ESCAP
SOUTH AND SOUTH-WEST
ASIA OFFICE

REGIONAL COOPERATION FOR ENERGY ACCESS AND ENERGY SECURITY IN SOUTH AND SOUTH-WEST ASIA

Prospects and Challenges

February 2013

UNITED NATIONS
ESCAP
Economic and Social Commission for Asia and the Pacific
South and South West Asia Office

DEVELOPMENT PAPERS 1302

February 2013

This paper was prepared by The Energy and Resources Institute (TERI) under contract for ESCAP. It benefited from comments and inputs from ESCAP member States in South and South-West Asia and from feedback received at the South and South-West Asia subregional consultation preparatory meeting for the Asian and the Pacific Energy Forum in 2013.

The TERI Research Study Team included

Advisor:	Ligia Noronha
Reviewer:	R K Batra
Principal Investigator:	Deepti Mahajan
Team Members:	Anmol Soni
	Madhura Joshi
	Nitya Nanda
	Swati Ganeshan
Secretarial Assistance:	M K Bineesan

For further details, please contact:

Dr. Nagesh Kumar, Director
South and South-West Asia Office (SSWA)
Economic and Social Commission for Asia and the Pacific (ESCAP)
C-2 Qutab Institutional Area, New Delhi-110016, India
Email: sswa.escap@un.org

FOREWORD

The Development Papers Series of the ESCAP South and South-West Asia Office (ESCAP-SSWA) promotes and disseminates policy-relevant research on the development challenges facing South and South-West Asia. It features policy research conducted at ESCAP-SSWA as well as by outside experts from within the region and beyond. The objective is to foster an informed debate on development policy challenges facing the subregion and sharing of development experiences and best practices.

This paper was prepared for ESCAP-SSWA by The Energy and Resources Institute (TERI), New Delhi. The research team comprised Dr. Ligia Noronha (Adviser), Deepti Mahajan (Principal Investigator), Anmol Soni, Madhura Joshi, Nitya Nanda and Swati Ganeshan. The study was prepared to provide countries of South and South-West Asia a review of the gaps and challenges to ensuring energy security in the subregion. It informed the Subregional Consultation for South and South-West Asia countries hosted by ESCAP-SSWA on 6-7 November 2012 in New Delhi to prepare the subregional perspective for the Ministerial Conference of the Asian and Pacific Energy Forum, which will be held in May 2013 in Vladivostok, Russian Federation. The draft study was revised in the light of the discussions at the Consultation and with the further inputs provided by the member States. It is now being issued to facilitate further dissemination of its findings and recommendations to the policy community across the subregion and beyond.

Access to energy is crucial for the achievement of the Millennium Development Goals. The paper highlights the absence of lifeline energy infrastructure and access as a dimension of economic deprivation that exacerbates social vulnerabilities and inequalities. The study concludes that the pathway to energy security in South and South-West Asia lies in improving utilization and equal distribution of energy resources including renewable energy resources; the upgrading and increased investment in energy infrastructure, improving energy access and delivery to populations; and the creation of subregional energy markets and shared technical and quality standards. The report then proposes a number of key actions that countries in South and South-West Asia can take immediately that will foster greater cooperation and realize immediate benefits in energy security.

We hope that this paper will contribute to a better understanding of the opportunities and challenges for regional cooperation for energy security in the subregion.

Nagesh Kumar
Director, ESCAP South and South-West Asia Office
and Chief Economist, ESCAP

Contents

List of Tables

List of Figures

REGIONAL COOPERATION FOR ENERGY ACCESS AND ENERGY SECURITY IN SOUTH AND SOUTH-WEST ASIA

EXECUTIVE SUMMARY

A country's position on the spectrum of energy production and consumption determines its energy interests vis-à-vis others, and defines its interactions in the international energy domain. The increasing pressure on inequitably distributed, scarce resources has the potential to lead to inter-state conflict and internal ferment. At the same time, however, it is agreed that the inherent nature of energy as a resource calls for international cooperation – between energy surplus and deficient countries, technology developers, manufacturers, emerging markets, service providers et al. Countries, if they choose to cooperate, can harness complementarities, effectively use available resources, and build cross-country energy capacities. This prospect holds out a range of opportunities for countries (Afghanistan, Bangladesh, Bhutan, India, Iran, Maldives, Nepal, Sri Lanka and Turkey) in the ESCAP South and South West Asia subregion (SSWA subregion).

With exponentially growing energy demand, the countries of the subregion face a number of energy challenges – energy poverty, lack of available supplies, poor energy infrastructure and transport facilities, and environmental externalities of energy production and use. According to World Energy Outlook 2011, in 2009, of the 1.3 billion global population without access to electricity, about 449 million live in Bangladesh, India and Pakistan. While energy policies geared towards efficient use of energy may help curb demand, it is clear that maintaining growth rates, as developing economies undergo structural changes and strive to meet welfare objectives, will necessitate increase in energy use.

This report highlights the major energy challenges that countries in the SSWA subregion face. It explores the linkages between energy and sustainable development in the subregion, in particular the relevance of energy resources, and attendant decisions, to poverty alleviation, gender equity, provision of education and health services, and protection of the environment. **The report suggests that the absence of lifeline energy is a dimension of economic deprivation, and exacerbates social vulnerabilities and inequalities. Access to energy is, therefore, crucial for the achievement of the Millennium Development Goals.** Since access to safe and convenient energy to all is itself a characteristic of developed societies, countries need to pursue this objective as an end in itself.

On the basis of a detailed review of the energy and sustainable development landscape of the subregion, the report identifies five core areas where the countries of the subregion can collaborate:

- **Improved utilisation of unequally distributed energy resources**

This, as a first step, encompasses a collective effort to map availability of energy reserves, prospecting for energy and collecting requisite data on the subregional energy potential. Trade and investment in energy can help harness complementarities in energy sectors of different countries. The subregion's energy trade potential is largely untapped, particularly, in natural gas and power. Petroleum products trade exists given India's emergence as a refining hub and other countries' limited refining capacity, but offers scope for expansion.

- **Establishment of energy infrastructure**

Infrastructural constraints limit domestic availability of energy, hamper trade and constrain service delivery. High capital investments and technical capacity required for the construction of energy

infrastructure often deter infrastructure growth. The report highlights that the SSWA countries would benefit from a collaborative effort towards building power and gas infrastructure. This includes additions to installed power capacity through building of conventional and non-conventional fuels-based power plants; laying down of cross-border transmission lines and strengthening of domestic transmission and distribution networks; construction of pipelines for gas and petroleum products trade; and possibly, subregional strategic oil reserves.

▪ Addressing the challenge of energy access

Access to energy remains a pressing challenge in most countries in the SSWA subregion. The deployment of new, efficient technologies can offer access solutions, particularly for decentralised electricity, and clean and convenient cooking. The interface between energy access and renewable energy provides an especially potent policy space. Renewable energy- based distributed generation can provide immense opportunities for community-level energy interventions. Further, the deployment of efficient cookstoves, a significant advance from the traditional earthen stoves used in rural homes, can help mitigate the health and environmental impacts of indoor biomass combustion. Cross-border technology dissemination, and sharing of best practices, are key points of action for governments in the subregion.

▪ Promotion of renewable energy and efficient energy use

Renewable energy and effective demand side management are critical for enhancement of energy security, and for mitigation of the environmental impacts of energy. Deficient in fossil fuels, South Asia, can especially benefit from the development of renewable energy resources – solar, wind, ocean, geothermal, biomass and small hydro. Technology and regulation both play an important role in the uptake and upscaling of renewable energy, and in the spread of energy efficient processes and practices. Inter-state collaboration would be beneficial for technology research and development, knowledge sharing and capacity building, deployment of adequate funds, design and operationalisation of new regulatory frameworks, and determination of technical standards.

▪ Creation of subregional energy markets

The creation of subregional energy markets would help achieve economies of scale and ensure that demand-supply complementarities are not laid waste. A subregion-level grid has been theoretically explored both for natural gas and power, and has been highlighted as a win-win scenario for member countries. Effective sub-regional markets will help ensure steady inflow of capital and facilitate sound planning of private and public investment. However, the various subregional energy frameworks that have been discussed by SAARC, ECO, BIMSTEC, USAID-SARI/Energy, ADB, UNESCAP and the World Bank, amongst others, call for domestic energy sector reform so as to create shared technical and quality standards, put in place required infrastructure, and introduce regulatory and pricing changes to promote competition.

The report concludes with proposed actions for the SSWA countries. It emphasises the following as part of the priority policy agenda for the subregion.

- Collection and sharing of energy data;
- Power inter-connections;
- Development of a central knowledge repository of best practices in energy access improvement and renewable energy development;
- Clean energy fund and technology incubation centre;
- Cross-country energy investments;
- Institutionalisation of energy cooperation that involves multiple stakeholders.

REGIONAL COOPERATION FOR ENERGY ACCESS AND ENERGY SECURITY

IN SOUTH AND SOUTH-WEST ASIA

1 INTRODUCTION

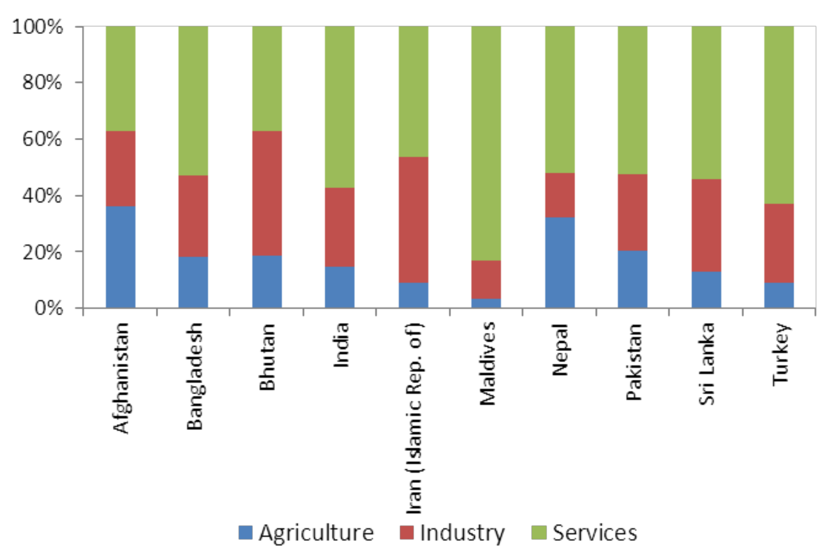
The South and South West Asia (SSWA) subregion comprises a diverse set of countries – in terms of their geography and level of economic development. Nearly 1.8 billion people reside in the constituent countries of Afghanistan, Bangladesh, Bhutan, India, Iran, Maldives, Nepal, Pakistan, Sri Lanka and Turkey, and the countries' density of population varies from over 1050 per sq. km. to less than 20 per sq. km. The economies of these countries are at different stages of the growth trajectory. Based on the level of per capita income, these countries can be categorised as low or middle income countries (see Table 1). While Afghanistan, Bangladesh and Nepal fall in the low per capita income group, Iran, Turkey and Maldives have income levels that place them in the group of upper middle-income countries.

Table 1: Income categories of countries in South and South West Asia

Low income	Lower Middle Income	Upper Middle Income
Afghanistan	Bhutan	Iran
Bangladesh	India	Maldives
Nepal	Pakistan	Turkey
	Sri Lanka	

Source: World Bank (2012a)

Figure 1: Sector-wise value added in South and South West Asia in 2010



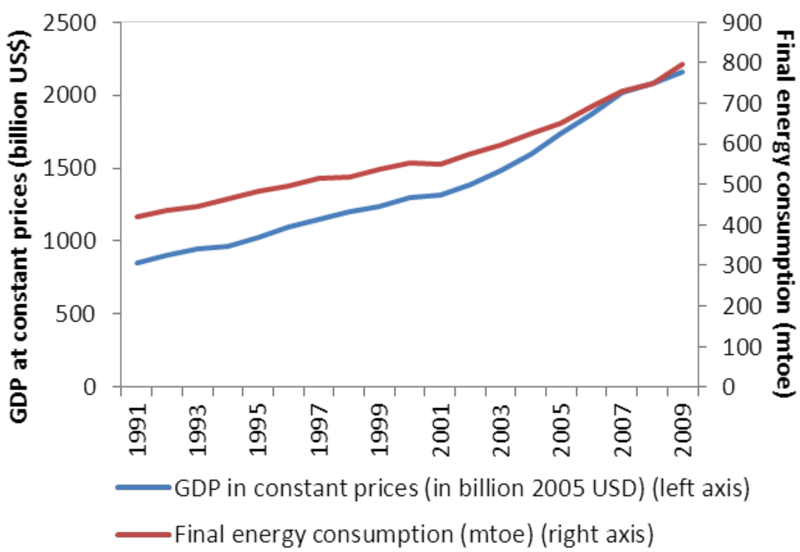
Source: UNESCAP (2012), Data in 2005 USD

More recently, the Gross Domestic Product (GDP) of the subregion has shown high rates of growth. The growth rate of the aggregate GDP of the South and South West Asia subregion for the period 2001-10 was in excess of 5% and the GDP of the subregion has doubled in the period from 1997 to 2010. The economies of these countries are predominantly driven by the services sector. With the exception of Afghanistan, Bhutan and Iran, the share of services in total value added in the GDP exceeds 50% of the total GDP in most countries of the subregion (see Figure 1).

1.1 Energy and Development

The high rate of economic growth in the subregion has been accompanied by an increase in energy consumption across the subregion (Figure 2).

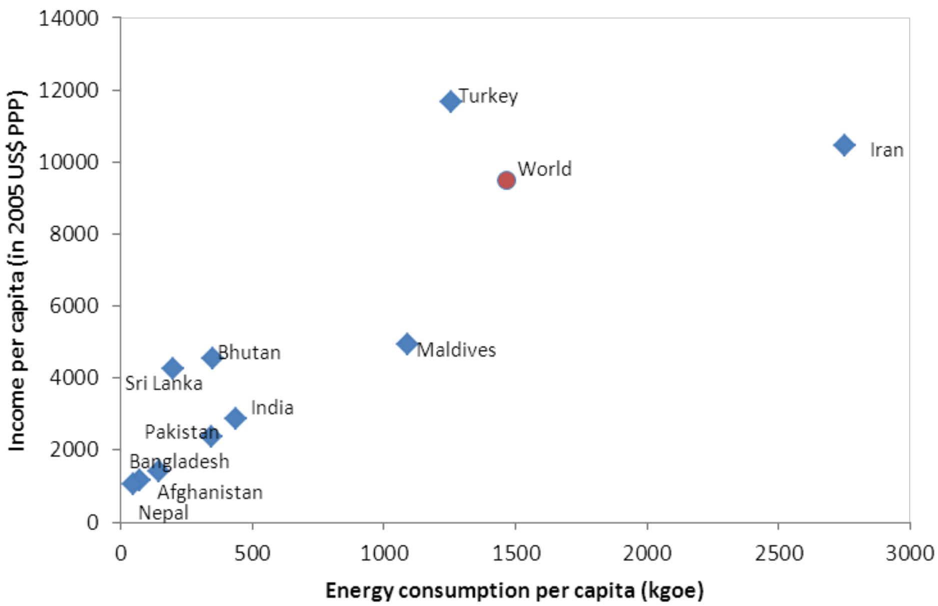
Figure 2: GDP and Energy Consumption



Source: UNESCAP (2012)
*Energy consumption does not include data for Afghanistan, Bhutan and Maldives

The average annual growth rate of final energy consumption beginning 1991 is 3.6%. In the period from 2001 to 2009, the growth rate increased to 4.7% (UNESCAP, 2012) as opposed to the world average growth rate of around 2% (BP, 2012). There is a notable variation in per capita energy consumption across countries and this correlates with the variation in per capita income levels of the countries (Figure 3).

Figure 3: Energy consumption vis-à-vis income level



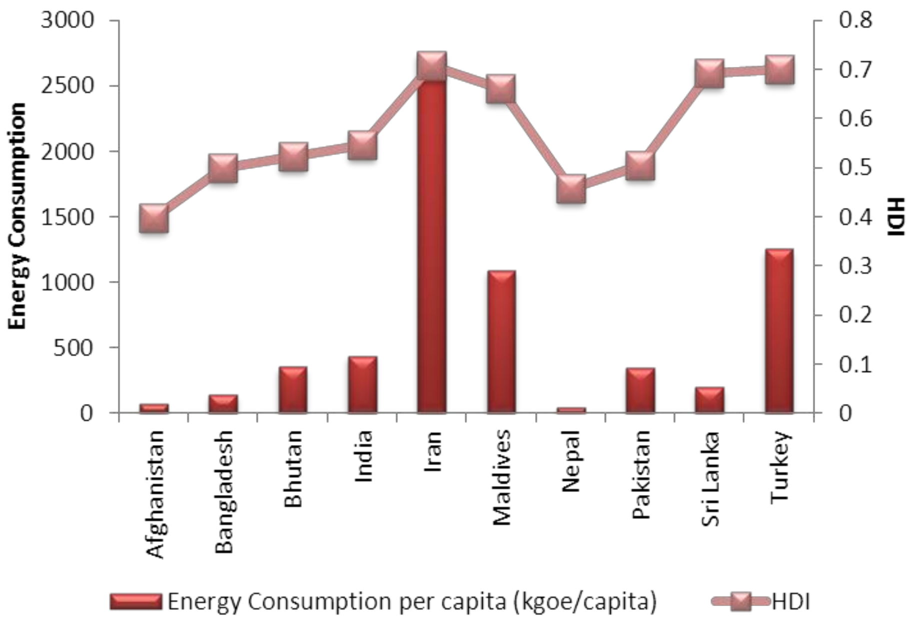
Source: UNSD (2012a), UNESCAP (2012)

Income and energy consumption in most countries are lower than the world average and while most countries of the subregion fall in the category of low per capita income and energy consumption (less than 500 kgoe and US$ 2500 annual per capita energy consumption and income respectively), Maldives, Turkey and Iran fall outside this group with the first two countries reflecting high levels of per capita income and Iran exhibiting high energy consumption which is almost four times the average of the subregion. In fact, the per capita energy consumption in Iran exceeds the world average as well.

Energy security, linked with the four 'A's of energy availability, accessibility, affordability and acceptability, is a paramount policy concern for countries in SSWA. 'Acceptability' here implies a choice being in agreement with the agenda of protecting the environment and mitigating climate change. Maintaining adequate energy supply, ensuring that energy reaches all, determining prices such that the poor can afford access to lifeline energy and responding to the call to make sustainable energy choices, are all integral to countries' energy objectives. Energy choices that countries make have significant economy-wide repercussions, and therefore the energy-growth-development linkage is integral to policy thinking.

Figure 4 maps the HDI values of countries (as reported in UNDP's Human Development Index 2011) against the country figures for per capita energy consumption. With some exceptions, it can be seen that countries with higher per capita energy consumption are also better placed on the human development index.

Figure 4: Per capita energy consumption and HDI in SSWA



Source: UNDP (2011a) and UNSD (2012a)

This is of particular significance for countries in SSWA, for a large populace here does not enjoy access to modern forms of energy. Widening access to clean and efficient energy, including grid-connected/decentralised power, is a key component of development efforts in the subregion. Even in electrified villages and cities, intermittent and inadequate supply paralyses day-to-day activities, industry and agriculture. In urban centres, this problem is also associated with reliance on polluting diesel for captive power generation during power outages. Clearly, enhancement in domestic energy supply requires investments in exploration of indigenously available resources and establishment of requisite infrastructure for energy transport and delivery. However, with energy-deficient economies dotting SSWA, effective sourcing of energy imports is an important component of countries' energy security strategy.

1.2 Energy Situation in South and South West Asia

Examining the energy situation of the subregion warrants an analysis of the available reserves of energy, and the potential of each country to explore and utilise these sources, followed by an examination of the energy demand supply analysis.

1.2.1 Energy resource endowments

The subregion's endowment of energy reserves, limited in the case of most energy sources, is unevenly spread across the subregion (Table 2). The Asian region is endowed with reserves of crude oil but these are mostly concentrated in West Asia. With reserves of 151 billion barrels of oil equivalent (bboe) at the end of 2011, Iran holds around 12% (Government of Iran, 2012) of the world's total crude oil reserves, and has the largest reserves in the subregion with a reserves to production (R/P) ratio of nearly 96 years (BP, 2012). India also possesses crude oil reserves, although its R/P ratio (currently at 30 years) is low.

Crude oil has recently been discovered in the north-eastern region of Bangladesh in the Kailashtila and Sylhet fields (Platts, 2012). Exploration activities are also being undertaken in Afghanistan, where blocks have been awarded for exploration and several international exploration companies have shown interest; and in Sri Lanka, where Cairn Lanka - a subsidiary of the UK-based Cairn Energy Plc, is carrying out exploration activities.

Table 2: **Fossil Fuel Reserves in the SSWA subregion, 2009**

	Oil reserves (Million metric tonnes)	**Gas reserves (Billion cubic metres)**	**Coal reserves* (Million metric tonnes)**		
			Anthracite	Lignite	Peat
Afghanistan	..	50	66	..	..
Bangladesh	3	344	293	..	..
Bhutan	..	..	..	..	..
India	740	1,074	56,100	4,500	..
Iran (Islamic Republic of)	17,329	29,610	1,203	..	..
Maldives	..	..	..	..	..
Nepal	..	0	..	1	..
Pakistan	42	840	1	2,070	..
Sri Lanka	..	..	..	..	5
Turkey	44	6	529	1,814	..

Source: UNSD (2012a)
Two dots (..) indicate that data is not applicable or available
*Coal reserves presented here are the proved recoverable reserves

In the case of natural gas, again, Iran holds the largest reserves and its R/P ratio is in excess of 100 years (BP, 2012). Other countries possessing natural gas reserves include India (R/P ratio of 28.5 years), Pakistan (20.9 years) and Bangladesh (18.3 years). Gas has also recently been discovered in Sri Lanka in the Mannar basin. The advent of shale gas production in USA has also led countries in the subregion to explore their sedimentary basins for shale reserves. Exploration studies to assess these reserves are currently being undertaken in India and Pakistan.

Coal reserves in the subregion are concentrated in South Asia. India, with over 60.6 billion tonnes of reserves accounts for the largest share of coal reserves in the subregion and the fifth largest in the world. Turkey and Pakistan follow this with 2.34 and 2.07 billion tonnes respectively. In total, the subregion accounts for 66.58 billion tonnes of coal reserves of which 58.19 billion tonnes are reserves of anthracite, and the remaining are of lignite and peat.

The subregion has limited reserves of uranium. The total reserves[1] in the subregion were in excess of 63 thousand metric tonnes. India has the largest reserves in the subregion followed by Turkey. Given the absence of dependable reserves of conventional sources of energy, nuclear power is serving as an alternative source for electricity generation in large consuming countries such as India and Pakistan (Dalton, 2011). Bangladesh and Iran, too, are exploring nuclear energy as a low carbon energy option.

Renewable sources of energy (bioenergy, solar, wind, hydro, tidal and geothermal energy) provide potential sources for meeting the energy demand with lower environmental footprint. Countries in the subregion have large potential in renewable sources of energy as regions in South Asia are endowed with abundant hydropower potential and solar radiation is abundant across the subregion with higher radiation levels in West Asia. The presence of water bodies and the terrain of countries in the subregion provide large potential for hydropower. As can be seen from Table 3, hydropower potential in the subregion is more evenly distributed than fossil fuel reserves. India has the largest potential for electricity generation using hydro power followed by Nepal and Pakistan. However, the extent to which this potential has been utilised is limited.

Table 3: Theoretical hydroelectric power potential in SSWA countries (in GWh/year), 2008

	Hydro potential (GWh/year)	Installed capacity (GW)	Actual generation (GWh)
Afghanistan	394,000	0.4	1,000
Bangladesh	4,000	0.230	780
Bhutan	100,000 [a]	1.505[a]	7,134
India	2,638,000	36.92	114,827
(Islamic Rep. of) Iran	448,000	7.70	17,987
Maldives	..	..	..
Nepal	733,000	0.665 [b]	3220 [b]
Pakistan	475,000	6.48	27,701
Sri Lanka	21,000	1.39	4,128
Turkey	433,000	14.55	33,270

Source: WEC (2010), [a] Government of Bhutan (2012), [b] Government of Nepal (2012)
Two dots (..) indicate that data is not available.

*Gross theoretical capability is the annual energy potentially available in the country if all natural flows were turbined down to sea level or to the water level of the border of the country (if the water course extends into another country) with 100% efficiency from the machinery and driving water-works. Unless otherwise stated, the figures have been estimated on the basis of atmospheric precipitation and water runoff.

1.2.2 Energy production

Energy production in the subregion is predominantly oriented towards fossil fuels (Table 4). Solid fuels (mostly coal) dominate energy production in India and Turkey whereas Pakistan and Bangladesh produce

[1] The reserves here refer to the 'Reasonably Assured Reserves' as reported in the 2009 Energy Statistics Yearbook (UNSD, 2012a).

natural gas. Electrical energy from hydropower sources forms the largest share of the total energy basket in Bhutan Sri Lanka does not produce any significant quantities of fossil fuels and the only domestically produced source of energy is hydropower. The production of domestic energy in many countries of the subregion suffers from the absence of infrastructure and low investments in developing these resources. Iran holds nearly 17% of the world's natural gas reserves (Government of Iran, 2012) and produces 5% of the total output. In Pakistan too, large reserves of coal in the Thar Desert region remain unexplored (Umar, 2007).

Table 4: Primary commercial energy production, 2009

	Solids	Liquids	Gas	Electricity
	Thousand tonnes of oil equivalent			
Afghanistan	350	..	3	67
Bangladesh	429	74	17,029	133
Bhutan	34	..	..	602
India	316,466	38,342	38,358	10,795
Iran	822	231,323	129,170	639
Maldives	..	..	..	..
Nepal	11	..	..	267
Pakistan	1,646	3,535	32,529	2,664
Sri Lanka	..	..	..	336
Turkey	17,403	2,434	626	3,258

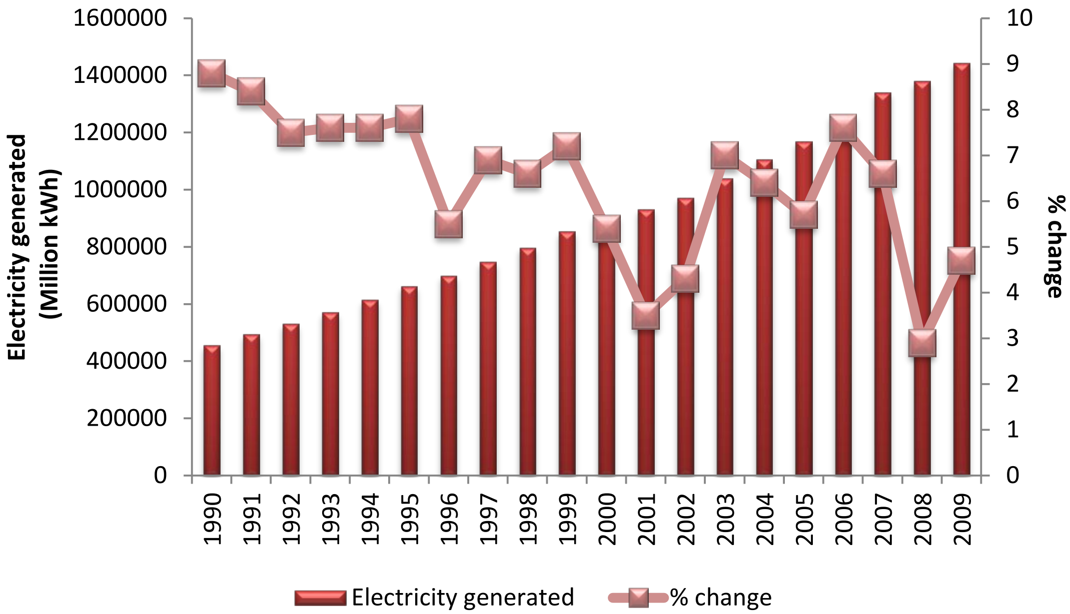
Source: UNSD (2012a)

Two dots (..) indicate that data is not available

Solid fuels include hard coal, lignite, peat, briquettes of hard coal, lignite and peat, coke, oil shale and bituminous sand **Liquid fuels** comprise of crude oil, all petroleum products, natural gas liquids and biodiesel **Gaseous fuels** include natural gas, gas works gas, coke-oven gas, blast furnace gas and biogas Primary electricity refers to the electrical energy of geothermal, hydro, nuclear, tide, wind, wave/ocean and solar origin. Production is assessed at the heat value of electricity (3.6 terajoules/million kWh).

The total power generation in the subregion has increased significantly (Figure 5). In nearly two decades, the electricity generation in the subregion has increased more than three times from 455 billion kilowatt hours (kWh) in 1990 to 1443 billion kWh in 2009. The average annual growth rate of power generated in this period was more than 6%. The dependence on fossil fuels in the countries is reflected in the power generation mix as well. Fossil fuels, primarily coal and petroleum products, form the largest share in the total power generated. Within thermal power, there is variation in the primary fuel for power generation across countries, from 100% petroleum dependence (in Maldives) to large dependence on natural gas (Pakistan and Bangladesh), and a mix of coal, hydropower and gas (India and Turkey).

Figure 5: Gross electricity generation in SSWA*



Source: UNESCAP (2012)
*Data for Afghanistan, Bhutan and Maldives is not included.

The share of renewable energy in the installed capacity mix is still limited and even though efforts have been made to increase its share, the available potential in these countries warrants stronger efforts to facilitate the uptake of renewable energy including biomass, solar, wind, small hydro, geothermal and ocean energy. Of these, while the first four forms of technologies have been implemented and in many cases commercialised, geothermal and ocean energy technologies are still at a relatively nascent stage in the subregion.

Energy from biomass resources can provide substantial potential to meet the energy requirements of the subregion in a sustainable manner and is, already, the largest contributor to the current renewable energy mix in many countries (WEC, 2010). Biofuels have a wide range of applications varying from power generation and heating to usage as a transport fuel. Countries in the subregion, particularly those in South Asia, have large potential of producing bioenergy given the availability of agro-residue and accumulation of municipal waste. Policies to establish local biogas plants to supply gas for cooking and heating have been introduced in the subregion.

Also, many countries across the world have mandated blending of liquid biofuels in transportation fuels. In the subregion, India has mandated 5% ethanol blending in petrol, and has set a target of increasing this number to 20% for both ethanol blending in petrol and biodiesel blending in diesel. However, meeting these targets is difficult due to lack of sufficient production, competitive markets and competing usage of land for producing food crops. A stable policy environment and adequate R&D support will be needed to increase the adoption of liquid biofuels in the energy mix of the country. Pakistan, too, has introduced a National Biodiesel Programme and has set a target of 5% share of biodiesel by 2015, further increasing this to 15% by 2025. According to the Renewable energy policy of Bhutan, the country has a target of development of 20 MW by 2025 (Government of Bhutan, 2012).

Abundant exposure to solar radiation in the subregion provides substantial potential to meet the energy needs of the countries. Solar energy can be harnessed through multiple applications: solar lanterns, water heating, cooking, home lighting, grid based as well as off-grid power generation through both thermal and photovoltaic technologies, and solar power based dryers in agriculture. These are particularly useful in countries that have large remote areas where grid connectivity is infeasible. Countries in the subregion have set targets to expand the share of solar power in the energy mix. India, under its Jawaharlal Nehru National Solar Mission (JNNSM) has set a target of generating 20,000 MW of grid-connected solar-based power by 2022, in addition to 2000 MW from off-grid solar installations. Pakistan also has a potential of 29 TW (Terawatt) of solar-based power generation and the Pakistan Council of Renewable Energy Technologies (PCRET) is undertaking research and development on solar thermal devices (WEC, 2010).

Wind energy is currently the most commercialised form of renewable energy, and has been growing at high rates. Improvements in technology and scale have facilitated a significant reduction in the cost of wind-based power generation in the recent past. This has led to an increase in the wind-based installation of generation capacities in most countries. India had a total 14,744.185 MW of monitored installed wind based generation capacity in July 2012 (CEA, 2012). In Turkey, the installed capacity increased from 18 MW as of end 2004 to 813 MW in end 2009, and a further 1030 MW was reported to be under construction (WEC, 2010). Sri Lanka has also set a target of installing 85 MW of wind-based generation capacity by 2015 (SLSEA, 2010a).

Adoption of geothermal energy remains limited in the subregion with Turkey being the only country where it is used for power generation. While the energy mix of India and Nepal also includes geothermal, its usage is limited to direct use and is not used for power generation on a commercial scale.

Countries in the subregion have taken governmental initiatives to assess renewable energy potential and facilitate development of these resources. Feed-in-tariffs and renewable purchase obligations have been adopted as policy incentives. At the same time, however, adoption of renewable forms of energy is constrained by factors such as availability of land, lack of available finance and high costs, inadequate infrastructure, and lack of access to technology.

1.2.3 Consumption of energy

As discussed earlier, energy consumption in the subregion has increased rapidly. However, availability and accessibility of modern commercial sources of energy in many countries is still limited, and the dependence on traditional biomass and fuel wood as sources of energy is still high. Households, especially those in rural areas in South Asia depend on these fuels for meeting their cooking energy needs. Highest dependence on these sources is noticeable in Bhutan and Nepal that are both located in mountainous regions of the Himalayas (Table 5). The dependence on traditional fuels in the subregion far exceeds the Asian as well as world average. This dependence has adverse implications on environment and health. Furthermore, this has socio-economic impacts in the form of drudgery for women and girls who spend considerable time and effort in collecting fuel wood for cooking, and therefore cannot seek formal education and/or employment. This link between development, gender inequality and access to energy has been realised as an issue of great concern in literature on development and energy poverty, and will be explored further in section 2.

Table 5: Total energy requirement and dependence on traditional fuels, 2009 (thousand terajoules)[2]

	Traditional fuels	Total energy requirement^	Traditional fuels as a % of Total Energy Requirement
Afghanistan	18	109	17%
Bangladesh	610	1,512	40%
Bhutan	45	56	80%
India	7,360	29,647	25%
Iran	19	9,029	0.21%
Maldives	14	21	67%
Nepal	159	219	73%
Pakistan	1,051	3,526	30%
Sri Lanka	105	276	38%
Turkey	193	3,967	5%
Total SSWA	9,574	48,362	20%
World	42,871	467,338	9%
Asia	17,384	205,613	8%

Source: UNSD (2012a)

^ Total energy requirement is defined as consumption of commercial energy plus biogas and traditional fuels which include fuelwood, charcoal, bagasse, animal, vegetal and other wastes.

[a] Nepal has reported a significant increase in total energy requirement from 2009 figures to 401,000 terajoules in 2012, with 348,000 terajoules, or 87 per cent of the total energy requirement being traditional fuels (Government of Nepal, 2012).

In terms of commercial energy consumption, the dependence on fossil fuels is prominent (Table 6). Natural gas forms the most important source of total energy supply in Bangladesh and Pakistan while coal and oil are the dominant sources of energy in India and Maldives respectively

The sector wise composition of final energy consumption has not varied much over the years and in most countries, the household sector has the highest share in the total final energy consumption, followed by the industry and transport sectors (Figure 6). The share of the household sector in Bangladesh, Bhutan and Nepal exceeds 60% of the total final energy consumption. The only exceptions are Afghanistan and India where transport sector and industry are the largest consumers of energy respectively.

[2] The figures shown in this table might vary from those quoted in the later sections primarily on account of difference in sources and the methodology adopted for calculating energy consumption.

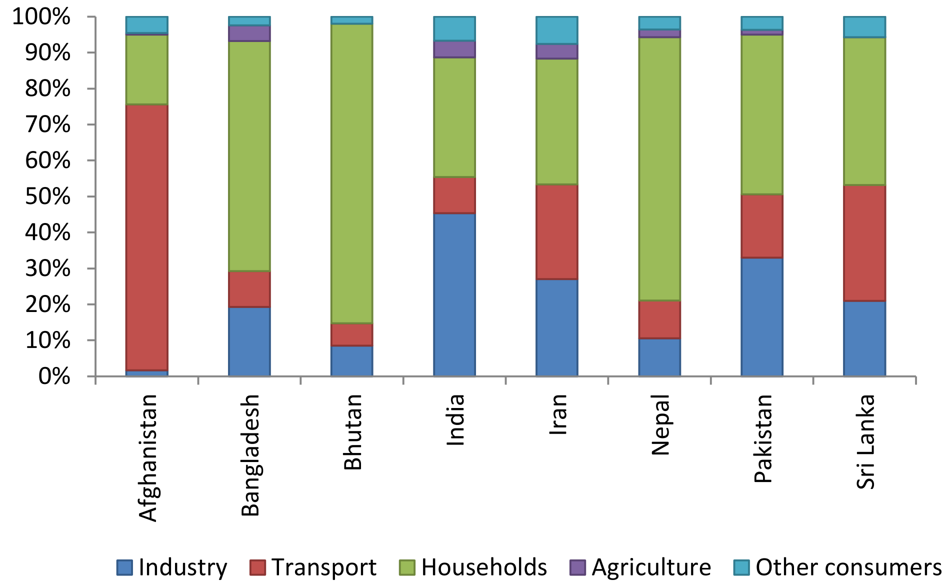
Table 6: Composition of commercial energy consumption in SSWA, 2009 (thousand tonnes of oil equivalent)

	Total Commercial Energy Consumption*	Solids	Liquids	Gas	Electricity
Afghanistan	2,173	350	1,671	3	149
Bangladesh	21,458	429	3,868	17,029	133
Bhutan	251	15	93	..	143
India	530,415	34,9305	13,1096	38,358	11,656
Iran	201,094	1,239	71,335	128,233	288
Maldives	340	..	340	..	..
Nepal	1,371	227	831	..	313
Pakistan	59,119	4,884	19,025	32,525	2,686
Sri Lanka	4,097	53	3708	..	336
Turkey	90,075	30,066	24,685	32,129	3,195

Source: UNSD (2012a)
The definitions of different categories of commercial fuels are same as those defined in Table 4.

As the economies of the subregion expand and higher levels of per capita income and standards of living are attained by people, the demand for energy in most sectors is projected to increase. As countries transition from traditional practices of agriculture towards more modern and mechanised farming techniques there will be an increase in the total demand for energy and energy equipment in these countries. Promoting sustainable agriculture and meeting the energy requirements through renewable forms of energy will assist in moderating the rising demand for energy in the sector. Further, growing aspirations of citizens coupled with rapid urbanisation has led to an increase in demand for mobility. In the period from 2001 to 2011 the number of cars, jeeps and taxis in India has increased at a compound annual growth rate of 10.5% while in the same period, the number of two wheelers has increased at a rate of 10.2%. The share of two wheelers in the vehicles in 2011 stood at 71.8% and that of cars, jeeps and taxis was 13.6% (MoRTH, 2012). Iran has 113 passenger cars per 1000 population (in 2008) as against a world average of 118 (in 2003) (UNESCAP, 2012). A modal shift has also been witnessed in countries wherein the share of public modes has been replaced with private owned vehicles. The high dependence of the transport sector on oil coupled with the relative shortage in availability of the resource and lack of availability of substitutes in the subregion, has created a need for introducing measures to enhance efficiency and reduce consumption. Introduction of efficient public transportation systems is essential for meeting the rising mobility needs in these countries.

Figure 6: Sector-wise trend in Final Energy Consumption in the Subregion, 2009



Source: UNSD (2012a)
*Comparable data was unavailable for Maldives and Turkey

In the industries sector, too, as economies move towards greater mechanisation and development of industrial complexes, the demand for energy will increase substantially, forcing countries to increasingly depend on imports. Further, the absence of sufficient capacity that leads to shortage of power supply to the sector has also led industries to depend on captive power generation which is often based on diesel. This option is not only more expensive than grid based power but is also highly polluting and adds to the demand for scarce petroleum products. Facilitating increased generation and increase in the proportion of renewables in the energy mix will be necessary to meet the demand of the sector.

1.2.4 Consumption-production balance and energy trade

Summarising the information on energy production and consumption provided in the previous sections, Table 7 presents the total commercial energy demand and production along with the total imports and exports of energy in the subregion.

As the domestic demand for energy is increasing in the subregion, countries are increasingly becoming dependent on imports. Bhutan and Iran are the only net exporters of energy in the subregion. While Bhutan exports power to India, Iran is an exporter of crude oil. India too exports electricity,[3] coal and petroleum products but the country imports large quantities of crude oil and natural gas. The dependence on imports to meet domestic requirements in the subregion varies from a maximum of 100% as in the case of Maldives to a minimum of around 7% in Iran (Figure 7). The average net import dependence of the subregion is 16%.

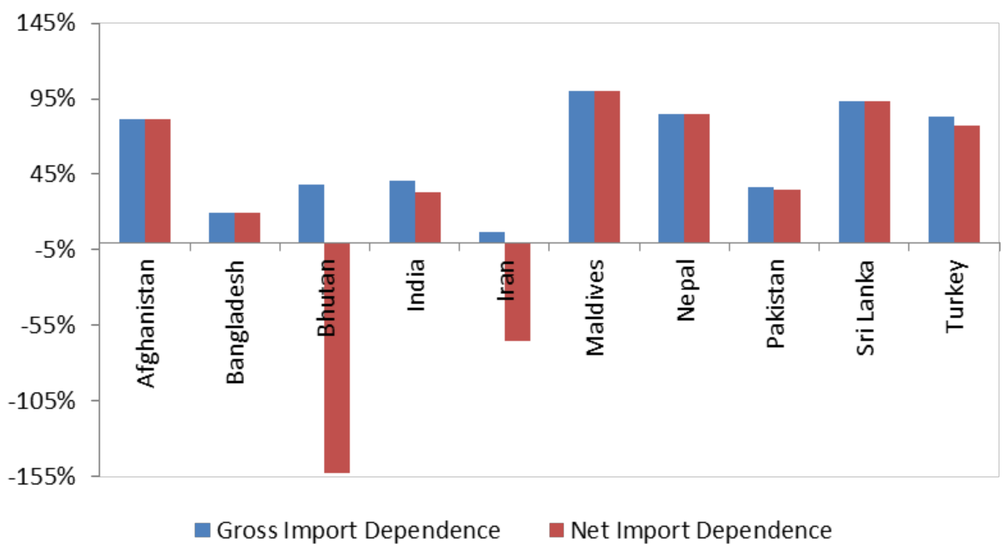
[3] Electricity is exported to Nepal and, in small quantities, to Bhutan (Bhutan re-imports from India for some places which are remote and not well connected to the Bhutanese national grid).

Table 7: Production, consumption and trade of commercial energy in SSWA (in thousand tonnes of oil equivalent), 2009

	Primary energy production	Imports	Exports	Energy Consumption
Afghanistan	420	1,763	..	2,173
Bangladesh	17,665	4,266	162	21,458
Bhutan	636	95	479	251
India	403,962	215,779	40,766	530,415
Iran	361,954	13,890	144,820	201,094
Maldives	..	340	..	340
Nepal	278	1,165	6	1,371
Pakistan	40,375	21,535	797	59,119
Sri Lanka	336	3,838	..	4,097
Turkey	23,720	74,656	5,181	90,075
Total SSWA	849,346	337,327	192,211	910,393

Source: UNSD (2012a)
Note: Here consumption also accounts for stock changes and bunker storage.
Two dots (..) indicate that data is not applicable or available

Figure 7: Energy import dependence in SSWA, 2009



Source: UNSD (2012a)

Countries engage in energy trade with other countries, both within and outside the subregion. Crude oil is traded on both spot and long-term markets whereas gas trade is largely through bilateral contracts and agreements. Petroleum trade is largely sea-borne. Recommendations for establishing pipelines for trading crude oil and refined products, especially in South Asia have been made; however, no infrastructure has been established yet. Most of the gas trade in the subregion is also sea-based, in the form of Liquefied Natural Gas (LNG) trade. Iran and Turkey are the only countries that import gas through pipelines. Development of cross-country pipelines in rest of the countries has been considered and different options are at various stages of exploration. Amongst these is the Turkmenistan-Afghanistan-Pakistan-India (TAPI) gas pipeline for which the Gas Sale and Purchase Agreement was signed in May 2012. Coal is largely imported from within Asia, and from South Africa and Australia. Electricity trade also forms a component of the total energy trade in the subregion; all countries except Maldives and Sri Lanka engage in power trade.

In conjunction with low domestic production, the import dependence in the subregion is also explained, by the lack of development of domestic infrastructure to support production of energy. Variation in the quality of domestically produced and imported resources, seasonal variations and complementarities in capacities for processing fuels, also contribute to the quantum of trade. Iran is a large producer and exporter of crude oil but depends on imports to meet the domestic requirement of petroleum products due to insufficient refining facilities. The country also imports natural gas from neighbouring Turkmenistan to meet the rising demand in its north-eastern region. Nepal is well endowed with hydro-resources but imports electricity from India, particularly in winters due to shortage of generation capacity. India, that holds large coal reserves, is both an exporter as well as importer of coal. Low quality coking coal is produced domestically and non-coking coal is imported. However, increasingly, imports of coking coal are also rising due to limited availability of resources in a context of increasing consumption, and inadequate development of available reserves.

The high dependence on imports has large implications on the current account balances of the economies. With rising international prices of resources, this burden is growing rapidly. In India, for instance, import of crude oil forms the largest component of the country's import bill. Further, most countries in South Asia are dependent on West Asia for meeting their crude oil and natural gas requirements. Concentration of imports from a particular region subjects the energy supplies of the importing country to significant risks, and efforts need to be made to diversify the sources of imports. To address this concern, countries are also exploring the option of acquiring equity energy assets overseas, which needless to say, come with their own attendant risks.

The increase in domestic demand for energy necessitates increasing the supplies of energy by facilitating more energy trade and increasing the share of renewable sources in the total energy mix of the countries. As sustainability becomes a critical component of energy decisions, it is clear that countries' energy choices will, and should be, determined by the environmental and social risks associated with different energy options.

2 CHALLENGES RELEVANT TO ENERGY SECURITY AND SUSTAINABLE USE OF ENERGY

Growing populations and rising incomes in the SSWA subregion are leading to a steady increase in the pressure on natural resources. Resource development and utilisation are integral to economic growth and development, and also major contributors to the environmental implications of growth. Development plans need to, at the outset, seek to eliminate or mitigate these environmental impacts. The three pillars of sustainable development - economic growth, environmental protection and social welfare, are non-hierarchical, and need to be seen as equally critical.

The 1992 Rio Declaration on Environment and Development highlighted that "the right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations." As governments in the subregion grapple with the challenge of providing better economic opportunities and social protection to their populace, they need to be aware of the environmental impacts of the choices being made. The preservation of the environment and natural resources, while a goal in itself, holds significant backward and forward linkages with growth. Environmental degradation, with its impact on life and livelihoods, is also a determinant of growth rates.[4]

2.1 Sustainable development challenges

The Millennium Development Goals reflect an international undertaking to improve the living conditions of the poor by 2015 and the goals have also been adapted at the national and subregional levels, for example through the creation of SAARC Development Goals. The Millennium Development Goals' links with energy and environment are evident. While MDG 7, 'Ensure environmental sustainability,' brings environment squarely within the discourse on MDGs, it is also clear that in the absence of reliable and affordable modern energy, the MDGs cannot be achieved. In fact, the availability of modern energy services is itself a feature of developed societies (Masud *et al* 2007). Table 8 summarises the MDG-energy linkages.

Table 8: Linkages between energy and Millennium Development Goals

S.No.	*MDG*	*Link with energy*
1.	Eradicate extreme poverty and hunger	Energy plays a key role in enhancing human and resource productivity, and in creating income opportunities.
2.	Achieve universal primary education	Energy provision can light homes and schools for hours of study that last beyond daylight.
3.	Promote gender equality and empower women	Modern energy can help reduce the burden of firewood collection that invariably falls on women. Women also bear the brunt of indoor pollution caused by inefficient cookstoves. Biomass combustion in traditional chulhas results in the release of concentrated air pollutants and carcinogenic compounds.
4.	Reduce child mortality	Improved incomes can help avoid health hazards related to malnourishment. Health facilities – preventive care, diagnostic help and treatment, require reliable energy supply.
5.	Improve maternal health	Modern energy in rural pockets is essential for delivery of health services at the right time.
6.	Combat HIV/AIDS, malaria and other diseases	Health facilities – preventive care, diagnostic help and treatment, require energy supply. Also, education, facilitated by provision of energy, can help increase awareness. Awareness creation through mass media also requires power.
7.	Ensure environmental sustainability	The production and use of energy, and energy fuel choices, have a direct link with the environment, including water and land. Excessive harvesting of biomass for use in rural homes can result in reduction in forests, loss of biodiversity etc.
8.	Develop a Global Partnership for Development	Energy, though marked by divergent interests, emerges as a shared concern and can provide a platform for international collaboration.

Source: Masud *et al* (2007); TERI analysis

The challenge lies in extending access to energy services in a manner that is equitable and does not add to local and global environmental impacts (UNDP, 2001). While, for some countries this means changing the pattern of existing consumption and reducing dependence on certain kinds of fuels; for many others, it

[4] According to a study conducted by TERI, it was estimated that the annual economic cost of pollution (air and water) and resource degradation (land and forests) is about 4% of India's GDP (TERI, 2010).

is still a question of achieving basic minimum access for a majority of its population through cleaner forms of energy. The Commission on Sustainable Development captured this dynamic:

> *"Energy for sustainable development can be achieved by providing universal access to a cost-effective mix of energy resources compatible with different needs and requirements of various countries and regions. This should include giving a greater share of the energy mix to renewable energies, improving energy efficiency and greater reliance on advanced energy technologies, including fossil fuel technologies. Policies relating to energy for sustainable development intended to promote these objectives will address many of the issues of economic and social development as well as facilitate the responsible management of environmental resources" (Commission on Sustainable Development, 2001).*

2.1.1 Population and poverty

The SSWA subregion has the highest population in the world and the rural-urban divide is starkly visible in these countries. Turkey and Iran have the highest urban populations (See Table 9) while Sri Lanka has the lowest. Afghanistan has the highest percentage growth rate in population at 2.7%. On the Gender Inequality Index, Afghanistan ranks 141, the lowest within the subregion in the Gender Inequality Index. India comes second at 129, with Pakistan, Nepal and Bangladesh ranking 115, 113 and 112 respectively.

Table 9: Population and gender inequality in the SSWA subregion 2011

Country	Growth rate (% 2011 data)	Urban (in thousands)	Rural (in thousands)	Share of urban population	Rank	Value
Afghanistan	2.7	7,613	24,746	23.5%	141	0.707
Bangladesh	1.2	42,698	107,795	28.4%	112	0.55
Bhutan	1.7	263	476	35.6%	98	0.495
India	1.4	388,286	853,206	31.3%	129	0.617
Iran	1.1	51,661	23,137	69.1%	92	0.485
Maldives	1.3	132	188	41.2%	52	0.32
Nepal	1.4 [a]	5,176	25,309	17.0%	113	0.558
Pakistan	1.8	63,967	112,778	36.2%	115	0.573
Sri Lanka	1	3,175	17,871	15.1%	74	0.419
Turkey	1.2	52,656	20,984	71.5%	77	0.443

Source: World Bank (2011); UNDESA (2012); UNDP (2011b), [a]Government of Nepal (2012).

Furthermore, large sections of the population in most SSWA countries are affected by income poverty as well as energy poverty. India and Bangladesh have the highest population living under $1.25/day, highlighting the inability of the poor to afford modern energy services leading to a reliance on traditional biomass for cooking. The rural-urban divide is accompanied by significant income inequalities. Sri Lanka, Iran, Turkey and Bhutan have the highest Gini coefficient in the sub-region (Table 10).

Table 10: Income, Poverty and Inequality in the sub-region

Country	Income per capita		Poverty				Inequality					
	in current US$	Year	Head Count at US$1.25/day	Year	Head Count at US$2/day	Year	Income held by lowest 10%	Year	Income held by richest 10%	Year	GINI	Year
Afghanistan	410	2010					4.1	2008	23.2	2008	27.8	2008
Bangladesh	770	2011	43.3	2010	76.5	2010	4	2010	27	2010	32.1	2010
Bhutan	2070	2011	10.2	2007	29.8	2007	2.8	2008	29.4	2008	38.1	2008
India	1410	2011	32.7	2010	68.7	2010	3.8	2005	28.3	2005	33.4	2005
Iran	4520	2009	1.5	2005	8	2005	2.6	2005	29.6	2005	38.3	2005
Maldives	6530	2011	Data not available				2.7	2004	28	2004	63.3	1997
Nepal	642 [a]	2011	24.8	2010	57.3	2010	3.6	2010	26.5	2010	32.8	2010
Pakistan	1120	2011	21	2008	60.2	2008	4.4	2008	26.1	2008	30	2008
Sri Lanka	2580	2011	7	2007	29.1	2007	3.1	2007	32.9	2007	40.3	2007
Turkey	10410	2011	0	2008	4.2	2008	2.1	2008	29.4	2008	39	2008

Source: World Bank (2012b), [a] Government of Nepal (2012).

2.1.2 Water and Health

Developing countries in the SSWA subregion along with poverty and inequality concerns also face challenges with access to basic welfare services. Table 11 shows the percentage of people with access to improved water sources in the countries under discussion. Energy and water have a strong linkage as the installation of wells, pumps or canals is possible with use of energy. Energy is also required to effectively utilise water resources, for instance for the use of water pumps in agrarian communities.

Further, health services in a large number of countries in the subregion are in a dismal state. The per capita expenditure on health is significantly low in most of the subregion (See Table 12) – a sign of how little importance the delivery of health services is accorded in the region. Bangladesh has the lowest per capita expenditure on health with Iran faring the highest in the region. Even emerging economies such as India have significantly low expenditure on health services. The need to address health deficits is acute, and eight priorities need to be highlighted here: addressing the social determinants of health; expanding access to primary health care; integration of child and maternal health into a continuum of care; addressing the health needs of the urban poor; devising sustainable financial strategies for the sector; improving governance of health systems; enhancing the affordability of medicines; and strengthening international and regional cooperation in the area (UNESCAP, ADB and UNDP, 2012).

Table 11: Access to improved water sources in 2010 (%)

Afghanistan	50
Bangladesh	81
Bhutan	96
India	92
Iran, Islamic Rep.	96
Maldives	98
Nepal[a]	83
Pakistan	92
Sri Lanka	91
Turkey	100

Source: World Bank, cited in UN Data (2012); [a] Government of Nepal (2012).

Table 12: Expenditure on health in 2006 (per capita)

	USD,PPP
Afghanistan	91[1]
Bangladesh	37[2]
Bhutan	140
India	86
Iran (Islamic Republic of)	678[3]
Maldives	422[2]
Nepal[a]	66
Pakistan	47
Sri Lanka	171[2]
Turkey	584

Source: WHO, cited in UN Data (2010); [a] Government of Nepal (2012).

[1] Ratios published in this report are calculated using the licit GDP (i.e. excluding opium) and government expenditures excluding external development budget expenditures. Estimates should be interpreted with caution as these are derived from scarce data. Missing per capita expenditure on health levels are due to nonavailability of purchasing power parity international $ values.
[2] Estimates updated using newly accessed data from national health accounts, surveys, or information provided during national consultation.
[3] Exchange rate changed in 2002 from multiple to a managed floating exchange rate. Inter-bank market rate used prior to 2002.

Though poor medical infrastructure, non-availability of trained doctors and nurses, and ill-affordability of health services, all contribute to the grim situation in the health sector, it cannot be denied that modern medical facilities are closely tied with energy access. Health, therefore, forms another important development sector, which depends on energy for unhindered functioning.

2.1.3 Education

Many countries in the subregion have poor track records in total net enrolment and percentage of pupils who reach the last grade of primary (Table 13). Gender inequalities are also visible in education whereby the number of literate males is higher in most countries. In comparison to male literacy, female literacy is the lowest in Pakistan, Bhutan, India and Nepal. While statistics for Afghanistan are not available, during the Taliban regime, women/girls were not allowed to attend school leaving a gap between men’s and women’s education in the country.

In addition to social and cultural reasons, dependence on traditional biomass for energy requirements has been seen to have an impact on the education of the girl child. Collection of biomass is an activity that is primarily carried out by women of the household, and leaves them with constrained opportunities and time.

Table 13: Education levels in the subregion

Country	Total net enrolment ratio in primary school		Percentage of pupils starting grade 1 who reach the last grade of primary		Literacy rates Males 15-24 years old (%)		Literacy rates Females (15-24 years old) (%)	
	Value	Year	Value	Year	Value	Year	Value	Year
Afghanistan	NA	NA	NA	NA	NA	NA	NA	NA
Bangladesh	NA	NA	66.20096	2009	75.46659	2010	78.49758	2010
Bhutan	89.34721	2011	91.03364	2010	80.04192	2005	67.96426	2005
India	98.15581	2008	65.79118	2005	88.41184	2006	74.35573	2006
Iran	99.56477	2007	94.34912	2008	98.78792	2008	98.51615	2008
Maldives	96.76789	2011	NA	NA	99.24022	2006	99.36065	2006
Nepal	NA	NA	61.6867	2007	87.6311	2010	78.38914	2010
Pakistan	74.05574	2010	61.50743	2009	79.14432	2009	61.46266	2009
Sri Lanka	94.13999	2010	98.6329	2006	97.68654	2010	98.58897	2010
Turkey	97.48598	2009	91.81307	2008	99.01896	2009	96.57019	2009

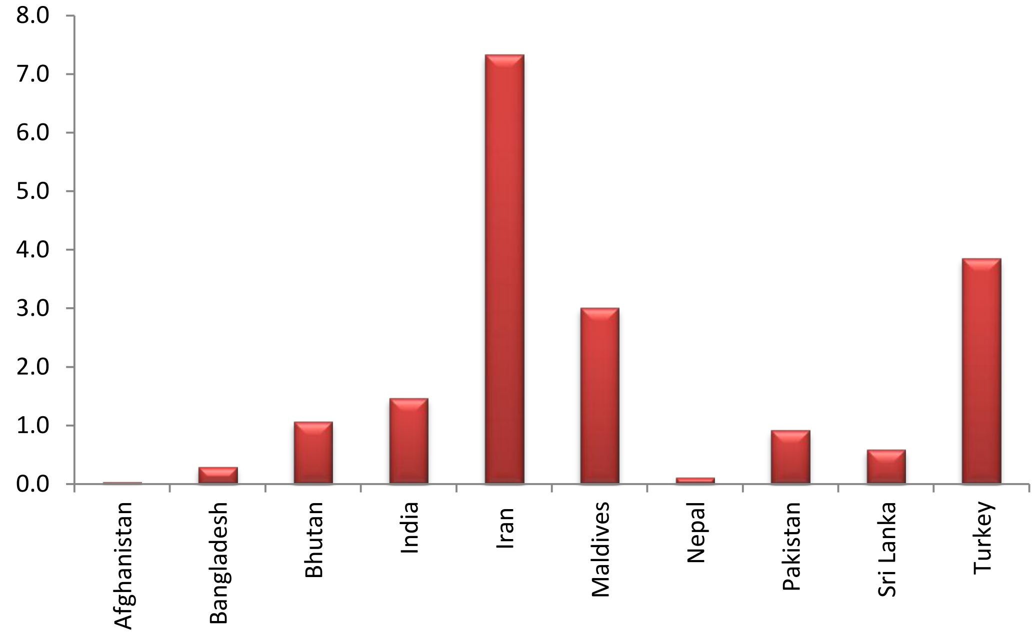
Source: UNSD (2012b); UNSD (2012c); UNSD (2012d); UNSD (2012e)

2.1.4 Environment

The SSWA subregion houses many climate sensitive regions. The Himalayan Hindukush, the source of most of the subregional rivers, stretches across six out of the ten countries in the subregion and is already seeing the impacts of climate change with receding glaciers, flash floods, glacial lake outbursts etc. Maldives, which is a low-lying archipelago, is extremely susceptible to climate risks. Similarly, the Sunderbans region has witnessed the impact of climate change related developments. While countries' current energy choices may not have a direct causal relationship with these changes, their current and future energy decisions will have a bearing on improving or deteriorating the conditions of their ecosystems. Throughout the energy fuels value chain, from resource extraction to end use, environmental impacts of energy are visible. Thus, one of the major challenges that the nations face is to balance economic growth and energy consumption with preserving the environment.

The subregion is largely dependent on fossil fuels for its energy needs along with the unserved population reliant on traditional biomass. Industrialisation and urbanisation have significant impacts on the environment leading to air, water and land pollution, increase in GHG emissions and deforestation. Figure 8 shows the absolute per capita carbon emissions in the countries in the subregion in the year 2008. It is clear that most countries of the subregion are characterised by low per capita emissions but as these countries develop, their emissions are expected to increase. In order to pursue a balanced approach to development, climate action and environmental protection will need to be tied closely with development objectives in the subregion.

Figure 8: Per capita carbon dioxide emissions (tonnes)



Source: UNDP (2011c).

*Carbon dioxide emissions, per capita: Human-originated carbon dioxide emissions stemming from the burning of fossil fuels, gas flaring and the production of cement, divided by midyear population.

a Emissions do not include carbon dioxide absorption through carbon sinks. For example, according to recent estimates, Bhutan emits approximately 1.5 million tonnes of carbon annually, and its forests absorb approximately 6.3 million tonnes, leaving it with a new emission of -4.7 million tonnes, and distinguishing it as one of the few countries in the world to have negative net carbon emissions.

2.2 Energy Challenges

The above section highlights some of the major sustainable development goals that the countries are working towards achieving. As discussed above, energy is the thread that runs across all Millennium Development Goals and is a major catalyst in the achievement of development objectives. With rising populations, increasing demand for services and infrastructure, a range of energy issues emerge as relevant for sustainable development pathways. The following section focuses on the major energy-related challenges that the countries in the subregion face.

2.2.1 Energy access

Energy supplies are inadequate even while access figures in the subregion remain dismal. Access to energy has often been described as the missing Millennium Development Goal (MDG); energy services can contribute significantly to the achievement of all MDGs. Access to modern energy can be measured in two forms: access to energy for lighting i.e. in the form of electricity; and access to modern cooking fuels such as LPG and electricity, or more efficient appliances/cookstoves that rely on traditional sources yet exhibit an advance in efficiency and convenience. While modern energy has been measured in two forms, however the other features of energy security – affordability and availability are concerns that move parallel to provisioning access to energy services. In developing countries where majority of the population lives on less than $2 per day, affordability plays a critical role in access, consequently as energy demand soars in these nations, the question of availability is a primary concern with many of them being import dependent.

The level of electrification in the subregion is very low, in particular in South Asian countries (See Table 14). Often, even where grid connected electricity is provided, the supply of power is intermittent. In the subregion, Afghanistan and Nepal have the lowest per capita electricity consumption (See Figure 9). A large number of households in the subregion rely on kerosene as a fuel for lighting. For India alone, these figures stand at 67.5 million rural and 3.7 million urban households. In case of access to cooking energy, majority of the population in the subregion depends on biomass, mainly fuel wood and dung cakes, to meet their cooking energy requirements. In India and Bangladesh, for instance, 72% and 88% of the population respectively still relies on traditional biomass for cooking (IEA, 2011a). This dependence on fuel wood has an impact on forestry and the environment, in general. Indoor air pollution caused due to burning of wood in traditional cookstoves is one of the major causes of respiratory ailments in rural areas. Women and young girls are generally responsible for collecting fuel wood thereby affecting their ability to seek employment and attend school.

Table 14: Access to electricity in the subregion

	Year	level (%)
Afghanistan	2009	15.6
Bangladesh[a]	2012	53
Bhutan[b]	2012	85.5
India	2009	66.3
Iran	2009	98.4
Maldives[c]	2012	100
Nepal	2009	43.6
Pakistan	2009	62.4
Sri Lanka	2009	77

Source: World Bank (2009); [a] Government of Bangladesh (2012); [b]Government of Bhutan (2012); [c] Climate Investment Funds (2012)

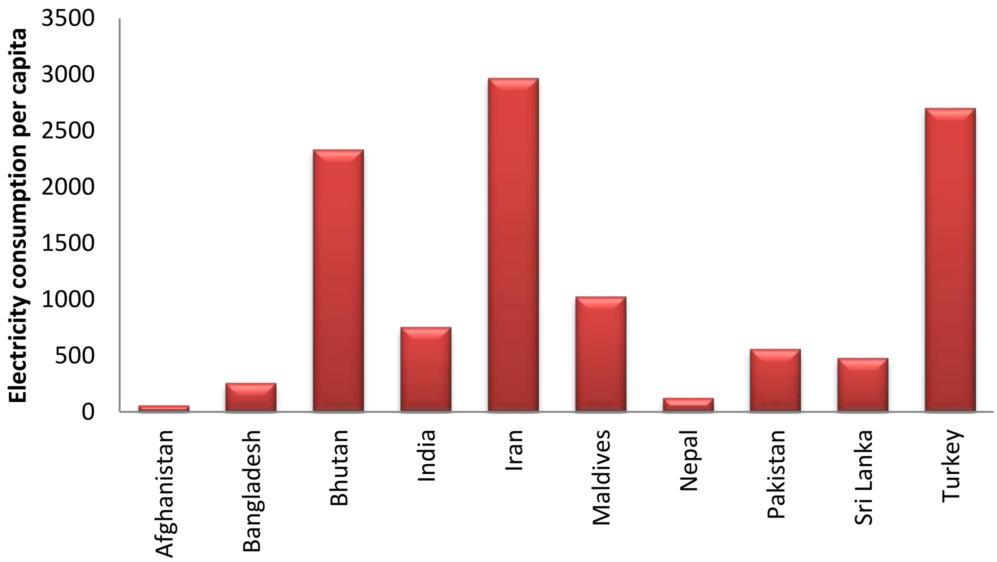
The ongoing domestic conflict in **Afghanistan** is a roadblock for improving energy access, making the development of physical energy infrastructure virtually impossible in many provinces. In many others, rough terrain and difficult geographic conditions limit accessibility; the advancement of off-grid energy sources has also proved difficult. With most parts of the country still lacking access to electricity, access is a major concern. The recently concluded Uzbekistan transmission line and the power swap deal with Iran have been able to improve services to Kabul. According to World Bank (2012c), only 15.6% of the total population has access to electricity.

According to the Government of **Bangladesh** (2012), in the year 2012, 53% of the population in Bangladesh have grid access to electricity. Demand is increasing at a rate of 10 % due to sustained GDP growth rate of more than 6%. The country's overall electricity generation is around 5500-6000 MW against a demand of about 7000 MW. Due to shortage of natural gas supply, around 600-800 MW of power could not be generated in spite of availability of capacity in the year 2012.

However, the Government of Bangladesh is making efforts to increase electricity supply. The Vision 2021 document of the Government envisages universal electricity access by 2021 (Planning Commission 2010). For this, efforts to increase the electricity generation capacity are being made. In order to diversify the generation mix, the country is increasing its dependence on coal-based generation, in addition to gas-based generation. This may, however, increase environmental concerns around production of electricity.

At the same time, Bangladesh is also actively developing its renewable energy sources. According to the Renewable Energy Policy, the country has set itself the target of achieving 5% RE share in the total power demand of the country by 2015 (MoPEMR, 2008).

Figure 9: Per capita electricity consumption in the subregion, 2009



Source: UNSD (2012a)

About 88% of Bangladesh's population relies on biomass for cooking (IEA, 2011a). To promote clean cooking facilities, the Institute of Fuel Research and Development has been engaged in developing improved cookstoves since 1978. Also, the government subsidises 26% of the total cost of an average size biogas plant for homes (which provide gas for cooking and lighting) (IEA, 2011a).

In **Bhutan**, the electricity coverage is 85.5 % as of September 2012. (Government of Bhutan,2012) As a country situated in the high ranges of Himalayas, Bhutan has elevations ranging from 100 to 7500 meters above sea level. Additionally, small size and dispersion of population increases the marginal cost of providing services. Many villages are small and isolated – located several days away from the nearest motor road (Tobgay, 2011). As access is difficult, the main source of primary energy supply for the majority of Bhutanese population is biomass – fuelwood, wood chips and animal dung, which is used for cooking and space heating. Fuelwood accounts for 60% of the total energy consumption and Bhutan's per capita fuel wood consumption is one of the highest in the world at 1.22 tons (Tobgay, 2011).

Households continue to depend on biomass as a source of energy mostly for cooking and heating. In 2005, the average urban household consumption of commercial energy was greater than 60% while the same for an electrified rural household was 13% and for a non-electrified household was not more than 6% (Ea & COWI, 2012). This difference is due to both unequal penetration of commercial energy sources as well as income disparity.

In **India**, as per the latest available data from Census 2011 (Government of India, 2011), more than 80% households still report traditional fuels as their primary source of cooking energy and 43% households rely on kerosene as their primary fuel for lighting. The supply of electricity in India is erratic with long periods of outages forcing rural populations to rely on kerosene and other traditional sources for meeting their lighting demands. Power cuts and outages are experienced in urban areas too, leading to an increase in reliance on captive power generation, in both the residential and industrial sectors. These captive power plants are usually based on diesel and have adverse ecological ramifications. A number of initiatives have been launched in India to increase the penetration of modern forms of energy, particularly in rural areas. The Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) and the Remote Village Electrification (RVE) Program aim to provide electricity access to rural areas. The RGGVY has achieved 52.5% connections to rural households including Below Poverty Line (BPL) households. The programme has been able to provide 79.1% connections to BPL households alone (Ministry of Power, 2012a).

Maldives has been able to provide energy access throughout its 200 inhabited islands. In 1998, the country had achieved 93% energy access with most islands receiving electricity supply. Only 23 islands, however, receive continuous supply (Reegle, n.d.). A recent 2008 UNDP study states that Maldives has achieved 100% access (UNDP 2009). Male and the islands in its vicinity account for nearly 51% of the power generated in all the inhabited islands of the country (Climate Investment Funds, 2012). Around 70% of the power generated is utilised in Male itself and approximately 60% of the electricity produced is generated and consumed in resorts (Reegle, n.d.). Due to significant number of dispersed islands, grid connected electrification has been a challenge. Diesel fuel is the major energy source for electricity supply in the country and there is lack of single grid connectivity.

Access to energy remains low in **Nepal**, especially in rural areas. Even though the share of traditional fuels in the total energy basket has declined in the recent years (from 91% in 1995/96 to 84% in 2010/11), a large proportion of the population still depends on fuel wood[5] for meeting its energy demand. Fifty seven per cent of the population has access to electricity of which 9 % is off grid renewable energy (Government of Nepal, 2012)., The per capita consumption of electricity in the country is one of the lowest in the subregion.

Schemes have been introduced to improve the energy access situation in the country. A Rural Energy Policy was adopted in 2006 with the goal of contributing to “rural poverty reduction and environmental conservation by ensuring access to clean, reliable and appropriate energy in rural areas.” The policy encourages use of all forms of renewable energy and also provides for institutional support to promote renewable energy in rural areas. The enhancement of energy access has also been linked to increasing the share of renewable energy in the country. Nepal has implemented the Community Rural Electrification Programme (CREP) and Rural Energy Development Programme (REDP). The Biogas Support Programme (BSP) of the Alternative Energy Promotion Council (AEPC) aims to increase the use of biogas in rural households, by providing household biogas plants.

Pakistan has very low per capita energy consumption and inequitable access to energy prevails in the country much like in other developing countries in the subregion. Power generation is largely based on oil and gas. Contrary to global trends, coal has a very small share in power generation and is mostly used in industry (PPIS, 2011). Further, due to the investment policies followed by the government in the 1980s and 90s, there was a large increase in IPP generation capacity and the power generation mix shifted from being dominated by hydel power towards one based largely on oil and gas (Munir & Khalid, 2012). Large line losses impact the availability of electricity; losses have been close to 20% of the net electricity generated (World Bank, 2012d).

In **Sri Lanka**, targeted programmes have been undertaken to address the issue of energy access. Level of electrification in the country is high – estimates range from 77% (World Bank, 2012e) to 85% (Wickramasinghe, 2011). As per the household electrification policy, 100% electrification needs to be achieved by 2016. Three projects, Energy Services Delivery (ESD), Renewable Energy for Rural Economic Development (RERED) and RERED.

[5] As per the SARI Energy database, fuel wood and dung together form approximately 90% of the total energy mix (SARI/Energy, nd.a.)

Additional Financing (RERED AF) with support from the World Bank and the Global Environment Facility, have been introduced to provide both grid-based and off-grid electricity access to rural populations. So far, a cumulative capacity of 2120 kW for off-grid and 187.67 MW for grid-connected electrification projects has been created (RERED, 2012). However, access to modern sources of cooking energy remains limited. Households continue to depend on biomass as a source of energy.

The access to energy services is significantly high in **Iran** and **Turkey**. Both countries have high rates of electricity access as shown in Figure 10. Table 15 provides a list of countries in the subregion that have taken on targets on universal electricity access.

Two primary factors that affect the uptake of modern forms of energy in the subregion are the availability of appropriate energy sources and the affordability of modern fuels. Innovative mechanisms need to be evolved to finance energy services in the countries of the subregion. A combination of government funding through provision of infrastructure and subsidies, donor based funding, provision of micro financing and Clean Development Mechanism (CDM) based funding, are being employed to improve energy access in the subregion, yet these efforts need to be scaled up. The large scale of interventions required foregrounds the importance of both government and private initiatives guided by innovative financial models. Public-private partnerships need to be fostered to catalyze development.

Table 15: Electricity access targets in the subregion

Countries	Target years for provision of electricity to all households
Bangladesh	2021
Bhutan	2013
India	2012
Sri Lanka	2016

Sources: Ea and COWI (2012); Ministry of Power (2012b); Planning Commission (2010); Wickramasinghe (2011).

2.2.2 Energy pricing, subsidies and taxation

The pricing of energy is a key determinant of consumption and even production patterns. Pricing affects the affordability and therefore the uptake of any fuel. Further, since a majority of the population in the subregion lives below the poverty line, the role of pricing accompanied by subsidies is crucial to achieving energy security. With pricing required to serve a range of objectives from increasing access to creating a level-playing field for public and private investors, the energy pricing debate in developing economies attracts a diversity of strong opinions. Prices of energy products and services are regulated by the government in most countries in the subregion under study. Governments control prices of final petroleum products, natural gas and electricity, subsidies are provided for various reasons – increasing access to modern energy forms, shielding the domestic economy from external price volatility and supporting select consuming sectors (such as power and fertilizers in the case of gas).

Energy subsidies are typically introduced with the aim of improving energy access and to support industries. Subsidies on energy are generally found to be regressive with benefits accruing disproportionately to richer households and draw from other development related expenditure (TERI & IISD, 2012). Further, in the long run these subsidies have been known to adversely impact macroeconomic variables such as the level of fiscal deficit, the inflation rate and the economic growth rate of countries. Performance of energy utilities such as oil companies and electricity distribution companies are also adversely affected in most cases due to lack of adequate and timely compensation. In some cases, large energy subsidies have also led international rating agencies to downgrade the economies of countries thereby adversely affecting the ability of these countries to seek investments in international markets. The availability of conventional fuels at subsidised prices is also a deterrent to the inflow of investments in the alternative energy sector.

Subsidies on fossil fuels are largely considered inefficiently targeted and lead to distortions in the market in the form of excessive consumption and perverse incentives to move towards energy intensive economic activities which have adverse implications on the environment. Since most countries are net importers of energy, the macroeconomic impacts of the rising subsidy burden are also high especially in cases where subsidies contribute substantially to the fiscal deficit of countries.

In addition, in order to promote renewable energy and to increase its cost competitiveness vis-a-vis fossil fuel based energy services, subsidies are also provided on renewable energy in many countries. Support to renewable energy is generally provided in the form of producer subsidies using instruments such as low interest financing, quotas, purchase agreements and even tax breaks. In Nepal, for instance, a subsidy policy for renewable (rural) energy was introduced in 2009. The policy aims to subsidise the provision of biogas for cooking and heating requirements, and solar and hydro based power for meeting the lighting requirements in rural and remote areas (REEEP, 2012a). In Maldives as well, provision of subsidies to expand renewable energy uptake is being considered by the government.

One of the major impediments to increasing energy access in **Afghanistan** is lack of funds. According to SARI-Energy, connecting each new customer would cost $1,000 in distribution costs itself, with Kabul estimated to require $310 million alone. The national utility Da Afghanistan Breshna Sherkat (DABS) earlier known as Da Afghanistan Breshna Moassassa (DABM) states that the current tariff regime is unable to recover any costs. In 2005, the revenue earned by the utility per kWh was $5.1 cents when the cost of generation was $12.3 (SARI/Energy, 2012).

In **Bangladesh,** the government regulates the prices of natural gas, prices of electricity and final petroleum products. Bangladesh has one of the highest subsidisation rates in the subregion with the average rate being 46.1% (IEA, 2011b). Total energy subsidy for the 2012 fiscal year amounts to nearly $3.9 billion (4.8% of the gross GDP) and nearly a quarter of the budget. The prices of petroleum products are subsidised and fixed by the government. Amongst petroleum products, diesel has the highest subsidy. For natural gas, the government increases prices occasionally to reduce subsidies but the prices are still low by international standards (BIDS & IISD, 2012).[6]

As **Bhutan** is dependent on India for imports of fossil fuel sources, the price of fossil fuels and other petroleum related products undergo changes as per fluctuation of prices of imports from India (Department of Energy, 2009). The government has plans of 100% electrification by 2013. For this, it is essential to subsidise electricity for domestic consumption. These subsidies are provided from royalty revenues accruing from power exports. These cross-subsidise domestic electricity prices, especially for rural consumption.

In **India,** most energy products are provided at subsidised rates to final consumers. In petroleum products, prices of domestic LPG cylinders, kerosene supplied through the Public Distribution System (PDS) and diesel are regulated by the government leading to a large burden on the oil sector in the form of under-recoveries, and the exchequer that shares this under-recovery burden. In 2011-12, the total under-recoveries were Rs. 1,38,541 crore (USD 28.91 billion) and the fiscal subsidy was Rs. 3023 crore (USD 631 million) (PPAC, 2012). Taxation policy of petroleum products is complex as both central and state

[6] Fuel prices were adjusted four times in 2011 and 2012 (BIDS & IISD, 2012)

government levy taxes on the products at different level wherein charges such as customs and central excise are levied by the central government and the sales tax is determined and collected by the state governments. Therefore despite the large burden of subsidies and under-recoveries, the sector remains a net taxed sector with tax related contributions amounting to as much as Rs 61,954 crore (USD 12.93 billion) in the forms of excise duty and Rs. 96,945 crore (USD 20.23 billion) as sales tax and a total contribution of Rs 2,32,769 crores (USD 48.57 billion) to the state and central exchequers in 2011-12 (PPAC, 2012).

Subsidies are also provided in the power sector where many state governments provide free power to rural areas and the agriculture sector, and subsidise the electricity tariffs for the residential sector. This has severely impacted the financial situation of power utilities and has impeded their ability to invest in expanding transmission networks.

In **Iran**, artificially controlled prices and government incentives to increase vehicle production were, for long, leading to an increase in the number of private vehicles and consequently gasoline consumption. Cognizant of the problems caused by an ever rising demand and low prices, the Government of Iran undertook energy reforms in December 2010 to phase out subsidies and replace them with cash transfers. Most citizens including children would receive these transfers. The Reform Act requires at least 50% of the revenue from reduced food and energy subsidies to be provided to households to compensate them for higher prices, with the remaining 30% to industry and 20% to government (Guillaume, Zytek, & Farzin, 2011). The price of heavily subsidized gasoline (for the first 60 liters purchased by each motorist per month) was increased to $0.40 per liter, from $0.10 per liter, and all gasoline purchased above the monthly quota was priced at $0.70 per liter going forward (Government of Iran, 2012).

Maldives provides subsidies to its power utilities. For instance, between June 2006-07, MRF 25 million (approx. USD 2 million) was provided as assistance by the government to island communities to sustain their power systems (MoEEW, 2007). Post the 2004 Tsunami, Maldives was also provided assistance by the Asian Development Bank for rehabilitation of power systems. Power generation costs in Maldives are high due to import of diesel that is the major fuel source for power utilities. A disparity in the tariffs between rural and urban islands has also been witnessed. Cross subsidies exist among consumer categories. Government business tariffs are higher than residential ones. Nearly 57% of the domestic category's bill is subsidised and paid to utilities (Climate Investment Funds, 2012). The National Energy Policy is seeking greater private sector involvement in the power sector (MoEEW, 2007). To reform the tariff determination mechanism for both conventional and renewable energy, measures are being taken under an ongoing technical assistance from ADB.

In **Nepal,** pricing of petroleum products is done with governmental approval. Currently, subsidies are provided on diesel and LPG. A Value Added Taxation (VAT) regime is followed for the pricing of these products. In case of electricity, prices are regulated by the Electricity Tariff Fixation Commission. Different price slabs are fixed for category-wise consumers. A time of day tariff has also been implemented in the country.

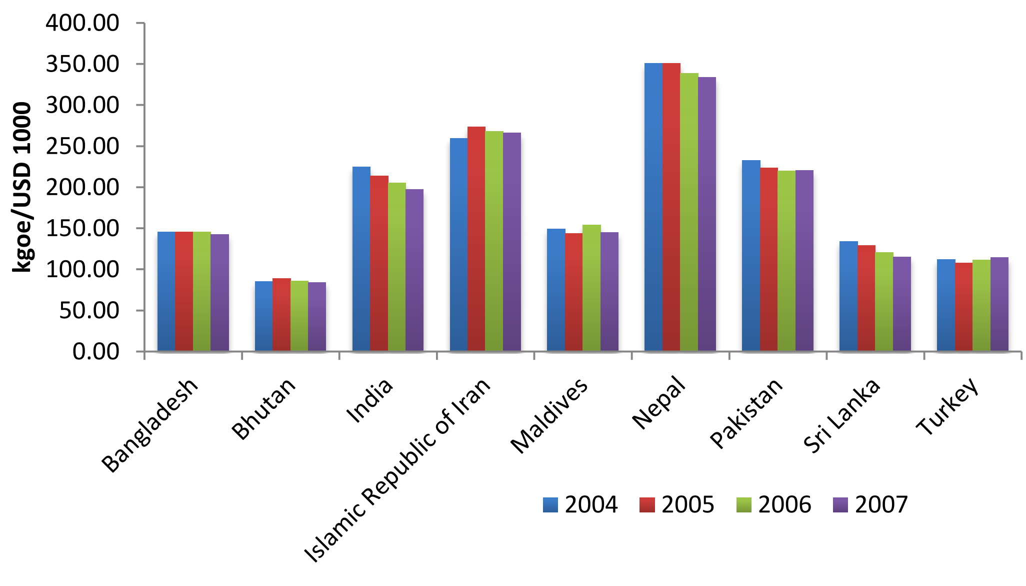
Both oil products and natural gas are subsidised in **Pakistan.** As per the IEA database (IEA, 2011b), the average subsidisation rate in the country was 28.9% in 2010 and subsidies formed 4.2% of the country's GDP. Largest subsidies are provided on natural gas (USD 4.93 billion) followed by electricity (USD 2.23 billion) and oil (USD 0.14 billion). IMF has warned the country to reduce this burden on fiscal balances. The inability of the government to compensate the power distribution companies for subsidies results in the latter not being able to repay their power purchase costs. This has led to mounting inter-corporate debt across government owned power companies (Trimble, Yoshida and Saqib, 2011).

As per the IEA database, the average subsidisation rate in **Sri Lanka** is 16.1% (IEA, 2011b). Subsidies are provided in the country on oil (USD 0.32 billion) and electricity (USD 0.19 billion). The rising international prices and relatively unchanged domestic petroleum product prices are leading to a mounting fiscal burden for the Sri Lankan government. Both petrol and diesel are priced below international market rates (Hook, Johnston, & Bland, 2011). The effectiveness of these subsidies has, however, been questioned by Coady *et al* (2006) who state that 25.1% of the subsidies were received by the bottom 40% of the population.

According to IEA (2009), **Turkey** imposes an 18% Value Added Tax on all energy products. In addition, excise taxes are also levied and based on per unit of energy and are dependent on the quality, content of energy and the end-user group. Excise taxes on gasoline and diesel have remained high. The electricity sector is subject to VAT only and the taxes focus on the energy sources rather than on competitiveness. Turkey has the highest prices in IEA countries for gasoline, diesel and heating oil. Oil products are expensive in relation to disposable income. The retail prices are also high as price caps were removed in 2005. High taxes on oil products are utilised to generate budget revenues (IEA, 2009).

For the development of renewable energy in Turkey, various incentives have been introduced. According to the report submitted by Turkey in Rio+20, license fee exemption, ease in renting and sharing rights in land allocations, discounts in system connection fees, discounts and exemption for various taxes and duties (Ministry of Development, 2012) have been introduced. With mandatory purchase obligations for distribution companies and application of feed-in-tariffs, incentives are provided to individual business entities establishing renewable energy production facilities of less than 500 kW (Ministry of Development, 2012).

Figure 10: Energy intensity of GDP (in $/kgoe)



Source: (World Bank, 2012f)

Note: The GDP used here is in constant 2005 dollars at PPP, Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport

2.2.3 Energy efficiency

Efficiency of energy production and use, as a component of demand side management, is as crucial to the subregion's energy security as enhancement of supply options. Energy efficiency can be measured for households, buildings, industrial processes, power generation and transport. To provide an indication of energy efficiency in the economies in the subregion, Figure 10 presents the trend in energy intensity of GDP in the countries of the subregion. It shows the units of GDP produced per kgoe of energy consumed in the country over four years.

The growing demand for energy in the subregion provides scope for adopting policies and processes that enhance energy efficiency in the industrial, residential, commercial and transport sectors. Large potential for gains from introducing energy efficient practices exists in all countries in the subregion and these gains, if translated into monetary terms, can lead to large savings for the economies of member countries. Especially in countries that have high transmission and distribution losses, energy efficiency translates into large reductions in electricity supply requirements.

Introduction of building energy codes, energy efficiency ratings, appliance efficiency standards, fuel efficiency norms, reduction of transmission and distribution losses in the power sector are all measures to enhance energy efficiency. In many countries of the subregion, several programs have been initiated to attain gains that can be achieved from energy efficiency. Energy audits, as a first step to identify the potential sectors for introducing efficiency measures, are being carried out in most countries of the subregion.

The limited access to electricity in **Afghanistan** implies that energy efficiency is still to emerge as an important concern. Without access to basic electricity services, the implementation or emphasis on energy efficiency is of little consequence. Needless to say, the expanding electricity sector could accrue benefits from donor agencies to invest in energy efficient distribution and generation systems for improving quality of services and save energy losses.

To ensure effective use of resources, the Government of **Bangladesh** has undertaken several initiatives and put in place good practices. In the electricity sector, the T&D losses have been steadily declining. The distribution system losses reduced from 25.34% in 2000-2001 to 12.10 % in 2011-2012. (Government of Bangladesh, 2012). Steps have been taken to revise the buildings code to add energy efficiency and use of solar energy, and to spread awareness about energy efficiency issues and renewable energy. Government, semi-government and autonomous organisations have been directed to use CFL bulbs in the next three years, and business communities are being encouraged to use solar energy. However, an energy efficiency law is lacking in the country which can help boost these efforts (The Daily Star, 2012a).

Recognising the need of energy efficiency, the Government of **Bhutan** is undertaking baseline study on energy efficiency covering residential, governmental and commercial buildings, transport, industry, and agriculture sectors (Government of Bhutan, 2012).

India has been initiating various mechanisms to enhance and expand energy efficiency in the country. The National Mission on Enhanced Energy Efficiency and the National Mission on Sustainable Habitat have been announced as part of the National Action Plan on Climate Change (NAPCC). The National Mission on Enhanced Energy Efficiency (NMEEE) aims to cut down the country's annual energy usage by 5% by 2015 (REEEP, 2012b). It is expected that the programs launched under the NMEEE will result in savings of the order of 10,000 MW by 2012 (PM's Council on Climate Change, 2008). The Bureau of Energy Efficiency (BEE) was set up in 2002 under the Energy Conservation Act of 2001. Different policies and measures have been introduced across sectors to reduce the consumption of energy. In 2011, a cap and trade scheme - Perform Achieve Trade (PAT), was introduced in order to support the shift towards energy efficiency in the industrial sector. The identified industry categories will participate in the trading of energy saving certificates (ESCerts). Comprehensive plan on labeling of appliances and a building code are also being implemented. The benefits are already visible in the savings so far. In 2009-10, the benefits were to the tune of 2868 MW of avoided power generation costs and the compounded cumulative electrical energy savings (w.r.t. 2007-08) were 32971 Million Units (MU) in 2009-10 (BEE, 2010).

The energy intensity of **Iran,** up to 2009, was considerably higher than the world average (Ministry of Energy, 2011) requiring improvements in energy efficiency in many sectors. The country has made efforts to reduce the energy intensity of its economy**.** The energy efficiency organisation (SABA) was established in 1996 with the aim of implementing the energy affairs department's plan of energy consumption rationalisation. In 2009, FAHAM (a national advanced metering infrastructure plan) was included in the agenda of the Iranian government and power ministry. FAHAM aimed at decreasing electricity losses by at least 1% per year and 14% decrease in overall network losses by 2015 (IEEO-SABA, 2012). The first phase of this plan was started in December, 2011. Iran is also aiming to improve the efficiency of its transport sector and to increase the usage of CNG therein.

Maldives aims to become a carbon neutral nation by 2020. In order to achieve this target, the government of Maldives has introduced several policy decisions like the National Energy Policy (2009-2013) and the National Energy Action Plan (2009-2013). Promotion of energy conservation and energy efficiency is one of the key issues identified in the National Energy Action Plan (2009-2013) (Climate Investment Funds, 2012). In order to meet this target, the country will need to affect reduction in energy intensity and dependence on fossil fuels. The tourism sector, which is both the largest consumer of energy as well as the largest source of GHG emissions, is being looked at for identifying potential for savings. Energy intensity is the highest in resort islands (Reegle, n.d.).

Nepal has potential for making significant gains by implementing energy efficiency initiatives. Introduction of labeling and rating programs for appliances, and energy audits to examine the energy consumption trends, will assist in reducing energy demand. A proposal has been made to set up a Nepal Energy Conservation Centre and a Nepal Productivity and Energy Conservation Centre. Projects on enhancing energy efficiency in the country have been undertaken in collaboration with GIZ and the Asian Development Bank.

The power sector in **Pakistan** suffers from major line losses and this lack of efficiency, in part, is one of the major causes of the persisting energy shortages in the country. The National Energy Conservation Centre (Enercon), administered by the Ministry of Water and Power is leading the move towards energy efficiency in Pakistan. Pakistan Energy Efficiency and Conservation Bill, 2011, has been introduced and is currently under consideration. Sectoral initiatives in buildings, transport, agriculture, power and industry have been recommended. As a first step to improve energy efficiency, energy audits and surveys have been carried out in high consumption sectors and demonstration projects have been put in place.

Sri Lanka has made efforts towards increasing energy efficiency. Energy labeling programmes have been developed for CFLs and are being developed for linear fluorescent lamps, ballasts and ceiling fans. A code of practice for energy efficient buildings has also been established and the capacity of energy managers and auditors is being built in the island nation. Efforts are also being made to reduce energy wastage and losses. A target has been set to reduce the technical and commercial losses to 12% and to achieve energy savings of 8.7% by 2020. Further, sector specific energy efficiency programmes have been introduced in the tea industry, hotel industry[7] and in the water supply and distribution in the country. The Government of Sri Lanka is also cooperating with the Japanese International Cooperation Agency (JICA) to promote energy efficiency in the country and the target of the programme is to reduce primary energy intensity below 500 toe/SDR by 2017 (SLSEA, 2010b).

Turkey's energy intensity has remained the same over a few decades. According to IEA, for every USD 1000 of GDP, Turkey requires 0.11 tonnes of oil equivalent of primary energy, 12% less than the European average (IEA, 2010). The Ministry of Energy and Natural Resources is the primary agency undertaking energy efficiency measures in the country. Majority of the work in this area is carried out by the Electrical Power Resource Survey and Development Administration (EIE). A key multi-stakeholder

[7] A Greening Sri Lanka Hotels project is being carried out under the Switch Asia Programme.

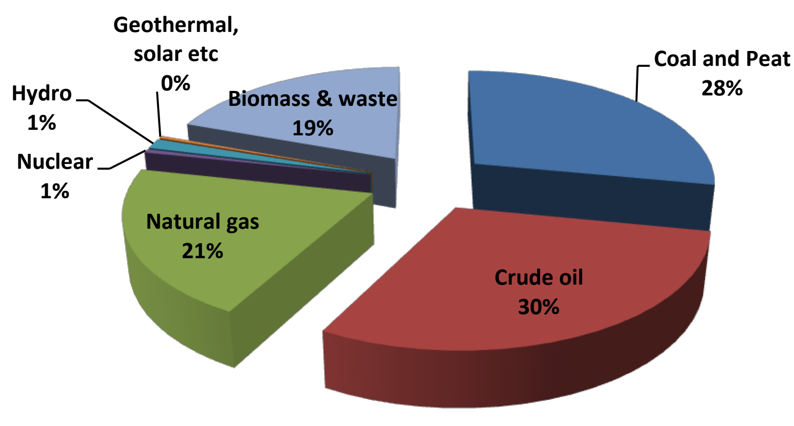
body, The Energy Efficiency Coordination Board has also been established to oversee the EIE. The Energy Strategy Plan sets a 20% primary energy intensity reduction target for 2023 compared with the 2008 levels (Ministry of Energy and Natural Resources, 2010). Turkey created an energy efficiency law in 2007 that is accompanied by various associated regulations. These regulations and policy framework are in consonance with the European Union laws on energy efficiency. The law aims to reduce energy intensity by 15% and targets the largest energy intensive sectors including manufacturing sector, transport, services, buildings as well as power sector.

2.2.4 Renewable energy[8]

Figure 11 shows a large contribution of fossil fuels to the energy mix. In order to reduce the fossil fuel dependence, it is essential for the countries in the subregion to develop their renewable energy resources. Countries such as Bhutan, Nepal, Maldives and Sri Lanka[9] are completely dependent on import of fossil fuels to meet their domestic requirements. Even India, Pakistan, Bangladesh spend a large share of their foreign exchange on importing crude oil. Despite having large oil and natural gas reserves (Iran's petroleum products' imports are significant.[10] Diversification of the energy mix to increase the share of renewable energy sources is essential in order to enhance the subregion's energy security, to reduce the impact of price shocks due to international crude oil fluctuations, and to mitigate the environmental externalities of energy production and use.

Renewable energy is ideal for addressing the energy access challenges of the region through decentralised electricity solutions. All countries in the subregion have immense potential for solar and biomass related power, and varying potentials for hydro and wind electricity. In view of this, many countries in the subregion have started programs with a focus towards developing their renewable energy-based power generation capacity. Solar energy and biogas are being looked at to provide decentralised electricity solutions in remote, rural areas in many countries in the subregion, including Bangladesh, India, Bhutan, Sri Lanka and Nepal.

Figure 11: Subregional energy mix, 2009



Source: IEA (2009)
*Afghanistan, Bhutan and Maldives are not included.

---

[8] This section includes a discussion on hydro resources – both large and small, as part of renewable energy.

[9] Cairn has recently discovered natural gas in Sri Lanka.

[10] According to the Iranian Ministry of Energy (2011), the imports of petroleum products fell significantly between 2009 and 2010

According to Rahman (2009), **Afghanistan** has a 304 MW installed capacity of hydropower, currently 183 MW is operational and there is potential for 25 GW including small and large hydropower. While the government plans to develop available resources, the prevailing conflict has been an impediment in the construction of physical infrastructure, specifically in provinces such as Kandahar. Solar energy is abundant with around 300 days of sun in the country. The solar radiation has been estimated to be 6.5Kwh per square metre per day. Two thousand individual projects of solar home systems (of between 20-40 W) have been installed. About 103 KW of lighting has been supplied with these installations. Wind energy has good potential in Afghanistan, with the south and west witness to around 120 windy days per year; 158 GW of electricity production is possible from this resource (Rahman, 2009).

Currently the renewable power generation capacity of **Bangladesh** is around 70 MW (Alauddin, 2012). The government has undertaken various initiatives to increase the share of renewables in the total power generation. The Energy and Mineral Resources Division reports that 50,000 household- and village-level biogas plants have been installed. The Renewable Energy Policy 2008 (MoPEMR, 2008) targets 500 MW of renewable energy by 2015 from various sources: 260 MW from solar and wind, and 206 MW from Solar Home Systems (SHS), biogas plants for cooking gas and power, solar mini grid, solar irrigation pump, and biomass based power. Bangladesh has also received support from ADB, as a part of the Asia Solar Energy Forum initiative, to develop 500 MW of solar power. Bangladesh's Solar Home Systems program has been very successful and is the fastest growing program in the world. According to the Government of Bangladesh, 230 MW of installed capacity for hydropower exists in the country (Government of Bangladesh, 2012). However, according to Gippner, (2010) the scope for hydro is rather limited due to the country's flat terrain and the large social and environmental impacts of these projects

Bhutan has tapped only 1,505 MW or 5% of its 30,000 MW of hydropower potential with 23,760 MW being techno economically feasible. As per the Government of Bhutan (2012), the installed capacity for solar is 0.152 MW. The solar resource in the northern and southern parts of the country was found to be 4.0 kWh/m^2 and 5.0kWh/m^2 per day respectively according to a study carried out by USAID (Department of Energy, 2009). The aim of the Rural Renewable Energy Development Project (funded by the ADB) is improving rural electrification and meeting rural energy demands. The scope of the project is on-grid electrification of 5075 households, off-grid electrification of 1896 households, installation & commissioning of 360kW pilot wind project and installation of 1600 biogas plant at the household level for cooking requirement.(Government of Bhutan, 2012)About 1,600 biogas systems will also be installed for cooking gas in remote households.

India has large estimated renewable energy potential from commercially exploitable sources: 48,5000 MW from onshore wind, 15,000 MW from small hydro, and 23,700 MW from biomass/bioenergy. In addition, India has the potential to generate 20-30 MW per square km. using solar photovoltaic and solar thermal energy (MNRE, 2011). India is implementing the world's largest wind resource assessment program comprising wind monitoring, wind mapping and complex terrain projects. This program covers 800 stations in 24 states with around 200 wind monitoring stations in operation at present.

India's Ministry of New and Renewable Energy (MNRE) is the apex authority for encouraging deployment of renewable energy in the country. Currently, renewables form about 12% of the total installed power generation capacity (MNRE, 2011). Several policies and initiatives have been announced to increase the uptake of renewable energy in the country. These include the Jawaharlal Nehru National Solar Mission (JNNSM) that envisages deployment of 20,000 MW of grid connected power by 2022. The Remote Village Electrification (RVE) program and the Village Energy Security Program (VESP) complement this program. The national goal for establishment of grid-connected renewable power is 72,400 MW in 2022. The potential for off-grid power has also been recognised by the MNRE. Regulatory interventions such as feed-in-tariffs and renewable purchase obligations have been introduced by state electricity commissions to assist in increasing the inclusion of renewable based electricity generation in the country. The country also has a large hydropower potential, only 33% of which has been exploited. Hydro-electricity plays an important role in meeting India's growing power demand but the social and environmental costs associated with the construction of large reservoirs and dams need to be paid attention to.

Iran has significant potential for renewable energy. The wind energy potential is approximately 40,000 MW of which about 18000 MW is in operation. The solar energy potential is about 60,000 MW over 2000 sq/km of area. In addition, it also has the potential for geothermal energy. In Meshkin-shahr, North-West of Iran, a geothermal power plant is under construction and installation. At present, Iran has reached a total of 209.3 MW of renewable electricity including 99.46 MW wind, 32.04 MW PV, 18.8 MW bio-mass and 59 MW small hydro (Iran has 7500MW medium and large hydro power) (Government of Iran, 2012). According to the 5th development plan of the country, Iran envisages increasing its renewable energy capacity. The government of Iran has facilitated investments through financial incentives for development for wind and solar power and inviting participation from private and cooperative sectors. Although the installed capacity of renewable energy in Iran is still low, considerable infrastructure development is being undertaken, such as designing and implementing completely domestic solar thermal power plants in the country, manufacturing localized middle-size 660 KW wind turbines and finally designing and manufacturing of large scale wind turbines (2.5 MW) (Government of Iran, 2012).

Maldives has an average of 280-300 sunny days (Waheed and Azwar, 2011). Thus, there is extensive potential for harnessing solar energy, Wind energy potential has also been mapped and significant wind speeds have been registered in the country. The government of Maldives is undertaking extensive efforts to achieve carbon neutrality by 2020. It is one of the six pilot countries participating in the Scaling Up Renewable Energy Program in Low Income Countries (SREP). The investment plan formed under this envisages that out of the total $139 million, $47.5 million would be from private investors (Climate Investment Funds, 2012). To attract investments various financial and risk mitigation tools such as elimination of import duty on RE products, and introduction of an FIT are being planned. The SREP Investment Plan focuses on solar PV, waste-to-energy and small and medium wind energy projects. Investments under this plant will result in the installation of 26MW of renewable energy generation and a reduction of almost 56,000 tCO_2/year in GHG emissions. Also, around 22 million litters of diesel consumption can be avoided (Climate Investment Funds, 2012).

Nepal has large renewable energy potential including both hydropower and solar for electricity, and biogas-based energy for meeting the cooking energy requirements in the country. The Alternative Energy Promotion Centre (AEPC) was established to increase the uptake of all forms of renewable energy. The hydropower potential of the country needs to be developed more proactively. There is room to expand the usage of renewable biomass in the form of biogas that will meet cooking energy requirements. Several programs aimed at increasing the share of renewable energy have been introduced under the aegis of the AEPC. These include the Biogas Support Programme, Energy Sector Assistance Programme (ESAP), Improved Water Mill (IWM) Programme, and Renewable Energy for Livelihood Programme (RELP), and the Renewable Energy Project (REP). The Government introduced a policy to sell 10% ethanol-blended petrol in 2004 but this has not been implemented yet. The primary challenge faced here was the price of ethanol. In 2009, the Government of Nepal put forth a plan to develop 25,000 MW of hydro-based power generation in 20 years (WECS, 2010).

Investments in renewable sources of energy are being made in **Pakistan** but currently renewables do not form a significant part of the energy mix in the country. The Alternative Energy Development Board (AEDB) is responsible for ushering in the growth of renewables. The total wind potential as estimated in 1990 by National Renewable Energy Laboratory (NREL) is 69,226 km^2 Class 3-7 winds at 50 m. According to the Alternative Energy Development Board (AEDB), the total hydroelectric potential in the country has not been fully investigated, but has been conservatively estimated to be 45,000 MW. According to Sheikh (2009), the micro/mini hydel potential of the country is 1200 MW.

According to the Sustainable Energy Authority (SEA) of **Sri Lanka**, studies are required to assess the wind energy potential of the country (SLSEA, 2010). Sri Lanka already has several ongoing large hydro generation plants. The potential for economically feasible, small hydro plants (with capacity of less than 10 MW) is estimated at 400 MW. As per the National Energy Policies and Strategies of the Ministry of Power and Energy (2006), the share of renewables needs to be increased to 10% of the energy mix by 2015. The Sustainable Energy Authority also carries out Awareness Programmes for officials to reduce delays in achieving the target. On- grid and off-grid electricity provision in rural areas has been undertaken as part of the projects funded by GEF and World Bank. In 1998, the Energy Services Delivery programme was launched followed by the Renewable Energy for Rural Economic Development Project in 2003 and Renewable Energy for Rural Economic Development Additional Funding in 2008. Off-grid solutions include provision of solar, wind and biomass-based energy to households.

Wind, solar and thermal are the key energy sources in **Turkey** with wind potential estimated to be 8000 MW and solar potential stated to be about 35 Mtoe per year. Geothermal energy potential in Turkey is also significant at 35,000 MW (Yuksel, 2010). Yet, the share of all three has remained miniscule in the energy mix. Turkey has significant hydropower potential with around 22 dams planned around the Euphrates and Tigris rivers. Turkey's hydropower potential can meet about 33-46% of the country's electricity demand in 2020 (Yuksel, 2010). Turkey intends to increase the share of renewable energy in electricity generation by at least 30% by 2023 (Capik *et al*, 2012).

Currently, Turkey has 228 hydroelectric power plants with a total installed capacity of 14,503 MW and hydro-electricity generated is 50,487 GWh/yr. The government proposes to expand its hydropower capacity to 35,000 MW by the year 2020. Wind energy is also envisioned as a significant resource for the country; the Strategic Plan (2010-14) of the Turkish Ministry of Energy and Natural resources predicts that wind energy capacity would reach 10,000 MW by 2015 and 20,000 MW by 2020. Turkey's annual biomass potential including annual crops, perennial crops, animal waste, forest residue, residues from both agro and wood industry, and others, in total accounts for 117 MT, offering an energy potential of 32 Mtoe (Capik *et al*, 2012). Biomass energy is a significant source for rural and remote areas in the region.

2.2.5 Energy trade

All the countries in this region (except Iran) are heavily dependent on fossil fuel imports to meet their energy requirements. However, energy trade within the subregion (if we exclude the imports from Iran) is not very significant. Though a number of energy trade possibilities have been discussed at various levels, trade amongst South Asian economies remains limited. There is no inter-country natural gas trade through pipelines. Electricity trade in the subregion is insignificant despite large potential. While section 3 of this report will delve into subregional trade opportunities, this section will discuss the trade relations that subregional countries have both within the subregion and with external actors. Most of the countries in the subregion face several challenges such as finance, lack of infrastructure, regulatory deficits as well as geopolitical tensions that have been roadblocks in building energy ties. Turkey has emerged as a major transit corridor for the global energy market.

Afghanistan has vast untapped resources that, if effectively developed, would prove to be instrumental in meeting domestic energy demand, and in earning resource revenues. Afghanistan would be a significant player in the formation of an energy corridor connecting Central Asia, Caspian, Middle East and South Asia. The Turkmenistan-Afghanistan- Pakistan-India (TAPI) pipeline is one major corridor. In 2009, the Hydrocarbon Law of Afghanistan shifted energy from being a state-owned sector to a fully privatised one. Since then, various multinational companies have shown keen interest in exploring oil and gas in the country. Six blocks have been offered on the Afghan-Tajik border, with around eight firms (including Exxon) showing interest to bid for these blocks. China has already won a block in Afghanistan (Reuters, 2012). The resource figures suggest presence of significant resources, with natural gas estimated to be around 3.6 to 36.5 tcf, and oil about 0.4-3.6 billion barrels (Blank, 2006).

China has shown keen interest in developing a pipeline project from Turkmenistan to China via Tajikistan and Afghanistan. Afghanistan is already an observer on the Energy Charter Treaty and the Shanghai Cooperation Organisation, two significant entities for fostering energy trade.

Petroleum products, coal and crude oil form the bulk of **Bangladesh's** energy imports. In 2010-11, it imported 1.4 million tonnes of crude oil and 3.2 million tonnes of refined petroleum products. Most of its petroleum needs are met through imports. It has trade ties with India, Kuwait, Saudi Arabia, UAE, Malaysia, Philippines and Singapore for crude and petroleum. There is a proposal to build a 100 km pipeline from Siliguri in India to Parbatipur in Bangladesh to export High Speed Diesel (Singh, 2011).

Bangladesh imports coal from Australia, India, Indonesia, Mozambique and South Africa (Government of Bangladesh, 2012). While there have been some problems in coal trade between Bangladesh and India (The Telegraph, 2011), the two countries are working to set up coal-based power plants in Bangladesh (Ahmed, 2012). The country is also interested in importing electricity from India, Bhutan and Nepal. A 500 MW grid interconnection project to facilitate electricity imports from India is underway. Bangladesh has agreed to cooperate with Nepal to manage its water resources and hydropower and it has also proposed to set up a hydropower project as a joint venture (The Daily Star 2012b; The Daily Star 2012c). The country has also signed a cooperation agreement with Russia to build two nuclear power plants in Rooppur of Pabna district of 1000 MW each(Government of Bangladesh, 2012). The country is also investing in LNG terminals with a view to bolster domestic supply with imports.

Bhutan has abundant hydropower and is a net exporter of electricity. Approximately 75% of the electricity generated is exported to India (Department of Energy, 2009). As the production of Hydropower is seasonal in nature, during the lean season months of November-February, the peak demand of the country rises which the firm generation capacity is unable to meet, leading to imports of electricity from India (Government of Bhutan, 2012).All of Bhutan's petroleum needs are met through imports from India. India has played a very important role in the development of hydropower in Bhutan which contributes over 19% to the GDP and contributes to more than one third of the government's annual revenue (MEA, 2011).

With the rising demand for energy coupled with the lack of domestic reserves, **India** is increasingly reliant on imports to meet the demand for conventional fuels. India imports nearly 80% of its domestic crude oil requirements and more than 10% of domestic coal requirements. The country will increasingly also need to import gas following the recent decline in domestic production. India is largely dependent on West Asia for crude oil imports and on Indonesia, Australia and South Africa for coal imports. Cross border linkages also exist in power which is imported from Bhutan and exported to Nepal. While, overall the country is a net importer of energy, the increase in refining capacity has contributed to making India a net exporter of refined petroleum products – particularly middle distillates. In 2011-12 almost 61 MT of petroleum products with a value of Rs. 284,644 crore were exported (PPAC, 2012).

Iran ranks among the top four countries in terms of proven reserves for both oil and natural gas. However, the refining capacity in Iran is not enough for the country's demand leading to imports of petroleum. The country is now investing in the construction of new refineries (Mohammadnejad, Ghazvini, Mahlia, & Andriyana, 2011). In 2010, it was the third largest exporter of crude oil in the world exporting around 2.2 million bbl/d of crude oil; its net oil export revenues amounted to approximately $73 billion (EIA, 2012). The top three export destinations for Iran were China, Japan and India. However, the sanctions imposed by the US and European countries on Iran in reaction to its uranium enrichment program has had some effect on Iranian exports. However, recently, exceptions from USA's unilateral sanctions were granted to Iran's 20 major buyers. .

Apart from oil and natural gas, Iran is also a net exporter of electricity. Currently it exports to Armenia, Pakistan, Turkmenistan, Turkey, Azerbaijan, Nakhichevan, Iraq and Afghanistan. Its electricity exports have increased over 46% this year as compared to the last (Press TV, 2012). Azerbaijan and Armenia also supply power to Iran due to seasonal biases. Iran also exports natural gas to Turkey and Armenia via pipelines. Some of the other pipeline projects under construction are Iran-UAE pipeline, Iran-Europe gas export pipeline and Iran-Pakistan pipeline.

Maldives is completely dependent on fossil fuel imports for its electricity and other energy needs. The State power utility and the other 1,000 other electricity generators in outer islands utilise diesel fuel oil for power generation. In 2011, Maldives spent $340 million on oil based imports (excluding bunker fuels) and the expenditure is expected to rise in 2012 to around $450 - $500 million In 2011, it spent $261 million (around 20% of its GDP) to import 316 thousand toe of diesel. Diesel forms around 81% of its fuel imports with around 44% being used for electricity generation (Climate Investment Funds, 2012). With increase in oil prices as well as the growth in consumption, the imports will increase significantly leading the country to spend a large part of its revenues on oil imports.

Nepal depends on imports to meet a significant proportion of its total energy requirements especially fossil fuels that are mostly imported. Refined petroleum products are imported from India, and the rising demand supply gap has also made the country dependent on India for meeting its electricity needs. In 2010-11, 694 GWh was imported from India (MoF Nepal, 2012). Power transmission links of 132 kV exist between the countries along Duhabi-Kataiya, Gandak-Ram Nagar and Mahendra Nagar-Tanakpur. While power trade links with India can be further strengthened, authorities in Nepal are cautious of excessive dependence on India (Gippner, 2010). A government-to-government umbrella framework agreement for power trade between the two countries can facilitate cross border trade in electricity (Gippner, 2010; Pandey, 2012). The development of power sector infrastructure requires investment and private participation and to address this, the Government of Nepal has opened the hydropower sector to foreign investment (Gippner, 2010).

Pakistan is a large importer of refined petroleum products. Imports mostly originate in West Asia. Possibilities of importing electricity from neighbouring Iran, Central Asian countries and India exist (Raza, 2012). Steps are being taken to increase energy collaboration between India and Pakistan. In August 2012, a group of experts from India and Pakistan met in Islamabad to discuss the possibility of cross border transmission connection with a capacity of 500 MW (PIB, 2012a). Joint Working Groups have been set up to explore opportunities for energy trade between the countries (PIB, 2012b). Pakistan is also in talks to develop cross border natural gas pipelines – the 1680 km long Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline and the Iran-Pakistan-India pipeline that will provide gas to the country. A sub-sea Qatar-Pakistan gas pipeline is being considered to support the declining domestic gas supplies. Coal is imported from Indonesia, South Africa, Australia and Canada (UNSD, 2012a). Pakistan is also collaborating with China in developing its energy resources - the Chashma 2 nuclear power plant was built and is being operated with Chinese support (Dalton, 2011).

Sri Lanka is dependent on imports of hydrocarbons to fulfil its domestic energy requirements. The rising demand for energy has made the country increasingly dependent on imports of energy sources. Crude oil is imported from countries in West Asia, particularly Iran that supplies over 90% of Sri Lanka's crude oil imports. Further, the largest Indian public sector, petroleum refining and distribution company, Indian Oil Corporation limited (IOCL), has its overseas venture Lanka IOC Plc in the country and the company has grown to become one of the largest private sector companies in the country.

An HVDC connection between Sri Lanka and India through the Gulf of Mannar has also been proposed to connect the power transmission networks of the two countries under the SAARC and BIMSTEC regional grid (SARI/Energy, nd.b.). The project has been contemplated for many years but has not come to fruition. The energy plans of Sri Lanka have indicated a move towards developing coal-based power generation facilities and to meet the demand for coal, imports will need to be increased (Pryantha, 2009). Efforts are also being made to engage with Maldives to enhance energy trade between the two countries.

Turkey is heavily dependent on fossil fuels for its energy needs and majority of these are imported. According to a report submitted by Turkey during Rio+20 in 2012, the country has stated that the imports-driven energy sector in the country negatively impacts the country's sustainable development (Ministry of Development, 2012). It states that the current account deficit to GDP was at 10% in 2011 due to import dependence and rising international oil prices. Turkey relies heavily on imports of gas as well as coal. Turkey's main supply pipelines are ones that deliver gas from Russia, transiting through Romania and Bulgaria. The other supply line is the Blue stream pipeline that runs through the Black sea. Russia accounts for about 50% of Turkey's natural gas supply. Other than natural gas imports, the main source of energy for Turkey is coal.

Turkey is a nation that lies in middle of a natural resource haven with 72% of proven gas and 73% of oil reserves of the world in its surrounding nations. With Caspian on one side, Asian countries on the other, close proximity to Northern Africa, East Europe and Russia, the country is significant as a transit state. Many natural gas pipelines are moving across its territory, while it is also a significant consumer of the resource. The Turkish straits are an important sea route for energy trade, with 3.7% of the daily oil needs being transported through this sea lane (MoFA, 2009). As the window to the Caspian and energy rich West Asia, its role in European energy markets is significant. With the growing pressure on the Turkish straits, the Turkish government has supported the Trans Anatolian by-pass pipeline that would divert some of the oil traffic to other major hubs such as Ceyhan. As a part of the East-West energy corridor Baku-Tbilisi-Erzurum pipeline also became operational in 2007 delivering gas from Azerbaijan, through Georgia to the Georgia-Turkey border.

2.3 Linkages between sustainable development and energy challenges

It is clear from the discussion above that sustainable development and energy are intrinsically linked. The provision of sustained supply of modern energy services has positive impacts on standard of living, enhances livelihood opportunities, empowers women and also enables the facilitation of basic services such as health and education. Renewable energy and energy efficiency interventions today, in addition to better management and utilisation of conventional fuels, is important both for the enhancement of energy security and for the mitigation of the negative environmental impacts of energy processes. The critical linkages between energy and sustainable development find ample illustrations. Lack of access to energy affects incomes and reduces livelihood options. Biomass is an important renewable energy resource available in SSWA countries with large agrarian economies. However, inefficient use of biomass in traditional cookstoves and excessive harvesting of biomass is a threat to health and forest resources. Here, with a focus on some key development-energy linkages, we seek to unravel the energy-sustainable development matrix. These cases also highlight the importance of targeted interventions that are alive to local contexts.

2.3.1 Lighting for education

Children in remote and rural areas without energy access are unable to study in the evening after dark. The provision of electricity removes these barriers and provides children with enhanced opportunities for education. Access to power also facilitates literacy programs for those engaged in work during day hours. SELCO, a for-profit social enterprise in India, that provides solar PV technology to households and commercial establishments holds out an example here. The main target constituency for this enterprise is rural households and the systems provided are customised according to the needs of each rural household. The enterprise has tied up with banks to provide soft loans to consumers for purchase of the systems. An impact assessment study of the project highlighted that 86% of poor customers stated significant savings in energy costs and the primary benefit cited was the education of their children (TERI, 2012a).

2.3.2 Empowering women

A large part of the responsibility to provide household energy services lies on women, especially in rural areas of developing countries. Women are involved in gathering firewood, making cow dung cakes, and are the main users of traditional cookstoves. Provision of adequate, safe and clean energy, therefore, has a positive impact on their lives, providing them time for income-generating activities, improving their health and reducing the load of household work. A number of governmental and non-governmental initiatives in SSWA countries have taken into account the gendered impacts of lack of energy access, and have launched programs with these in view. According to an ADB report, one such example of women themselves undertaking efforts to facilitate provision of energy is the Solar Warriors of Bhutan (ADB 2009). As a part of the programme to train people in rural electrification funded by ADB, 35 rural, illiterate Bhutanese women were chosen as Solar Warriors who took part in the rural electricians training programme held by the Barefoot College in Jaipur, India. Since 1989, Barefoot College has been conducting solar electrification in rural, remote, non-electrified villages in India. It trains poor, rural and illiterate people in solar electrification as Barefoot Solar engineers. Within 3 months of returning to Bhutan after the training, these women Solar Warriors set up workshops in their villages and installed panels in around 504 households in 46 villages in 13 districts. They also provided maintenance services for repaired panels. The impact of this initiative was two-fold: first, empowerment of women through capacity building and employment, and second was the positive impact of the provision of energy services on the rural women's daily lives. Across these electrified households, there was a reduction in use of kerosene, fuelwood and resin. It saved many women, long treks to collect wood or purchase kerosene, in difficult hilly terrain (ADB, 2009).

2.3.3 Creating livelihoods

The provision of energy creates and enhances livelihood opportunities. A case in point is the Solar Home Systems in Bangladesh that has created livelihoods at various stages of the implementation of the programme. The initiative is a collaboration between six partners including the Government of Bangladesh and various donor agencies. The programme runs through disbursement of grants by Infrastructure Development Company Limited (IDCOL) which offers grants to micro-finance institutions, NGOs, private sector organisations, amongst others, to purchase the SHS systems. While the participatory organisation receives 10% of the system cost as down-payment from households purchasing SHS and enter into a lease agreement, these organisations also provide the after-sales services. The programme has created income opportunities for participating organisations, distributors of SHS equipment, and service providers. It has also enhanced livelihood opportunities for owners of small business enterprises who could keep their units open till late in the evening (TERI, 2012a).

2.3.4 Protecting the environment

Most SSWA subregion countries are dependent on fossil fuels for energy. Efforts are, however, being made to move the energy mix towards the use of cleaner fuels. In addition, countries are implementing sectoral programmes to increase efficiency of energy use. Energy is the largest contributor to greenhouse gas emissions and any effort to tackle climate change necessarily calls for energy interventions. The Indian government's National Action Plan on Climate Change stated the need to focus on activities that have dual benefits for energy security and climate mitigation. A number of urban and rural energy interventions can be designed that serve this purpose. Design and implementation of programs that force a shift in modes of transport from personal vehicles to public transport options is a contributor to reduction in passenger vehicles and fuel used per passenger kilometre. At the same time, it is a significant contributor to reduction in city pollution levels and emissions from the transport sector. Similarly, rural energy programs that seek to provide adequate, clean fuels to households not only improve energy security at the household level but also bring down indoor pollution and emissions. For instance, the deployment of energy efficient cookstoves in Thatta, Pakistan, helped achieve multiple energy and environment goals. The primary aim of the project was to distribute energy efficient products such as improved cookstoves and to build the capacity of local community-based organisations to address environmental concerns. The impact of the project was significant on the environment wherein, for 1150 households, the project reduced indoor air pollution by 80%, fuelwood consumption by 40-60%, health impacts of cooking energy by 25-50%, GHG emissions by 50% and household energy expenses by 50% (UNDP, n.d.).

Appropriately designed energy interventions accelerate the process of achieving sustainable development goals. At the same time, it is notable that no sustainable development program can be effectively implemented in the absence of basic energy services. As the economies of the SSWA region chart their development pathways, planners need to be cognizant of these linkages and the inter-dependence of development objectives. While countries face unique challenges and the need to design programs for localised needs cannot be overstated, the shared energy and development concerns that mark this region trigger thinking on how the subregion can work together to assist national governments and what scope exists for the subregion to articulate a common energy vision. In a global context marked by a strong tendency towards economic regionalisation and establishment of regional free trade areas, the SSWA subregion has failed to operationalise a collaborative framework for action on economic and social priorities.

3 OPPORTUNITIES FOR THE SUBREGION: ENERGY IN A COLLABORATIVE FRAMEWORK

It is clear that countries in the subregion share many energy concerns. There also exist complementarities that hold out promise for cooperation. This is despite the fact that countries in South Asia do not boast of large indigenous energy reserves, apart from availability of hydro-based power in Nepal and Bhutan. Bringing South West Asian countries, Turkey and Iran, into the purview of the study brings in new dimensions. While Turkey’s strategic importance as a transit country is relevant more to continental Europe, which sources supplies from Russia and the Caspian Sea region through Turkey, Iran’s rich oil and gas reserves bring a large world energy supplier into the ambit of subregional analysis. This offers further opportunities for energy trade, in addition to possibilities for inter-country cooperation on building energy infrastructure, conducting joint prospecting for reserves, power trade, and technology development.

The following section enlists the driving forces for cooperation: the prospect of effectively utilising inequitably distributed resources in the subregion; development of adequate infrastructure; the need to address energy access concerns; creation of efficient subregional energy markets; and promotion of sustainable energy choices and practices. Through an exploration of the subregional energy landscape, and citation of specific utilised and untapped opportunities, it provides a blueprint for subregional energy cooperation.

3.1 Improved utilization of unequally distributed resources

Energy production centres often do not overlap with centres of high energy consumption. Also, energy resources and capabilities are unequally distributed across a geographical region, and exploitation of resources in one country has repercussions for others. This necessitates inter-state interaction on energy issues. By its inherent nature, therefore, energy policy incorporates inter-state cooperation and management of ties with external partners. This holds good for the subregion; surplus resources are available in countries where technical capacity for resource development is not high, and temporal changes in demand and supply create complementarities for trade.

3.1.1 Resource estimation itself remains an area of uncertainty in the subregion. Could the countries in the subregion collaborate to bring more clarity on available reserves?

Resource estimation, the starting point for national and subregional energy planning, itself remains a concern in some countries in the subregion. Lack of quality data and uncertainty over reserves can lead to the promulgation of policies based on false presumptions, with serious consequences both in the short and long term. Recent studies that indicate a vast over-estimation of India's coal reserves, suggest that an appropriate estimation of the country's reserves would bring the reserves-to-production (R/P) ratio down from 200 years to 40 (Batra and Chand, 2011). This holds testimony to the need for countries in the subregion to adopt globally accepted procedures for classification of mineral resources and reserves.

A range of energy opportunities exist in the subregion that need to be supported by reliable data for the furtherance of investment and policy action. Also, there are opportunities for countries to collaboratively estimate resource potential where the resources and the techno-economic capabilities for exploration are available with different countries in the subregion.

A cloud of uncertainty has marked gas reserves in Bangladesh, and oil and gas companies in the subregion can play a role in prospecting for gas in the country. Increased production of natural gas would be a boon not only for energy-deficient Bangladesh but also for surrounding India and Pakistan which have large requirements of gas for their power and fertilizers industries.

Some cross-country engagement on resource exploration is underway. Some of the examples are Cairn India's discovery of gas in the Mannar coast off Sri Lanka, a country which has been dependent on imports for all its hydrocarbons requirements. The commercial viability of the blocks is yet to be established. The Sri Lankan government is slated to auction oil and gas exploration blocks in the Mannar and Cauvery basins, and this offers a good opportunity for oil and gas companies in the subregion, particularly in India, to employ their exploration and production capabilities for the development of Sri Lankan resources.[11]

3.1.2 Maximisation of trade potential is a priority for regional initiatives the world over. Is the subregion paying attention to prospects for energy trade?

Uneven distribution of energy resources necessitates trade in energy goods and services. The subregion, due to non-avalability of significant surplus reserves offers limited potential in energy trade. Yet the available potential too has not been thoroughly exploited.

Oil and gas

One of the foremost areas of opportunity is that offered by oil and gas trade between Iran and other countries in the subregion. Iran is home to about 12% of the world's proven reserves of oil (Government of Iran, 2012), and is already an important supplier for countries in the subregion. However, the standoff between Iran the US and EU over Iran's nuclear program, and the sanctions imposed have impacted Iran's energy engagement with other subregional countries. While the subregion dwells on opportunities for enhancing energy ties, in such a scenario, the impact of extra-subregional politics on inter-state interactions cannot be discounted.

[11] One of India's largest public sector oil and gas companies, Oil and Natural Gas Corporation, has sought exploration rights off Sri Lanka's coast.

Table 16: Existing Non-Power Energy Trade in the Region

India-Nepal, Bhutan, Bangladesh, Sri Lanka (petroleum products)	Nepal and Bhutan are dependent on India for petroleum products, Sri Lanka and Bangladesh too import from India
India- Bangladesh (Coal)	Bangladesh imports from India
Iran-India-Pakistan-Turkey (Oil)	Iran is among the major sources of oil for India, Pakistan and Turkey
Afghanistan-Pakistan-Iran	Afghanistan imports power from Iran and Pakistan. However, power situation is improving in Afghanistan which may not import power for long.

Source: TERI compilation

A Cross-country pipeline from Iran has also been considered as a possible option. The Iran-Pakistan-India gas pipeline project, envisaged first in 1989, planned to tap gas from Iran's South Pars field, and involved the laying of a pipeline from Assaluyah in Iran to the Pakistan border, covering a distance of 1115 km, and a further 760 km through the territory of Pakistan to the Indian border. Within India's territory, the pipeline was to travel a further distance of 900 km to connect the north Indian gas market (Batra, 2007). However, extended consultations have continued over the years on price of gas to be paid by India and Pakistan. Currently, the project is being considered as a pipeline between Iran and Pakistan. .

On the Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline, Afghanistan and Pakistan are both gas importers as well as transit countries, and India is the final import destination. The four participating countries recently signed the Gas Sale Purchase Agreement. The project plan envisages that the pipeline, extending from the Yolotan-Osman gas fields to Fazilka at the Pakistan-India border, will be operational by 2018. The 1680 km-long pipeline is expected to transport 90 mmscmd of gas, out of which 38 mmscmd each will be India's and Pakistan's allocation, and the remaining gas will be for Afghanistan. The contract price of the pipeline gas is linked to a formula that contains indices based on fuel basket and other indices not as volatile as crude oil (The Hindu, 2012). The Indian cabinet also agreed recently to pay 50 cents per mmBtu to Pakistan and Afghanistan as transit fees. The project has been welcomed as a positive step by the governments involved.

Petroleum products

India has emerged as a sub-regional refining hub and the trade of petroleum products from India to other countries in the subregion offers scope for increase. Already, Bhutan, Nepal, Pakistan, Sri Lanka and Bangladesh, import petroleum products from India. One of India's leading public sector, petroleum refining and distribution company, Indian Oil Corporation Limited (IOCL) has an overseas venture, Lanka IOC Plc, in Sri Lanka. Lanka IOC holds one-third share in Ceylon Petroleum Storage Terminals Ltd, the Common User, Facility for storage and distribution of petroleum products. Most of Bhutan's petroleum requirements are met through Indian exports. Nepal's complete petroleum products requirement, 11% of total energy consumed, is sourced from India, under a five-year contract signed in March 2007 between Nepal Oil Corporation Ltd. and Indian Oil Corporation Ltd. In view of the increasing demand for petro-products, an MoU has been signed by the two companies for the construction of a cross-border pipeline for petroleum products trade from IOC's Raxaul depot to NOC's depot, Amlekhgunj (Nepal Oil Corporation Limited, 2009).[12] Pakistan and Bangladesh import significant part of their refined oil from UAE and Singapore respectively which are also the major export destinations for Indian refined oil. Thus, there is scope for trading in refined oil within the regions that is still unutilised.

[12] Following the completion of a Detailed Feasibility Report (DFR), the construction and investment modalities are being discussed by the companies (Nepal Oil Corporation Limited, 2009).

The significance of petroleum products trade in the subcontinent has urged the governments of India and Pakistan to establish the India-Pakistan Expert Group on Petroleum and Petrochemicals Trade. The recent round of talks under the expert group, in July 2012, focused on the identification of possible supply routes, points of supply, definition of standards and regulations, and enhancement of direct banking and postal services. The talks as yet have seen limited success, with no consensus on a long-term supply agreement and the related clause of building a pipeline. There has, however, been some agreement on allowing petroleum products trade on land via the Wagah border. The high shipment costs is a deterrent for Indian oil companies to supply to Pakistan and, at present, trade in liquids is not allowed on land routes (Bhutta, 2012).

Power inter-connections

Since a large part of the region is not well endowed with fossil fuel reserves, harnessing of hydroelectric potentials and power trade are of significance. Power trade is currently ongoing in the subregion yet there is scope for expansion. Table 18 lists existing power inter-connections in the subregion. Among the South Asian countries, Sri Lanka has almost exhausted its potential hydropower capacity. The potential capacity in Bangladesh is quite low. India has almost half of the potential hydroelectric capacity of the subregion, yet the total potential cannot even satisfy the current level of demand in the country. Pakistan is in a better situation but its potential is not enough to meet its demand in the long run. With low current utilisation levels, however, Afghanistan, Bhutan and Nepal offer substantial surplus electricity generated from hydropower alone that can be exported to other countries. The current installed capacity in Bhutan is about 1505 MW as against the technical potential 23,760MW (total being 30,000 MW) Bhutan and India have a National Transmission Grid Master Plan for evacuation of power from Bhutan to India up to 2030. Though India and Pakistan are unlikely to export electricity to other countries on a net basis, they can be engaged in exchanges with neighbouring countries. Iran and National Thermal Power Corporation of India are planning to work together on a power plant of 3000MW for export of power to India through Afghanistan and Pakistan (Government of Iran, 2012).

Table 17: Interconnections in the electricity sector

Countries	Subregional interconnections
Afghanistan	Power system is fragmented. Externally is interconnected with and imports from Iran and Central Asia.
Bangladesh	Interconnection with India under construction
Bhutan	Externally interconnected with India, exports power to India. Some small reimports from India as well.
India	Externally interconnected with Nepal (exports power to) and Bhutan (imports power from); subsea interconnection with Sri Lanka for export of power under development; lines with Bangladesh under development
Iran	Interconnected with Afghanistan, Pakistan and Turkey to export power
Maldives	Not interconnected
Nepal	Interconnected with India, imports power in limited quantity.
Pakistan	Interconnected with and imports power from Iran. Interconnection for imports of power between Central Asia (via Afghanistan) under discussion
Sri Lanka	Interconnection with India for import of power under development
Turkey	Interconnected with Iran for import. Interconnection between Central Asia (via Afghanistan) under discussion

Source: Adapted from Gippner (2010)

There exists clear seasonality in hydropower generation that can be exploited for furthering trade. The peak months for hydro-power generation are August-September while the lean remain from January to June. Such seasonal complementarities in power production and demand underscore the importance of trade. High demand season in one country coincides with a season of energy surplus in another. Hydro-power from Nepal and Bhutan can potentially meet the high demand for power in India and Pakistan during the summer monsoons, while Nepal can import base load capacity during winters when the flow in the rivers is low (Lama, 2004). Power transmission linkages between Pakistan, India and hydropower surplus countries will help augment power supply in the subcontinent. Indian thermal power generation has been mostly designed to match and balance the lean dry months created by the hydel plants in winter and the pre-monsoon season; the same can be designed to account for fluctuations in Nepal and Bhutan as well. For Pakistan, import of hydropower would complement the power import from Central Asia and Iran (which supplies about 70 MW to Makran region including Gwadar port).

Seasonality in power supply and demand in a year as well as variations in demand within a day can be a source of complementarity and therefore cooperation across South Asian countries. Inability to match supply and demand domestically can lead to major losses. This is extremely pertinent in a country where the climatic conditions remain similar in the entire country. For instance, in Bangladesh, sizeable generation capacities to the tune of 1200 MW remain unutilised during the off-peak hours though the country faces shortage of power during peak hours. This available capacity can be a ready source for regional cooperation for import-export of electricity from and to neighbouring countries (Nanda and Goswami, 2008). India, by virtue of being a large country, can manage such fluctuations better.

Countries in the European Union hold out a good example of how cross-border electricity trade can be increased with greater coordination between networks of geographically contiguous countries and with facilitation of access to cross-border power capacity (through auctioning of capacity) (European Commission, 2012). Even though power trade across borders in the SSWA region is already a reality, the inadequate development of infrastructure, and to some extent, lack of coordinated policymaking, have constrained cooperative development of resources and sharing of electricity.

3.2 Infrastructure development

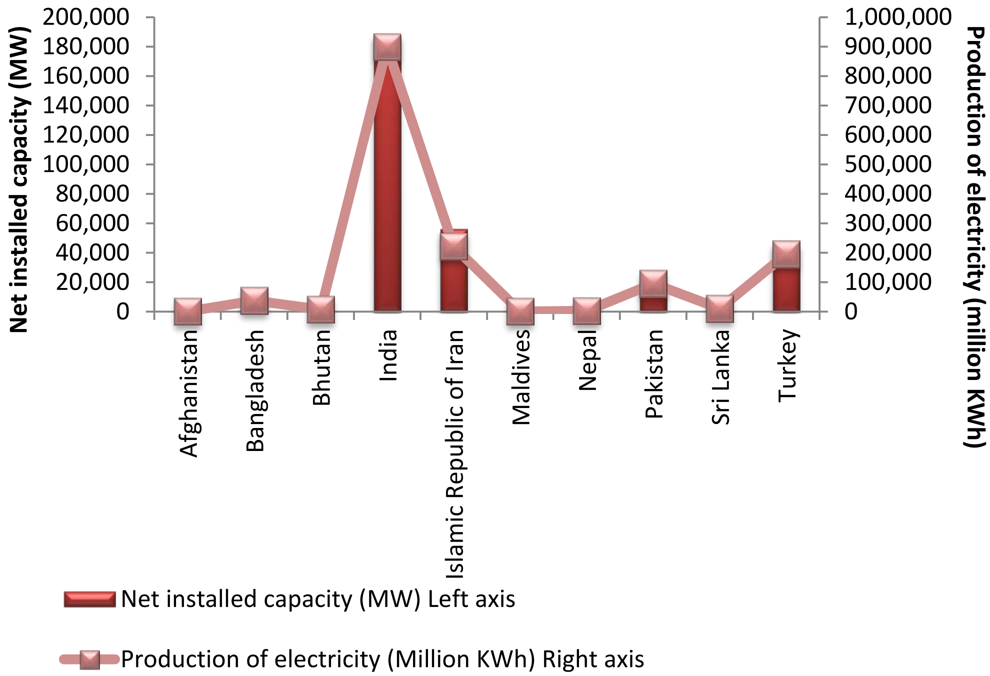
Efficient, reliable and safe infrastructure is the backbone of any energy system. As the countries in the South and South West Asia subregion invest in enhancing their energy security, expansion of and improvement in available infrastructure and development of new energy infrastructure is a necessity. Cooperation in this area allows for initial capital investment to be shared between countries while resulting in a reduction in technical and operational costs borne by each country.

3.2.1 Power infrastructure development – both domestically and across borders – facilitates trade. Can the Bhutan-India success story be strengthened and replicated?

An initiative that would generate rich dividends for the subregion, is the establishment of power plants and transmission lines in a collaborative framework. Development of hydropower plants in Nepal, Bhutan and Afghanistan that is assisted by the neighbouring countries can not only help develop hydel resources in these countries but also generate power trade potential, particularly with Bangladesh, India and Pakistan. The potential capacities in Afghanistan, Bhutan and Nepal cannot be utilised without outside support.

Bhutan today has substantial surplus capacity that has been developed largely with support from India (See Box 1). For a summary of installed generation capacities and production in countries in the subregion, see Figure 12.

Figure 12: **Installed power generation capacity and production in the subregion, 2009**



Source: UNSD (2012a)

The Bhutanese success story can easily be replicated in Nepal though the country need not follow the same model of energy development. There has not been much progress in the proposed large power projects in the country, and India has been assisting Nepal in the development of relatively smaller hydro power projects like Pokhra (1 MW), Trisuli (21 MW), Western Gandak (15 MW) and Devighat (14.1 MW). Presently, three major hydropower projects viz. Pancheshwar (5600 MW), Sapta Koshi (3300 MW) and Karnali (10800MW), are under discussions at various levels as projects of mutual interest. Indian private companies are engaged in Nepal's power sector. The Government of Nepal has awarded Upper Karnali hydropower project (300MW) to a consortium consisting of GMR Group companies and Italian-Thai Development Project Co of Thailand on build-own-operate-transfer basis and a Memorandum of Understanding (MoU) has been signed in this regard in January 2008. According to the MoU, the GMR, Energy would provide 12% of free power (36 MW) to Nepal. In addition, GMR Energy would also pay 27% free equity to the Nepal Government. Similarly, Government of Nepal has awarded Arun-3 hydropower project (900MW) to Sutlej Jal Vidyut Nigam Ltd. (SJVNL) on build-own-operate-transfer basis for a period of 30 years and a Memorandum of Understanding (MoU) was signed in March 2008. According to the MoU, the SJVNL would provide 21.9 % of power (88 MW) to Nepal free of any charge. Further, the SJVNL would also pay 7.5 % of its total income as royalty to the Nepal Government. India is also building a coal-based power plant near Khulna in Bangladesh as a joint venture. Discussions are on for another coal based power plant as India-Bangladesh joint venture in South East Bangladesh. Further, India's plan of establishing Ultra Mega Power Plants (UMPP) of about 4000 MW each, using super critical technology; the challenges being encountered in the process of competitive bidding and commissioning of projects, and the outcomes over the next few years, will hold valuable lessons for power development with reduced emissions and higher efficiency.

There have also been discussions on laying power transmission lines from India to Sri Lanka (submarine power cables), from India to Nepal, and from Iran to Afghanistan, and further initiating import of power to Iran from Tajikistan through Afghan territory. Recently, there has been an agreement for export of electricity from India to Bangladesh. Transmission lines are being constructed between Berhampore in India and Bheramara in Bangladesh. The lines would have a capacity of 500 MW, even though the initial supply of power from India to Bangladesh would be 250 MW. However, the implementation of the agreement might get delayed due to concerns around land acquisition in West Bengal, India. The power purchase agreement, despite some initial differences, has been agreed on.

The potential for power trade in the subregion is, often, difficult to operationalise due to, and is limited by, inadequate infrastructure capacity. For power transfers over long distances, HVDC lines result in lower electricity losses and are cost-effective. Between Bangladesh and India, the difference in the transmission systems is proposed to be synchronised by installing a back-to-back high voltage HVDC link with an initial transfer capacity of 500MW which could be upgraded to 1000 MW (Global Transmission Report, 2012). A 700km HVDC transmission line to Quetta in Pakistan is also being considered by Iran. Some connections between Bhutan and India include the 132 kV S/C lines connecting the eastern part of Bhutan to Assam in India. The western part of Bhutan is linked to Birpara (in West Bengal), India through a 220 kV double-circuit lines. It is also linked to Siliguri (West Bengal) through two 400 kV double circuit lines. The construction of a 400 kV double-circuit transmission line between the two countries was inaugurated in 2011 (Bhutan Power Corporation Ltd. 2012). Nepal power systems are also interconnected with India (Uttar Pradesh and Bihar) but these lines have limited capacity. However, a 400 KV double circuit transmission line between Nepal and India (Dhalkebar-Muzarffarpur, D-M line) is at stage of going into construction. Earlier in 2012, negotiations started between Iran and Pakistan to increase the current trade of 35 MW (Iran exports to Pakistan) by tenfold, and a new transmission line of 700 km is being planned to facilitate this (Iran Independent News Service, 2012).

Box 1: Bhutan-India cooperation in power development and trade

In Bhutan, hydropower contributes more than 19% to GDP and about 40% in export earnings. It also brings almost half of the government revenue and funds critical improvements in development of the country.

India has played an important role in the hydropower sector of Bhutan, with the provision of technical and financial assistance, including project design and engineering services, construction supervision services for hydro projects and transmission lines, and easy finance. India-Bhutan energy cooperation started in 1967, when Bhutan started importing electricity through the Jaldhaka hydropower plant, located in West Bengal, a state of India. The cooperation initiative got further strengthened with the development of 336 MW Chukha hydel project that was commissioned in 1988. Immediately, it became a source of revenue, export earnings and overall economic development of Bhutan as about 75% of the total generation capacity from Chukha was exported to India. By 2007, two more hydel power project came up in Bhutan with Indian assistance: the 60MW Kurichhu and 1020MW Tala hydro power projects. Realising the potential of hydro-power projects as a means to earn more revenues and further economic development, Bhutan signed a Framework Agreement with India in December 2009, whereby India committed to develop 10,000 MW of installed capacity in Bhutan by the year 2020 and buy the surplus power. The 1200MW Punatsangchhu-I Hydroelectric Project is already under construction and planned to be commissioned by 2016, while various other projects are under discussion and the Detailed Project Reports (DPRs) are being prepared.

Box 1…continued

Bhutan: Hydropower Projects under the 10,000 MW development plan (Department of Hydropower and Power Systems)

No.	Name of the Project	Installed Capacity	Estimated Project Cost (Million-Nu)	Implementation Model (Loan-Grant Ratio)	Year of Commissioning Expected
1	Punatsangchhu - I	1200	66,000	IG (60:40)	2016 (Under Construction)
2	Punatsangchhu - II	1020	54,000	IG (70:30)	2017 (Under Construction)
3	Mangedechhu	720	32,259	IG (70:30)	2018 (Under Construction)
4	Kuri Gongri	2640	207,508	IG (70:30)	2023 (DPR studies to commence soon)
5	Bunakha	180	24,926	JV (70:30) (THDC)	2020(JV Agreement under finalization)
6	Sankosh	2560	97,628	IG (70:30)	2019 (Pre-construction activities to start soon)
7	Wangchhu	570	40,027	JV (70:30) (SJVNL)	2020(JV Agreement under finalization)
8	Chamkharchhu - I	770	47,760	JV (70:30) (NHPC)	2021(JV Agreement under finalization)
9	Amochhu	540	35,129	IG (70:30)	2020(DPR completed)
10	Kholongchhu	600	31,436	JV (70:30) (SJVNL)	2020(JV Agreement under finalization)
	Total	**10,800**	**636,673**		

Source: Bisht (2011); Government of Bhutan (2012)

Power outages, intermittent supply to newly electrified towns and villages, and lack of grid connectivity are issues that characterise most countries in the subregion, particularly in South Asia. The development of internal transmission lines and maintenance of area power grids remain concerns in large and small countries alike. Large aggregate technical and transmission (AT&T) losses call for a significant overhaul of infrastructural development initiatives – an area where countries can offer lessons to each other. The countries can even conduct R&D activities in the area of smart grids, and initially pursue digitisation and use of advanced sensing, communication and control technologies, at the level of mini-grids that cater to local communities. Technological advancements that have already been made in the field of renewable energy systems, sensors & control systems, protection circuits etc. can facilitate the integration of various renewable energy resources in a controlled and efficient manner and on a common platform, in order to improve the efficiency and reliability of the overall system (TERI, 2008).

3.2.2 While the network of pipelines across the world is increasing as pipelines are built to carry Central Asian and West Asian gas to far-flung centres of consumption, the subregion has exhibited no move to catalyse the discussions on the Iran-Pakistan-India pipeline and the Turkmenistan-Afghanistan-Pakistan-India pipeline. Is there a future for these projects? What other pipeline projects are feasible?

In terms of gas trade, as of now, India is the only South Asian country that imports Liquefied Natural Gas (LNG) in limited quantities. There is no other trade in natural gas within South Asia or with outside countries as there are no gas pipelines and no country, other than India, has LNG import facilities

The laying down of pipelines for oil and gas trade comprises an initiative in the area of energy infrastructure that assumes inter-state collaboration as a prerequisite. A 2007 World Bank study stated that pipeline gas is competitive with LNG imports and regasification up to a distance of 3500 km (World Bank, 2007). The distance been Central Asian countries/Iran and India falls under 3500 km. While the discussions on the IPI pipeline have taken more of a bilateral character – limited to Iran and Pakistan, the agreement on TAPI is also in the early stages and may not materialise very soon.. Iran, Afghanistan and Pakistan are important transit countries for India to gain access to Central Asia and the Caucasian countries.

Nevertheless, India and Pakistan are engaged in another significant energy dialogue on gas trade. Gas Authority of India Limited (GAIL) is proposing to extend to Lahore a natural gas pipeline it has recently installed from the west coast to Bhatinda in Indian Punjab which is around 25-km away from the India-Pakistan border. GAIL has plans to import LNG at one of its import terminals in Gujarat and move this gas through the Dahej-Vijaipur-Dadri-Bawana-Nangal-Bhatinda pipeline to Punjab and then into Pakistan. Pakistan may experience its worst gas crisis in 2016 when the deficit is expected to hit 3.021 bcfd (billion cubic feet per day). Since Pakistan has not built any LNG import terminals thus far, this venture would be prudent for Pakistan. The LNG terminal will take a minimum of four years to build while the existing pipeline can be extended into Lahore within months.

3.2.3 For a largely import-dependent set of countries, could strategic oil reserves be developed in a framework of collaboration?

In the domain of energy infrastructure, most of the subregion – heavily dependent on oil imports, may also collaborate to put in place a crisis response coordination mechanism in the form of strategic oil reserves. India has already begun the construction of phase 1 of its reserves comprising 37.5 million barrels of oil, which along with available commercial stocks, would meet 78 days of import requirement. Could the countries of the subregion envisage an arrangement whereby these reserves offer assistance to other countries in the event of supply crisis? Here, access could be provided in lieu of capital investment, rental payments and/or participation in the procurement of oil for building the reserves. Lessons can be drawn from other countries' experience of sharing strategic reserves as agreed between Japan and New Zealand, and Japan and South Korea, for instance.

3.3 Need to address energy access concerns

Energy access remains one of the most pressing concerns across the countries of the subregion. More than half of the population of South Asia has no access to modern forms of energy. Iran and Turkey are, however, better off.

3.3.1 Could cross-country exchanges on technology/practices facilitate better electricity access?

Globally, 1.3 billion people are without access to electricity. Of these 289 million are in India, and 96 million and 64 million are in Bangladesh and Pakistan. With insufficient grid connectivity, and intermittent power provided to grid-connected, remote areas, renewable energy-based decentralised electricity solutions are a priority for the region in order to improve electrification and meet peak load shortages. These could be based on small hydro, solar, wind or biomass. Decentralised generation is operationalised with small modular power generation technologies, mostly based on locally available renewable energy sources, and can also be integrated with the grid (Mathur, Cherail, & Mahajan, 2009).

The installation of biomass gasifiers for community-based power production has been practiced in India and is of immense relevance to agriculture-based economies where a large amount of agricultural and farm residue is generated. The subregion can benefit greatly from the adoption of best practices from across the region on deployment of biomass gasifiers for power generation, and use of solar lanterns for unelectrified and semi-electrified households. Governments in the region need to make a systematic effort to share experiences and emerging knowledge in this area. Box 2 provides a snapshot of solar energy programs for decentralised energy in the subregion. A knowledge management system could be created which makes available information of rural power programs, financing mechanisms and business models, technological advances, manufacturing capacities and investment opportunities (Srivastava and Misra, 2007).

3.3.2 As reliance on biomass for cooking energy continues, how can countries in the subregion affect a transition to clean and convenient cooking?

While the provision of power for lighting is critical, equally important is the fulfilment of energy needs for cooking, through a source that is efficient, convenient and safe. World over 2.7 billion people are without access to clean cooking facilities. Of these 840 million are in India, and more than a 100 million in Bangladesh and Pakistan each. Traditional biomass dominates as a cooking medium in the countries of South Asia. In recent years, research studies have highlighted issues such as indoor pollution, health ills and environmental risks associated with the use of traditional biomass for cooking and heating. The use of biomass has also meant an additional burden on the women of the household who walk miles to collect firewood. With these concerns in the backdrop, there has been an effort to develop clean biomass-based cookstoves (that use less firewood and reduce pollution) and to deploy them to promote effective and healthy use of biomass. India, a pioneer in the development of biomass gasifiers and cookstoves, can take a lead in disseminating these technologies in the subregion (Nanda and Goswami, 2008). It is pertinent, however, that energy access solutions are sensitive to local requirements and are viable in the long run. In order to ensure availability of appropriate energy supplies, service delivery and affordability, there is a need to promote knowledge exchange for better understanding of rural/urban contexts, penetration of sustainable energy choices, and better targeting of subsidies.

3.4 Promotion of sustainable energy choices and practices

Both from the point of view of energy security and sustainability, renewable energy and energy efficiency need to be prioritised in energy decision-making. Renewable energy can significantly augment energy supplies in the subregion while offering scope for devising local energy solutions. In addition, effective demand side management across sectors reduces consumption and minimises wastage of energy. The availability of efficient electrical appliances and consumer education to promote their use can go a long way in reducing residential energy consumption. Further, sustainable building design reduces energy consumption for lighting and space conditioning in buildings, as do adoption of efficient technologies and practices in energy-intensive industries.

3.4.1 A focus on sustainable development will necessitate the development of renewable energy technologies and their deployment. Can a pooling of strengths be envisaged for the development of alternative energy and cleaner use of conventional fuels?

Clean energy is critical for the subregion to meet the burgeoning energy demand in a manner that does not compromise the environment. Renewable energy development in the subregion holds a host of benefits for countries in the subregion while offering a range of opportunities for cooperation. India's strengths in the alternative energy sector can be harnessed for subregional energy security. Cleaner use of traditional fuels is a policy priority in the subregion, with a large population dependent on biomass for their energy requirements. This also holds for cleaner and more efficient use of coal.

As discussed earlier, India's lead in development of clean cookstoves and biomass gasifiers provides an opportunity for technology dissemination. India's manufacturing base in solar PV modules, and solar thermal systems, too, can be employed for RE advancement in the region. The rich hydro-resources in the subregion call on countries to invest in small hydro projects that allow the harnessing of hydropower without the environmental and social externalities associated with large hydropower projects. Run-of-the-river hydropower systems that do not require storage of water also help avoid conflicts amongst upstream and downstream countries.

In order to pursue collaborative clean technology development, the institution of clean fossil fuels and renewable energy fund may be considered. This would be comprised of differential contributions from countries in the subregion. The fund could be used to offer support to R&D, and RE pilot projects and their upscaling. In addition, the countries could establish a subregional energy R&D incubation centre that would nurture scientific innovation. The establishment of such a centre will also allow the scientific communities from different countries to interact with each other and foster research partnerships. A beginning in this direction has been made by capacity building initiatives undertaken by regional/subregional arrangements, and need to be built upon. The Regional Clean Coal Partnership was launched by USAID-SARI/Energy and focused on not only building technical capacity on coal beneficiation and optimisation of combustion efficiency of coal, but also trained senior coal sector managers in finance and logistics management, and social and environmental concerns.

Along with the enhancement of domestic supply with RE, demand side management too is crucial for energy conservation and for reducing the pressure on energy supplies. In some countries in the subregion, including India, Pakistan, Iran, Sri Lanka and Turkey, efficiency initiatives have been taken in the buildings sectors, where a beginning has been made in the development of energy codes and their implementation. Energy consumption in the buildings sector can be reduced substantially by the adoption of efficient practices during construction and use, the application of sustainable building design, efficient lighting and space conditioning, and use of RE wherever possible. The transport sector, too, offers scope for energy savings with the introduction of fuel efficiency norms, and shifts in modal conditioning, and use of RE wherever possible. The transport sector, too, offers scope for energy savings with the introduction of fuel efficiency norms, and shifts in modal transport. Further, in most countries, standards have been set for industry efficiency and waste discharge. In some instances, market mechanisms have been created to encourage saving energy. For instance, in India, the Perform, Achieve and Trade (PAT) mechanism included in the National Mission on Enhanced Energy Efficiency part of the National Action Plan on Climate Change, requires 700 of the most energy intensive power stations and industry units in the country to be mandated to decrease their energy consumption by a unique specified percentage respectively.

However, large scale adoption and implementation of energy efficiency measures hinges, to a large extent, on the perception of energy consuming entities – households, companies, manufacturing plants, farmers, manufacturers, governments, financial institutions and other organisations (Reddy, 1990). Absence of complete information about the benefits of the usage of modern technology, lack of availability of modern infrastructure, absence of right price signals, cost of technology etc. have limited the adoption of energy efficiency enhancement instruments (Sorrell, Mallett, & Nye, 2011). There is immense scope for exchange of knowledge and best practices in these areas. This holds for technology changes but also for policy interventions for inducing changes in consumer behaviour, including appliance labeling, and tightening of fuel economy standards.

Box 2: Solar energy innovations

A number of innovative energy programs have been charted around solar energy in the subregion, particularly for expanding access in rural areas. In India, two programs – SELCO India and Lighting a Billion Lives, provide interesting case studies.

SELCO India provides sustainable energy solutions to households, commercial entities and industries, but operates mainly with the purpose of serving under-served rural households. SELCO systems utilise solar photovoltaic (PV) modules to provide power for multiple applications including lighting, pumping of water, and communication, and provides service and maintenance services too. It started out with solar home systems in 1995 and SHS remains its core business even today. One of the reasons for its expanding reach has been the ability to tie up with rural and commercial banks, NGOs and credit cooperatives, to develop financial solutions that make solar technology affordable, with the provision of loans and the facility of staggered payments (SELCO, 2012; TERI, 2012a).

Lighting a Billion Lives (LaBL), an initiative of The Energy and Resources Institute (TERI), is based on an entrepreneurial model of energy service delivery which is geared towards providing solar lamps, disseminated through micro solar enterprises. The program is focused on provision of solar lanterns to unelectrified and semi-electrified rural areas. Capital costs are largely supports by grants. The established enterprises, facilitated by loans and partially subsidised by TERI or other partners, are managed by a trained local entrepreneur. The entrepreneur rents out solar lanterns to village inhabitants for a nominal daily rent. This model brings clean energy to villagers at an affordable price (TERI, 2012b). To date, the program has touched about 400,000 lives, in 1700 villages spread over 22 states.

The Solar Homes Systems program in Bangladesh started by the Infrastructure Development Company Limited (IDCOL), a nonbanking financial institution established by the Government of Bangladesh, provides another example of a successful initiative. This program is the result of cooperation amongst six partners, including the Government of Bangladesh, IDCOL, donor agencies (World Bank's IDA, GEF, amongst others), participating partner organisations (POs), manufacturers/suppliers, and experts. The program has brought access to electricity to a number of rural households in the country, innovatively employing micro-credit facilities. IDCOL provides refinancing facility to partner organisations and channels grants. Technical and logistical assistance is provided to partners (IDCOL, 2012). The project has improved access to off-grid energy, generated employment (in POs, and for people engaged in distribution and servicing), and increased incomes (TERI, 2012a).

Access to lighting enhances overall quality of life: increase in hours spent at work and better incomes; safety for women and children; and ease in carrying out day-to-day activities.

Source: SELCO (2012); TERI (2012a); TERI (2012b); IDCOL (2012)

Capacity building is essential for the creation of sustainable urban and rural centres in the subregion. A comprehensive capacity building framework needs to be adopted at the subregion level that pays attention to staffing criteria, skill development and innovative financing, including market-based funds and public-private partnerships.[13] Efficient production and use of energy requires technical capacities to be built across stakeholders, within energy ministries and their affiliates, power utilities, local government bodies such as urban municipal corporations, and energy service companies. While some cross-border training programs have been initiated by regional organisations and forums, a stronger inter-governmental push is required here.

[13] This suggestion was part of the interventions by the Indian delegation at the Second Session of UNESCAP Committee on Environment and Development, 22-24 February, 2012.

3.5 Creation of efficient subregional markets

The creation of efficient subregional energy markets would help achieve economies of scale while ensuring that demand-supply complementarities are not laid waste. The creation of efficient markets will ensure an inflow of capital and facilitate effective planning of private and public investment. The idea of a subregional grid has been explored with regard to both gas and power. It is clear, however, that in a context of lack of technical capacity and mounting subsidies, a range of government-led pricing and regulatory reforms will be required for the efficient functioning of subregional markets.

3.5.1 What inter-state energy networks have been proposed by regional/subregional initiatives?

An integrated electricity grid with trading arrangements among the countries can improve efficiency in the entire subregion. Even if most countries in the region have excess demand in electricity, trade can still thrive for trade would help reduce the distance between the points of production and consumption, and thereby reduces transmission losses. South Asia, where transmission and distribution losses of electricity are among the highest in the world will do well to take a cooperative approach. Needless to say that such an approach will not only help climate change mitigation but also make economic sense in an energy-starved region like South Asia.

Recognising the potential benefits, under the umbrella of the South Asian Association for Regional Cooperation (SAARC), member countries' energy ministers in principle agreed on inter-grid exchanges. A Task Force has finalised a common template on technical and commercial aspects of electricity grid interconnection amongst the SAARC Member States. Expert Group on Electricity in its Meeting held in January 2011 considered the (i) Concept Paper on the Road Map for developing SAARC Market for Electricity (SAME) and (ii) concept paper on SAARC Inter-Governmental Framework Agreement for Regional Energy Cooperation (See Table 18). Progress on these concepts was reviewed by the Energy Ministers Meeting held in September 2011. However, there has been more progress at the bilateral level, between India and other South Asian countries.

Table 18: Milestones in Energy Cooperation Under SAARC

January 2000	Technical Committee on Energy
January 2004	Specialised Working Group on Energy
October 2005	First meeting of energy ministers, Islamabad: Formation of Expert Group on energy conservation and efficiency and Roadmap for SAARC region
March 2006	Establishment of the SAARC Energy Centre in Islamabad
March 2007	South Asia Energy Dialogue: Recommendations to promote cooperation
April 2009	Meeting of the Working Group: Establishment of expert groups on a) oil and gas, b) electricity, c) renewable energy, d) technology and knowledge sharing
December 2009	Meeting of the Working Group: Presentation of the Task Force draft report on the technical and commercial aspects of the electricity grid interconnections

April 2010	Concept of SAARC Market for Electricity in the 16th SAARC Summit Declaration
January 2011	Expert Group on Electricity in its Meeting considered the (i) Concept Paper on the Road Map for developing SAARC Market for Electricity (SAME) and (ii) concept paper on SAARC Inter-Governmental Framework Agreement for Regional Energy Cooperation.
September 2011	Energy Ministers Meeting reviews the progress on SAME and SAARC Inter-Governmental Framework Agreement for Regional Energy Cooperation.

Source: TERI compilation

Further, energy market formation is a focus area for USAID-South Asia Regional Initiative (SARI), too, which commissioned the "Four borders study," concluding that it is technically feasible to build transmission interconnections that would benefit Bangladesh, Bhutan, India and Nepal (Nexant, 2001). USAID-SARI has been instrumental in planning generation and transmission system expansion on a regional basis. Supported by the World Bank, SARI promotes energy security in South Asia through three focus areas: cross border energy trade, energy market formation, and regional clean energy development. A feasibility study was also conducted for a trans-BIMSTEC Gas Pipeline Project under the umbrella of the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) that includes countries from South Asia. Also, capacity building workshops have been organised to further the Trans-BIMSTEC Power Exchange and Development Project.

The World Bank and the Asian Development Bank (ADB) have actively been supporting regional efforts through large-scale infrastructure investment, technical assistance, feasibility studies and advisory services. ADB's SAARC Regional Energy Trade Study (SRETS) in December 2010 proposed four concrete courses of action: creating a subregional power grid involving Bangladesh, Bhutan, Nepal and India; building LNG terminals; building power plants and enhancing refining capacity. The South Asia Growth Quadrangle (SAGQ), comprised by Bangladesh, Bhutan, India and Nepal, eventually led to the formation of the South Asia Subregional Economic Cooperation (SASEC) assisted by the ADB. SASEC's mission is to identify and implement subregional projects that foster growth. Energy and power are listed amongst priority areas. The Economic Cooperation Organisation (ECO) could also be more effectively employed as a forum for discussing energy trade amongst countries of the subregion, particularly amongst the South West Asian and bordering countries.

The vision of an Asian Energy Highway put forth by ESCAP that envisages the extension of the ASEAN Power Grid, provides further impetus to the subregional initiative of building power inter-connections. The ASEAN Power Grid comprises of 16 projects, five of which are operational, four are under construction and seven are in preparatory stages (Han and Liying 2012). Though countries would encounter a range of challenges in the process (Han and Liying, 2012), such as the need to harmonise regulations and laws, acquire land rights for transmission lines, ensure the trickling of benefits to rural and urban populations alike, and arrive at a resolution in cases of territorial disputes, the benefits that would accrue to the Asian region through increased energy connectivity need to be foregrounded and pursued.

Box 3: Possibilities for energy cooperation in the subregion

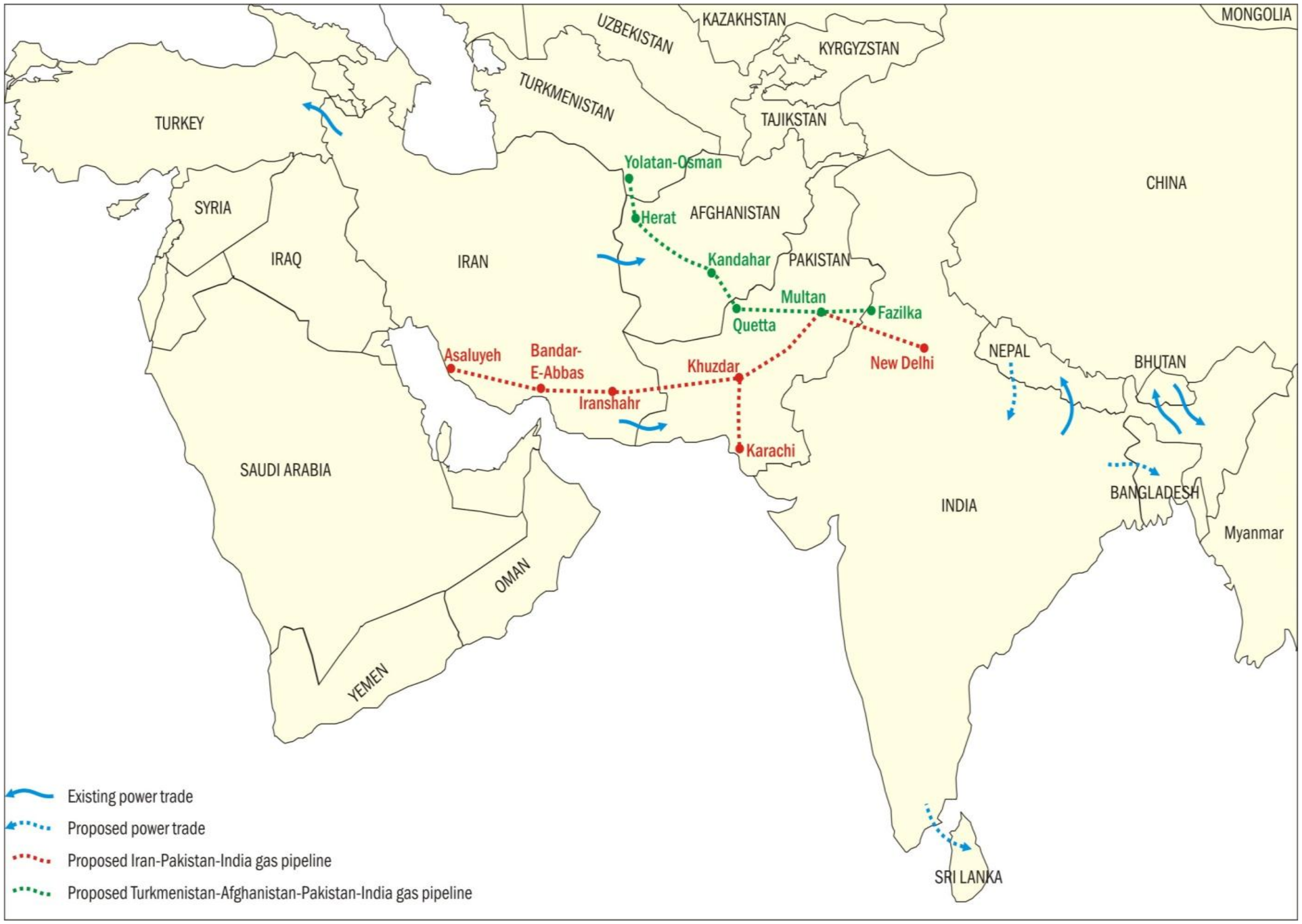
- Collection and compilation of accurate energy data, particularly on energy reserves and renewable energy potential in the subregion.
- Cross-country investments and energy trade:
  - trade in natural gas (from Iran to other countries);
  - petroleum products (from India); and
  - power (from hydro-power rich Bhutan and Nepal, and bilateral and plurilateral exchanges across the subregion).
- Building of adequate energy infrastructure in the form of power plants, transmission lines and pipelines.
- Creation of a knowledge repository for sharing of experiences in the domains of energy access, renewable energy development and energy efficiency.
- Collaborative clean technology research and development.
- Creation of a subregional clean energy fund.
- Strengthening of existing subregional frameworks of cooperation, and institution of new, target-driven mechanisms focused on energy.

The countries in the SSWA subregion are attending to multiple energy challenges. While supply is constrained, calling for enhanced exploration of domestic resources and planning of import options, consumption sectors on the demand side present their own set of challenges. Grappling with similar challenges, and endowed with varied strengths, the countries in the subregion have a range of energy opportunities to collaborate on. Box 3 summarises the main possibilities discussed in this section.

A number of initiatives have been taken by governments in the region, bilaterally and multilaterally. As discussed above, subregional and regional organisations have played a facilitative role in many of these initiatives. ADB provided a loan of $150 million for the Tanahu Hydro Power Project (140 MW) in Nepal. ADB has also offered a US$100 million loan for building a cross-border power grid between India and Bangladesh. The World Bank has supported a number of studies on regional energy trade. Its study 'Potential and Prospects for Regional Energy Trade in the South Asia Region' laid down a set of guidelines for promoting energy trade between countries in South Asia and defined the role international financial institutions and bilateral donors could play (World Bank, 2007). BIMSTEC, understood to present potential for a successful subregional free trade agreement (Banik, 2006), holds out potential for power interconnections along with trade in petroleum products, coal and gas. Figure 13 provides a snapshot of existing and proposed power trade flows and proposed international gas pipelines.

Often discussions on subregional cooperation get punctuated by the reiteration of "sovereign" interests that may overshadow shared benefits around non-traditional security issues such as energy. However, as has been rightly put by Caballero-Anthony (2007), "shared vulnerabilities of the regional states should be enough impetus… to navigate through contentious waters to urgently address these security threats."

Figure 13: Power trade flows and international pipelines



Disclaimer: The designations employed and the presentation of material on this map do not imply the expressing of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Note: The lines are indicative of direction of flows, and do not represent exact routes/locations.

Source: TERI compilation

4 PROPOSED ACTIONS

In order to effectively utilise the many opportunities for energy cooperation highlighted in the preceding sections, countries need to adopt a 'way of seeing' that gives significance to collaboration over unilateral aggrandisement and accepts the merit of fashioning new approaches of multi-level governance. The subregional/regional level, as an intermediate level of governance, is particularly relevant for examining and tackling issues such as energy, that require cross-country interaction but for which global engagement may prove ambiguous or undemocratic (See Mahajan and Sharma, 2011). The preceding sections' part of this report have delved in detail into energy challenges that the region faces and the various opportunities for cooperation that are on offer. Clearly, development – economic and social, is closely tied with the availability of modern forms of energy. Energy is necessary for increasing economic and human productivity; improving people's welfare; reducing transaction costs; providing employment; and "connecting communities to economic, trade, and information networks and resources that can lead to self-sustaining growth" (Masud *et al*, 2007). Policy planning with the objective of expanding energy access and increasing per capita energy consumption in the subregion, is concomitant with the concern that this would mean expanded, accelerated resource use and environmental challenges. Despite what the Kuznets relationship suggests with regard to environmental parameters and per capita income, growth and employment generation policies cannot disregard environmental concerns in the rush to reach growth targets. Energy resource use, that is integral to this process, cannot be pursued without a thought to sustainability.

What is required in terms of policy action is the establishment of a virtuous cycle that recognises the links between poverty alleviation, welfare, energy provision, and protection of environment, and is informed both by possible trade-offs and the possibility of working towards multiple objectives simultaneously. A subregional effort in this regard can strengthen available knowledge and capacity, and bring larger technical and financial resources to the table. The objective of this section is to lay down some specific, prioritised areas that can be pursued as part of a subregional programme of activities. It seeks to delineate steps that governments in the subregion need to give form to the vision of subregional cooperation on energy.

4.1 Energy data collection and sharing

As has been discussed in section 3, availability of information on energy reserves and clean energy potential (both in terms of renewable energy deployment and energy savings) is essential for robust energy planning. While an under-estimation of resources can impede investment and fuel resource nationalism, an inflated assessment of fuel reserves can lead to flawed infrastructure and overall energy system planning. It is clear that a techno-economic evaluation of opportunities is the first step towards formulating a joint energy program.

Steps to be taken:

Government-led evaluation of internal technical capacities and available know-how needs to be undertaken.

- An investor-friendly resource atlas needs to be built for the SSWA subregion. Select country governments could take charge of one sector each, for the consolidation of information on available expertise and appointment of inter-country teams. These teams would lead resource assessment exercises, and bring in relevant private and public enterprises.

Participation of foreign private players, both from within the subregion and external, needs to be encouraged.

4.2 Power inter-connections

International trade and exchange of electricity makes both economic and logistic sense: it may be economically more advantageous for the border regions of one country to rely on power from a nearby power station in a neighbouring country than a distant station within the country's territory. Also, electricity cannot be stored and, therefore, supply and demand need to be efficiently managed. The potential for power inter-connections in the subregion is vast, and has been highlighted as one of the most crucial areas for inter-state collaboration. Multilateral institutional arrangements such as SAARC (SAARC Energy Ring, SAARC Market for Electricity); USAID/SARI (Four Borders study); ADB (SAARC Energy Trade Study, South Asia Subregional Economic Cooperation); BIMSTEC (Trans-BIMSTEC Power Exchange and Development Project), have championed electricity trade amongst the subregional countries. Some initiatives have been taken bilaterally yet a multilateral framework for power exchange has not been implemented. This would be crucial for the subregion's integration with the Asian Energy Highway.

Steps to be taken:

The efforts towards international power trade through cross-border transmission lines need to go hand-in-hand with domestic energy planning. In fact, a subregional impetus can catalyze domestic reforms. For instance, large-scale power trade in the subregion requires synchronization of grids and technical standards, establishment of financially sustainable power sector entities, promotion of competition, and delineation of a predictable regulatory environment.

Table 19: Regional power arrangements

S. No.	Regional Power Trade Arrangements	Member Countries
1.	Nord Pool	Norway, Denmark, Sweden, Finland, Estonia, Lithuania
2.	North American Electric Reliability Corporation (NERC)	Canada and USA
3.	European network of transmission system operators for electricity (ENTSO-E) (Earlier coordinated by Union for the Coordination of Transmission of Electricity)	Austria, Bosnia and Herzegovina, Belgium, Bulgaria, Switzerland, Cyprus, Czech Republic, Germany, Denmark, Estonia, Spain, Finland, France, UK, Greece, Croatia, Hungary, Ireland, Iceland, Italy, Lithuania, Luxembourg, Latvia, Montenegro, FYROM, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Sweden, Slovenia, Slovak Republic
4.	Southern African Power Pool	Botswana, Malawi, Mozambique, Lesotho, Democratic Republic of Congo, Tanzania, Angola, Zambia, Namibia, Zimbabwe, Swaziland, South Africa, Lesotho
5.	South East Europe Regional Energy Market (SEEREM)	EU, Bosnia and Herzegovina, Bulgaria, Croatia, Albania, Montenegro, Former Yugoslav Republic of Macedonia, Romania, Serbia and the UN Mission in Kosovo

Source: TERI compilation

Countries need to establish a framework for cost-reflective pricing of electricity services. Appropriate power tariffs are essential for the financial health of power utilities, and investments in the sector would not be forthcoming if clear and rational tariff regulations are not adhered to.

Technical capacity building needs to be undertaken in the areas of high voltage transmission, and reduction in transmission and distribution losses.

The establishment of a regional power trading corporation in the subregion could help disseminate information on plant structures, avoidable cost of generation, sales volumes, target utilisation and market conditions (Lama, 2005). Nexant (2001) proposes the execution of an Inter-Utility Memorandum of Understanding, that would establish principles for trade and transfer.

Countries need to carefully assess other regional power arrangements to draw lessons on best practices (Table 19). The South African Development Community holds valuable insights for the subregion, given the similarities in the two regional contexts (Lama 2005). A coordination centre in one of the participating countries' capital city (Harare) has been set up to monitor the operations of the Southern African Power Pool (SAPP), collect data, conduct training and share relevant information with participating countries.

4.3 Subregional knowledge repository

The creation of a subregional knowledge management system for ideas and emerging knowledge from ongoing projects is of particular relevance for the domains of energy access and clean energy. This would help in upscaling isolated, scattered experiments.

For electricity access, while it is important for the countries to expand the reach of grid-connected power, decentralised electricity solutions need to be affected to reach unelectrified households and meet peak load shortages. Renewable energy-based power generation holds significant potential here. In the subregion, a number of renewable energy projects based on biogas, solar power, wind and small hydro have been installed to provide for cooking/lighting needs. In India, in order to expand access to electricity, the government has launched the Rajiv Gandhi Grameen Vidyutikaran Yojana (initiated in 2005) and the Remote Village Electrification Program (initiated in 2001) that look to provide lifeline electricity to rural/remote areas by extending free power connections to households subsisting below the poverty line and by subsidising capital costs by 90% through government grants (Government of India, cited in Shenoy *et al* 2011). Significant advances have also been registered by governmental and non-governmental distributed generation units. In India, initiatives such as SELCO and TERI's Lighting a Billion Lives (LaBL) discussed earlier hold out interesting illustrations. The successful Solar Home Systems program in Bangladesh is also one example of how renewable energy can be made affordable with the design of appropriate business models. In the same vein, deployment of clean cooking technologies has been a programmatic theme across different country initiatives. Learnings can be shared across the region on how to offer the poor energy choices that are sustainable and in sync with socio-cultural realities, while being sensitive to the gendered impacts of energy patterns.

A range of renewable energy and energy efficiency initiatives have been pursued in SSWA countries that have met success. The business models, technologies, after-sale practices and impact assessment tools employed in one country context can hold important lessons for other countries. The establishment of a 'clearing house' for ideas, project experiences, technical know-how and local knowledge will contribute towards ready availability of information and facilitate exchange.

With pricing of energy emerging as an important domestic issue in countries of the subregion – an issue that usually elicits strong opinions across the economic spectrum, countries can share best practices on reform of subsidy regimes.

Steps to be taken:

Energy ministries from the countries of the subregion should take the first step towards the establishment of a knowledge repository, with the compilation of best practices for improving energy access and introducing/upscaling renewables. Energy research institutes and universities could also be engaged in this exercise. [14]

A subregion-level analytical study needs to be undertaken on energy pricing regimes, plans for reform that have been promulgated by governments, and the policy gaps that need to addressed.

4.4 Clean energy fund and technology incubation centre

A focus on clean energy - cleaner fossil fuels, renewable energy and energy efficiency, is a critical and integral part of a subregional energy effort. Given that these are emerging fields of knowledge that are witness to rapid, new advances and call for significant investments in research and development, a pooling of resources on this front would be useful for the subregion particularly for economies that are not home to a strong manufacturing or research base in such technologies.

One feasible initiative in this regard would be the establishment of a clean fossil fuels and renewable energy fund. Both the cleaner use of fossil fuels and renewable energy are important policy areas for the subregion. The presence of coal resources in some countries suggests that the subregion would benefit from research in the area of carbon capture and storage of carbon dioxide for low carbon power production, coal to liquids and coal to substitute natural gas (SNG). Though the implementation of these options is capital intensive, research and exploration in these areas would advance the paradigm of energy innovations in the subregion. Further, the establishment of a technology incubation centre, would provide support for application-oriented R&D and help stakeholders from the subregion develop targeted energy solutions in the areas of renewables, smart grids, and sustainable consumption.

Steps to be taken:

A cross-country team needs to be put together to study the various models followed for the institution and disbursement of international development funds. This team should put forth design options for a clean energy fund scheme, possibly with differential contributions from participating SSWA countries. The fund could be disbursed by a fixed treasurer country or be rotated amongst members on an annual basis.

The prospects of better utilising the SAARC Development Fund for targeted energy projects need to be explored.

4.5 Energy investments

The Joint Study Group appointed by the Governments of India and Sri Lanka in 2003 stated that "the interest of Indian companies to participate in future bids for coal-fired plants in Sri Lanka may be accentuated by the existence of a regional power pool." Cross-sectoral investments and international investments across the value chain can help develop mutual stakes in each other's energy industry. Complementary strengths such as that exhibited by India and Iran – Iran's abundance of oil, and India's refining capabilities, create opportunities for investments in each other's energy sector. India's investments in Bhutan's hydropower sector have been able to create a win-win situation for both countries, whereby Bhutan is receiving funds and technical assistance and India is assured of power supply.

ADB's SAARC Regional Energy Trade Study (SRETS), amongst its recommendations, suggested the construction of a joint subregional LNG terminal. Joint investments in infrastructure projects can help overcome the barrier of high upfront costs.

[14] For instance, the SAARC Energy Centre and the South Asia University could take on the task of maintaining this database.

Steps to be taken:

Encourage participation of both public and private sector players in exploration and production, and infrastructure building projects across countries. Public-private partnerships can help raise the large investments required for infrastructure development. It is incumbent on governments to put in place a predictable regulatory environment.

In order to overcome the problem of delays in infrastructure projects, these should be strictly bound by contractual arrangements that clearly lay down each party's responsibilities, and define time-bound project schedules.

4.6 Institutionalization of cooperation

Given that political mistrust impedes cooperation in the subregion, it is pertinent to develop legal-institutional arrangements that lend credibility to collaborative initiatives and provide assurance to involved parties. In this process, countries may seek support from multilateral institutions such as the World Bank, ADB and UNESCAP. Multilateral banks and institutions can also emerge as sources of finance for energy projects. A multi-level, multi-stakeholder process of engagement that engages national and local governments, private interests, industry groups and citizens, and is steadfastly geared towards employing collaborative instruments to derive energy benefits for the subregion, is critical to harness available opportunities. A recently concluded ADB-supported study undertaken by TERI, the Institute for Global Environmental Strategies (IGES) and the Asian Energy Institute (AEI), comprised an analysis of select Asian case studies of innovative energy policies and grassroots-level interventions. It concluded that a multi-level and multi-actor approach to finance, capacity building, technology diffusion and policy, is central to the success and effectiveness of energy interventions (TERI 2012a). Box 4 provides a summary of key ingredients for the delivery of sustainable development outcomes, as observed by the study team.

Box 4: What works for the successful delivery of energy outcomes?

1. **Mechanisms for coordination and cooperation** amongst different agencies or stakeholders
2. **A needs based customized approach to energy service delivery** in financing as well as technology adoption
3. **A distributed strategy across technology and governance levels for clean energy development** links what is happening in the market and at the grassroots back to the lab and to those who make policies based on such feedback loops.
4. More than making a technology or measure available, it is important to ensure that it enjoys **acceptability and a buy-in from the target group**.
5. Market development strategies and development of market driven programmes require **more stakeholder participation** that can provide benchmarking standards to main product quality and ensure technology delivery.
6. **Innovative finance mechanisms** that lay emphasis on self-sustainability, away from grant based approaches have been effective. Major sources of feasibility-viability gap financing have been multilateral and bilateral funding. New financing models such as carbon financing are being explored to ensure self-sufficiency and financial sustainability.
7. **Appropriate risk regulatory frameworks** are needed to address the management of wastes from selected technologies (for instance solar PV panels) so that manufacturers can design solar modules, which are safer and easier to reuse and recycle, and markets to be developed for the same.

Source: TERI (2012a)

Steps to be taken:

Along with the pursuance of large, multilateral initiatives, bilateral and trilateral energy projects should be encouraged as building blocks of a subregional framework.

If required, countries participating in an energy project should seek third party monitoring of projects, from neutral, multilateral arbiters. Where the facilitation of existing multilateral frameworks is not possible, countries should, at the outset, define a project-specific framework of engagement, with clauses covering breach of contract.

Beginning from the project planning stage, energy projects and policy programs should involve all relevant stakeholders in order to avoid conflicts of interest and ensure recognition of multiple expectations and impacts. The engagement of relevant stakeholders helps spread risks, builds confidence and ensures popular acceptance of outcomes.

The above list of proposed actions is an indicative list of priorities that the subregion should consider on energy. Energy – a critical input to economic growth and development and a key human security issue, could provide the right platform to bring the subregion together, and emerge as a confidence building element in subregional ties. However, without appropriate planning and political will, negotiations on this shared concern can become a story of stumbling blocks rather than shared benefits. The litmus test for the subregion is to translate available opportunities for energy cooperation into expected benefits for the subregion's people.

5 A SUBREGIONAL POLICY AGENDA

In light of the analysis of energy and sustainable development issues undertaken as part of this study, and the assessment carried out for the identification of specific possibilities for energy cooperation, this section summarizes the critical elements of a subregional policy agenda for energy access and security.

Thinking beyond national borders: Energy resources are seen as strategic – critical for military, economic and social development. This understanding has relegated energy to the domain of zero sum game politics. However, the relationship of energy with life and livelihood concerns indicates that energy needs to be viewed through the lens of 'human security' instead of 'national security.'

The energy-development-sustainability nexus: The inter-dependence of objectives in the areas of energy, development and sustainability, can be ignored only at the subregion's peril. In a schematic of multi-level governance, the subregion provides an optimal policy space to highlight this nexus, issue directives to national governments, and design and implement projects that are undergirded by this understanding.

Energy poverty as a dimension of economic and social vulnerability: Provision of access to modern, convenient and clean forms of energy needs to be a core component of development strategies in the region. Universal electricity access, through grid-connected and off-grid power, and elimination of the inefficient use of traditional sources for cooking, should be highlighted as a priority subregional agenda. In countries marked by social and economic stratification, energy has emerged as another dimension of inequality. The challenge is to transform energy into an instrument that bridges these gaps. It must be recognised that energy access is crucial for the achievement of the MDGs.

Enhancement of energy trade and trade-related infrastructure: Though a large number of countries in the subregion are highly import-dependent, a range of trade and investment opportunities can be identified, particularly in power, natural gas and petroleum products. The harnessing of this trade potential depends on the consolidation of political will, establishment of the right market conditions within participating countries, and creation of requisite infrastructure. Countries need to build energy linkages at multiple levels, guided neither by "myopic bilateralism," nor by "doctrinaire multilateralism" (Iyer, cited in Mahajan 2007). Timely investments in building infrastructure for subregional connectivity – roads, rail links, pipelines and transmission lines, are critical.

Central importance of clean energy to sustainable energy choices: Renewable energy and energy efficiency initiatives can help reduce reliance on fossil fuels, decrease the burden of foreign exchange outflows on national budgets, enhance energy supply in the economy, and lead to a more equitable energy landscape. Most subregional members have inadequate supply of fossil fuels, and need to necessarily invest in clean energy forms.

Support to energy R&D: Adequate public investment in research and technology development; establishment of institutions of higher learning in theoretical and applied sciences, and science policy; facilitation of private and government-led energy research programs; institution of fair and robust intellectual property rights protection regimes, are significant for the nurturing of energy innovations in the subregion. The SSWA subregion should aim to become a producer of knowledge in the area of energy technologies rather than just a receiver.

Investment in new, targeted, multi-actor institutional frameworks, in addition to adequate attention to existing ones: Subregional/regional arrangements encompassing the SSWA subregion have been associated with a mixed track record. It is unfortunate that many energy projects are put through feasibility analyses and detailed work plan design but do not see the light of the day. Political rivalry, and unnecessary politicisation of economic and welfare issues, should not be allowed to thwart possibilities for cooperation. While countries need to push for the implementation of ongoing energy programs under the aegis of established institutions, they also need to establish new, targeted collaborative institutional frameworks that respond to a specific energy/development need. The involvement of multiple stakeholders in energy processes is critical for arriving at informed decisions.

REFERENCES

ADB (2009). 'Women become Solar Warriors.*' Powering the Poor, 2009, Projects to increase access to clean energy for all*. Available at http://www.adb.org/sites/default/files/Powering-the-Poor.pdf. Date accessed on 4 September, 2012.

Ahmed, A. (2012, January). 'India's National Thermal Power Corporation signed an agreement with Bangladesh's Power Development Board to establish a 1320 MW coal-based plant.' *Live Mint*. Available at http://www.livemint.com/Politics/lF0rkWJx1ptwJ3vZrnxobK/Bangladesh-inks-deal-with-India-for-power-plant.html. Date accessed 3 October, 2012.

Alauddin, M. (2012). 'Renewable Energy Development in Bangladesh.' Energy for All. Available at http://www.energyforall.info/site/wp-content/uploads/2012/03/10-RE-Development-in-Bangladesh-Alauddin.pdf. Date accessed 3 September, 2012.

Banik, N (2006, December, 23). 'How Promising is BIMSTEC?'. *Economic and Political Weekly*, XLI (51). Available at http://www.ifmr.ac.in/pdfs/How%20Promising%20is%20BIMSTEC.pdf. Date accessed 20 October, 2012.

Batra, R K. (2007, June). 'Gas without borders.' *Hardnews*.

Batra, R K. and S K. Chand (2011, March). 'India's coal reserves are vastly overstated: is anyone listening?' *TERI Policy Brief*. Available at http://www.teriin.org/policybrief/index.php?a=3. Date accessed 16 August 2012.

BEE. (2010). Energy Savings Achieved, Bureau of Energy Efficiency. Available at http://www.beeindia.in/content.php?page=miscellaneous/energy_savings_achieved.php.Date accessed on 12 September, 2012.

Bhutan Power Corporation Ltd. (2012). 'The Foundation Casting Inauguration Ceremony of 400 kV Puna-IT/L Project.' Bhutan Power Corporation Limited. Available at http://www.bpc.bt/archives/2537. Date accessed 16 October 2012.

Bhutta, Z. (2012). 'Euphoria evaporates: Pakistan and India fail to strike oil trade deal.' *The Express Tribune*. Available at http://tribune.com.pk/story/411082/euphoria-evaporates-pakistan-and-india-fail-to-strike-oil-trade-deal/.Date accessed 18 August 2012.

BIDS & IISD. (2012, April). *A Citizen's Guide to Energy Subsidies in Bangladesh*. Bangladesh Institute of Development Studies and International Institute for Sustainable Development (IISD).

Bisht Medha. (2011). India-Bhutan Power Cooperation: Between Policy Overtures and Local Debates, *IDSA Issue Brief*, Institute for Defence Studies and Analyses.

Blank S. (2006, August). 'Afghanistan's energy future and its potential implications.' *Eurasianet*. Available at http://www.eurasianet.org/departments/insight/articles/eav090306.shtml. Accessed on 14 September, 2012

BP (2012). *Statistical Review of World Energy*. Available at http://www.bp.com/assets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/statistical_review_of_world_energy_full_report_2012.pdf. Date accessed 24 September 2012.

Caballero-Anthony, Mely. 2007. 'Energy, Climate Change and Sustainable Development: Are Regional Security Frameworks Prepared?'. *RSIS Commentaries,* S. Rajaratnam School of International Studies,

February 2013

Nanyang Technological University, Singapore. Available at http://www.rsis.edu.sg/publications/Perspective/RSIS1232007.pdf. Date accessed 15 September 2012.

Capik, M, Yilmaz, A.O., Cavusoglu, I. (2012). 'Present situation and potential role of renewable energy in Turkey.' *Renewable Energy*, 46, pp. 1-13

CEA. (2012, July). 'Monthly Generation Report (Renewable Energy Sources), 2012-13.' Central Electricity Authority, Ministry of Power, Government of India. Available at http://cea.nic.in/reports/articles/god/renewable_energy.pdf. Date accessed 19 October, 2012.

Climate Investment Funds. (2012, October). *Investment Plan for Maldives*. Meeting of the SREP Sub Committee. Istanbul, Turkey. Available at https://www.climateinvestmentfunds.org/cif/sites/climateinvestmentfunds.org/files/SREP_5_Maldives_0.pdf. Date accessed 30 November, 2012.

Coady, D., El-Said , M., Gillingham, , R., Kpodar, K., Medas, P., & Newhouse, D. (2006). *The Magnitude and Distribution of Fuel Subsidies: Evidence from Bolivia, Ghana, Jordan, Mali, and Sri Lanka*. International Monetary Fund.

Commission on Sustainable Development. (2001). *Report on the Ninth Session, 5 May 2000 and 16-27 April 2001*. Commission on Sustainable Development Economic and Social Council, E/CN.17/2001/19. Available at http://www.un.org/esa/sustdev/csd/ecn172001-19e.htm#Decision%209/1. Date accessed 15 October 2012.

Dalton, T. (2011, May). 'The Myth of Nuclear Energy in Pakistan.' Carnegie Endowment for International Peace. Available at http://carnegieendowment.org/2011/05/17/myth-of-nuclear-energy-in-pakistan/39yw. Date accessed 06 October 2012.

Department of Energy. (2009). *Overview of energy polices of Bhutan*. Department of Energy, Ministry of Economic Affaris. Thimpu: Royal Government of Bhutan.

DIREC (2010). *India's Renewable Energy Sector - Potential and Investment Opportunities*. Available at http://www.direc2010.gov.in/pdf/India's-RE-Sector-Potential-and-Investment-opportunites-SSM.pdf, Date accessed 29 July, 2012

Ea & COWI (2012). Bhutan: A national strategy and action plan for low carbon. Energy Analysis and COWI.

EIA (2012) 'Iran.' Country Analysis Briefs. The Energy Information Administration. Available at http://www.eia.gov/emeu/cabs/Iran/pdf.pdf Date accessed October 15, 2012

European Commission (2012). 'Electricity.' Competition. European Commission. Available at http://ec.europa.eu/competition/sectors/energy/electricity/electricity_en.html Date accessed 25 August 2012.

Gippner, O. (2010) Energy Cooperation in South Asia: Prospects and Challenges. VIII+54. Kathmandu: South Asia Watch on Trade, Economics and Environment (SAWTEE).

Global Transmission Report (2012). 'India-Bangladesh transmission link.' Global Transmission. Available at http://www.globaltransmission.info/archive.php?id=3976. Date accessed 15 October 2012.

Government of Bhutan. (2012). Planning and Coordination Division, Department of Hydropower and Power Systems, Ministry of Economic Affairs. Input to subregional preparatory consultation meeting for Asia and Pacific Energy Forum 2013.

Government of India (2011). House Listing and Housing Census Data Highlights - 2011. Ministry of Home Affairs, Government of India. Available at http://www.censusindia.gov.in/2011census/hlo/hlo_highlights.html. Date accessed 12 September, 2012

Government of Iran. (2012). Deapartment of Trade Negotiations and Energy, Ministry of Foreign Affairs. Input to subregional preparatory consultation meeting for Asia and Pacific Energy Forum 2013.

Government of Nepal. (2012). National Planning Commission Secretariat. Input to subregional preparatory consultation meeting for Asia and Pacific Energy Forum 2013.

Guillaume, D., Zytek, R., & Farzin, M. R. (2011). Iran - the chronicles of the subsidy reform. Washington: International Monetary Fund.

Gorashi, A.H. & Rahimi, A. (2011). 'Renewable and non-renewable energy status in Iran: Art of know-how and technology gaps.' Renewable and Sustainable Energy Reviews, 15, pp. 729-736.

Han, E and S. Liying (2012). 'Exploring the idea of an Asian energy Highway,' Website of Singapore International energy week, Available at http://siew.sg/energy-perspectives/energy-security/exploring-idea-asian-energy-highway. Date accessed 20 October 2012.

Hook, L., Johnston, T., & Bland, B. (2011, April). 'Fuel subsidies drag on emerging economies.' The Financial Times. Available at http://www.ft.com/intl/cms/s/0/81a781a0-69d7-11e0-89db-00144feab49a.html#axzz29NOPxxUE. Date accessed 15 October, 2012.

IDCOL (2012). 'IDCOL Solar Energy Program.' Infrastructure Development Company Limited. Available at http://www.idcol.org/energyProject.php. Date accessed 28 August 2012.

IEA (2009). 'Energy Balance.' International Energy Agency. Available at http://iea.org/stats/prodresult.asp?PRODUCT=Balances. Date accessed 25 September 2012.

IEA (2010). 'Turkey Review 2009.' Energy Policies of IEA Countries. Paris: International Energy Agency.

IEA. (2011a, October). Energy for all – Financing access for the poor. International Energy Agency. Available at http://www.iea.org/publications/freepublications/publication/weo2011_energy_for_all.pdf Date accessed 20 August, 2012

IEA. (2011b). 'Fossil Fuel Subsidy Consumption as a proportion of the full cost of supply, 2010.' International Energy Agency. Available at http://www.iea.org/subsidy/index.html. Date accessed 15 Septmber, 2012.

IEEO-SABA (2012). 'FAHAM.' Iran Energy Efficiency Organization (IEEO-SABA). Available at http://hooshmand.saba.org.ir/en/news/1701. Date accessed 17 October, 2012.

Iran Independent News Service (2012). 'Iran to increase power export to Pakistan massively.' Iran Independent News Service. Available at http://www.iranwpd.com/index.php?option=com_k2&view=item&id=3030:iran-to-increase-power-export-to-pakistan-massively&Itemid=66&lang=en. Date accessed 17 October 2012.

Karbassi, A.R, Abduli, M.A & Abdollahzadeh, M. (2007). 'Sustainability of energy production and use in Iran.' Energy Policy, 35, pp. 5171-5180.

Lama, M (2004). 'Energy Cooperation in South Asia.' Paper presented at the South Asia Free Media Association Regional Conference, August 20-21, 2004, Dhaka.

Lama, M. (2005). 'Energy Cooperation in South Asia,' South Asia Journal, 9.

Mahajan, D (2007). 'Identity, Nation and the Region: Trends and Concerns in South Asia.' CT Working Paper IX. New Delhi: Women in Security Conflict Management and Peace.

Mahajan, D and D Sharma (2010). 'Energy, climate, and security inter-linkages: Leveraging the region,' AEI Newsletter, 10, January 2011.

February 2013

Masud et al (2007). Energy for All: Addressing the Energy, Environment and Poverty Nexus in Asia. Manila: Asian Development Bank.

Mathur, A., Cherail, K., & Mahajan D. (2009). 'Incentivizing change in energy choices,' in Ligia Noronha and Anant Sudarshan (eds.) *India's Energy Security*. London: Routledge

MEA (2011). *Bhutanese economy and future direction* (Powerpoint presentation). Ministry of Economic Affairs, Royal Government of Bhutan.

Ministry of Development (2012, June). *Turkey's sustainable development report: Claiming the future.* Ministry of Development, Government of Turkey. Available at http://www.uncsd2012.org/content/documents/490Turkey'sSustainableDevelopmentReportClaimingtheFuture2012.pdf. Date accessed 7 September, 2012.

Ministry of Energy. (2011). 'Comparison of Energy Intensity Indicator.' *Iran and World Energy Facts and Figures, 2010,* pp. 96. Ministry of Energy, The Islamic Republic of Iran.

Ministry of Energy and Natural Resources (2010). *Strategic Plan 2010-2014*. Available at http://www.enerji.gov.tr/yayinlar_raporlar_EN/ETKB_2010_2014_Stratejik_Plani_EN.pdf. Date accessed 19 September, 2012.

Ministry of Finance (2011). 'Power and Energy.' *Bangladesh Economic Review*, pp 119-146. Ministry of Finance. Dhaka: Government of the People's Republic of Bangladesh.

Ministry of Power (2012a). 'Rajiv Gandhi Grameen Vidyutikaran Yojana: Report C-Physical & Financial Progress of RGGVY Projects Under Implementation (State-wise).' Ministry of Power, Government of India. Available at http://rggvy.gov.in/rggvy/rggvyportal/plgsheet_frame3.jsp. Date accessed 12 September, 2012.

Ministry of Power (2012b). 'Power for All by 2012.' Ministry of Power, Government of India. Available at http://www.powermin.nic.in/indian_electricity_scenario/power_for_all_target.htm. Date accessed 18 October, 2012.

Ministry Of Power and Energy. (2006). *National Energy Policy and Strategies of Sri Lanka*, Government of Sri Lanka.

MNRE (2012, February). *Strategic Plan for New and Renewable Energy Sector for the period 2011-17*. Ministry of New and Renewable Energy Government of India, Government of India.

MoEEW (2007, July). *Maldives climate change in-depth technology needs assessment - Energy sector*. (Report submitted by Commerce Development & Environment Pvt. Ltd). Ministry of Environment, Energy and Water, Republic of Maldives.

MoF Nepal (2012). 'Physical Infrastructure.' *Economic Survey 2011-2012*, ch. 10. Available at http://www.mof.gov.np/ajw/uploads/uploaded_image/Chapter%2010.pdf. Date accessed 12 September, 2012.

MoFA (2009, January). *Turkey energy strategy*. Ministry of Foregin Affairs, Government of Turkey. Available at http://www.mfa.gov.tr/data/DISPOLITIKA/EnerjiPolitikasi/Turkey's%20Energy%20Strategy%20(Ocak%202009).pdf. Date accessed 25 September, 2012.

Mohammadnejad, M., Ghazvini, M., Mahlia, T., & Andriyana, A. (2011). 'A review on energy scenario and sustainable energy in Iran.' *Renewable Energy and Sustainable Energy Reviews*, 15, pp. 4652-4658.

MoPEMR (2008, December). *Renewable Energy Polciy of Bangladesh*. Power Division, Ministry of Power, Energy and Mineral Resources, Government of the People's Republic of Bangladesh.

MoRTH. (2012). *Road Transport Yearbook (2009-10 & 2010-11)*. New Delhi: Transport Research Wing, Ministry of Road Transport and Highways, Government of India.

Munir, K., & Khalid, S. (2012, June). 'Pakistan's Power Politics.' *Economic and Political Weekly*, XLVII(25), pp. 24-27.

Naim-Ul-Karim. (2012, April). 'Bangladeshis boil over power, water, gas shortage amid rising temperature.' *Xinhuanet News*. Available at http://news.xinhuanet.com/english/world/2012-04/05/c_131509364.htm. Date accessed 4 September, 2012.

Nanda, N. and Goswami, A. (2008). 'Energy Cooperation in South Asia: Prospects and Challenges.' *Man and Development*, 30(1).

Nepal Oil Corporation Limited (2009) 'About us.' Nepal Oil Corporation Limited. Available at http://www.nepaloil.com.np/main/ Date accessed 18 August 2012.

Nexant (2001) *The Four Borders Project: Reliability Improvement and Power Transfer in South Asia*. Prepared for USAID-SARI/Energy Program. Available at http://pdf.usaid.gov/pdf_docs/PNACP539.pdf. Date accessed 20 September 2012.

Pandey, R.C. (2012). 'Status of Cross Border Trade and Energy Market – Nepal-India Exchange.' USAID-SARI/Energy, South Asia Regional Workshop on Policies and Regulations to Increase Cross Border Energy Trade, New Delhi, India,February 15-17, 2012. Available at http://www.sari-energy.org/PageFiles/What_We_Do/activities/Cross_Border_Conference_Feb_2012/Presentations/3.1_Nepal_Pandey.pdf. Date accessed 3 October, 2012.

PIB. (2012a, September). 'Power Export to Pakistan.' Press Information Bureau, Government of India.

PIB. (2012b, May 9). 'Export of Power and Petroleum Products to Pakistan.' Press Information Bureau, Government of India.

Planning Commission. (2010). Outline Perspective Plan of Bangladesh 2010-2021, Making Vision 2021 A reality. Planning Commission, General Economics Division. Dhaka: Government of People's Republic of Bangladesh.

Platts. (2012). 'Bangladesh finds new oil resources, revises gas reserves lower for 2 fields.' *Platts*. Available at http://www.platts.com/RSSFeedDetailedNews/RSSFeed/Oil/7622995. Date accessed 24 September, 2012.

PM's Council on Climate Change, Government of India. (2008). *National Action Plan on Climate Change*. Available at http://pmindia.nic.in/climate_change_english.pdf. Date accessed 19 October, 2012.

PPAC. (2012, September 7). Petroleum Planning and Analysis Cell, Ministry of Petroleum and Natural Gas, Government of India. Available at http://ppac.org.in/. Date accessed 19 October, 2012.

PPIS (2011).' Infrastructure Map - 2011.' Pakistan Petroleum Information ServiceEnergy, Directorate general of Petroleum Services, Government of Pakistan. Available at http://www.ppib.gov.pk/Energy%20Map%202011.pdf. Date accessed 21 July, 2012

Press TV (2012, September). 'Iran's electricity exports to neighbouring countries up 46%.' *Press TV*. Available at http://www.presstv.ir/detail/2012/09/11/261027/irans-electricity-exports-increase-46/. Date accessed on 5 October, 2012.

Priyantha, D.C. (2009, January). 'Energy status and future outlook.' *Daily News*. Available at http://www.dailynews.lk/2009/01/27/fea03.asp. Date accessed 4 October, 2012.

Rahman, A. (2009). 'Energy Sector Afghanistan: Importance of renewable energy for Afghanistan.' Presented at International Conference on Renewable Energy in Central Asia: Creating Economic Sustainability to Solve Socio-Economic Challenges, Dushanbe, Tajikistan. Available at http://www.carnegieendowment.org/files/Presentation_-%20Ashraf.pdf. Date accessed 20 September, 2012.

Raza, H. A. (2012). 'Transmission Operation Issues for Cross-Border Energy Trade for Pakistan.' USAID-SARI/Energy Regional Workshop on Transmission Operations For Cross Border Energy Trade, Thimphu, Bhutan, August 28-30, 2012. Available at

http://www.sari-energy.org/PageFiles/What_We_Do/activities/BhutanCrossBorderWorkshopAug2012/PResentations/Hilal_Raza_Bhutan_Presentation_on_Pakistan_30.8.2012_Final.pdf, last accessed on October 3, 2012.

Reddy, A (1990). *Barriers to Improvements in Energy Efficiency*. Prayas Energy Group, Pune. Available at http://www.amulya-reddy.org.in/Publication/20-BARRIERS-sri.pdf. Date accessed 12 October, 2012.

REEEP (2012a). 'Policy DB Details: Nepal (2012).' *REEEP Policy Database*. Renewable Energy and Energy Efficiency Partnership. Available at http://www.reeep.org/index.php?id=9353&text=policy-database&special=viewitem&cid=44. Date accessed 5 October, 2012.

REEEP (2012b). 'Policy DB Details: India (2012).' *REEEP Policy Database*. Renewable Energy and Energy Efficiency Partnership. Available at HYPERLINK "http://www.reeep.org/index.php?id=9353&special=viewitem&cid=40" http://www.reeep.org/index.php?id=9353&special=viewitem&cid=40 . Date accessed 14 October, 2012.

Reegle. (n.d.). ' Energy profile Maldives (Policy and Regulation).' Clean energy Info Portal- Reegle. Availbale at http://www.reegle.info/countries/maldives-energy-profile/MV#renewable_energy. Date accessed 27 September, 2012.

RERED. (2012). 'Energy Services Delivery Project.' Renewable Energy for Rural Economic Development Project. Available at http://www.energyservices.lk/statistics/esd_rered.htm. Date accessed 15 October, 2012.

Reuters (2012, July 16). 'Afghanistan may attract more energy firms as Exxon shows interest.' *Reuters*. Available at HYPERLINK "http://in.reuters.com/article/2012/07/16/afghan-energy-idINL3E8IA3FP20120716" http://in.reuters.com/article/2012/07/16/afghan-energy-idINL3E8IA3FP20120716 . Date accessed 16 September, 2012.

SAARC (2009) 'Area of Cooperation: Energy.' South Asian Association for Regional Cooperation. Available at http://www.saarc-sec.org/areaofcooperation/cat-detail.php?cat_id=55. Date accessed 19 September 2012.

SARI/Energy (2012). 'Afghanistan.' South Asia Regional Initiative for Energy, Cooperation and Development, USAID. Available at http://www.sari-energy.org/PageFiles/Countries/Afghanistan_Energy_Overview.asp. Date accessed 10 September, 2012.

SARI/Energy (nd.a.). *Mutual Benefits of an Indo-Lanka Transmission System Interconnection*. South Asia Regional Initiative for Energy, Cooperation and Development, USAID. Available at http://www.sari-energy.org/successdocs/IStudy_IndoLankaInterconnect.pdf. Date accessed 18 October, 2012.

SARI (nd.b.), 'Nepal: Energy Sector Overview.' South Asia Regional Initiative for Energy, Cooperation and Development, USAID. Available at HYPERLINK "http://www.sari-energy.org/PageFiles/Countries/Nepal_Energy_detail.asp" http://www.sari-energy.org/PageFiles/Countries/Nepal_Energy_detail.asp , accessed on September 30, 2012

SELCO (2012) Website of SELCO Solar Pvt. Ltd. Available at HYPERLINK "http://www.selco-india.com/index.html" http://www.selco-india.com/index.html .

Shahmoradi, A., & Honarvar, A. (2008). Gasoline subsidy and consumer surplus in the Islamic Republic of Iran. OPEC .

Shenoy, M et al (2011) 'Indian Energy Policy and Strategy: Pre- and Post-Copenhagen 2009,' in G Carbonnier et al (eds.) Energy and Development. New York: Palgrave Macmillan.

Sheikh, M.A. (2010). 'Energy and renewable energy scenario for Pakistan.' Renewable and Sustainable Energy Reviews, 14, pp. 354-363

Singh, B. (2011, April, 15). 'Numaligarh Refinery Ltd to build 100-km pipeline from India to Bangladesh for Rs. 150 crore.' The Economic Times. Available at HYPERLINK "http://articles.economictimes.indiatimes.com/2011-04-15/news/29421860_1_nrl-numaligarh-refinery-bangladesh-government" http://articles.economictimes.indiatimes.com/2011-04-15/news/29421860_1_nrl-numaligarh-refinery-bangladesh-government . Date accessed 3 October, 2012.

SLSEA (2010a), 'Introduction to Renewable Energy, Renewable Energy Forecast.' Sri Lanka Sustainable Energy Authority. Available at HYPERLINK "http://www.energy.gov.lk/sub_pgs/energy_renewable_intro_forcast.html" http://www.energy.gov.lk/sub_pgs/energy_renewable_intro_forcast.html , accessed on September 27, 2012.

SLSEA. (2010b). 'JICA Project.' Sri Lanka Sustainable Energy Authority. Available at http://www.energy.gov.lk/sub_pgs/jica.html. Date accessed 18 October, 2012.

Sorrell, S, Mallett, A., & Nye, S. (2011). Barriers to industrial energy efficiency: A literature review. Vienna: United Nations Industrial Development Organization.

Srivastava L. and N. Misra (2007) 'Promoting regional energy cooperation in South Asia.' Energy Policy, 35, pp. 3360-3368.

TERI (2008) 'Accelerating the Deployment of Distributed Generation based Smart Mini-Grids in India,' Issues Paper compiled for multi-stakeholder discussion held in TERI, on 03 April 2008. Discussion was supported by The Nand and Jeet Khemka Foundation.

TERI (2010) Green India 2047 Renewed: Looking Back to Change Track. New Delhi: The Energy and Resources Institute

TERI (2012a). Learning from emerging energy innovations in Asia: Contributing to the discourse on an institutional framework for sustainable development. New Delhi: The Energy and Resources Institute.

TERI (2012b). 'Lighting a Billion Lives.' The Energy and Resources Institute. Available at http://labl.teriin.org/index.php?option=com_content&view=article&id=6&Itemid=137#. Date accessed 28 August 2012.

TERI & IISD. (2012, March). A Citizens' Guide to Energy Subsidies in India. The Energy and Resources Institute, and International Institute for Sustainable Development. Available at http://www.teriin.org/events/INDIA_CITIZEN_GUIDE.pdf. Date accessed 19 October, 2012.

Thapa, Bishal, Amit Sharma and Rashika Gupta (2007) 'Prospects for energy integration', Himal South Asian, April 2007.

The Daily Star. (2012a, March 26). 'Energy Conservation law must for an efficient sector: experts.' The Daily Star. Available at http://www.thedailystar.net/newDesign/news-details.php?nid=227763. Date accessed 6 September, 2012.

The Daily Star (2012b, August 1) 'Eyes on Hydropower.' The Daily Star. Available at http://www.thedailystar.net/newDesign/news-details.php?nid=244358. Date accessed 9 October, 2012.

The Daily Star (2012c , September 1). 'PM for joint venture with Nepal.' The Daily Star. Available at http://www.thedailystar.net/newDesign/news-details.php?nid=247892. Date accessed 8 October, 2012.

February 2013

The Hindu (2012) 'TAPI pipeline gas sale agreement signed.' The Hindu. Available at http://www.thehindu.com/business/Economy/article3449588.ece. Date accessed 25 August 2012.

The Telegraph (2011, June 30). 'Bangla lifts ban on coal' in The Telegraph, Calcutta. Available at http://www.telegraphindia.com/1110630/jsp/northeast/story_14177982.jsp. Date accessed 8 October, 2012.

Tobgay, S. (2011). Bioenergy needs assessment study in Bhutan - Status, issues, concerns and opportunities. Policy and Planning Division, Ministry of Agriculture and Forests, Royal Government of Bhutan.

Trimble, C., Yoshida, N., & Saqib, M. (2011, July). Rethinking Eletricity tariffs and Subsidies in Pakistan. World Bank. Available at http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2011/08/31/000386194_20110831050158/Rendered/PDF/629710ESW0whit0020110Final00PUBLIC0.pdf. Date accessed 13 August, 2012

Umar, A (2007). 'The Role of Private Sector in Pakistan's Energy Sector.' In R. M. Hathway, B. Muchhala, & M. Kugelman (Eds.), Fuelling the Future: Meeting Pakistan's Energy Needs in the 21st Century (p. 203). Washington D.C.: Woodrow Wilson International Center for Scholars.

UN (2012) 'Pursuing Shared Prosperity in an Era of Turbulence and High Commodity Prices,' Economic and Social Survey of Asia and the Pacific 2012. Bangkok: United Nations

UN Data (2010). 'Per capita government expenditure on health (PPP int. $).' World Health Organization, United Nations Data. Available at http://data.un.org/Data.aspx?d=WHO&f=MEASURE_CODE%3aWHS7_108. Date accessed 17 October, 2012.

UN Data (2012). 'Improved water source (% of population with access).' World Development Indicators, United Nations Data. Available at http://data.un.org/Data.aspx?d=WDI&f=Indicator_Code%3aSH.H2O.SAFE.ZS. Date accessed 11 September, 2012.

UNDESA (2012). 'Population of Urban and Rural Areas and Percentage Urban, 2011.' *World Urbanization Prospects: The 2011 Revision*. Population Division, United Nations Department of Economic and Social Affairs. Available at http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm. Date accessed 11 September, 2012.

UNDP (2001). 'Sustainable Development, Energy and the Environment.' *UNDP's Climate Change Initiatives*. New York: Bureau for Development Policy, United Nation's Development Programme.

UNDP (2009). *The energy access situation in developing countries: A review focusing on Least Developed countries and Sub-Saharan Africa*. Available at http://content.undp.org/go/cms-service/stream/asset/?asset_id=2205620. Date accessed 15 September 2012

UNDP (2011a). 'Sustainability and Equity: A Better Future for All.' *Human Deveopment Report 2011*. United Nations Development Programme.

UNDP (2011b). 'Gender Inequality Index and related indicators.' *Human Development Report 2011* (Table 4). Available at http://hdr.undp.org/en/media/HDR_2011_EN_Table4.pdf. Date accessed 11 September, 2012.

UNDP (2011c). 'Human Development Statistics Data.' *Human Development Report 2011*. United Nations Development Program. Available at http://hdr.undp.org/en/reports/global/hdr2011/download/. Date Accessed 20 October 2012.

UNDP (2011d). *Towards an 'Energy Plus' Approach for the Poor: A review of good practices and lessons learned from Asia and the Pacific*. United Nations Development Programme

UNDP (n.d.). *Delivering energy services for poverty reduction: Success stories from Asia and the Pacific*. *Regional Programme for Poverty Reduction*. Bangkok: United Nation's Development Program, Regional Centre. Available at at http://content.undp.org/go/cms-service/stream/asset/?asset_id=2095748. Date accessed 2 September, 2012.

UNESCAP (2012). 'Statistics.' Available at http://www.unescap.org/stat/data/statdb/DataExplorer.aspx. Date accessed 29 September 2012.

UNSD (2012a). *2009 Energy Statistics Yearbook*. United Nations Statistics Division. Available at http://unstats.un.org/unsd/energy/yearbook/default.htm

UNSD (2012b). 'Total net enrolment in primary education, both sexes.' Millennium Development Goals Database, United Nations Statistics Division in United Nations Data. Available at http://data.un.org/Data.aspx?d=MDG&f=seriesRowID%3a589. Date accessed 8 October, 2012.

UNSD (2012c). 'Percentage of pupils starting grade 1 who reach last grade of primary, both sexes.' Millennium Development Goals Database, United Nations Statistics Division in United Nations Data. Available at http://data.un.org/Data.aspx?d=MDG&f=seriesRowID%3a591. Date accessed 8 October, 2012.

UNSD (2012d). 'Literacy rates of 15-24 years old, men, percentage.' Millennium Development Goals Database, United Nations Statistics Division in United Nations Data. Available at http://data.un.org/Data.aspx?d=MDG&f=seriesRowID%3a657. Date accessed 8 October, 2012.

UNSD (2012e). 'Literacy rates of 15-24 years old, women, percentage.' Millennium Development Goals Database, United Nations Statistics Division in United Nations Data. Available at http://data.un.org/Data.aspx?d=MDG&f=seriesRowID%3a658. Date accessed 8 October, 2012.

Waheed. A. & Azwar A. (2011). *Renewable energy status in the Maldives*. Presentation at the Executive Exchange to SOLAR 2011 Conference and Exhibition.. Available at http://www.sari-energy.org/PageFiles/What_We_Do/activities/SOLAR_2011/Presentations/SOLAR_Maldives.pdf. Date accessed 16 September, 2012

Wangdi P. (2010, July. 'Energy from solar, wind and gas to power 10,000 households.' *Business Bhutan*. Available at http://www.businessbhutan.bt/?p=2248. Date accessed 9 October, 2012.

WECS (2010). *Energy Sector Synopsis Report*. Kathmandu: Water and Energy Commission Secretariat, Government of Nepal.

WEC (2010). *2010 Survey of Energy Resources*. London: World Energy Council.

Wickramasinghe, A. (2011). 'Energy access and transition to cleaner cooking fuels and technologies in Sri Lanka: Issues and Policy Limitations.' *Energy Policy, 39,* pp. 7567-7574.

World Bank (2007) *South Asia Energy: Potential and Prospects for Regional Trade*. The World Bank: Washington DC.

World Bank. (2009). 'Access to electricity (% of population).' World Bank Statistics. Available at http://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?display=default. Date accessed 24 July, 2012.

World Bank (2011). 'Population growth (annual %).' The World Bank Statistics. Available at http://data.worldbank.org/indicator/SP.POP.GROW. Date accessed 11 September, 2012.

World Bank (2012a). 'Country and Lending Groups.' The World Bank . Available at http://data.worldbank.org/about/country-classifications/country-and-lending-groups. Date accessed 19 September, 2012.

World Bank (2012b). 'Poverty.' The World Bank. Available at http://data.worldbank.org/topic/poverty. Date accessed 5 October, 2012.

February 2013

World Bank. (2012c). *World Development Indicators 2012*. Available at http://data.worldbank.org/sites/default/files/wdi-2012-ebook.pdf. Date accessed 7 September, 2012

World Bank. (2012d). 'Electric power transmission and distribution losses (% of output).' World Bank Statistics. Available at http://data.worldbank.org/indicator/EG.ELC.LOSS.ZS. Date accessed 15 October, 2012.

World Bank. (2012e). 'Electrification Rate.' World Bank Statistics. Available at http://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?display=default. Date accessed 24 July, 2012.

World Bank (2012f). 'Energy use (kg of oil equivalent) per $1,000 GDP (constant 2005 PPP).' World Bank Statistics. Avaliable at http://databank.worldbank.org/ddp/html-jsp/QuickViewReport.jsp?RowAxis=WDI_Ctry~&ColAxis=WDI_Time~&PageAxis=WDI_Series~&PageAxisCaption=Series~&RowAxisCaption=Country~&ColAxisCaption=Time~&NEW_REPORT_SCALE=1&NEW_REPORT_PRECISION=0&newReport=yes&IS_REPORT_IN_REFRESH_MODE=true&IS_CODE_REQUIRED=0&COMMA_SEP=true. Date accessed 15 October, 2012.

Yuksel.I. (2010) 'Energy Production and Sustainable energy policies in Turkey.' *Renewable Energy 35*, pp 1469-1476