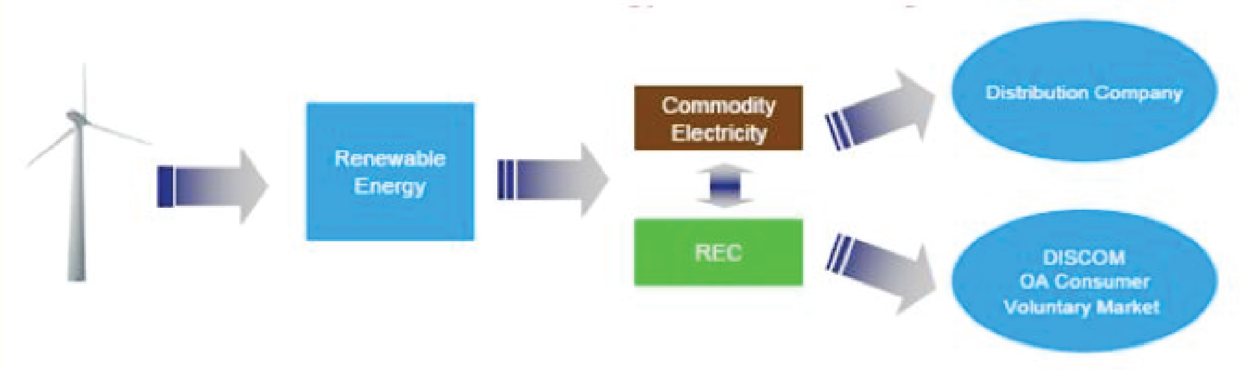
[2] The Green Power Certification Council, "Green Power Certification has launched in Japan", *Press release*, June 7, 2001. Available from http://eneken.ieej.or.jp/greenpower/eng/temp/04/01.pdf (accessed 25 February 2012).

[3] SEMI website "SEMICON Japan Goes Green: Event to Use Renewable Energy". Available from www.semi.org/en/Issues/Sustainability/P042626 (accessed 25 February 2012).

provides them with proof for their reduced emissions and their support for greening the power industry (this then is the individual contribution encouraged by the scheme).

The mechanism of Green Power Certifications divides generated renewable energy into two components – the physical commodity electricity and a tradable certificate (Green Power Certificate, representing the high value of renewable energy use).

Figure 1: The two components of the renewable energy certificate



Source: Energy Alternatives India website "Renewable Energy Certificates (REC) Trading Takes Off in India". Available from http://eai.in/blog/2011/03/renewable-energy-certificates-rec-trading-takes-off-in-india.html (accessed 28 February 2012).

The commodity electricity is sold to the distribution utility at an agreed tariff, while the Green Power Certificate can be traded on platforms similar to a stock exchange. The energy trade is based purely on demand and supply, adding value to renewable energy through flexible market forces.

Third party certification by the state-owned Green Energy Certification Center

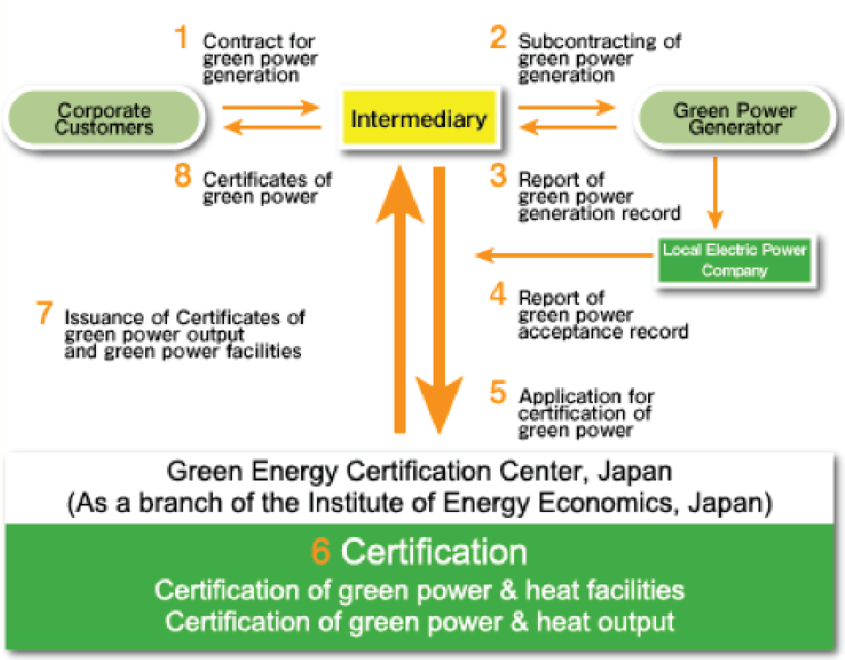
To ensure the successful commercialization of the Green Power Certification system, the Green Energy Certification Center was established in 2008. As part of the Institute of Energy Economics, the Center is a legal entity and superseded the Green Power Certification Council which could not take legal responsibility for its actions. Today, the Green Energy Certification Center observes the compliance of the following criteria:[4]

- The quantity of generated green power from certified facilities is verified according to the descriptions of the certification rules.
- Green power is certified by independent and neutral organizations.
- Public understanding and awareness of green power is enhanced.

The Center acts as a neutral, third-party certification entity that assists the certificate issuer or intermediary facility between green power producers and corporate consumers (figure 2).

[4] Green Energy Certification Center website "How GECCJ Was Established". Available from http://eneken.ieej.or.jp/greenpower/eng/01-2.htm (accessed 24 February 2012).

Figure 2: How the Green energy certification system works



Source: Green power website "The Position and Role of GECCJ in the System". Available from http://eneken.ieej.or.jp/greenpower/eng/01-3.htm (accessed 26 February 2012).

Results

The total number of green power generation facilities accredited by the Green Energy Certification Center in 2008 increased to 121, equalling a total power generation capacity of 161 MW, up from 94 MW in the previous year.[5]

In fiscal year 2010, the Green Energy Certification Center certified a total of 270 million kWh of green power, recording a historical high since the scheme started in 2001.[6] The increase was attributed to the subsidies introduced by the national and local governments in 2009, which boosted the number of new installations of residential PV systems. The largest single capacity increase was recorded in 2001 for a huge biomass electricity generation project.

[5] Institute of Energy Economics, *Japan Energy Brief No. 15* (Tokyo, 2011). Available from http://eneken.ieej.or.jp/en/jeb/1109.pdf (accessed 24 February 2012).

[6] ibid.

Table 1: Record of green electricity certified

Fiscal year	Facilities		Amount of electricity	
	Project	Capacity	Project	Amount
		kW		million kWh
2001	2	15 900	3	1 158
2002	1	7 650	9	29 112
2003	2	3 295	12	32 801
2004	9	28 215	20	39 216
2005	22	53 641	34	50 480
2006	20	22 851	71	114 263
2007	30	94 972	120	87 371
2008	50	161 633	205	238 113
2009	264	50 698	343	233 396
2010	498	103 844	473	270 545

Source: Institute of Energy Economics, *Japan Energy Brief No. 15* (Tokyo, 2011). Available from http://eneken.ieej.or.jp/en/jeb/1109.pdf (accessed 24 February 2012).

The scheme was expanded to include green thermal energy for heat generation in 2008. Although solar thermal energy was the main target, the thermal project scope was enlarged to include snow and ice energy and woody biomass thermal energy, starting from the fiscal year 2010, and resulting in an increased level of interest in green certificates.[7] In 2010, the amount of Green Power Certificate issuers exceeded 50 organizations. The number of applicants increased rapidly in 2011, when more firms and individual consumer's turned towards renewable energies after the accident of the Fukushima nuclear power plant.[8] This opened the eyes of private actors on the importance of both corporate social responsibility and individual's environmental consciousness.

Considerations for replicating

The establishment of Green Power Certificates acknowledges both the environmental and economic value added through the use of renewable energy and facilitates a fair price alignment, balancing the elevated investment requirements for many renewable technologies. There is considerable optimism in the trading of renewable energy certificates as a growth driver for the renewable energy industry, which can be adjusted to the characteristics of the energy market in many countries. Important for the implementation in Japan and for the replication in other countries is the establishment of an independent third-party certification facility that takes legal responsibility for its actions, the simultaneous introduction of financial incentives by the government and the expansion of the scope of the Green Power Certificate Scheme to include heat-related projects and thereby better reflect and communicate the range of possible renewable energy-related endeavours.

[7] ibid.

[8] ibid.

CASE STUDY

Paying people to save energy
Japan's housing eco-point system

Key points

- ***Incentive programmes aimed at rewarding the greening of houses can encourage a higher uptake of efficient measures for residential retrofitting projects.***

There was progress…

Following on from the success of the eco-point system in promoting energy-efficient appliances, the Japanese Government expanded the programme to include residential buildings. The expansion was stipulated in the Emergency Economic Countermeasures for Future Growth and Security, which took effect in January 2010.

What was done?

The housing eco-point system is an incentive programme jointly implemented by the Ministry of Land, Infrastructure, Transport and Tourism, the Ministry of Economy, Trade and Industry and the Ministry of Environment to promote green buildings to fight against global warming and to stimulate the economy. "Eco-points" are given to people who build a green home or undertake energy-efficient remodelling. One eco-point is equivalent to 1 yen but it cannot be redeemed for cash; points can be exchanged for eco-friendly products or gift certificates or used for additional renovations.

In the first phase, the programme, with 100 billion yen in funding,[1] was initially intended to cover houses whose construction or renovation started before January 2012. However, the eligible period was reduced five months (to the end of July 2011) due to the large number of applicants exhausting the budget earlier than planned.[2]

The programme was recently resumed with 144.6 billion yen funding[3] that had been set aside in the third supplementary budget for fiscal year 2011.[4] Under the newly revived scheme, eco-friendly house renovations that start between 21 November 2011 and 31 October 2012 receive eco-points for improved thermal insulation of windows, replaced panes and exterior walls and ceiling or floor heat insulation. New eco-friendly house construction that started between 21 October 2011 and 31 October 2012, including houses meeting building energy-efficiency performance standards and wooden houses meeting energy saving standards, are awarded eco-points. Homeowners of new and refurbished homes will be given eco-points of 300,000 yen per unit in disaster-affected areas and 150,000 yen in other areas.[5]

[1] Japan, *Second Supplementary Budget for FY2009* (Tokyo, Ministry of Finance, 2009). Available from http://www.mof.go.jp/english/budget/budget/fy2009/09sb02b.pdf (accessed 17 March 2012).

[2] Japan, Ministry of Economy, Trade and Industry, "Reduction of Construction Period for Point Issuance under the Program to Promote the Spread of Eco-Friendly House by Utilizing Eco-points (Eco-Point System for Housing)", *Press release*, 13 May 2011. Available from www.meti.go.jp/english/press/2011/0513_03.html (accessed 16 March 2012)

[3] Japan, *The Outline of the 3rd Supplementary Budget of FY2011* (Tokyo, Ministry of Finance, 2009). Available from www.mof.go.jp/english/budget/budget/fy2011/11sb03.pdf (accessed 17 March 2012).

[4] Bank of Japan, *Montly Report of Recent Economic and Financial Developments* (Tokyo, 2012). Available from www.boj.or.jp/en/mopo/gp_2012/gp1201b.pdf (accessed 15 March 2012).

[5] Masahiro Takeishi, "Welcome Back, Eco points / Firms Ready to Capitalize on Push for Energy-Efficient Homes", *The Daily Yomiuri*, November 8 2011. Available from www.yomiuri.co.jp/dy/business/T111107004145.htm (accessed 15 March 2012).

Results

As a result of the housing eco-point system, the domestic home remodelling market grew 13 per cent on the year to 5.9 trillion yen in 2010.[6] The Government estimated the accrued economic benefits in the first phase were about 3.4 trillion yen.[7] The Government has granted eco-points for 637,629 new houses and 582,012 refurbishments as of January 2012.[8]

Considerations for replicating

Fiscal constraints on the budget: Although financial incentive can be a good way to attract consumers to a retrofitting project, the incentive programme alone cannot go very far due to the potential budget restraints. A combination of regulations such as building standards and codes and mandatory building certification and incentives will help steer more people to building eco-friendly homes.

Weaknesses

- **Points programme does not subsidize the upfront costs:** Because the points are given in the forms of green products or certificates after the completion of the projects, this does not directly help in lowering the upfront costs of building or remodelling an eco-friendly home.
- **No incentives for tenants:** The housing eco-point system targets only homeowners and developers. It also appears that no provisions have been made for tenants, who represent some 40 per cent of the population.

Further reading

Japanese Green Building Technologies: New Innovations and Policy, by Russell Vare, JETRO Green Building Report, vol. 2 (Tokyo, Japan External Trade Organization, 2010).
ary 2012.

[6] Japan, Ministry of Land, Infrastructure, Transport and Tourism, Ministry of Economy, Trade and Industry, and Ministry of Environment website "Eco-points for housing". Available from http://jutaku.eco-points.jp/newsrelease/111014_1.html (accessed 11 November 2011) [Japanese language website].

[7] Masahiro Takeishi, "Welcome Back, Eco points / Firms Ready to Capitalize on Push for Energy-Efficient Homes", *The Daily Yomiuri*, November 8 2011. Available from www.yomiuri.co.jp/dy/business/T111107004145.htm (accessed 15 March 2012).

CASE STUDY

Mandating the best energy-efficient appliances
Japan's Top Runner programme

Key points

- ***The Top Runner concept sets standards for both available products and future technological developments.***
- ***Manufacturers accepted the standards because of their flexibility and the realistic targets, which were set in consultation with industrial groups.***
- ***A government-induced labelling programme ensures that Top Runner products are publically highlighted.***
- ***Compliance with the standards increased the energy efficiency of Japanese appliances.***

There was a problem…

In the 1980s, the Japanese Government imposed mandatory energy efficiency standards for appliances and automobiles. However, the standards failed to induce sufficient energy-efficiency improvements because they were rarely revised and were largely based on negotiations with industry members without any explicit standard-setting method.

What was done?

To correct the situation, the Top Runner approach was adopted during a revising of the Energy Conservation Law in the 1990s, under the leadership of the Ministry of Economy, Trade and Industry (METI).

The Government makes energy efficiency compulsory

The METI launched the Top Runner programme in 1998 to improve the energy efficiency of end-use products. As part of the Energy Conservation Law, the programme set mandatory energy efficiency standards, based on the most efficient "top runner", or top-performing, products in the market. The programme currently targets 23 product groups in the residential, commercial and transport sectors.[1]

The scope of the programme is based on three criteria:

1. Products involving large domestic shipments
2. Products that consume a substantial amount of energy in the use phase
3. Products with considerable room to improve energy efficiency

The programme started with 11 products: room air conditioners, fluorescent lighting, televisions, copying machines, computers, magnetic disk units, video cassette recorders, refrigerators, passenger vehicles and freight vehicles. After it showed impact, the METI added three more products in 2005, followed by an additional seven in 2002 and two more in 2009, resulting in the present coverage of 23 items. The product coverage is reviewed every two to three years.

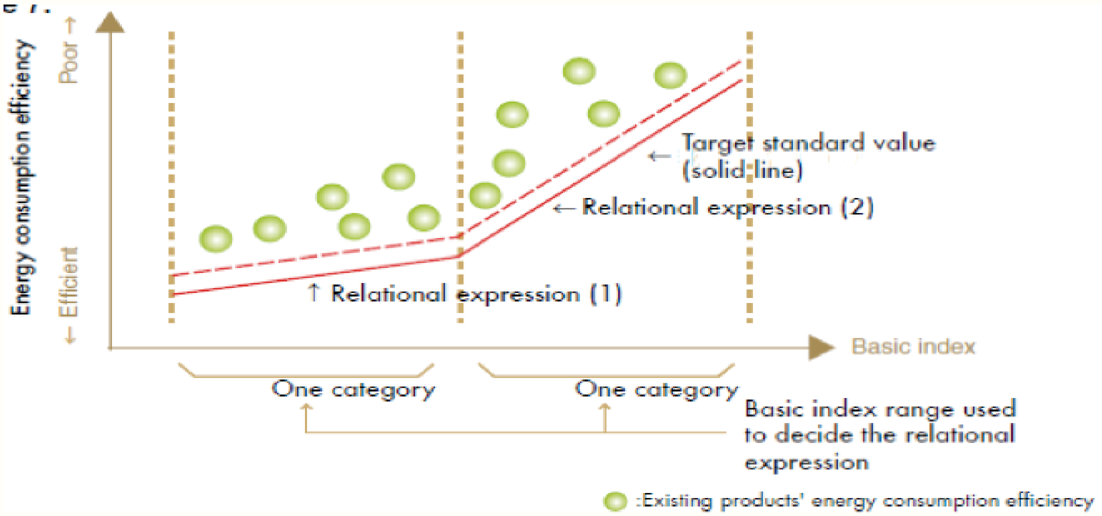
[1] Agency for Natural Resources and Energy, "Status of the additional qualifying under the Top Runner programme" (2011). Available from www.enecho.meti.go.jp/policy/saveenergy/data/111102tokuteikiki-tsuika.pdf (accessed 8 January 2012).

Performance targets for enterprises are based on the value of the most energy-efficient product at a given time rather than fixed targets

Targets are periodically reviewed and aligned based on the performance of the "best in the class", which creates a benchmarking. Standards are essentially anchored on data relating to the appliances currently sold in the market. However, projected technological improvements are also considered. For example, the Top Runner standards for room air conditioners smaller than 4 kW for 2010 were set based on an anticipated 3–4 per cent improvement of the Top Runner products in 2005.[2] This projection was assessed during a discussion within the Air Conditioner Evaluation Standard Subcommittee in 2006.

Because detailed market and engineering information on targeted products is required, there is strong involvement of industry associations during the standard-setting process. It usually takes about a year or two to set the standard for one product. Additionally, standards are differentiated by various parameters, such as the size of a liquid crystalline display or the weight of a vehicle.

Figure 1: Schematic overview of the standard-setting process in the Top Runner approach



Source: Agency for Natural Resources and Energy, *Top Runner Programme: Developing the World`s Best Energy-Efficient Appliances* (Tokyo, Japan, Ministry of Economic, Trade and Industry, 2010). Available from www.enecho.meti.go.jp/policy/saveenergy/toprunner2010.03en-1103.pdf (accessed 25 January 2012).

An institutional framework for setting the Top Runner standards is established

Japan's energy conservation policies are determined by an Advisory Committee for Natural Resources and Energy. The Committee is an advisory body to the METI Minister. For the Top Runner standard values, evaluation standard subcommittees consist of representatives of academia, industry, consumer groups, local governments and the media; the members determine the standard details, including technical feasibility for individual machinery and equipment products. The Energy Efficiency Standards Subcommittee approves the draft and then submits a final version to the Advisory Committee for Natural Resources and Energy for endorsement. The METI authorizes the energy efficiency standards, based on the final report of the Energy Efficiency Standards Committee.[3]

Not the absolute but the weighted average energy efficiency of all products manufactured within one year marks compliance

To comply with the Top Runner standards, manufacturers must ensure that the weighted average energy efficiency of the products sold in the target year achieves the requisite standards.

[2] Osamu Kimura, "Japanese Top Runner Approach for Energy Efficiency Standards" (Tokyo, 2010) Available from www.climatepolicy.jp/thesis/pdf/09035dp.pdf (accessed 25 January 2012).

[3] ibid.

Weighted average energy efficiency = the sum of {(the number of units shipped domestically for each product name and type) × (energy consumption efficiency per unit)} / the total number of units shipped domestically.

This means that manufacturers must achieve the standards on average, based on the number of products they sell. This flexibility enables manufactures to provide a range of models to meet the market demand (from inexpensive but energy-inefficient models to expensive but energy-efficient models) while guiding the overall market to greater energy efficiency.[4]

Naming and shaming non-complying producers

In case of non-compliance, the Top Runner programme takes a "name-and-shame" approach.[5] The METI first makes a recommendation to the non-complying producer to improve the energy efficiency performances and then goes public with that recommendation if the producer does not comply. If the attempts fail, the METI orders the producer to meet the recommendations. Thus far, this name-and-shame approach appears to be working well; no manufacturer has been publicized as non-complying to date.

A voluntary labelling scheme helps consumers to make informed choices

To popularize highly efficient machinery and equipment that have achieved the Top Runner status by distinguishing them from conventional goods, the METI in 2000 created the Energy Saving Labelling Programme, which is based on the Japanese Industrial Standard (JIS).[6]

The label includes a symbol that shows the degree of energy-saving standards of a particular product, the energy-saving standard achievement rate, the energy consumption efficiency and the target per fiscal year. During the initial phase, the labelling programme targeted five product categories, including air conditioners, fluorescent lights, televisions, refrigerators and freezers. Additional product items, including computers, magnetic disk units and transformers, followed later.

Participation in the energy-saving labelling programme is voluntary, based on the JIS system. Labelling can appear on products, product catalogues, packaging and tags.

Lessons learned

Simple mandatory energy efficiency standards are not enough. The fixed efficiency standards introduced by the Japanese Government in 1980 did not bring about the desired technological changes. Success was only achieved through the dynamic standards, introduced in the late 1990s, that were based on top-performing technologies in the market, projected technological capacities and consultation with industrial groups.

Non-compliance punishments do not necessarily have to be of a monetary nature. Many technological standards are enforced under penalty of financial punishment. The Top Runner programme, based solely on a "name-and-shame" chastisement, is proof that non-monetary values can also move industries to achieve environmental goals.

The legislative and institutional framework has to encompass national goals, technological possibilities, monitoring measures and communication procedures. The Government did not stop its programme at the standards setting stage. It embedded the programme into the national policy framework, established and involved a whole chain of institutions to oversee the implementing and updating processes and even introduced a monitoring system that entails voluntary labelling that communicates with the public.

[4] Ryoichi Komiyama and Chris Marnay, *Japan's Residential Energy Demand Outlook to 2030 Considering Energy Efficiency Standards: Top-Runner Approach* (Berkeley, 2008). Available from http://eec.ucdavis.edu/ACEEE/2008/data/papers/8_254.pdf (accessed 6 February 2012).

[5] Joakim Nordqvist, *Evaluation of Japan`s Top Runner Programme: Within the Framework of the AID-EE Project* (Active Implementation of the proposed Directive on Energy Efficiency project, 2006). Available from www.aid-ee.org/documents/018TopRunner-Japan.PDF (accessed 25 January 2012).

[6] Ministry of Economic, Trade and Industry (METI), "Japan, Top Runner Program: Developing the World`s Best Energy-Efficient Appliances" (Tokyo, METI, 2010). Available from www.enecho.meti.go.jp/policy/saveenergy/toprunner2010.03en-1103.pdf (accessed 25 January 2012)

Success factors

The following points were indispensable for the implementation and contribute strongly to the further success of the Japanese Top Runner programme:[7]

- Periodical update and review of standards
- Consideration of future technological developments
- Consultation with industrial groups
- Flexible compliance mechanisms
- Clear communication mechanisms of Top Runner products to the public.

Further reading

Evaluation of Japan`s Top Runner Programme: Within the Framework of the AID-EE Project, by Joakim Nordqvist (Active Implementation of the proposed Directive on Energy Efficiency project, 2006). Available from www.aid-ee.org/documents/018TopRunner-Japan.PDF

Japanese Top Runner Approach for Energy Efficiency Standards, by Osamu Kimura (Tokyo, Central Research Institute of Electric Power Industry, 2010). Available from www.denken.or.jp/en/serc/research_re/download/09035dp.pdf

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Top Runner Program: Developing the World's Best Energy-Efficient Appliances (Tokyo, Ministry of Economic, Trade and Industry, Japan, 2010). Available from http://www.enecho.meti.go.jp/policy/saveenergy/toprunner2011.03en-1103.pdf

[7] Joakim Nordqvist, *Evaluation of Japan`s Top Runner Programme: Within the Framework of the AID-EE Project* (Active Implementation of the proposed Directive on Energy Efficiency project, 2006). Available from www.aid-ee.org/documents/018TopRunner-Japan.PDF (accessed 25 January 2012).

CASE STUDY

Doing the seemingly impossible
London, United Kingdom's congestion charge

Key points

- ***The successful induction of the congestion charge in London, United Kingdom highlights the importance of strong political leadership with a clear vision in jump-starting the transition from motorized transport system towards eco-efficient public transport system.***

- ***Although the charge was met with initial resistance from the public, London is now known for its high-quality bus networks, partly subsidized from the revenues raised from the congestion charge.***

There was a problem…

In 2002, London suffered the worst congestion in the United Kingdom, with average traffic speeds slower than 12 km per hour. The city lost between an estimated £2 million and £4 million every week in terms of time lost due to congestion.[1]

What was done?

In February 2003, the London Congestion Charging Scheme was launched to address to reduce the volume of moving vehicles. The scheme covered a 22 square kilometre area initially, but had almost doubled in size in February 2007.

- Drivers pay a charge of £8 to enter the zone between 7 a.m. and 6 p.m., Monday to Friday.
- Drivers found to be evading the charge area are issued a penalty charge notice.
- Environment-friendly vehicles are exempted. A number of vehicles are exempt from the charge, including those that present positive environmental benefits compared with conventional vehicles (hybrid cars and those that run on alternative fuels, such as electric, hydrogen and liquid petroleum gas).

Results

By 2006, the congestion charging zone had reduced congestion in central London by 26 per cent, compared with the 2002 level.[2] The following highlights some of the broader economic, environmental and social benefits of the scheme.[3]

- **Reduced pollution:** Greenhouse gas emission reduced by 16 per cent from 2002 to 2003. NOX and PM10 within the congestion charging zone decreased by 18 per cent and 22 per cent, respectively, by 2004.
- **Increased modal share of buses during charging hours:** There was a 37 per cent increase in the number of passengers entering the congestion charging zone by bus during charging hours in the first year.
- **Increased pedestrian safety:** There have been between 40 and 70 per cent fewer accidents that resulted in personal injury within the zone.
- **Raised revenue:** The scheme generated £122 million net in fiscal year 2005/2006.[4]

[1] Transport for London website, "Congestion Charging" (2007). Available from www.cclondon.com/whatis.shtml (accessed 16 November 2011).

[2] European Environment Agency, *Success Stories within the Road Transport Sector on Reducing Greenhouse Gas Emission and Producing Ancillary Benefits* (Copenhagen, 2008). Available from www.eea.europa.eu/publications/technical_report_2008_2/at_download/file (accessed 16 November 2011).

[3] ibid.

- **Cost savings:** Based on the £8 charge, the scheme is estimated to save £2.5 million per year as a result of a reduction in vehicle kilometres travelled, fuel consumption and CO_2 emissions. The scheme achieves a cost efficiency of £78 million when all costs and benefits are considered.
- **Increased sales of hybrid vehicle:** The congestion charge is boosting sales of hybrid cars – Honda and Toyota increased their supply of hybrid vehicles in 2007.

Lessons learned

Political leadership and commitment: Not surprisingly, there was a significant level of opposition to the introduction of the scheme – from the media, politicians and local residents and businesses. The mayor of London, Ken Livingstone, was heavily engaged in the project, setting out a clear vision and delivery plan and driving forward the introduction of the scheme using devolved powers.

Success factors

Communication strategy: Formal and informal public consultations were conducted throughout the development of the scheme, with feedback reports subsequently made public. Media campaigns explained the operation and implications of the scheme. A clear vision and delivery plan for the scheme helped to raise confidence in the long-term financial benefits, both in terms of the expected revenue generation and the cost savings as a result of reduced congestion, all of which helped to justify the initial costs (£162 million).

Clearly defined roles and responsibility of the Transport for London: Overall responsibility for managing the scheme was allocated to one agency, the Transport for London, which manages the whole of London's transport network. This move ensured sensible designs, implementing and ongoing management of the scheme and that it was integrated with the wider transport strategy for the city. The initial technology and infrastructure costs, at £162 million, were covered by the Transport for London's General Fund.[5] The agency is subsequently responsible for issuing penalty notices and controlling penalty payments with mobile enforcement units.

Considerations for replicating

Research and extensive trials prior to the launch: In many cases, successful implementing depends on how to design the scheme. In the case of London's congestion charge, extensive research and trials were conducted prior to the actual launch. Findings from the research and trials had a critical role in providing convincing evidence to win over public acceptance.

How to recycle the revenue: The scheme was able to generate income that exceeded its operating costs, making a contribution of £303 million to the public purse between 2002 and 2006.[6] Revenue from the scheme is used to fund major public transport improvements, including improving bus services and renovations to the London Underground.

Further reading

Congestion Charging, by Transport for London (London, 2007). Available from www.cclondon.com/whatis.shtml.

Impacts Monitoring: Fourth Annual Report, by Transport for London (London, 2006). Available from www.tfl.gov.uk/assets/downloads/FourthAnnualReportFinal.pdf

Success Stories Within the Road Transport Sector on Reducing Greenhouse Gas Emissions and Producing Ancillary Benefits, by European Environment Agency (Copenhagen, 2008).

[4] Transport for London, *Central London Congestion Charging: Impacts Monitoring* (London, 2006). Available from www.tfl.gov.uk/assets/downloads/FourthAnnualReportFinal.pdf (accessed 16 November 2011).

[5] European Environment Agency, *Success Stories within the Road Transport Sector on Reducing Greenhouse Gas Emission and Producing Ancillary Benefits* (Copenhagen, 2008). Available from www.eea.europa.eu/publications/technical_report_2008_2 (accessed 26 February 2012).

[6] Ibid.

CASE STUDY

Easing into carbon trading
Republic of Korea's Emissions Target Management Scheme

Key point

- ***The Emissions Target Management Scheme is a tool for a smoother transition to the Emissions Trading Scheme.***

There was a need for a transition…

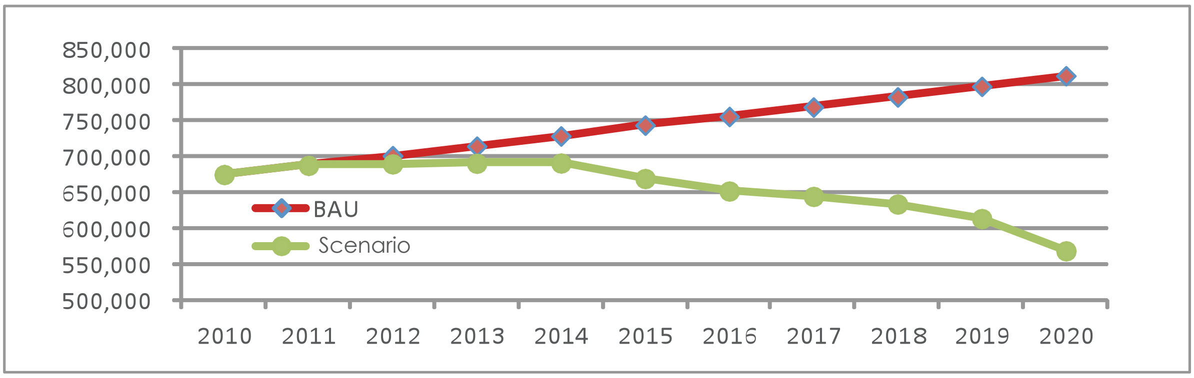
The Korean Government's National Strategy for Green Growth and Five-Year Plan called for a shift from voluntary commitments by companies to market-based instruments limiting their greenhouse gas emissions. Some 468 entities whose greenhouse gas emissions amount to 60 per cent of the total national emission were targeted to reduce either the amount of greenhouse gas they emit or the amount of energy they consume. There was concern, however, that instituting an emissions trading scheme right away would lead to negative impacts on business if there was no preparatory phase.

What was done?

To help companies make a smoother transition to a low carbon enterprise and minimize the potential negative impacts on their business, the Emissions Target Management Scheme was mandated by the Basic Law on Green Growth and guidelines were stipulated in accordance with the Directive on the Operation of Emission Target Management Scheme (March 2011). The Emission Target Management Scheme was adopted to provide precise and fair reduction targets and to create an enabling environment for introducing the future Emissions Trading Scheme.

According to the reduction target, the overall national emissions will reach its highest level in 2014 and start to decrease from 2015, which will enable the decoupling of emissions from economic growth. The annual net cost to meet the target is expected to reach US$1.6 billion per year and cumulate up to US$14 billion by 2020. Although GDP is projected to decline by 0.5 per cent by 2020 compared with 2011, according to the roadmap scenario,[1] allocating a carbon-related fiscal budget to R&D investment will generate a surplus in the midterm due to technological advancement impacts.

Figure 1: Annual greenhouse gas emissions reduction scenario



[1] Kyungho Lee, "Confirmation of a Road Map to Reduce 30% National GHGs Emission: Expected Cost for 14 trillion Won by 2020". *The Aisa Economy*, 12 July 2011. Available from www.asiae.co.kr/news/view.htm?sec=eco3&idxno=2011071209173541812 (accessed 17 August 2011) [in Korean].

Note: BAU: business as usual; Scenario: as laid out in the Emissions Target Management Scheme
Source: Korean Government official policy web portal, "Sectoral yearly target setting of greenhouse gases emission for 2020 low carbon green growth roadmap"(2011).

To reduce the business-as-usual level of greenhouse gas emissions (estimated at 813 million tons by 2020), specific reduction targets are designated to 25 businesses in seven sectors:[2]

1) electricity generation
2) industry
3) transport
4) building
5) agriculture and fisheries
6) waste
7) public and others.

Institutional arrangement

The Ministry of Environment is in charge of the overarching framework, coordinating line ministries and building up the enabling conditions, such as setting standards, drafting guidelines and managing verifying agencies. Engaged ministries select entities to be subjected to the scheme per sector, set targets based on negotiations and evaluate performance records.[3] The system will be supported by the National Greenhouse Gas Inventory System, managed by the Greenhouse Gas Inventory & Research Center for Korea, track greenhouse gases emitted by entities and provide the data required for measuring, reporting and verifying, in line with an international standard.

The Emissions Target Management Scheme is one of the policy options for creating an enabling condition for the future introduction of the Emissions Trading Scheme, which will aim to mitigate national greenhouse gas emissions. The Government (through different ministries) set up the physical and legal infrastructure for the scheme's operation. For example, the Ministry of Environment released guidelines on methodologies.[4]

Prior to the 2012 enforcement of the Emissions Target Management Scheme, the preparatory work included the targeting of businesses, submission of emissions records and verification reports, setting the targets and submission of implementing plans. Targeted businesses were given until March 2012 to submit a performance report and details; assessments will be conducted in June. Orders to improve will be issued where required.

Preparatory measures prior to introducing the Emissions Trading Scheme

- **Targets are negotiated:** Entities can reflect their needs and circumstances, such as future investment plan, onto their target setting. Targets based on average emissions for the latest three years will be negotiated every five years.

- **A phase-by-phase approach is introduced to reduce resistance from the private sector while building capacity and confidence:** The Emissions Target Management Scheme is expected to help companies take proactive actions in mitigating their greenhouse gas emissions and invest in energy-efficiency improvements.[5]

[2] ibid.

[3] Ministry of Knowledge and Economy for 374 entities from energy and industrial sector, Ministry for Food, Agriculture, Forestry and Fisheries for 27 entities agriculture and forestry sectors, Ministry of Land, Transport and Marine Affairs for 46 entities from building/transportation, Ministry of Environment for 23 entities from waste sector.

[4] Guideline for the Measurement, Reporting and Verification, a list of entities to be complied with the greenhouse gas target management, how to set targets, etc.

[5] The Korean Government decided to postpone the implementation of the Emissions Trading Scheme to 2015, originally to be introduced in 2013, due to concerns for losing business competitiveness as well as resistance from the private sector.

To gain support from the private sector for the Emissions Target Management Scheme, the Government sought input when developing the system through more than 100 consultations with actors in the private sector. To help relieve resistance, the Government initially lowered the penalty for non-compliance (down to US$8,800 maximum).[6] However, having met criticism on the stringency of that penalty, the Government recently announced intent to strengthen it. With public awareness growing on the increased danger of global warming, there is also a growing consensus among industries on the need to reduce emissions from their business practices.

- **Government sets the rules and determines the sequence of phases:** There are complementary measures for minimizing potential negative impacts on companies' competitiveness, such as:
  - Simplifying the procedure required for reporting greenhouse gas emissions for relatively small emitters.
  - Provide flexibility in reducing greenhouse gas emissions. The Government credits emission reductions prior to the official enforcement of the system. Reduction activities carried out beyond the boundary, such as big companies helping small companies in their supply chain to reduce greenhouse gas emissions, will be counted.

- **International measuring, reporting and verifying standards are benchmarked for business opportunities in the carbon market:** Applying international standards to the domestic measuring, reporting and verifying system reduces time and cost while building confidence within the private sector. The Emissions Target Management Scheme mandates the entities to measure their greenhouse gas emissions, to submit their performance report and to be verified, based on standards corresponding to the international benchmark. By mandating companies to conform to the international standard from the beginning, companies become better prepared to participate in both the domestic and international carbon markets.

Success factors

- **Consistent policy direction:** Clear policy direction was presented to targeted industries that will be subjected to the Emissions Target Management Scheme through public hearings and consultations before its enforcement.
- **Financial incentives and consulting services:** The Government provides consulting services for small and medium-sized enterprises to help them set up an inventory and energy management system. Financial incentives are provided in the form of loans through energy service companies for energy efficiency improvement projects. Early mitigation actions taken by industries have been acknowledged.
- **Verification professionals:** The Government is keen to nurture professional verifiers and has deployed education and training programmes and imposed qualification standards for verification bodies.
- **Coordination among ministries:** Coordination among ministries is key to the successful application of the scheme. A regular consultation meeting was arranged for discussion on issues raised within each sector. Additionally, the emission target management scheme has clearly defined roles of work.

Expected results

For the transport sector, greenhouse gas emissions should be reduced by 34.3 per cent compared with the business-as-usual level of 2020, along with 26.9 per cent for building, 26.7 per cent for electricity generation, 25 per cent for public sector, 18.2 per cent for industry, 12.3 per cent for waste and 5.2 per cent for agriculture and fishery. Among the 25 industries (figure 2), electrical/electronics industry is mandated to reduce 61.7 per cent of its greenhouse gas emissions, which is the highest target, followed by display (39.5 per cent), automobile (31.9 per cent) and semiconductor (27.7 per cent).[7]

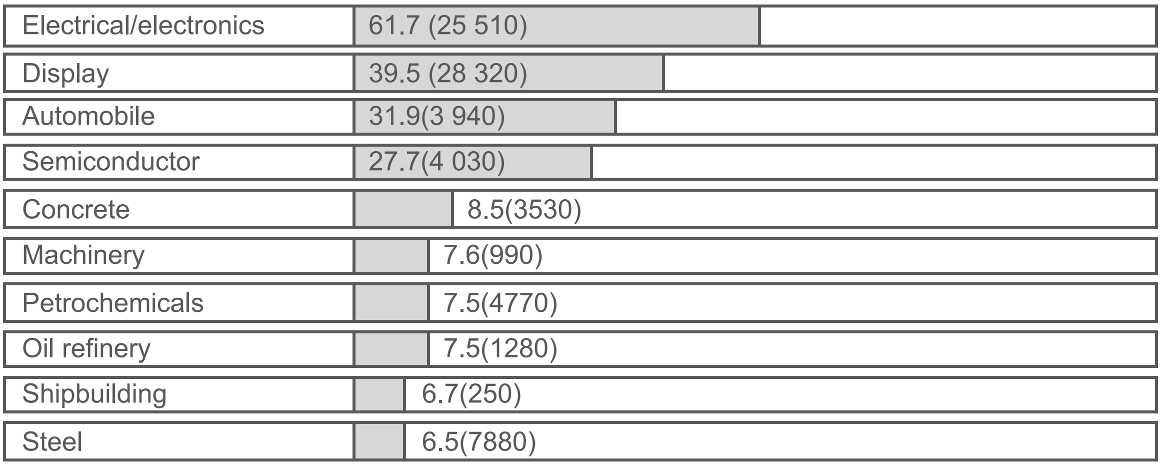
[6] Heeyoon Park, "Government Takes Stances on Strengthening EMTS", *Anjun Journal*, November 23, 2011. Available from www.anjunj.com/news/articleView.html?idxno=4027 (accessed 12 December 2011).

[7] Kyungmin Kang, "Greenhouse Gas Emission Reduction Target of 62% for Electricity and Electronics Sector: Target Allocation for 471 Enterprises by September", *The Korea Economic Daily*, 12 July 2011. Available from www.hankyung.com/news/app/newsview.php?aid=2011071230591 (accessed 17 August 2011) [in Korean].

Table 1: Greenhouse gas emissions reduction rate compared with business-as-usual practices, by 2020 (unit: %)

Industry	Electricity generation	Transport	Building	Agriculture/ fisheries	Waste	Public/ others	Total national reduction
18.2	26.7	34.3	26.9	5.2	12.3	25	30

Figure 2: Industry greenhouse gas emissions reduction target(unit: %(millions)



Note: The order is by reduction percentage, compared with business as usual by 2020; the figure in the parenthesis is the net reduction amount.

Source: Kyungmin Kang, "Greenhouse Gas Emission Reduction Target of 62% for Electricity and Electronics Sector: Target Allocation for 471 Enterprises by September", *The Korea Economic Daily*, 12 July 2011. Available from www.hankyung.com/news/app/newsview.php?aid=2011071230591 (accessed 17 August 2011) [in Korean].

Remaining issues

- Because entities are categorized on a sector basis and managed by line ministries, the role of the Ministry of Environment in coordinating all ministries is critical to avoid any potential overlapping burden on companies.
- There should be a clear arrangement between the Emissions Target Management Scheme and the Emissions Trading Scheme to give a consistent message to the private sector and relieve companies' concerns that they will be controlled by both of them. The Government announced that entities whose emissions amount to more than 25,000 tons of CO_2 will not be targeted by the Emissions Target Management Scheme but by the Emissions Trading Scheme as of 2015.[8]
- Several incentives for companies that reduce emissions beyond their targets are under consideration, such as acknowledgement of early mitigation actions for the Emissions Trading Scheme and awards for best performers.

[8] Greenhouse Gas Inventory & Research Center of Korea, "Greenhouse Gas Target Management". Available from www.gir.go.kr/eng/og/hm/nc/a/OGHMNCA010.do (accessed 20 February 2012)

Considerations for replicating

Emissions trading schemes can be a jolt to some businesses. They need time to prepare both mentally and physically do changing the way they operate. A transition scheme can muffle the impact and ease businesses to making the necessary change. In the Republic of Korea, the Emissions Target Management Scheme is expected to help companies take proactive action in mitigating their greenhouse gas emissions and invest in energy-efficiency improvements while preparing for the next, more stringent measure – the Emissions Trading Scheme.

Further reading

Greenhouse Gas Target Management (Seoul, Greenhouse Gas Inventory & Research Center of Korea, 2010). Available from www.gir.go.kr/eng/og/hm/nc/a/OGHMNCA010.do.

Charging ahead into green lifestyles
Republic of Korea's green credit card

Key point

- ***Linking low-carbon lifestyles with a mainstream incentive system, such as credit cards, engages consumers towards more sustainable consumption patterns, in turn greening the supply chain.***

There was a need…

The Korean Ministry of Environment introduced a green credit card scheme in July 2011 to encourage consumers to adopt more sustainable lifestyle patterns by providing tangible economic rewards. Points are accumulated as rewards for saving on utility use (tap water, electricity and gas heating), using public transport or purchasing eco-friendly products. Accumulated points can be used like cash to purchase products and services at a variety of places, such as hotels, restaurants and theatres. Points can also be used to buy eco-friendly products, such as hybrid cars or energy-efficient light bulbs. The scheme is envisaged to contribute towards reducing about 3 per cent of the annual CO_2 emissions from the residential sector by 2014 when the number of cardholders is expected to exceed 3 million.[1]

What was done?

Carbon points generated from saving energy in residential and commercial building sectors

A carbon point scheme, based on the amount of saved electricity, gas and tap water in the building sector, was incorporated into the green credit card scheme. The carbon point scheme was initially introduced by the Ministry of Environment in 2008 and operated by municipal governments, with technical support from the Korea Environment Corporation. Both the Ministry of Environment and the municipal governments are responsible for mobilizing the financial resources that are granted as carbon points. Households can acquire points if their monthly utilities usage is less than their average use in the two years prior to the application date.

Green purchasing points

Green points can be obtained whenever people purchase green products, certified with eco-labels, such as Korea Eco-Label and Carbon Label, via the green credit card. The Ministry of Environment signed a memorandum of understanding with 49 private companies (18 manufacturers,[2] 8 distributors and retailers, 2 franchised coffee shops and 16 affiliated shops) in January 2012.[3] Points are also acquired when people bring their own cups to the coffee shop and return used cellular phones to providers. Manufacturers and distributors engaging in this scheme are partly responsible for providing the financial resources that flow into the green purchasing points.

Public transport point

Paying public transport fares with a credit card is common in the Republic of Korea and is widely accepted by different modes of public transport (bus, express bus, mini bus, subway and taxis). Fare discounts are provided when people transfer from one mode of public transport to another. The credit card companies provide points to passengers engaging in this scheme. Thus green points can amplify the "pull-factor" for using public transport.

[1] Republic of Korea, *Green Growth in Daily Lives* (Seoul, Presidential Committee on Green Growth, 2011).
[2] Including Hyundai automobile company and LG electronic appliances.
[3] Korea Environmental Industry & Technology Institute, *Green Consumption* (Seoul, 2011). Available from www.greencard.or.kr/gc/benefit/consu mption.do (accessed 30 January 2012).

Institutional arrangement[4]

- The Ministry of Environment is in charge of setting up an overarching system and coordinating partner organizations (local governments, the Korea Environmental Industry and Technology Institute (KEITI) and credit card companies).
- Local governments are in charge of operating the carbon point scheme and coordinating utilities companies with financial support from the Ministry of Environment. For instance, carbon points are issued according to the amount of energy that is reduced from a baseline assessment. Data for energy, water and gas use is collected to set the baseline in cooperation with the utilities companies, such as Korea Electric Power Corporation and the Korea Gas Safety Corporation. The Korea Environment Corporation collects data from utility companies, calculates the amount of reduced consumption and reports it to the local government, which then authorizes the payment of points.
- The Korea Environmental Industry and Technology Institute is in charge of managing the green purchasing points, namely identifying eco-friendly manufacturers, establishing a partnership with them and managing the eco-labelling scheme.

Strengths of the scheme

- Green credit card points can be more widely used due to use of the network built up by credit card companies in comparison to the stand-alone incentive schemes, such as carbon points, that local governments manage. Featuring minimal implementing costs, this can be a cost-effective policy measure to induce behaviour changes towards low-carbon and greener lifestyles.
- It is easy and convenient for people to manage points generated from different sectors (building, transport, purchasing) via one handy credit card.
- By motivating consumers towards greener lifestyles, the whole supply chains for products and services becomes greener to meet the new demand for eco-friendly products.
- Encouraged by the additional economic incentives, more people rely on public transportation.
- The incentives lead to reduced CO_2 emissions in the building sector.

Weaknesses of the scheme

- The more people purchase or move about, the more rewards they receive – but this does not provide any incentive for consuming less or reducing travel.
- Carbon points are issued based on the relative amount of saved energy from a baseline assessment, without the consideration of the absolute amount of energy use. Thus the green credit card scheme may need to be combined with other policy measures to increase effectiveness.

Lessons learned

Low-carbon behaviours need to be visible. Users of the green credit card scheme can easily track the amount of their CO_2 emission reduction, energy savings and economic rewards related to lifestyle changes they make through:

- The eco mileage scheme, one of the carbon point schemes run by the Seoul municipal authority, which provides information through its website (http://ecomileage.seoul.go.kr/). Card users can access real-time data on the volume of energy consumption from their house from the site. By inputting basic information, such as name and address, into the Eco-Mileage Programme website, the amount of energy, gas and water consumption is automatically presented.
- Receipts with the detailed information encourage green purchasing by informing consumers how many points each purchase provides.

[4] Republic of Korea, *Launching Green Credit Card* (Seoul, Ministry of Environment, 2011).

Considerations for replicating

The private sector must be engaged. To be successful, points should be easily convertible into real monetary value at a variety of places. Otherwise, consumers will not be motivated enough to change their behaviour to acquire the points. It is important for governments to set up a network consisting of credit card companies, manufacturers, distributors and retailers that can expand the scope of the scheme and maximize the net impacts. Participating businesses are expected to commit a certain portion of their profit to finance the point scheme, which can be a financial burden for them. In the case of the Republic of Korea, policies supplemented the green credit card scheme, such as the one providing subsidies to stores specializing in green products.

Existing incentive schemes must be integrated. The green credit card scheme is expected to be an integrated single platform in which people manage the points generated from their efforts to mitigate greenhouse gas emissions in their daily lives. The Ministry of Knowledge and Economy offers a similar incentive programme called Carbon Cashbag, which provides points in addition to the existing points system run by a private company when people purchase eco-friendly products bearing the Carbon Cashbag labels. Without careful coordination of similar initiatives, the strength of the scheme would be offset and financial resources would be wasted due to an inefficiency-inducing overlap of services, provided by different ministries.

Simple design and effective communication – an incentive scheme has to be easy to understand and simple to follow. The credit card scheme should be easily understandable and retractable for ordinary users. The rewards need to be clearly communicated to consumers to minimize potential confusion with any existing incentive scheme. Timely updates, accurate and reliable information provided on the respective websites is also critical. For instance, a dedicated website for the green credit card (www.greencard.or.kr) is currently being operated to publicize the benefits as well as to provide guidelines on how to register.

Republic of Korea's Framework Act on Low Carbon, Green Growth

There was a need for a legal basis…

Despite a number of environmental protection laws,[1] the Republic of Korea's national policy strongly focused on economic growth and industrialization until the mid-1990s, when the Government first recognized the importance of sustainable development. The Framework Act on Sustainable Development followed in 2007. When the Korean Government committed to achieving a significant cut in emissions through a shift from energy-intensive industries to low-carbon ones, it needed the legal grounds on which to build the implementing system for green growth, specifically the Presidential Committee on Green Growth, then to mandate that committee with the power to develop a five-year plan for the national strategy for green growth.[2] In place were only fragmented laws and regulations.

How it works

The Korean National Assembly enacted the Framework Act on Low Carbon, Green Growth in January 2010 to provide the legal basis for implementing policy measures that address climate change and energy issues and promote eco-efficient development.

Major provisions of the act:[3]

- General provisions cover the purpose and definitions of the act and terms, basic principles of low carbon green growth, responsibilities of the State, local governments, the business sector and the general public and the relationship with other acts.
- Establishment of low carbon green growth strategies and plans at the national and local government levels.
- Guidelines on the composition, operation and functions of the Presidential Committee on Green Growth.
- Basic principles of a green economy and green industry, facilitating research, development and commercializing of green technology and the creation of green jobs.
- Realization of a low-carbon society through basic principles and plans for coping with climate change and energy policies, reducing greenhouse gases, reporting on greenhouse gas emissions and energy consumption, establishing an integrated greenhouse gas information management system, introducing a cap-and-trade scheme, managing greenhouse gases in the traffic sector, assessing the impacts of climate change and implementing adaptation measures.
- Realization of green life and sustainable development through basic principles and plans for sustainable development, promoting green homeland, water management, green buildings, eco-tourisms and facilitating green life campaigns, education and public relations activities.

Supplementary provisions include a request for data, improved international cooperation and the preparation of national reports.

[1] The previous environment protection laws are Environmental Pollution Prevention Act (1963), Environmental Preservation Act (1977) and Framework Act on Environmental Policy (1990).

[2] Korean Government official web portal, "Korea's Carbon Target Obtains Legal Ground: Framework Act on Low Carbon Green Growth Went into Effect" (2010). Available from www.korea.net/detail.do?guid=46155 (accessed 19 August 2011).

[3] Republic of Korea, Framework Act on Low Carbon, Green Growth (2010). Available from www.law.go.kr/engLsSc.do?menuId=0&subMenu=5&query= per centEC per centA0 per cent80 per centED per cent83 per cent84 per centEC per cent86 per cent8C per cent20 per centEB per cent85 per centB9 per centEC per cent83 per cent89 per centEC per cent84 per centB1 per centEC per cent9E per centA5 per cent20 per centEA per centB8 per centB0 per centEB per centB3 per centB8 per centEB per centB2 per cent95#liBgcolor0 (accessed 15 August 2011).

Considerations for replicating

Strategies and policies require a legal basis, which also ensures that they endure beyond the turnover of political administrations. As an umbrella law, the Framework Act on Low Carbon, Green Growth is significant because it combines the existing but fragmented laws, regulations, takes precedence over other acts and allows for more efficient control of the national goal for low carbon green growth.

Further reading

"Development and evaluation of laws and regulation for the low-carbon and green growth in Republic of Korea", by M. Jang. J. Kim and S, Suh, *International Journal of Urban Sciences* (2010), 14(2), pp.191-206. Available from www.ijus-uos.com/ijus/journal/download.php?filename=ch5.pdf

CASE STUDY

Republic of Korea's investment plan for low carbon green growth

There was a need for financing…

When the Korean Government announced its National Strategy for Green Growth and Five-Year Plan in 2008, it needed to include a well-conceived plan for expenditures on concrete policy initiatives towards achieving green growth.

What was done?

The Government extended the Green New Deal programme, which was a stimulus package initially adopted to tackle the financial crisis after 2008 but with emphasis on greening the economy as a way of stimulating new growth. The Green New Deal was expanded into a five-year development plan, with a committed budget equal to 2 per cent of the annual GDP – all through Government investment. Two public enterprises contributed 8.5 trillion won (0.8 per cent of GDP). The allocated budget covered large construction projects, including land, water and building development as well as green transport infrastructure.[1]

The Government's investment in low carbon green growth is all the more significant in terms of its proportion within the Republic of Korea's annual GDP. Allocating 2 per cent of the annual GDP is beyond the recommendation of the international community.[2] The United Nations Environment Programme policy brief suggests that an investment of 1 per cent of global GDP can contribute to reducing carbon dependency and lead to the greening of the global economy.[3] *The Stern Review on the Economics of Climate Change* reported that investing 2–3 per cent of global GDP per annum enables the stabilization of greenhouse gas concentrations in the atmosphere.[4]

Expected results

Through the investment plan, positive economic and social impacts are expected, such as production increases, value addition and job creation:[5]

1) Production should increase in value, from 182 trillion won to 206 trillion won from 2009 to 2013, which would translate into an annual sum of 36–41 trillion won, or about 3.5–4 per cent of the annual GDP.

2) The value-added effect is estimated at 75–95 trillion won, from 2009 to 2013, and annually 15–19 trillion won, which amounts to 1.5–1.8 per cent of the annual GDP.

3) Job creation in green industries is estimated at 1.18–1.47 million people, from 2009 to 2013. Overall job creation is estimated at 1.56–1.81 million, with an annual average of 0.31–0.36 million jobs for both skilled and unskilled labourers.

[1] Randall S. Jones and Byungseo Yoo, *Korea's Green Growth Strategy: Mitigating Climate Change and Developing New Growth Engines*, (Paris, OECD, 2011). Available from www.oecd-ilibrary.org/docserver/download/fulltext/5kmbhk4gh1ns.pdf?expires=1327649323&id=id&accname=guest&checksum=98298B5F649C09F4A12957D2A70A00A7 (accessed 28 February 2012).

[2] Meeyoung Cho, "South Korea to Spend $85 billion on Green Industries", *Reuters*, 6 July 2009. Available from www.reuters.com/article/2009/07/06/us-korea-greengrowth-idUSTRE5651Y720090706 (accessed 10 November 2011).

[3] United Nations Environment Programme, *Overview of the Republic of Korea's National Strategy for Green Growth* (Geneva, 2010). Available from www.unep.org/PDF/PressReleases/201004_unep_national_strategy.pdf (accessed 10 November 2011).

[4] Nicholas Stern, *The Economics of Climate Change: The Stern Review* (Cambridge, Cambridge University Press, 2006).

[5] Republic of Korea, *Road to Our Future: Green Growth* (Seoul, Presidential Commission on Green Growth, 2009).

Considerations for replicating

A well-designed national strategy alone will not lead to successful policy implementation. It must be presented alongside a comprehensive portfolio of policy measures that includes dedicated public investment. The Korean Government's budgeting of 2 per cent of its annual GDP on the green growth projects provided the necessary guarantee to the private sector and consumers that the vision and strategy were not mere ambitions but true changes the Republic of Korea was committed to make.

CASE STUDY

A paradigm shift for economic growth
Republic of Korea's National Strategy for Green Growth and Five-Year Plan

Key point

- ***More than a vision, green growth is pursued as a top-down long-term strategy, complete with a legal framework, a coordinating institution and five-year mid-term plans.***

Background

A strong focus on quantitative growth brought economic development to the Republic of Korea, but it also left numerous challenges for the economy and the environment. A high dependence on energy imports, such as petroleum and liquefied natural gas, increased the country's vulnerability to fluctuations of energy prices and supplies. In addition, rapid industrialization and urbanization imposed a significant burden on the environment and natural resources, such as water and biodiversity. From 1990 to 2005, carbon emissions in the country doubled, making it one of the world's major carbon emitters.[1]

What was done?

During a national address on the sixtieth anniversary of the establishment of the Republic of Korea in August 2008, President Lee Myung-bak announced low carbon green growth as a new vision to guide the nation's long-term development. As a means to tackle the global financial and economic crisis occurring at that time, the Korean Government launched a Green New Deal aiming to stimulate job creation and economic recovery over the period 2009–2012. Composed of a mix of financial, fiscal and taxation policies, the green stimulus package mainly covers renewable energy, energy-efficient buildings, low-carbon vehicles, railways and water and waste management, with a budget allocation of US$30.7 billion (80 per cent of the total stimulus package). The Presidential Committee on Green Growth was established as an inter-ministerial body to follow up the vision with a multi sector approach to economic and environmental planning.

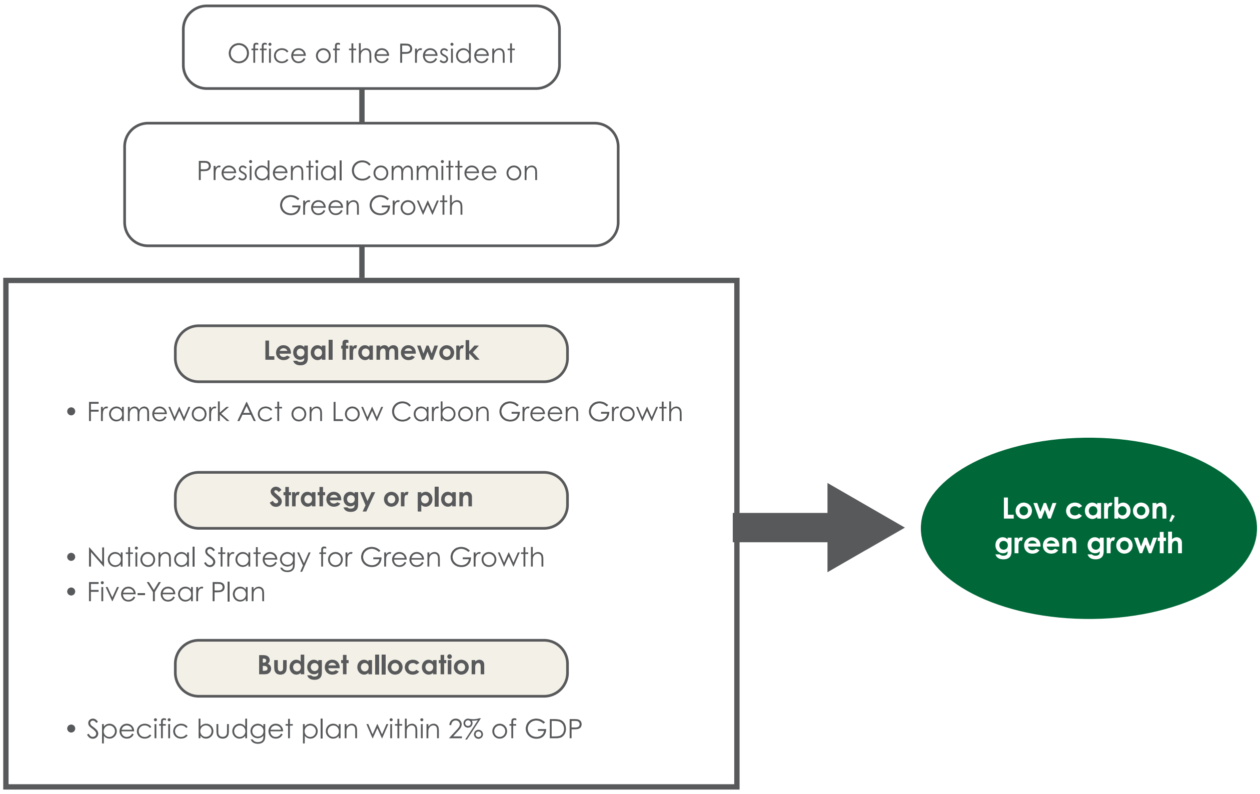
As a long-term perspective to implement the nation's new low carbon green growth vision, the National Strategy for Green Growth was announced in July 2009, together with the Five-Year Plan, which sets out mid-term policy goals (2009–2013). The Green New Deal expands overall government investment and the number of projects. To provide the legal and institutional basis for the country's green growth strategy, the Framework Act on Low Carbon, Green Growth as well as its enforcement decree was enacted in January 2010. In July 2011, the Korean Government announced a specific sector-based target aiming to reduce 30 per cent of greenhouse gases from the "business-as-usual" level by 2020.

Table 1: Green growth initiatives in the Republic of Korea

Time	Green growth initiatives
August 2008	President announces low carbon green growth as a national vision
January 2009	Launch of Green New Deal
February 2009	Establishment of Presidential Committee on Green Growth
July 2009	Development of the National Strategy for Green Growth and Five-Year Plan
January 2010	Enactment of Framework Act on Low Carbon, Green Growth
July 2011	Development of 2020 roadmaps for greenhouse gas emissions reduction

[1] United Nations Environment Programme, *Overview of the Republic of Korea's National Strategy for Green Growth* (Geneva, 2010). Available from www.unep.org/PDF/PressReleases/201004_unep_national_strategy.pdf (accessed 12 August 2011).

Figure 1: Diagram showing the relationship among green growth initiatives



The National Strategy for Green Growth (2009–2050)[2]

The National Strategy for Green Growth up to 2050 includes a fundamental paradigm shift from quantitative to qualitative growth and consists of three objectives and ten policy directions.

As a comprehensive policy framework, the National Strategy aims to 1) mitigate climate change and promote energy independence, 2) create new engines for economic growth and 3) improve the quality of life and the Republic of Korea's international standing.

To mitigate climate change and promote energy independence, the strategy calls first for setting medium- and long-term mitigation goals, increasing the use of new and renewable energy sources and strengthening the adaptation capacities to counter adverse impacts of climate change. Second, to create engines for growth, the strategy's emphasis lies in the development of green technology, the greening of industries, a transition to a more advanced industrial structure and laying the ground work for a green economy. Third, to raise the overall living quality and contribute to the international standing of the Republic of Korea, the strategy focuses on greening the infrastructure, expanding public awareness and actively engaging in international cooperation.

[2] Republic of Korea, *National Strategy for Green Growth and Five-Year Plan* (Seoul, Presidential Committee on Green Growth, 2009). Available from www.greengrowth.go.kr/?page_id=2450 (accessed 10 August 2011).

Table 2: Ten policy directions to achieve the three objectives

Objective	Mitigation of climate change and energy independence	Creating new engines for economic growth	Improve quality of life and international standing
Policy direction	1. Mitigate greenhouse gas emissions	4. Develop green technologies	8. Green the land and water and build green transportation infrastructure
	2. Reduce the use of fossil fuels and increase energy independence	5. Green existing industries and promote green industries	9. Bring green revolution into our daily lives
	3. Strengthen the capacity to adapt to climate change	6. Advance industrial structures	10. Become a role model for the international community as a green growth leader
		7. Engineer a structural basis for the green economy	

Source: Republic of Korea, National Strategy for Green Growth and Five-Year Plan (Seoul, Presidential Committee on Green Growth, 2009). Available from www.greengrowth.go.kr/?page_id=2450 (accessed 10 August 2011).

The Five-Year Plan for Green Growth (2009–2013)[3]

To follow through on the National Strategy for Green Growth, the Five-Year Plan for Green Growth was announced in July 2009. This mid-term strategy draws from the five-year plans of the early development era of the Korean economy, which the Government recognized as effective. In terms of green growth, the revival of five-year planning appeared prudent for building public consensus and allocating the national budget. The Green New Deal announced in early 2009 is incorporated in the Five-Year Plan and contains a budget and detailed tasks assigned to line ministries and local governments.

The annual spending of 2 per cent of GDP for the Five-Year Plan is largely financed from the central government budget. More than half of the total expenditure is allocated to two of the ten policy categories, which centre mostly on public construction: 1) green the land and water and build green transport infrastructure and 2) strengthen the capacity to adapt to climate change. Two main projects are the ongoing Railroad Construction Project and the Four Major Rivers Restoration Project. To boost the railway passengers from 18 per cent in 2009 to 26 per cent in 2020, express trains are being expanded (Korea Train Express, KTX). To secure water resources and prevent floods, a large portion of the budget (15.4 trillion won) has been allocated to the Four Major Rivers Restoration Project.

Of the plan's total budget, expenditure on R&D consumes 12 per cent, in contrast with the large portion of budget on construction-related projects. However, within the five-year framework, the R&D investment in 27 core green technologies gradually will expand from 2 trillion won in 2009 to 3.5 trillion won by 2013, which is equivalent to 13 trillion won cumulatively. Fiscal support for green R&D by small and medium-sized enterprises as well as investment in public R&D is also included in the plan.

[3] Republic of Korea, *Road to Our Future: Green Growth* (Seoul, Presidential Committee on Green Growth, 2009). Available from www.google.co.kr/url?sa=t&rct=j&q=Road+to+Our+Future:+Green+Growth&source=web&cd=1&ved=0CEcQFjAA&url=http per cent3A per cent2F per cent2Feng.me.go.kr per cent2Ffile.do per cent3Fmethod per cent3DfileDownloader per cent26attachSeq per cent3D2098&ei=i1ciT5LFE4vyrQeq7dWXCA&usg=AFQjCNF9xQxlBNo2A4yG8Tb6AvNXsa8iLw&cad=rjt (accessed 10 August 2011).

Financing and incentives

To promote the greening of industries, the Government introduced tax incentives and subsidies for investing in green technology and industry. A tax exemption has been provided to a certain level for dividends and interest from deposits, bonds and investment funds that invest at least 60 per cent of their total capital in firms and projects with national green certificates.[4] Also, as a means of green financing, the Government expanded the loan programme for green firms and projects and launched a green private equity fund to financially support firms, projects and technologies that are granted green certificates.

Table 3: Fiscal expenditure on green growth for 2009–2013(unit: trillion won, %)

Category	Total[5]	2009	2010–2011	2012–2013	Rate of increase
Total	**107.4**	**17.5**	**48.3**	**41.6**	**10.2**
Mitigate climate change and increase energy independence	56.9	8.6	29.2	19.2	14.0
Create new engines for economic growth	28.6	4.8	10.7	13.1	9.4
Improve quality of life and international standing	27.9	5.2	10.5	12.2	3.6

Source: Republic of Korea, National Strategy for Green Growth and Five-Year Plan (Seoul, Presidential Committee on Green Growth, 2009). Available from www.greengrowth.go.kr/?page_id=2450 (accessed 10 August 2011).

Results

Through the National Strategy for Green Growth and the Five-Year Plan, the Korean Government is expecting production increases, value addition and job creation. The development of green technology is expected to contribute to overall productivity, which will lead to a redoubling of the economic spill over effect. By 2013, the Government is expecting an increase in production worth approximately US$182–$206 billion, which is equivalent to 20 per cent of the 2009 GDP, and the creation of 1.6–1.8 million jobs.[6]

Success factors

- **Strong government commitment and leadership** have enabled the Republic of Korea to actively pursue its new national vision of shifting the growth paradigm towards low-carbon green growth.
- **A legal foundation** has been established through the Framework Act on Low Carbon Green Growth and the Enforcement Decree, which provide consistency and longevity in executing the policy.
- **The institutional framework** is embodied in the Presidential Committee on Green Growth, which is an overarching institution with direct responsibility for promoting green growth.
- **A specific budget** was allocated for the five-year plan, which enables practical actions to carry out the green growth policy and plan relevant projects with long-term perspective.

[4] Green certification is a national certification system certifying a green technology or a promising green project to clearly stipulate the object and scope of supporting green investment and concentrate on investment as part of the Government´s low carbon, green growth policy. The programme is coordinated by the Korea Institute for Advancement of Technology.

[5] The total amount eliminated overlaps among allocations to projects under the 10 policy directions.

[6] Republic of Korea, Road to Our Future: Green Growth (Seoul, Presidential Committee on Green Growth, 2009). Available from www.google.co.kr/url?sa=t&rct=j&q=Road+to+Our+Future:+Green+Growth&source=web&cd=1&ved=0CEcQFjAA&url=http per cent3A per cent2F per cent2Feng.me.go.kr per cent2Ffile.do per cent3Fmethod per cent3DfileDownloader per cent26attachSeq per cent3D2098&ei=i1ciT5LFE4vyrQeq7dWXCA&usg=AFQjCNF9xQxlBNo2A4yG8Tb6AvNXsa8iLw&cad=rjt (accessed 10 August 2011).

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Korea's Green Growth Strategy: Mitigating Climate Change and Developing New Growth Engines, by S. Jones and B. Yoo (Paris, OECD, 2011). Available from www.oecd-ilibrary.org/docserver/download/fulltext/5kmbhk4gh1ns.pdf?expires=1327649323&id=id&accname=guest&checksum=98298B5F649C09F4A12957D2A70A00A7

CASE STUDY

Republic of Korea's Presidential Committee on Green Growth

There was a commitment to follow…

The Republic of Korea's greenhouse gas emissions almost doubled between 1990 and 2005, the highest growth rate among OECD countries. The Government realized it was an unacceptable development and committed to achieving a significant cut in emissions through a shift from energy-intensive industries to low-carbon ones. The Government launched its National Strategy for Green Growth and the Five-Year Plan for Green Growth in 2008. It included "a target of reducing emissions by 30 per cent by 2020 relative to a 'business-as-usual' baseline implying a 4 per cent cut from the 2005 level. Achieving this objective in a cost-effective manner requires moving from a strategy based on voluntary commitments by firms to market-based instruments. The priority is to establish a comprehensive cap-and-trade scheme, supplemented, if necessary, by carbon taxes in areas not covered by trading."[1]

What was done?

The Presidential Committee on Green Growth in the Republic of Korea was established in February 2009 to follow through on the national strategy. Formed by integrating an existing sustainable development commission and two other committees on energy and climate change, the Presidential Committee is an overarching institution that reports to the country's president on realizing the national vision of low carbon green growth.

The Presidential Committee's role:[2]

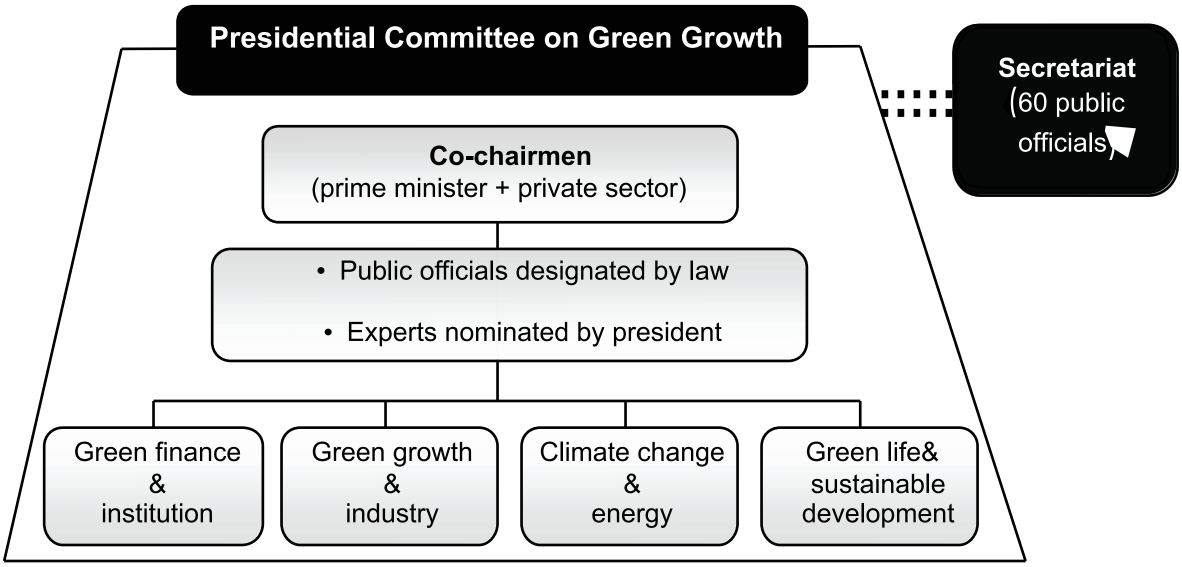
- deliberate on the Government's major policies and plans related to green growth and matters concerning the performance of such policies and plans
- coordinate appropriate central administrative agencies and local governments
- discuss various subjects relevant to pursuing green growth as a national think tank
- participate in the global green growth dialogue and international negotiations.

The Presidential Committee is composed of public officials and experts commissioned by the president, the number of which is never to exceed 50 members. The committee is led by a co-chairmanship, consisting of the prime minister and a commissioned expert member appointed by the president. As of August 2011, there were14 public officials (including the Minister of Strategy and Finance, the Minister of Knowledge Economy, the Minister of Environment, and the Minister of Land, Transport and Maritime Affairs) and 36 civil experts who have expertise and experience in low carbon green growth issues, such as climate change, energy and resources, green technology, green industries, green life and sustainable development. The cooperation between the public and private entities is due to the Government's pursuit of creativity and capacity from the private sector in policy-making and implementation.

[1] R. S. Jones and B. Yoo (2011), *Korea's Green Growth Strategy: Mitigating Climate Change and Developing New Growth Engines*, OECD Economics Department Working Papers, No. 798 (OECD Publishing, 2011). Available from http://dx.doi.org/10.1787/5kmbhk4gh1ns-en

[2] Republic of Korea, Framework Act on Low Carbon, Green Growth (2010). Available from http://eng.me.go.kr/board.do?method=view&docSeq=8744&bbsCode=law_law_law

Figure 1: Organization structure of the Presidential Committee on Green Growth



Source: Presidential Committee on Green Growth website, "About PCGG: Organization".

A secretariat of 60 public officials assigned to six teams (policy planning and coordination, energy policy, climate change policy, green technology and industry, green life and sustainable development and international cooperation) supports the Presidential Committee. The secretariat's main tasks include: organizing regular meetings of the Presidential Committee, coordinating green growth policies and plans between the central and local governments and supporting R&D projects on low carbon green growth.

In line with the Presidential Committee, city and provincial governments also have a local committee on green growth under the supervision of the mayors and governors to deliberate on specific matters concerning their policies that are relevant to low carbon green growth.[3]

[3] ibid.

CASE STUDY

Huge test of state-of-the-art ideas
Republic of Korea's smart grid development

Key point

- ***The Korean smart grid case exemplifies how a government can nurture promising but still immature low carbon technologies to become an engine for economic growth.***

There was a vision…

Following the announcement of the Five-Year Green Growth Plan and the national vision, *Building an Advanced Green Economy* in 2009, the Korean Government pinpointed smart grid development as one of several directions for achieving low carbon green growth. The Ministry of Knowledge Economy and its subsidiary organization, the Korean Smart Grid Institute, are taking the lead in this ambitious initiative.

What was done?

The Government drafted the Korean Smart Grid Roadmap 2030 in 2010, which consists of a vision, short- to medium-term goals (2012, 2020 and 2030) and five implementing areas – smart power grid, smart consumer, smart transportation and smart renewables and smart electricity service. In conjunction, an investment plan worth 7 trillion won for technology development (Government: 2.2 trillion won, private sector: 4.8 trillion won) and 20.5 trillion won for construction of infrastructure (Government: 0.5 trillion won, private sector: 20 trillion won) was committed.[1]

By 2030, the Government's efforts in smart grid development is expected to reduce approximately a total of 230 million tonnes of greenhouse gas emissions, create 50,000 jobs annually, generate 74 trillion won worth of domestic demand, reduce 47 trillion won worth of energy imports, discourage the construction of 3.2 trillion won worth of new plants and increase 49 trillion won worth of exports.[2]

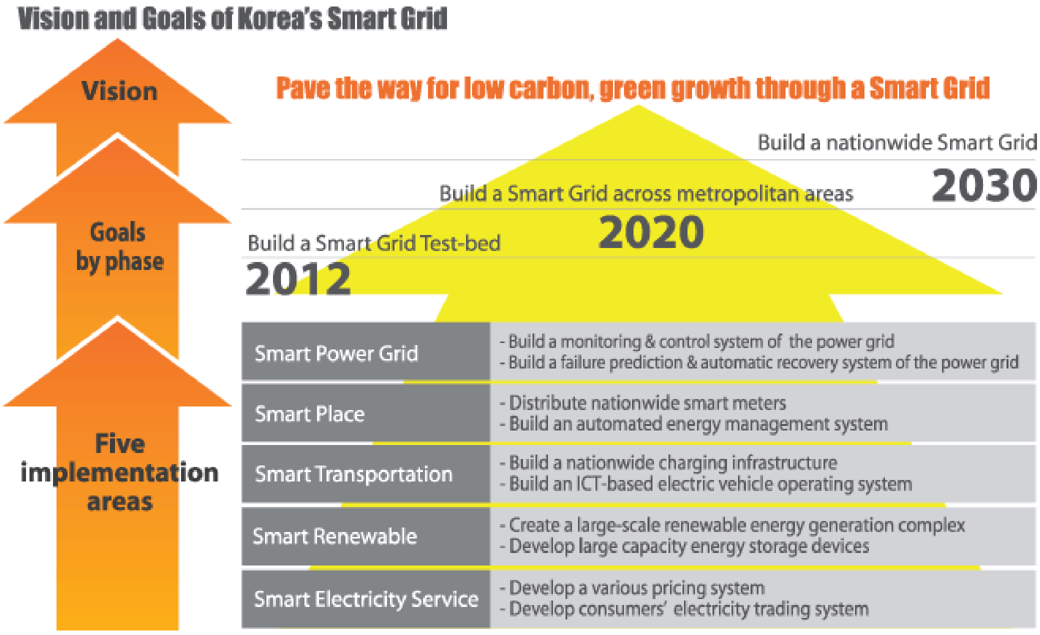
The roadmap cites several major milestones: i) build a smart grid test-bed by 2012, ii) build a smart grid across metropolitan areas by 2020 and iii) build a nationwide smart grid by 2030 (figure 1). The Government also expects to export the smart grid technologies abroad.[3]

[1] Ministry of Knowledge Economy and Korea Smart Grid Institute, "*Korea's Smart Grid Roadmap 2030: Laying the Foundation for Low Carbon, Green Growth by 2030*", pamphlet (Seoul, 2010). Available from www.smartgrid.or.kr/Ebook/Roadmap2/Roadmap2.html (accessed 30 September 2011).

[2] ibid.

[3] Korea Smart Grid Institute website "FAQ's". Available from www.smartgrid.or.kr/10eng6-1.php (accessed 30 September 2011).

Figure 1: The Government's vision for the smart grid



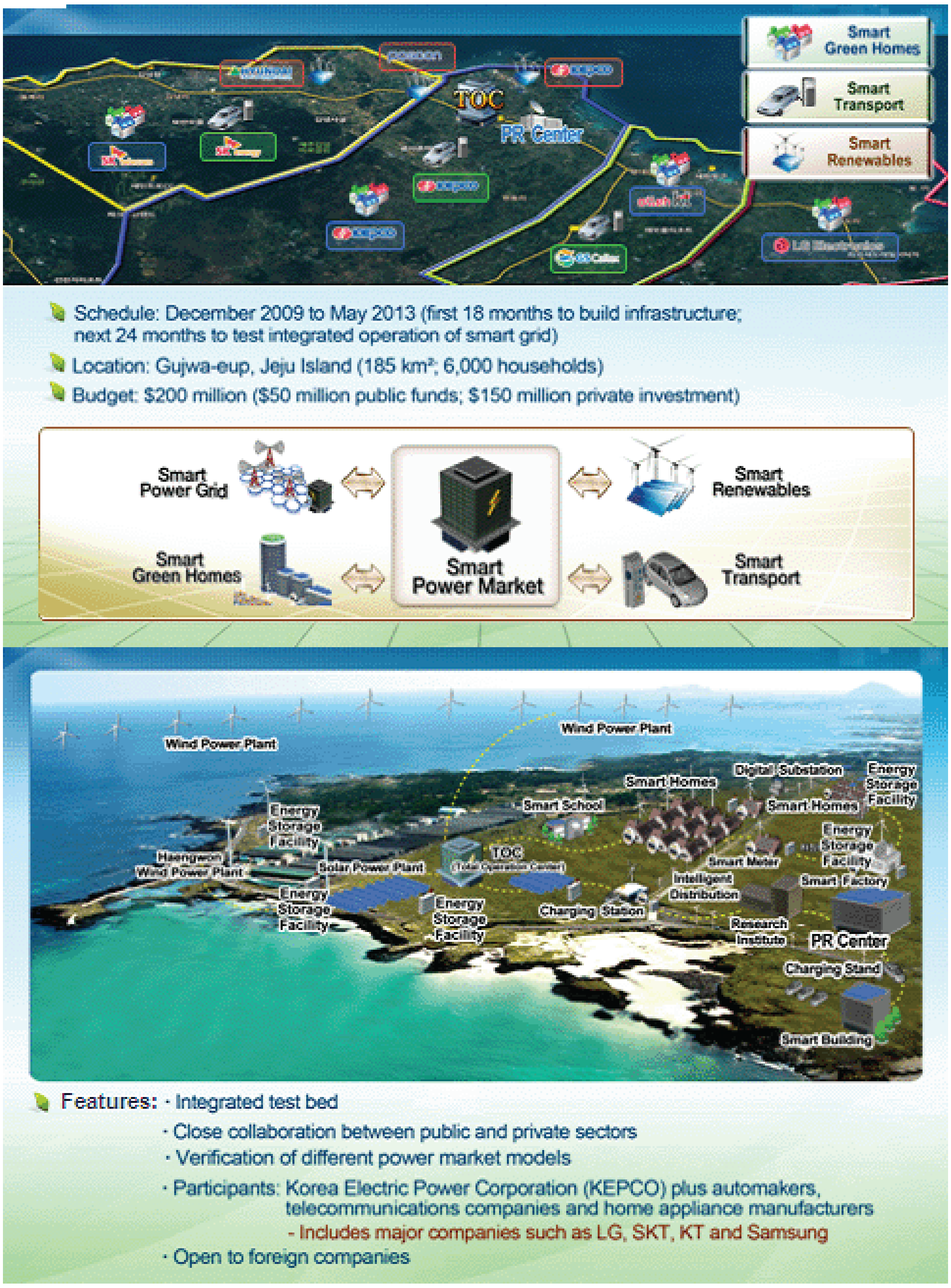
Source: Ministry of Knowledge Economy and Korea Smart Grid Institute, "*Korea's Smart Grid Roadmap 2030: Laying the Foundation for Low Carbon, Green Growth by 2030*", pamphlet, (Seoul, 2010). Available from www.smartgrid.or.kr/Ebook/Roadmap2/Roadmap2.html (accessed 30 September 2011).

The Jeju smart grid test-bed project

In 2009, the Government embarked on the construction of a smart grid test-bed in Jeju Island at the southern tip of the country, which is expected to be the world's largest smart grid demonstration project that showcases state-of-the-art technologies and applies innovative business models (figure 2). The Government will invest a total of 64.5 billion won (approximately US$57.8 million) between 2009 and 2013.[4]

[4] Korea Smart Grid Institute website "Korea's Jeju Smart Grid Test-bed Overview". Available from www.smartgrid.or.kr/10eng3-1.php (accessed 30 September 2011).

Figure 2: Jeju Island smart grid test-bed overview



Source: Korea Smart Grid Institute website, *Jeju's Smart Grid Test-bed Overview*. Available from www.smartgrid.or.kr/10eng3-1.php (accessed 30 September 2011).

The project aims to raise energy efficiency, build eco-friendly infrastructure that reduces CO_2 emissions, create new growth opportunities and enhance the quality of life.[5] More specifically, it aims to reduce electricity costs and energy consumption through the application of smarter technologies, renewable energy and efficient energy services.[6]

There are five areas of implementation: i) smart power grid to build smart power infrastructure, ii) smart place to lay the foundation for efficient energy use, iii) smart transportation to lay the foundation for expanded distribution of electric vehicles, iv) smart renewables to manage clean energy reliably, and smart electricity service to manage clean energy reliably and v) provide new electricity services. The demonstration project covers two

[5] ibid.

[6] Mark McDonald, "To Build a Better Grid", *The New York Times*, July 28, 2011. Available from www.nytimes.com/2011/07/29/business/global/to-build-a-better-grid.html?_r=1&pagewanted=all (accessed 30 September 2011).

phases: The basic stage (2010–2011) focused on infrastructure development for the smart power grid, smart place and smart transportation components. The expansion stage (2012–2013) on integrated operations focuses on smart electricity service components, providing innovative power services and renewable energy sources to the power grid.[7] The test-bed project is a partnership between the Government, private companies, research institutes and academia (approximately 10 consortiums, 168 companies in five areas.[8]

Figure 3: Map of the Republic of Korea

Source: Google Maps website. Available from http://maps.google.com/ (accessed 30 September 2011).

Results

More than 2,000 (among the 6,000 total) homes have been connected to the test grid since July 2011. The residents received new electrical meters, switches, home appliances and other technologies to enable a two-way real-time communication between the end user and the utility company to encourage electricity use when it is at the cheapest rate. The Government and the private sector covered the cost of the solar panels and storage batteries, worth US$15,000 for each set-up, which have been installed in 150 homes so far. This allows the end users to generate their own electricity and sell the surplus to the utility companies. AC/DC quick-charging stations have been set up for the 31 residents who own electric cars.[9]

Future prospects

The Jeju Island project will be followed by similar projects at the city level in the coming years. The Government expects three to four cities will have smart grid technologies by the end of 2013.[10]

The Korean Government is currently implementing a US$25 million technology project in Chicago, Illinois in the United States that involves installing energy-saving equipment in a maximum of 14 buildings (commercial and residential) and provides funding to R&D programmes on smart-grid technology in universities. The project is working to propel Illinois as the country's leader in smart grid development and R&D, resulting in the creation of job opportunities.[11] The Republic of Korea hopes that the Chicago project will open new opportunities to export its smart grid technologies around the world, a long-term goal included in the Smart Grid Roadmap.

[7] Korea Smart Grid Institute website "Test Bed Background". Available from www.smartgrid.or.kr/10eng3-3.php (accessed 30 September 2011).

[8] Korea Smart Grid Institute website "Jeju Test-bed Budget and Consortium". Available from www.smartgrid.or.kr/10eng3-5.php (accessed 30 September 2011).

[9] McDonald op. cit.

[10] McDonald op. cit.

[11] Julie Wernau, "South Korea Launches Energy Savings Project in Chicago," *The Chicago Tribune*, July 21, 2010. Available from http://articles.chicagotribune.com/2010-07–21/business/ct-biz-0722-korean-tech–20100721_1_buildings-aon-center-south-korea (accessed 3 October 2011).

Considerations for replicating

The Five-Year Green Growth Plan, a national R&D strategy, the Smart Grid Roadmap and an investment plan politically and strategically positioned the smart grid technology as an emerging national industrial priority to drive future economic growth. The Korean case exemplifies how a government can nurture promising but still immature low-carbon technologies through appropriate national policy frameworks, short- to long-term policy measures, public investments and innovative partnership schemes with the private sector. The Korean case also shows how a government can support and bridge technologies in demonstration projects to move towards the commercialization phase. The methodologies applied in the Republic of Korea can be a reference point for developing countries that seek to use technological innovations as a driver of economic growth or want to strengthen their deployment capacity.

Further reading

Korea's Smart Grid Roadmap 2030: Laying the Foundation for Low Carbon, Green Growth by 2030 (Seoul, Ministry of Knowledge and Economy, Government of the Republic of Korea and the Korea Smart Grid Institute). Available from www.smartgrid.or.kr/Ebook/Roadmap2/Roadmap2.html.

CASE STUDY

Fast track to high-speed rail
Republic of Korea's Train eXpress

Key points

- ***The Korean Train eXpress, or KTX, has become a competitive and reliable mode of medium- to long-distance intercity transportation.***

- ***Investment in the KTX, which constituted a major change in government policy from the previous focus on road infrastructure, has helped revitalize the railway industry and its competitiveness.***

There was a problem…

The KTX Gyeongbu (Seoul–Busan) high-speed rail line was commissioned in 1992 to service excess demand for transport along this corridor, which was home to about two thirds of the country's population and nearly three quarters of its gross national product generation. Some 66 per cent of passengers and 70 per cent of freight traffic ran through the Seoul-Busan corridor, and existing infrastructure was not capable of supporting the increasing transportation demand –highways were experiencing congestion and conventional rail lines could not add train capacity.[1]

What was done?

The Government decided to invest in the construction of a new high-speed railway connecting Seoul and Busan in 1992 along with the electrification of the existing Homan line (Daejon-Mokpo) to expand the high-speed rail network.[2] The total cost of the projects was approximately US$17.6 billion. The Government contributed 45 per cent of the cost for the KTX project (10 per cent in loans and 35 per cent in grants). The rest of the funding came from the Korea High Speed Rail Construction Authority (KHRC) – 29 per cent from bonds, 24 per cent from foreign loans and 2 per cent from private capital.[3]

Results

The KTX train sets have 935 seats spread over 18 passenger carriages.[4] The two lines serve an average of more than 100,000 users daily, and trains can reach maximum speeds of 300 kilometre per hour on sections of the 238.6 kilometre of new track (34 per cent of the total KTX track).[5] In its second year of operation, the Gyeongbu line had an average load factor of 85 per cent and the Honam line had 57 per cent.[6]

The difference it made

Rail times: Since the completion of the first and second phases of the KTX service, rail transit time from Seoul to Busan dropped by 53.6 per cent to 1 hour and 56 minutes. The electrification and introduction of high-speed rail

[1] Nam-Geon Cho and Jin-Kyu Chung, "High speed rail construction of Korea and its impact", *KRIHS Special Report Series* (Anyang, Korea Research Institute for Human Settlements, 2008).

[2] Chun-Hwan Kim, "Transportation revolution: The Korean hi-speed railway", *Japan Railway & Transport Review 40* (Tokyo, 2005).

[3] ibid.

[4] ibid.

[5] Kyung Chul Lee, "Launch of Korean high-speed railway and efforts to innovate future Korean railway" *Japan Railway & Transport Review* (2007) 48.

[6] Nam-Geon Cho and Jin-Kyu Chung, "High speed rail construction of Korea and its impact", *KRIHS Special Report Series* (Anyang, Korea Research Institute for Human Settlements, 2008).

trains on the Honam line reduced the rail travel time from Seoul to Mokpo by 35 per cent, to just 2 hours and 58 minutes. The efficiency of the KTX has been a major boon for Korail (Korea Railroad) – by bringing in about a third of the total rail passengers, the KTX brought in approximately two thirds of the Korail's income.[7]

Air travel: Demand and supply of air service between the cities served by the KTX declined substantially with its opening: between 27.8 and 78.7 per cent decline, depending on the origin and destination cities.[8] Flights between Seoul and Daegu, for example, dropped from 2,903 flights serving 338,559 passengers in the eight months before KTX opening to just 375 flights serving 27,854 passengers during the same period two years later[9] – a remarkable 92 per cent reduction in passengers. At the same time, more than 70 per cent of travel switched from air to rail within the first months of KTX service.[10] The total CO_2 emissions from domestic aviation began to drop[11] after 2004 – an 87 per cent decrease from 2004 to 2008.[12]

Ground transport: Car travel on express roads (measured by toll-gate traffic volume) dropped slightly for shorter distances served by the Seoul-Busan line and more significantly as distance increased (17.3 per cent reduction from Seoul to Busan). The express bus service experienced a similar but more pronounced pattern of reduced use in the first five months of the KTX operation (32 per cent reduction in trips from Seoul to Daegu and 35.5 per cent from Seoul to Busan).[13]

Future plans

Track upgrades are in progress to improve the speed and service of the Gyeongbu and Honam lines to further increase the high-speed rail system's capacity and efficiency in relation to car or air transport alternatives. The Honam KTX line, until now running on upgraded conventional track, will operate on a new high-speed rail line by 2014.[14]

Further reading

High speed rail construction of Korea and its impact, by Nam-Geon Cho and Jin-Kyu Chung, KRIHS Special Report Series (Anyang, Korea Research Institute for Human Settlements, 2008).

[7] Kyung Chul Lee, "Launch of Korean high-speed railway and efforts to innovate future Korean railway" *Japan Railway & Transport Review* (2007), No. 48.

[8] Sunduck Suh and others, "Effects of Korean train express (KTX) operation on the national transport system" *Proceedings of the Eastern Asia Society for Transportation Studies* (2005), vol. 5, pp. 190 – 198.

[9] Nam-Geon Cho and Jin-Kyu Chung, "High speed rail construction of Korea and its impact", *KRIHS Special Report Series* (Anyang, Korea Research Institute for Human Settlements, 2008).

[10] Dong-Chun Shin, *Recent Experience of and Prospects for High-Speed Rail in Korea: Implications of a Transport System and Regional Development from a Global Perspective* (Berkeley, Institute of Urban and Regional Development, UC Berkeley, 2005). Available from http://iurd.berkeley.edu/publications/wp/2005-02.pdf (accessed 15 November 2011).

[11] There may be exogenous explanatory factors for the decrease in emissions beginning after 2004.

[12] International Energy Agency (IEA), *Transport Greenhouse Gas Emissions: Country Data* (Paris, IEA/OECD, 2010).

[13] Sunduck Suh and others, "Effects of Korean train express (KTX) operation on the national transport system" *Proceedings of the Eastern Asia Society for Transportation Studies* (2005), vol. 5, pp. 190 – 198.

[14] Nam-Geon Cho and Jin-Kyu Chung, "High speed rail construction of Korea and its impact", *KRIHS Special Report Series* (Anyang, Korea Research Institute for Human Settlements, 2008).

CASE STUDY

Pay as you throw
Republic of Korea's volume-based waste charging scheme

Key point

- ***The policy has an indirect impact on increasing recyclability, but its main purpose is to reduce the amount of waste at post consumption, to be incinerated or sent to landfills.***

There was a problem…

In the Republic of Korea, the amount of wastes had been increasing dramatically during early 1990s in support of population growth and increases in middle income classes. The taxation or monthly fee for waste collection was running at that time with the fixed rate regardless of the amount of waste generation, which was not effective in reducing the wastes. By 1995, the municipal waste generation reached 1.59 kilograms per capita per day in urban areas.[1] Identifying dump sites for waste disposal was another challenge for government given the high population density and limited land areas.

What was done?

The Korean Ministry of Environment introduced the volume-based waste charging system in 1995 to incentivize residents to reduce their waste. It is based on separate waste streams, segregating recyclables items from non-recyclable waste. Households are required to purchase government-issued plastic bags and to dispose only what cannot be recycled. Each municipality sets the price for the official plastic trash bags, thereby setting the price of disposal according to the amount of waste generated. Fines apply for households who violate the law.

The Government is planning to apply the unit charging scheme to food waste starting in 2012. It aims to shift the focus of the food waste treatment from recycle (either to be composted or to be source of energy) to reduction of wastes at the source.[2] Municipal governments are experimenting with pilot projects to test the effectiveness of various instruments (for measurement and collection of wastes and charging fees) and expanding the coverage.

Results[3]

- **Waste reduction:** The total amount of waste has decreased about 24 per cent from 58,118 tonnes per day in 1994 to 50,007 tonnes per day in 2004. Waste generation per capita per day has been reduced 23 per cent from 1.33 kilograms in 1994 to 1.03 kilograms in 2004.

- **Economic benefits** accrued from 1995 to 2004 are more than 8 trillion won (US$8 billion) resulted from avoided waste treatment and market value of increased recycling products. The amount of recycles in 2004 is 2.8 times higher than 1994 (8,927 tonnes per day in 1995 to 24,588 tonnes per day in 2004).

[1] The International Bank for Reconstruction and Development and the World Bank, *What a Waste: Solid Waste Management in Asia* (Washington, D.C, 1999). Available from www.worldbank.org/urban/solid_wm/erm/CWG%20folder/uwp1.pdf (accessed 23 February 2012).

[2] Ministry of Environment of Republic of Korea, "Stiff competitions for the reduction of food waste among the municipal governments", *Press release*, April 8, 2011. Available from www.me.go.kr/web/286/me/common/board/detail.do?boardId=notice_02&idx=177331 (accessed 1 March 2012) [in Korean language].

[3] Ministry of Environment of Republic of Korea, "Evaluation Results on the Progress of Volume Based Waste Charging Scheme Over Ten Years (1995 to 2004)", *Press release*, January 16, 2006. Available from www.me.go.kr/web/286/me/common/board/detail.do?boardId=notice_02&idx=142913 (accessed 1 March 2012) [in Korean language].

- **Ecological benefits:** The reductions have resulted in reduced contaminated water from the landfill, reduced pollution from incinerators and efficient use of lands due to the avoidance of constructing new landfill

Lessons learned

- **An appropriate fee rate is critical for the success.** The price needs to be set to incentivize people to reduce the amount of waste but not burden their household budget. The earnings from selling the plastic garbage bags can be recycled to operate the scheme, thereby alleviating the financial burden on the local government. In the Republic of Korea, prices were steadily adjusted according to the increase in living expenses.

- **Communicate the benefits and provide detailed guidance:** To be effective, the segregation between recyclables and non-recyclables has to be done properly by households. The Korean Government provided a detailed list of what waste can be disposed and where via brochures and commercial advertising.

- **Impose a penalty for non-compliance:** People can be fined up to round US$900 for disposing garbage not in the officially issued plastic bags. A CCTV is installed in the designated dumping sites of many cites to catch violators.

Consideration for replicating

Supplementing with policies targeting upstream transformation: Although the policy has an indirect impact on increasing recyclability, its main purpose is to reduce the amount of waste at post-consumption, to be incinerated or sent to landfills. The extended producer responsibility amplifies the effect of minimizing waste at the source by influencing the production process. Setting up the system for the segregation, collection and treatment of recyclable waste can enhance the overall sustainability of waste management by addressing the wastes not covered by a volume-based waste charging scheme.

Further reading

"Volume-based waste fee system", by Kwang-yim Kim, in *Korea Environmental Policy Bulletin*, (Seoul, Korea Environment Institute, 2003). Available from http://eng.me.go.kr/file.do?method=fileDownloader&attachSeq=1564.

Waste Management in Korea, by H. J. Ahn and others (Chapel Hill, NC, Kenan-Flagler Business Scholl, University of North Carolina, 2006). Available from http://specials.kenan-flagler.unc.edu/kicse/ORIG Shared Documents/Waste Management in Korea.pdf

CASE STUDY

Controlling traffic through policy
Singapore's traffic policy package

Key point

- ***Singapore demonstrates it is possible to pre-empt traffic congestion and that no single measure can help address the congestion problem in any city.***

There could have been a problem…

Until the 1970s, there was little regulation controlling transport services in Singapore. Prior to the 1970s, land transport was given little prominence. A transportation unit existed in the Public Works Department, at that time the government department in charge of most things, from building the first library to pedestrian overhead bridges, bus shelters and roads. After gaining independence in 1965, the People's Action Party government began to look at the larger picture in transport infrastructure. They first commissioned a comprehensive study of transport from 1967 to 1971 and a master plan for Singapore up to 1992. The studies foresaw massive traffic congestion by 1992 without car restraints.[1]

What was done?

The Road Transport Action Committee was set up in the 1970s to look into pre-empting traffic jams. An interim measure to resolve traffic congestion in the city was the introduction of the first "user pays" system of charging for road use. Since then, Singapore has controlled its ever-increasing car ownership with integrated and coordinated land-use strategies and transportation planning with traffic-demand management.

To reduce car use, the Singapore Government introduced the following:[2]

Vehicle quota system: To cap the number of newly registered vehicles, Singapore introduced a vehicle quota system in 1990 that restricted vehicle growth to 3 per cent a year – down from 6 per cent a year. Under the quota system, prospective buyers must bid for a certificate of entitlement, which is valid for ten years. Vehicle owners must bid to purchase a certificate from the Government before the vehicle can be driven.

Taxes and fees on vehicles: To limit car ownership, an import fee of 130 per cent of the open-market value of the vehicle has been levied, an excise tax of 20 per cent and a registration fee of US$90. All these taxes and fees have made owning a car in Singapore very expensive.

Area licensing system: This scheme was introduced in 1975 and is based on cordon pricing. Special licenses must be purchased and displayed on the windscreen to enter a restricted zone, such as the central business district in peak periods. Emergency vehicles are exempted. Changes have been made to the scheme due to the increased congestion and traffic flows. Charges have increased, and the boundary has been extended. The scheme has been successful in alleviating congestion. There remains a manageable number of vehicles entering the zones during the scheme's operating hours. There has been a substantial modal shift away from car use. To avoid the charges, motorists switch to public transport or travel in off-peak hours. The large revenues generated have been used to improve infrastructure.

[1] National Library Singapore website, "Singapore Land Transport System" (Singapore, 2012). Available from http://libguides.nl.sg/content.php?pid=93596&sid=698339 (accessed 8 March 2012).

[2] Institute for Global Environmental Strategies, *Environmentally Sound Transport Planning in Singapore* (Kitakyushu, Japan, 2003). Available from http://enviroscope.iges.or.jp/contents/APEIS/RISPO/inventory/db/pdf/0019.pdf (accessed 26 February 2012).

Weekend car or off-peak car scheme: This system allows weekend-only car users to save on registration and road taxes in return for their reduced car use. Under the revised scheme, converted or new cars can have unrestricted access on weekends and evenings of public holidays.

Parking: The Land Transport Authority manages parking spaces. Public parking charges have been raised and also additional surcharges were levied to discourage car use.

Park and ride system: To alleviate congestion in the central business district, the park-and-ride system was introduced in 1975. Parking lots were opened near the mass rapid transit (MRT) system and bus stations to encourage motorists to commute by public transport.

Extensive networks of public transport: While the demand-side measures listed above were effective in pushing motorists away from private vehicles, the high-quality public transport network absorbed the increased mobility demand. Singapore has a well-developed, comprehensive MRT system spanning the entire city with 79 stations. The operators also run bus and taxi services, which ensure a high level of integration of public transport and ease of interchange.

The light rail transit (LRT) in Singapore acts as the connecting service to the MRT for intracity travel. The LRT offers a better alternative to buses to avoid traffic congestion and also causes less environmental effects. All stations are within walking distance to apartment blocks to make them more accessible.

Included in the network development were bicycle parking spaces and allowing foldable bikes on the MRT.

Lesson learned

No single measure can help address the congestion problem in any city. Singapore's integrated measures, consistent improvements to its existing schemes and provisions for better alternatives according to change in demand and car ownership have made it one of the best transport systems in the world.

CASE STUDY

Integrating environmental costs to tackle water scarcity
Singapore's water pricing policy

Key points

- ***Singapore's water management shows that basic utilities do not have to be under-priced for better access. By integrating ecological costs, the country has improved both security and quality of water while effectively tackling water scarcity and making its water industry more competitive.***

- ***A separate tax rebate on utilities and subsidies targeting lower-income households have been introduced to decouple distributive impacts from over-consumption.***

There was a concern…

Being a city-state with an area of about 700 square kilometres and a population of about 5 million (as of 2009), with steady high growth and prosperity, Singapore's water consumption has been continuously increasing and is still continuing to rise. Singapore has long been heavily dependent on imported water and experienced chronic water shortage. How to provide clean water to all its population in a sustainable manner has been a major concern for the government.

What was done?

Since the 1980s, Singapore has been making significant efforts to create a comprehensive environmental management system, including water supply, control of river pollution, establishment of well-planned industrial estates and a world-class urban sanitation system for the entire population. As a result, the country has tackled its chronic water shortage and heavy dependence on imported water from neighbouring countries (mostly Malaysia).

Demand management through water pricing

1. Integrating ecological costs of water and streamlining the rate based on water use amount

The effective water pricing reform starting in 1997 aimed to reflect not only the full cost recovery but also the increasing water scarcity and high incremental costs of additional water supplies. The existing increasing block tariff system composed of three tiers, and an exemption of the water conservation tax for the bottom tier (covering 56 per cent of the households with less than 20 cubic metres of water use per month, as of 1997) was transformed into a flat-rate system, which is comprised of two tiers with thresholds of 40 cubic metres per month, in which both the bottom and upper levels pay the water conservation tax. At the same time, favoured rates for households over industry and business were abolished to apply the same rate to both entities, only based on their respective water use amount.

As a result of the four annual increments, the price for water has risen by 120 per cent for households after the price reform in 1997. The average monthly domestic bill including taxes increased from S$13 in 1996 to S$30 in 2000. Water tariff also provided incentives for water conservation by including a water conservation tax whose proceeds are directly attributed to the government. Sewage tariff (called "waterborne fee") which consists in a share charged for the maintenance of the public sewage system, are also levied. Still this residential tariff is found to be much lower than those in some European countries such as Germany and industrial tariffs are set even lower.[1]

[1] Cecilia Tortajada, "Water management in Singapore" *Water Resources Development* (2006), vol. 22, No. 2. pp 227-240. Available from www.adb.org/Documents/Books/AWDO/2007/br01.pdf (accessed 15 March 2012).

At the same time, by simplifying the tariff structure into a flat rate (a two-tier system) with the same rate application to both households and business, (dis)incentives of overuse by small-size households has been discouraged while businesses could decrease their tax burden, which resulted in a higher competitiveness.

Tables1, 2, and 3: Water pricing structure in Singapore (as of July 2011)

Tariff category	Consumption block (m³ per month)	Tariff (S/m³) (before GST)	Water conservation tax (% of tariff) (before GST)
Domestic	0 to 40	1.17	30
	Above 40	1.4	45
Non-domestic	All units	1.17	30
Shipping	All units	1.92	30

Note: S= cents; GST= goods and services tax, currently at 7%

Tariff category	Consumption (m³ per month)	Waterborne fee ($/m³) (before GST)	Waterborne fee ($/m³) (after GST)	Sanitary appliance fee (before GST)	Sanitary appliance fee (after GST)
Domestic	All units	0.2803	0.3	$2.8037 per chargeable fitting per month	$3.00 per chargeable fitting per month
Non-domestic	All units	0.5607	0.6		
Shipping	All units	-	-	-	-

Tariff category	Consumption block (m³ per month)	Tariff (cents/ m³)	WCT (% of tariff)	WBF (cents/ m³)
Industrial water	All unites	46	-	-

Note: WCT= water consumption tax; WBF = waterborne fee (sewage tax)

2. Decoupling distributive impact from (dis)incentive of over-consumption

The reformed water pricing system does not have a lifeline tariff component because it favoured small-size households rather than low-income households and failed to discourage wasteful use of water. Instead of the lifeline tariff or progressive water tariff system, such as an increasing block tariff, adverse impacts on poorer households were addressed in a separate scheme of subsidies and rebates on utility bills (including water, electricity and gas) to decouple the distributive impacts from disincentives on (wasteful) water consumption.

The U-Save rebate scheme, originally introduced in 1996 to offset an electricity price rise, is reviewed every year to assess the impacts on the lower-income households of the changed costs of living due to increases in water and electricity prices, general inflation and changes in goods and service tax rates. The scheme also addresses inadvertent impacts on the lower-income households of economic downturns incurred in economic restructuring or outbreak of epidemics (such as SARS).

The country's innovative public housing scheme (HDB housing scheme) made the targeting of beneficiaries relatively easy and effective, considering that more than 80 per cent of the population lives in HDB flats, including low-income households (who cannot afford to procure a house in the private market). The rebate scheme was based on the type (size) of the HDB flat as well as the number of residents. The rebate is credited by Singapore Power Services, Ltd., the country's billing agent, onto the account of the household utility bills. Households can use the credits to pay their utilities, including water, electricity and gas. Credits not used in the same month can still be used in subsequent periods: this provides stronger incentives to conserve water, energy and gas.

Results

Impacts of the reformed water pricing and overall water management in Singapore are found to be remarkable:

- Domestic per capita water consumption reduced from 176 to 160 litres per day from 1994 to 2005. The country is targeting 140 litres per day by 2030.
- Water security has improved as the percentage of imported water has reduced from over 50 per cent in 1994 to 33 per cent in 2008. The country is positive about its goal of achieving self-sufficiency by 2061.
- The U-Save rebate scheme has covered more than the negative impact of the rising water prices on the low-income households.
- Strategic long-term investment in national water projects (such as the NEWater recycling scheme, the deep tunnel sewerage system, desalination and rainfall storage at the Marina Barrage) have spawned a thriving water industry with more than 50 international and local companies active in the Singapore water market.

Success factors

Comprehensive approach for water management: This involved the combination of both supply and demand management through major national water projects; achieving balance between quantity and quality of water; considering equally efficiency and equity, strategic national interest and economic efficiency; and strengthening internal capacities and reliance on external sources.

Importance of enabling environment: Successful water management and pricing policies were possible because of the country's institutional effectiveness (including legal and regulatory frameworks), the Government's strong political will and an experienced and motivated workforce. The effectiveness of water management policies go hand in hand with the effective management of other utilities and sectors – overall fiscal efforts need to be taken into account.

The message from Singapore's water management practice is clear: Integrating ecological prices of water (and other utilities) to reflect full cost recovery as well as its scarcity level can be an effective way to tackle its quantity as well as quality challenge and to induce more efficient use.

Lessons learned

Being a public good does not mean that it should be cheap or free: The perception that the price of water and (other utilities) should be artificially lowered through government subsidy to secure the unhampered access of the people (and particularly the poor) to the basic good water may need to be revised; empirical evidence shows that subsidized water price (or IBT) may not be effective, neither to address scarcity challenges nor to address the distributive problematic. As shown in the case of Singapore, securing ecological efficiency and sustainable use of water through restoring its full price by integrating ecological costs (and the real value) can be a more effective option. When combined with separate compensation measures which should be well-targeted for the most affected, equity concerns of the price reform could be addressed more effectively.

Further reading

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CASE STUDY

Picking up neighbourhood garbage solutions
Sri Lanka's community-based decentralized solid waste management

Key point

- ***A neighbourhood integrated resource recovery centre reduces greenhouse gas emissions using an approved methodology and thus qualifies as a Clean Development Mechanism project, which allows facilities to sell their carbon credits.***

There was a problem…

Matale is a medium-sized urban centre in central Sri Lanka, surrounded by large plantations and famous for its spice gardens. In addition to agriculture, the city's economic activities include tourism and trade. The city generates 21 tonnes (21,000 kilograms) of municipal waste per day. Even though 80 per cent of waste generated in Matale has potential to be used for composting and biogas generation or to be recycled, 17 tons are disposed at an open dumpsite. The Municipal Council spends 20 per cent of its budget on solid waste management, but there is no city-wide collection. Households describe the service provided by the municipality as poor.

What was done?

In 2006, ESCAP, Sevanatha and the Matale Municipal Council jointly piloted a Community-Based Decentralized Solid Waste Management Project to improve services in one ward while reducing costs, producing economic outputs and minimizing the amount of waste that was sent to the landfill.[1] The partners established an integrated resource recovery centre (IRRC) in Gongawela ward to collect waste from households and businesses through the employment of a staff of six waste pickers then sort and treat the waste for various uses, including turning it into compost that they sell. To improve waste separation, the community was involved; households were trained to separate waste into two bins, organic and inorganic. In addition, as the workers collect the waste from the households they notice whether the waste is separated properly or not and discuss the situation with the residents. Because it is not possible to reach 100 per cent waste separation from households, waste is sorted one more time by the workers at the plant into organic waste, recyclables and rejects. Since 2007, it has collected and composted segregated waste from about 600 households and small businesses.

After the success of the pilot project, the Matale Municipal Council decided in 2010 it was a suitable option for treating all waste. With assistance from ESCAP and Waste Concern, the approach is being scaled up to treat 20 tonnes of waste per day.

Recycling into compost

The IRRC produces high-quality compost using the aerated box method. It is comparatively cost- effective, using less land than other methods for composting, such as wind row, and with low construction costs. The technology is simple and non-mechanical, which makes it easy for staff to operate and maintain while keeping operating costs low. In comparison with more advanced technological compost technologies, there are minimal breakdowns and need for repairs. The production period for compost is on average 90 days. Strict quality control is maintained, and the compost complies with numerous standards for certified organic compost.

To further reduce costs for the municipality by minimizing the rejects that need to be sent to the landfill, the IRRC also stores, processes and sells recyclable material. Because the waste is sorted at households, the recyclable

[1] The pilot project was based on an approach developed by Waste Concern, an NGO from Bangladesh, to reduce government costs while providing a business opportunity for a local entrepreneur, improving services to households and managing waste in a more eco-efficient manner.

material is clean (hasn't been spoiled by other waste), which increases its value. Additionally, by storing the recyclable material and selling it in bulk at an appropriate time, the IRRC draws a higher price than if sold daily.

Results

The IRRC combines environmental and social benefits with a strong business approach that makes it sustainably ideal. The environmental and health benefits from ensuring that waste is collected and treated appropriately are the most obvious advantage, but there are others:

- **Reduced waste and greenhouse gas emissions.**
- **Turned a profit:** The Matale IRRC struggled to make a profit in the first years but has since improved its management and is now turning a profit. The current collection of fees from households and the sales of compost almost cover its operating costs. The IRRC has operated for three years without any support from ESCAP. In 2009, the local government built a second plant with funds from the central Government and which was recently handed over to the Sevantha NGO to manage. Because the construction costs were low, it was possible for the municipality to raise funds for a second plant locally.
- **Created jobs and increased quality of life:** The IRRC employs six workers from the waste-picker community and provides a clean working environment. Other waste pickers in the city have also benefitted. The IRRC buys recyclable material from them at a price that is transparent and often better than what junk shops pay.

Lesson learned

To be profitable, access to a bulk market for compost is necessary: To maximize profits, a facility needs to sell its compost in bulk to large buyers. Long before a facility ignites its operations, a market for the compost and possible distribution channels should be established.

Success factors

Site selection: The plant is located within the neighbourhood it services and opposite the mayor's house. Due to its central location, transportation costs are kept low, and fruit and vegetable vendors operating in the area even bring their waste directly to the plant. The fact that the facility is located in the neighbourhood it services also reduces the risk of contamination because transport distances are short. The central location gives both the project and the facility a "centre of importance" image, an important factor in motivating households to separate their waste.

Involvement of the community for waste segregation at the source: Asking households to sort their waste helps relieve excess labour in the centre and, most critically, involves the households in the recycling process and thus helps sensitize the community more deeply about individual consumption and waste levels. Ideally, it leads to changes in behaviour.

The support and leadership of the local authority: The Municipal Council of Matale was willing to engage in a public-private partnership with an NGO, a partnership model that was uncommon in Sri Lanka. Further, the municipality supported the IRRC by providing workers, giving it a land concession and by collecting rejects from the plant. Their strong support for the approach also led to the construction of a second plant, although with funds from a national solid waste management project.

Consideration for replicating

Under a regional ESCAP project, the IRRC approach is being replicated and further improved in ten cities in Asia; some facilities will include a biogas digester to treat meat and fish waste and produce biogas and convert used cooking oil into biodiesel. Depending on the local context, a single facility can process between 2 and 20 tons of waste a day, serving a population of 1,000–50,000 people.

The partnership model will look different in the various cities. In some cities, the model will be similar to the one in Matale, with a public-private partnership between the local government and an NGO. In other cities, the management may be with local government but the workers may operate the plant as a cooperative and receive the financial and social benefits.

Because the IRRC reduces greenhouse gas emissions using an approved methodology, it qualifies as a Clean Development Mechanism project under the Kyoto Protocol, which also allows facilities to sell their carbon credits to industrialized countries for a profit. Countries can have an access to additional funding through the Clean Development Mechanism.

CASE STUDY

Greening a well-established industry
Thailand's bioplastics companies

Key points

- ***The type of industry that is best suited for greening strongly depends on national or even local characteristics, such as resource availability, infrastructure, technological standards or existing business networks.***

- ***Greening a well-established industry encompasses long-term goals, specific targets, success indicators, implementing strategies, actions, government incentives, budget allocation and the nomination of state agencies responsible for supervising each of those factors. Otherwise, new businesses can't compete with their brown counterparts.***

- ***The government's role is essential in terms of laying down the broader policy framework during the initial start-up phase. Cooperation and collaboration among government, academia and the private sector are crucial for greening and improving the competitiveness of the industry.***

There was an opportunity…

Thailand is a biomass-rich country. It possesses sufficient feedstock resources, particularly sugar and cassava, which are selling at competitive prices to support a plastics industry. Owing to that, Thailand is the leading plastics exporter in ASEAN, with more than 4,000 companies in the plastics industry and a worldwide customer base.[1] The industry can expand into bioplastics by tapping into existing capabilities, networks and resources of the well-established, conventional plastics industry.

What was done?

Feasibility study

In 2003, bioplastics emerged as a potential green industry particularly suited for Thailand. The Government conducted a feasibility study [2] that revealed that the country possessed several comparative advantages, including existing capabilities and infrastructure, and that the development of a bioplastics industry would be productively worthwhile. The National Innovation Agency was asked to create a roadmap with recommendations and development plans.

Industry group creation

In 2006, the Thai Bioplastics Society was created to promote business activities and leverage resources to assist in preparing the national roadmap. A year later, the Thai Bioplastics Society was replaced by the Thai Bioplastics Industry Association.

National roadmap for the development of bioplastics industry [3]

In 2008, the National Innovation Agency presented the roadmap that directed the coordinating of efforts among government agencies through four strategies:

[1] National Innovation Agency, *National Roadmap for the Development of Bioplastics Industry* (Bangkok, Ministry of Science and Technology, 2008). Available from www.nia.or.th/bioplastics/download/bioplast_roadmap_en.pdf (accessed 29 January 2012).

[2] Ibid.

[3] ibid.

1. Stimulate the readiness of biomass raw materials
2. Accelerate and generate new technologies
3. Build industry and innovative businesses
4. Establish supportive infrastructure

The four strategies covered the entire value chain of the bioplastics industry. The roadmap provided targets, indicators and action plans and designated sectors and organizations for implementing. The total budget for the roadmap strategies at that time was 1.8 billion baht (US$57.5 million), and the government investment was expected to leverage over 5.5 billion baht (US$175.6) of economic value-added for the private sector during the five-year implementing period.[4]

Government funded R&D programmes

The roadmap provided 1 billion baht for R&D of bioplastics technologies, 10 per cent of which was to be used to accelerate technologies that could be immediately deployed. The remainder was allocated to generate indigenous new technologies.

Government incentives to encourage private investments

Thailand's Board of Investment (BOI) put several incentives for investment in place, as highlighted in the following table 1.

Table 1: Examples of BOI incentives for investment in bioplastics

Tax incentives	Non-tax incentives
Corporate income tax exemption for eight years and additional 50% reduction for five years	Land ownership rights for foreign investors
Deductions for infrastructure construction and installation costs	Permission to bring in foreign experts and technicians
Import duty reductions or exemptions for machinery and raw materials	Work permit and visa facilitation

Source: National Innovation Agency, "Eco-industry: Bio-based materials", PowerPoint presentation (Bangkok, Thailand, Ministry of Science and Technology 2009). Available from www.nia.or.th/bioplastics/download/bioplastics_presentation_en.pdf (accessed 23 January 2012).

Collaboration between companies and government created a strong industry group

Entrepreneurs responded to the government initiatives. The Thai Bioplastics Society attracted five members when it was first created. Five years later, there were 50 members in the Thai Bioplastics Industry Association.[5]

Government initiatives and incentives lead to investments in production facilities by both international and domestic firms

In 2008, the Dutch firm Purac opened a state-of-the-art biodegradable chemical compound production facility in Thailand. In 2010, Purac invested an additional 2 billion baht in a new production facility located within the same complex.[6] In 2011, Mitsubishi and PPT announced a 6 billion baht joint venture project to build the world's first factory to produce biodegradable plastics from sugar.[7]

[4] Ibid.

[5] Thailand Bioplastics Industry Association website "Members" (2008). Available from www.tbia.or.th/en/members.php?type_id=3 (accessed 05 February 2012).

[6] Nanchanok Wongsamuth. "Purac Predicts Bioplastics Boom," *Bangkok Post*, April 2, 2010.

[7] Yuthana Praiwan. "Greener Plastic from Sugar a First." *Bangkok Post*, July 15, 2011, sec. B1.

Success factors

Industry and government cooperation. The high level of collaboration between industry and the Government encouraged private investments and innovative activities. In one project, for example, Purac supplied the raw materials for research, the Government provided funding for the researchers and the Thai Bioplastics Industry Association funded further development of the technology.

Strong industry group and international collaboration. The Government encouraged Thai companies to engage with international bioplastics companies and promoted close collaboration with international partners. The Thai Bioplastics Industry Association collaborated with bioplastics industry groups from the European Union, Australia, Japan, the Republic of Korea, Taiwan Province of China and the United States.[8]

Supportive government policies. In addition to investment incentives, other government policies promoted the use of bioplastics, the development of Thai industrial standards for bioplastics and consumer awareness.[9] The roadmap's action plans and budget support reduced the time and cost gaps in developing the bioplastics industry.

Considerations for replicating[10]

Existing capability and infrastructure definitely needs to be considered in the development of a green industry. An assessment of the overall prospects and readiness along the value chain should be conducted. Industry feedback should be solicited throughout the development process. Engaging the research community and private firms ensures that the industry shares the same development vision and goals. Although the successful development of a greening strategy for the bioplastics industry might be unique for Thailand, other industry sectors likely have similar potential, depending on national circumstances.

[8] Thailand Bioplastics Industry Association, *Thailand Bio Plastics Outlook* (Bangkok, 2011).

[9] National Innovation Agency in the Ministry of Science and Technology, *Eco-Industry: Bio-based Material* (Bangkok, 2009). Available from www.nia.or.th/bioplastics/download/bioplastics_presentation_en.pdf (accessed 23 January 2012).

[10] Pornpun Theinsathid, Achara Chandrachai and Suwimon Keeratipibul, "Managing bioplastics business innovation in start up phase", *Journal of Technology Management & Innovation* (2009), vol.4, No.1. Available from www.scielo.cl/pdf/jotmi/v4n1/art07.pdf (accessed 24 January 2012).

CASE STUDY

Economic policy targets polluters
Thailand's initiative on environmental tax reform

Key point

- ***With increasing environmental degradation and rising demand for a better environment, the Thai Government realized its pollution policies needed to include changing consumer behaviour by strengthening economic policy instruments.***

There was a one-sided focus…

Until recently, environmental taxes in Thailand have largely focused on pollution control and management rather than on changing behaviour. Among them were fees on industrial wastewater pollution (since the late 1980s) and a small excise tax on petroleum products (since 1991).[1] During the 1990s, the country has effectively eliminated lead from petrol products by charging gasoline tax based on lead content.[2] The taxing, however, was not significantly affecting consumer behaviour.

What was done?

To establish a legal framework for a more comprehensive and integrated approach, the Government drafted the Act on Economic Instruments for Environmental Management, which proposes a central governing committee to be chaired by the Minister of Finance and whose members would consist of senior officials from the Ministries of Natural Resources and Environment, Industry, Interior and Public Health as well as representatives of the private sector and local governments, experts and academia. The institutional framework would allow determining, in an integrated and multi-sectoral manner, the appropriate economic instruments for different purposes and appropriate administration of the funds derived. In October 2010, the cabinet agreed in principle with the proposed fiscal measures for the environment bill.

The Act combines a variety of economic instruments, including environmental tax, user fees or charges for pollution management, product surcharge, performance bonds, tradable permits, subsidies and other support mechanisms under one law and allows product prices to include end-of-life management fees.

In this context, in mid-2011, the Excise Department of Thailand announced a "green tax" proposal. A number of measures were selected to strengthen the environmental protection by enforcing the "polluter pays" principle. For instance, the excise taxes on cars would be determined by their carbon emissions rather than engine size.[3] Oil excise tax will also shift towards a carbon emissions base from volume. Air conditioners would not be exempt from taxation anymore, and the tax rates will depend on their energy-efficiency performance. Products, including such environmentally harmful substances as oil lubricants, pesticides, tyres and packaging, would also be taxed.

Revenue recycling for greening the economy

Part of the revenue collected through the green taxes will be earmarked for a newly established environment fund. While the vehicle and fuel taxes are expected to become higher in the short term with the introduction of

[1] Background information from the Fiscal Policy Office of Royal Thai Government shared at the South-East Asian Training of Trainers Seminar on Green Growth Policy Tools for Low-carbon Development, from 31 August to 5 September 2009, Kanchanaburi, Thailand.

[2] AEA Technology, *Promotion of Market-Based Instruments for Environmental Management in Thailand*, Report for the Asian Development Bank (London, 2001).

[3] Wichit Chantanusornsiri, "Green Tax Could Affect Many Sectors", *Bangkok Post*, June 23 2011. Available from: www.bangkokpost.com/business/economics/243554/green-tax-could-affect-many-sectors (accessed 24 February 2012).

the new taxes, the resulting reduced use of carbon-emitting products and the development of low or zero-emission technologies will mitigate economic and environmental impacts in the longer-run.

Expected results

The Government is in the process of implementing a ten-year Alternative Energy Development Plan (2011–2030) and a 20-year Energy Efficiency Development Plan (2011–2030), with the goal to increase the share of the alternative energy sources up to 20 per cent of the country's total energy use by 2021. Through these efforts, the country aims to reduce the greenhouse gas emissions by 205 million tons by 2030.[4]

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[4] Pithaya Pookaman, "Statement", presented at the High-level Segment of the UNFCCC 2011 COP17 and CMP 7, Durban, 8 December 2011. Available from http://unfccc.int/files/meetings/durban_nov_2011/statements/application/pdf/111208_cop17_hls_thailand.pdf (assessed 24 February 2012).

Attracting investment
Thailand's tax incentives for eco cars

Key points

- ***Promoting the manufacturing of environment-friendly automobiles can boost exports and industry competitiveness in response to growing global demand for these goods.***
- ***A policy package that combines strict environmental standards with attractive tax incentives worked well to attract private investments.***
- ***Involving manufacturers in the policymaking process enhances overall participation in the policy scheme.***

There was an ambition…

The automobile industry is contributing to the export-driven economy of Thailand, with cars and related parts representing 9 per cent of the total volume of exports in 2008.[1] In particular, Thailand is one of the biggest manufacturers of pick-up trucks.[2] In pursuit of keeping its export edge and trying to hurry ahead of the global trend of tightening regulation on the environmental quality of vehicles, the Thai Government in the mid-2000s began working towards becoming the champion of the "eco car" market by 2015.[3]

What was done?

Preferential excise tax for eco cars

The Thai Government first offered tax incentives for the manufacturing of eco cars, in 2007. A preferential excise tax rate of 17 per cent for eligible eco cars was introduced, which was a rate far less than the 30 per cent excise tax imposed on conventional vehicles.[4] Producers who want to apply for the scheme must make a car that is small and energy efficient. Makers of petrol-powered small cars with engines bigger than 1,300 cc need not apply. Additionally, a manufacturer must guarantee to invest more than 5 billion baht in eco car production and produce more than 10,000 vehicles annually.[5]

Attractive tax incentives and strict environmental standards for manufacturers

In 2007, Thailand's Board of Investment drew up a plan to introduce more tax incentives for eco car manufacturers. In this scheme, the manufacturers can enjoy a tax exemption on corporate tax for up to eight years, a tax exemption on the import duty for machinery and equipment and up to 90 per cent reduction in the import duties on raw materials and finished parts for two years[6] if they fulfil the required strict environment and investment-related conditions listed below.

[1] Japan External Trade Organization, *Economic Outlook of Thailand in 2008/2009* (2009).

[2] *The Economist*, "Thailand's eco-drive: The Detroit of Asia thinks green", June 21, 2007.

[3] Interview with Thai Board of Investment, Bangkok, 16 March 2011.

[4] *The Economist*, "Thailand's eco-drive: The Detroit of Asia thinks green", June 21, 2007.

[5] The Board of Investment, "BOI to Promote Eco-cars Maximum Incentives for Integrated Car Assembly and Key Parts Manufacturing Projects", *Press release*, June 15, 2007. Available from www.boi.go.th/english/download/hot_topic/112/Copy%20of%20translation2_rev%5B1%5D.pdf (accessed 30 January 2011).

[6] The Board of Investment, "BOI Grants Special Incentives to Eco-Car Projects 90% Duty Reduction on Eco-Car Parts and Raw Material Imports", *Press release*, July 16, 2009. Available from www.globaltradealert.org/sites/default/files/Board%20MT%20-%20Eco%20Car%20Measure%20edited.pdf (accessed 30 January 2011).

Box 1: Criteria for manufacturers to join the Thai eco car scheme

- Environment-related criteria
  - Car should consume less than 5 liters per 100 km
  - Car should comply with Euro4 standard or higher
  - Car should emit no more than 120 g of CO_2 per km
  - Car should satisfy safety standards, both for front and side impacts, as specified by UN Economic Commission for Europe Regulation 94 and Regulation 95, respectively.
- Investment-related criteria
  - Project should integrate car assembly, engine manufacturing and the manufacture of parts
  - Investment should be more than 5 billion baht
  - Production capacity must not be smaller than 100,000 units per year from the fifth year of operation
  - Project should produce a minimum of four out of the following five engine parts: cylinder heads, cylinder blocks, crankshafts, camshafts and connecting rods
  - Materials and parts should be locally unavailable to apply for reduction on import duties.

Sources: The Board of Investment, "BOI to Promote Eco-cars Maximum Incentives for Integrated Car Assembly and Key Parts Manufacturing Projects", *Press release*, June 15, 2007. Available from www.boi.go.th/english/download/hot_topic/112/Copy%20of%20translation2_rev%5B1%5D.pdf (accessed 30 January 2011).
The Board of Investment, "BOI Grants Special Incentives to Eco-Car Projects 90% Duty Reduction on Eco-Car Parts and Raw Material Imports", *Press release*, July 16, 2009. Available from www.globaltradealert.org/sites/default/files/Board%20MT%20-%20Eco%20Car%20Measure%20edited.pdf (accessed 30 January 2011).

Car manufacturers began producing eco cars

The tax incentives were introduced in 2009; five car manufacturers applied and were approved for the project. Among them, Nissan Motor was the first to start selling an eco car (in March 2010); it has since exported 54,000 cars (as of September 2010). Other manufacturers are still in the preparation stage (table 1). Although it is an ongoing project, if all five manufacturers follow through, more than 25 billion baht is expected to be invested in the programme, and more than 500,000 eco cars are to be produced by 2015.

If the exports of automobiles remain at about the same level for the next five years as they were in 2010 (1.6 million units)[7] and if the five eco car manufacturers do indeed produce 500,000 cars by 2015, then about 30 per cent of all cars produced in Thailand would be eco cars.

Lesson learned

Strict environmental standards can increase industrial competitiveness: Thailand imposed a very strict emissions standard for car manufacturers to qualify for the corporate tax incentives in 2009, requiring a limit of 120 grams of CO_2 per kilometre. In contrast, the European Union standard is 130 grams of CO_2 per kilometre.[8] Such a strict standard has had great impact on increasing the environmental quality of vehicles produced in Thailand. Also, by adhering to stringent standards, manufacturers can easily export to other high-standard markets.

A total capital investment of 69 billion baht was committed to the eco car programme until now, to which about 11,000 jobs are related. The total production capacity amounts to 658,000 cars per year, of which more than 60 per cent are being exported, which is equivalent to 113 billion baht.[9]

[7] Thai Automotive Industry Association website "Vehicle Production: 1990-2011". Available from www.thaiauto.or.th/Records/eng/vehicleproduction_eng.asp (accessed 15 March 2011).

[8] European Union website "CO2 Emission Limits on New Vehicles" (25 March 2008). Available from http://europa.eu/legislation_summaries/internal_market/single_market_for_goods/motor_vehicles/interactions_industry_policies/l28200_en.htm (accessed 27 April 2011).

[9] Vallop Tiasiri, "ECO technology for future vehicles", presented at the Sixth International Conference of Automotive Engineering, Bangkok, 29 March 2010.

Success factor

Involving manufacturers has been the key to success. The Government included manufactures in the policy-making processes, which contributed to their acceptance of the eco car programme. The Government appears to have achieved its objective of attracting foreign investment to facilitate a competitive new product.[10] This shows that even strict environmental regulations are welcome if they are combined with attractive tax incentives. Additionally, there has been no ownership restriction for the programme, enabling 100 per cent foreign-owned companies to benefit.

Table 1: Production plans for the eco car programme in Thailand[11]

Corporation	Plan
Nissan	Started sales of "March" in March 2010 Production plan: 90,000 units for FY2010
Honda	Planning to start sales of "Brio" from May 2011 Sales plan: 40,000 units for the first year
Suzuki Motor Corporation	Planning to start production from March 2012 Production plan: 10,000 by the end of the first year
Mitsubishi Motors	Planning to start sales of "Global Small" in FY2011 Planning to start new factory for "Global Small" in March 2012 Production plan: 150,000 units annually
Toyota	N/A

Considerations for replicating

Adding zest to strict environmental standards by providing attractive tax incentives not only improves the environmental quality of products but also increases industrial competitiveness. It is also useful for attracting investment, fostering industry development and increasing employment.

[10] Interview with Thai Board of Investment, Bangkok, 16 March 2011.

[11] Compiled by United Nations Economic and Social Commission for Asia and the Pacific from the following corporate websites: Nissan website "Nissan Starts Export of the New March" (30 June 2010). Available from www.nissan-global.com/EN/NEWS/2010/_STORY/100630-01-e.html (accessed 30 January 2011); Honda website "Honda Exhibits World Premiere of Honda BRIO Prototype, Honda's New Small Vehicle Developed for Asian Markets at the 27th Thailand International Motor Expo 2010 Global Compact Car from Thailand" (30 November 2010). Available from http://world.honda.com/news/2010/4101130BRIO-Prototype/ (accessed 30 January 2011); Suzuki website "Suzuki starts building automobile plant in Thailand" (2009). Available from www.globalsuzuki.com/globalnews/2009/1124.html (accessed 30 January 2011); Board of Investment, "Mitsubishi Confirms Eco-Car Production in Thailand to Begin by 2011", *Press release*, April 19, 2010. Available from www.boi.go.th/english/download/hot_topic/393/PressRelease-Mitsubishi%20Ecocar.pdf (accessed 30 January 2011).

CASE STUDY

United States' hydrogen economy

Key point

- ***Technologies to produce, store and distribute hydrogen should be further developed, based on investment in R&D and consistent energy policy to strengthen price competitiveness and achieve commercialization.***

There was concern...

The tragic terrorist event of 11 September 2001 propelled the United States to pursue a hydrogen economy as a means to reduce its dependence on oil and oil imports and achieve national energy security.

What was done?

The US president at that time announced a US$1.2 billion Hydrogen Fuel Initiative in 2003 to steadily shift the nation's transportation fuel use from petroleum to clean hydrogen – considered to be a long-term solution for energy needs in the country.[1]

As a long-term vision, the initiative follows four phases: 1) progress in technology, policies and market, 2) transition to the market place, 3) expansion of markets and infrastructure, and 4) realization of the hydrogen vision.[2] The term "hydrogen economy" was first put forward in 1970.[3]

Currently, the United States is focusing on developing technologies by investing in technology R&D.[4] The United States, Canada, Denmark, Germany and Japan are leading the hydrogen fuel cell technology with nationwide fuelling networks.[5]

[1] Tomorrow is Greener website "The Coming Hydrogen Economy" (12 October 2010). Available from www.tomorrowisgreener.com/the-coming-hydrogen-economy (accessed 23 September 2011).

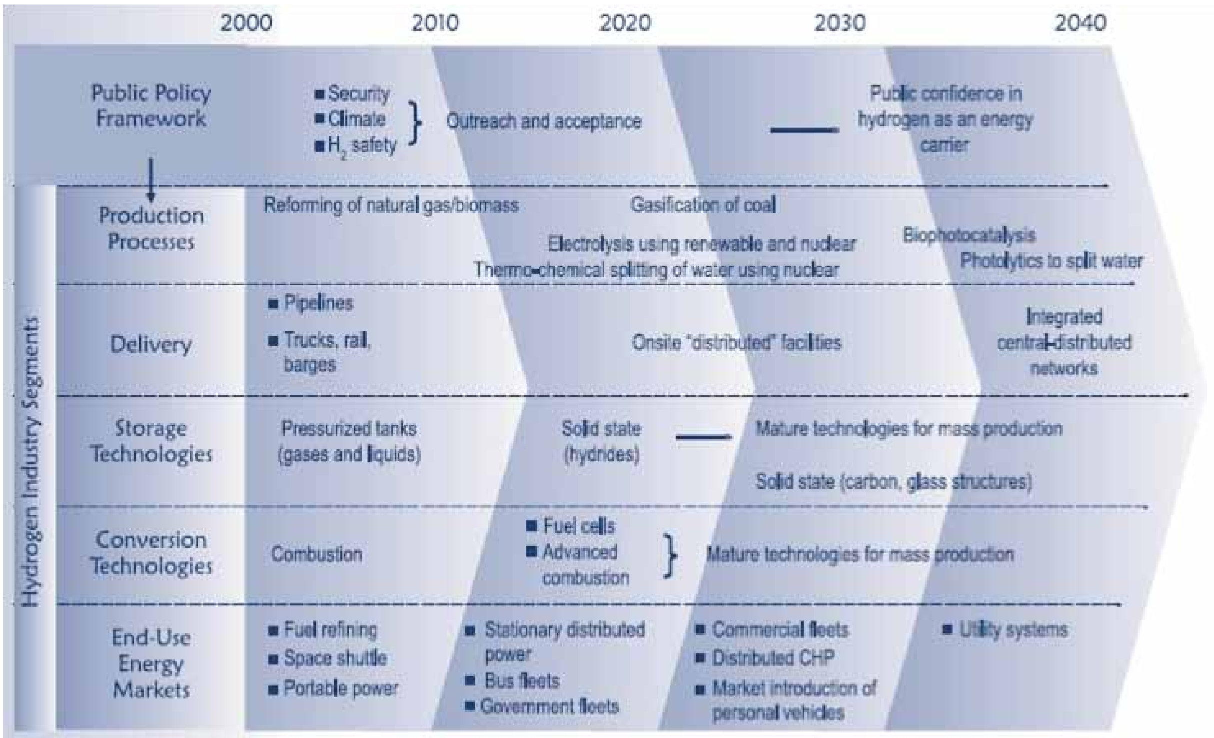
[2] United States of America, *A National Vision of America's Transition to a Hydrogen Economy: To 2030 and Beyond* (Washington, D.C., Department of Energy, 2002). Available from www.hydrogen.energy.gov/pdfs/vision_doc.pdf (accessed 25 September 2011).

[3] During a speech at General Motors Technical Center, John Bockris first publicly used the term "hydrogen economy".

[4] US Department of Energy "Department of Energy Awards Nearly $7 Million to Advance Fuel Cell and Hydrogen Storage Systems Research", *Press release*, 9 August 2011. Available from www.doe.gov/articles/department-energy-awards-nearly-7-million-advance-fuel-cell-and-hydrogen-storage-systems (accessed 23 September 2011).

[5] Inhabitat, "Germany to Create National Hydrogen Fuel Network by 2015", *The Guardian*, 15 September 2009. Available from www.guardian.co.uk/environment/2009/sep/15/germany-hydrogen-fuel-network (accessed 23 September 2011).

Figure 1: Overview of the transition to the hydrogen economy in the United States



Source: US Department of Energy, *A National Vision of America's Transition to a Hydrogen Economy – To 2030 and Beyond* (Washington, D.C., 2002)

Success factors

Hydrogen has potential to majorly mitigate climate change because it emits no greenhouse gas when combusted as fuel. As a non-polluting source of energy, hydrogen leaves no carbon footprint and releases more energy per gram than any other fuel. In addition, there is no threat of oil spills or oil well fires, which devastate the marine nature. As a constituent of water, hydrogen is renewable and is all around.

Considerations for replicating

Hydrogen is considered as one of the least efficient and most expensive substitutes for conventional energy sources, such as fossil fuel. The price issue is a major hurdle.[6] Current technologies to produce, store and distribute hydrogen fuel need to be further developed to ensure price competitiveness.

To realize a hydrogen economy, governments should invest in R&D to develop the technology, considering there are few drawbacks to hydrogen becoming commercially viable. In addition to finding cheaper ways to produce hydrogen, the infrastructure should be ready to support convenient access to hydrogen fuels. Public-private partnerships are crucial in a sense to develop a new vehicle infrastructure and distributed generation systems.[7] Additionally, safety concerns can be overcome through safety controls that engender public acceptability in hydrogen use as a future energy source.

[6] Robert S. Boyd, "Hydrogen Cars May Be a Long Time Coming", *McClatchy Newspapers*, 15 May2007. Available from www.mcclatchydc.com/2007/05/15/16179/hydrogen-cars-may-be-a-long-time.html (accessed 30 September 2011).

[7] US Department of Energy, op. cit.

CASE STUDY

Taking a leading step away from its CO_2 footprint
United Kingdom's carbon budget

Key point

- ***The United Kingdom provides an innovative example of a nationally led effort to reduce CO_2 emissions through carbon budgets.***

There was courage to change and to be the first…

In 2008, the UK Parliament passed legislation that introduced the world's first long-term legally binding framework that required at least an 80 per cent slash in greenhouse gas emissions by 2050 and 34 per cent by 2020. The law also required the United Kingdom to establish and, as of 2009, adhere to a carbon budget – a cap on the total quantity of greenhouse gas emissions over five-year periods, the first in the world as well. The law also set up a Committee on Climate Change (CCC) – the first of its kind and an independent but statutory body of experts to advise the Government on the level of carbon budgets and on where cost-effective savings could be made. The CCC brings together expertise from the fields of climate science and policy, economics, business competitiveness and financial management.[1]

Under a system of carbon budgets, every tonne of greenhouse gas emitted between the start point and 2050 is counted, and a country needs to achieve corresponding reductions in each period of time.

What was done?

In its December 2008 report, the CCC advised on the level of the first three carbon budgets for three five-year periods. The first budget (2008–2012) set maximum net emissions at 3 billion tonnes of CO_2 equivalent, a 22 per cent reduction from the 1990 levels. The second budget (2013–2017) limits emission to 2.78 billion tonnes of CO_2 equivalent, a 28 per cent reduction, and the third budget (2018–2022) restricts emissions to 2.54 billion tonnes of CO_2 equivalent, a 34 per cent cut.[2] In proposing those levels, the CCC followed the European Union framework and produced two sets of budgets: an interim budget, to apply before a second global agreement on greenhouse gas emissions (following the Kyoto Protocol) are reached, and an intended budget to apply after a global deal is reached. Both sets of budgets are designed to apply to all greenhouse gases rather than just CO_2.

The interim budget will require an annual average emissions reduction of 1.7 per cent over the first three budget periods. The intended budget requires an emissions reduction of 42 per cent relative to 1990 and 31 per cent relative to 2005 in 2020. This will require an annual average emissions reduction of 2.6 per cent over the first three budget periods.[3]

As if that commitment was not staggering enough, in May 2011 the UK Government announced an unprecedented fourth carbon budget (2023–2027) (set in law at the end of June 2011) to halve the 1990 levels of CO_2 emissions by 2027.[4]

[1] United Kingdom, Department of Energy and Climate Change website "Climate Change Act 2008". Available from www.decc.gov.uk/en/content/cms/legislation/cc_act_08/cc_act_08.aspx (accessed 4 March 2012).

[2] *World Nuclear News*, "UK Proposes Fourth Carbon Budget" (May 19 2011). Available from www.world-nuclear-news.org/EE-UK_proposes_fourth_carbon_budget-1905114.html (accessed 17 November 2011).

[3] Committee on Climate Change website "1st to 3rd Carbon Budgets". Available from www.theccc.org.uk/carbon-budgets/1st-3rd-carbon-budgets-2008-2022 (accessed 21 November 2011).

[4] Committee on Climate Change website "Carbon Budgets". Available from www.theccc.org.uk/carbon-budgets (accessed 21 November 2011).

The UK Low Carbon Transition Plan

To achieve the challenging targets and move towards a low-carbon economy, the Government announced the Low Carbon Transition Plan, which details emissions cuts by sector. It proposes that half of the required cuts in emissions by 2020 will come from power and heavy industry, 20 per cent from transport, 15 per cent from homes, 10 per cent from workplaces and 5 per cent from agriculture. It is also expected to create 1.2 million new green jobs and provide 1.5 million households with support to produce their own renewable energy. Estimations indicate that the entire plan will save about 715 million tonnes of CO_2 and orient the United Kingdom towards fulfilling the first three of its carbon budgets.[5] The Low Carbon Transition Plan sets emission reduction targets and defines action areas by sector:[6]

- **Power sector and heavy industry:** The plan aims to cut emissions by 22 per cent from 2008 levels by 2020 by producing around 30 per cent of electricity from renewable sources and helping to build nuclear power stations.
- **Homes:** The plan aims to cut emissions by 29 per cent of the 2008 levels by investing money to help households become energy efficient, distributing smart metres and introducing clean energy cash-back schemes.
- **Transport:** 14 per cent of the 2008 level of emissions from domestic transport is going to be cut by tightening emission standards for new cars and by investing money in electric and plug-in hybrid cars, recharging infrastructure and low-carbon bus technology.
- **Workplaces:** 13 per cent of emissions in comparison to the 2008 levels are expected to be reduced by creating jobs in the low-carbon industry.
- **Farms:** The plan will also look to reduce farming and waste emissions by 6 per cent of the 2008 levels.

The Carbon Plan

The Carbon Plan (December 2011) is a package of measures to ensure that the United Kingdom achieves its emissions reduction targets in the first four carbon budgets and is securely headed towards its 2050 target. The Carbon Plan explains "how the UK will achieve decarbonisation within the framework of [their] energy policy: to make the transition to a low carbon economy while maintaining energy security, and minimizing costs to consumers, particularly those in poorer households."[7]

The details cover specific actions by sector – such as low-carbon buildings, transport, industry, electricity, agriculture, land use, forestry and waste. With electricity generation, for instance, it touches on how to shift away from fossil fuels to renewable, for heating of homes and buildings it explains how to better insulate and use low-carbon energy alternatives and for road transportation, it talks of how to provide better public transport and electric vehicles. The country's Green Investment Bank will support innovations in green technologies for de-carbonizing the power, buildings and road transport sectors – partly based on the belief that early investment in technological options will reduce costs for deploying technologies in 2020 and at the same time improve the competitiveness of UK industries.[8]

Costs and financing

The CCC estimated the cost of meeting the four carbon budgets at less than 1 per cent of its GDP and the cost of meeting the 2050 target between 1 and 2 per cent of GDP.[9] Given the relative capital intensity of low-carbon

[5] United Kingdom, *The UK Low Carbon Transition Plan: National Strategy for Climate and Energy* (London, HM Government, 2009). Available from http://www.decc.gov.uk/assets/decc/White%20Papers/UK%20Low%20Carbon%20Transition%20Plan%20WP09/1_20090724153238_e_@@_lowcarbontransitionplan.pdf (accessed 12 March 2012).

[6] Felicity Carus, "The Low Carbon Transition Plan at a Glance", *The Guardian*, July 15 2009. Available from www.guardian.co.uk/environment/2009/jul/15/renewableenergy-carbon-emissions (accessed 21 November 2011).

[7] United Kingdom, *Carbon Plan: Executive Summary* (London, Department of Energy and Climate Change, 2011). Available from www.decc.gov.uk/assets/decc/11/tackling-climate-change/carbon-plan/3751-carbon-plan-executive-summary-dec-2011.pdf (accessed 12 March 2012).

[8] United Kingdom, *Carbon Plan* (London, Department of Energy and Climate Change, 2011). Available from www.decc.gov.uk/assets/decc/What%20we%20do/A%20low%20carbon%20UK/1358-the-carbon-plan.pdf (accessed 27 February 2012).

[9] Committee on Climate Change website "Costs & Opportunities". Available from www.theccc.org.uk/carbon-budgets/economics-a-impacts/costs-a-opportunities (accessed 21 November 2011).

technologies, the investment costs to meet carbon budgets are estimated to reach up to £16 billion annually by 2030, with £10 billion on electricity generation.[10] Several programmes were set up to finance the carbon budget scheme. An Environmental Transformation Fund and a Low Carbon Investment Fund were set up as incentives for companies; the funds offered financial support for the research and development of low-carbon technologies and helped in commercializing.[11] The Low Carbon Buildings Programme provided grants for the funding and installation of micro-generation technologies.[12] These three funding mechanisms were all closed to allocation by 2011. The Enhanced Capital Allowances, in contrast, is a tax exemption scheme allowing businesses to claim 100 per cent first-year capital allowances on their spending on qualifying plant and machinery and is still in place.[13]

Policy path leading to carbon budgets

The UK Government became an early player in the low-carbon field, making its early adoption of the carbon budget not too much of a surprise. The following highlights three early milestones:

- **Renewable Transport Fuel Obligations Act:** Implemented in 2008, it was designed to ensure that at least 5 per cent of all fuel used for road transportation came from renewable sources by 2010.[14]
- **Code for Sustainable Homes:** Officially launched in 2006, it is a voluntary environmental impact and sustainability rating system for residential properties, aiming for a reduction in the environmental impact of housing and setting minimum standards for the design and construction of new homes.[15]

Results

British Prime Minister David Cameron noted, "The transition to a low-carbon economy is necessary, real, and global. By stepping up, showing leadership and competing with the world, the UK can prove that there need not be a tension between green and growth."[16]

Developing and implementing carbon budgets are expected to bring the United Kingdom many significant opportunities. The global market for environmental goods and services is already lucrative, thus presenting a great incentive for the country to become a leader in the production of low-carbon goods and services. The Government is expecting co-benefits from policies to reduce carbon emissions, such as reduced reliance on imported gas and oil, reduced local air pollution through low-carbon vehicles and renewable energy sources and increased health benefits.

[10] ibid.

[11] United Kingdom, Department of Energy and Climate Change website "Historic Funding". Available from www.decc.gov.uk/en/content/cms/funding/funding_ops/innovation/historic/historic.aspx (accessed 5 March 2012).

[12] United Kingdom, Department of Energy and Climate Change website "Low Carbon Buildings Programme". Available from www.decc.gov.uk/en/content/cms/funding/funding_ops/innovation/historic/buildings_prog/buildings_prog.aspx (accessed 12 March 2012).

[13] United Kingdom, Department of Energy and Climate Change website "Enhanced Capital Allowances". Available from www.decc.gov.uk/en/content/cms/emissions/ecas/ecas.aspx (accessed 12 March 2012).

[14] Karen Ellis, Bryn Baker and Alberto Lemma, *Policies for Low Carbon Growth* (London, Overseas Development Institute, 2009). Available from www.odi.org.uk/resources/docs/5570.pdf (accessed 26 February 2012).

[15] United Kingdom, *Code for Sustainable Homes: A Step-Change in Sustainable Home Building Practice* (London, Department for Communities and Local Government, 2006). Available from www.planningportal.gov.uk/uploads/code_for_sust_homes.pdf (12 March 2012).

[16] United Kingdom, Department of Energy and Climate Change, "UK Proposes Fourth Carbon Budget", *Press release*, No. 11/041, May 17, 2011. Available from www.decc.gov.uk/en/content/cms/news/pn11_41/pn11_41.aspx (accessed 12 March 2012).

Considerations for replicating

Developing a carbon budget is a complicated process, requiring:

- Legally established short-, medium- and long-term greenhouse gas emissions target and goals
- Timetables for reducing emissions to achieve medium- and long-term targets
- A transition plan and strategies
- Specific measures and actions to reduce greenhouse gas emissions
- Sector-based plans
- Investment plans.

CASE STUDY

Addressing Competitiveness in introducing ETR
United Kingdom's climate change levy

Key point

- ***The UK Government introduced an energy tax targeting business and commercial users and a concessionary tax reduction scheme to address competitiveness concerns of energy-intensive industries***

Background

Rising oil prices and worsening carbon impacts on the environment raised concerns in the United Kingdom, as in many other countries. Addressing these challenges and in response to its 1992 agreements during the United Nations Conference on Environment and Development, the Government launched in 2000 a climate change programme that committed the country to reducing its CO_2 emissions by 20 per cent of its 1990 levels by 2010.

What was done?

The United Kingdom's climate change levy (CCL) was announced in 1999, legislated in 2000 and finally adopted in April 2001. The CCL is a tax on energy use, which embraces the supply of specified energy products as fuel used by business consumers in industry, commerce, agriculture and public administration. It is not a carbon tax and cannot be applied to taxable commodities supplied for use by domestic consumers, charities or the transportation sector. The four groups of taxable energy products are electricity, coal and lignite products, liquid petroleum (LPG) and natural gas when supplied by a gas utility.[1]

Complementing the levy is a national climate change agreement (CCA) that allows energy-intensive industrial sectors to reduce the amount of CCL they pay, given their energy use and their need to compete internationally. The CCA is a concessionary tax reduction scheme aiming to address competitiveness concerns of energy-intensive industries and to make the introduction of the levy more feasible. The CCL and CCA were developed in parallel with the UK Emissions Trading Scheme (ETS), which allows CCA holders who overachieve their targets to sell the abundant allowances. The UK ETS was started in April 2002 and stopped accepting direct participants in 2006, although current participants can still trade allowances through a registry.[2]

The CCA is a flexible mechanism for individual industrial sectors to negotiate with the Government over sector-specific targets of energy-efficiency improvement or greenhouse gas reduction. As a result, eligible energy-intensive industries can obtain up to 65 per cent discount from the climate change levy, on condition that they meet agreed targets in energy-efficiency improvements or carbon emissions reductions.[3]

Scope

Because the CCL focuses only on energy use and not on greenhouse gas emissions, it charges a tax on energy delivered to business users. Domestic or non-commercial users as well as charities and some small businesses

[1] United Kingdom of Great Britain and Northern Ireland, HM Revenue and Customs website "Climate Change Levy-Introduction". Available from http://customs.hmrc.gov.uk/channelsPortalWebApp/channelsPortalWebApp.portal?_nfpb=true&_pageLabel=pageExcise_InfoGuides&propertyType=document&id=HMCE_CL_001174 (accessed 14 March 2012).

[2] United Kingdom of Great Britain and Northern Ireland, *The UK Emissions Trading Scheme: A New Way To Combat Climate Change* (London, National Audit Office, 2004). Available from www.nao.org.uk/publications/0304/uk_emissions_trading_scheme.aspx (accessed 14 March 2012).

[3] United Kingdom of Great Britain and Northern Ireland, Department of Energy and Climate Change website "Climate Change Agreements". Available from www.decc.gov.uk/en/content/cms/emissions/ccas/ccas.aspx (accessed 14 March 2012).

(users of small quantities of fuels) do not have to pay. Specifically, the scope of the CCL covers electricity, natural gas, coal, coke and LPG used for energy generation. In addition, gas used as chemical feedstock or for transport and electricity generated from alternative energy sources are not subject to the levy. The climate change levy is charged at a specific rate per unit of energy. Each of the four categories of taxable commodity has its separate rates which are based on the energy content and expressed in kilowatt-hours (kWh) for gas and electricity and in kilograms for all other commodities. Levy rates were frozen from 2001 to 2007 but have increased since then in line with inflation.

Table 1: History of taxable commodity rates

Taxable commodity	Rate from 1 April 2008	Rate from 1 April 2011	Rate from 1 April 2012
Electricity	£0.00456 per kW hour	£0.00458 per kW hour	£0.00509 per kW hour
Gas supplied by a gas utility	£0.00159 per kW hour	£0.00169 per kW hour	£0.00177 per kW hour
Petroleum gas or other gaseous hydrocarbon	£0.01018 per kg	£0.01083 per kW hour	£0.01137 per kW hour
Any other taxable commodity	£0.01242 per kg	£0.01321 per kg	£0.01387 per kg

Source: ESCAP adapted from other sources: United Kingdom of Great Britain and Northern Ireland, HM Revenue and Customs website "Climate Change Levy-Changes to Rates". Available from http://customs.hmrc.gov.uk/channelsPortalWebApp/channelsPortalWebApp.portal?_nfpb=true&_pageLabel=pageExcise_InfoGuides&propertyType=document&id=HMCE_PROD1_027235 (accessed 14 March 2012); United Kingdom of Great Britain and Northern Ireland, HM Revenue and Customs website "Climate Change Levy Rates from 1st April 2011". Available from http://customs.hmrc.gov.uk/channelsPortalWebApp/channelsPortalWebApp.portal?_nfpb=true&_pageLabel=pageExcise_ShowContent&id=HMCE_PROD1_031183&propertyType=document (accessed 14 March 2012).

Climate change agreements

The climate change agreement is a policy measure that is designed to address competitiveness impacts for energy-intensive sectors produced by the levy. Businesses that sign a CCA are eligible to receive a tax discount up to 65 per cent (35 per cent tends to be the norm) if they meet agreed-upon energy efficiency or greenhouse gas emissions reduction targets. The CCA covers a range of industry sectors, from major energy-intensive processes such as known in steel, chemical and cement sector, to agricultural businesses as intensive pig and poultry rearing. The two-tier structure of the CCA allows either an agreement between the Government and a specific sector (umbrella agreement) or between the Government and a specific facility operator (underlying agreement). Upon signing an umbrella agreement, which is negotiated on a sector-by-sector basis between the secretary of state and industry sector associations (aluminium, cement, paper, etc.) or an underlying agreement for individuals, a business receives a discount on the energy tax.

From the beginning of the levy till 1 April 2011, the reduced tax rate for participants of the CCA was 20 per cent (an 80 per cent discount). Beginning in April 2011, that rate increased to 35 per cent. The current CCA scheme was originally to end in March 2013, but has since been extended to 2023 and the rates will return to 20 per cent after the current scheme ends.[4] This extension will provide the industry with more certainty to invest in energy-efficiency measures with longer payback periods, enabling the 54 participating sectors to continue their eligibility for the scheme and levy discount.

Measures to increase political feasibility

The details of the CCL design are attributed to specific considerations of the UK Government at the time. As noted, the Labour Government in 1997 was hesitant to impose value-added taxes in the household sector, and policymakers did not want to introduce income regressive taxes and increase the burden on the poor.

[4] United Kingdom of Great Britain and Northern Ireland, *Climate Change Levy: Reform of Climate Change Agreements* (London, HM Revenue and Customs, 2011). Available from www.hmrc.gov.uk/budget2011/tiin6125.pdf (accessed 15 March 2012).

Energy taxes on households are generally income regressive because the poor spend a greater proportion of their disposable income on energy. This can explain why the UK Government limited the energy tax to the actual scope, choosing to tax businesses rather than households.

At the same time, the Government wanted to engage industry and shed a reputation of "high tax and high public spending". In addition, there were concerns of how the levy would affect the competitiveness of industry that has high energy costs, which were addressed by the CCA – a flexible mechanism for emissions reductions.[5]

Revenue recycling and revenue neutrality

The CCL was also designed to recycle the revenue by matching it with a 0.3 per cent reduction in employers' national insurance contributions (the National Insurance Fund provides such benefits as unemployment insurance and retirement pension).[6] In addition, by targeting and lowering the labour tax, the Government aimed to encourage employment. The policy was supposed to achieve revenue neutrality, but according to the National Audit Office, from 2001 to 2007, the CCL was actually revenue negative, meaning the revenue collected through the levy was less than reductions in national insurance contributions.[7]

Results

The CCA in combination with the CCL have resulted in positive impacts on emissions reductions. While its economic impacts are still to be further proven and discount rates to be made more stringent, the CCA has generated "awareness impacts" among industries that have led to broader innovation and other economic benefits.

Environmental impacts

The CCL and CCA are widely recognized as having reduced greenhouse gas emissions in the United Kingdom. The two mechanisms are the second and third most significant climate change policies, respectively, in the United Kingdom. The CCL and CCA are estimated to have reduced 3.5 and 1.9 MtC in 2010, when compared with a business-as-usual scenario. Only the European Union's Emission Trading System (EU ETS) has contributed to greater carbon savings, with the second phase of the EU ETS projected to have saved 8.0 MtC in 2010.[8]

Research indicates the CCA generated additional emissions savings in terms of raising awareness among industry management in what has been labelled an "announcement effect" or "awareness affect." This effect is said to have a bigger impact on emissions reductions than what only a CCL might have generated.

Innovation impacts

The research also demonstrates that the energy tax resulted in increased innovative activity. There has been a marked increase in the United Kingdom in the area of patents regarding climate change and energy efficiency. However, this evidence also found that businesses that were subjected to the full CCL were 16 per cent more likely to innovate than their CCA counterparts.

Economic impacts

The research suggests that the impact of the CCL and CCA on international competitiveness is currently inconclusive. GDP and employment were slightly higher and average industrial costs were lower (due to national insurance reductions and the revenue negative aspect of the tax), although the balance of payments were slightly

[5] The Organisation for Economic Co-operation and Development Environment Programme, *The United Kingdom Climate Change Levy: A Study in Political Economy* (Paris, 2005). Available from www.oecd.org/dataoecd/54/41/34512257.pdf (accessed 17 November 2012).

[6] United Kingdom of Great Britain and Northern Ireland, HM Revenue and Customs website "National Insurance and state benefits". Available from www.hmrc.gov.uk/ni/intro/benefits.htm (accessed 12 March 2012).

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"For more details of EU ETS, see a case study: EU ETS of this Roadmap.

negative. Neither companies that paid the full CCL nor companies in CCAs seemed to be significantly affected by competitiveness impacts in terms of job losses, output or productivity. Thus, in light of the overachievement of targets, it appears that the CCL and CCA increased competitiveness because businesses were able to cost-effectively reduce their energy use. In addition to these benefits, the administrative costs of the levy have been small – an important characteristic for an efficient tax.[9]

Lessons learned

Matching CCL with the carbon content of fuels: One criticism of the CCL is that there is a perverse incentive due to the tax not being related to the carbon content of the fuel. The following table shows the rates of the CCL on different fuel types for the period 2001–2010. It shows that coal is levied, with respect to carbon emissions, at a rate that is equivalent to approximately £16 per tonne carbon, while natural gas and electricity are taxed at a rate nearly twice as high.[10]

Fuel type	Tax rate	Fuel price	Implicit carbon tax
	GBP per kWh		GBP per tonne carbon
Electricity	0.0043	0.0425	31
Coal	0.0015	0.0246	16
Gas	0.0015	0.0091	30
LPG	0.0007	0.0085	22

Source: Organisation for Economic Co-operation and Development, *The Political Economy of Environmentally Related Taxes* (Paris, 2010).

This may have an effect on incentivizing businesses to switch to a more polluting fuel, like coal. However, the carbon content of the source of electricity generation is not considered, so generators are not inclined to change to lower carbon fuels. Matching the carbon content of fuels with the levy rate would provide an incentive for businesses to switch to lower carbon fuels.

More stringent CCA targets: Research seems to show that the negotiated CCA targets were too lax because there has been wide success meeting the targets as well as some cases of "overcompliance."[11] Sectors were allowed to choose their own baseline years. As a result, more than two thirds of the sectors chose baseline years of 1999 or earlier, meaning that any emissions reduction that had occurred before the policy was instituted could be applied to the CCA targets. In the first target period, 88 per cent of units met their targets. In the second and third periods, 98 per cent and 99 per cent of units, respectively, met their targets.[12] In fact, 15 of 40 industrial sectors met their 2010 targets by 2002. On top of that, businesses missing their targets were able to use the UK ETS to purchase allowances and thus were not strongly motivated to transform industry processes towards more efficient energy use.

One explanation for this overachievement may be that the CCA process allows managers to find cost-effective measures to meet their targets. In the best case, this would mean that there is indeed great opportunity for energy efficiency improvements. Another explanation may simply be that in certain sectors, industrial managers with better knowledge about their own business were able to convince outside parties (Government) that "cost-effective measures were limited" and then went on to prove themselves wrong.[13] Stronger or more stringent targets may in fact improve the environmental and economic benefits.

[9] ibid.

[10] Organisation for Economic Co-operation and Development, *Taxation, Innovation and the Environment* (Paris, 2010).

[11] The Organisation for Economic Co-operation and Development Environment Programme, *The United Kingdom Climate Change Levy: A Study in Political Economy* (Paris, 2005). Available from www.oecd.org/dataoecd/54/41/34512257.pdf (accessed 17 November 2012).

[12] Organisation for Economic Co-operation and Development, *Taxation, Innovation and the Environment* (Paris, 2010).

[13] Paul Ekins and Ben Etheridge, "The environmental and economic impacts of the UK climate change agreements" *Energy Policy* (2006), No. 15, pp. 2071-2086.

CCA versus full CCL: The argument has been made that a CCA is inefficient and that it renders the CCL less beneficial, both economically and environmentally, when coupled together in a scheme. Economic theory says that discounting the CCL rate for some sectors in essence increases the tax for others and increases costs for the entire economy.[14] On the other hand, some research has shown that the CCA in fact enhanced the environmental benefits and emissions reductions over a situation without a CCA, due to the awareness effect and the financial incentive for eligible industries.[15] As pointed out, the awareness effect may have incited managers to more actively seek cost-effective energy-efficiency measures, something that the tax may not have done. In addition, it is useful to think about whether a levy would have been politically feasible in the absence of such a policy as a CCA.[16]

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15 ibid.

16 ibid.

CASE STUDY

Innovative financing
United Kingdom's Green Deal and the United States' Property Assessed Clean Energy

Key point

- ***Innovative financing mechanisms, such as the Green Deal and the Property Assessed Clean Energy, can significantly lower the upfront financial burdens for consumers by aligning the payment for retrofitting projects according to incremental gains.***

There was a problem…

Refurbishing old and energy-inefficient buildings is a great concern in many countries. In the United Kingdom, single-family houses, which are more energy consuming compared with apartments, account for 85 per cent of total housing.[1] Although the economic gains from improving the efficiency of existing buildings are bigger than the costs, the retrofitting market is still very limited due to several obstacles. Upfront costs can be the biggest hurdle, especially for the residential sector, given that the economic returns are incrementally delivered. In addition, the risks associated with the retrofitting projects can be a barrier for both house owners and finance institutions to invest in efficiency gains.

What was done?

The United Kingdom and the United States of America are making a strong move towards energy-efficient buildings by introducing innovative financing schemes to scale up building retrofitting projects.

Green Deal in the United Kingdom

The UK Government plans to launch the Green Deal programme in October 2012 to finance retrofitting residential buildings, ranging from wall insulation to loft insulation, boiler upgrades and installation of ground source heat pump and solar panel. Currently 500 demonstration projects, known as Pay As You Save (PAYS), are being used to prepare for the introduction of the scheme. The Green Deal provides loans of up to £10,000 through private financing to cover the upfront costs for retrofits to households on the basis of the level of energy savings projected. The repayment levies on their utility bills, according to the saving up to 25 years and the obligation to repay, is tied to the energy bill of the property. Since this is not a personal loan or an advance payment scheme, once the homeowners move, the liability remains with the next inhabitants of the property. The UK Government plans to embrace 14 million households by 2020 involving £100bn and expects to create up to 65,000 jobs by 2015.[2]

Property Assessed Clean Energy programme in the United States

The Property Assessed Clean Energy, or PACE, programme is a property-secured financing mechanism for clean energy projects, including energy efficiency retrofit and installation of renewable energy for residential and commercial buildings. First introduced in the city of Berkeley, California in 2009, it has been adopted to finance relatively large-scale retrofitting projects in more than 27 states. Local governments are responsible for mobilizing finance, for instance through issuance of bonds, to fund retrofitting projects. The loans are provided based on

[1] Paul Ekins and others, *The KfW Experience in the Reduction of Energy Use in and CO2 Emissions from Buildings: Operation, Impacts and Lessons for the UK* (London, UCL Energy Institute, University College London and LSE Housing and Communities, London School of Economics, 2011).

[2] *BBC Business News*, "UK Government's Green Deal to Cut Fuel Bills", November 23, 2011.

the property assessment (including clean property title and tax payment records) and repaid over 20 years through a special tax, property tax (assessment) or through utility bills.[3] The financing is secured with a lien on the property, and in the event of foreclosure, the energy financier is paid before other claims against the property.

Despite the economic and environmental benefits, the residential programme was halted in July 2010 (commercial financing where exists is still operational) due to conflict over controlling mortgages from homes with PACE assessment between the Federal Housing Finance Administration and the Department of Energy. State governments and environmental advocates are currently seeking to revive the residential PACE programme.[4]

Advantages of such programmes

Such programmes enable building owners to pay back loans incrementally as the benefits from building retrofitting are accrued, thereby lowering upfront financial burdens.

Because the responsibility for repaying loans are attached to the property, more people can invest in the long-term efficiency gains without the concern that they may end up with paying the costs while the benefits are taken by the other inhabitants. Under both the UK and American schemes, if the property is sold before the end of the repayment period, the new owner inherits both the remaining repayment obligation and the financed energy improvements.

Table 1: Comparing Green Deal and PACE

	Green Deal	**PACE**
Target	Individual homeowners	Muitifamily residential (greater than four units), commercial and industrial buildings
Type of services provided	• Commercial loans to cover upfront costs • Technical assistant by accredited adviser and installer • Extra help provided by and energy service companies (ESCO) (from 2013) for lower income households and costly projects	• Preferential loans to cover upfront costs
Repayment obligation is secured through	The payment of energy bills, rather than against ownership of the property.	Ownership of the land
Motivation for participation	• Landlords are mandated to comply with minimum energy performance criteria. • Measure to protect home owners: energy saving must be greater the repayment charge on the bills (according to 'the golden rule')	• Lower interest rate • Tax benefits (tax-deductible interest payments) • Easier application process than applying for a second mortgage
Role of government	• No government subsidies on the interest rates • Set up legal framework and coordination among utilities company, home owners and finance institutions	• Mobilize finance • Set up legal framework and coordination among utilities company, home owners and finance institutions

[3] United States of America, *Property-Assessed Clean Energy (PACE) Programs* (Washington D.C., Department of Energy, 2011). Available from www1.eere.energy.gov/wip/solutioncenter/financialproducts/pace.html (accessed 31 January 2012).

[4] Bethany K Speer, "Residential PACE Halted: Senior Lien a No-Go with Fannie Mae and Freddie Mac", *Renewable Project Finance of the National Renewable Energy Laboratory*, July 26 2010. Available from https://financere.nrel.gov/finance/content/residential-pace-halted-senior-lien-no-go-fannie-mae-and-freddie-mac (accessed 8 February 2012).

Challenges to innovative financing

- **Complicated procedures:** Procedures for financing programmes may be too complicated to understand for many homeowners and lenders.

- **Certain level of financial and institutional capacity required:** The new financing schemes require governments' capacities to handle complexity and risks related to the operation of scheme. Governments need to coordinate among financing institutions, local authorities, utilities companies, ESCOs and building owners; clear standards and procedure should be set up and billing process should be reformed.

- **Increased risks associated with the property:** The PACE programme has experienced strong resistance from household lenders against adding additional risk to residential mortgages. In the case of foreclosure within the PACE programme, the property tax assessment is prioritized over private liens. Public funding jointly established with local municipalities can be used to address the homeowner and lender concerns over that priority. Though the Green Deal is not a property-secured financing scheme, potential buyers and tenants can be reluctant to choose the house under the scheme due to the concerns of additional charge on the utility bill as well as uncertainty on the savings.[5]

Lessons learned

Simplify the procedures for the sake of building owners to increase their uptake: The Green Deal will streamline the procedure for the convenience of homeowners by providing a combination of services ranging from assessment to installation and financing in a kind of one-stop procedure.

Support by governments in the initial stage makes a difference: Governments' financial as well as institutional assistance can be instrumental until the energy-efficiency projects obtain commercial viability. For example, the UK Government will set up a Green Investment Bank to finance green projects, including domestic energy efficiency, during the first stage of its Green Deal implementation.[6]

Piloting helps design the details of the full-fletched scheme to maximize the benefits: Without a well-established institutional set-up, the provision of financial and technical assistances with numerous individual households can induce huge transaction costs. The Green Deal was tested as a pilot project with a limited number of households and the PACE was scaled up after its initial success in California. Learning from its early experiences, the PACE is currently focusing on financing relatively large-scale projects to ensure the cost-effectiveness.

Address concerns for low-income households: Impoverished household's difficulty in accessing fuel due to their poverty conditions is a significant social concern. Currently, PAYS is supported by Warm Front, a UK Government-funded programme that works to upgrade the energy efficiency of vulnerable households. Within the programme, eligible households qualify for annual winter fuel payments. The local energy company will replace Warm Front as of April 2013 as part of a government obligation to reduce greenhouse gas emission by upgrading the energy efficiency of low-income and vulnerable households. The energy company's obligation is expected to supplement the Green Deal by subsidizing the upfront investment of basic heating systems or insulation of low-income and vulnerable households to heat their houses to a suitable level.[7]

[5] *BBC Business News*, "UK Government's Green Deal to Cut Fuel Bills", 23 November 2011.

[6] HM Government, *Update on the Design of the Green Investment Bank* (London, Department for Business Innovation and Skills, 2011). Available from www.bis.gov.uk/assets/biscore/business-sectors/docs/u/11-917-update-design-green-investment-bank.pdf (accessed 24 February 2012).

[7] David Hough, Paul Bolton and Patsy Richards, "Water Front Scheme", Commons Library Standard Note (London, 2012). Available from www.parliament.uk/briefing-papers/SN06231 (accessed 9 March 2012).

Considerations for replicating

Substantial building energy savings can be realized in Asian and Pacific countries by improving existing inefficient buildings. Studies show that current building energy consumption could be cut by 25 per cent in China and India with cost-effective improvements in energy efficiency.[8]

- **Data collection, objective measurement and evaluation of the energy-saving performance:** The central government should closely coordinate with local governments in compiling data on the energy-saving performance of building improvement projects, ensuring objective measuring by competent assessors and evaluating the energy saving performance results.

- **Preparing clear home improvement standards and taking quality assurance measures:** Having clear standards is a precondition for implementing a financing programme. Standards and guidance should be kept up to date according to building technology development to ensure that contractors continually improve their awareness of what can be done.

- **Raising public awareness:** Information about the financing programme, including its financial and environmental benefits, should be clearly explained to homeowners, tenants and the industry players. In addition, advices and education for behaviour change can be provided in parallel with retrofitting projects, considering the responsibility to repay the costs ultimately remains with house owners.

- **Incentivizing landlords in private rented houses:** Building retrofits should not be limited to owner occupiers but it also needs to be extended to rented homes. However, landlords often lack motivation to invest in improving energy efficiency in their properties as they do not get direct benefits. The Green Deal intends to enable local authorities to mandate that landlords of the poor-energy performing properties, certified low grade via the energy performance certificate, apply energy efficiency measures without any upfront costs.[9]

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[8] Joe Huang and Joe Deringer, *Status of Energy Efficient Building Codes in Asia: China, Hong Kong, Taiwan, Japan, Korea, Malaysia, Philippines, Singapore, Thailand, India* (Hong Kong SAR, Asia Business Council, 2007).

[9] United Kingdom, *The Green Deal: A Summary of the Government's Proposals* (London, Department of Energy and Climate Change, 2010).

CASE STUDY

Taxing plastic bags and other pollutants
Viet Nam's Environmental Protection Tax Law

Key points

- ***Viet Nam is introducing a tax reform to green its taxation practices towards achieving a more sustainable and greener path of development.***
- ***Introduction of the Law was based on a careful preparation including preliminary impact analysis and technical support of international organizations. For effective reform, careful designing on the taxation and revenue recycling structure is important.***

There was a problem…

With rapid economic growth raising energy and resource consumption, the Vietnamese Government recognized its development path could not cope in the long term without changes to its trajectory.

What was done?

The Government included a greater emphasis on environmental conditions into its growth plan in the past decade. This involved establishing legal institutions and a policy framework for more sustainable growth and development: the Ministry of Natural Resources and Environment was created and a fiscal decision was embraced to allocate 1 per cent of the state budget for environmental protection expenditure.

In November 2010, the National Assembly of Viet Nam passed the Environmental Protection Tax Law (with 98.7 per cent of the votes), which entered into force on 1 January 2012. For drafting the law, the Ministry of Finance consulted the German GIZ (Deutsche Gesellschaft fűr Internationale Zusammenarbeit GmbH) for technical advice. The new law taxes a range of environmentally harmful activities and substances. The Environment Protection Tax is an indirect tax that applied to the production and importation of certain goods, including petroleum products, and calculated as an absolute amount on the quantity of the goods.

Energy is largely targeted in the form of different types of fuels, with coal and refined fuels accounting for 99.5 per cent of the taxes. The taxable objects include refined fuels, such as gasoline, diesel, mazut, paraffin and kerosene, coal, hydrochlorofluorocarbon (HCFC) substances, plastic bags and a subset of harmful chemical substances used in agriculture and forestry. New revenues generated by the taxes are to be recycled through environmental programmes, although the details on how this will be done have not yet been specified.

Expected results

Two economic modelling exercises have been completed to assess the outcomes of the new law. A computable general equilibrium model by Willenbockel of the Institute of Development Studies (2010) projects that CO_2 emissions will drop by 2.3–7.5 per cent, depending on the tax rate. He also projects that the impact of a low level tax will result in welfare loss that is equivalent to a 0.66 per cent loss of household income for consumption of private goods. The impact analysis on the welfare of the households (defined as consumption of private goods) indicates that the law is not strictly income regressive. These findings need to be considered with caution because the model does not take into account welfare gains resulting from the Government's revenue recycling policies and actions and their increased beneficial environmental impacts.

Another economic general equilibrium modelling exercise by Coxhead and Chan (2011) projects that GDP growth will be reduced by 0.34 per cent and the consumer price index will increase by 0.44 per cent, benefiting the poor in some cases. The study notes that these findings, however, will not lead to a conclusion that the law is going to be a threat to the economic development of Viet Nam because the modelling neither includes the value of environmental benefits and potential social benefits of the revenue recycling nor considers the competitiveness impacts.

Lessons learned

These studies, though limited, show that the design of an environmental tax reform and how the revenue is recycled is crucial to the success of such reform in Viet Nam. To maximize the economic and environmental benefits, it is recommended to set up a clear and stable mid-term to long-term roadmap with a gradual tax increase scheme, that is announced well in advance and that indexes tax rates to inflation and recycles revenue through investments in energy efficiency and renewable sources,

As well, the relationship between the new environmental law and existing laws should be clearly defined to avoid overlapping; the roles of the relevant environmental agencies need to be clarified.[1]

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CASE STUDY

Becoming an eco-model city
Yokohama, Japan's eco-city initiative

Key points

- ***Urban redevelopment of Yokohama is an example of city-wide system change towards an eco-city.***
- ***Urban built environments have developed to accommodate the needs and welfare of citizens and to create a greener engine of future development.***

There was a problem…

The Yokohama population growth doubled from 1960 to 1980 and large-scale new towns were sprouting up and down the country without any control. The city experienced a shortage of housing, lack of green space, under-development of schools, roads and sewage system. The residences adjacent to industrial areas suffered from noise and pollution.

What was done?[1]

Urban transit railways were quickly installed to accommodate the urban sprawl and various modes of public transport, such as subway, light rail, bus and cycling were coordinated. Industrial areas were retrofitted to minimize the adverse impacts on the neighbourhoods and reformed into a mixed-use urban centre. A water and green network along the coast was rehabilitated to enhance ecological sustainability of cities, serving recreational purpose of citizens at the same time.[2]

Legal framework: From the beginning of the new century, Yokohama started to react to the climate change issues. A Yokohama Anti-Climate Change Measure Regional Promotion Plan, effective from 2001 to 2010, followed on the heels of the national legal framework – Law Concerning the Promotion of the Measures to Cope with Global Warning. Then came the Yokohama Anti-Climate Change Action Policy (CO-DO30), setting the medium- to long-term (2007–2050) action plan to complement the Yokohama Anti-Climate Change Measure Regional Promotion Plan. In parallel, the city administrators devised a series of strategic plans to turn Yokohama into an eco-model city (later known as the Yokohama CO-DO30 Road Map, or Eco-Model City Action Plan).

Target setting: Under the CO-DO30, targets were set to decrease 30 per cent greenhouse gas emissions per person by 2025 and 60 per cent by 2050, while increasing ten-fold the renewable energy use by 2025, compared with 2004 levels.

The scope and scale of the CO-DO30 Road Map are not limited to new projects but require the transformation of the existing socio-economic system of the city.

Promoting energy-saving houses: In the residential sector and with the purpose of promoting energy-saving houses, the city planners expanded the scope of buildings that require mandatory building certification, called the Comprehensive Assessment System for Built Environment Efficiency, with subsidies for the assessment costs. In addition, newly built houses are required to comply with the energy conservation standards. Low-interest loans are available for house owners who wish to construct green houses.

[1] City of Yokohama, *Yokohama CO-Do30 Road Map: Eco-Model City Action Plan* (Yokohama, Japan, 2009). Available from www.c40cities.org/docs/ccap-yokohama-road-map.pdf (accessed 22 January 2012).

[2] Toru Hashimoto, "Experiences of Yokohama: The compatibility of economy and ecology", PowerPoint presentation, September 2011.

CO_2 emission from transport sector: Demand-side management entailed eco-driving practice, improvement of the quality of public transport, a community-wide bicycle scheme and promoting electric vehicles. At the end of 2009, 10 rechargers and 34 electric vehicles had been introduced.

Increase in penetration of renewable energy: Solar and bio-energy are two major sources of renewable energy now used in Yokohama. Economic and regulatory measures were imposed or are being considered, such as subsidies for the installation of solar water heaters and renewable energy use targets in buildings at a certain size. The government aims to establish a designated entity called Yokohama Green Power to promote renewable energy. By the end of 2009, 2,945 units of solar power generation had been installed.

Preserving green areas: The city increased urban green areas by planting trees and promoting green rooftops or walls. Green areas are protected via the Urban Green Space Conservation Law and finances required for conserving green areas are mobilized by levying a green tax and offering special treatment for fixed asset taxes in certain green areas.

Projects were initiated in line with the achievement of the greenhouse gas emissions reduction and renewable energy use increase targets:

Yokohama Green Valley (started in 2010): Apart from the government's efforts to green existing businesses by reforming financial institutions to favour green business and by operating carbon offsetting sponsored by the city government, the project of the Yokohama Green Valley aims to form clusters consisting of business, factories and public facilities in a compact manner. The purpose of the project is to boost green innovation and to commercialize green technologies. Included is an energy-monitoring project, an electric vehicle-sharing project and an environmental education programme in collaboration with universities in the city.[3]

Yokohama Smart City Project (started in 2010): The Yokohama city planners aim to set up and test a smart grid as the future generation energy network, in cooperation with the national government and private sector during a five-year demonstration project (2010–2014). The project covers three areas: Minato Mirai 21, Kohoku New Town and the Yokohama Green Valley area, with 165,600 households. Specific activities centre on the large-scale introduction of renewable energy through the home energy management system, the building energy management system, the thermal energy management at the district level, mutual supplementation between the community energy management systems, a large-scale power system network, next-generation transport systems and lifestyle reforms.[4]

Results

The environmental state of the city has improved dramatically. Fifty years ago the city was dominated by industrial pollution; today it ranks above average in terms of energy use and CO_2 emissions, environmental land use and building regulations, sustainable transportation, waste management, air quality and environmental governance. In terms of water quality and management, it ranks well above average – considered among the best in Asia.[5] In 2008, Yokohama was honoured by the Japanese Government as an eco-model city.[6]

[3] City of Yokohama, "Yokohama as an 'Eco-Model City' Formulates Action Plans for Its Key Project 'Yokohama Green Valley Initiative'", *Press release*, January 13, 2010. Available from www.city.yokohama.lg.jp/ex/mayor/interview/pressroom/newsrelease/h21/newsrelease100114-e.pdf (accessed 22 January 2012).

[4] City of Yokohama, *Master Plan of Yokohama Smart City Plan* (Yokohama, Japan, 2011). Available from www.city.yokohama.lg.jp/ondan/english/pdf/initiatives/master-plan-of-yscp-press.pdf (accessed 22 January 2012).

[5] Economist Intelligence Unit and Siemens AG, *Asian Green City Index, Assessing the Environmental Performance of Asia's Major Cities* (Munich, 2011).

[6] City of Yokohama, *Yokohama 3R Dream: Yokohama Municipal Solid Waste Management Master Plan* (Yokohama, Japan, 2010). Available from www.city.yokohama.lg.jp/shigen/sub-keikaku/keikaku/3rm/plan/3rmplan/3rmplangaiyo-en.pdf (accessed 22 January 2012).

Success factors

- **Political commitment and long-term vision:** A defining element in the progress that Yokohama has made is the continual succession of city leaders who brought about change and kept driving it in a consistent manner, regardless of the mayor in charge. Once the greenhouse gas emission reduction and renewable energy use increase targets were set, the status of actions to achieve those targets were continuously monitored and verified. A series of supportive policies and actions were pursued in accordance with the existing law.

- **Budgeting for climate change prevention measures:** Through provisions within the city budget, the local government showed its determination to continually promote low-carbon projects. The total budget currently for supporting low-carbon development is more than US$15.7 million (1.2 billion yen). That includes more than US$4.5 million (352 million yen) in energy innovation and US$3.4 million (261 million yen) in promoting local eco-activities and university eco-education.[7]

- **Awareness raising and education:** To accelerate the efforts to mitigate climate change, the Yokohama leaders realized it was essential for individual citizens to take actions that contribute to emissions reductions, considering that greenhouse gas emissions from people's daily activities accounted for a large percentage of the total greenhouse gas emissions in the city. Yokohama Eco School (YES) activities have expanded as a framework that establishes and enables cooperation between the public, companies, universities and the government for creating innovative climate change measures.[8]

Considerations for replicating

Lead by examples: The Yokohama city administrators took the initiative to adopt low-carbon measures, such as retrofitting public facilities, installing rainwater harvesting system, monitoring energy consumption and CO_2 emission through information technologies and installation of solar power generators. These actions not only helped reduce CO_2 emissions from the public sector but also disseminated good practices to the public.

Alliance with other cities: Being a member of networks among local governments, cities can access up-to-date knowledge and good practices that have a potential for replicating. Yokohama is a member of the Large Cities Climate Leadership Group (C40), consisting of cities around the globe, as well as the Council of the Low Carbon Cities and the Metropolitan Network of 8 Prefectures and Cities based in Japan.

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[7] City of Yokohama, *Projects on Measures to Mitigate Climate Change in the FY2011 Draft Budget* (Yokohama, Japan, 2011). Available from www.city.yokohama.lg.jp/ondan/english/pdf/initiatives/2011-budget-for-climate-change.pdf (accessed on 23 January 2012).

[8] ibid.

The Asia-Pacific region has come to a historical crossroad: development goals are within reach and the region has the opportunity to lift its people out of poverty. But arriving at those goals and pulling millions more people out of poverty cannot be done through conventional growth strategies. Resource constraints, price volatility and the climate crisis have removed business as usual as an option for all economies. The situation now requires a serious re-examination of the resource- and carbon-intensive growth strategies. Every country in the Asia-Pacific region needs to drastically improve its resource efficiency. The region must embrace a new growth strategy that can turn the trade-off between economic development and environmental protection into a win-win synergy in which "going green" drives economic growth.

The ***Low Carbon Green Growth Roadmap for Asia and the Pacific*** explores the opportunities that a low carbon green growth path offers to the region. It articulates five tracks on which to drive the economic system change necessary to pursue low carbon green growth as a new economic development path. In particular, the "visible structure" of the economy, comprising such physical infrastructure as transport, buildings and energy systems, together with the "invisible structure", which encompasses market prices, governance, regulations and lifestyles, have to be re-oriented towards resource efficiency. The Road-map provides policymakers in the region with a comprehensive list of policy options and practical implementing strategies as well as examples of successful practices, woven through more than 100 fact sheets and case studies.

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