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for environmental protection

Energy end use efficiency promotion in Asian developing countries

Issues and policy options
Summary of ESCAP activities

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Summary

Many economies in Asia and the Pacific have shown remarkable growth rates over the past decades, resulting in similar high energy consumption growth rates. These trends are expected to continue in the near future. To match demand, supply capacity would have to be expanded at enormous investment cost. This could be reduced if energy were used more efficiently. This report gives an overview of technical options for improving energy end-use efficiency in the productive, residential and commercial sectors. Despite recognition that such options are not only environmentally benign, but are often cost-effective as well, much of the economic potential of energy saving options has not been realized.

Various barriers, of a technical, financial, economic and institutional nature, have so far inhibited the application of energy-efficient appliances, equipment and processes in many countries of the ESCAP region. Governments can play an important role in promoting energy-efficient practices. A review of the current policy activities of selected countries is given. ESCAP, as the regional arm of the United Nations, seeks to assist both government and private sector entities in their energy efficiency promotion efforts. The paper ends with a description of ongoing ESCAP projects in the field of energy efficiency.

Units and abbreviations

Physical units

In physical sciences, quantities are preferably given in units from the so-called 'international system of units' (SI). Basic SI QUANTITIES and units are: DISTANCE OR LENGTH (l): metre (m), MASS (m): kilogramme (kg), TIME (t): second (s), ELECTRIC CURRENT (I): Ampère (A), TEMPERATURE (T): Kelvin (K) and LUMINOSITY (I): Candela (c), supplemented by the ANGLE (α): radian (rad) and the 3-dimensional SOLID ANGLE (Ω): steradian=sr . Other units can be expressed in these basic units by simple expressions.

Often multiples of a unit are used in steps of thousand. To notate such large numbers in a simple way these are expressed as powers of ten. The POWER or INDEX is the number that is written as exponent (e.g. 10^3 = 1,000 = ten to the power three. Thousand is the PREFIX). The number three indicates how many positions the decimal point is shifted to the right. Indexes of numbers smaller than 1 are written as a negative number, indicating how many positions the point has shifted to the left (e.g. 10^{-3} = 0.001).

Much used prefixes are given a name and symbol:

E = exa = 10^{18}	G = giga = 10^9	h = hecto = 10^2	m = milli = 10^{-3}
P = peta = 10^{15}	M = mega = 10^6	d = deci = 10^{-1}	μ = micro = 10^{-6}
T = tera = 10^{12}	k = kilo = 10^3	c= centi = 10^{-2}	n = nano = 10^{-9}

Other SI units, derived from the SI basic units, and their notations:

VOLUME:	m^3
VELOCITY:	metre per second ($m/s = m\cdot s^{-1}$)
ACCELERATION:	$m\cdot s^{-2}$
FORCE:	1 Newton (N) = 1 $kg\cdot m/s^2$ (defined as the force that produces an acceleration of one metre per second per second on a mass of one kilogramme)
ENERGY:	1 Joule (J) = 1 Newton-metre = 1 $kg\cdot m^2/s^2$ (the energy needed when a force of 1 N acts through a distance of 1 m)
POWER:	1 Watt (W) = 1 J/s = 1 V·A (one Joule per second; equivalent to one Volt-ampère, i.e., the power in a circuit in which a current of one Ampère flows across a potential difference of one volt)
ELECTRIC CHARGE:	1 Coulomb (C) = 1 A·s
ELECTRIC POTENTIAL	1 Volt (V) = 1 J/(A·s)
LIGHT CURRENT:	1 lumen (lm) = 1 cd·sr

Much used non-SI units and equivalents:

MASS

	kg	(metric) tonne	(long) ton	(short) tonne	pound (lb)
kg	1	0.001	0.000984	0.001102	2.2046
tonne	1000.0	1	0.984	1.1023	2204.6
long ton	1016.0	1.016	1	1.120	2240.0
sh. ton	907.2	0.9072	0.893	1	2000.0
pound	0.454	0.000545	0.000446	0.0005	1

VOLUME

	US gallon	imperial gallon	barrel	cubic feet	cubic metre
US gallon	1	0.8327	0.02381	0.1337	0.0038
I. gallon	1.201	1	0.02859	0.1605	0.0045
barrel	42.0	34.97	1	5.615	0.159
ft^3	7.48	6.229	0.1781	1	0.0283
m^3	264.2	220.0	6.289	35.3147	1

ENERGY

	Joule	Btu	kWh	toe	tce
J	1	$947.8\cdot10^{6}$	$277.7\cdot10^{9}$	$2.388\cdot10^{5}$	$341.2\cdot10^{9}$
Btu	1,055.1	1	$2.9307\cdot10^{6}$	$252.0\cdot10^{6}$	$360.0\cdot10^{6}$
kWh	$3.6\cdot10^{6}$	3412.0	1	$85.98\cdot10^{6}$	$0.1228\cdot10^{3}$
toe	$41.868\cdot10^{9}$	$39.681\cdot10^{6}$	11630	1	1.4286
tce	$29.31\cdot10^{9}$	$27.777\cdot10^{6}$	8141	0.7	1
cal	4.1868	252.0	$1.163\cdot10^{6}$	10^{10}	$1.429\cdot10^{10}$

DEFINITIONS:

1 British Thermal Unit (Btu): the heat required to raise the temperature of one pound of water by 1° Fahrenheit.
1 calorie (cal): the heat required to raise the temperature of 1 gramme of water by 1°C
1 tonne of oil equivalent (toe): 10^7 kcal
1 tonne of coal equivalent (tce): 0.7 toe
1 kWh: 1 kilowatt-hour = 3.6 MJ
1 kgf m = 9.807 J
1 ft lb = 1.3558 J

DISTANCE / LENGTH

1 inch (in) = 2.54 cm
1 foot (ft) = 30.48 cm
1 yard (yd) = 0.9144 m
1 mile (ml) = 1.60934 km
1 seamile = 1.852 km

POWER

1 kgf m/s = 9.807 W
1 ft lb/s = 1.3558
1 horsepower (hp) = 745.7 W = 75 kgf m/s
1 metric horsepower = 735.3 W = 550 ft lb/s

TEMPERATURE

Conversion Celsius to Kelvin: (t °C) = (t + 273.15) K
Conversion Fahrenheit to Celsius: (x °F) = (x-32)·5/9 °C
Conversion Celsius to Fahrenheit: (y °C) = 32 + 9/5·y °F

HEATING VALUES OF FUELS

The HEATING (OR CALORIFIC) VALUE of a fuel is the amount of heat in a given quantity, which can be released in combustion. The NET HEATING VALUE (NHV) is the gross heating value minus the latent heat of evaporation of water vapour released in the combustion process. The more hydrogen a fuel has (oil has more than coal, gas more than oil), the more vapour is formed, and the higher the difference between gross and net HV.

Greenhouse gases

The amount of emitted gases is usually given in multiples of grammes:

1 gC = 1 gramme of carbon
1GtC = 1 gigatonne of carbon = 10^9 tonnes = 1 PgC
1 tC = 1 tonne of carbon
1 TgC = 1 teragramme of carbom = 10^{12} grammes of carbon
1 PgC = 1 GtC = 10^{15} grammes of carbon

1 gCO = 1 gramme of carbon monoxide, equivalent to 0.4286 gC (conversion based on the atomic weight of the C and O atom)
1 gCO_2 = 1 gramme of carbon dioxide, equivalent to 0.2727 gC

Similarly,
1 gN_2O = 1 gramme of nitrous oxide, and is equivalent to 0.3182 gN

Emissions of a gas will increase its atmospheric concentration. The atmospheric concentration of greenhouse gases is usually given in 'ppmv' (parts of that gas per million of air particules per unit volume), or 'ppbv' (parts per billion), etc. Combining the radiative forcing per molecule (which is different for each gas and relatively well known) with the change in concentration gives the the RADIATIVE FORCING of that change.

In order to express the global warming effect of various greenhouse gases, the so-called GLOBAL WARMING POTENTIAL (GWP) has been developed, which is used for example by the Intergovernmental Panel on Climate Change (IPCC) of the United Nations. It takes into account the radiative forcing of the gas and less accurately known factors, such as the lifetime of the gas in the atmosphere, the time horizon over which effects are regarded, and indirect impacts on other greenhouse gases. Indexes other than the GWP have been developed and each have their conceptual weaknesses.

The convention is to express the GWPs of greenhouse gases in one common unit, relative to carbon dioxide, for example $gC_{(eq)}$. This unit is used in the figures of paragraph II.3.2. The following GWP conversion factors are assumed: 1 gCO_2 ≙ 0.2727 gC, 1 gCO ≙ 0.8181 gC, 1 gCH_4 ≙ 5.727 gC, 1 gNO_x ≙ 10.909 and 1 gCFC-11 ≙ 954.459 gC.

C: carbon, CFC: chlorofluorocarbons, CH_4: methane, CO_2: carbon dioxide, CO: carbon monoxide, H_2O: water, N: nitrogen, NO: nitrous oxide, NO_2: nitrogen oxide, NO_x: oxides of nitrogen, O: oxygen, O_3: ozone, S: sulphur, SO_2: sulphur dioxide, SPM: suspended particulate matter.

Preface

In the 1980s the Economic and Social Commission for Asia and the Pacific (ESCAP) has been the main executing agency in a major regional programme in the field of energy, namely the *Regional Energy Development Programme (REDP)* and its sister programme, the *Pacific Energy Development Programme (PEDP),* both financed by the United Nations Development Programme (UNDP).

Building on the decade-long experiences of REDP and PEDP, UNDP has developed a successor project RAS/92/070, *Programme for Asian Cooperation on Energy and Environment (PACE-E)* for the period 1993-1997 and designated ESCAP as the main executing agency. The PACE-E project emphasizes the new issues that have emerged, since the conception of REDP, environmental sustainability and the shift from energy supply to the demand side.

PACE-E consists of six programme elements, of which *Conservation and Efficiency (C&E)* is one. Under C&E a series of workshops is organized, each focussing on a particular theme related to energy end use efficiency. In March 1994 the *Workshop of Regional Policy Makers on National Strategies and Regional Cooperation in Energy Efficiency Promotion* was convened in Bangkok, organized by ESCAP, which served as 'kickoff' activity for C&E.

Another initial C&E activity is this publication. It aims at giving an overview of issues and options in energy end use efficiency and of the implementation status of efficiency promotion policies in the non-industrialized countries of Asia and the Pacific.

The ESCAP secretariat wishes to express its appreciation to UNDP for funding support to PACE-E. It acknowledges the Dutch Government for making available, through the United Nations Industrial Development Organization (UNIDO) project TF/RAS/92/010, Mr. J. H.A. van den Akker, for preparing and editing this publication. Also, the ESCAP Secretariat wishes to express its appreciation for the Energy Management Centre (EMC) of India, which prepared a discussion paper, *Policy Guidelines for Energy Efficiency Promotion*, with research inputs from Tata Energy Research Institute (TERI), India, and was presented at the above-mentioned workshop in March 1994. Elements of this paper served as a valuable input for this publication as well.

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I Overview

Energy is a prerequisite for all economic activity and development. The developing countries, including those in Asia, will continue to require more and additional energy resources as they seek to achieve an accelerated growth of the gross domestic product to secure higher living standards. This process will show also higher levels of industrialization and a rapid rise in the demand for consumer goods, light, refrigerators, televisions, for example. Chapter two gives an overview of past and future trends in energy consumption in Asia and the Pacific.

Therefore, throughout the ESCAP region, Government authorities, energy planners and utilities expect significantly increasing levels of energy demand and consumption. Primary energy consumption in the developing countries of the Asian and Pacific region will rise from 1,401 Mtoe [1] (1990) to 3,480-3,812 Mtoe in 2010, according to recent ESCAP projections. Throughout Asia, ensuring an adequate energy supply is of primary importance, but these efforts will face serious environmental, operational and financial constraints.

The generation and use of commercial energy are associated with various immediate and long-term environmental impacts that in recent years have also gained increasing recognition. Environmental impacts of energy use appear at all levels: (a) at the local level, air pollution (smog), with harmful effects on human health, (b) at the regional level, acid rain, affecting natural ecosystems, and (c) at the global level, global warming, with possible adverse climate change impacts.

Developing and carrying out solutions to the energy-environment problems remains an urgent task in the years ahead. As in other countries, energy policy makers in Asia face the dilemma that all presently available commercial sources of energy, fossil fuels, nuclear power, large-scale hydropower and renewable energy technologies, have some major technical or economic constraints and/or negative environmental impacts.

In the light of the above, most national Governments and the international and regional organizations have recognized and emphasized the importance of energy economy and energy efficiency as a cornerstone of all efforts to attain sustainable energy development. As in all energy-consuming sectors it is not energy *per se* that is needed, but the particular services provided by energy. Hence, if the services per unit of energy are increased, development is achieved at less expense to the environment.

Apart from environmental benefits, Asian countries can take advantage of enhanced energy economy and efficiency in terms of reduced investments in energy supply infrastructure, reduced dependence on energy imports, reduced strains on the balance of payments, delayed depletion of scarce energy reserves and stimulation of indigenous technical competence and industrial capacity. Enhanced intermediate and end-use energy efficiency in the industrial, service and transport sectors of developing and developed countries can strengthen national and international competitiveness, facilitate economic expansion and enhance diversification through new and additional business opportunities.

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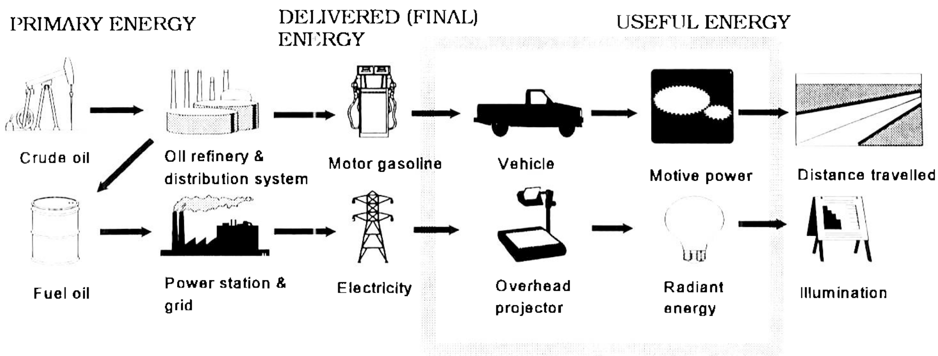
1 Mtoe = million tonnes of oil equivalent

Box 1.1 The energy supply system



Energy end use

Energy is transformed through a chain of events. PRIMARY SOURCES are, e.g., crude oil, natural gas, coal, water, solar energy and biomass. These may be directly delivered into final uses (e.g. fuelwood for direct combustion in a woodstove) but usually need some transformation steps (e.g. a refinery, power plant or charcoal kiln) to obtain a readily usable form of SECONDARY ENERGY (e.g. gasoline, electricity, charcoal). Whether primary or secondary, the energy delivered to the end user is called DELIVERED ENERGY or FINAL ENERGY. The consumer does not want energy as such, but is interested in useful services (e.g. distance travelled, illumination or food cooked), rendered by the transformation of delivered energy carriers in end-use devices (e.g. vehicles, electric appliances, cooking stoves) in USEFUL ENERGY (e.g. motive power, stationary power, electricity or heat).

According to the First Law of Thermodynamics, a balance of energy always exists, in any energy conversion or end use process. Thus,ENERGY INPUT of the process, equals ENERGY OUTPUT, which consists of the USEFUL ENERGY and ENERGY LOSSES. In other words: energy is always conserved, but its form may be converted. Sometimes, it must be converted; according to the Second Law of Thermodynamics no conversion of fuel (by a device or process) into a higher-quality fuel or useful work is 100 percent efficient. Therefore, in each transformation step of the energy supply system, certain *losses* (WASTE ENERGY), usually dissipated into the environment in the form of heat, are unavoidable.

The EFFICIENCY η in each energy conversion step, in a device or a process, can be given as:

$$\eta = \frac{\text{useful energy}}{\text{energy input}}, \quad \text{energy input} = \text{energy output} = \text{useful energy} + \text{waste energy}$$

To give an example, the energy (end use) efficiency η_e of a wood stove is generally between 5 and 10 percent, of a charcoal stove is between 15 and 35 % of a LPG stove between 55 and 60 %, and of an electric stove between 60 and 75%. Such efficiencies are nominal values for that particular device.

The ENERGY SYSTEM EFFICIENCY η_s includes all the losses in producing η_p, converting η_c and delivering η_d a fuel to the end consumer:

$$\eta_s = \eta_p \cdot \eta_c \cdot \eta_d \cdot \eta_e$$

This results in particularly low system efficiencies of certain fuels, e.g. charcoal (η_c = 16-50 %) and electricity (η_p = 28-33%), due to the huge losses in energy in conversion of wood into charcoal and in the generation of electricity. When comparing devices, one should thus not only look at the efficiency, economics or emission of the fuel use in that particular device, but also at the overall energy system characteristics of the fuel.

SOURCE: *Bioenergy*, J.H.A. van den Akker, M. Monteiro (ed.), Integrated Institute of Interdisclipinary Integration (forthcoming 1995, Amsterdam, Netherlands).

It is possible to improve low energy end use efficiencies through the adoption of proven cost-effective technologies. These include more efficient lights, refrigerators, cars and trucks, industrial boilers, electric motors, biomass stoves, pump systems and a variety of more energy-efficient manufacturing processes. Many examples of energy-efficient equipment, appliances and processes are given in chapter three.

Despite the multiple benefits of energy-efficient technologies, many may not yet be widely used. Various technologies are still in various stages of research and development (R&D). Commercialization will only become available in the medium or longer term. However, cost-effective, technically viable measures are not implemented because of various impediments to their adoption. Such barriers include market failures (lack of information and awareness, disconnection of responsibility between consumer and supplier, owner and tenant), adverse pricing and taxation policies, technical and infrastructural barriers and, often, the policy makers' bias in favour of large supply side projects, against a multitude of small demand-side projects.

Many policy responses to overcome these barriers might be adopted. Of vital importance is improved information to consumers and producers on energy efficient technologies, for example, through awareness campaigns, training and consultancy services and energy labelling programmes. National or regional energy conservation centres can play a catalytic role in creating a critical mass of skilled personnel and know-how.

Reforms in energy policies can encourage purchase of energy efficient equipment, but they alone are not sufficient to overcome strong institutional barriers, and need to be supplemented by energy efficiency standards and innovative financial support mechanisms. Closer links between energy suppliers and users and change in restrictions on private power generation, are examples of other policies that might be used to reinforce price signals.

Through integrated resource planning, including both supply and demand, in energy decision-making, the traditional bias in favour of supply expansion could be lessened.

Chapter four gives a thorough review of barriers and policy options, illustrated by various examples throughout the Asian region. Here, several developing countries are seeking alternative ways of meeting energy demand by adopting improved energy end use technologies. Increased attention is given to the politically sensitive questions of energy pricing and ownership and management of energy supply industries. Many countries have developed energy conservation and efficiency policy institutions.

Evidence of change can also be found in donor institutions. Both bilateral and donor agencies and multilateral development banks have begun to incorporate environmental impact assessment, have developed energy conservation and efficiency projects and encourage a larger role for the private sector. For example, the Economic and Social Commission for Asia and the Pacific (ESCAP) has reacted in a timely manner on this momemtum for change through various activities in the area of energy and the environment. For a short description of its programme, the reader is referred to chapter five.

II Patterns of energy use in Asian countries

II.1 Regional overview of energy trends

II.1.1 Primary energy demand. Final energy demand per type of fuel and per sector

Figures 2.1 and 2.3 [1/] show the commercial primary and final energy consumption patterns in selected developing economies of the ESCAP region. Solids (basically coal) have had the largest share of consumption in the region, and have grown steadily. The decrease in oil consumption share is compensated by the increase in natural gas share. The share of electricity has been increasing. The above picture is, of course, heavily influenced by the two largest energy consumers in the region, China and India. Excluding these, liquid fuels replace solid fuels as the dominant fuel type.

Figure 2.3 shows, for the same group of developing countries, the sectoral composition of the commercial energy consumption. The aggregate figures reveal the productive sectors (industry, agriculture) as the major energy consuming sector with 64 percent, followed by the commercial and residential sector (19 percent) and the transport sector (13 percent). Again, this pattern is mainly influenced by India and China, which together account for around 80 percent of the total final energy consumption. Excluding these countries, industry and agriculture's share is reduced to 35 percent and that of the transport sector raises to 27 percent. The role of the transport sector is even more pronounced in the sectoral composition of the ASEAN

Box 2.1 The concept of "primary energy consumption", as used in energy statistics

Commercial energy is consumed in the form of solids, liquids, gases and electricity. The primary consumption of SOLIDS refers to the use of primary forms of solid fuels, net imports and changes in stocks of secondary fuels; the consumption of LIQUIDS refers to the use of petroleum products (including feedstock), natural gasoline, condensate and refinery gas and to inputs of crude petroleum to thermal power plants; the consumption of GASES refers to the use of natural gas and coke-oven gas, net imports and changes in stocks at gas works; and the consumption of ELECTRICITY refers to the use of primary energy and net imports of electricity. PRIMARY ELECTRICITY consumption refers only to electricity generated from hydropower, nuclear, geothermal and other new and renewable energy sources, and does not include the consumption of SECONDARY ELECTRICITY generated from the conversion of fossil fuels. Thus the "weight" of primary electricity is net of any conversion factors. If such primary electricity would be replaced by fossil fuel generation, its "weight" would increase by a factor of three, reflecting conversion losses.

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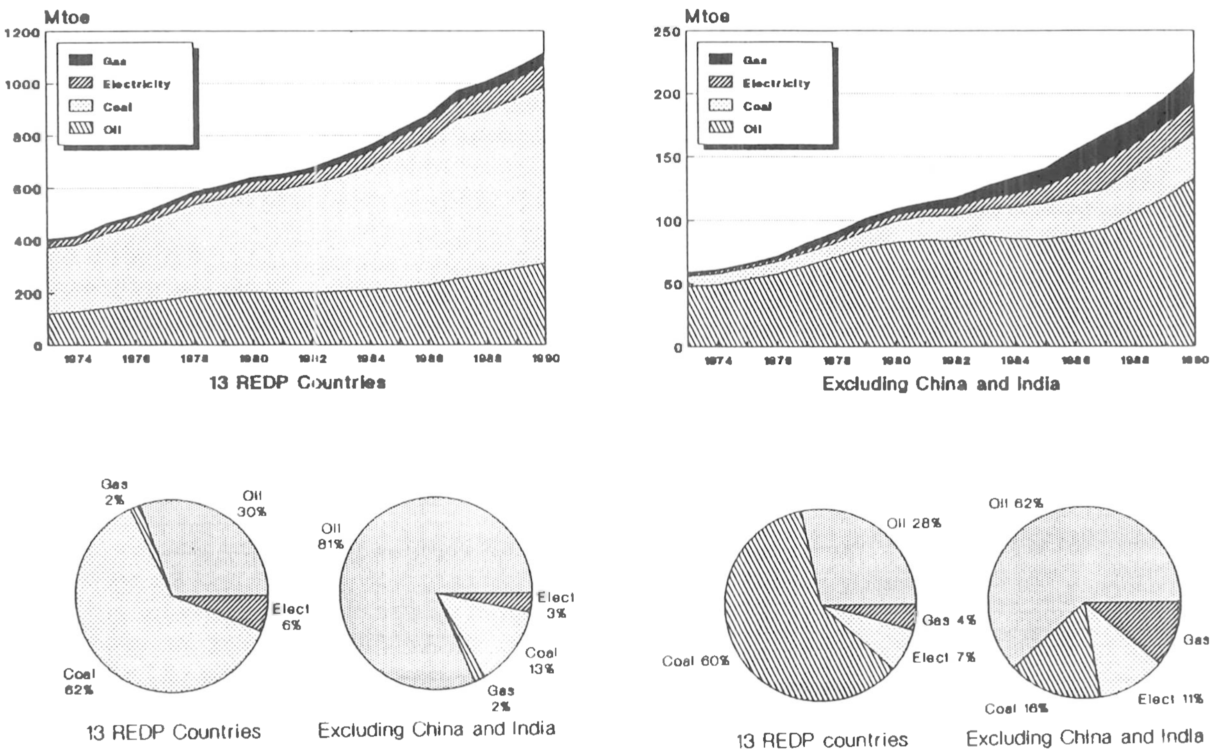
1 Data used in many figures and tables of this chapter are taken from the publication *Sectoral Energy Demand Studies in Asia: Synthesis Report*, Regional Energy Development Programme (REDP), ESCAP / UNDP (1992, United Nations, New York). The report is based on data from 13 REDP-participating countries, China, India, Indonesia, Republic of Korea, Lao People's Democratic Republic, Malaysia, Maldives, Myanmar, Nepal, Philippines, Sri Lanka, Thailand and Viet Nam, supplemented by data from *Energy Indicators of Developing Member Countries of ADB*, Asian Development Bank (April 1992, Manila, The Philippines).

***Figure 2.1* Primary commercial energy consumption**



SOURCE: *Sectoral Energy Demand Studies in Asia: Synthesis Report,* Regional Energy Development Programme (REDP), ESCAP / UNDP (1992, United Nations, New York), p.4, fig. 1 and 2.

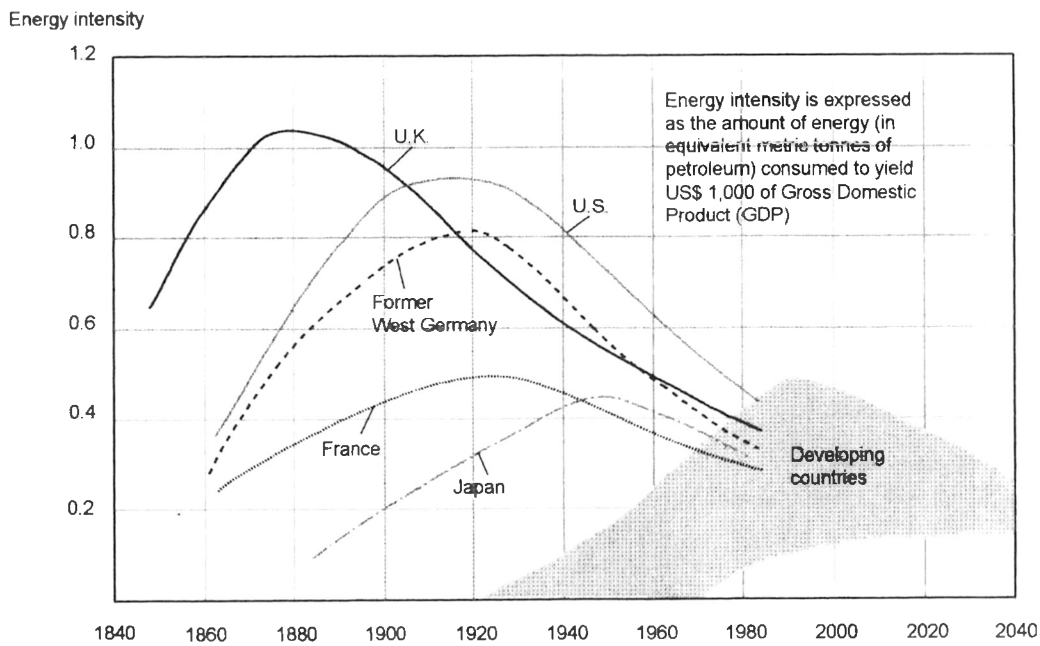
countries (about 36 percent). This indicates the increasing importance of the services sectors (commerce, transport) with the increasing development of a country.

Table 2.1 shows the historical trend of consumption of all forms of commercial primary energy in the ESCAP region and aggregate world trends. The latest revised data indicate that the regional primary energy consumption increased at an average annual rate of 4.8 percent over the period 1970-1990, a significant growth rate compared with the world average of 2.7 percent.

The regional total commercial energy consumption reached 1,697 Mtoe (1990), up from 664 Mtoe in 1970. This high growth rate was achieved as a result of the impressive growth in the developing countries of the region, that is of economic growth, high population growth, rapid urbanization, high energy intensity (owing to the industrialization stage of their economic development) and of less efficient energy use (than state-of-the-art technology would allow). The consumption in those economies has been rising continuously despite several energy crises during the 1970s.

As compared with the industrialized countries, where the average annual energy consumption per capita generally ranges between 1500 and 3500 koe [2/] per capita per annum, consumption in the developing countries and areas of the ESCAP region is still comparatively low. Exceptions are the newly industrializing economies (NIEs, Hong Kong, the Republic of Korea, Singapore and Taiwan Province of China), where industrialization, consumption patterns and lifestyles are more similar to those of industrialized countries.

***Figure 2.2* Energy intensity and industrialization**



SOURCE: *Scientific American* (September 1990), "Energy for the developing world", Amulya K.N. Reddy, José Goldemberg.

II.1.2 Energy intensity

Intensity is a measure to show how much energy is used in overall economic development. In the past, production in the industrialized countries was characterized by high and initially increasing commercial intensities, which then peaked and gradually fell with shifts in the economic structure, with improvements in material use and productivity and with increased energy conversion efficiency. Some historical trends are shown in figure 2.2. The world's aggregate energy intensity has been decreasing steadily over the past few decades and is expected to decrease further. However, the situation in developing countries is different from that of industrialized countries. Often, they need increasing amounts of energy to fuel their rapidly growing economy. Although there are some elements of inefficiency in energy use, structural changes (from being low-energy-intensive to being high-energy-intensive) are the main reason for rising energy intensities.

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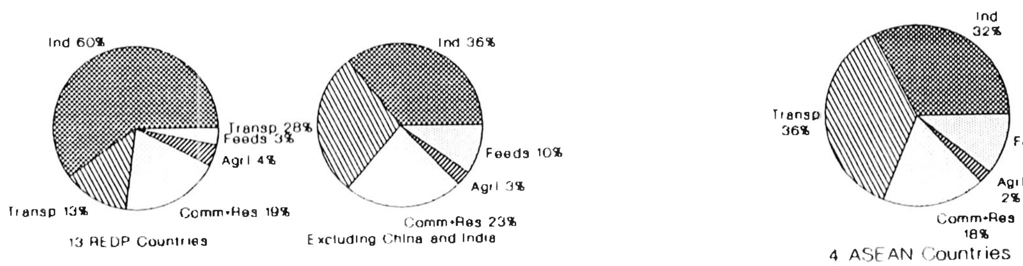
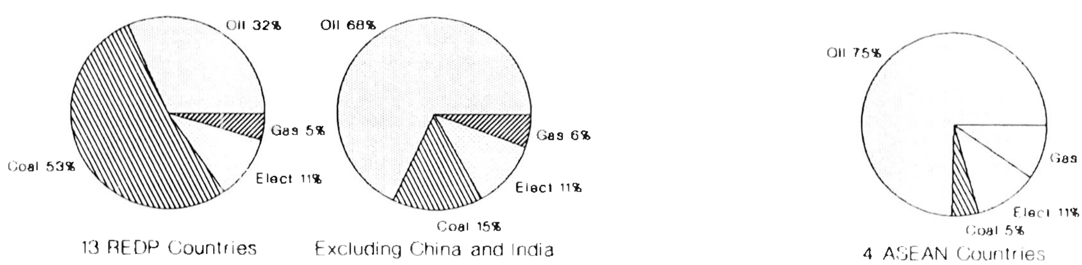
2 koe = kilogramme of oil equivalent, toe = tonne of oil equivalent, M = mega = million

Figure 2.3 Final commercial energy consumption by sector and fuel type, 1990



SOURCE: *Sectoral Energy Demand Studies in Asia: Synthesis Report,* Regional Energy Development Programme, ESCAP / UNDP (1992, United Nations, New York), fig. 3



SOURCE: *Sectoral Energy Demand Studies in Asia: Synthesis Report,* Regional Energy Development Programme, ESCAP / UNDP (1992, United Nations, New York).

Table 2.1 Consumption of commercial primary energy in the ESCAP region and the world

		Consumption, in million toe Parenthesis: koe per capita					Average annual consumption growth rate (percent)		
		1970	1975	1980	1985	1990	1980/70	1990/80	1990/70
World		4434 (1212)	5122 (1267)	5892 (1339)	4276 (1326)	7602 (1407)	2.9	2.6	2.7
ESCAP region	Total	664 (348)	849 (377)	1039 (424)	1300 (477)	1697 (559)	4.6	5.0	4.8
	Devel-oping	361 (190)	520 (245)	676 (292)	895 (346)	1195 (413)	6.5	5.9	6.2
	Indus-trialized	303 (2543)	330 (2569)	363 (2700)	405 (2897)	502 (3485)	1.8	3.3	2.6

SOURCE: *Energy Statistics Yearbook,* United Nations, various issues

Table 2.2 **Indicators of economic growth, energy consumption and energy intensity for selected members of ESCAP**

	Population (in million) 1992	Comm. energy cons (in million toe, 1992)	GDP per capita (1992 US$)	PPP adjustment USA=100	GDP per capita (1992 PPP$)	Commercial energy consumption per capita (in koe) 1971	1992	Commercial energy intensity (koe/US$GDP) 1971	1992	(PPP-adjusted) 1992	Energy imports as % of merchandise exports 1971	1992	% biomass in total energy consumption %biomass 1971	1991
High-income														
Australia	17.5	92.10	17 260	75.0	17 430	4035	5263	1.11	0.31	0.31	4	6	3	3
France	57.4	231.55	22 260	83.0	19 289	3019	4034	1.00	0.18	0.20	14	9		
Japan	124.5	446.46	28 190	87.2	20 265	2539	3586	1.11	0.12	0.17	20	16		
Netherlands	15.2	69.31	20 480	76.0	17 662	3918	4560	1.25	0.22	0.25	14	8		
New Zealand	3.4	14.56	12 300	62.3	14 479	2448	4282	0.91	0.36	0.30	8	7	2	
Singapore	2.8	12.32	15 730	72.3	16 803	1551	4399	1.25	0.27	0.25	23	15		
United Kingdom	57.8	216.35	17 790	72.4	16 826	3778	3743	1.43	0.21	0.22	14	6		
United States of America	255.4	1956.87	23 240	100.0	23 240	7615	7632	1.43	0.33	0.33	9	14		1
Middle-income														
Kazakhstan	17	80.27	1 680	20.7	4 811		4722		2.50	0.87				
Korea, Rep. of	43.7	112.27	6 790	38.7	8 994	507	2569	1.67	0.38	0.29	18	19	14	1
Kyrgyzstan	4.5	5.17	820	12.2	2 835		1148		1.43	0.41				
Malaysia	18.6	26.88	2 790	34.8	8 088	435	1445	1.11	0.48	0.16	11	4	22	10
Papua New Guinea	4.1	0.96	950	8.7	2 022	136	235	0.48	0.23	0.11	11	12	78	65
Philippines	64.3	19.42	770	10.7	2 487	221	302	1.11	0.37	0.11	15	22	45	34
Russian Federation	149	844.09	2 510	26.9	6 252		5665		1.50	0.60				
Thailand	58	35.61	1 840	25.5	5 926	177	614	0.91	0.32	0.10	17	10	54	29
Lower-income														
Bangladesh	114.4	6.75	220	5.3	1 232	18	59	0.19	0.18	0.03	31	12		51
Bhutan	1.5	0.02	180	2.7	627	0.001	15		0.09	0.02			98	82
China	1162.2	697.32	470	9.1	2 115	281	600		1.43	0.32	1	4	7	7
India	883.6	207.65	310	5.2	1 208	112	235	1.00	0.83	0.21	12	26	31	26
Indonesia	184.3	55.84	670	12.8	2 975	72	303	0.91	0.43	0.10	2	6	68	43
Lao P.D.R.	4.4	0.18	250	8.3	1 929	55	41		0.15	0.02	271	46	82	88
Nepal	19.9	0.40	170	4.8	1 116	6	20	0.08	0.13	0.02	10	23	97	93
Pakistan	119.3	26.60	420	9.2	2 138	111	223	0.67	0.56	0.11	12	21		22
Sri Lanka	17.4	1.76	540	12.2	2 835	81	101	0.43	0.18	0.03	2	12	61	57

SOURCE: data are taken from *World Development Report 1994*, The World Bank (1994, Oxford University Press, New York, USA) and *World Resources 1994-1995*, The World Resources Institute (1994, Oxford University Press, New York, USA).

Intensity levels in the ESCAP region are quite diverse (see table 2.2). China, India and the Central Asian republics have high intensities (using GDP [3/] expressed into US dollars based on exchange rates), followed by Indonesia, Malaysia, Pakistan, Philippines, Republic of Korea and Thailand in the mid-range. Countries, such as Bhutan, the Lao People's Democratic Republic and Sri Lanka are characterized by low intensities. If purchasing power parities (PPP) are used, some changes in rankings are observed. The Central-Asian republics remain very intensive, followed by China and the Republic of Korea. India moves down towards Malaysia in the upper-middle range. Indonesia, Pakistan, Philippines are in the lower-middle range, while Papua New Guinea moves upwards, leaving Bangladesh, Bhutan and Sri Lanka in the low range. It is instructive to look in figure 2.4 at the relationship between energy intensities, GDP per capita and energy consumption per capita. The following trends can be derived:

1. Indonesia, Nepal, Philippines, Thailand and, until the early 1980s, the Republic of Korea show increasing energy consumption per capita with increasing energy intensity. This suggests a strong relationship between economic growth and energy consumption (which is typical for a developing country), although the rate varies from country to country depending on the economic and industrial structure;

2. For China and, since the 1970s, for the Republic of Korea the increase in energy consumption per capita is achieved with declining intensity. The case of China is mainly due to improved efficiency in industry and households, while the case of the Republic of Korea could be attributed to the expansion of less energy-intensive industries;

Table 2.3 Major energy consuming sectors in industry in selected Asian countries (sectors consuming more than 15 percent of the total)

SECTORS	China	Indonesia	Malaysia	Republic of Korea	Thailand	Sri Lanka	Philippines	Viet Nam
Steel	+			++++				
Chemicals	++	++++				+		+
(Fertilizer)		(+++)						
Building materials	++	++	++	++	++++	++	++	
(Cement)		(+)		(+)	(+++)		(+)	
Food	+		+++		+	++		+
Textile					+	++		+

Source: *Sectoral Demand Studies in Asia: Synthesis Report*, Regional Energy Development Programme, ESCAP / UNDP (1992, United Nations, New York), p. 25, table 1.

Share of total consumption around:	15 percent	+	30 percent	+++
	20 percent	++	35 percent	++++

3 GDP = Gross Domestic Product

3. Declining per capita energy consumption with declining intensity can be observed in Myanmar and Sri Lanka, primarily due to a declining total energy consumption in both countries;

4. In some periods, a relatively stable per capita energy consumption with declining intensity, for example, in the cases of Thailand and Philippines, expresses either improved efficiency or expansion of less energy-intensive industries.

Looking at the relationships between economic growth, energy consumption and intensity, one can conclude that, to a considerable extent, energy intensity appears to be a function of modernization and economic development. However, there is no univocal relationship between energy demand and GDP, because intensities vary between countries in the same stage of development, reflecting varying resource endowment and varying energy policies.The past patterns of industrialized countries (see figure 2.2) and newly industrializing economies (Hong Kong, Singapore, the Republic of Korea) may suggest that developing economies, too, can probably curb energy intensity increases in a distant future, as higher levels of productivity in industrial manufacturing are achieved, more value added is produced in the service sectors, and more and improved infrastructures are established. However, past development in the industrialized countries has shown also, that scant economic success is not a guarantee for improved energy efficiency. Yet, the developing countries today are in a considerably better position than industrialized countries at their earlier stages of development. Today, developing countries have the option of attaining energy efficiency more rapidly by "leapfrogging", i.e., by way of directly adapting more advanced technologies. Chapter three gives detailed examples of such advanced technologies.

II.2 Sectoral overview

II.2.1 Energy services: industry and agriculture

The INDUSTRY SECTOR consists of manufacturing, mining and construction, while manufacturing can be subdivided, following ISIC [4] classification, into: (1) food products, (2) textiles, (3) wood products, (4) paper and pulp, (5) chemical products (including fertilizer), (6) basic metals, (7) nonmetallic minerals (including building materials, such as cement and glass), (8) machinery, (9) other fabricated metal products and electrical equipment and (10) others.

Industrial firms vary in size and sophistication. TRADITIONAL FIRMS are usually handicrafts, including crop processing, textiles and garment production, carpentry and masonry, leather working, brick and pottery production, blacksmithing and many others. Wood and charcoal are the traditional fuels, supplementing human muscle power. Nowadays, small shops in developing countries use modern technologies as well, e.g. electric welding equipment in blacksmithing or diesel engines in crop processing. Key factors in shifting to modern fuels are fuel availability and reliability and maintenance of equipment. Usually handicraft firms are characterized by energy inefficiency and low manufacturing productivity.

MODERN INDUSTRIES are most varied in terms of items produced, processes employed, as well as in size, age and facility conditions. The sector is diverse, ranging from light industries (e.g. shoes, textiles, food processing, glass and brick making), heavy and energy-intensive industries (e.g. pulp and paper,

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4 ISIC: International Standard Industrial Classification

processing of metals, cement), mining and feedstock industries (e.g. chemicals, fertilizer). Fuel use is also varied (wood, bagasse, coal, diesel and gas oil, fuel oil, natural gas, electricity). Manufacturing absorbs between 80 and 98 percent of energy demand in industry in Asian developing countries. [5/] Within the manufacturing subsector, heavy industry and within heavy industry, a few energy-intensive materials, steel, cement, chemicals (especially fertilizer) and pulp and paper, usually account for much of the energy used by industry (see table 2.3). Together, steel, non-metallic minerals, chemicals, and pulp & paper, consume 58 percent of industrial energy consumption in China, 58 percent in India, 68 percent in Indonesia, 75 percent in Korea and 47 percent in Thailand. Capital goods are generally less energy-intensive to produce than the basic materials. Food industry generally appears in industrial energy statistics as energy-extensive, but taking woodfuels into account it becomes a significantly energy-intensive industry in some countries.

In the developing countries manufacturing energy intensities can be expected to decline over time as newer production processes are applied, more efficient tools are used and existing facilities and plants are improved. This has been already the overall trend in most countries in the region in the 1980s, without significant differences between intensive and non-intensive sectors (see figure 2.5). Country trends can be explained by various changes, i.e., the more efficient use of energy, energy substitution (coal for oil or the reverse), and also structural changes (for example, towards a higher growth of energy-intensive industries to the detriment of less-intensive one, typical for developing lower-income countries, or the opposite for higher-income ones), which can reinforce or offset one another.

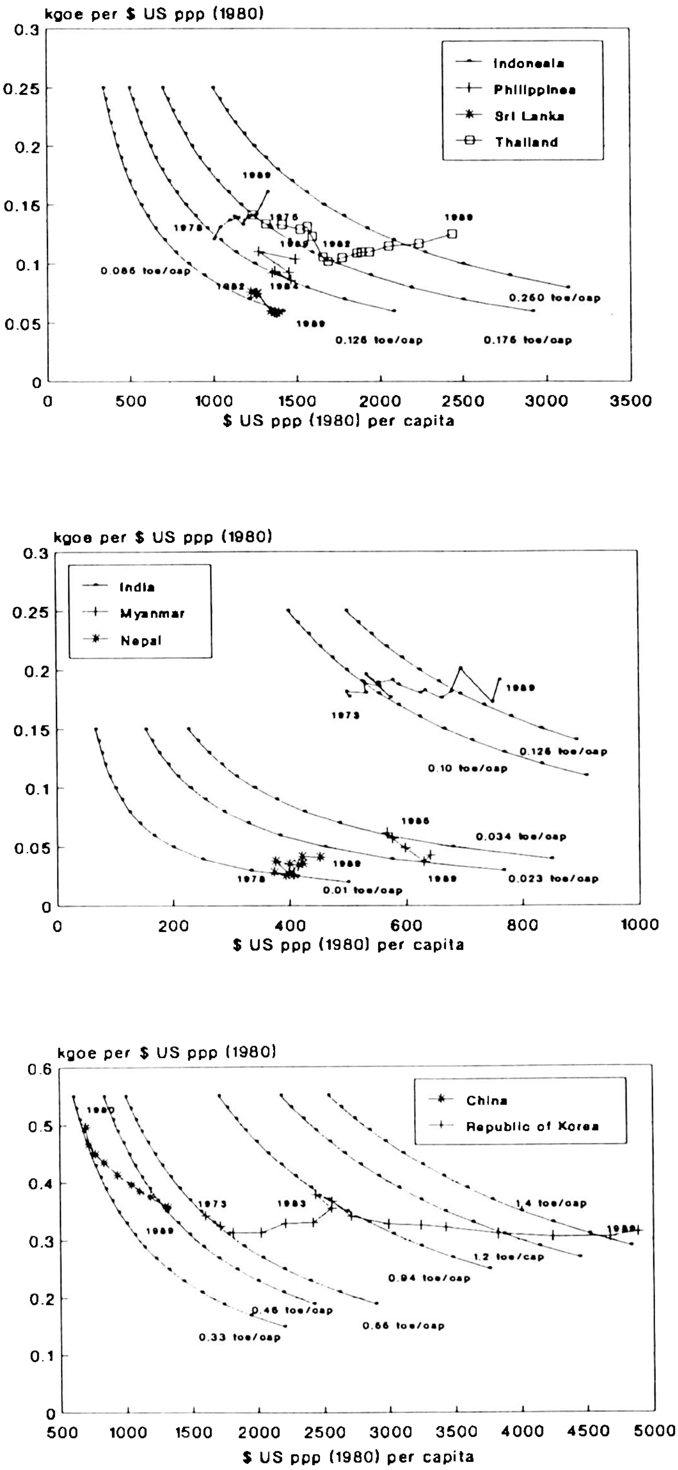
Developing countries will expand material-intensive industries and their infrastructure. The total energy needed to produce the materials for their infrastructure will increase rapidly as Asian developing countries build their roads, buildings, industry and power plants. This modernization process will vary from country to country and is influenced by a variety of factors, including (a) competition and openness of markets, which tends to accelerate technological adaptation and progress, and (b) economic growth and industrial integration, which can bring economics of scale in production and lead to decreasing energy intensities. Energy pricing, industrial development policies and incentives for reduced energy consumption will be important factors that determine the prospects for energy efficiency.

In most countries of the ESCAP region many energy audits have been undertaken in individual plants or for certain industrial processes. These studies have shown that there is considerable potential for cost-effective improvements in energy management and/or retrofit investments. Technically proven, energy conservation techniques, recycling and resource efficiency could save an estimated 10-30 percent of industrial energy.

Agriculture, forestry and fisheries account for only a small part of fuel use in Asian countries, around 5 percent of energy consumption. This may be due to poor statistics on agricultural energy consumption, interwoven as the sector is with the other sectors, i.e., the residential (farming households), industry (production of farm equipment, fertilizer, food and wood processing) and transport sectors (moving agricultural produce, fish catch and wood products). The main source of power in traditional and semi-commercial agriculture in many countries in the South is animal and human muscle power, supplemented

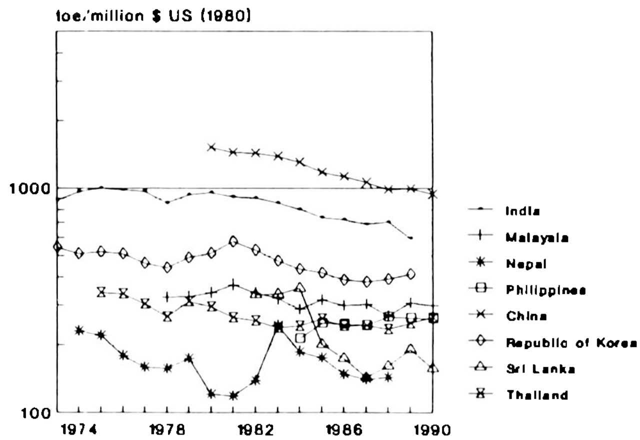
5 *Sectoral Energy Demand Studies in Asia: Synthesis Report*, Regional Energy Development Programme, ESCAP / UNDP (1992, United Nations, New York), § 6.1

Figure 2.4 **Relationship between energy intensity, per capita GDP and per capita energy consumption**



SOURCE: *Sectoral Energy Demand Studies in Asia: Synthesis Report,* Regional Energy Development Programme, ESCAP / UNDP (1992, United Nations, New York), fig. 19, p. 22

***Figure 2.5* Energy intensity in industry in selected Asian countries**



SOURCE: *Sectoral Energy Demand Studies in Asia: Synthesis Report*, Regional Energy Development Programme (REDP), ESCAP / UNDP (1992, United Nations, New York); fig. 21, p. 27.

by wood, for example, for the smoking of fish or curing of tobacco, and these seldom appear in energy statistics.

Nonetheless, some trends can be derived. With increasing development one can observe a progressive trend replacing human power by animal draught power, followed by a transition from traditional labour-intensive agricultural methods to more mechanized practices. Tasks are not mechanized at the same pace. Operations first to be mechanized are usually soil preparation and transport, followed by harvesting and weeding. Mechanical traction comes in many forms, ranging from draught-powered implements to large tractors. Irrigation, usually on commercial plots, is most commonly done by electric motor or diesel driven pumps. Of commercial fuels, petroleum products are the main source of agricultural energy but the share of electricity in agriculture is growing faster than that of fossil fuels in most countries, possibly due to achievements of rural electrification schemes. [6/]

II.2.2 Energy services: transportation

The transportation sector covers all the road, marine and air transport. With the important exceptions of rail in China and India, commercial transportation in Asian developing countries is road-based, consuming mainly fossil fuels (gasoline and diesel). Water transport is especially important in the two archipelagic countries in the region, Indonesia and the Philippines. Domestic air transport plays a minor role in terms of total fuel consumption. Gasoline and diesel are the most important fuels, due to the

6 *Regional* Energy Development Programme, ESCAP, UNDP, *Sectoral Energy Demand Studies in Asia: Synthesis Report* (1992, United Nations, New York).

importance of road transport. Trucks and pickups, which are mainly used for freight transport, absorb between 46 percent and 70 percent of the energy used in road transport. The importance of other vehicles varies by country. Private car ownership is important, for example in Indonesia, the Republic of Korea, Malaysia, Sri Lanka and Thailand; motorcycle fuel consumption is important in Sri Lanka and Thailand. Conversely, public transport is substantial, for example in Hong Kong, Singapore and the Philippines (buses and jeepneys).

As most Asian economies grow, transport services grow accordingly to supply the raw materials, labour, food and consumer goods needed, and to integrate rural areas into the larger economy. Also, higher standards of living associated with economic expansion lead to sharply rising demand for personal vehicles. Not surprising energy demand for transport has grown even more rapidly than GDP in the recent years, in countries such as the Republic of Korea and Thailand (see figure 2.6).

II.2.3 Energy services: the residential and commercial sectors

The most important energy service in the residential sector is COOKING food In Malaysia, Philippines and Thailand, for example, around 85 to 86 percent of the total household energy demand is for cooking (taking both commercial and biomass-derived fuels into account), the share being more for rural households than for urban ones. [7/] Most rural people rely on biomass, wood, crop residues and dung for cooking, except in higher-income countries such as the Republic of Korea. In the urban areas people rely on a mix of fuels, including wood, charcoal, fossil fuels and electricity.

In rural areas wood is mostly collected 'free' (by women and children). In most humid areas, rural users of wood fuels (i.e. wood and its derivative, charcoal) rarely attack the prime forest itself, but obtain firewood by gathering dead wood from common lands, roadsides and wastelands. They are often not a cause but rather the victims of deforestation. In (semi-)arid areas or densely populated areas rural wood consumption can be critical, often reflected by the use of crop residues and dung, instead of wood. In urban areas wood fuels are supplied on a commercial basis. For many (low-income) urban households in Asia wood fuels are the dominant fuel. Also, certain industries require wood, such as brick-making and tobacco curing, which can greatly affect local wood stock. Due to the wood fuel demand concentrated in growing cities, deforestation in many of the peri-urban areas is increasing, facing the urban population with climbing prices of wood fuels and the rural women with increased difficulties in firewood procuring.

In the houses of the higher-income households (often dwelling in urban areas) mostly modern energy carriers are used, electricity and fossil fuels (coal, oil or gas) and are used for cooking, lighting, water heating, space-conditioning and for a whole range of electric household appliances.

Higher income and reliable fuel supplies, enable people to switch to modern stoves and cleaner fuels, such as kerosene, liquified petroleum gas, natural gas and electricity. Such a transition is widely observed around the world, irrespective of cultural traditions. These technologies are preferred because of their convenience, comfort, cleanliness, ease of operation, speed and combustion efficiency.

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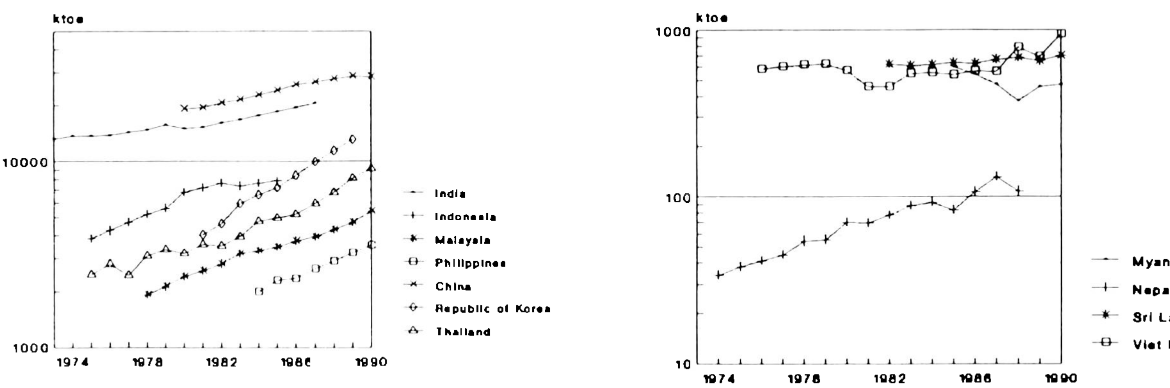
7 *Sectoral Energy Demand Studies in Asia: Synthesis Report*, Regional Energy Development Programme (REDP), ESCAP/UNDP (1992, United Nations, New York).

Figure 2.6 Trends in transport energy demand in selected Asian countries



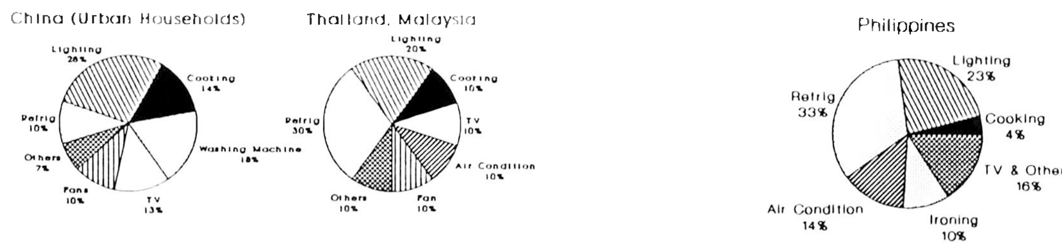
SOURCE: *Sectoral Energy Demand Studies in Asia: Synthesis Report,* Regional Energy Development Programme (REDP), ESCAP / UNDP (1992, United Nations, New York); fig. 22, p. 31.

LIGHTING plays a very important role in social life, both domestic and in commerce and industry, enabling activities at night or where light is inadequate. Electricity demand for lighting accounts between 20 and 40 percent of the household electricity demand in Asian countries (see figure 2.7). As rural income increases, and with increasing migration to urban areas, people gain greater access to modern fuels and electricity. Lighting technologies follow a clear progression in performance, efficiency and cost, going from the open fire, kerosene wick or pressure lamp to the use of electric incandescent or fluorescent lamps. The shift to electric lighting occurs usually wherever electricity has been made available, and in contrast to kerosene or oil lamp lighting it provides a high quality light. The most common technologies are incandescent bulbs (dwellings) and fluorescent tubes (commercial buildings).

As income increases with economic development, households begin to buy ELECTRIC APPLIANCES, radios, televisions, fans, refrigerators and, depending on the climate, heaters or air-conditioners. In many developing countries, air-conditioning used to be only a minor energy end use. However, with growing prosperity air-conditioning will become widely used in many homes and offices, in particular in countries with warm and humid climates. Residential space heating is not a major end use in developing Asian countries, except for China (where coal is used to heat homes), the Republic of Korea, and for mountainous regions.

Gradual improvement in energy efficiency of household appliances can be expected to occur as households become able to afford better quality devices and high quality fuels. In general, with increasing income one can observe: (1) steady or increasing biomass consumption in rural areas, and declining biomass consumption in urban areas, (2) substitution of modern fuels for biomass cooking (especially in urban areas). Also, most households in developing Asian countries will demand higher

***Figure 2.7* Household electricity by appliance type for selected Asian countries**



SOURCE: *Sectoral Energy Demand Studies in Asia: Synthesis Report*, Regional Energy Development Programme (REDP), ESCAP / UNDP (1992, United Nations, New York); fig. 38, p. 46.

level of services, especially when these will be met by the expansion of the electricity grid. Hence, average energy use per capita may increase even if the technical efficiency improves.

The overall energy trend in the Asian countries more or less reflects the above. A comparison of the per capita energy and electricity consumption between China, India, Malaysia, the Republic of Korea, the Philippines, Sri Lanka and Thailand is shown in figure 2.8. Although final consumption per household looks quite different, the range is narrowed if one accounts for differences in appliance efficiencies (low-efficient coal and biomass). Looking at useful energy consumption, the role of cooking is very similar, about 0.2 toe per household. Significant variation can be seen in electricity consumption per household, roughly according to income levels of countries. In 1990, the Republic of Korea had an electricity consumption approaching 2500 kWh per household, while the Lao People's Democratic Republic had an electricity per household consumption of 135 kWh. Unit consumption of electricity has progressed rapidly in Asia, around 10 percent per year in China, 10 percent in India, 9.5 percent in the Republic of Korea and around or more than 5 percent in Malaysia, Thailand, Viet Nam and Sri Lanka.

Similarly, the electricity consumption in the commercial sector has been progressing in the 1980s, reflecting a larger diffusion of electric appliances, especially lighting, and in South and South-East Asian countries, air-conditioning. In the office environment, space-conditioning systems, computers, photocopiers and fax machines have become common, not only in industrialized but developing countries as well. Also, oil products remain important in the commercial sector, due to the relative importance of commercial cooking in for example restaurants and hospitals, and in northern Asian countries, for space heating.

Whereas some energy efficiency gains will be attained along with technical progress, there will always remain a differential between socially desirable and individually achieved efficiency levels. However, the width of the gap depends on Government policies and on their control and guidance of individual investment and consumption decisions.

II.3 Energy issues and options

II.3.1 Future perspective

Table 2.4 is the result of ESCAP work on the projection of the likely energy demand of the members and associate members of the ESCAP region. In the business-as-usual scenario (S1), the annual growth rate of regional commercial energy consumption is projected to be 4.4 percent for the period 1990-2000 and 4.3 percent for the period 2000-2010. In the energy efficiency scenario S2, the annual growth rate is 4 percent for the period 1990-2000 and 4.1 percent for the period 2000-2010. A slightly lower (3.9 percent) growth rate is projected for conservation and efficiency improvements with higher investment and fuel switching (S3).

The projected growth rate of 4.6-5.1 percent for developing economies in the ESCAP region is smaller than the historical growth rate of 6.2 percent per year in commercial energy consumption during the 1980s. Lower economic growth rates and especially expected energy conservation efforts may justify this. Also, the growth rates are somewhat higher than the global fossil fuel energy projection of 4.2 percent for the period 1990-2020 for developing countries, which seems reasonable also given the economic dynamics of the Asian and Pacific region.

As observed in the historical trend of energy consumption, the continuing dominance of fossil fuels in the energy mix is to stay. It is widely expected that the historical trend observed in the 1980s will continue in future. Some change may occur within the fossil fuel mix at the expense of OIL, but given a relatively low oil price, such interfuel change may be slow. NATURAL GAS will become a major component in the energy mix, owing to its reputation as a relatively environmentally benign fuel and more so to its occurrence in many Asian and Pacific countries. COAL will remain a dominant fuel also in the regional fuel mix, especially in 'coal-rich' countries as India and China, and in certain sectors, such as power supply and energy-intensive industries (e.g. steel mills and cement plants). Technological advances such as integrated gasification combined cycle and fluidized bed combustion will mitigate some of the harmful impacts of coal utilization. High growth is also expected in electricity demand, which could actually lead to supply problems in some countries due to interruptions because of the lack of generating capacity.

How to meet the energy demand growth in the region is the core issue of energy development and management. Constraints on unlimited development are the concern over the environmental degradation and the cost of energy supply capacity expansion.

Table 2.4 Primary energy consumption scenarios to the year 2010

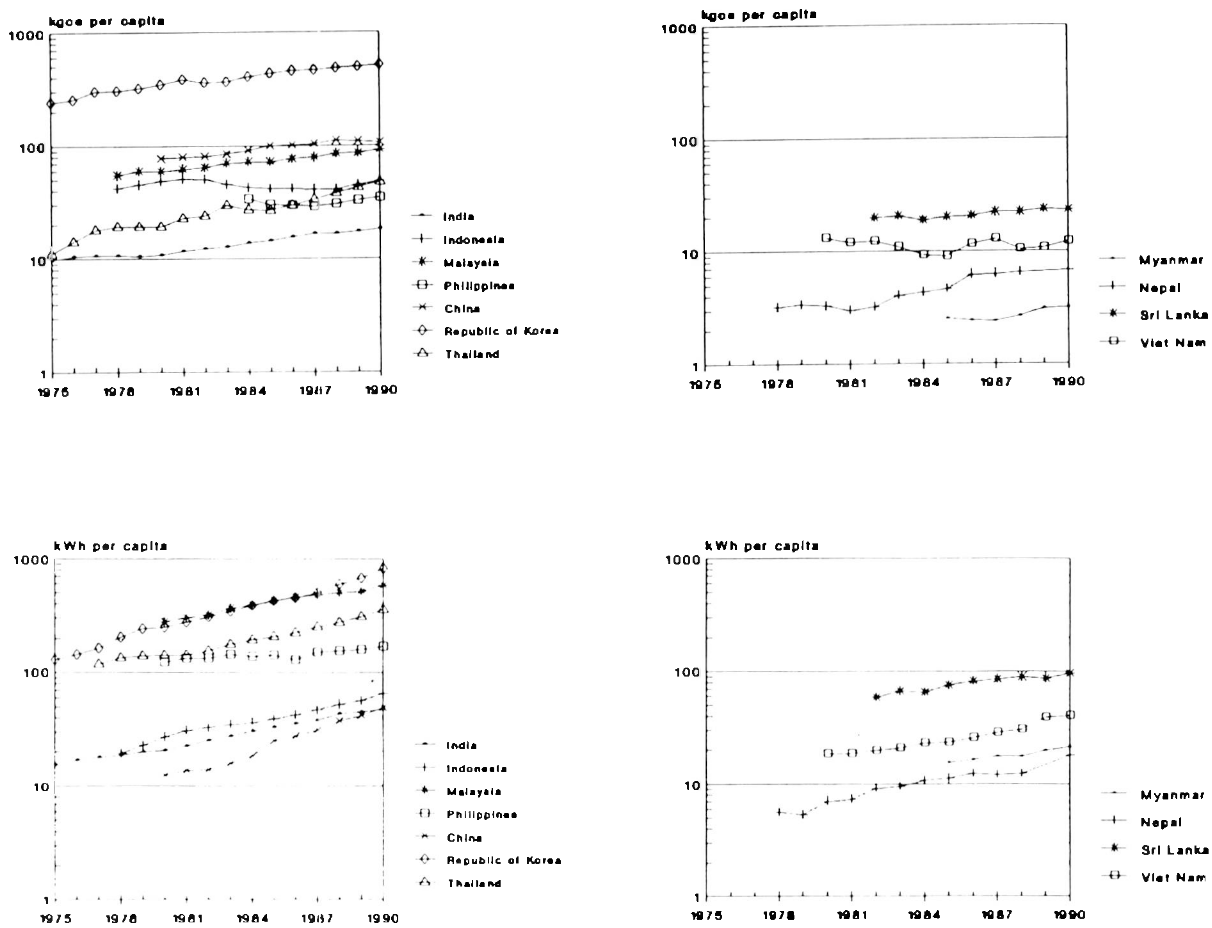
(In thousand tons of oil equivalent and percentages)

Subregions of Asia and the Pacific	Consumption		Projections					Average annual growth rate (percentage)				
	1980	1990	2000 S2	2000 S1	2010 S3	2010 S2	2010 S1	1990-00 S2	1990-00 S1	2000-10: S3	2000-10:S2	2000-10 S1
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
East and North East Asia	489 858	830 003	1 283 760	1 321 440	1 968 920	2 003 850	2 098 520	4 5	4 8	4 4	4 6	4.7
South East Asia	70 383	126 651	227 810	237 320	395 340	406 900	433 980	6 0	6 5	5 7	6 0	6 2
South and West Asia	143 149	286 325	498 250	521 800	820 030	847 000	916 770	5 7	6 2	5 1	5.4	5.8
Central Asia		95 196	118 100	130 200	139 700	146 700	178 300	2 2	3 2	1 7	2 2	3 2
Pacific	2 704	3 432	4 200	4 400	5 100	5 400	5 900	2 0	2 5	2 0	2 5	3 0
Total Asia and the Pacific												
Developing economies	706 094	1 341 607	2 132 120	2 215 160	3 329 090	3 409 850	3 633 470	4 7	5 1	4 6	4 8	5 1
Industrialized economies	424 900	530 400	644 400	655 000	724 300	731 400	750 900	2 0	2 1	1 2	1 3	1.4
Grand total Asia and the Pacific	1 130 994	1 872 007	2 776 520	2 870 160	4 053 390	4 141 250	4 384 370	4 0	4 4	3 9	4 1	4 3

Scenarios:
- S1: business-as-usual scenario, assuming past trends to continue
- S2: Conservation scenario without significant investment
- S3: Conservation with higher level of investment and fuel switching

SOURCES: ESCAP Secretariat, based on United Nations *Energy Statistics Yearbook*, World Bank, *World Tables*

Figure 2.8 **Per capita commercial energy consumption and electricity consumption for selected Asian countries in the residential and commercial sectors**



SOURCE: *Sectoral Energy Demand Studies in Asia: Synthesis Report,* Regional Energy Development Programme, ESCAP / UNDP (1992, United Nations, New York); fig. 34 and 35, p. 41.

***Table 2.5* The world's 20 most polluted cities**

	Population, m 1990, est.	Population, m 2000, proj.	Sulphur dioxide	Particulate matter	Lead	Carbon monoxide	Nitrogen dioxide	Ozone
Bangkok	7.16	10.26	○	●	◐	○	○	○
Beijing	9.74	11.47	●	●	○	–	○	◐
Bombay	11.13	15.43	○	●	○	○	○	–
Buenos Aires	11.58	13.05	–	◐	○	–	–	–
Cairo	9.08	11.77	–	●	●	◐	–	–
Calcutta	11.83	15.94	○	●	○	–	○	–
Delhi	8.62	12.77	○	●	○	○	○	–
Jakarta	9.42	13.23	○	●	◐	◐	○	◐
Karachi	7.67	11.57	○	●	●	–	–	–
London	10.57	10.79	○	○	○	◐	○	○
Los Angeles	10.47	10.91	○	◐	○	◐	◐	●
Manila	8.40	11.48	○	●	◐	–	–	–
Mexico City	19.37	24.44	●	●	◐	●	◐	●
Moscow	9.39	10.11	–	◐	○	◐	◐	–
New York	15.65	16.10	○	○	○	◐	○	◐
Rio de Janeiro	11.12	13.00	◐	◐	○	○	–	–
São Paolo	18.42	23.60	○	◐	○	◐	◐	●
Seoul	11.33	12.97	●	●	○	○	○	○
Shanghai	13.3	14.69	◐	●	–	–	–	–
Tokyo	20.52	21.32	○	○	–	○	○	●

Source: United Nations ● High pollution ◐ Moderate to heavy pollution ○ Low pollution – No data available

Of the 20 most polluted cities in the world, 11 are situated in Asia

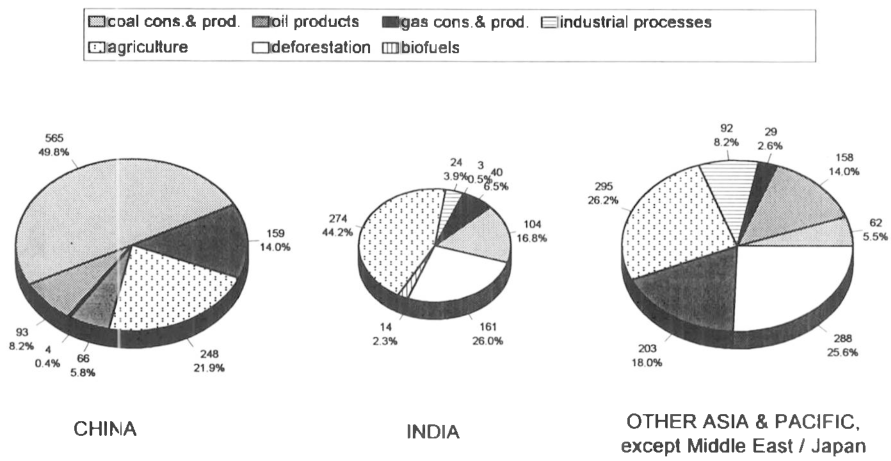
SOURCE: *The Economist* (September 1994), based on United Nations data

II.3.2 Environmental issues

The generation and use of commercial energy are associated with various immediate and long-term environmental impacts that in recent years have also gained increasing recognition. Environmental impacts of energy use appear at all levels, local, regional and global. Many developing countries in the ESCAP region, with their sprawling urban centres, rapid industrial development and growing vehicle populations have seen large increases in emissions.

At the local level, burning of fossil fuels causes air pollution, especially in urban areas with their concentration of vehicles and industrial establishments (see tables 2.5 and 2.6). At high concentrations, CARBON MONOXIDE (CO) emissions have been shown to have harmful effects on human health. Although there are a variety of CO sources, vehicle exhausts account for nearly all CO in some urban areas. The gas, once inhaled, interferes with the oxygen transport in the blood, and this may lead to drowsiness and perception loss, slow reflexes and to headaches. Carbon monoxide also indirectly contributes to smog formation and greenhouse warming. Successful CO reduction measures have relied on catalytic converters, which change CO into carbon dioxide. This has successfully reduced CO levels in cities in industrialized countries.

Figure 2.9 **Annual greenhouse gas emissions in the mid-1980s in Asia**



The absolute numbers give the annual emissions (1985) in TgC (10^{12} gramme of carbon equivalent).

SOURCE: *Climate Change in North-South Perspective,* J.H.A. van den Akker, Netherlands Energy Research Foundation ECN (September 1991, Petten,The Netherlands). No. ECN-I--91-059

PARTICULATES result from smoke, soot, dust, sulphate (from sulphur dioxide SO_2) and organic compounds. Both particulates (also known as SPM: suspended particulate matter) and sulphur dioxide are irritants, damaging lung tissues and causing various lung ailments. Particulates result from fuel combustion. SO_2 emission predominantly arise from sulfur-containing fossil fuel, mostly coal used in residential heating and in electricity generation, from some industrial processes and diesel exhaust fumes. Various techniques have been applied in industrialized countries (coal washing, low sulphur coal switching, scrubbers, high stacks, cleaner diesel fuel).

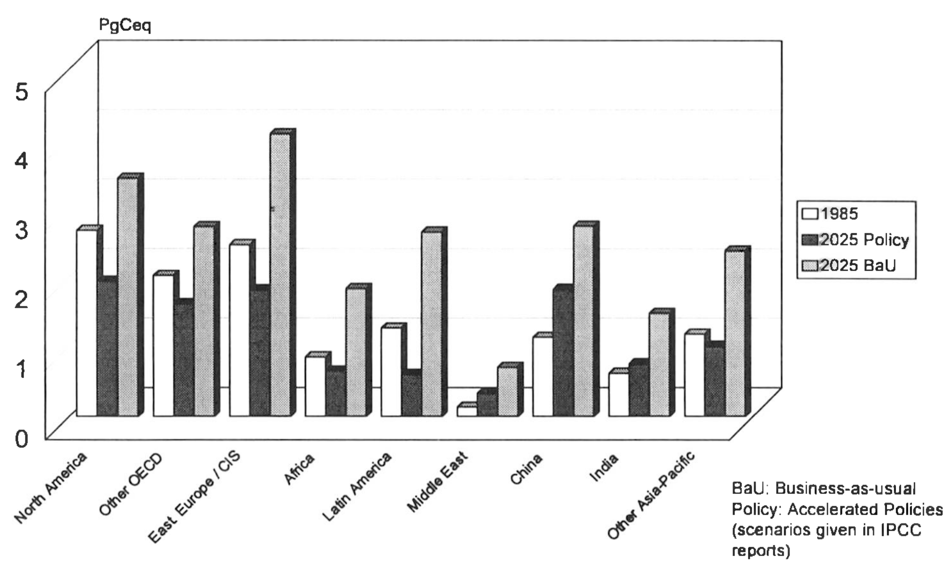
PHOTOCHEMICAL SMOG refers to the mixture of gases formed when emitted gases, including volatile organic compounds (VOCs) and nitrogen oxides (NO_x) react under the presence of sunlight and in certain atmospheric conditions (thermal inversion). The resulting mix of chemicals is dominated by ozone, which is a toxic gas that breaks down biological tissues. Apart from ozone, also its precursors NO_x and VOCs, pose a threat to human health. NO_x gases are formed in any fuel combustion process at high temperatures (for example in vehicles, power stations and industrial boilers). VOCs result from various sources: vehicles, refineries and use of solvents. Urban photochemical smog is a widespread phenomenon in both the industrialized and developing countries.

A host of other substances adds to pollution load in cities, ranging from metals such as lead (used as a fuel additive) and organic compounds such as benzene and aldehydes.

On the regional level ACID DEPOSITION poses a potential transboundary pollution problem. Through various reactions in the atmosphere, nitrogen oxides and sulphur dioxide are converted into acids (nitric acid HNO_3 and sulphuric acid SO_2). They readily dissolve in water, acidify the droplets in the sky and when they fall make acid precipitation: acid rain, acid fog, acid dew, etc. In Europe and North America, the "high stacks" policy of coal power stations has led to problems of acid precipitation. The NO_x and SO_2 gases are emitted by high smokestacks into the atmosphere, where they are converted into sulfate and nitrate particulates and carried away with the wind. Vehicle traffic is another major source. Similar regional acid rain problems are emerging in Asia. Acid rain has a severe effect on terrestrial and aquatic ecosystems.

Figure 2.10 Contribution of the Asia-Pacific region to greenhouse gas emissions in 1985 and 2025

Greenhouse gases partially absorb the radiation the earth emits into space, in other words, trap heat and thus act like the glass of a greenhouse. Naturally, various greenhouse gases occur in the atmosphere, leading to a natural greenhouse effect. Without it, the average global surface temperature would be about -18 °C, making the planet unhabitable. One of the long-term consequences of human activities is the release of 'greenhouse gases' in the atmosphere, which adds to the natural atmospheric concentration of these gases. Strictly, this is an 'enhanced greenhouse effect'. It is the resulting rate of change in atmospheric concentration, as has been recorded in this century (10 to 100 times faster than natural changes, e.g. those in the Ice Ages), which has lead to concern. This prompted the United Nations General Assembly to set up the Intergovernmental Panel on Climate Change (IPCC).



Source: *Climate Change in North South Perspective, Greenhouse Gas Emissions, Climate Change Impacts and Response Options*, J.H.A. van den Akker, Netherlands Energy Research Foundation ECN (September 1991, Petten, Netherlands). No. ECN-I--91-059

Scenarios and data are mainly based on the Intergovernmental Panel on Climate Change (IPCC), established by the United Nations. PgCeq: petagramme of carbon equivalent. Peta = 10^{15}

At the global level, the continuing accumulation of GREENHOUSE GASES in the atmosphere is expected to possibly cause changes in climate, sea level and ecosystems, the full impact of which mankind has not yet been able to assess (see figures 2.9, 2.10 and box 2.2). Human-caused greenhouse gases emissions include carbon dioxide CO_2 (released in energy production and consumption, cement production and deforestation), methane CH_4 (resulting from energy production and consumption, landfills, wet rice cultivation and animal husbandry), carbon monoxide CO (resulting from energy consumption), nitrogen dioxide N_2O (energy consumption and production, fertilizer use) and the halocarbons (including chlorofluorocarbons, CFCs). Fossil fuel consumption has been identified as one of the main causes contributing to the expected global warming.

II.3.3 Energy pricing and costs

Environmental damage is manifested in losses in health, productivity and amenity. This bears some cost to society. Up so far, these are 'externalities'. Ideally, these should be taken as components of the full cost to society of energy supply. In some countries, with the introduction of some environmental standards, a part of the environmental cost is internalized in the energy cost.

In practice, however, domestic energy prices do often not even reflect international energy prices. The World Bank estimated in its *World Development Report 1992* [8/] that subsidies for energy cost the Governments of developing countries and the former Soviet Union and Eastern Europe more than US$ 230 billion a year, more than four times the total volume of official development assistance.

Another issue is the cost of infrastructure. In the Asian and Pacific developing economies, the power sector alone would need US$ 576 billion - US$ 674 billion over the period 1990-2000 for infrastructure development; this estimate does not include the cost of mitigating environmental impacts. [9/] For example, for coal-fired power plants, the additional environmental abatement cost could be in the range of 1 percent to as high as 50 percent of generation costs, depending on the degree of abatement needed and technology chosen.

II.3.4 Supply and demand options

Developing and implementing solutions to the energy-environment problems will remain one of the major urgent tasks in the years ahead. As in other countries, energy policy makers in Asia face the dilemma that all presently available commercial sources of energy have some major technical or economic constraints and/or negative environmental impacts. The environmental impacts of fossil fuels such as coal, oil and gas have been well studied and are already widely known. Supply side options include the optimization of use of existing supplies and switching to sources of energy that produce less pollution per unit of useful energy delivered. For example, in several countries higher priority is given to less polluting fuels such as natural gas instead of coal and oil.

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8 *World Development Report 1992, Development and the Environment,* The World Bank (1992, Oxford University Press, New York, Oxford)

9 ESCAP, *Infrastructure Development as Key to Economic Growth and Regional Cooperation,* (1994, ST/ESCAP/1364).

Box 2.2 Energy efficiency and greenhouse gas emission abatement

A series of IPCC reports were published in 1990 to give an overview of the state of knowledge on climate change and its impacts. As part of this work scenarios of anthropogenic greenhouse gas emission were designed in order to assess the resulting atmospheric concentrations, climatic changes (temperature increases, sea level rise) and the impacts thereof on ecoystems and human settlements.

The BUSINESS-AS-USUAL (BAU) scenario assumes that no major emission control policies are implemented. This means, only a moderate increase in energy efficiency, a continuing domination of fossil fuels, current emission controls on CO and NO_x as well as current emissions factors from agriculture, rapid deforestation and low compliance with the Montreal Protocol on reduction of halocarbon emissions.As a consequence the greenhouse gas level in the atmosphere (CO_2, CO, CH_4, N_2O, NO_x, CH_4 and halocarbons, CFCs and HCFCs) would be double that of the pre-industrial level (i.e. 1765) by the year 2030. The average global surface temperature would increase with 1°C above current level by 2025 and 3.4 °C by 2100.

The ACCELERATED POLICIES scenario assumes a major phase-in of non-fossil fuels starting in the early part of the next century, a major switch within fossil fuels to natural gas, a high degree of energy end use efficiency, halting deforestation by 2025 and major reforestation efforts and a total phase out of chlorofluorocarbons and freezing the level of other halocarbons. As a result, the concentration of greenhouse gases would stabilize to about 50 percent above pre-industrial level. Realized temperature increase would be 0.7 °C by 2025 and 1.8 °C by 2100.

The following table gives the contribution of various options to the reduction in emissions by the year 2025 between the Business-as-Uusal and the Accelerated Policies scenario, distinguishing between industrialized and transitional economies (North) and developing countries (South).

REDUCTION OPTION	ANNUAL EMISSION REDUCTION in 2025	
(in TgC, 10^{12} grammes of carbon equivalent; totals may not add due to rounding)	SOUTH	NORTH
ENERGY END USE EFFICIENCY	*1221*	*3000*
- electricity end use efficiency improvements	431	1868
- fossil fuel end use efficiency improvements	639	1132
- efficiency improvements biofuels (includes also deforestation avoided by fuelwood deficit)	151	
-		
OTHER OPTIONS ENERGY SECTOR	*1346*	*1254*
- efficiency improvements in energy supply; cogeneration	348	247
- substitution of coal and oil by natural gas	166	500
- substitution of fossil fuels by synthetic and/or biomass fuels (includes carbon fixation on the required new biomass plantations)	783	342
- emission controls (CO and NO_x)	29	96
- penetration of solar, hydro and geothermal in energy mix	20	69
FORESTRY AND LAND USE CHANGE	*3115*	*93*
- new fuelwood plantations (includes emission reduction due to carbon fixation and avoided deforestation)	280	
- halting deforestation through sustainable land use and agroforestry	2415	73
- other (industrial wood plantation, reforestation, improved forestry)	420	20
OTHER (landfills, fertilizer, rice paddies, substitution for CFCs)	*918*	*488*
TOTAL REDUCTION (between Business-as-usual and Accelerated Policies scenarios)	6602	4838
Annual emission in 1985	5185	7184
Annual emissions in 2025, Business-as-Usual scenario	11766	10201
Annual emissions in 2025, Accelerated Policies scenario	5164	5363

SOURCE: *Climate Change in North-South Perspective: Greenhouse Gas Emissions, Climate Change Impacts and Response Options*, J.H.A. van den Akker, Netherlands Energy Research Foundation ECN (September 1991, Petten, Netherlands). No. ECN-I--91-059

The expansion of nuclear energy would reduce carbon emissions, but in many countries concern on safety, security (including nuclear weapon proliferation) and waste disposal continues to pose public acceptance problems. Hydropower schemes can be environmentally benign, but the frequent inadequate compensation for displaced persons in earlier projects has lead to growing public opposition against the construction of new large dams and reservoirs. Small hydropower has few negative impacts, but its potential as a major contributor to the energy mix will be limited as it is very site-specific. Renewable sources of energy, including wind and tidal power, biogas and biomass, geothermal and solar-photovoltaic offer environmentally attractive alternatives. However, without additional resources, research efforts and major technological breakthroughs the renewable sources of energy can only offer limited economically viable alternative solutions, at least on the short term.

Fossil fuels are likely to remain a major source of energy. Some environmental abatement through clean fuel technology and conversion efficiency improvements will be indispensable. Advanced clean technologies include 'clean coal' technologies, such as fluidized bed combustion (FBC) [10/] and integrated gasification combined cycle (IGCC).

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10 In fluidized bed combustion (FBC) pulverized coal is injected with limestone particles in a hot bed. Calcium in the limestone combines with sulfur in the coal to reduce SO_2 emissions, and because of the relatively low combustion temperatures also NO_x formation is reduced.

In coal gasification several technologies are combined. Coal is gasified to produce a mix of gases, of which the major pollutants are removed before combustion. A turbine burns the gas to produce electricity. A waste heat recovery boiler produces steam, which is used in a steam turbine to produce electricity.

Table 2.6 Selected atmospheric pollutants and their effects

GAS	MAJOR HUMAN SOURCES	Greenhouse effect	Ozone layer depletion	Acid precipitation and corrosion	Smog	Decreased visibility	Decreased self-cleansing of atmosphere	Adverse human health impacts
Carbon dioxide (CO_2)	Fossil fuel and biomass burning. Deforestation	+	+/-					
Carbon monoxide (CO)	Incomplete fuel combustion (e.g. in vehicles)	(+)	+/-					+
Methane (CH_4)	Fuel combustion and production. Rice cultivation. Landfills. Cattle.	+	+/-				+/-	
Oxides of nitrogen: nitric oxide (NO) and nitrogen dioxide (NO_2)	Fuel combustion in motor vehicles and furnaces. Biomass burning.		+/-	+	+	+	-	+
Nitrous oxide (N_2O)	Fertilizer. Biomass burning. Deforestation	+	+/-					+
Sulphur dioxide (SO_2)	Fossil fuel burning. Ore smelting	-		+		+	+	+
CFCs	Aerosol sprays. Foams. Refrigerants	+	+					
Ozone (O_3)	Emissions from motor vehicles- Reactions with NO_x and hydrocarbons			+	+	+	-	+
Suspended particle matter	Smoke from fuel and biomass burning			+		+	(+)	+
Volatile hydrocarbons	Partial combustion of carbonaceous fuels. Industrial processes. Solid waste disposal. Solvents				(+)	+		+

IMPACTS:

+	contribution to the effect
(+)	indirect contribution
-	amelioration of the effect
+/-	varying effects

III Options for energy efficiency improvements of equipment and processes

The rationale for the promotion of energy efficiency has been described in the previous chapter. Many technical options may exist to increase energy efficiency. An overview of these options is given in table 3.1. However, the number of options which consumers may be willing to consider is more limited. For a realistic assessment of the potential for energy conservation and energy efficiency gains, it is essential to distinguish between the theoretically possible conservation/efficiency potential or what is socially desirable (taking external costs and benefits into account) from the economically feasible potential (which is smaller, depending on what is economically beneficial from the individual producer's or consumer's point of view) and from the actually realized energy efficiency and conservation, which is, again, only a fraction of the above. The next chapter will discuss the factors causing the gap between feasible and realizable potential in energy efficiency, indicating the elements of an active energy efficiency promotion policy necessary to shrink this gap.

III.1 Industry and agriculture

III.1.1 Industry

Fuel use in the industrial sector is quite varied, comprising wood, charcoal, bagasse, coal, diesel, gas oil, fuel oil, natural gas and electricity. Yet, the number of end uses to which energy can be divided is fairly limited. One main end use includes combustion engines and electric motors (to drive pumps and fans in heating or cooling systems, as well as compressors, conveyors, machine tools, rollers, crushers and other direct-drive systems).

The other main end use is processing of materials. Of these, especially cement, steel, pulp and paper and chemicals (specifically fertilizer production) form large, energy-intensive industries. Energy is consumed in the form of electricity for electrolysis (e.g. in aluminium production) and of various fossil fuels for heating and drying in the processing and conversion of raw and intermediate materials into useful end products. A few energy-intensive materials, steel, cement, chemicals (especially fertilizer) and paper, account for much of the energy consumed in industry.

Regular revision of operating and maintenance procedures (e.g. shutting off stand-by furnaces, calibration of instruments and inspection and repairing) is an example of a short-term measure that is often very cost-effective. Longer-term measures include changes in processes that require plant redesign and thus larger investments). These include:

i) Recovery and re-use of waste heat.

High-temperature heat (higher than 650°C) is produced in furnaces (steel making, copper refining, glass melting), incinerators and cement kilns. Medium-temperature heat sources (230-

Box 3.1 Energy utilization in China's industry

China's industrial sector is characterized by a relatively high energy intensity, as is indicated in the table. The following factors contribute to that:

1. Many industries rely on low-level technology. For example, one fourth of China's iron and steel plants rely on open-hearth furnaces. The more efficient electrolytic process comprise only one fifth of China's capacity. In the case of ammonia production, 65 percent is produced using coal. This coal-based process is 20 percent more energy-intensive than the one based on natural gas. In cement production, China uses the wet process for half of its cement output, which is 80 percent more energy-intensive than dry kiln processes. Now obsolete in industrialized countries, the graphite anode often used in the production of caustic soda, absorbes 530 kWh more per tonne of material than electrolytic slots.

2. Production equipment is in many cases out of date. China's coal boilers operate at 50 percent thermal efficiency, or sometimes as low as 20-30 percent, well below the 80 percent level commonly found in industrialized countries.

3. Lack of scale economy. Cement production is over 200 million tonnes per year, of which 70-85 percent is produced in small enterprises. These use small rotary kilns that require 1.3 times more energy than medium and large ones. China's ammonia production capacity is about 20 million tonnes a year, of which 82 percent comes from small and medium-sized enterprises. Their unit energy consumption of ammonia produced is 1.6-1.7 times higher than that of large factories.

4. Energy prices are too low. Since the early 1980s coal prices have remained far lower than the production cost. This has hit not only the coal sector (in terms of financial losses), but also in terms of energy conservation efforts. Even in energy-intensive industries, the energy input accounts for only a small share of total financial inputs, for example 8 percent in the chemical industry and 14 percent in the building materials industry.

SOURCE: *Energy Policy* (December 1991), "Policies to promote energy conservation in China", Wu Zongxin and Wei Zhihong.

Energy requirements of energy-intensive products

Product (toe/tonne)	**China**	**Industrialized**	**India**
Steel	0.95	0.56	0.95
Electrolytic aluminium	5.00	4.69	
Synthetic ammonia	1.47	0.84	
Caustic soda	1.11	0.80	
Cement	0.13	0.08	0.20
Plate glas	0.41	0.28	
Paper	0.99	0.82	1.11

Indian data are taken from *UNEP Industry & Environment* (April-June '90)

650°C) are turbine and engine exhausts and flue gases from boilers or ovens. Low-temperature heat sources comprise condensate and cooling water from high-temperature processes. High- and medium-temperature heat can be used to produce steam to drive a turbogenerator or to supply process steam for pre-heating.

ii) Improvements in the electric system.

Most electric equipment is in the form of lamps, motor-powered drives (such as pumps, fans, blowers, compressors, machine tools and various conveyors and rollers), electric furnaces and electrolysis equipment. Electricity conservation can be achieved by better lighting techniques in plant buildings, reduction of the factory's peak load (by rescheduling operations, automization and replacement of oversized or inefficient equipment) and introduction of variable speed drives (VSDs). VSDs are electronic devices that enable a motor to vary its speed in order to match power demand.

Box 3.2 Cogeneration in Thai sugar mills

In Thailand the Electricity Generating Authority (EGAT) is the state enterprise responsible for power generation. An annual growth of 700-800 MW is expected during 1992-2001, for which investments of about US$ 4 billion during 5 years would be needed. In order to lessen this financial burden, the Government encourages private participation in electricity generation.

Sugar mills are an attractive option in the private power programme, as expertise and equipment for electricity generation already exist. In sugar mills, the fiber part of the cane (called bagasse, some 30 percent by weight of the crushed cane) is normally used to produce steam for process heat and electricity generation. Annual production of sugar cane in the 46 Thai mills is about 36 million tonnes, yielding some 12 million tonnes of bagasse. Currently, the bulk is used for on-site power and heat requirements, and only 10 percent is available for electricity generation.

Much more could be made available for surplus electricity, to be sold to the grid. First, with introducing minor modifications in the process, it should be possible to obtain up to 25 percent more bagasse, which would make about 2.7 million tonnes of bagasse available for surplus power generation. Secondly, the efficiency of the sugar mill power plant can be improved by introducing bagasse drying (decreasing the moisture content of the bagasse fired in the boiler) and by introducing more efficient high-pressure boilers. Thirdly, there is also a large amount of cane trash, in addition to bagasse, amounting to 8.6 million tonnes a year, which presently is left on the field, but could be made available as supplementary fuel. Introducing such improvements would make available a maximum electricity generation potential of 8006 GWh in the Thai sugar mills.

SOURCE: *Energy* (Vol.17, No.3), "Evaluation of alternatives to increase the electrical generation capacity of Thai sugar mills". A. Therdyothin, S.Bhattacharya and M.Tabucanon.

iii) Shifting to more efficient processes.

STEEL PRODUCTION consists of 7 major processes: preparation of the ore, production of the coke, ironmaking, steelmaking, casting, forming and heat treating. In all of these processes energy efficiency improvements can be achieved by switching to direct production methods of steel from coal (instead of coke) and by using of improved casting techniques.

In CEMENT PRODUCTION there are two main manufacturing processes: (a) the wet process, in which water is added to the raw materials so that the material is fed into the kiln in a slurry, and (b) the dry process, in which the raw materials is fed as a dry powder into the kiln. In many countries cement production is increasingly based on the dry process, because it uses substantially less thermal energy than the wet process. Other improvements include the use of better quality raw material and better grinding equipment.

NITROGEN FERTILIZERS are basically made from ammonia, in which natural gas is usually used as feedstock and as fuel. Pollution control measures can simultaneously allow increases in production and reductions in energy use (e.g. capturing hydrogen lost from the synthesis process).

In the PAPER AND PULP industry substantial reductions in energy use are possible, leading to improved product quality as well. For example, improved presses can be used to squeeze the water out of the paper before drying. The use of enzymes is preferable to traditional chemical or mechanical pulping. Waste products (such as the 'black liquor') can be used as a source of energy.

iv) Shifts to more efficient materials:

Large savings are possible from the increased use of RECYCLED MATERIALS, especially the more energy-intensive ones, such as steel, aluminium, paper and glass. Even greater savings can be

Table 3.1 Possibilities for improving energy end use efficiency

SELECTED SHORT-TERM ENERGY EFFICIENCY OPTIONS

Industry and agriculture sectors

- efficiency improvements in present production processes, inclusively. quality control and 'just-in-time' inventory control
- recycling (in particular energy-intensive materials and/or complex composite materials)
- substitution of materials with low energy-intensive materials
- improved electromechanical drives (VSDs), motors, pumps, fans etc
- optimization of thermal processes, including waste heat recovery (heat exchangers), insulation, steam traps, improved combustion control.
- cogeneration (employing steam-injected gas turbines)
- application of proven new high efficiency industrial processes
- efficient machinery design rules and design software
- improved operation and maintenance (e.g. lubrication, proper belts, adjustments to gears)
- adequate equipment testing procedures, standards and diagnostic equipment

Transport sector

- improved fuel efficiency of road vehicles and motors
  - advanced vehicle design (reduced weight, reducing aerodynamic drag, shifting from rear to front wheel drive, 4- and 5-speed automatic transmission, variable speed transmission, improved tyres and lubricants)
  - improved engine performance (fuel injection, roller cam followers in valves, intake valve control, low friction rings & pistons, turbocharging)
  - shifting from 2-stroke to 4-stroke engines. Hybrid cars (electric motor and diesel engine). Freight trucks: diesel rather than gasoline engines.
- improved vehicle operational efficiency: traffic management to reduce congestion, improved driver behaviour, regular vehicle maintenance
- improved road conditions
- shifting from private automobiles to mass transit and bus systems

Residential and commercial sectors

- improved biomass and other cooking stoves
- improved refrigeration systems (improved but environmentally friendly insulants, voltage stabilizing VSD, 2-compressor system, adaptive defrost)
- improved space conditioning
  - improvement of energy efficiency of air-conditioning
  - improved heat efficiency through highly efficient insulating materials
  - better design (orientation and opacity of windows, building envelope etc.)
  - use of heat pumps in buildings
  - use of control systems
- improved lighting efficiency (CFL compact fluorescent lamp, voltage stabilizing ballasts, reflectors, advanced daylighting control, task lighting)
- improved efficiency of electric home and office appliances
- improved operation and maintenance

SELECTED MEDIUM-TERM ENERGY EFFICIENCY OPTIONS

Industry and agriculture sectors

- increased use of energy-efficient high-performance materials
- advanced and new process technologies
- use of biological phenomena in processes
- localized energy conversion

Energy storage and generation

- advanced batteries

Transport sector

- improved fuel efficiency road vehicles
- use of alternative fuels (electricity, methanol, ethanol, natural gas, hydrogen)
- reducing transport demand, through better land use and urban planning: matching residences with jobs, schools and shops, improved telecommunications
- public transportation:
  - intra-city shift to public transport
  - intercity trains
  - better intermodal integration

Residential and commercial sectors

- improved energy storage systems
  - use of information technology to anticipate and satisfy energy needs
- improved building systems
  - new building materials
  - windows that adjust opacity

achieved from re-using materials in the same form, instead of melting them down and recasting them.

SUBSTITUTION OF MATERIALS can have two effects. For example, plastics are being used as substitutes for metal in many auto body parts, hereby reducing weight and improving fuel efficiency and durability. On the other hand, the increasing mixture of different materials makes recycling more complicated and costly.

QUALITY CONTROL during the production process can play an important role in saving energy by reducing the amount of scrap and reworking that is necessary.

v) Cogeneration.

This is the combined production of electricity and steam (for on-site heating requirements). Current practice is that heat and electricity are often produced separately, respectively in industry and in electricity-generating plants. In industries heat is usually provided by direct combustion of fossil fuels. An alternative for industries is to use the fossil fuel to generate electricity while the waste (low-grade) heat is used for process requirements. Overall efficiency of the fuel, only around 30-35 percent in the case of electricity generation, can be increased to 60 percent in this way. The additional advantage is that if all economic generation possibilities of a country are used, then a large fraction of a nation's electricity demand can be supplied by decentralized (private) cogeneration facilities instead of by the main (public) grid.

Established manufacturing processes cannot be changed or modified easily. Although the eventual introduction of the above-mentioned processes may therefore be regarded as medium-term options, it is essential that new investments in industrial manufacturing processes should accommodate for energy efficiency as one of the main objectives.

III.1.2 Agriculture

The main source of power in traditional and semi-commercial agriculture in many Asian countries is animal and human muscle power. Energy conservation may not be the major policy objective, but rather a transition from traditional labour-intensive agricultural methods to more modern practices. The aim is to achieve higher agricultural productivity. However, agricultural modernization need not always be associated with introducting or increasing the use of commercial energy. Modernization is a step-by-step approach that includes:

- soil conservation, erosion control, water use and supply control;
- the role of higher value inputs, i.e., supply of higher-yielding crop varieties, fertilizer and pesticides;
- improvement of farming practices, introducing new concepts (e.g. intercropping or agroforestry) while maintaining the multiple roles and needs served by taditional technologies (e.g. draught animals, providing meat, leather, dung in addition to traction and being a financial asset);
- an adequate agriculture support infrastructure (such as adequate credit supply, extension and repair and maintenance facilities);
- proper pricing of agricultural inputs and outputs (allowing the market to work).

Various opportunities to improve efficiency of energy use in agriculture and fisheries are implicitly mentioned in other paragraphs dealing with industry and transportations, such as efficiency in agricultural transport (techical improvements in traction and transport equipment for cultivation and other operations), in the inputs-supplying industries (tools, fertilizers, chemicals) and in the agroindustries (crop processing and storage).

Main energy uses in agriculture proper are traction and irrigation. Energy use by mechanical traction varies widely per region and according to operating conditions, from workers primarily relying on hand tools to greater use of animal and mechanical traction. Usually productivity is improved by increased mechanization, but has been said before, mechanization is not an end in itself. Ambitious mechanization projects, introducing tractors, have often failed, as the financial and technical infrastructure was not ready. Many countries have made greater use of draught animals therefore. However, in densily populated areas, draught animals may become increasingly difficult to support, as pasture is converted into crop area, and the animals may require the output of several times as much land for fodder as they can work. A variety of improvements in nutrition, draught harnass design and veterinary care can greatly improve work output by draught animals. Mechanical traction comes in many forms, from small power tillers to large tractors. Generally, diesel-powered equipment is roughly 25 percent more efficient than gasoline-powered equipment.

In rural areas pumps are important for domestic water supply and for irrigation. Numerous improvements are possible. These include technical improvements, such as reducing the friction in the piping system and foot valve of the pump and using integrated pumpsets (instead of units in which motor and pump are separate). Other measures include better techniques for delivering the water to the plant (such as drip irrigation and the use of computers and sensors to monitor water needs and scheduling irrigation). In households and offices pumps are used to raise water from the well or street level to the roof, from which it is distributed through gravity. Here, better management can be achieved by installing controllers that shut off the pump whenever the tank is full to avoid spillage. The end user can save energy by water conservation, e.g. regular checks for leaks in the water flow system and by employing low-flow toilets.

Table 3.2 Electrically operated water pumps in some Asian countries

Country	Year	Number of pumps	Pumps per 1000 km^2	Pumps per million population
Bangladesh	1983	9,200	64	129
India	1983	5,130,000	1,620	7,502
Pakistan	1982	76,397	95	911
Philippines	1981	750	3	16
Thailand	1982	375	2	8

In India there were about 3.1 million diesel pumps in 1983. The number of diesel pumps has not been estimated since. In 1988/89 there were 7.6 million electric pump sets in India. Assuming the same proportion of diesel and electric pumps in 1988/89 as in 1983, the total population would have been 12.1 million.

SOURCE: *Energy End Use, An Environmentally Sound Pathway,* Asian Development Bank (June 1994, Manila, Philippines). *TERI Energy Data Directory and Yearbook,* Tata Energy Research Institute (1989, New Delhi). *Pacific and Asian Journal of Energy,* 1(1)45-53, S. Ramesh and T.V. Natarajan, "Policy options in rural electrification in India, with special reference to pumpset energization".

III.2 Transportation

Almost all car manufacturers have developed highly fuel-efficient prototype vehicles. Fuel efficiency can be expected to increase in new cars. Currently, developing countries have little influence over the design and commercialization of new cars. Prospects for actually achieving energy efficiency will continue to depend mainly on the development of the crude oil price, as well as Government policies in industrialized countries concerning energy prices, emission restrictions, taxation, speed limits and other policy instruments, pushing automotive technologies towards a greater energy efficiency.

In freight and passenger transport, the existing fleet in Asian developing countries is generally older, smaller and less technologically sophisticated than in industrialized countries. Fleets are older because the fraction of the fleet that is scrapped each year is smaller, and due to lower labour cost, repair is cheaper. Technology improvements include improved carburetors, electronic ignition, fuel injection, the use of radial tyres, the use of four-stroke rather than two-stroke engines, reducing friction in the moving parts of the engine and the transmission, turbocharging, improved lubricants etc. Here, a possibility for efficiency improvement lies in periodic engine rebuilding when it is taken to a local shop for repair, as well as in increasing scrappage rates (through minimal quality requirements and testing for annual registration), establishing emission standards and mandatory installation of catalytic converters. In most countries, purchase taxes are already structured to discourage the purchase of large and/or imported cars, suggesting a role for efficiency standards too. Proven efficiency improvements, such as the use of larger trucks (more efficient than small ones in terms of energy use per weight transported) and the use of aerodynamic improvements and turbochargers, require nonetheless smooth, uncongested, paved heavy duty roads. On congested and unpaved roads the efficiency of engines drop sharply. Road improvement therefore can increase energy efficiency by allowing for higher, sustained speeds, and the use of larger, heavier trucks. On the other hand it may encourage increased traffic and thus increase energy demand.

***Table 3.3* Characteristics of the Indian rail system**

	Number of locomotives 1971	1987	Energy intensity '82/83 (toe/million gross t-km)
steam (coal)	9,387	4,950	60.8
diesel	1,169	3,182	3.5
electric	602	1,366	3.4

SOURCE: *Teri Energy Data Directory and Yearbook*, Tata Energy Research Institute (TERI), (1988, New Delhi, India), pp. 165. Railway Board, cited in *Pacific and Asian Journal of Energy*, 1(1)1-12, J. Dunkerley, I. Hoch, C. Gadhok and K. Thukral

The rail systems of China and India use a mix of diesel, coal and electric locomotives (see table 3.3). The energy as well as environmental benefits of replacing for coal in locomotives are usually considerable.

In addition to transport improvements within each mode, the energy efficiency of the transport sector as a whole (as measured by energy consumed per tonne-kilometre or per passenger-kilometre) can be improved by encouraging the movement of both freight and passenger traffic to more efficient modes. In freight traffic rail uses about one fourth to one third of the energy per tonne-kilometre that road vehicles consume. In passenger transport the private car is the least efficient option, and most energy-efficient options are the bus, and for intercity traffic, the railway. Nonetheless, bus and railway systems in developing countries often provide unsatisfactory services, not offering an attractive alternative to those who can afford a private car.

Congestion, on the one hand, acts as a deterrent by discouraging the use of cars, and forces people to use mopeds and bicycles or the public transport, but on the other hand increases the fuel use per kilometre and has economic consequences ('time is money'). A more extensive road system alleviates congestion. But from an energy and transport efficiency point-of-view, it should be combined with offering alternatives in an integrated and planned manner, including mass transit systems (subway and other rail-based light transit systems) and an efficient bus system, supported by various policy measures (e.g. a ban on using cars on various days, area licensing systems and electronic road pricing). The cities of Singapore and Hong Kong have shown how urban mass transportation systems can be established and maintained successfully, although acknowledging that both cities are more affluent than the average megacity in the developing countries.

III.3 Residential and commercial sectors

Generally, the use of wood fuels, i.e. charcoal and fuelwood, is very inefficient in terms of useful energy consumption. There are two ways to raise efficiency of energy use:

i) Substitution by (more efficient, cleaner and easier-to-use) fossil fuels and electricity;
ii) High-efficiency cooking stoves and charcoal production methods.

Efficiency, investment cost, fuel cost and stove performance generally increase as consumers shift progressively from wood stoves ('end use' efficiencies between 7 percent (%), open fire, and 25%, portable metal stove) into charcoal (between 15 and 25%), kerosene (40%), LPG or gas and electric stoves (some 70%). Efficiencies and cost tell a different story if one does not only look at the purchaser's perspective, but from the energy supply system's. When energy losses of converting wood into charcoal and fuel to electricity are taken into account the 'system' efficiency of energy delivery drop to respectively 3 to 8 percent (charcoal) and about 25% (electricity).

***Table 3.4* Estimates of electricity consumption, Bangkok**

	Power (W)	Usage (hrs.)	Annual consumption (kWh)
Colour television	79	2,014	159
Refrigerator	109	5,760	628
Rice cooker	1,149	230	264
Clothes washer	1,567	91	143
Air-conditioner			
window	1,815	1,442	2,617
central	2,257	1,564	3,530
Ceiling fan	77	2,061	159
Water heater	4,418	54	239

SOURCE: *Energy Efficiency and Household Electric Appliances in Developing and Newly Industrializing Countries,* Stephen Meyers *et.al.*, Lawrence Berkeley Laboratory (December 1990, Berkeley, U.S.A.), no. LBL-29678.

Lighting can be made more energy-efficient through the use of circular fluorescent lamps and compact fluorescent lamps (CFLs). Country studies on India and Brazil have shown that the large-scale introduction of CFLs in households can be very cost-effective from national and utility perspectives. However, to this day the capital cost of CFLs on one side, and subsidized electricity prices on the other side, limit the market penetration of energy-efficient lighting. For example, the overall efficiency of a 60 W incandescent bulb is some 13 lumens per Watt, while that of a CFL is some 45 lm/W. The higher initial capital cost of the CFL (US$ 15, less than US$ 1 for the incandescent lamp) is effectively outweighed by its higher lifetime (thus lowering the annualized capital cost) and its higher efficiency (lowering the annual operating cost), if the lamp is operated for at least 40 minutes a day. If operated for longer periods per day, the CFL is actually cheaper than the incandescent lamp. For example, if operated for 6 hours a day, annual savings in total cost (capital and operating cost) are US$ 7 per year. [1]

In view of the rapid growth of the commercial sector in many Asian countries, efficiency improvements in the lighting systems of commercial buildings and modern urban households are especially important. Although, commercial buildings often use fluorescent lamps already, opportunities exist in replacing standard fluorescent tubes, by more efficient models, that are improved in design and use of materials (high efficiency core-coil ballast and better diffusers and reflectors). Furthermore, better controls (occupancy sensors and photocells) can help to reduce excessive lighting in unoccupied spaces. Also, the importance of good lighting design should not be minimized.

Air-conditioners vary widely in their energy efficiency, but high efficiency systems are, or could be, available in most Asian countries. Adequate designs of new buildings (including shades, reflective or tinted coatings and improved insulation) can be used to reduce cooling loads. Even retrofits can be highly effective, such as putting reflective plastic film on windows. Using the most energy-efficient appliances

Box 3.3 Appliance efficiency in Indonesia

The appliance market in Indonesia is dominated by companies that operate as joint ventures with Japanese manufacturers. Appliances sold include ready-made imports, assembled units and appliances manufactured locally (with local and imported components). For larger appliances (such as televisions refrigerators, videos) most imports come from Japan, smaller items (e.g. fans, rice cookers) imports come from other Asian countries.

In practice there are two appliance markets. One providing for the expatriates and upper class, providing high-quality imported goods, usually as energy-efficient as similar products in industrialized countries. Locally made, and generally lower-quality, appliances cater for the rest of the population.

It appears that most appliances, made in Indonesia, follow designs made in Japan 10 years ago, and follow trends in energy efficiency improvements with a time lag of 5 to 10 years. Thus one can expect a future increase in appliance efficiency, albeit at a slow pace. Some examples.

The most popular refrigerators are small-sized ones (volume less than 150 litres) and have one door. Around one third are big models, two doors and a full freezer. On these models, manufacturers have started to introduce some 'electricity-saving' technology, such as rotary compressors, voltage regulators and fan systems.

Television energy use will be determined by two opposite trends. One one hand, the wattage of models has shown a decreasing trend. Offsetting this trend is the shift from black & white to colour models (which consume 2 to 3 times more energy).

In air-conditioning the most popular type is the window-type unit. The split-type system is more energy efficient, but also more expensive.

SOURCE: *Energy Policy* (July/August 1991), "Improving appliance efficiency in Indonesia", Lee Schipper, Stephen Myers.

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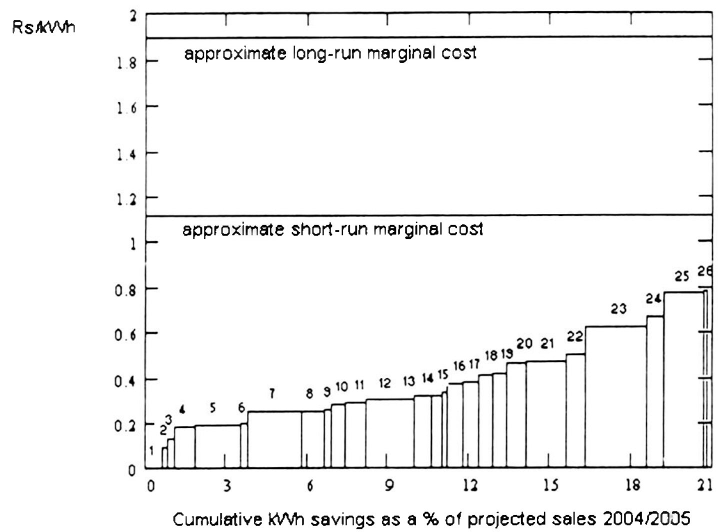
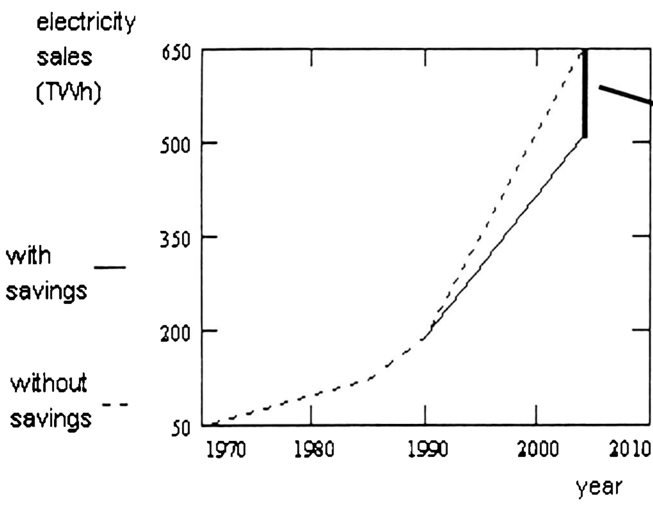
1 Data adapted from: *Fueling Development, Energy Technologies for Developing Countries*, Congress of the United States, Office of Technology Assessment (1992, Washington D.C.), figures 3-10A to 10D, p. 68.

Figure 3.1 Supply curve for conserved electricity in India

SOURCE: *Opportunities for Improving End-Use Electricity Efficiency in India,* S. Nadel, K. Vihendra, S. Gopinath. The World Bank, U.S. Agency for International Development, American Council for an Energy-Efficient Economy (November 1991).



Numbers in graph correspond to the measures listed in table 2 of the paper.
1 Rs (rupee) equals US$ 0.05



reduced electricity needs with 20% by 2004/2005 at less than half the cost of expanding power capacity

***Table 3.5* Cost-effective options for electricity savings in India**

				Savings as a percentage of projected GWh sales	
		Cost of saved energy (Rs/kWh)	Possible energy savings in 2004/2005 (Gwh)	Individual	Cumulative
1	TLD lamp	0.00	4,328	0.67	0.67
2	centrifical. refrig. compressor	0.09	1,135	0.17	0.84
3	improved arc furnace	0.13	1,620	0.25	1.09
4	meter agricultural pumpsets	0.18	5,185	0.80	1.88
5	incandesc. to fluorescent fixture	0.19	10,715	1.64	3.52
6	HPSV lamp & ballast	0.20	1,676	0.25	3.78
7	motor rewinding, etc.	0.25	13,291	2.04	5.81
8	high-efficiency motors	0.25	5,023	0.77	6.58
9	air compressor O&M	0.26	2,188	0.34	6.92
10	HVAC efficiency improvements	0.28	3,220	0.49	7.41
11	two-speed motors	0.29	9,869	0.76	8.17
12	high-efficiency, new pumpsets	0.30	11,822	1.81	9.98
13	moderate-efficiency refrigerators	0.32	4,207	0.65	10.63
14	membrane chlorine-alkal. process	0.32	2,222	0.34	10.97
15	room air-conditioning eff. impr.	0.33	1,441	0.22	11.19
16	circular fluorescent lamps	0.37	3,725	0.57	11.76
17	optimize industrial pumps	0.38	4,054	0.62	12.38
18	optimize industrial fans	0.41	3,187	0.49	12.87
19	more efficient fans	0.42	3,613	0.55	13.42
20	improved aluminum smelters	0.46	4,386	0.67	14.10
21	electronic ballast	0.47	9,737	1.49	15.59
22	high-efficiency refrigerators	0.50	4,774	0.73	16.32
23	variable speed drives	0.62	14,361	2.22	18.54
24	compact fluorescent lamps	0.67	4,312	0.66	19.21
25	agricult. pumpset rectification	0.77	10,344	1.59	20.79
26	efficient evaporation cooler	0.79	1,183	0.09	20.88
	TOTAL		141,616	20.88	20.88

SOURCE: *Opportunities for Improving End use Electricity Efficiency in India,* S. Nadel, K. Vihendra, S. Gopinath, The World Bank, U.S. Agency for International Development, American Council for an Energy-Efficient Economy (November, 1991).

in the office or home environment will keep internal heat gains low. Alternatives to electric-powered air-conditioning can be utilized, such as variable-pitch fans, evaporative coolers and absorption chillers. Similarly, energy savings in space heating can be achieved by higher equipment efficiency and a better insulation. Water heaters are also gradually becoming more common in a growing number of developing countries. Again, energy efficiency varies with products and with the technology used. Whereas storage heaters are often energy-intensive, hot water pumps and solar water heaters are more energy-efficient and may be cost-effective.

Electronic equipment, such as faxes, televisions or computers, are usually chosen on the basis of performance and cost, not on the basis of energy requirements. Buying modern products that have additional features such as sensors and/or timers could reduce energy consumption, by shutting off equipment when not in use.

Utilities may directly benefit by reducing the amount of subsidized power they sell. It will often be less costly for the utility to subsidize more efficient appliances, such as efficient lightbulbs than continue to subsidize electricity, especially when utilities must finance expensive new generation capacity. However, at present institutional structures in many Asian countries generally have favoured the separation between supply side and demand side management of energy supply, thus encouraging the inefficiencies in the consumer choice of end use lighting technology, that arise from this division in responsibility (see paragraph IV.2.2).

III.4 Supply curves for energy efficiency

The overall technical potential for electricity savings in a particular country or region can be displayed in a SAVINGS SUPPLY CURVE. A supply curve indicates the maximum savings potential and the cost of saved energy for a discrete number of energy efficiency measures. The measures are usually ranked from most to least economical. Most of supply curve studies have been performed in the United States of America and in a few other industrialized countries, such as in the United Kingdom of Great Britain and Northern Ireland and in Sweden. Figure 3.1 presents a supply curve, developed by researchers for India, and table 3.5 lists the corresponding 26 electricity end use efficiency measures. Successful application of these measures would reduce electricity use by 21% below forecasted levels in the year 2005 [2/].

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2 The cost of saved energy (CSE) is calculated as follows:

CSE (Rs/kWh) = (measure cost * capital recovery factor) / annual kWh savings

'Measure cost' (basically the 'initial cost' plus 'on-going cost' of one of the 26 measures, exclusive taxes and duties) and 'annual kWh savings' are unique for each appliaction. The capital recovery factor is calculated using the 'loan payment formula' $(d(1+d)^n) / ((1+d)^n-1)$, where d is the discount factor (10 percent) and n is the life time of the measure (with 20 years as a limit).

The CSE can be compared to the societal marginal cost of electricity generation to estimate its cost-effectiveness. LONG-RUN MARGINAL COSTS are based on the assumption that demand and power supply are in balance (over the long run), meaning that one kWh saved means that one kWh less needs to be generated. Over the short run this is not so, as one kWh saved will be sold to someone else. The SHORT-RUN MARGINAL VALUE of a kWh saved can be approximated by looking at the marginal revenues from kWH sales. In India, is is usually the industrial sector that faces

Box 3.4 Electricity, agriculture and waterpumping in India

In 1992 India generated 289 TWh, i.e. 374 kWh per person (cf. United States, 11,000 kWh). Installed capacity in 1992 was 81,204 MW. Of the 289 TWh totally produced, some 264 TWh were generated in public utilities, of which 190 TWh were sold to consumers.[1/] It has been estimated that 5.5 percent annual economic growth for the coming 10 years requiers an extra 8.5 percent power capacity per year. Thus capacity would have to be expanded to some 235,000 MW to be able to meet the projected energy sales of 646 TWh. That means an investment of US$ 55 billion over the 1992- 2004/5 period (unless energy efficiency improvement measures such as described in table 3.5 and figure 3.1 would be taken).

On average the (short-run marginal) cost of producing electricity is about $ 0.055 per kWh, while the price is $ 0.042. Electricity is mainly run by state electricity boards. State governments have an interest in keeping prices low out of fear to loose votes in state elections, especially farmers' votes. In Tamil Nadu, for example, farmers get their electricity free.

Irrigation frees the farmer from vulnerability to irregular rains and raises yields allowing double- or even triple-cropping. Not surprisingly, electricity sales to agriculture has shown the highest increase rate over the past 2 decades, from 10 percent in 1970/71 to 24 percent in 1987/88. In India, most agricultural energy is used for pumping. Energy consumption in 1989/90 was about 32 TWh (for an estimated 8 million electric pumps), which could increase to128 TWh by 2004/5.

The typical pumpset features an inefficient pump, linked with a belt to a motor, foot valves and return and supply pipes. Possible retrofit measures include replacement of pipes and foot valve by low-friction equivalents, as well as replacement of existing pumps and motor with new monoblock pumpsets (in which pump and motor are one unit). Such a retrofit package could reduce electricity use by 30-50 percent at a cost of approximately Rs. 9,000 (equivalent to US$ 450, at 1990 exchange rate). Assuming that the actual savings are 35 percent, then the cost of saved energy (CSE) would be Rs. 0.77/kWh, for a typical pump of 4 kW, operating at 950 full-load hours a year with a peak load factor of 16 percent, assuming a pumpset lifetime of 15 years. These figures were used to calculate the CSE of option 25 in table 3.5.

The relative abundance of electric pumps *vis-a-vis* diesel pumps is influenced by its economics as perceived by the user. As electricity is heavily subsidized, electric pumps are much less expensive than the alternatives (such as diesel or biogas pumps). Annualized lifecycle cost would be US$ 143 a year (in 1987 US$) of an electric pump and US$ 705 a year of a diesel pump. Without fuel subsidies, annualized lifecycle cost would amount to US$ 755/yr for electric pumps and US$ 720 for diesel pumps. Dual-fuel biogas/diesel pumps would be even cheaper than diesel pumps. On the short term however, the heavy subsidy for agricultural electricity cannot be easily removed for political reasons. Offering the lowest cost alternative farmers prefer electric pumps, but also for reasons of convenience, as electric pumps are less mechanically dependable than diesel pumps.

1/ The difference between sales and generation at public utilities can be accounted for by self-consumption, export and import, but includes also transmission and distribution losses. These losses were 21 percent in 1990. Unofficially the figure would be 48 percent, including 'unauthorized sales' by utility employees and because of 'jumpers' that people attach to power lines.

Exchange rates: 1987, 1 US$ = 15 Rs., 1990, 1 US$ = 20 Rs., 1994, 1 US$ = 31 Rs.

Data were compiled from: *Opportunities for Improving End use Electricity Efficiency in India*, US Agency for International Development, S. Nadel, S. Gopinath, V. Kothari (November 1991); *Energy End Use An Environmentally Sound Pathway*, Asian Development Bank (June 1994, Manila, Philippines); *Energy Statistics Yearbook*, United Nations, various issues; *The Economist*, "A survey of India" (21 January 1995).

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load and voltage reductions first. Thus, the short-run marginal value can be approximated by the average revenues per kWh from industrial customers. Long-run marginal cost are estimated at Rs. 1.77-2.02/kWh. Short-run marginal cost are estimated at Rs. 0.9-1.3/kWh. Efficiency measures can save the Indian utilities money whenever the CSE is less than the marginal cost.

In the CSE, also the fraction of applications in 2004/05 for which a measure is suitable, is taken into account. This means that, e.g. if high-efficiency refrigerator s (not used in 1991) will be used in 80 percent of the cases in 2004/2005 (instead of the current standard type in the other), then the percent applicable factor will be 80 percent.

As in India, similar energy efficiency and conservation potentials exist in other Asian developing nations, but supply curve studies for these countries have not been undertaken yet.

Similar work, done so far, in the United States of America, Europe, Brazil and India, indicates that electricity use can be reduced by 20 to 40 percent with measures that have already been commercialized and that are cost-effective to consumers and society.

IV Elements of energy conservation and efficiency promotion policies

IV.1 Constraints on energy efficiency improvements

The existence of large and cost-effective opportunities for energy end use, as discussed in chapter three, raises the question why such cost savings have not been exploited more. Throughout the Asian region some barriers are common, involving a variety of market allocation failures, pricing policies, institutional impediments and infrastructural barriers. For easy reference, a summary of barriers and policy responses is given in table 4.1, and are elaborated in more detail in this and the next paragraphs. Chapter five discusses ESCAP activities in support of Asian and Pacific developing countries' efforts to implement energy efficiency promotion measures.

IV.1.1 Lack of information, training opportunities and consultancy services. Technical barriers

Many investors and most of the consumers have insufficient information on the rapidly evolving technologies that are available. Furthermore, they are uncertain regarding energy savings and the cost-effectiveness of employing more efficient designs.

The energy-efficient equipment developed in the industrialized countries may not be suited to the conditions in developing countries. Considerable adaptation may be needed. Yet, funds for the necessary research and development may not be available when supplying companies are small and/or markets are small or expensive to access. Markets in developing countries are smaller thus making the penetration of large-scale technologies less viable. Low-efficiency equipment often circulates widely in second-hand markets in developing countries, sometimes as "gifts" from industrialized countries. Penetration of high-efficiency technologies is often hampered by patents, as the royalties for its use adds to the initial cost of the equipment. Also, the support infrastructure of skilled personnel and spare parts supply, needed for installing, operating and maintaining high-efficiency equipment, may be lacking or inadequate. Technologies for measuring the efficiency of equipment, as needed in energy audits, may not be available or inaccurate. Foreign exchange shortages often exacerbate these problems in handling imported high-efficiency equipment.

Users may waste energy for various reasons. For example, lights in buildings may be kept on for security reasons. Bus drivers leave their engines on for long periods, while waiting for passengers.

IV.1.2 Market failure: disconnection responsibility for energy saving investments and energy operating cost

An important market failure is formed by the initial prevailing preference for less-capital intensive (but often not the most energy-efficient) technologies, equipment and products, without adequately taking into account, or without being able to, the true lifecycle cost, let alone the long-term economic and environmental implications of wasting energy. Within a firm, accounts for operating costs (such as paying the energy bill) are separated from accounts for capital investments (as in more efficient equipment). Thus, budgets for capital investment may be cut, even though the return on investment might have been much higher than the total cost (i.e. annualized capital and operating cost) to the firm. Also, users may not find a level of energy cost saving attractive to justify investment in technical and managerial personnel to realize such savings.

In the building sector, the responsibility for making capital investments and paying the operating cost are often separated. Energy users in buildings, especially low-income ones, are extremely sensitive to the first cost of equipment, and are often not even the purchasers of the equipment they use. The owner will buy an air- conditioner based on the lowest first cost, while the tenant must pay the operating cost. Similarly, the construction sector tends to compromise on the energy efficiency of buildings to minimize construction cost and maximize profits.

Building owners, occupants and entrepreneurs alike will resist buying energy-efficient products and equipment at greater (initial) purchase cost, in view of the requirements for rapid payback in developing societies were capital is usually scarce (and effective discount rates are high). Energy efficiency is often of secondary concern to industrial firms. Energy is just one input in the production process, and must compete with other cost/benefit concerns, including profitability, competitiveness, product quality and quantity, reliability etc. Especially in developing countries capital costs are relatively high as compared with energy costs and labour costs. Sometimes, local industries are protected from competition and thus are not inspired to lower costs. In general, smaller manufacturing firms are less energy-efficient and require greater capital investment per unit output to realize energy savings than can be achieved in large plants.

A similar disconnection-of-responsibility barrier can be observed in the electricity sector. Here, capital can be saved because the higher initial cost of efficient end use equipment is usually outweighed by the savings realized from building fewer power plants, as has been discussed with India as an example in paragraph 3.4. The perception that energy efficient equipment has a high capital cost, results from consumers facing the increase in capital cost of more efficient appliances, but not 'cashing' the decrease in the capital cost of building fewer power plants.

The generally high demand in the growing economies for road vehicles, combined with inflation (which protects the value of used cars), relatively cheap labour for maintenance and expensive capital have led to low scrappage rates and therefore an older (and less energy efficient) road vehicle fleet. Energy efficiency is often a secondary interest to vehicle owners, who value vehicle acceleration, roominess, comfort or accessories such as air-conditioning, more than energy consumption, especially when fuel prices are low.

IV.1.3 Financial and economic barriers

Many countries in the ESCAP region have had some implicit or explicit energy subsidization. Often, fuel and electricity prices do not transfer the full cost of energy use to the individual consumer, let alone the external cost, such as environmental damage. Social objectives, including the desire to ensure that fuels are price-stable and affordable by the poor, often play a major role. Economic objectives are reflected in policies that promote rural electrification. Policies to keep energy prices low in general bias the choice of technology against efficiency and will not encourage consumers to adopt a conservation behaviour. Also, when revenues cannot cover the cost of energy supply, declining quality and shortages may result.

Table 4.1 Policy options in tackling barriers to energy efficiency

BARRIERS	POLICY OPTIONS
LACK OF INFORMATION AND KNOW-HOW - lack of information on cost-effective opportunities and savings - lack of awareness and wasting behaviour among consumers - lack of information consultancy services - lack of diagnostic and measuring technologies for energy audits - shortage of skilled and technical and managerial personnel	**INFORMATION AND TECHNOLOGY TRANSFER** - information exchange (through conferences, workshops, clearinghouses, personnel training, customer information, energy labelling, extension services, demonstration programmes, marketing programmes, awareness campaigns) - energy service companies (ESCOs) - energy audits, performed by in-house employees or from the outside (e.g. ESCOs)
MARKET FAILURES - disconnection of responsibility for initial capital cost (e.g. owner of a building) and operating cost (e.g. tenant) - disconnection of responsibility between utility and user - high initial cost of equipment - secondary interest of users in energy efficiency that must compete with other factors (quality, quantity, reliability, etc.) - multiple roles and needs served by an existing technology that may not be met with a new one - low scrappage rates of cars - smaller markets inhibiting cost-effective application of large-scale imported technology	**INCENTIVES** - application of demand-side measures by utilities - alternative financial arrangements to redress the 'disconnection' between utility and user, including direct installation, grants or loans, wherever appropriate - permission to generate private power and incentives for cogeneration
FINANCIAL AND ECONOMIC - subsidized energy prices, which reduces the end user's willingness to invest in efficient equipment - inappropriately designed tariffs and taxes, biasing purchasing decisions towards less efficient technologies - uncertainty and instability in international energy price development - lack of funds and foreign exchange (to purchase technologies, for spare parts, for research and development)	**PRICES, TAXES AND TARIFFS** - appropriate energy pricing policies - tax incentives to stimulate investment in energy efficiency - adjustment of import restrictions on energy-efficient technology
INFRASTRUCTURAL AND INSTITUTIONAL - inadequate infrastructure to adequately support high efficiency technologies (e.g. voltage jumps damaging sensitive electric equipment, dirty fuel clogging car fuel injectors, lack of a reliable spare part supply system, poor roads, inadequate public transport system) - bias of energy planners towards a small number of large supply-side projects (as opposed to a multitude of small demand-side projects) - political instability - lack of promotional organizations	**INFRASTRUCTURAL AND INSTITUTIONAL** - establishment of research and development programmes and training of highly skilled personnel at centres of excellence in developing countries (possibly in conjunction with sister institutions in industrialized or newly industrializing countries) - standards and testing protocols for new and second-hand equipment; energy labelling - validation of energy efficiency technologies under field conditions - integrated resource planning ('least-cost' planning), including end use efficiency considerations - improved data collection (through surveys) on equipment and end user preferences, manufacturers and distributors - establishment of energy conservation policy coordinating bodies

Adapted from *Energy End Use Efficiency Promotion*, J. van den Akker, paper presented at "Asia Energy Efficiency Conference" (21-22 September 1994), organized by REED Exhibitions Ltd. at ELENEX '94 Exhibition, Singapore

Although designed to help the poor, subsidies often have an opposite effect, benefiting the more affluent, who, not the poor, are connected to the electricity grid and are the heaviest users of fuels.

Electricity often tends to be underpriced. Electricity pricing is often based on historical accounting costs of utility plants. This practice tends to undervalue the true cost of electricity. In addition, time-invariant tariffs do not discourage high consumption during peak hours. In oil-exporting developing countries, prices of transport fuels are often kept low, offering little incentive to economize. In oil-importing countries, gasoline prices are generally higher than international cost, but diesel fuels are often lower.

International energy price development has influenced energy conservation efforts in various ways. Uncertainty on energy price development raises the risk that price drops will reverse the profitability of investment. In response to the oil price shocks in 1973/74 and 1979/80 several countries in the ESCAP region established energy conservation projects. Since the 1980s slump in the international oil price, in many cases energy conservation projects lost the priority attention of politicians again.

High import tariffs and non-fiscal barriers can bias purchase decisions away from efficient products and appliance, or may stop energy efficient products from entering a country altogether.

IV.1.4 Institutional and infrastructural barriers

Efforts to improve energy efficiency can be impeded by frequent brownouts or voltage jumps that energy-efficient technologies may be unable to handle well. The available transport infrastructure may strongly influence the choice of technology and also its end use efficiency. For example, dirty fuels clog injectors. Unleaded fuel may not be available in some areas or countries.

Poor land use planning or ineffective implementation has often encouraged the sprawling growth of Asia's megacities. As often public transport infrastructure has not kept pace with the urban sprawl; a reliance on personal transport instead of mass transport has been the result. This often results in congestion, with lower average speeds and reduced fuel use efficiencies, leading to increased polluting emissions. Poor city planning can prevent the establishment of efficient transportation corridors for mass transit options. Poor integration between transport modes, such as between rail and bus systems, often result in people avoiding both due to lack of connectivity and flexibility. A poor service provided by buses, overcrowded, slow and infrequent, will only drive people into their private cars.

Traditionally, the public power sector, encouraged by multilateral development banks and bilateral donor agencies, has concentrated on large-scale supply-side oriented projects, such as major electricity-generating facilities. But also, the private sector has been accustomed to large-scale projects. In fact, energy planners in general have been biased to the supply side for reasons of administrative simplicity. Demand-side data on energy efficiency equipment, end user preferences and operating conditions, are usually scattered throughout the residential, industrial, transport and commercial sectors, are difficult to identify and to gather and thus are not well known. In contrast, energy supply data are in general readily and reliably gathered from a few producers or distributors. Therefore, energy planners often have had a bias towards a small number of large projects, usually for energy supply, against a large number of small projects on energy end use efficiency.

IV.2 Policy options to promote energy efficiency

IV.2.1 Training. Consultancy services. Technology transfer

Information

An essential step in improving energy efficiency is the improved flow of information. First, the gathering of data on energy-efficient equipment, user preferences, operating conditions, manufacturers and distributors, including detailed field studies would help guide policy decisions. Second, manufacturers need internationally available information on newer energy-efficient products, processes and technologies, which can be channelled through manufacturers' associations. Furthermore, they need information on local availability, energy audit consultancy, financing sources and incentives. Third, potential users cannot choose a device, however cost-effective and energy-efficient, if they do not know the efficiency of other models. Labelling of appliances can provide such information.

Brochures, television programmes, public demonstration programmes, newspaper adds, product endorsements, trade fairs, secondary school curricula and awards are examples of the variety of marketing tools that might be used to increase awareness on energy-efficiency technologies.

Energy Service Companies (ESCO)

Industries, commercial buildings and other energy-using groups, need information on how to save energy. Except for the largest industries, the task will go beyond the capabilities of the existing staff. Energy service companies (ESCOs) are companies formed by the private sector that specialize in identifying cost-effective (retrofit) investment opportunities and are paid according to how much they can save. ESCOs provide services such as training, audits and informational support, and pre-financing (e.g. to purchase energy diagnostic equipment) to help overcoming the prevailing initial reluctance and/or lack of knowledge of investment opportunities in energy conservation. ESCOs form a cost-effective mode compared with other alternatives for implementing energy efficiency projects.

Major ESCO success stories in the United States and Australia have come from the industrial and commercial sectors. Equipment supply and service companies can set up ESCOs. Since the payments are linked to 'measured' savings, there is an added interest on the part of the ESCO to ensure that the equipment delivers the required performance characteristics. The ESCO's primary aim is to deliver efficiency and thus has no special interest in promoting any particular supplier of equipment. The energy user can continue to concentrate on their daily operations of production, marketing etc. The boost has also come from an exceptional interest from the electricity companies. Those have observed could get a higher return from investments in energy savings than from investments in new generating capacity and from sale of more electricity. The model of ESCOs developed in the United States need not be replicated in the ESCAP region. It may need to be modified taking into account the local conditions. It is of course, extremely important that there exists an appropriate fiscal and financial climate that will encourage market mechanisms to push energy efficiency from an idea to an actuality. Generic forms of contracts for ESCOs would need to be developed to adequately protect both parties.

Energy audits by a skilled team, either factory workers employees or from an ESCO, can provide highly useful information. Training programmes are needed to ensure adequate technical and managerial personnel.

IV.2.2 Alternative arrangements to redress the 'disconnection'

Incentives can supplement market forces or substitute these where they do not exist. In principle, the private sector can be considered capable enough to select cost-effective energy savings options. However, market forces are imperfect because of various barriers (mentioned in the preceding paragraph) that inhibit the realization of energy savings even if these are technically and economically feasible. Thus, market forces may be supplemented by incentives, including tax credits, accelerated depreciation, soft loans, grants and even free installation of equipment. Usually such programmes should go with measures of other types such as awareness campaigns and improved access to information sources. Experience in the United States [1/] has shown that the institutional context in which incentives are offered is crucial (utility involvement in demand-side management, appropriate fiscal, trade and pricing policies, information campaigns) as well as involvement of the target group (use of delivery agents that are part of the energy-using community itself, whether it is composed of consumers, small firms or big firms), more than the actual financial terms of the programme (grant, loan, tax credit).

Demand-side management

Demand-side management (DSM) is the identification of cost-effective measures, which if initiated, would bring down the specific electricity consumption of the activity under consideration, for a given level of output. This of course means there is no loss of output (in factories) or comfort level (in buildings). This also includes shifting of consumption from periods when electricity is more expensive to periods when electricity is comparatively less expensive. This can be encouraged by introducing higher prices for peak periods, concessional prices for off-peak periods, seasonal tariffs, curtailable rates etc. Another measure is to make connection fees dependent on a building's or plant's energy use.

The final decision is with the customer who has to purchase, install and use the energy efficient equipment or appliances. The decision depends on whether such an appliance is available (locally made or imported) and at what cost. Here, the availability of finance can improve the adaptation of conservation measures. As long as electricity prices to the end user are higher than the marginal cost of supply, the utility can afford to give some incentive. One example of an alternative arrangement is as follows. The end user chooses equipment according to the total lifecycle cost and pays this cost in a front-end deposit or posts a bond to the utility, against which the utility would charge the capital cost of the equipment and the monthly electricity bill.

Loans or rebates from the utility to the purchaser of energy efficient equipment can lower the initial-cost barrier. One conceptual problem is that users that would have purchased efficient equipment anyway then effectively would get the loan free. This reduces the effectiveness of the programme by raising the cost per additional user involved.

Electric utilities in the United States and Europe also invested in efficiency measures in the industrial and commercial sectors. In the industry, these included motors, furnaces, material handling systems, and in commercial sectors they included lights and light fixtures and accessories, space-heating and cooling, as well as systems that use day lighting on an increasing scale.

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1 *Energy Policy* (September 1991), "The proof of the pudding, making energy efficiency work," John B. Robinson

Private sector participation

Utility regulations that inhibit or restrict the generation and sale of private power (e.g. cogeneration) and limit the role of the utility in implementing demand-side measures should be re-evaluated. Often, state-owned or controlled utilities refuse to purchase privately generated power at reasonable cost, or refuse it at all. Self-generated electricity is often heavily taxed if sold, while utility-generated power is subsidized, making it difficult for private power to compete. Means of rewarding both utilities and private entrepreneurs for energy saved and energy generated should be explored, and laws should be changed accordingly.

IV.2.3 Financial and economic incentives. Price policy

In many Asian countries energy consumption is implicitly subsidized. Prices for fuels (oil, coal and gas) and in particular for electricity are often set or influenced by the Government instead of by market forces, either by direct regulation or indirectly through taxation. This results in not transferring the full cost of energy use to the individual consumers, making energy consumption cheaper than energy conservation.

Energy pricing

In recent years there has been a trend to liberalize price regulation schemes, so that the funds necessary for investment in supply capacity expansion (or demand-side measures!) can be recovered. Ideally, energy prices should equal long-run marginal costs of energy supply. Especially, the international lending institutions are pushing the developed countries to ensure that prices reflect at least a sizeable portion of the marginal cost. Some countries like Malaysia, Indonesia, Sri Lanka and Thailand have revised prices substantially in the recent past. Prices are still below long-run marginal costs in most countries.

At present, world market prices for crude oil and petroleum products are at a low level. Hence, there are few incentives for energy end users to undertake the investments necessary to achieve energy efficiency. Environmental taxes (e.g. the 'carbon tax') on fossil fuels could encourage energy conservation, but raises the question on international competitiveness of the national production, if other countries do not introduce such taxes simultaneously.

Financial incentives and disincentives

The private sector relies on market mechanisms as far as possible. However, markets are imperfect and various barriers exist that inhibit the realization of technically and economically feasible energy savings options. Examples of such barriers are lack of information for both consumers and producers of energy efficient technologies, lack of access to capital, lack of competition in monopolistic markets, requirements for rapid payback, externalities, behavioural attitudes etc. Incentives (or disincentives) supplement market forces. However, in cases where efficiency targets could be achieved through market forces in a technical and economically viable way, incentives should not be introduced. The incentives should be tailor-made and preferably be introduced on a short-term basis. Further, incentives are not necessarily of a financial nature only (such as soft loans, tax holidays, tax exemptions) but can be awards and prizes, going together with promotional measures such as awareness campaigns and with improved acces to information.

Energy efficiency improvement ultimately requires the undertaking of investment projects. To facilitate such investment projects, the Governments can provide various fiscal and financial incentives. In India, the Government allows 100 percent depreciation and concessional excise/custom duty for notified energy conservation equipment. It also provides soft loans for installing energy conservation equipment through the financial institutions.

Taxes may hamper the incorporation of energy-efficient products in the consumer's purchase decision, as these are often based on sales price, rather than based on input power of the device. Similarly, high import tariffs and non-fiscal barriers may stop energy-efficient products and technologies from entering a domestic market.

Taxation may have very ambiguous impacts. If taxation policy is used to achieve environmental objectives, i.e., taxes are raised to discourage energy consumption, then, if these objectives would be achieved, the revenues from that tax would decline, thus conflicting with another objective of taxation policy, i.e. meeting the Government's revenue raising. On the other hand if consumption is NOT reduced, than the policy might be effective for revenue objectives, but not for the environmental objective. Consideration may be given to use a part of the consumption tax revenues to finance energy efficiency investment incentives. In short, a variety of tax incentives (tax credits, accelerated depreciation) and disincentives can be used to stimulate investment in energy efficiency if chosen carefully.

Electricity tariffs

Utilities, in search for money when Government subsidies are cut, are moving towards marginal cost in their energy pricing. However, there are several problems in moving immediately to a new level of tariffs. With the large unsaturated demand for electricity in the developing countries, changes in price levels are unlikely to have any significant impact on conservation. Nonetheless, price increases can give the utilities more revenues, which can be used to increase internal resource generation and to improve operating efficiencies.

Industrialized countries have pioneered innovative pricing mechanisms, such as time-dependent tariffs, to either increase the night time demand or to shift peak demand to off-peak demand. Many developing countries in the region are yet to consider innovative pricing option as a serious alternative of managing the peak demand problem. Even in countries such as Sri Lanka and Thailand, where time-of-use tariffs have been in force for some time, the reports regarding the success of these tariffs have not been very encouraging. There is an urgent need to consider innovative pricing plans to manage the demand efficiently.

IV.2.4 Institutional and infrastructural arrangements

Energy conservation and efficiency centres: policy coordination

Effective promotion of end use energy efficiency is only possible through institutionalization, i.e., the establishment of a national or regional coordinating body, which has sufficient authority to initiate and guide legislation (e.g. on minimum energy efficiency standards), to supervise regulatory bodies and/or to introduce incentive programmes.

Most of the countries of the ESCAP region have some high-level coordinating body to guide the national investments in the energy sector. In most countries that responsibility falls under the ministry involved (e.g. the Ministry of Energy or Industry). Other countries have set up autonomous "energy efficiency promotion bodies" or even full-fledged ministries, responsible for energy efficiency and conservation. Examples are given in table 4.2.

The objectives of these organizations generally are along the following lines:

- Promotion of inter-fuel substitution towards realizing overall efficiency gains;
- Promotion of an increase use of domestic resources including renewable energy sources;
- Promotion of efficiency in energy end use;
- Adaptations in energy pricing to encourage energy efficiency;
- Identification of selective fiscal instruments to promote energy conservation;
- Coordination of development and research in energy efficient technologies;
- Looking into the institutional issues, surrounding energy efficiency promotion;
- Coordination of major awareness programmes on energy conservation and efficiency;
- Regulation and legislation to promote energy efficiency, including standards, labelling and efficiency test programmes;
- To encourage the opening of the economy to provide for an increased role in energy efficiency.

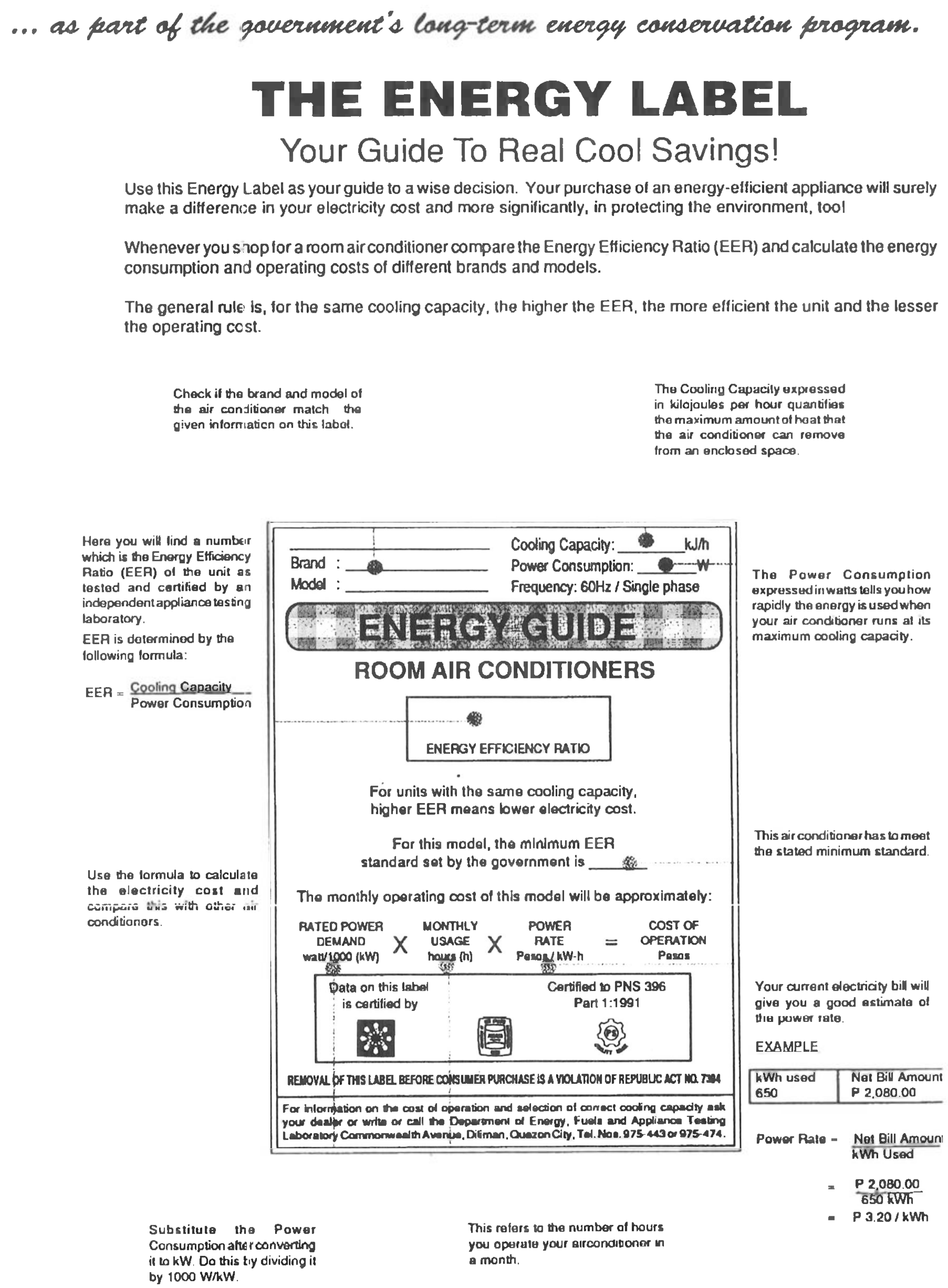
Table 4.2 **Energy conservation and efficiency centres in Asia**

Bangladesh	Energy Monitoring Unit
India	Energy Management Centre
Indonesia	KONEBA
Pakistan	National Energy Conservation Council
Philippines	Philippine Energy Conservation Center, Inc.
Republic of Korea	Korea Energy Management Center
Sri Lanka	Ministry of Energy Conservation
Thailand	Energy Conservation Center of Thailand

However, often the mandate of the coordinating bodies focuses on the expansion and improvement of the energy/electricity supply side, but at the same time, many of the parastatal organizations are prevented from being engaged in (semi)commercial energy efficiency promotion. Coordinating bodies and energy utilities should integrate demand-side planning with the supply side, in order to make investment decisions based on the lowest cost of providing energy services. Currently, utilities base their investment budgets on a comparison of the cost of different sources of generating capacity, coal, oil, gas, hydro etc. The supply option that has lowest cost is usually chosen. Integrated resource planning expands this planning system to include 'energy end use efficiency' as an alternative. If energy efficiency is the way to have the lowest cost of providing services, then utilities would invest in energy efficiency. However, the range of opportunities for energy efficiency equipment, end user preferences and operating conditions is often not well known in many developing countries. Data collection, for example, by detailed field studies and surveys, would help to guide policy makers.

Many Asian countries established energy conservation centres in the wake of the shockwaves triggered by the oil price hikes in the 1970s. However, with the fall of the international oil price in the 1980s, such institutions have found themselves in difficult positions to obtain the budget to finance their operations and services. In some countries, conservation centres have become dependent to a considerable extent on international contributions. To raise the necessary income, providing services for fees would

Figure 4.1 Example of a Philippine energy label for air-conditioners



strengthen and sustain their personnel, information and technology base. As is the case with education and health services, (partial) governmental support will be needed for their sustenance.

Energy standards and labels

The efficiency of equipment can be clearly listed by ENERGY LABELS. This provides purchasers with a very useful means of comparing alternatives. Examples of successful labelling programmes are from other areas, such as nutrition value labels for food products, 'green' labels for environmentally friendly products and labels for food products produced by small-scale producers in developing countries.

In the United States, household appliances are required, by federal law, to have energy consumption labels. This was preceded by a voluntary labelling programme. Air-conditioners were the first in the series of appliances to have energy consumption labels. Although information on the labels vary in different states, they generally contain information on:

- The energy consumed by the appliance over a given period;
- The energy cost for running the appliance for a given number of hours in a year;
- Information showing variation in cost and consumption for a range of end use habits.

Some Asian countries have also initiated programmes to label energy efficiency of major electrical products. For example, energy efficiency labelling was introduced for various electrical appliances in the Republic of Korea. Here it was found that three months after the introduction of green labels in competitive market conditions, manufacturers used the 'snob appeal' of these labels to sell efficient products. Figure 4.1 shows an example of an energy label that was recently introduced in the Philippines.

Measuring the efficiency of equipment needs to be done with standardized test procedures in recognized test centres, rather than relying only on (misleading) manufacturer information. A major problem often found in developing countries is that they start with existing standards of the developed countries, which may be too stringent in view of the conditions in a developing country, and thus difficult to enforce. A gradual policy is recommendable, setting some lower standards, followed by setting up higher standards and introduction of energy labels.

MANDATORY STANDARDS aim at producers to ban inefficient products that do not meet a 'minimum energy efficiency', while VOLUNTARY STANDARDS (usually set as an average efficiency level of all models) and energy labels aim at pushing a whole population of products towards efficiency through improved consumer information.

Devices suited to standardization include lamps, refrigerators, other household appliances and industrial equipment such as motors. Standardization supplements imperfect market conditions, for example, when few manufacturers dominate the market and when purchase cost tends to bias purchase decisions.

Standards can be supplemented by taxation. While a minimum energy efficiency standard sets the floor on the energy efficiency of an appliance, a graduated tax can then give an incentive to achieve higher energy efficiency. For developing countries, mandatory standards may be difficult to establish since there are only limited facilities for testing and means for enforcement. A step-wise introduction and tightening of standards may be a more recommendable approach.

Energy conservation and efficiency centres: research, development and dissemination

To gather a critical mass of highly skilled technical and managerial personnel, national or regional centres of excellence can play an important role in developing countries. Research and development (R&D) programmes might be established at such centres, possibly linked with sister research institutes in industrialized countries. Here, one should focus on technologies that can be developed in mass production. Also, a valuable activity for such centres could be to develop technology and software for 'measuring' energy savings and validate these under field conditions, as well as to develop and demonstrate computer design tools. Conventional design rules of equipment and industrial processes often lead to excessive oversizing of equipment. Centres of excellence may also play a role in setting up training programmes to ensure highly skilled technical and managerial personnel.

Currently, testing of energy-efficient appliances is non-existent in many developing countries. Independent institutions are needed, that develop standards and testing procedures and publish compilations of the energy performance of available equipment and appliances, as well as laboratories that certify the energy consumption of efficiency of the various products tested.

IV.2.5 The role of governmental and non-governmental organizations in energy conservation

The energy conservation effort is very decentralized in nature. Hence, large-scale gains in energy efficiency are not possible, unless the multitude of energy consumers adopt energy conservation in homes, offices and plants as their way of life. Because of its decentralized character, Governments can merely play a catalytic role to initiate the desired type of behaviour with the following measures:

(i) To undertake policy initiatives to bring about the rational use of energy in the economy;

(ii) To create the necessary institutional set-up and infrastructure for programme formulation, coordination and implementation;

(iii) To initiate actions to boost demand for adopting energy conservation practices and to strengthen the supply response. Examples are mass-media-based awareness campaigns, demonstration projects to promote technologies that are in the pre-commercialization stage, and subsidies for energy audit and feasibility studies;

(iv) To initiate actions to actually bring about adoption of energy conservation practices and/or installation/ retrofitting of energy conservation equipment, training programmes for energy managers/auditors, trainers and shop floor workers and provision of R&D grants for the development of energy efficient devices and equipment.

The contents of these measures will vary from country to country depending upon local conditions and environment.

In the transport sector the Government plays an essential role in providing an adequate infrastructure investment in roads to allow higher average speeds and transport of heavier loads. Here, full consideration should be given to investment in public transport systems (light train mass transit, railways, bus facilities and separate bus lanes) and in non-motorized transport modes, such as segragated bicycle paths, broad intersections and adequate space for pedestrians.

A long-term, but particularly effective, means of improving transport efficiency is land-use planning. This encompasses matching residential areas to jobs, schools, shopping and transport corridors, so that transport distances are minimized and the opportunities for using mass transit options are maximized. A phased policy approach could start with traffic management measures, such as constructing dedicated busways, high-occupancy vehicle lanes, automatised traffic light systems, followed by the construction of light-rail systems. Another policy measure would be full cost pricing of automobile use. This means that, apart from the usual fuel costs and vehicle taxes, the full cost of car use should be borne by the user, including costs of road infrastructure (through road pricing), of economic losses caused by congestion (through area licensing and other congestion control measures), of parking space (full parking fee) or even of the medical and economic cost associated with death or injury due to car accidents and due to pollution costs. On the longer term, effective traffic control measures should ultimately culminate in a comprehensive urban transport system, combined with appropriate land-use planning.

IV.3 Implementation of energy efficiency promotion measures: experiences from the ESCAP region [2]

IV.3.1 Bangladesh

Energy management and conservation in Bangladesh were initiated through the Bangladesh Energy Efficiency Project in 1984. The Energy Monitoring Unit (EMU) was established to develop, initiate and implement a national industrial energy management, conservation and diversification programme. The work of EMU is guided by the Energy Monitoring & Conservation Centre (EMCC) under the Ministry of Energy and Mineral Resources.

Foreign consultants have been retained by EMCC to develop and supplement the in-house expertise of EMU in developing the national programme and policy. The following energy conservation and efficiency activities have been undertaken:

- Energy audits of 47 large and medium-sized industrial consumers;

Box 4.1 Aspects of the Bangladesh draft energy conservation act

- Set energy standards for different equipment and machinery
- Enforce compulsary reporting of energy utilisation by certain category of consumers
- Impose penalties for violations of set rules
- Allocate responsibilities for enacting rules
- Set operating conditions of air-conditioning, decorative lighting, etc.
- Conduct regular energy audits in industries and power plants
- Ensure labelling of equipments & machinery both imported or locally manufactured, stating energy use informations

SOURCE: *Worldwide Energy Conservation Handbook*, The Energy Conservation Center, (March 1993, Japan)

2 See also annex B, "Status of energy conservation & efficiency policies in selected Asian counties," and annex C, "Review of issues and options in the transportation sector of selected Asian countries"

- Examination of the various institutional, legal, financial and educational issues that could be acting as barriers to the achievement of national energy efficiency goals;
- Preparation of a National Energy Management and Conservation Programme based on national level savings potential, resource availability and training requirements.

The energy efficiency improvement measures identified by the EMU energy audits were classified into three broad categories: housekeeping/"quick fix" measures, combustion control/retrofit measures and industry-specific improvements. The total saving potential has been identified as about 19 petajoule annually. There is a 15-20 percent conservation potential in the industrial sector, [3/] 25 percent in the transport sector, 30 percent in domestic kerosene consumption and 40 percent in fuelwood consumption.

There is no restriction on the private sector to generate power for its own use. At present, the generation and sale of electricity is restricted to public utilities, BPDP, DESA and REB. It has been proposed, in view of possible power shortages, to liberalize the rules regarding private generation.

Box 4.2 China: energy conservation measures and policies

During the 1980s the Government of China has adopted the following concrete energy conservation measures:

- The establishment of energy conservation departments at various levels of government and in many large- and medium-sized enterprises.
- The publication by the State Council on instructions how to save electricity, coal and oil.
- The surveying of energy consumption in China's major industries.
- The enactment of the "Provisional Regulation for Energy Conservation Management" by the State Economic Council in 1986.
- The popularization of technologies and programmes aimed at saving energy and water in the industrial sector.
- The adoption of incentive programmes which reward energy conservation and punish waste.
- The establishment of special funds and loans for energy conservation and technical renovation.
- The gradual adjustment of energy prices.
- The development of a set of technical criteria for project design targeted at increasing energy conservation.
- The dissemination of catalogues containing information about more efficient mechanical and electrical products.
- The enhancement of energy standardization and monitoring.
- The formulation of a draft law of energy conservation.

Some successes can be attributed to these measures. Energy intensity declined by 5.6 percent per year between 1980 and 1988. Because of this decline, China saved the equivalent of 175 Mtoe of energy over the entire period, or 22 Mtoe per year. A recent estimate has revealed that half of these changes resulted from changes in China's economic structure, 40 percent from the enhancement of energy management and technical renovation and 10 percent from importing energy-intensive products as opposed to producing them domestically.

SOURCE: *Energy Policy*, December 1991, "Policies to promote energy conservation in China", Wu Zongxin, Wei Zhihong. *Energy of China*, No. 5, October 1990, "Summary of the 5th official meeting of the energy conservation of the State Council", Ye Qing.

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[3] *Rural Energy Systems in the Asia-Pacific, A Survey of their Status, Planning and Management*, K.V. Ramani, M.N. Islam, A.K.N. Reddy (eds.); Asia and Pacific Development Centre and Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH (1993, Kuala Lumpur, Malaysia).

IV.3.2 China

Energy conservation is a high-priority strategy of the Government to meet the gap between demand and indigenous supply of energy. The focal body for planning and coordinating energy conservation in China is the Working Conference for Energy Conservation (WCEC) under the State Council. WCEC consists of representatives of the State Planning Commission, Ministry of Energy, other sectoral ministeries and provincial governments. The main function of WCEC is to identify the opportunities for energy conservation in energy supply and demand, to formulate the national energy conservation programme and to coordinate implementation aspects.

The Ministry of Energy holds multimedia public awareness campaigns and organizes the councils and offices responsible for promoting, supervising and inspecting the achievement of energy conservation targets by the provincial, municipal and autonomous regions. The Government has set an example by reviewing the specific energy consumption of products and processes and has set target consumption figures for performance improvement. The Government also encourages the adoption of advanced technologies in cogeneration, air-conditioning and refrigeration, boilers, fans, pumps, lighting, transformers and other energy consuming devices by providing necessary funding and technical support.

Enterprises consuming 10,000 tce [4/] annually (or more) are required to appoint an energy manager to implement energy conservation measures. Energy conservation designing regulations have been introduced for 27 processes, including iron and steel smelting, synthetic ammonia and caustic soda production.

The energy sector in China is subsidized and energy prices are low. Because of low energy prices, the energy sector lacks attraction for investors, the energy enterprises have insufficient funds and wasteful use of energy is on the increase. Coal prices, for example, are lower than the production cost, resulting in a loss for the coal industry of about 3.7 billion yuan in 1988. The result of lower energy prices is that factory managers do not view the cost of the energy inputs as high and conservation as an urgent issue. China plans to adjust and rationalize energy prices. First, by gradually raising the regulated prices of coal and other fossil fuels. Second, a two-tier price system is envisaged. Prices of scheduled products that follow government-set prices and prices of unscheduled products that may fluctuate within a range.

Another constraint in China is the physical vastness of the energy conservation programme and the limited foreign exchange accessible to purchase needed energy efficient equipment and technologies.

IV.3.3 India

Energy conservation efforts started in India as early as 1961 with conservation of coal and were accorded more priority after the first oil crisis of the 1970s. A number of national and state level organizations were involved in promoting energy conservation and efficiency in various sectors of the economy. However, due to lack of coordination, the efforts of these organizations remained fragmented and marginal. The Energy Management Centre (EMC) was set up in 1989 under the Ministry of Power in collaboration with the Commission of the European Communities. Its main functions are training, research and information dissemination.

4/ tonne of coal equivalent

The planning process in the country is coordinated by the National Planning Commission between the union and the state governments. Also energy planning is coordinated by the Planning Commission, which has a Member for Energy and Power. Since 1951, India has planned its development through Five-year Plans. A review of energy conservation activities at the end of 7th Five-year Plan has identified the barriers to energy conservation. Activities that have been initiated to remove the constraints are summarized below:

- To develop a national energy use database by collecting and analysing data on energy supply, demand and prices and setting up an information centre for the dissemination of rational use of energy techniques. Such a step would provide the necessary information for planning energy management activities;

Box 4.3 Some energy conservation measures taken in India

Railways:	Maintenance of locomotives. Regular energy audits. Design modifications. Strengthening of institutional arrangements, regular training programmes. Computerized monitoring of locomotives.
Road transport	A series of measures, including operation control, training for upgrading driver's skills and proper use of cluthches, reduction of body weight.
Small-scale industries	Energy saving awareness among enterpreneurs, provided by SIDO (Small Industries Development Organization).
Agricultural pumps	Efforts to popularize monoblock pumpsets and to rectify existing pumpsets.
Air-conditioning	PU foam insulation (taken up by manufacturers).
Lighting industry	Promotion of fluorescent and sodium vapour lamps.
Standards	Establishment of a cell for energy conservation in the Bureau of Indian Standards. Selected mandatory certification of efficiency parameters.
Incentives	Provision of subsidy for conducting Energy Audit and Feasibility Studies. Soft loan schemes for replacement of inefficient oil-fired boilers. Accelerated depreciation (or tax exemption) on investments in energy conservation technologies.
Research, development & dissemination	Demonstration projects to promote energy conservation equipments/technologies that are in the pre-commercialization stage. Model depot scheme for the state road transport undertakings. R & D grants for development of energy efficient devices and equipment.
Awareness	Promotion work related to energy conservation by launching mass-media based awareness campaigns, production of video films, bringing out case studies, product/consultant directories, instituting "Award Schemes", etc.
Training	Training programmes in the area of energy conservation for energy managers and auditors, supervisors and managers, trainers, shop floor workers, and agriculture pump auditors.

SOURCE: *UNEP Industry and Environment* (April-June 1990), "Energy efficiency and conservation in India", Rajendra K. Pachauri, TERI.

- Other constraints include lack of awareness on energy conservation techniques. These are being addressed in international and national programmes such as the Senior Management Commitment Programme, Training of the Trainers, Programme for Building Energy Audit Services and the recently concluded international programmes with the United Nations Development Programme and assistance from the European Union for strengthening energy audit capabilities in the country.

Energy conservation efforts in the country have been focussing primarily on industry through improving end use equipment and through the substitution of conventional energy sources by renewable sources. Several incentives are offered, as described in box 4.4.

Box 4.4 Incentives to promote energy efficiency in India

Fiscal incentives

The following fiscal incentives are offered:

- 75 percent depreciation allowance on the written-down value of energy-saving devices;
- 30 percent depreciation allowance on the written-down value of renewable energy devices used;
- central excise duty exemption for the manufacture of energy efficiency and conservataion-related equipment;
- 20 percent exemption in the central excise duty for fuel-efficient wheeled vehicles up to 1000 cc engine capacity;
- full exemption of customs duty for solar and wind energy equipment:
- concession of up to 50 percent on customs duty for components and raw materials for the manufacture of fuel-efficient motor cars up to 1000 cc engine capacity.

Financial assistance

Subsidies of up to 80 percent are available from the central Government for the installation of renewable energy devices, as well as certain subsidies from state governments.

Development banks and financing institutions provide low-interest concessional loans for projects featuring the manufacturing and installation of renewable energy sources or saving in energy consumption.

The Industrial Development Bank of India has two major schemes. The Energy Audit Study Scheme provides a subsidy of up to 50 percent on the cost of audit studies by energy consultants, up to a maximum of Rs 100,000 (equivalent to US$ 3,873). Under the Finance for Energy Conservation Scheme, assistance is provided in the form of loans up to Rs 40 million (US$ 1.55 million), at a 14 percent interest rate (subject to a limit of 50 percent in the gross fixed assets of the industry).

The Energy Banking Scheme encourages private companies to set up their own renewable energy farms and bank power to the state utilities, while in times of shortages power banked with the utilities can be withdrawn. For projects under this scheme interest rates of 5.5 to 8.5 percent are offered.

SOURCE: *Rural Energy Systems in the Asia-Pacific, A Survey of their Status, Planning and Management,* K.V. Ramani, M.N. Islam, A.K.N. Reddy (eds.); Asia and Pacific Development Centre and Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH. Kuala Lumpur, Malaysia, 1993.

IV.3.4 Indonesia

Energy planning in Indonesia is undertaken in the framework of five-year national development plans *(REPELITA)*. Following the approval of the REPELITA the incorporated energy plan is translated into specific programmes and projects, which are implemented by the ministerial departments and state energy enterprises involved.

A ministerial level coordinating body on energy (BAKOREN [5]) had been set up for the formulation of overall energy policy including energy conservation policy. It is chaired by the Minister of Mines and Energy (MOME). Within this arrangement the Director General of Electric Power and New Energy (DGENE) of MOME is responsible for implementation of energy conservation programmes.

The low price of energy, the reluctance by plant managers and lack of information on appliances in the household sector have been identified as barriers for exploiting energy saving potential. In Indonesia, households and commercial establishments in practice subsidized the industries and the socially underprivileged consumers. While the commercial consumers were bearing the largest portion of cross subsidy, the household sector also extended a substantial subsidy to the industrial sector. Recently, steps were taken to reduce the subsidy to the industries and to remove it altogether in the near future [6]. The combination of low electricity and constrained incomes leads to a tendency to buy appliances with the lowest purchase cost. Even if consumers are interested in buying energy-efficient equipment, the lack of good and reliable information makes it difficult for them to evaluate costs and benefits. Problems in plant operation, related to the use of vantage technology, poor maintenance and lack of spare parts also leads to inefficient use of energy.

With the assistance of the World Bank, the Government established in 1987 an autonomous energy conservation consulting company (KONEBA). [7] This ESCO provides technical and consulting services on various aspects of energy conservation, such as training and information dissemination, energy audits and implementation of energy conservation, mainly to large industrial establishments (fertilizer, textiles, petrochemicals, tea and glass industries).

The programme implemented by the Government includes:

- Awareness campaigns through the mass media, such as the national radio (RRI), television (TVRI), newspapers, billboards and posters;

- Energy audits and surveys. One finding of a survey on 38 plants (metal, cement, fertilizer, sugar, glass, chemical, pulp and paper etc.) showed average savings of about 11 percent on oil, possible with just better housekeeping measures, requiring no or small investments only. [8] Surveys in office and commercial buildings have resulted in the publication of guidelines for energy conservation in buildings by the Department of Public Works. A survey carried out in 1991 estimated that, if 38 percent of the incandescent lamps in the urban areas of Java were replaced by fluorescent bulbs, a saving of about 111 GWh of urban household electricity consumption for lighting could be achieved; [9]

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5 *Badan Koordinasi Energi Nasional*, National Energy Coordinating Board.

6 By 1992 the average tariff for industrial consumers had been increased with 35 percent over the 1990 tariff to nearly the same as the average tariff for residential consumers.

7 *Konservasi Energi Abadi*, Energy Conservation Corporation.

8 *Current Energy Conservation Status*, prepared by Irzal N. Hatab, Ministry of Mines and Energy, Indonesia for the "International Energy Conservation Symposium" (30-31 October 1988, Islamabad, Pakistan).

9 *Rural Energy Systems in the Asia-Pacific, A Survey of their Status, Planning and Management*. K.V. Ramani, M.N. Islam, A.K.N. Reddy (eds.). Deutsche Gesellschafft für Techmische Zusammenarbeit, Asia and Pacific Development Centre (1993, Kuala Lumpur, Malaysia).

- Implementation of rules and regulations in support of energy conservation policy , which is effected through Presidential Decrees (KEPPRES). For example, all government buildings have to report their energy use. Other regulations would target the industrial sector. In 1990 a national committee on energy conservation was formed to formulate laws, regulations and guidelines and to implement campaigns;

- Demonstration projects, e.g., in the area of energy saving stoves and wood stoves. A number of efficient stoves have been developed, e.g. the SAE and Lorena stoves. Their dissemination will be implemented with participation of non-governmental organizations and islamic eduaction centres *(Pesantren)*.

Other incentives could include voluntary agreements with manufacturers or mandatory standards. The approach requiring the least degree of intervention in the market, involves providing better information, through labelling of selected appliances. Such programmes would require some kind of testing programme.

Box 4.5 Energy efficiency policy and promotion institutions in the Republic of Korea

INSTITUTION:	ENERGY CONSERVATION PLANNING AND POLICY:

Energy Policy Office of the Ministry of Energy and Resources.
- Energy Conservation Policy Division
- Energy Conservation Management Division
	- Reinforcement of the existing sectoral energy conservation programmes
	  - management of energy-intensive buildings/industries
	  - funding and incentives to accelerate energy investment
	  - education, training and publicity activities
	- Fundamental programmes to minimize energy demand
	  - industrial restructuring
	  - establishment of energy-efficient traffic system
	  - recycling and conservation of materials and resources
	  - promotion of research, development and dissemination programmes for energy efficiency technologies
	- Energy pricing
	- Dissemination of energy-efficient appliances and equipment
	  - introduction of minimum efficiency standards
	  - introduction of efficiency rating and labelling

KEMCO (The Korea Energy Management Corporation)	- Propulsion of energy rationalization projects - Diagnosis on energy management - Research, development and distribution of energy conservation technology - Surveys and studies on energy management - Publicity and education - Promotion of district heating
KEEI (The Korea Energy Economics Institute)	- Economic research, analysis, forecasting and policy development for long and short-term demand/supply, pricing and investment in energy resources - Analysis of energy markets - Contract research, consulting and training for industries - Operation of energy census and energy databank - Promotion of international cooperation

SOURCE: *Worldwide Energy Conservation Handbook*, The Energy Conservation Center of Japan (March 1993, Tokio, Japan)

The principle body for electricity generation and supply in the country is PLN. Apart from this state enterprise, licences to supply electric power for public or own use can be given to cooperatives and private enterprises. If sold to PLN, prices are set by MOME. If sold to entities other than PLN, the price could be set by the producer and the buyer, but would be subject to MOME approval.

IV.3.5 Republic of Korea

Energy conservation has been accorded one of the highest priority areas as reflected in the national economic policy of the Government. The second oil crisis of the late seventies prompted the Republic of Korea to engage in more intensified energy conservation programmes consisting of several activities. These included technical assistance (i.e. energy audits in the industrial, commercial, and transport sectors), demonstration projects, information services on energy management technology, financial assistance (loans for the installation of energy saving equipment, subsidies for research and development), public information and awareness campaigns as well as technical training and seminars.

To strengthen this energy programme, two significant laws have been enacted, the *Rationalization of Energy Utilization Act (Law No. 3181,* 28 December 1979), prescribing the safe operation and effective use of heat equipment and materials to prevent possible hazards, and the *New and Renewable Energy Development Promotion and Development Act* (4 December 1987), aiming at facilitating research and development activities to encourage the use of new and renewable sources of energy on a long-term basis.

Despite advanced arrangements and efforts in energy conservation, the country faced increased consumption of energy because of the industrial structure changing towards highly energy intensive industries. To cope with this problem the revised energy conservation strategy emphasises the following:

- Closed supervision on the reorganisation of the country's industrial structure towards a less energy-intensive one through implementation of a pre-audit/approval system;

- Expansion of energy-related research, development and dissemination to attain further gains in energy conservation, and to develop new and renewable sources of energy.

IV.3.6 Malaysia

Energy conservation is considered vital and is a primary objective of Malaysia's national energy policy. The Ministry of Energy, Telecommunications and Posts is the principal agency responsible for carrying out the energy conservation policies. Under the Ministry, a Working Committee on Energy Conservation has been formed. Malaysia's national energy conservation programme included campaigns for efficient use of energy, energy conservation training and information dissemination seminars for engineers and technical executives, energy audit services for factories, recognition awards for deserving energy conservation performances, and plans for establishment of an energy conservation centre.

Funding for energy conservation projects is primarily sought from oil companies, electric supply companies/authorities and other government agencies. The Standards and Industrial Research Institute of Malaysia (SIRIM) plans to establish an energy-labelling unit with the aim of introducing appropriate regulations and standards on energy equipment. To promote energy efficiency in cars, various taxes (road, sales and gasoline taxes), tolls (new expressways) and fees (parking) have been introduced. The

Box 4.6 Summary of major energy conservation programmes in the Republic of Korea

Mandatory labelling programmes for fuel efficiency improvements in cars	- Labelling for domestic and imported cars - Taxes on purchase and annual road taxes based on engine size
Energy conservation during vehicle operation	- Mandatory curbs on car use for public service personnel - Voluntary curbs on car use in private sector - Publication of booklet "Guide to Fuel Economy and Fuel-Saving driving"
Public relations (PR)	- Establishment of PR programmes - Mass media campaigns - Exhibitions, seminars and conferences - Development of texts for primary and secondary schools
Reduction in electricity peak demand	- Improvements in tariff structure - Mandatory installation of ice storage systems in new or reconstructed buildings - Financial support for manufacturers - Tax reduction for building owners
High-efficiency appliances	- Implementation of energy labelling for refrigerators, vehicles, lighting and air-conditioners - Expansion of distribution of fluorescent lamps
Energy Impact Assessment (EIA)	- Institutionalization of EIA for large public work projects - Energy audits for high-energy consumption buildings
Financial support for research and development on energy-saving technologies (ESTs)	- Subsidies for industries in ESTs - Establishment of a "Supporting Center for Energy-Resource Technology Development" - Completion of survey on market demand and selection of 100 ESTs
Conservation plan for energy-intensive industries	- 5-year plan for energy-intensive industries, covering investment and saved energy estimates and efficiency improvement targets - Free diagnostic analysis for 500 companies - Special plan to improve the efficiency of boilers and electric motors
Training and technical information supply	- Intensive management by appointed specialists for 250 small- and medium-sized companies
Energy pricing	- Maintenance of a low price for residential LPG - Study on the implementation of a flexible oil pricing system

SOURCE: *Demand-Side Management: Opportunities and Perspectives in the Asia-Pacific Region, Conference Proceedings*, International Energy Agency, Organization for Economic Cooperation and Development (Seoul, Republic of Korea, 4-5 November 1993). Prepared by Korea Energy Economic Institute and Ministry of Trade, Industry and Energy.

Government has promoted projects to build low-capacity national cars (e.g. the *Proton)* to persuade people away from imported big cars.

Constraints being faced by Malaysia's national energy conservation programme in attaining its goals and targets, include lack of awareness and knowledge of opportunities and technologies, limited availability of experienced professional staff, lack of finance and low returns on investments in conservation projects. Self-generation of electricity is allowed, but selling it directly to consumers would require a licence, which usually was not given, although possible under the *Electricity Supply Act* of 1990. The situation might change, as the Government maintains its interest in decentralised energy systems and private sector participation.

IV.3.7 Pakistan

The Energy Wing of the Planning and Development Ministry is responsible for plans for the energy sector. Implementation responsibility lies with the ministries involved (fossil fuels: Ministry of Petroleum and Natural Resources, electricity: Ministry of Water and Power), the power utilities and the Pakistan Atomic Energy Commission). In 1986 the *National Energy Conservation Council* (ENERCON) was established to plan and coordinate energy conservation activities at the national level.

ENERCON has worked in all the subsectors of the economy. Besides receiving support from USAID, it has been negotiating with other donor agencies to receive support for expanding its activities. ENERCON has very successfully launched a number of activities, such as awareness campaigns, energy audits, targeted retrofit services, demonstration projects, training and information dissemination.

Specific measures envisaged for energy conservation include:

- Technical services for industry, comprising boiler/furnace tune-up, steam system survey and electric survey;
- Demonstration projects to illustrate savings attainable by the use of combustion control technology, waste heat recovery systems, energy accounting systems, etc.;
- Retrofitting existing buildings;
- Improving the design of new buildings (National Energy Conservation Building Code);
- Retrofitting of pumping systems in agriculture;
- Efficiency improvements of tractors through improved information to farmers;
- Automobile engine tune-ups;
- Use of liquified natural gas as a motor fuel;
- Appropriate tariff and non-tariff measures, leading to reduced peak and overall power demand.

Regional cooperation has been proposed by Pakistan to promote energy conservation. It has also offered its services to other countries to assist them in developing their national energy conservation capabilities.

As in most countries of the region, Pakistan faces constraints in pursuing energy conservation such as lack of funds, higher taxes on efficient equipment and lack of ample incentives.

IV.3.8 Philippines

The Department of Energy (DoE) provides the central coordinating body for the implementation of energy policies and programmes. DoE was created in 1992, as it was recognized that the dismantling of the Ministry of Energy (MoE) under the previous administration was one of the factors contributing to the power shortage crisis that plagued the country. The DoE has four operating bureaus, of which the Energy Utilization and Management Bureau is one. In fulfilment of its mandate to ensure efficient use of energy, the Department of Energy has embarked on a comprehensive energy management programme.

In the domestic sector, campaigns have been launched to create greater awareness on energy conservation. The information dissemination programme also includes posters, stickers and publications. [10/] Various seminars and training programmes of energy efficiency and conservation have also been conducted to facilitate technology transfer. [11/]

Extensive energy audits and boiler efficiency tests are conducted in the industrial and commercial sectors. Consultancy and energy audit services have been extended to about 700 manufacturing firms. [12/]

The Fuels and Appliance Testing Laboratory was established in 1987 to develop and set up an energy labelling programme. Testing standards for refrigerators/freezers and air-conditioners were completed, and minimum energy standard and labelling programme for air-conditioners is now being implemented with the Bureau of Product Standards (see figure 4.1).

A significant accomplishment of the programme was the implementation of 18 demonstration projects on different energy conservation technologies, such as combustion control, waste heat recovery, cogeneration and waste fuel utilization, through a soft-loan scheme provided by the USAID-funded technology transfer for energy management project.

Other foreign-assisted projects include the Philippine-German rational use of energy project, the UNDP industrial management consultancy and training project and the ASEAN-Australian project on building energy modelling and energy conservation in industrial equipment and processes. These have provided assistance to the private sector through energy audits, software development, the provision of equipment and mobilization of energy management advisory units, the establishment of an energy management information system and the establishment of the Fuel and Appliance Testing Laboratory.

The ultimate vision of the Government of the energy sector is free-market oriented and private-sector dominated. Fiscal incentives are available for firms engaged in the installation of power-generating facilities for new or expanding manufacturing plants. Private corporations and cooperatives are allowed to construct and operate electricity-generating plants. Some even favour the privatization of the NPC, the National Power Corporation.

To provide the impetus for greater end use efficiency, a programme for the restructuring of power tariffs to approximate long-run marginal cost shall be undertaken coupled with extensive DSM programmes.

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10 For example: *Industrial Energy Audit Manual*, *Energy Conservation Booklet Series* and energy conservation manuals. The DOE maintains the Energy Management Consultancy Library, containing publications, journals, reports and audiovisuals.

11 For example, DOE conducts the Basic Energy Management Training Course. The *Energy Management Association of the Philippines* (ENMAP) and the *Philippine Energy Conservation Center, Inc. (PECCI)* conduct periodic seminars on energy conservation and energy-and-environment issues.

12 *Philippine Energy Plan, 1993-2000*, Department of Energy (1992, Manila, The Philippines).

IV.3.9 Sri Lanka

The Ministry of Power and Energy (MPE) is an umbrella ministry that is responsible for the supply of commercial energy sources. The main commercial energy supply utilities, such as CEB, Ceylon Electricity Board, function under this Ministry. New impetus to energy management and conservation was lent in 1990 with the creation of the Ministry of Energy Conservation under MPE.

Box 4.7 Sri Lanka: responsibilities of the Ministry for energy conservation

a) To ensure the efficient and effective planning, development, utilization and management of energy resources;

b) To identify, analyse, develop and coordinate energy policies concerning conservation, demand-side management and interfuel substitution;

c) To provide and/or promote an effective institutional infrastructure to realize national energy conservation strategies;

d) To develop, manage and administer the National Energy Conservation Fund;

e) To ensure the effective participation and integration with Ministry of Power and Energy and other relevant organizations in activities on energy conservation, demand-side management and interfuel substitution;

f) To promote research, development and dissemination of renewable and energy conservation technologies;

g) To collect necessary data and disseminate information;

h) To ensure the development and flow of the necessary resources (human, financial, etc.) to realize goals and objectives of energy conservation.

This project ministry has undertaken various activities, supported by both governmental and non-governmental organizations:

- Establishment of an energy conservation advisory services for all sectors, domestic, commercial and industrial;

- Implementation of awareness programmes in all sectors. They now have to be institutionalized, as the facilities available have been inadequate. Human resources have to be trained and suitable equipment and instruments need to be procured;

- Implementation of a programme for improved wood stoves for fuel-wood conservation. Since 70 per cent of Sri Lanka's required energy is obtained from fuelwood, the programme is of high priority. However, after five years the programme has reached only 12 per cent of the target group;

- Modernization of production processes in traditional industries in Sri Lanka, such as tea - processing, brick kilns, the coconut oil and coconut industry, tile factories etc., that, in general, still use outdated technology.

* Training of trainers in energy conservation.

A National Energy Conservation Act is in preparation, aiming at the promotion, coordination and monitoring of energy conservation and efficiency.

IV.3.10 Thailand

The Thai Government started implementing the Sixth Five-year National Economic and Social Development Plan in 1986. The plan consisted *inter alia* of policies and strategies for sustainable economic growth and financial stability. Energy policies were geared towards the reduction of energy imports, the diversification of energy supplies, the promotion of energy conservation and the encouraging of private sector participation. Guided by these policies, the Government has set reasonable targets for energy consumption growth, the import of energy supplies and the generation of electricity.

The agency responsible for setting the energy policy is the National Energy Policy Committee (NEPC), a cabinet-level committee, and its operating arm, National Energy Policy Office (NEPO). Responsible for implementation are the three electric utilities (EGAT, MEA and PEA), the Ministry of Science, Technology and Energy and the Petroleum Authority of Thailand. The lead agency for energy conservation and efficiency is the Department of Energy Development and Promotion (DEDP) of the Ministry of Science,Technology and Energy. Through the DEDP, The Energy Conservation Center of Thailand (ECCT) has been set up to provide services directly to almost all sectors of the economy. The Center offers engineering consultancy services and conducts awareness campaigns. [13/]

The tripling of EGAT's generating capacity (from 10,000 to 30,000 MW in 1991-2006) will be Thailand's largest infrastructure project and is already straining the utility's capabilities. Therefore, in 1991 Thailand became the first country in the region to adopt a comprehensive demand-side management plan. EGAT established a Demand Side Management Office (DSMO) in 1993. Some months before, in 1992, the Thai legislature had passed an Energy Conservation Law. To implement investments in energy efficiency and renewable energy the Energy Conservation Promotion Fund was established, providing grants and low-interest loans. [14/]

EGAT's DSM office promotes the use of efficient lighting (energy-efficient straight-tube fluorescent lamps and CFL lamps, low-loss magnetic ballasts). Agreements have made with manufacturers to switch to these models. In existing and new buildings up to respectively 30 and 50 percent can be saved by efficiency measures, by improvements such as overhangs, improved window glazing, efficient lighting systems, variable speed drives for fans and pumps, and high-efficiency chillers.

The industrial sector accounts for half of Thailand's demand for electricity, of which three-quarters is consumed by motors. Currently, more energy-efficient models, available in industrialized countries, are not manufactured in Thailand. The DSMO seeks to promote the use of energy-efficient models, which can save 2 to 14 percent, and variable speed drives (VSD), which can save between 15 and 50 percent of the motor power use and can be used in 40 percent of the applications.

The residential sector accounts for 25 percent of Thailand's energy use. DSM activities will be two-pronged: improvements in appliance efficiency and residential rebate programmes. The DEDP is

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13 Much information in this paragraph is based on *Thailand's Energy Efficiency Industry: Potential for Investment*, International Institute for Energy Conservation (Bangkok, Washington DC).

14 The initial allocation was US$ 60 million with annual capital inflows expected of US$ 60-80 million.

Box 4.8 Components of Thailand's Energy Conservation Promotion Act (1992)

ENERGY CONSERVATION IN PLANTS

Factories that fall under the law are defined as those having a transformer of more than 1000 kVA or an annual energy use exceeding 35 million Btu. Owners must conduct energy audits, appoint a full-time certified energy manager, keep records on energy use and submit those to the Government and submit an energy rationalization plan for review and approval. Non-compliance will be met with penalties (e.g. by increasing the tariff). Owners are given three years time to meet requirements.

ENERGY CONSERVATION IN LARGE BUILDINGS

Owners of controlled buildings must appoint energy managers, conduct audits and keep record of energy use, and submit an energy plan for review and approval. Three years are given to owners to meet efficiency requirements. A model energy code for new commercial and institutional buildings has been prepared by the Government.

STANDARDS FOR APPLIANCES, EQUIPMENT AND MATERIALS

The Government will issue regulations concerning the minimum efficiency of equipment appliances, building materials and control systems.

ENERGY CONSERVATION PROMOTION FUND

Low-interest loans and grants are provided for energy efficiency and renewable energy projects, as well as for research and development, demonstration, promotion and education. Funds come from the Government, the private sector, foreign governments and international organizations. Funds may be granted to individuals, businesses (for example to the owners of the large plants and buildings, mentioned before), non-governmental organizations and government agencies. A levy of 0.10 Baht per litre of petroleum products also adds to the Fund.

SOURCE: *Thailand's Energy Efficiency Industry: Potential for Investment*, International Institute for Energy Conservation (IIEC), Bangkok, Washington DC.

empowered by law to issue energy efficiency standards for domestic appliances. The initial focus will be on improving refrigerator and air-conditioning efficiency. Incentives will be given to manufacturers and consumers to spur production and sale of more efficient models. The DSM office is planning to establish a load control project. By spot metering in buildings in Bangkok and by audits the potential for load management will be assessed.

Technical publications in the form of booklets, pamphlets, posters and newsletters on energy conservation have been distributed to factories, building owners and other concerned organizations. Video presentation and television broadcasts on energy conservation have been conducted. Research and development activities have been conducted on high efficiency lighting equipment, freezers, electronic thermostat controls and ballasts. Several training courses and seminars on fuel and electricity savings have been conducted, with participants from industrial enterprises, building corporations and governmental organizations.

IV.4 Implementation of measures in the transportation sector: experiences from Asian countries

This paragraph focuses on levels of congestion and air quality and congestion management with two cities in the Asian and Pacific region as examples, Bangkok and Singapore [15/]. The example of Bangkok is illustrative for the general approach in the area: building more freeways, launch megaprojects. The example of Singapore shows the rare example in the region of reducing automobile use in heavily congested corridors. A summary of measures taken in various cities is given in annex C.

Bangkok has 15 percent of Thailand's population and 50 percent of that nation's vehicle population. This vehicle population is estimated to growth with 15 percent per year. In 1990 2.8 million motor vehicles were on Bangkok's roads, of which 1.2 million cars.

Already, many of Bangkok's roads are congested and their surroundings polluted. In the central business district traffic flows at an average 6-10 km/hr during peak hours (with a worse crawl rate of 1-2 km/hr). Air quality is another concern. Carbon monoxide and suspended particle levels are very high, exceeding by far WHO standards. It is estimated that an 8-hour exposure to street level air is equivalent to smoking 9 cigarettes per day. Most exposed people are police officers, tuk-tuk drivers and street vendors.

To counter the problem the main strategy of the Thai authorities seems to be building major new highways. [16/] A start has been made with the construction of light railway systems, however, it may take 5 to 15 years for these systems to become fully operational. Exclusive bus lanes have been introduced, but are not enforced regularly. Other measures even counteract vehicle congestion management measures. In 1991, for example, duties and taxes on cars went down from 300 percent to 112 percent and on motorcycles from 180 to 60 percent. As household incomes will increase, the desire for cars will increase as well. Car population is expected to increase to 2.0 million in 2000 and the total number of motorized trips from 7.0 million to 11.3 million. Air pollution and congestion problems will worsen correspondingly.

Singapore offers some interesting possibilities for trying to limit urban traffic problems. The basic idea is that car users have to pay nearly the total cost of car use, which means that no subsidies, direct or indirect, are given, leading to very high road taxes, licences, insurances, high parking costs and entry fees to congested areas. Some examples are given below.

Singapore is the only country in the world with a strict Area Licensing Scheme (ALS). All peak hour car users going into the central business district have to pay a heavy entry fee. Various policy tools have been introduced to limit car population growth. To be eligible to hold a car, prospective owners have to bid for a certificate. Such a certificate can cost about US$ 7,000 to 10,000. Apart from that, a high tax

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15 Most of the data in this paragraph are taken from the *Asian Journal of Environmental Management*, (Vol.1, No.2, November 1993), "Congestion management and air quality: lessons from Bangkok and Mexico City". V.Setty Pendakur, University of British Columbia (Vancouver, Canada).

16 The mass transit master plan approved by the Government envisages a total system of 242.6 km, including a 34.4 km underground train, costing a total of about US$ 20 billion. Expressway expansion 1993-2000 would be 130.6 km, requiring some US$ 3.6 billion. Data are taken from *Bangkok Post* (30-12-1994), "Economic Review 1994".

has to be paid, even for older cars, as most older cars are also heavy polluters. Use of a parking space in the ALS area adds a monthly US$ 60, but is not applicable to car pools with three or more people. Another new idea is the 'weekend car'. In order to enable 'social' car uses, taking the vehicle for peak-period transport is severely limited, but use during evenings, Saturday afternoons, Sundays and public holidays is exempted. For the future, electronic road pricing is considered.

Of course, such restrictions cannot be implemented if at the same time no alternative in the form of a good public transport is offered. Singapore has vastly expanded is bus system and recently built a 44 km mass rail transit (MRT) system at a cost of US$ 3 billion.

As a result of the introduction of the ALS system in 1974-75, the number of bus trips increased from 33 to 43 percent, the numbers of car trips went down from 48 to 27 percent, while car pools more than doubled (from 8 to 19 percent)

V The role of ESCAP

V.1 ESCAP in brief

The Economic and Social Commission for Asia and the Pacific (ESCAP) was founded in 1947 as the regional arm of the United Nations, providing a forum for cooperation among member countries on topics spanning the broad spectrum of economic and social development. The role of ESCAP assumes particular significance in the absence of any other region-wide assembly of Governments in this part of the world. Groupings such as ASEAN or South Pacific Forum function on a subregional basis only.

ESCAP is an integral part of the United nations and reports annually to the Economic and Social Council (ECOSOC). ESCAP is one of the five regional commissions; the other four are located in Africa, Europe, Latin America and Western Asia. The Commission is composed of 48 member states and 10 associate member states (see map of the ESCAP region on page 78). [1/]

The Commission holds an annual plenary session where general policies and the work programme are reviewed and decisions are made on work to be undertaken in the following year. The Commission has adopted a thematic approach to planning and programming its activities, in order to meet the needs and priorities of the region in an integrated and multidisciplinary way. The programme of regional cooperation for development in Asia and the Pacific consists of six subprogrammes: regional economic cooperation, environment and sustainable development, poverty alleviation through economic growth and social development, transport and communications, statistics, least-developed, landlocked and island developing countries. The conference structure reflects this thematic programme approach. Under the Commission, which annually convenes on ministerial level, officials from member countries meet in thematic commissions, annually or every odd year, to discuss and make recommendations [2/] on the programme.

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1 *Regional member states:* Afghanistan, Armenia, Azerbaijan, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Democratic People's Republic of Korea, Fiji, India, Indonesia, Islamic Republic of Iran, Japan, Kazakhstan, Kyrgyzstan, Lao People's Democratic Republic, Malaysia, Maldives, Marshall Islands, Federated States of Micronesia, Mongolia, Myanmar, Nauru, Nepal, Pakistan, Papua New Guinea, Philippines, Republic of Korea, Russian Federation, Samoa, Singapore, Solomon Islands, Sri Lanka, Tajikistan, Thailand, Tonga, Turkmenistan, Tuvalu, Uzbekistan, Vanuatu, Viet Nam.
Non-regional member states: Australia, France, Netherlands, New Zealand, United Kingdom of Great Britain and Northern Ireland, United States of America.
Associate members: American Samoa, Commonwealth of the Northern Mariana Islands, Cook Islands, French Polynesia, Guam, Hong Kong, Macau, New Caledonia, Niue, Republic of Palau,

2 *Subsidiary structure of the Commission:*
- Committee on Regional Economic Cooperation
- Committee on Environment and Sustainable Development
- Committee on Poverty Alleviation through economic growth and social development
- Committee on Statistics
- Committee on Transport and Communications
- Special Body on Least Developed and Land-Locked Developing Countries
- Special Body on Pacific Island Developing Countries

ESCAP's 15-storey headquarters is located in Bangkok, Thailand. This secretariat is composed of professional and general service staff, and is divided in various divisions and services. [3/] The work methods of ESCAP consist of providing statistical and information services (including publications), organizing or supporting regional and national experts group meeting and training workshops, as well as providing consultancy and technical support for member countries.

Through its Environment and Natural Resources Management Division (ENRM), ESCAP assists members and associate members in the region to benefit from their natural resources, including energy, by promoting interdisciplinary research, sponsoring technical cooperation among developing countries and stressing the environmental impact of those resources.

V.2 ESCAP energy efficiency activities

V.2.1 Introduction: ESCAP and energy

One important theme within the ESCAP subprogramme on environment and sustainable development is ENERGY DEVELOPMENT AND MANAGEMENT. The multidisciplinary staff of the Energy Resources Section, part of the ENRM Division, is responsible for research, training, advisory and publishing activities in the area of energy and the environment. The current work is geared towards:

1. improvements in energy management techniques, for example, sectoral demand studies, optimum pricing, demand side management;
2. energy efficiency and conservation;
3. promotion of energy-efficient lifestyles;
4. fossil fuel substitution / switching;
5. promotion and dissemination of new and renewable sources of energy;
6. optimum utilization of electricity;
7. impacts on the environment (acid rain, urban air pollution, siting of large dams).

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[3] *Organizational structure of the ESCAP Secretariat:*
- Office of the Executive Secretary
- Development Research and Policy Analysis Division
- Division of Administration
- Environment and Natural Resources Management Division
- ESCAP Pacific Operations Centre
- Industry and Technology Division
- International Trade and Economic Cooperation Division
- Population Division
- Programme Management Division
- Rural and Urban Development Division
- Social Development Division
- Statistics Division
- Transport, Communications and Tourism Division
- United Nations Information Service
- UNCTAD/ESCAP Joint Unit on Transnational Corporations

In the 1980s ESCAP was the main executing agency in a major regional programme in the field of energy, namely the *Regional Energy Development Programme (REDP),* financed by the United Nations Development Programme (UNDP), focusing on energy planning and management, energy modelling, energy conservation in the field of electric power, coal and gas and on new and renewable sources of energy. Its sister programme, the *Pacific Energy Development Programme (PEDP),* had similar objectives for the Pacific subregion.

V.2.2 PACE-E, Conservation and efficiency

Building on the decade-long experiences of REDP and PEDP, UNDP has developed the successor project *Programme for Asian Cooperation on Energy and Environment (PACE-E)* for the period 1993-1997 and has designated ESCAP as the main executing agency. The PACE-E project emphasizes the new issues that have emerged, since the conception of REDP, environmental sustainability and a shift from energy supply to the demand side.

The PACE-E programme consists of six PROGRAMME ELEMENTS: 1. Energy-environment planning, 2. Coal development and utilization, 3. Natural gas and petroleum development, 4. Rural energy-environment development, 5. Conservation and efficiency, and 6. Electric power system management.

As in REDP, the PACE-E work programme is geared to address the capacity-building, information and training needs through working groups aimed at promoting technical cooperation among developing countries (TCDC) in the above-mentioned programme elements. In each country, focal points are appointed for each programme element, who participate in these working groups. In Annex D a list of current PACE-E focal and subfocal points is given.

Although ESCAP is the main executing agency for PACE-E, its various activities are typically implemented by counterpart organizations, which can be national, regional or international, preferably from the Asian and Pacific region.

Under the CONSERVATION AND ENERGY (C&E) programme element, a series of workshops will be organized. The C&E workshops of PACE-E are designed for policy makers and experts, aiming to promote regional cooperation and dialogue and to extend knowledge regarding effective policies and strategies for energy efficiency promotion.

Six C&E workshops were convened during 1994/1995:

CODE: TITLE, PLACE AND DATE OF EVENT:

C&E.1 *Workshop of Regional Policy Makers on National Strategies and Regional Cooperation in Energy Efficiency Promotion*
Bangkok, 23-25 March 1994.
Organized by ESCAP, in conjunction with two other activities: the *ELENEX'94 Exhibition,* organized by Bangkok Exhibition Services (BES), and the *Thailand Energy Efficiency Conference '94,* organized by The Energy Conservation Center of Thailand.

C&E.2 *Sectoral Meeting of Experts and Policy Makers on Energy-Environment Strategies for Urban Transportation*
Hong Kong, 16-18 May 1994.
Hosted and co-organized by the University of Hong Kong

C&E.3 *Regional Workshop for Executives of Energy Conservation and Efficiency Centers in Asia*
Seoul, Republic of Korea, 9-11 May 1995
Hosted and co-organized by The Korea Energy Management Corporation (KEMCO).

C&E.4 *Regional Policy Workshop on Energy Efficiency Standards & Labelling*
Singapore, 22-23 September 1994
Co-organized by the Asia office of the International Institute for Energy Conservation (IIEC), Bangkok, in conjunction with the *ENEX-Asia'94 Exhibition* and *Asia Energy Efficiency Conference,* both organized by REED Exhibition Companies.

C&E.5 *Regional Workshop on the Role of Consumer Organizations and other Non Governmental Organizations in Promoting Energy Efficiency and Sustainable Energy Use*
Penang, Malaysia, 29 November - 1 December 1994.
Hosted and co-organized by the Asia and Pacific office of the International Organization of Consumer Unions (IOCU), Penang, Malaysia.

C&E.7 *Regional Workshop on Investment Promotion of the Domestic Manufacturing of Energy-efficient Products*
Manila, Philippines, 27-29 September 1995
Hosted and co-organized by the Philippine Energy Conservation Center, Inc. (PECCI)

V.2.3 Asia Energy Efficiency 21

From 3 to 14 June 1992 the *United Nations Conference on Environment and Development* (UNCED) was held at Rio de Janeiro, Brazil. The UNCED meeting, as well as its preparatory and subsequent follow-up meetings have repeatedly emphasized the importance of energy economy and energy efficiency as the cornerstone of all efforts to attain more sustainable energy development: increased energy economy and improved energy efficiency can significantly reduce environmental degradation and simultaneously contribute to more sustainable energy use, improved energy security, reduced investments in energy supply infrastructure and a reduced dependence on energy imports. Promotion of energy efficiency can thus contribute significantly to more sustainable economic development paths.

Agenda 21, the conference's blueprint for sustainable development, adopted at the Rio Conference, recognizes that [4/]

> "reducing the amount of energy and materials used per unit in the production of goods and services can contribute both to the alleviation of environmental stress and to greater economic and industrial productivity and competitiveness. Governments, in cooperation with industry, should therefore intensify efforts to use energy and resources in an economically efficient and environmentally sound manner."

In its recommendations regarding the implementation of Agenda 21, UNCED reaffirmed the role of the United Nations regional commissions, such as ESCAP, in promoting and enhancing regional and subregional cooperation for sustainable development. In this context, an Ad-Hoc Meeting on *Global*

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4 *United Nations Conference on Environment and Development, Report of the United Nations Conference on Environment and Development*, annex II, sect. I, chap. 4, (Document A/CONF.151/26, Vol.I, p. 40).

Box 5.1 Summary of the Asia Energy Efficiency 21 project proposal

Project duration: 3 years

Lead agency: ESCAP (Economic and Social Commission for Asia and the Pacific)

Priority area: Reduction of greenhouse gas emission through energy end-use efficiency improvements

Objective: Provision of SUPPORT to manufacturers, distributors and users of energy-efficient technologies, facilitating and promoting inter- and intra-regional exchanges of know-how and information on investment opportunities in the domestic development, application and marketing of energy-efficient products and appliances and manufacturing processes.

Results:

1) Increased contacts and exchange of know-how between and among (prospective) manufacturers, distributors and users of energy-efficienct equipment and technologies, as well as government trade officials and consultants, at events such as trade and investment promotion fairs, or symposia and seminars, by supporting or suggesting organizers to build energy efficiency components in these events

2) Publications on selected energy-efficient technologies, processes and products, energy & cost saving potential, business opportunities and investment potential, environmental pollution abatement and control, energy efficiency services, legal and institutional settings, energy efficiency standards, sources of information and expertise.

3) Energy-efficiency-related training programmes (e.g. energy management, energy auditing, energy-efficient technologies, counseling and consulting, energy efficiency promotion, investment promotion).

4) Advisory and consultancy services for the promotion of foreign and intraregional investments in energy-efficient domestic production processes as well as in the domestic manufacturing of energy-efficient appliances and products

Status: Proposal has been sent to UNDP / GEF for consideration

Energy Efficiency 21 (GEE 21) [5/] was convened in 1992, which was attended by representatives of the divisions responsible for energy at the United Nations regional commissions and by interested donor delegations.

The Meeting considered important efforts to stimulate, facilitate and increase contacts between manufacturers, distributors and users of energy-efficient technologies and products, as well as financiers, regulators and policy decision makers, providing for a wide range of information, training, technology transfer, and trade and investment promotion services, as well as for policy advisory services related to energy use and energy efficiency. The Meeting recommended the development of regional project frameworks, which account for regional and subregional conditions and self-assessed national technical assistance, information and training needs, and for the formulation of regional action plans, to coordinate and guide the initiation, implementation and support of national, subregional and regional energy efficiency promotion events.

Whilst the PACE-E module on Conservation and efficiency (C&E) aims to service POLICY-MAKERS, the ESCAP secretariat felt the need for a programme of more OPERATIONAL activities, aiming at leveraging

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5 See also the draft *Working Paper No.1*, Ch. A, and/or original documentation of the Meeting: Economic and Social Council, Economic Commission for Europe, Ad Hoc Meeting on Global Energy Efficiency 21, Resumed Session, 19-20 October 1992, *Report of the Meeting*, Document ENERGY/AC.13/4, 20 October 1992.

private sector investment in energy efficiency, in line with the GEE21 concepts. Consequently, the secretariat drafted a project proposal called *Asia Energy Efficiency 21.* The proposal was presented at the PACE-E C&E1 workshop, held in Bangkok, 23-25 March 1994. The Workshop group of regional policy makers, endorsed the AEE 21 proposal unanimously and requested the secretariat to forward the proposal for multilateral funding, observing that GEF and/or UNDP [6/] would be suitable sources of funding considering project objectives and GEF criteria. A brief summary of the *Asia Energy Efficiency 21* project initiative is presented in the box 5.1.

V.2.4 Other projects in energy efficiency

Another example of the involvement of ESCAP in energy efficiency promotion is the Japanese-funded project *Promotion of commercial energy conservation consulting services in countries of the ESCAP region.* In four countries, India, Indonesia, Thailand and Viet Nam, one-week training courses have been organized for independent consulting engineers, architects, agents of energy-using equipment and other persons interested in commercial marketing of energy advisory services. The training courses are conducted by international energy management experts in cooperation with local counterpart organizations.

Also funded by Japan, is the *Training programme for energy efficiency managers from transitional and developing ESCAP Countries.* The project aims to draw on the ample expertise of national energy conservation and efficiency centres in the region (e.g. the Republic of Korea, Thailand) to assist the transitional economies (Central Asian republics, Lao People's Democratic Republic, Mongolia, Viet Nam) in the formation and the strengthening of national energy efficiency centres. Some ten trainee executives will be trained (at a 4-day workshop in Bangkok, and through specialized on-the-job training in established energy efficiency centres) on the various aspects of organization and management of energy efficiency centres.

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6 UNDP: United Nations Development Programme
The funds of the GEF (Global Environmental Facility) are aimed at addressing global environmental problems, such as deforestation and global warming. GEF is administered by UNDP, together with the World Bank and the United Nations Environment Programme.

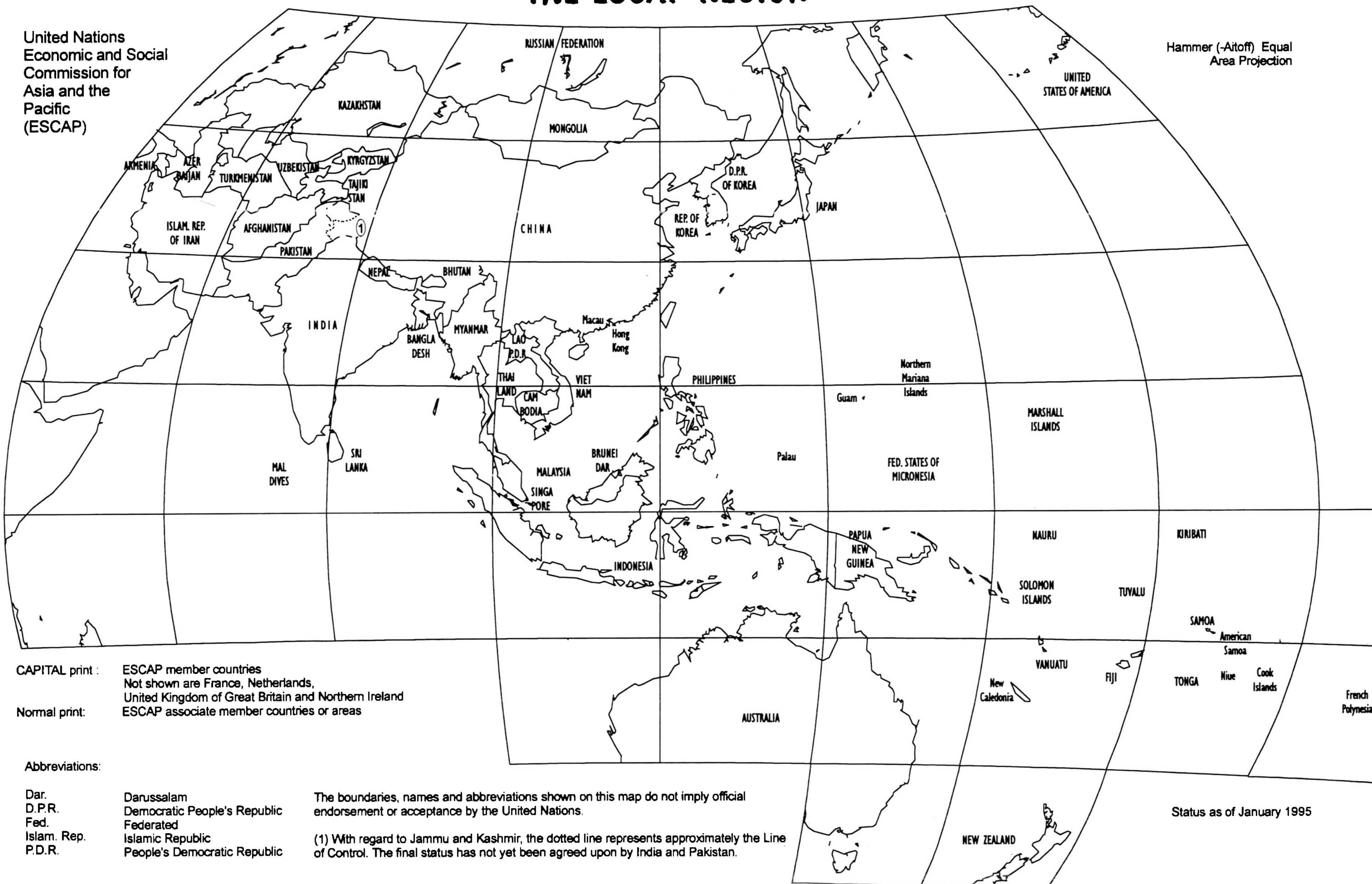
Table 5.1 Description of recent ESCAP activities in energy end use efficiency promotion

	Programme for Asian Cooperation on Energy & the Environment (PACE-E) **Conservation & Efficiency**	**Promotion of Commercial Energy Conservation Services**	**Training Programme for Energy Efficiency Centre Managers**
Status / duration	In execution 1993/94 - 1997	In execution 1993-1995	In execution 1995-1996
Participating countries	Various countries in ESCAP region	India, Indonesia, Thailand, Viet Nam	Transitional economies (Central Asian republics, Lao P.D.R, Mongolia, Viet Nam)
Financial support	United Nations Development Programme (UNDP)	Japan	Japan
Objective	*C&E: to* promote dialogue and exchange of know-how among energy efficiency experts and energy planners	To offer training for consulting engineers, architects, energy management experts, interested in marketing of energy advisory services	To offer training to executives in the establishment and management of energy efficiency centres
Output / activity	Regional workshops for policy makers / expert group meetings Implemented in 1994/1995: 1 *National Strategies in Energy Efficiency Promotion*, Bangkok 2 *Urban Transportation*, Hong Kong 3 *Energy Efficiency Centres*, Seoul 4 *Standards & Labelling*, Singapore 5 *Role of Consumer organizations and NGOs*, Penang 7 *Investment Promotion of Domestic Manufacturing of Energy-Efficient Products*, Manila Planned for 1996: 6 *Energy Efficiency Standards for Commercial Buildings* 8 *Role of Chambers of Commerce and Industry* 9 *Domestic Resource Mobilization / Finance for Energy Efficiency Promotion* 10 *Perspectives for Energy Efficiency Promotion in the ESCAP Region* (concluding seminar) Publication: *Energy End Use Efficiency Promotion in Asian Developing Countries*	- Series of one-week training courses - Publications: 1. *Guidebook for Energy Consultants and Service Companies in Asia*, 2. *Directory of Energy Consultants, Service Companies, Manufacturers and Distributors of Energy Efficient Equipment and Appliances in Asia.* Trainings implemented: 1. Bangkok, Dec. 1993 2. Hanoi, April 1994 3. New Delhi, April 1994 4. Pune/Bombay, April 1994 5. Ho Chi Minh City, July 1994 6. Jakarta, July 1994 7. Hanoi, October 1994 8. Bangkok, January 1995 9. Beijing, February 1995	- Regional workshops - On-the-job training in established partner organizations
Comment			The on-the-job trainings of officials from transitional economies at energy efficiency centres are being implemented in 1995. A regional workshop is scheduled for January 1996 in Bangkok.

THE ESCAP REGION

United Nations
Economic and Social
Commission for
Asia and the
Pacific
(ESCAP)

Hammer (-Aitoff) Equal
Area Projection



CAPITAL print : ESCAP member countries
Not shown are France, Netherlands,
United Kingdom of Great Britain and Northern Ireland

Normal print: ESCAP associate member countries or areas

Abbreviations:

Dar.	Darussalam
D.P.R.	Democratic People's Republic
Fed.	Federated
Islam. Rep.	Islamic Republic
P.D.R.	People's Democratic Republic

The boundaries, names and abbreviations shown on this map do not imply official endorsement or acceptance by the United Nations.

(1) With regard to Jammu and Kashmir, the dotted line represents approximately the Line of Control. The final status has not yet been agreed upon by India and Pakistan.

Status as of January 1995

Annexes

A Some tips for energy conservation

A.1 Processes and equipment

ITEM	WHY IMPORTANT ?	HOW TO CONSERVE ?	WHO CAN HELP ?
1. Industrial furnaces	- heat loss through furnace structure increases energy consumption	- repair furnace linings - inspect insulation for periodic maintenace and update	- plant maintenance - furnace manufacturer - plant employees
2. Burners	- either incomplete combustion or too great an amount of excess air wastes significant fuel amounts	- perform periodic combustion analysis and adjust burners - maintain, repair or replace inefficient burners	- plant maintenance - combustion specialist - burner manufacturer - fuel supplier representative
3. Combustion gases heat recovert	- products of combustion, which leave at temperatures higher than supply air, represent a loss of energy	- use exhaust gases to preheat combustion air by use of a recuperator heat exchanger - use exhaust gases to generate steam or hot water and to heat secondary fluids or air for other uses	- consulting engineer - recuperator manufacturer representative - energy supplier representative
4. Process heat distribution system (steam condensate, hot and chilled water) and process fuel distribution system (fuel oil, LPG, diesel, coal etc.)	- any losses in the distribution system require greater energy input for the same end use	- repair leaks in any line. Shut off or remove unused lines - provide for periodic maintenance checks on controls, valves and accessories - meter consumption and compare at regular intervals to identify unusual changes	- plant employees - plant engineer and maintenance - energy supplier representative
5. Incineration of industrial waste	- possible source of energy. Recovered heat can be used for process	- investigate the possibility of incorporating a heat recovery system into the incineration process	- mechanical/chemical consulting engineer - representative from heat recovery equipment of incineration equipment manufacturer
6. Cooling towers / evaporative coolers	- heat rejection is required by many industrial processes, such as die-casting machines, plastic moulders and air compressors	- investigate the possibility of using the heat for preheating boiler feedback or for hot water use, for heating stockpiles or other low-temperature applications	- mechanical consulting engineer - heating, ventilating and air conditioning engineer
7. Exhaust over vats, tanks, grinding and other operations	- energy is required to heat the makeup air from the outside - energy is also needed to maintain the temperature of the bath	- consider the use of heat recovery equipment from the exhaust air to the makeup air - check the possibility of introducing outside air directly to operate without heating - install covers over vats and tanks, or if unsuitable, consider insulating balls floated on the surface	- consulting engineer - ventilation specialist - plant engineer
8. Compressed air system	- energy is used to drive the air compressor - drive may be either electric motor, engine or turbine drive	- use coolest intake air available, possibly from outside the building - repair all leaks - operate at the lowest air pressure required - consider the possibility of using the heat from the aftercooler for supplementing the plant space heat - do not use compressed air for cooling equipment or for personal comfort. It is expensive ventilation. Use air blowers at required locations instead - investigate the possibility of shutting down the compressor when not in use	- plant engineer - plant maintenance - mechanical consulting engineer - plant employees

9. Electric power system	- transmission losses include transformers and line losses - high peak demand and low power factor increase both operating cost (for the plant) and investment cost (for the electricity generating utility)	- de-energize transformers whenever possible - clean transformer heat exchanger surfaces - investigate the possibility for scheduling the use of power to periods of reduced demand - if power factor is low, additional load may involve expensive cabling cost	- electrical consulting engineer - utility representative - plant engineer
10. Electric motors		- turn of equipment when not in use - if operating efficiency is below 70%, investigate further - if due for retirement, investigate higher efficiency motors and matching of motor to the load using adjustable speed drives	- plant employees - electrical consulting engineer - plant engineer - electric utility representative

A.2 Plant and office buildings

ITEM	WHY IMPORTANT ?	HOW TO CONSERVE ?	WHO CAN HELP ?
1. Lighting		- turn off lights when not in use - install lighting only to that required for task - consider replacing lighting with more efficient lamps - incandescent to fluorescent - consider using fittings which are more effective in directing light to the work area - consider integration of daylight with electric lighting - ducted fittings will improve the operating efficiency of suitable lamps - lamps and fittings should be cleaned as part of a regular maintenance programme. - heat reflective coatings may make windows more useful - control windows brightness. If windows admit excessive light, the general lighting standard may have to be raised to reduce contrasts	- illuminating engineer - electric utility representative - plant engineer - plant employees
2. Space air conditioning and heating systems	- the energy required by the heating, ventilating and air-conditioning system is used for fan motors, refrigeration and heating systems	- an overall complete analysis is required to minimize energy use - control settings should not be changed without considering the effect on the whole system - clean filters on a regular basis - lock out refrigeration system by a return air thermostat	- HVAC engineer
3. Steam and hot water		- insulate lines - repair leaks - check operation of traps - use of insulated storage tanks to receive heated water during off-peak hours can improve operating efficienies	- plant and building maintenance
4. Central system boilers	- combustion of fuels to generate hot water or steam	- perform periodic combustion analysis and adjust burners - consider heat recovery from flue gases - clean, blowdown to maintain operating efficiency - consider the use of small local electric boilers for isolated low level requirements	- plant engineer - combustion specialist - consulting engineer - original equipment manufacturer
5. Unit heaters	- combustion of fuels for heating air	- readjust burners for maximum efficiency - clean heat exchanger surfaces - cycle fan operation	- combustion specialist - plant engineer

6. Hot water for personal use	- heat is required to raise the temperature of the water from the entering temperature to the desired temperature - the heating rate required is approximately Power (kW) = 4.2 · flow rate · (1/5) · temperature rise (°C)	- repair leaks at hot water taps - check to see that hot water taps are shut off when not in use - reduce hot water thermostat setting to the lowest temperature which is acceptable - separate system from space heating or other hot water system - clean heaters regularly, following the manufacturer's recommendations. Should be flushed and cleaned periodically - check the standard of insulation on all hot water pipes	- plant maintenance - plant employees
7. Ventilation	- ventilation air may be required for dilution	- requirements for ventilation may have changed. Evaluate present requirements - measure present ventilation. Use minimum possible but now below requirements of code	- mechanical consulting engineer
8. Openings in structures (e.g. loading docks)	- excessive filtration of outside air requires extra energy	- close all unnecessary openings, unused exhaust fans, broken windows, structural openings - enclose the trucks or railroad cars at the loading platform - consider the use of plastic strip partitions - investigate the possible use of automatic doors or curtains	- plant and building maintenance - outside contractor - plant employees
9. Wall and roof insulation	- most uninsulated walls and roof structures may allow 2 to 3 times the heat loss of an insulated one	- insulate roof end walls which reduce heat loss through the building structure	- plant maintenance - outside contractor
10. Windows and doors	- heat loss by transmission and filtration - doors and windows on opposite walls permit excessive infiltration by direct flow of air through the building	- add weather stripping or seal windows - erect weather screens, externally or internally, air locks and internal doors to help protect doorways and break the flow of air - add door closers - lock, seal or change doors and/or windows on one wall	- plant maintenance - outside contractor
11. Control systems and settings	- controls determine the actual operating characteristics of the system	- original system design and operation may have ben based on different parameters and energy costs. A new look up may tune the system for lower energy costs.	- control specialist - consulting engineer

SOURCE: *SCNCER Newletter* (December 1991), based on the *Energy Management Manual* of the Electricity Trust of South Australia

B Status of energy conservation and efficiency activities in selected countries of the ESCAP region

	BARRIERS TO ENERGY EFFICIENCY IMPROVEMENTS	ORGANIZATIONS / INSTITUTIONS	EFFICIENCY PROMOTION POLICIES	ENERGY CONSERVATION LAWS	INCENTIVE MEASURES	PROJECTS AND ACTIVITIES	INTERNATIONAL COOPARATION
BANGLADESH	1. Uncertainty about return on energy conservation investments 2. Shortage of funds 3. Low consciousness 4. Lack of government measures 5. Subsidized energy tariffs	*Government:* 1. Energy Monitoring & Conservation Centre (EMCC) under Ministry of Energy & Mineral Resources EC budget 1991: US$ 57,900 *Non- or semi-government:* 1. Different training institutions (energy conservation courses)	Preparation of a national energy management and conservation programme.	1. policy for imposing penalty for low power factor 2. emission control for vehicles and industry 3. efficiency control for boilers, furnaces and other industrial installations 2. energy conservation act under study (machinery standards, energy utilisation reporting, penalties and enforcement, operating conditions of certain equipment, labelling)	Not yet undertaken	1. Establishment of Energy Monitoring Unit in EMCC (1984) Results: a. energy audits in 47 medium-sized and large companies, b. study of institutional, legal, financial and educational issues, c. national report showing national savings potential (about 19.05 PJ annually) 2. Industrial Energy Efficiency project (US$ 11 million), Implementing EEIOs in industry	Industrial Energy Efficiency projects (consultancy, installation of energy auditing equipment)
CHINA	1. Subsidized energy pricing structure 2. Difficulty in obtaining good energy conservation equipment 3. Uncertainty about return on energy efficiency investments 4. Shortage of funds	*Government:* 1. State Planning Commission, Working Conference for Energy Conservation. EC budget 1991: 910 Rmb Yuan *Non- or semi-government:* 1. China Energy Conservation Association (information exchange)	Outline Energy Conservation Technology Policy (1983). Aims: a. setting goals for reducing energy demand by 2000, b. promotion of energy-efficient technologies	1. Provisional regulations for energy conservation management (1986) (administrarive setup of energy conservation, designing regulation of 27 processes). 2. Energy Conservation Law in preparation	Proposed regulations of raw materials and fuel-saving reward for state-owned enterprises.	1. Investments in construction and in technical innovation	n.a.
INDIA	1. Low consciousness among consumers, producers and government 2. Fuel subsidy 3. Lack of information and accessible techniques 4. Lack of finance	*Government:* 1. Energy Management Centre (under Ministry of Power). Functions: training, research and information dissemination	1. Rationalization of electricity tariff structure 2. Eight Plan of Planning Commission	1. Environmental Impact Assessment Act (EIA prior to project approval). 2. efficiency standards for refrigeration, air-con., and other electric appliances 3. efficiency conrol regulations for boilers, furnaces and other industrial installations 4. emission controls for vehicles and industry	1. import duty reduction for energy conservation equipment 2. concessional loans 3. accelerated depreciation for tax Financial support for energy audits and energy conservation projects.	1. Programme for Energy Audit Study Services 2. senior management commitment programmes Proposed: energy efficient lighting	Contemplated are training programmes, programmes for rectification of agricultural pumps, promotion activities through mass-media, demonstration projects

	BARRIERS TO ENERGY EFFICIENCY IMPROVEMENTS	ORGANIZATIONS / INSTITUTIONS	EFFICIENCY PROMOTION POLICIES	ENERGY CONSERVATION LAWS	INCENTIVE MEASURES	PROJECTS AND ACTIVITIES	INTERNATIONAL COOPARATION
INDONESIA	1. Low price of energy, cross-subsidies 2. Low consciousness 3. Lack of information on appliances	*Government:* 1. BOKAREN (ministerial level energy coordination body) 2. Directorate-General of Electric Power and New Energy (DGENE) *Non- or semi-governmental:* KONEBA and various NGOs	Various presidential decrees in support of energy conservation (KEPRES), apart from National Policy Guidelines, 1993-1998. Rationalization of taiffs and energy subsidies under consideration	1. Obligatory EIA (environmental impact analysis for industry and power. 2. Emission controls for vehicles and industry	n.a.	1. Establishment of an energy conservation company (KONEBA) to provide technical and consultancy services, mainly to large industrial establishments. 2. Demand-side management project 3. Information dissemination, training courses, efficient woodstoves, efficient boilers	n.a.
MALAYSIA	1. Lower impact of energy cost on total cost of an enterprise 2. Shortage of skilled manpower 3. Shortage of funds 4. Lack of training 5. Shortage of measuring equipment 6. Acceptance, suitability and awareness of technology	*Government:* 1. Ministry of Energy, Telecommunications and Post *Non- or semi-governmental:* 1. Tenaga Nasional Research and Consultancy Edn. 2. Federation of Malaysian Manufacturers	1. National Energy Policy (1987), stating supply, demand and environmental objectives, including energy conservation 2. Air Quality Act (1974) 3. Guidelines for Energy Efficiency in Buildings (1989)	1. Emission controls for vehicles and industry 2. EIA for major/ infrastructural projects affecting environment	n.a.	1. Energy conservation awareness activities: campaigns, seminars, energy efficiency awards for industry, energy audit services 2. Demand-side management projects 3. ASEAN cogeneration project	nil.
PHILIPPINES	1. Uncertainty about return on energy efficiency investments 2. Difficulty in obtaining good information 3. Lack of incentives 4. Lack of equipment maintenance 5. Tariff structure	*Government:* 1. Department of Energy, Energy Conservation Division En.cons. budget: 1,512,000 pesos *Non- or semi-government:* 1. Energy Development and Utilization Foundation, Inc. (EDUFI) 2. Energy Management Association of the Philippines (ENMAP) 3. Philippines Energy Conservation Center, Inc.	Power Development Plan 1993-2005	1. Mandate to promote the judicious use of energy (1992), encompassing mandatory energy utilisation report for certain industries, low-interest loans, advisory services, information dissemination and training programmes) 2. EIA for infrastructural projects 3. Energy efficiency standards for air-conditioners 4. Emission controls for vehicles and industry	Concessionary loan financing and incentives for a. projects promoting the utilization of non-conventional sources of energy, b. projects promoting the more efficient use of energy, c. projects for replacement of machinery and equipment by more energy-efficient ones	1. Residence and industry: a. information dissemination, consultancy and training, c. advisory services, energy management, energy labelling 2. Transportation: limited information dissemination 3. Demand-side management	1. Philippine-German technical cooperation on rational use of energy (1991, 113,000 pesos) 2. Swedish project on combined heat and power system (1991, 564,000 pesos) 3. UNDP (1,632,000 pesos) 4. Australia-ASEAN: industrial equipment and processes, 1991: 752,000 pesos, modelling of buildings

	BARRIERS TO ENERGY EFFICIENCY IMPROVEMENTS	ORGANIZATIONS / INSTITUTIONS	EFFICIENCY PROMOTION POLICIES	ENERGY CONSERVATION LAWS	INCENTIVE MEASURES	PROJECTS AND ACTIVITIES	INTERNATIONAL COOPARATION
REP. OF KOREA	1. Low impact of energy cost on total cost of an enterprise 2. Unreliable results from energy conservation equipment 3. Access to good information 4. Shortage of funds 5. Low consciousness 6. Weak testing organization 7. Low standardization	*Government:* 1. Ministry of Trade, Industry and Energy Energy rationalization fund, budget 1991 US $19,875,000 R&D fund: US$ 15,375,000 *Non- or semi-government:* 1. Korea Electric Power Co. 2. Korea Energy Management Corporation (KEMCO) (technical development, dissemination, promotion) Budget 1991 US$ 16,528,000 2. Korea Energy Economics Institute (KEEI) (analusis, reserach, energy databank)	A comprehensive Energy Conservation Plan (1992), aiming at: a. reinforcement of existing sectoral conservation programmes, b. minimize energy demand (industry, transport, recycling), c. energy pricing, d. R&D and dissemination of energy efficient technologies (minimum efficiency standards, labelling)	1. Rationalization of Energy Utilization Act (1979). Summary: energy management by field, management of heat and materials, energy use rationalization fund, KEMCO 2. District Energy Supply Act 3. Environment Protection Law 4. Energy efficiency standards for refrigeration, air-conditioners and other electrical appliances 5. Energy control regulations for boilers, furnaces and other industrial installations, 6. Emission controls for vehicles and industry	1. Concessionary loan financing 2. Tax reductions / exemptions 3. Credits for energy-efficient buildings in electricity rate	1. Power sector: demand-side management programme 2. Residence: connection to CHP network, high-efficiency appliances dissemination, labelling programme for refrigerators, bulbs and air conditioners, financial support for thermal insulation, information dissemination, 3. Industry: compulsory report on energy consumption, energy management of energy-intensive industries, demonstration scheme, financial support, energy audits 4. Transportation: energy audits for transport companies, training, labelling programme for cars, car pooling system, promotion of small cars	1. UNDP, North-East Asia project (including Tumen Area Development project) 2. APEC, energy projects 3. IEA, Int'l Conference on Demand Side Management
SINGAPORE	1. Low impact of energy cost on total cost of enterprise 2. Uncertainty about return on energy efficiency investments 3. Low consciousness 4. Lack of training	*Government:* 1. Public Utilities Board 2. Building Control Division	1. Energy conservation in building and industry 2. Traffic regulations	1. The Building Control Act (1979). A set of energy conservation standards for building design has been incorporated into the Building Regulations 2. Statutory Boards (Taxable Services) Act (1982). Provision for tax exemption for energy-efficient industrial consumers. 3. Transportation: various regulations and restrictions on private car ownership and use	1. Property Tax Act (1982). Tax refund for building owners who retrofit their buildings for energy conservation 2. The Income Tax Act (1983). Accelerated depreciation for tax to encourage installation of energy-efficient machinery.	n.a.	n.a.

	BARRIERS TO ENERGY EFFICIENCY IMPROVEMENTS	ORGANIZATIONS / INSTITUTIONS	EFFICIENCY PROMOTION POLICIES	ENERGY CONSERVATION LAWS	INCENTIVE MEASURES	PROJECTS AND ACTIVITIES	INTERNATIONAL COOPARATION
SRI LANKA	1. Low impact of energy cost on total cost of enterprise 2. Uncertainty about return on energy efficiency investments 3. Shortage of funds 4. Shortage of government measures 5. Lack of education 6. Lack of standards and testing facilities 7. Lack of incentives 8. Lack of promotional institutions	*Government:* 1. Ministry of Power and Energy, Project Minister of Energy Conservation. 2. Ceylon Electricity Board. 3. Ceylon Petroleum Corporation Energy Conservation Fund. Budget 1991 US$ 140,000. Budget 1993 US$ 540,000. *Non- or semi-goveryment:* 1. Sri Lanka Energy Managers Association (SLEMA) (training, audits, promotion, foreign linkages) 2. National Engineering Research and Development Center (NERD)	Promotion, coordination and monitoring of energy conservation by establishment of a national conservation center.	National Energy Conservation Act in preparation.	1. National Award by SLEMA to industrial and commercial enterprises 2. Tax concessions 3. Subsidies on improved wood stoves. 4. Transportation: regulations and discriminatory import duties on large cars 5. EIA for environment-sensitive project and for all Board of Investment projects required. 6. Emission controls for industry	1. Power sector: Demand-side Management programme. 2. Residential: a. publicity and promotion programmes through mass media, b. promotion and dissemination of efficient wood stoves. 3. Industry: a. energy audits, b. implemtation of some energy conservation measures, c. fuel switching	1. World Bank: survey of domestic and commercial energy conservation potential 2. Netherlands: training for engineers on energy management in industry. In preparation: ADEME (France): establishment of a National Energy Conservation Centre
THAILAND	1. Llow impact of energy cost on the whole cost of enterprise 2. Uncertainty about return on energy efficiency investments 3. Low consicousness 4. Lack of training	*Government:* 1. Ministry of S,T&E, Department of Energy Development and Promotion (DEDP), Energy Conservation Division Energy Conservation Programme, budget (excluding salary and administrative expenses) US$ 560,000 (1991) *Non- or semi-government:* 1. the Energy Conservation Centre of Thailand (ECCT)	Seventh National Economic and Social Plan (1992-1996) encourages the efficient use of energy	1. Energy Conservation Promotion Act (1992). Main issues: a. designated factory and commercial buildings have to assign energy management to conduct conservation activities, b. funds are available for energy-efficient appliances, materials and building design, and renewable energy projects.	Import duty reduction (1983) for imported energy conservation equipment	1. Power sector: comprehensive 5-year Demand-side management master plan. 2. Residential: campaign for promotion of public awareness 3. Industry: energy audits, technical information service, energy conservation training programme, study and development	1. Sweden: industrial cogeneration development (1992-1993) 2. Japan: support for Energy Conservation Programme

SOURCE: *Energy Efficiency Promotion,* J.H.A. van den Akker, paper presented at the "Asia Energy Efficiency Conference", 21-22 September 1994, organized by REED Exhibitions, ELENEX '94 Exhibition. Information is compiled from: (a) *Worldwide Energy Conservation Handbook,* The Energy Conservation Center, Japan, March 1993, (b) participants at the *Workshop of Regional Policy Makers on National Strategies and Regional Cooperation in Energy Efficiency Promotion*, organized by ESCAP, Bangkok, 23-25 March 1994, (c) *Policy Guidelines for Energy Efficiency Promotion,* discussion paper NR/EEP/3, 23 March 1994, prepared by the Energy Management Centre of India for the mentioned Workshop in Bangkok.

C Summary of issues and options in the urban transportation sector in selected economies of the ESCAP region

	CHINA	HONG KONG	MALAYSIA	PHILIPPINES	REPUBLIC OF KOREA	SINGAPORE	THAILAND	VIET NAM
1. ASSESSMENT OF URBAN AIR POLLUTION	Global Air Monitoring Project since 1981. Two pollutants, SO_2 and SPM are measured in 5 cities, Beijing, Guangzhou, Shanghai, Shenyang and Xian. Pollutants of most concern are SPM, SO_2 and CO.	A network of 11 monitoring stations, measuring SPM, NO_x, SO_2, O_3 and CO. Pollutants of most concern are SPM and NO_x.	Measured are SO_x, NO_x, particulates, CO and HC. NO_x and SPM are mainly emitted in Klang. NO_x is mainly emitted in Klang and Kuala Lumpur.	Previous network of monitors in Metro Manila for CO, HC, NO_x, O_x, and SPM (incl. Pb) has almost ground to a halt. Recent monitoring has been part of specific studies. Very high Pb and SPM in Manila	Measured are CO, SO_2, CO, HC, NO_2 and SPM	A network of 15 monitoring stations, measuring SO_2, CO, NO_x, O_3, hydrocarbons and SPM. A telemetric system is used. Concentrations are generally low.	In Bangkok CO, SPM, Pb and SO_2 have been measured. Main pollutants are CO and SPM.	Monitoring is reported for CO, NO_2, SO_2, SPM and dust deposition in Hanoi. Some concentrations (incl. Pb) are elevated, especially near roadways.
2. RELATIVE CONTRIBUTION OF MOTOR VEHICLES TO URBAN AIR POLLUTION	In some cities, motor vehicles have become the major contributor of certain air pollutants. For example, Beijing: emissions of CO, hydrocarbons and NO_x form 58%, 87% and 69% of total varied emissions, respectively.	Vehicular emissions are responsible for about 90% of the fine particulates and 75% of NO_x measured. Chemical analysis of fine particulates suggests diesel exhaust is main contributor	Motor vehicles are responsible for 67% of NO_x, 26% of PM and 100% of CO and HC emissions.	Motor vehicles are the main cause of CO, hydrocarbons and NO_x, whereas diesel vehicles are significant sources of SO_x and PM.	Contribution of motor vehicles to air pollutants: (a) nation-wide: 60% CO, 67% HC, 50% NO_2; (b) Seoul: 59% CO, 66% HC, 76% NO_2 and 35% of SPM.	Motor vehicles are the major sources of CO, hydrocarbons, nitrogen oxides and lead, and hence the formation of photochemical smog. They contribute also to SPM levels.	Bangkok has a serious problem of CO from gasoline vehicles, and SPM from diesel vehicles. Hydrocarbons mainly result from 2-stroke motorcycles and tuk-tuks.	Over the next 7 years a ten-fold increase is expected of the main pollutants, CO, CO_2, NO_x, HC, aldehydes, Pb, SO_x and salt.
3. HEALTH EFFECT STUDIES	Investigation in Shenyang revealed decreased pulmonary function and increased prevalence of congestion of throat and retropharyx folliculosis in children living in industrial areas, compared to those living in residential or rural areas.	Using US data, it has been estimated that there were 280 lung cancer cases from diesel exhaust in 1992, which would rise to 590 by 2010 if unchecked.	n.i.	Recent studies of groups exposed to motor vehicle emissions found a high incidence of respiratory tract diseases and seriously elevated blood lead and carboxyhemoglobin levels.	n.i.	A study of respiratory illness of school children, carried out in 1983, found that cultural and socioeconomic factors were probably more important. An asthma study is currently underway.	Eight hour exposure to street level air pollution is equivalent to smoking 9 cigarettes per day. Most exposed people are traffic police, tuk-tuk and motorcycle taxi drivers/passengers and street vendors. Among a survey of 1758 police officers, 753 suffered from respiratory diseases, and 420 had been suffering more than 5 years.	n.i.

	CHINA	HONG KONG	MALAYSIA	PHILIPPINES	REPUBLIC OF KOREA	SINGAPORE	THAILAND	VIET NAM
4. VEHICLE POPULATION AND EXPECTED TRENDS	n.i.	430,000 vehicles registered at the end of 1993. 66% of the vehicles are gasoline-fueled, consuming 33% of fuel. Taxis, buses and most trucks are diesel-fueled. Over the next 20 years a doubling of distance travelled is expected.	During 1980-83 and 83-91 the average total vehicle growth rate was 6.5% and 5% respectively. Total number of vehicles registered in KL and Selangor was about 1.57 million, of which 43% motor cars and 44% motorcycles.	2.1 million vehicles registered in 1993. 42% in Metro Manila. 70% are gasoline-fuelled. 40% are cars and 40% utility vehicles (incl. jeepneys).	As of August 1994, 7 million vehicles were registered, of which 69% passenger cars, 23% trucks and 8% buses. 49% of the vehicles are registered in the capital region. Should current trend continue, there would be 13 million cars by 2000.	580,000 vehicles as end of 1992, increasing at 2% per year. Half are cars, 20% goods vehicles and 20% motorcycles. 85% are gasoline-fuelled.	Half of the nation's vehicles, 2.8 million, are in Bangkok (which has 15% of the population). Motor vehicle population grows at 15% annually.	In 1993: 600,000 motorcycles, 11,500 sidecars, 47,500 cars, 42,000 buses and 91,800 trucks. More than 1 million vehiclesd estimated in 2000.
5. FUEL QUALITY	n.i.	Both leaded (0.17 gPb/l) and unleaded gasoline, with a higher tax on the former. 68% of sales are unleaded. Diesel S content 0.4%	Both leaded and unleaded gasoline.	Leaded (0.15 g/l) gasoline and unleaded introduced at 30 stations in Manila. Diesel S content 0.7%.	Lead in gasoline max. 0.013 g/l. Diesel S content max. 0.1%	Leaded has 0.15 g/l. New vehicles since Jul 91 use unleaded. Diesel S content 0.5% (0.3% in July 1996).	Leaded and unleaded (cheaper) available.	n.i.
6. ENVIRONMENTAL LEGISLATION	Law on Environmental Protection enacted, followed by specific laws, e.g. Air Pollution Law. Regulations are administered by National Environmental Protection Agency, Environmental Protection Commission and Ministry of Public Health. Emission standards for motorcycles, petrol engine and diesel vehicles.	Various ordinances and regulations have been enacted. These include introduction of unleaded gasoline in 1981 and the mandatory use of unleaded from 1992. Currently, gasoline vehicles under 2.5t must comply with emission standard (Europe, 93/59/ECE).	Responsible for the Environmental Quality Act (1974) is the Department of Environment. Regulations for vehicle noise, smoke and gas emissions.	Basic law of 1964, amended in 1976. Air quality part amended in 1993. Rules for motor vehicles set in 1980. Draft Clean Air Bill since 1993. For gasoline, ECE requirements for CO and HC. For diesel smoke density limits, including an "anti-smoke belching" campaign.	Environment Conservation Act, implemented by Environment Administration of Korea. The new Air Quality Control Act calls for gradually more stringent standards. Emission standards for motorcycles, heavy duty vehicles and diesel passenger cars and trucks.	Clean Air Act and Regulations administered by Ministry of the Environment. Road Traffic Act administered by Traffic Police and Registry of Vehicles. Very high level of enforcement. For gasoline vehicles, ECE R15.04 since 1986 and from July '92 ECE R83. Diesel, ECE R24.03 since 1991. Motorcycles US 86.410-80 since '91.	n.i.	Environmental Protection Law promulgated in December 1993. Some local air quality standards have been issued. No emission standards have been established.
7. INSPECTION AND MAINTENANCE PROGRAMMES	n.i.	Random checking of smoke emissions at testing centres. A comprehensive I/M programme is under consideration, with testing linked to licence renewal.	n.i.	Mainly for-hire vehicles are inspected at 4 inspection facilities in Metro Manila (CO, HC and smoke).	Safety and emission testing every 6 months to 2 years, depending on vehicle type. Random roadside inspections.	Periodic and random inspections. High standard of maintenance and repair.	n.i.	Annual safety checks for cars, buses and trucks carried out by traffic police.

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8. TRANSPORTATION AND TRAFFIC MANAGEMENT	n.i.	Greater emphasis on transportation and land use planning, including expansion of the mass transit system.	n.i.	Serious congestion in Metro Manila. An expanded mass transit system is urgently required.	High dependency on buses (in Seoul 39%of total passenger transportation). Expansion of subway to be completed 1996/99.	For-pronged strategy: 1. limit vehicle growth and usage (vehicle quota system, restrictions on import, area licensing scheme, by 1997/8 electronic road pricing) 2. efficient public transport, integrating MRT and buses 3. building an extensive comprehensive network of roads and expressways 4. systematic town planning to minimize the need to travel.	Traffic control manually by police to operate signal times. ATC system is planned. Exclusive bus lanes, but not enforced regularly. Contraflow lanes are fully enforced. Planned are extensions of expressways, surrounding the centre, as well as mass transit systems. Especially a good public transport (buses and MRT integrated) is absent and urgently needed.	n.i.

SOURCE: compiled from country papers presented at *Workshop on Motor Vehicle Emission Control*. organised by Environmental Health Centre of World Health Organization (WHO), 26-30 September 1994, Kuala Lumpur, Malaysia. Except for Thailand data, which are taken from "Congestion Management and Air Quality: Lessons from Bangkok and Mexico City", V. Setty Pentakur, in *Asian Journal of Environmental Management*. Vol.1, No.2, November 1993.

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NFG: National focal group
CDU: Coal development and utilization
C&E: conservation & efficiency
EEP: Energy-environment planning
EPSM: Electric power system management
NG&PD: Natural gas and petroleum development
PACE-E: Programme for Asian Cooperation on Energy and the Environment
REED: Rural energy-environment development