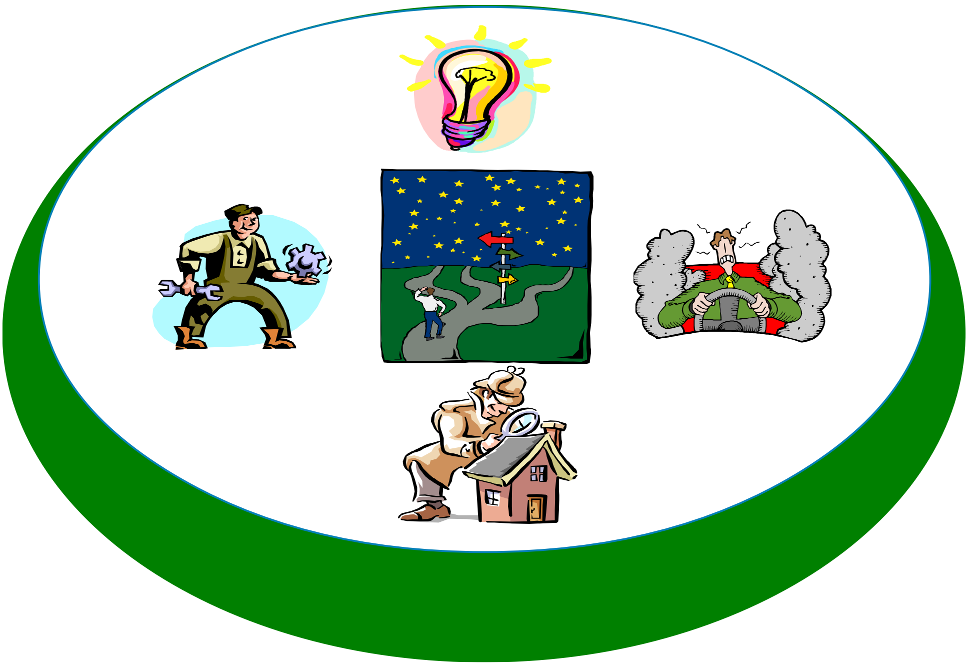
ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC

End-use Energy Efficiency and Promotion of a Sustainable Energy Future

Energy Resources Development Series No. 39



United Nations

ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC

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Foreword

Energy has long been recognized as an essential ingredient for the sustenance of life and as a powerful booster for an economy. The recent revelation of its strong relationship with environmental issues has further strengthened its social implications.

The ESCAP regional gross domestic product (GDP) rose by approximately 6 per cent, almost three points higher than the 2001 rate, and three points higher than the expansion of global output in 2003. This is in spite of an energy intensity about 50 per cent higher than the world average. The developing economies in the region, the largest contributors to the region's lift in GDP, have energy intensity almost three times the world average. Therefore, there is huge potential and a strong need for higher GDP growth by lessening the utilization of total primary energy sources, i.e., by increasing the efficiency of the economy. The world's most efficient economies, with the lowest energy intensity, are also from this region, which enhances the scope for stronger intraregional cooperation.

On issues concerning energy for sustainable development, the World Summit on Sustainable Development, held in Johannesburg in September 2002, emphasized more efficient use of energy and energy policies supportive of developing countries' efforts to eradicate poverty. Subsequently, the Ad Hoc Expert Group Meeting on End-use Energy Efficiency towards Promotion of a Sustainable Energy Future, held in November 2002, reviewed and provided expert advice on major issues, concerns and policy options for further improving energy efficiency, promotion and planning. Conducive national policy and regulatory frameworks are essential if industrial manufacturers, commercial distributors and residential consumers are to be expected to give greater preference to energy efficiency. Dissemination, application and adaptation of more resource-efficient and environmentally friendly energy technologies will be crucial.

It is heartening to note that the Expert Group, which included government experts and policy makers, senior researchers and academics, as well as civil society and NGO representatives, identified issues and actions for regional and subregional cooperation and also national follow-up to the implementation of the recommendations adopted at the World Summit on Sustainable Development related to integrated development for a sustainable energy future. The recommendations are classified under the general, industry, road transport, construction and buildings and electrical appliances

categories, as well as in the areas of activity of international organizations. All efforts have been made to present the outcome of the meeting and its documents in sequence with situational analysis, policy options and country experiences, making it more lucid and useful to the target audience.

Major inputs used in the preparation of chapters 2, 3, 4 and 5 of this book were received from the following consultants: Ponudurai Rajamanikam, Adrian Bradbrook, Brahmanand Mohanty and Peter du Pont, respectively. Apart from those, the other participants in the Ad Hoc Expert Group Meeting, who attended the meeting in their personal capacity and contributed significantly to the preparation of the above-mentioned chapters through their presentations and interactions were: M.A. Rashid Sarkar (Bangladesh), Sat Samy (Cambodia), Tri Mumpuni (Indonesia), Mayam Ayumi (Indonesia), S.M. Sudeghzadeh (Islamic Republic of Iran), Abdol Reza Karbassi (Islamic Republic of Iran), Shuichi Kawano (Japan) as keynote speaker, Jeong-In-Kim (Republic of Korea), Jai Ok Kim (Republic of Korea), Soontorn Boonyatikarn (Thailand) and Nyguyen Huu Dung (Viet Nam). Other experts, contributing through active participation in the meeting in their own capacity were: Masahiro Miyazaki (Japan), Phorntippha Boonie Kerr (Thailand), Pongthep Phinainitisatra (Thailand), Sommai Phon-Amnuaisuk (Thailand) and Chirasak Boonrowd (Thailand). Among the members of the Expert Group were Romeo Pacudan, representing the United Nations Environment Programme (UNEP), and Jan van den Akker, representing the United Nations Development Programme (UNDP), who presented papers and participated in the meeting. Gayathry (Malaysia) extended significant cooperation in obtaining some data.

ESCAP wishes to acknowledge the valuable contributions made by the participating experts and resource persons. ESCAP expresses its appreciation to Binoy Krishna Choudhury, Energy Management Department, Indian Institute of Social Welfare and Business Management, India and Ms. Maritess I. Cabrera, Asian Institute of Technology, for their contribution in the technical editing of this publication.

It is our sincere hope that readers and users of this publication will find it useful and informative. In particular, we also hope that this publication draws the interest and attention of the policy makers in different government bodies, the decision-making authorities in corporate sectors and non-government organizations, as well as academics and researchers, including other individuals working in this field, particularly those in the ESCAP region.

Preface

Energy services move today's civilization. Such an indispensable element has also become a cause of concern to the global community primarily for two reasons: dwindling fossil fuel resources and the environmental impact of unsustainable consumption and production patterns.

The representatives of the peoples of the world, assembled at the World Summit on Sustainable Development, in Johannesburg, South Africa, from 2 to 4 September 2002, declared boldly that they assumed collective responsibility for advancing and strengthening the interdependent and mutually reinforcing pillars of sustainable development – economic development, social development and environmental protection – at the local, national, regional and global levels. Stressing the urgent need to change the course of development, and ensure a future where everyone's basic needs were met without further damage to the earth, five young people from different parts of the globe clearly sent perhaps the strongest message when they said that the children of the world were disappointed because too many adults were too interested in money and wealth to take notice of serious problems that affected everyone's future. They stressed that we could not buy another planet, and our lives and those of future generations depended on us.

The Johannesburg Summit emphasized issues concerning energy for sustainable development, namely, more efficient use of energy and energy policies supportive of the efforts of developing countries' to eradicate poverty and regularly evaluate available data to review progress to that end. The Summit, in which more than 22,000 people participated, called for action at all levels to accomplish the following:

(a) Recommend that the policies of international financial institutions and other agencies' support developing countries, as well as countries with economies in transition, in their own efforts to establish policy and regulatory frameworks that create a level playing field between the following: renewable energy, energy efficiency, advanced energy technologies, including advanced and cleaner fossil fuel technologies, and centralized, distributed and decentralized energy systems;

(b) Support efforts to improve the functioning and transparency of energy markets as well as information about them to ensure consumer access to reliable, affordable, economically viable, socially acceptable and environmentally sound energy services;

(c) Introduce policies to reduce market distortions and promote energy systems compatible with sustainable development through the use of improved market signals and by removing market distortions;

(d) Take action, where appropriate, to phase out subsidies in this area that inhibit sustainable development;

(e) Promote cooperation between international and regional institutions and bodies dealing with different aspects of energy for sustainable development;

(f) Strengthen and facilitate, as appropriate, regional cooperation arrangements for promoting cross-border energy trade, including the interconnection of electricity grids and oil and natural gas pipelines;

(g) Promote an integrated approach to policy-making at the national, regional and local levels for transport services and systems to promote sustainable development, with a view to providing efficient transport, increasing energy efficiency and reducing pollution;

(h) Promote investment and partnerships for the development of sustainable, energy-efficient multimodal transport systems, including public mass transport systems.

The Plan of Implementation, in chapter III, "Changing unsustainable patterns of consumption and production", calls for strengthening and, where appropriate, facilitating dialogue forums among regional, national and international producers and consumers of energy.

Some of the important achievements of the Summit are as follows:

(a) Countries in Latin America and the Caribbean reaffirmed a pledge to use renewable energy to meet 10 per cent of their energy needs by 2010;

(b) An association of nine major electricity companies, the "E7", signed a range of agreements with the United Nations to facilitate technical cooperation for sustainable energy projects in developing countries. The South African energy utility Eskom announced a partnership to extend modern energy services to neighbouring countries;

(c) A partnership on cleaner fuels and vehicles was announced by the United Nations Department of Economic and Social Affairs, the United Nations Environment Programme (UNEP) and the United States Environmental Protection Agency, with broad support from partners in the private sector, the NGO community and Governments of developed and developing countries;

(d) UNEP launched the Global Network on Energy for Sustainable Development to promote the research, transfer and deployment of cleaner energy technologies to the developing world;

(e) The European Union announced a $700-million partnership initiative on energy and the United States of America stated that it would invest up to $43 million in 2003. Germany announced a contribution of 500 million euros over the next five years to promote cooperation on renewable energy;

(f) During the Summit process, the United Nations received a total of 32 partnership submissions for energy projects with over $26 million in resources.

A number of meetings of the Commission on Sustainable Development and meetings of the Conference of Parties, such as the eighth session of the Conference of Parties, held in New Delhi in November 2002, stressed several issues related to a sustainable energy future, including the actions needed to diversify energy supply by developing advanced, cleaner, more efficient, affordable and cost-effective energy technologies, including fossil fuel technologies and renewable energy technologies, hydro included, and their transfer to developing countries on concessional terms as mutually agreed. At its eleventh session, held in April 2003, the Commission on Sustainable Development decided to focus on energy for sustainable development as one of the issues in its thematic cluster for the 2006-2007 cycle.

The Ad Hoc Expert Group Meeting on End-use Energy Efficiency towards Promotion of a Sustainable Energy Future was organized in Bangkok in November 2002 to solicit experts' views in this emerging area and achieve a consensus to formulate concrete recommendations for the improvement of end-use energy efficiency in Asia and the Pacific with a view to promoting a sustainable energy future. The present publication is primarily based on the deliberations and discussions of the meeting as well as the presentations and recommendations made by the experts who attended.

The Expert Group Meeting produced a number of findings and significant recommendations after deliberating on the four major energy-intensive sectors (industry, road transport, construction and buildings and domestic electrical appliances) as the potential areas for energy efficiency policy initiatives. It is envisaged that these deliberations, analyses, findings and recommendations will supply some food for thought with a view to assisting Governments, policy makers, planners, researchers and academics in the ESCAP member countries and areas to adopt appropriate policies in support of a sustainable energy future.

The secretariat, while preparing the manuscript, has emphasized consistency in presenting three facets of ensuring the decision-making process: better awareness, capacity-building, and policy initiatives and regulations. The secretariat would like to thank all concerned, in particular the authors of various documents or reports and the participants of the Expert Group Meeting, for their valuable support and contributions.

The success of this publication will depend on the usefulness and benefits it provides to you, who has the most important role in improving end-use energy efficiency for promoting of a sustainable energy future. The views, ideas and constructive criticism offered by the reader are essential and most welcome in making this work more rewarding.

Explanatory notes

The term "ESCAP region" is used to include all the countries and areas as indicated below (see map of ESCAP region next page).

- **East and North-East Asia:** China, Hong Kong (China), Japan, Democratic People's Republic of Korea, Republic of Korea, Macao (China), and Mongolia
- **South-East Asia:** Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam
- **South and South-West Asia:** Afghanistan, Bangladesh, Bhutan, India, Islamic Republic of Iran, Nepal, Pakistan, Sri Lanka and Turkey
- **North and Central Asia:** Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Russian Federation, Tajikistan, Turkmenistan and Uzbekistan
- **Pacific:** Australia, Fiji, Guam, Kiribati, Maldives, Marshall Islands, Federated States of Micronesia, New Zealand, Northern Mariana Islands, Palau, Papua New Guinea, Samoa, Solomon Islands, Timor-Leste, Tonga and Vanuatu

"Developed countries" refers to countries and areas with developed economies. Australia, Japan and New Zealand are the only developed countries in the ESCAP region.

"Developing countries" refers to countries and areas with developing economies as well as economies in transition (such as Armenia).

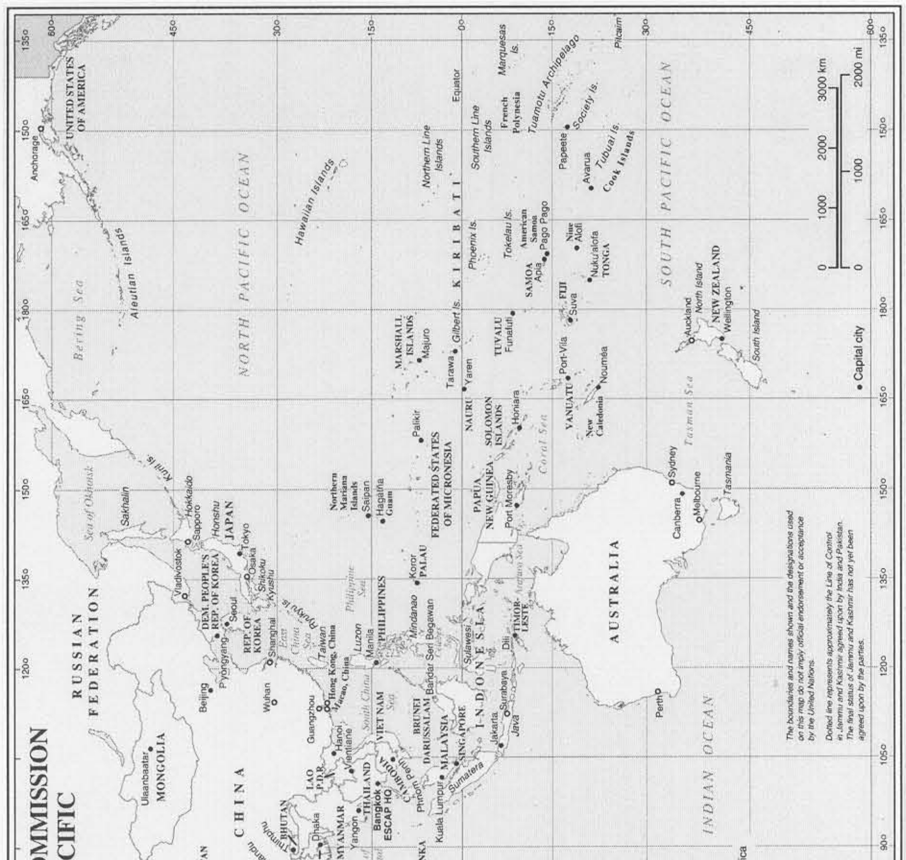
Growth rates are on an annual basis.

Unless otherwise mentioned, references to "tons" indicate metric tons.

Minor discrepancies in totals and percentages are due to rounding off.

In statistical tables, spaces are used to separate thousands in figures.

Monetary values are in United States dollars unless otherwise specified.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MONGOLIA
CHINA
INDIA
JAPAN
AUSTRALIA
INDIAN OCEAN
NORTH PACIFIC OCEAN
SOUTH PACIFIC OCEAN
KIRIBATI
NEW ZEALAND
• Capital city

The following symbols have been used in tables:

Two dots	(..)	indicate that the data are not available or are not separately reported
Two hyphens	(--)	indicate that the amount is nil or negligible
Blanks	( )	indicate that the item is not applicable
One dot	(.)	is used to indicate decimals

The units kgoe, toe, ktoe and mtoe stand for kg, tons, kilotons and million tons of oil equivalent, respectively. The term “billion” signifies a thousand million. The term “trillion” signifies a million million. A number of such terms, units and symbols are shown in the annex. The abbreviations used are shown separately in the list of abbreviations.

List of abbreviations

ACE	ASEAN Centre for Energy
APEC	Asia-Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
BAU	Business as usual
CAFE	Corporate average fuel economy
CDM	Clean Development Mechanism
CFL	Compact fluorescent lamps
CLASP	Collaborative Labeling and Appliance Standards Program
CSD	Commission on Sustainable Development
DOE	Department of Energy (Philippines)
DSM	Demand side management
EGAT	Electricity Generating Authority of Thailand
ENCON	Energy Conservation Act (Thailand)
ESCOs	Energy service companies
EU	European Union
FDI	Foreign direct investment
GDP	Gross domestic product
GEF	Global Environment Facility
IEA	International Energy Agency
IEEN	Norwegian Industrial Energy Efficiency Network
IEEO	Iran Energy Efficiency Organisation
IPCC	Intergovernmental Panel on Climate Change
IPPs	Independent power producers
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
KEMCO	Korea Energy Management Corporation
LPG	Liquefied petroleum gas

MIEEIP	Malaysian Industrial Energy Efficiency Improvement Project
MIME	Ministry of Industry, Mines and Energy (Cambodia)
NEDO	New Energy and Industrial Technology Development Organization
NG	Natural gas
NGO	Non-governmental organization
OECD	Organization for Economic Cooperation and Development
PV	Photovoltaic
R&D	Research and development
RD&D	Research, development and demonstration
SAARC	South Asian Association for Regional Cooperation
SEC	Specific energy consumption
SMI	Small and medium-scale industries
SREP	Small renewable energy power plant
TFC	Total final energy consumption
TPES	Total primary energy supply
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
VES	Vehicle emission standard
WB	World Bank
WEC	World Energy Council
WSSD	World Summit on Sustainable Development
WTO	World Trade Organization

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Chapter 1

END-USE ENERGY EFFICIENCY IN ASIA AND THE PACIFIC: POTENTIAL FOR AND CHALLENGES TO IMPROVEMENT

1.1. Introduction

The growing demand for energy and the environmental pollution associated with it have raised serious concern all over the world, including the ESCAP region. Most countries in the region are heavily dependent on fossil fuels, a major input for continued economic growth. However, unsustainable consumption of energy, particularly fossil fuels, has had adverse environmental impacts, including the emission of greenhouse gases into the atmosphere.

Fossil fuel reserves, which are limited, are available only in a few countries. Countries that do not have the financial resources to procure petroleum and coal therefore have unmet energy needs, and this has affected their economic growth. Those with adequate resources have managed to diversify their energy mix by exploiting indigenous energy resources, such as hydropower, geothermal energy and biomass. However, such resources are inadequate for the energy needs of many countries, which must resort to imports in order to supplement their energy supply.

This unsustainable pattern of energy demand growth is serious in the ESCAP region because of the huge and growing population, which requires substantial quantities of energy for economic development. While some countries in the region have reached the developed stage, many others are still struggling to provide basic services and infrastructure facilities, among others, to support their growing populations.

One of the ways to attain sustainable development in the region is to promote **end-use energy efficiency**, or the more efficient use of final energy or useful energy in industry, services, agriculture, households, transportation and other areas (see figure 1-1). These sectors use various types of equipment and devices that consume energy at varying levels of efficiency depending on their characteristics and working conditions, among others. While there are many examples of energy efficiency having been

Figure 1-1. Areas of potential for energy efficiency

Energy System

Energy Sectors

Extrac and treatment	Gas well	Gas well	Coral mine		Uranium mine	Oil well	Agroforestry
Primary energy	Natural gas	Natural gas	Coral, lignite	Sunlight	Uranium	Oil	Biomass
Conversation technologies		Heat Production	Power plant, cogeneration	Photovoltaic cell	Power plant	Refinery	Charcoal, ethanol plant
Distribution technologies	Gas grid	District heat network	Electricity grid	Electricity grid	Electricity grid	Rail pipeline	Track
Final energy	Natural gas	District, heat (hot water, steam)	Electricity	Electricity	Electricity	Kerosene	Charcoal, ethanol
Conversion of Final energy	Oven, boiler	Local distribution	Electric arc furnace	Light bulb, TV set	Freezer	Stoves, aircraft	Stoves, automobiles
Useful energy	Heat from radiators	Cooling, heating	Melting heat	Light emission	Cooling	Cooking heat, acceleration, overcoming air resistance	Cooking heat, acceleration, overcoming air resistance
Technology producing the demanded service	Oven, boiler	Local distribution	Electric are furnace	Light, bulb, TV set	Freezer	Stoves, aircraft	Stoves, automobiles

Energy Service

Energy services	Space conditioning	Space conditioning	Steel making	Illumination, communication	Food storage	Cooked food, air transportation	Cooked food, road transportation

Source: UNDP/UNDESA/WEA (2000). *World Energy Assessment: Energy and the Challenge of Sustainability* (United Nations Development Programme, Bureau for Development Policy, New York).

attained in equipment and devices in various economic sectors, there remain enormous opportunities for end-use energy efficiency in many developing countries in the ESCAP region. Many countries in the region have taken steps in this direction and have achieved financial and energy savings. However, several barriers still hamper the promotion and wider dissemination of increased end-use energy efficiency.

For the ESCAP region, realizing the potential for energy saving will depend highly on the policies adopted to promote end-use energy efficiency. Several policy options are presented in succeeding chapters, particularly for the residential, industrial, transportation, public and commercial sectors, the major energy-consuming sectors in the countries of the region.

1.2. Situation analysis of end-use energy efficiency

The ESCAP region has an enormous, growing population which is expected to use more resources, including energy, to achieve economic growth. More often than not, however, economic development comes at a cost to the environment.

Most of the countries in the region are dependent on depletable fossil fuels to support their economies, but only a few are endowed with energy resources. However, all countries have various types of renewable energy sources that they can tap for power generation and other energy applications. Diversifying the energy mix through the use of indigenous energy resources has enabled many countries to reduce their dependence on energy imports. Improving energy utilization is a good option for reducing energy demand at all levels and sectors of society, results in energy and financial savings, and ultimately contributes to economic development.

1.2.1. Socio-economic and environmental situation

Table 1-1 shows the major indicators of Asian and Pacific countries. Highlights of some these indicators are discussed below.

Population dynamics

In 2001, the ESCAP region had a population of 3.71 billion people or 62 per cent of the world's total. China, India and Indonesia, the most populous countries in the region, are ranked first, second and fourth most populous countries in the world. These countries alone accounted for 67 per cent of the region's population in 2001.

Table 1-1. Selected demographic, macroeconomic and environmental indicators, 2001

Country	Population (thousands)	Annual growth rate (per cent)	Projected population, 2025 (thousands)	GDP (current \$ billion)	Annual GDP growth (per cent)	GDP per capita (\$)	CO_2 emissions, 1999 (metric tons per capita)
World	**6 148 000**	**..**	**..**	**31 135.82**	**1.13**	**5 080**	**3.77**
ESCAP	**3 781 169**	**1.20**	**4 726 822**	**8 096**	**..**	**2 172**	**2.51**
East and North-East Asia	*1 492 063*	*0.70*	*1 682 882*	*5 898*	..	*3 990*	*3.17*
China	1 284 972	0.80	1 470 787	1 159	7.30	911	2.25
Hong Kong, China	6 879	1.10	8 762	163	0.47	24 215	6.23
Japan	127 100	0.20	120 913	4 141	–0.58	32 601	9.12
Democratic People’s Republic of Korea	22 428	0.70	25 872	--	..	--	9.41
Republic of Korea	47 676	0.80	52 541	427	3.10	9 024	8.44
Macao, China	449	1.00	529	6	2.13	14 089	3.50
Mongolia	2 559	1.10	3 478	1	1.10	420	3.17
South-East Asia	*529 455*	*1.40*	*678 842*	*544*	..	*1 041*	*1.48*
Brunei Darussalam	346	2.30	473	5	1.00	14 088	14.15
Cambodia	13 441	2.50	22 310	3	6.30	278	0.06
Indonesia	214 840	1.30	272 911	141	3.44	676	1.16
Lao People’s Democratic Republic	5 403	2.30	8 721	2	5.68	324	0.08
Malaysia	23 639	2.00	31 326	88	0.45	3 699	5.44
Myanmar	48 364	1.30	60 243	--	9.70	--	0.20
Philippines	77 131	1.90	107 073	71	3.22	911	0.98
Singapore	4 148	3.20	4 998	85	–2.37	20 545	13.73
Thailand	62 968	1.00	65 299	115	1.94	1 885	3.31
Viet Nam	79 175	1.30	105 488	33	6.84	414	0.60
South and South-West Asia	*1 509 510*	*1.70*	*2 110 410*	*869*	*24.53*	*586*	*1.19*
Afghanistan	22 474	3.40	45 193	..	..	..	0.04
Bangladesh	140 369	2.10	210 823	47	5.27	352	0.20

Table 1-1. *(Continued)*

Country	Population (thousands)	Annual growth rate (per cent)	Projected population, 2025 (thousands)	GDP (current $ billion)	Annual GDP growth (per cent)	GDP per capita ($)	CO_2 emissions, 1999 (metric tons per capita)
Bhutan	2 141	2.60	3 843	1	7.00	637	0.49
India	1 025 096	1.60	1 351 801	481	5.45	466	1.08
Iran (Islamic Republic of)	66 475	1.50	99 343	114	4.81	1 767	4.80
Maldives	300	3.00	580	1	3.45	2 229	1.74
Nepal	23 593	2.30	38 706	6	4.75	236	0.15
Pakistan	142 326	2.40	250 981	59	2.74	415	0.73
Sri Lanka	19 104	1.00	22 529	16	–1.45	836	0.47
Turkey	67 632	1.40	86 611	145	–7.49	2 119	2.99
North and Central Asia	*219 095*	*–0.10*	*214 539*	*360*	..	*1 693*	*8.15*
Armenia	3 788	0.10	3 736	2	9.58	686	0.98
Azerbaijan	8 096	0.70	9 076	6	9.88	705	4.21
Kazakhstan	16 095	–0.40	16 090	22	13.47	1 487	7.38
Kyrgyzstan	4 986	1.30	6 460	2	5.33	308	0.97
Russian Federation	144 664	–0.60	125 687	310	5.00	2 141	9.82
Tajikistan	6 135	0.80	8 066	1	10.20	169	0.83
Turkmenistan	4 835	2.00	6 844	6	20.50	1 097	6.36
Uzbekistan	25 257	1.50	34 203	11	4.20	455	4.78
Pacific	*31 046*	*1.40*	*40 149*	*426*	*26.24*	*13 514*	*12.43*
American Samoa	66	2.90	129	..	..	..	..
Australia	19 388	1.20	23 523	369	3.90	19 019	18.16
Cook Islands	19	-0.50	23	..	..	..	..

Table 1-1. *(Continued)*

Country	Population (thousands)	Annual growth rate (per cent)	Projected population, 2025 (thousands)	GDP (current $ billion)	Annual GDP growth (per cent)	GDP per capita ($)	CO_2 emissions, 1999 (metric tons per capita)
Fiji	823	1.10	954	2	4.32	2062	0.91
French Polynesia	237	1.60	318	..	..	..	2.32
Guam	158	1.90	242	..	..	..	26.79
Kiribati	93	2.50	112	--	1.56	430	0.29
Marshall Islands	53	2.00	69	--	1.66	1937	..
Micronesia (Federated States of)	120	1.90	204	--	0.90	1914	..
Nauru	12	1.80	20	..	..	..	..
New Caledonia	220	2.00	316	..	..	..	7.98
New Zealand	3901	0.80	4418	50	3.20	13 101	8.08
Niue	2	–3.10	2	..	..	..	..
Northern Mariana Islands	81	5.50	157	..	..	..	..
Palau	20	2.20	30	--	1.00	6280	12.86
Papua New Guinea	4920	2.30	8023	3	–3.38	552	0.48
Samoa	159	0.30	200	--	6.20	1404	0.82
Solomon Islands	463	3.40	943	--	–9.98	683	0.40
Timor-Leste	753	2.17		--	18.24	517	..
Tonga	101	0.60	110	--	0.47	1371	1.21
Tuvalu	10	0.90	14	..	..	..	..
Vanuatu	202	2.60	342	--	–1.85	1096	0.42

Sources: a. United Nations (2003). *World Population Prospects: The 2002 Revision* (New York, United Nations).
b. World Bank (2003). *World Development Indicators* database accessed on February 2004 from <http://devdata.worldbank.org/data-query/>.

Note: Population-related data are from United Nations (2003), while economic and environmental data are from the World Bank (2003).

ESCAP estimates that the region's population, which has grown by 1.2 per cent per annum on average, will reach 4.73 billion by 2025. Developed countries (Australia, Japan and New Zealand), which accounted for nearly 4 per cent of the region's population in 2001, would see their populations stay the same by 2025 or slightly decrease from current levels. On the other hand, the population in most developing countries would increase by about 20 per cent.

In 2001, South and South-West Asia was the most populous subregion, accounting for 40 per cent of the region's population, followed by East and North-East Asia at 40 per cent. South-East Asia (14 per cent), North and Central Asia (6 per cent) and the Pacific (1 per cent) accounted for the balance. By 2025, the distribution of the population in these areas will have slightly changed, with South and South-West Asia increasing the most and accounting for 45 per cent of the region's population.

Among the large developing countries, the population growth rate in 2001 ranged from 0.8 per cent in China to 2.4 in Pakistan. Only the Russian Federation had a negative population growth (–0.6 per cent per annum).

Macroeconomic indicators

In 2001, Japan had the highest GDP (over $4 trillion) in the ESCAP region followed by China (about $1.2 trillion), India ($481 billion) and the Republic of Korea ($427 billion). These countries alone accounted for nearly 77 per cent of the region's GDP. In terms of GDP growth rate, Turkmenistan, with a rate of 20.50 per cent per annum, led all countries in the region, followed by Timor-Leste (18.24 per cent) and Kazakhstan (13.47 per cent). Meanwhile, GDP per capita was highest in Japan ($32,600 per capita) followed by Hong Kong, China ($24,215), Singapore ($20,545), and Australia (over $19,000).

Environmental indicators

A very significant environmental impact from the various economic sectors including energy, is the emission of air pollutants, particularly greenhouse gases (GHG), such as carbon dioxide (CO_2). The magnitude of the environmental impact associated with GHG emissions from fossil fuel combustion, which supported industrialization, is not unknown. There is now at least an acknowledgement of energy linkages to regional and global environmental problems and of their implications. The environmental degradation caused by GHG emissions from conventional energy consumption has become a major threat to human health and the quality of life and has affected the ecological balance and biological diversity. Emissions from anthropogenic GHGs are altering the atmosphere in ways that may already have a discernible influence on climate change.

The level of emissions of CO_2, one of the major GHGs, is used as an indicator of environmental degradation. A higher level of CO_2 emission not only indicates a greater risk through the greenhouse effect but also more dependence on fossil fuels, a non-renewable resource. The ESCAP region had an average per capita CO_2 emission of 2.49 tons per year in 1999 (see table 1-1). This value is much lower than the world average. The average per capita CO_2 emission for developed countries in the region was 10.3 tons per year, which is about four times that of the developing countries. Countries with the highest per capita emission in the region include Australia and Brunei Darussalam.

1.2.2. Energy and sustainable development

While the ESCAP region may have significant energy resources, those resources are not equally distributed among the countries of the region. The huge population and dynamic growth of individual countries necessitate the use of massive quantities of energy. Some countries in the ESCAP region have abundant supplies of fossil fuels and renewable energy sources. Through trade, other countries with insufficient indigenous energy supplies can tap into these resources. How long these resources would last would depend on the consumption patterns, economic conditions and activities as well as climate in the various countries in the region.

An overview of the energy sector in the ESCAP region is presented in table 1-2 showing information about energy supply and consumption in selected countries in the region. Some parameters that indicate the sustainability of the energy sector in the region are briefly reviewed, the main data for which are shown in table 1-3. Box 1 shows the description and implications of these sustainability parameters.

Table 1-2. Major energy information for selected countries in Asia and the Pacific

Country	TPES mtoe	TPES per capita toe/person	Energy production mtoe	Proven fossil fuel reserves mtoe	Electricity generation mtoe	Own use & distribution losses per cent	TFC mtoe
World	**10 029**	**1.64**	**10 209**	**830 303**	**1 331.0**	**18**	**6 995**
ESCAP region	**4 002**	**0.95**	**3 997**	**374 169**	**471.0**	**21**	**2 785**
Developing countries	*3 348*	*0.70*	*3 627*	*321 160*	*360.0*	*24*	*2 356*
Developed countries	*655*	*4.35*	*369*	*52 681*	*110.9*	*12*	*429*
East and North-East Asia	*1 892*	*1.29*	*1 296*	*74 467*	*244.2*	*17*	*1 287*
China	1 139	0.90	1 139	73 666	126.6	22	785
Democratic People's Republic of Korea	20	--	19	366	1.7	--	18
Hong Kong, China	16	2.42	--	--	2.8	12	12
Japan	521	4.09	104	402	88.9	11	342
Republic of Korea	195	4.11	34	33	24.2	11	130
South-East Asia	*402*	*0.80*	*438*	*10 436*	*33.6*	*14*	*285*
Indonesia	152	0.73	234	6 268	8.7	17	118
Malaysia	52	2.17	78	2 258	6.1	8	32
Myanmar	12	0.25	15	--	0.5	25	11
Philippines	42	0.54	20	328	4.0	17	25
Singapore	29	7.06	--	--	2.8	18	11
Thailand	76	1.23	40	1 229	8.8	12	53
Viet Nam	39	0.49	50	352	2.6	16	35
South and South-West Asia	*825*	*0.56*	*788*	*79 264*	*79.7*	*31*	*615*
Bangladesh	20	0.15	16	963	1.4	23	17
India	531	0.51	438	41 878	49.6	35	380
Iran (Islamic Republic of)	120	1.86	247	32 426	11.2	22	99
Nepal	8	0.36	7	--	0.2	27	8
Pakistan	65	0.46	49	1 672	6.2	30	52
Sri Lanka	8	0.42	4	--	0.6	19	7
Turkey	72	1.06	26	2 324	10.6	26	52

Table 1-2. *(Continued)*

Country	TPES mtoe	TPES per capita toe/person	Energy production mtoe	Proven fossil fuel reserves mtoe	Electricity generation mtoe	Own use & distribution losses per cent	TFC mtoe
North and Central Asia	*749*	*3.43*	*1 210*	*157 724*	*91.4*	*28*	*511*
Armenia	2	0.60	1	--	0.5	33	1
Azerbaijan	12	1.43	20	1 743	1.6	25	6
Georgia	2	0.46	1	--	0.6	28	2
Kazakhstan	40	2.71	84	17 771	4.8	29	21
Kyrgyzstan	2	0.45	1	--	1.2	38	2
Russian Federation	621	4.29	996	134 611	76.5	29	427
Tajikistan	3	0.49	1	--	1.2	16	3
Turkmenistan	15	2.82	50	1 859	0.9	30	10
Uzbekistan	51	2.02	56	1 740	4.1	18	38
Pacific	*134*	*5.74*	*265*	*52 279*	*22.1*	*16*	*87*
Australia	116	5.94	250	51 884	18.7	17	73
New Zealand	18	4.75	15	395	3.4	15	14

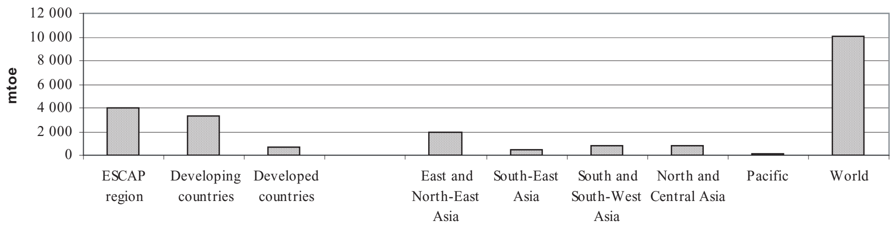
Sources:
a. BP (2003). *Statistical Review of World Energy 2003*, 53[rd] edition.
b. Energy Information Agency (2003). "Philippines: Country analysis brief", August 2003, Department of Energy, http://www.eia.doe.gov/emeu/cabs/apec/indicatorstbl.html.
c. International Energy Agency (2003). *Energy Balances of Non-OECD Countries* (Paris, OECD/IEA).
d. International Energy Agency (2003). *Energy Balances of OECD Countries* (Paris, OECD/IEA).
e. Sarkar, Rashid (2002). "*Realization of productivity and energy efficiency gains in industrial establishments in Bangladesh*", presented at the Ad Hoc Expert Group Meeting in End-Use Energy Efficiency towards Promotion of a Sustainable Energy Future, Bangkok, 18-20 November 2002.

Notes:
a. Most of the data come from IEA, except those for fossil fuel reserves, which are based on other sources listed below.
b. TPES – Total primary energy supply.
c. TFC – Total final energy consumption.

Energy supply and production

The ESCAP region had around 4 billion tons oil equivalent (toe) of energy supply, accounting for nearly 40 per cent of the world's total primary energy supply (TPES) in 2001 (see figure 1-2). Much of this supply is in the form of fossil fuels (coal, oil and natural gas), hydropower and combustible renewables and waste.

Figure 1-2. Total primary energy supply in Asia and the Pacific, 2001



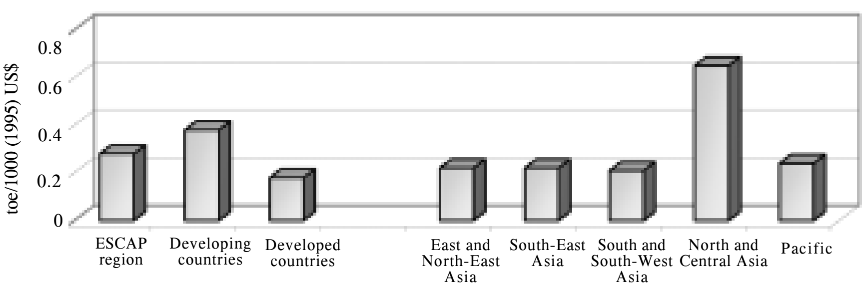
The developing member countries accounted for 84 per cent of the region's supply, and the developed countries 6 per cent. East and North-East Asia accounted for the bulk of the region's primary energy supply (47 per cent), owing mainly to contributions from China (60 per cent), Japan (28 per cent) and the Republic of Korea (10 per cent). South and South-West Asia accounted for 21 per cent of the region's supply owing to India (64 per cent), the Islamic Republic of Iran (15 per cent), Turkey (9 per cent) and Pakistan (8 per cent). North and Central Asia contributed 10 per cent to the region's TPES owing primarily to the share from the Russian Federation. Meanwhile, the Pacific countries, comprising Australia and New Zealand, accounted for only 3 per cent of the region's TPES.

The ESCAP region, which accounted for 62 per cent of the world's population and 40 per cent of the total primary energy supply in 2001, appears to have a rather low supply of energy per capita or TPES intensity. In 2001, the region's TPES per capita was around 0.95 toe per capita, which is lower than the world figure (1.64 toe per capita). Developed countries in the region had four times this value, while the developing countries had around 0.70 toe per capita. The Pacific (including Australia and New Zealand) had the highest TPES intensity (5.74 toe per capita) among the subregions, followed by North and Central Asia (3.43), East and North-East Asia (1.29), South-East Asia (0.80), and South and South-West Asia (0.56). Singapore had the highest TPES intensity at over 7 toe per capita, followed by Australia (5.94), New Zealand (4.75), the Russian Federation (4.29), the Republic of Korea (4.11) and Japan (4.09).

Although a high TPES intensity is believed to indicate a high standard of living, it is not always desirable because it could also point to higher wastage of energy, resulting in lower end-use energy efficiency.

Meanwhile, most developing countries and transitional economies in the region had very high energy intensities compared with developed countries. In 2001, the energy intensity among developing countries was 0.38 toe per $1,000 (see table 1-3 and figure 1-3), while that for developed countries was 0.18 toe per $1,000. The value for the ESCAP region was 0.28 toe per $1,000, which is higher than the world figure of 0.24 toe per $1,000. North and Central Asia had the highest energy intensity among the subregions at 0.65 toe per $1,000, and South and South-West Asia had the lowest (0.21). The countries with the highest energy intensity were Uzbekistan (0.91 toe per $1,000), Turkmenistan (0.72) and Azerbaijan (0.53).

Figure 1-3. Energy intensity in Asia and the Pacific, 2001



It is possible to further improve the present energy intensity, thus realizing economic growth without increasing energy consumption and CO_2 emission. This implies the need to review and improve on policies that are desirable in the developing countries to support the lowering of energy intensity.

Table 1-3. Some derived sustainability parameters for selected countries in Asia and the Pacific, 2001

Country	TFC/TPES	Energy intensity (kg/1995 $ PPP)	Share of renewables (per cent)	Share of hydropower in electricity generation (per cent)	Reserves of fossil fuels to consumption (years)	Reserves of fossil fuels to TPES (years)	EP/TPES
World	**70**	**0.24**	**11**	**17**	**102**	**83**	**1.02**
ESCAP region	**70**	**0.28**	**15**	**15**	**119**	**93**	**1.00**
Developing countries	*71*	*0.38*	*19*	*18*	*97*	*80*	*1.14*
Developed countries	*66*	*0.18*	*2*	*8*	*123*	*96*	*0.48*
East and North-East Asia	*68*	*0.22*	*12*	*13*	*49*	*39*	*0.69*
China	69	0.24	19	19	82	65	1.00
Democratic People's Republic of Korea	86	--	5	53	20	18	0.94
Hong Kong, China	72	0.10	--	--	--	--	--
Japan	66	0.17	1	8	1	1	0.20
Republic of Korea	67	0.29	1	1	--	--	0.18
South-East Asia	*71*	*0.22*	*26*	*13*	*37*	*26*	*1.09*
Indonesia	77	0.27	32	10	62	41	1.54
Malaysia	63	0.28	5	10	46	44	1.50
Myanmar	91	0.06	77	32	--	27	1.26
Philippines	59	0.15	23	15	14	8	0.47
Singapore	36	0.35	--	--	--	--	--
Thailand	71	0.21	17	6	20	16	0.53
Viet Nam	90	0.26	58	59	24	9	1.28
South and South-West Asia	*75*	*0.21*	*31*	*14*	*144*	*96*	*0.95*
Bangladesh	83	0.10	38	6	77	47	0.79
India	71	0.20	39	13	133	79	0.82
Iran (Islamic Republic of)	83	0.34	1	4	273	270	2.06
Nepal	99	0.29	85	99	--	--	0.87
Pakistan	81	0.27	37	26	44	26	0.75
Sri Lanka	93	0.14	53	47	--	--	0.56
Turkey	71	0.19	9	20	37	32	0.36

Table 1-3. *(Continued)*

Country	TFC/TPES	Energy intensity (kg/1995 $ PPP)	Share of renewables (per cent)	Share of hydropower in electricity generation (per cent)	Reserves of fossil fuels to consumption (years)	Reserves of fossil fuels to TPES (years)	EP/TPES
Central and North Asia	*68*	*0.65*	*1*	*21*	*231*	*211*	*1.62*
Armenia	61	0.24	--	17	--	--	0.26
Azerbaijan	56	0.53	--	7	153	151	1.69
Georgia	82	0.18	27	80	--	--	0.52
Kazakhstan	53	0.47	--	15	490	441	2.08
Kyrgyzstan	72	0.18	--	91	--	--	0.61
Russian Federation	69	0.67	1	20	238	217	1.60
Tajikistan	88	0.44	--	98	--	--	0.42
Turkmenistan	64	0.72	--	--	120	121	3.29
Uzbekistan	75	0.91	--	13	35	34	1.10
Pacific	*65*	*0.24*	*5*	*15*	*429*	*390*	*1.98*
Australia	63	0.24	4	8	476	449	2.17
New Zealand	75	0.25	6	54	31	22	0.82

Sources:
a. BP (2003). *Statistical Review of World Energy 2003*, 53rd edition, accessed on November 2003 from <http//www.bp.com>.
b. Energy Information Agency (2003). "Philippines: Country analysis brief", accessed on November 2003 from <http://www.eia.doe.gov/emeu/cabs/apec/indicatorstbl.html>.
c. International Energy Agency (2003). *Energy Balances of Non-OECD Countries* (Paris, OECD/IEA).
d. International Energy Agency (2003). *Energy Balances of OECD Countries* (Paris, OECD/IEA).
e. Sarkar, Rashid (2002). "*Realization of productivity and energy efficiency gains in industrial establishments in Bangladesh*", presented at the Ad Hoc Expert Group Meeting on End-Use Energy Efficiency towards Promotion of a Sustainable Energy Future, Bangkok, 18-20 November 2002.

Notes:
a. Most of the data were calculated based on statistics from IEA (see Table 1-2), except those for fossil fuel reserves, which are based on other sources listed below.
b. All data are for 2001, except for reserves of fossil fuels which are for 2002.
c. TFC/TPES – Ratio of total final consumption to total primary energy supply; EP/TPES – Ratio of total energy production to total primary energy supply; PPP – purchasing power parity.

Box 1-1. Seven sustainability parameters

Ratio of TFC to TPES: This non-dimensional quantity indicates the ability of a nation to make energy resources (TPES) available for use in different service sectors, like industry, transport, construction and buildings, commerce, domestic and agriculture. The difference of this value from 1 indicates the losses in the process of fossil fuel production, transportation, conversion, supply and distribution, etc. As some of these losses are inevitable in the energy conversion cycles (like Rankine Cycle, Carnot Cycle, etc.), its value may increase if the share of electricity increases in the energy mix of a nation. It is thus directly linked with the development process of the nation. The share of electricity in the energy mix is normally higher in developed nations than in developing nations. However, a higher value indicates higher utilization of TPES and definitely lower losses, many of which are avoidable, like material losses while handling and storing of fossil fuels, distribution losses of energy carriers including electricity, wastage within the power plants. In general, a lower value indicates more irreversibility and losses, hence less sustenance.

Energy intensity: This is the ratio of TPES to GDP, expressed as tons of oil equivalent (toe) per $1,000. An efficient economy should be able to generate more GDP by utilizing less TPES. Thus, generally, the lower the energy intensity, the more developed the nation is and the higher the scope for sustenance. However, low intensity may also mean inadequate energy supplies in an economy, as evident in figure 1-2.

Share of combustible renewables and wastage in TPES: Combustible renewables are mainly biomass, which historically is the primary source of energy and even today is the major source in many developing countries. Utilization of wastes as energy resources is fast gaining popularity and already contributing a significant part to TPES in many developed countries. It is interesting to note that both the combustible renewables and wastes are favourable contributors to TPES in terms of sustainability, which will be higher if this share increases.

Share of hydropower in total electricity generation: Since hydro-electricity is a renewable energy resource, the higher the share, the better the sustainability. It may be noted that hydropower is the only significant renewable energy resource for electricity generation in this region, except for the contribution of geothermal energy in Indonesia, Japan and the Philippines. Wind energy is rapidly gaining ground, while solar PV is slowly moving into the energy mix.

Ratio of total reserve to total annual consumption of fossil fuels: The reserve to production ratio (R/P) is often used to estimate the life of the fossil fuels in a particular country or region. It may be noted that the amount of fossil fuel consumed is normally different from the production (P) because consumption = production + imports – exports. Therefore, the ratio of total reserves to total annual consumption of fossil fuels has been used here in place of the conventional R/P ratio. This is a crucial indicator because it projects the number of years that fossil fuels, on which civilization now depends excessively, will continue to be available. The numerator

Box 1-1. *(Continued)*

will increase as more successful exploration and discoveries as well as technological improvements lead to higher levels of reserves. However, the denominator will also increase as the population increases and a higher level of energy dependence causes the rate of fossil fuel consumption to rise. If the value of this ratio falls, it is a warning to the proponents of a sustainable energy future. This approach also takes into account the additional demand for coal after oil and gas are exhausted.

Ratio of proven reserve to TPES: The share of fossil fuels in TPES is increasing in developing countries, gradually approaching 100 per cent. If all the sources for TPES were fossil fuels, the life of the fossil fuels could be estimated from the ratio of proven reserves to TPES. However, for all practical purposes, the ratio of total reserves to total annual consumption, indicating the estimated number of years the fossil fuels would last, would be expected to be slightly higher; yet, it would remain unfavourable to sustainability in the long run.

Ratio of total energy production to TPES: In the short term, every country looks for self-reliance in energy production and use. That is achieved if this ratio is one or higher, which may indicate that the country is in no immediate danger as far as a sustainable energy future (in the short term) is concerned.

Fossil fuels

Some countries in the region have large reserves of fossil fuels. In 2002, the ESCAP region had over 374 billion toe or nearly 40 per cent of the world's fossil fuels reserves. Of these, the developing countries and economies in transition accounted for nearly 86 per cent. North and Central Asia accounted for 42 per cent of the region's total reserves, followed by South and South-West Asia (21 per cent), East and North-East Asia (20 per cent), the Pacific (14 per cent) and South-East Asia (3 per cent).

The countries with the largest fossil fuel reserves include the Russian Federation, which accounted for 16 per cent of the world's reserves, followed by China (9 per cent), Australia (6 per cent), India (5 per cent), the Islamic Republic of Iran (4 per cent), Kazakhstan (2 per cent) and Indonesia (1 per cent). Table 1-4 shows the countries with significant fossil fuel reserves in the region.

The ESCAP region is expected to be self-sufficient in fossil fuels for 119 years given the available reserves and the rate of consumption (see table 1-3 and figure 1-4). The world figure is 102 years. Much of this resource would come from the Pacific (Australia) and North and Central Asia (Kazakhstan, the Russian Federation, Azerbaijan and Turkmenistan), where reserves could last from 120 to 490 years. The reserves of India, China and Indonesia are expected to last for 133, 82 and 62 years, respectively.

Figure 1-4. Estimated duration of fossil fuel reserves based on annual consumption (Asia and the Pacific, 2001)

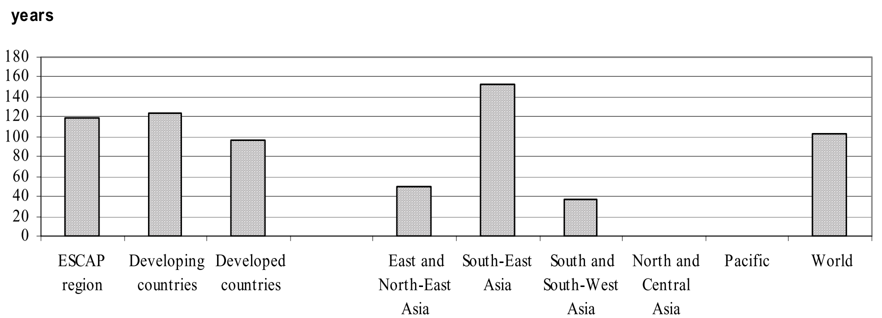


Table 1-4. Estimated reserves of fossil fuels, 2002

Country	Reserves (mtoe)
Russian Federation	134 611
China	73 666
Australia	51 884
India	41 878
Iran (Islamic Republic of)	32 426
Kazakhstan	17 771
Indonesia	6 268
Turkey	2 324
Malaysia	2 258
Turkmenistan	1 859
Azerbaijan	1 743
Uzbekistan	1 740
Pakistan	1 672
Thailand	1 229
Bangladesh	963
Japan	402
New Zealand	395
Democratic People's Republic of Korea	366
Viet Nam	352
Philippines	328
Republic of Korea	33

Source: BP (2003). *Statistical Review of World Energy 2003*, 53rd edition. Other references are shown in table 1-2.

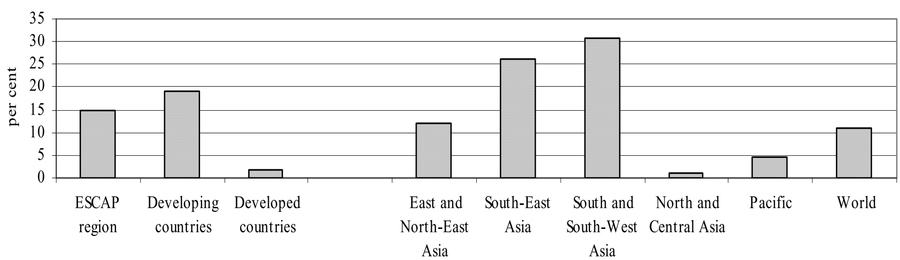
Many countries in the region are already importing fossil fuels. Some countries are almost totally dependent on external sources to meet their domestic requirement for fossil fuels. They include Singapore, Nepal, Kyrgyzstan, Tajikistan, and Hong Kong, China.

Combustible renewables and waste

Many countries in the region have abundant supplies of renewable energy, including combustible renewables or biomass. Were it not for this abundant energy supply, the world's reserves of fossil fuels would be declining at a much faster rate. A number of countries are highly dependent on this resource particularly for heating purposes in the domestic and commercial sectors. Even countries that have an ample supply of fossil fuels have diversified their energy mix to include combustible renewables to ensure energy security, lessen their dependence on this scarce resource and extend their fossil fuel reserves.

In 2001, the average share of combustible renewables and waste in the ESCAP region's total primary energy supply was 15 per cent (see table 1-3 and figure 1-5). In developed countries, the share was only 2 per cent, while in developing countries it was 19 per cent. Among the subregions, only North and Central Asia and the Pacific are not very dependent on biomass for energy. Among the countries in the region, Nepal had the largest share of combustible renewables to TPES at 85 per cent, followed by Myanmar (77 per cent), Viet Nam (58 per cent), Sri Lanka (53 per cent), India (39 per cent), Bangladesh (38 per cent), Pakistan (37 per cent) and Indonesia (32 per cent). Most of these countries have substantial fossil fuel reserves; yet, they are still dependent on combustible renewables, which are used mainly in the rural areas.

Figure 1-5. Share of combustible renewables and waste in TPES (Asia and the Pacific, 2001)



Hydropower

Another important renewable energy source is hydropower. Excluding geothermal energy, hydropower is the most significant renewable energy contributor to the total electricity generation mix in the region. The availability of this resource has reduced the fossil fuel dependence of some countries in the region. While hydropower accounted for only around 15 per cent of the region's electric power generation in 2001, it is the dominant source in the power generation mix of a number of countries, including Nepal, Tajikistan, Kyrgyzstan and Georgia. Other countries with significant hydropower utilization are shown in table 1-5.

Table 1-5. ESCAP member countries with a significant share of hydropower in electricity generation

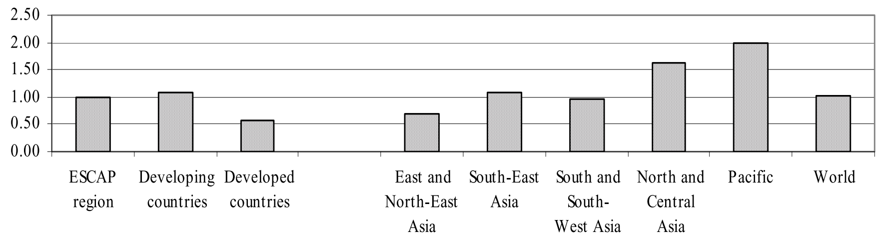
	Per cent
Nepal	98.8
Tajikistan	97.7
Kyrgyzstan	91.0
Viet Nam	59.5
New Zealand	53.8
Democratic People's Republic of Korea	52.5
Sri Lanka	46.9
Myanmar	32.2
Pakistan	26.2
Russian Federation	19.6
Turkey	19.5
China	18.9
Armenia	16.8
Philippines	15.4
Kazakhstan	14.6
India	12.8
Uzbekistan	12.5
Indonesia	10.5
Malaysia	9.9
Japan	8.1

Sources: a. IEA (2003). *Energy Balances for Non-OECD Countries* (Paris, OECD/IEA).
b. IEA (2003). *Energy Balances for OECD Countries* (Paris, OECD/IEA).

Energy production

In terms of energy production, the region as a whole is self-sufficient (the energy production (EP) to TPES ratio is equal to or more than one), and there does not seem to be any immediate danger of an acute shortage of energy. However, most countries in East and North-East Asia, excluding China, have low energy production (figure 1-6) and must therefore supplement their energy requirement by means of imports. Most countries in South and South-West Asia, excluding the Islamic Republic of Iran, are also energy deficient, with EP/TPES ratios ranging from 0.40 to 0.80. In South-East Asia, Indonesia, Malaysia, Myanmar and Viet Nam have EP/TPES ratios ranging from 1.25 to 1.53. On the other hand, the Philippines and Thailand have ratios lower than 0.60. Many countries in North and Central Asia (Azerbaijan, Kazakhstan, the Russian Federation, Tajikistan, Turkmenistan and Uzbekistan) are resource-rich, with EP/TPES ratios from 1.2 to 3.3.

Figure 1-6. Ratio of energy production to total primary energy supply, Asia and the Pacific, 2001



Electricity generation

Nearly 12 per cent of the ESCAP region's TPES is in the form of electricity (see table 1-2). In 2001, the ESCAP region produced around 470 mtoe of electricity, which is 35 per cent of the world's total. The developing countries in the region accounted for 76 per cent of electricity production, while the developed countries accounted for 24 per cent. East and North-East Asia produced more than half of the region's total electricity (52 per cent), followed by North and Central Asia (19 per cent), and South and South-West Asia (17 per cent). The Pacific countries accounted for 5 per cent. China had the highest electricity production, accounting for

27 per cent of the region's total, followed by Japan (19 per cent), the Russian Federation (16 per cent) and India (11 per cent).

Meanwhile, the ESCAP region's distribution losses and electricity for own use reached 21 per cent of total electricity generation in 2001. This is higher than the world average of 18 per cent. The developing countries in the region had a higher value for own use and distribution losses (24 per cent) compared with the developed countries (12 per cent). Most countries in South and South-West Asia, and North and Central Asia had losses higher than 20 per cent.

Energy consumption

The ESCAP region consumed 2,785 mtoe of energy, or 40 per cent of the world's total final energy consumption (TFC) in 2001 (see table 1-2). Developing countries and economies in transition accounted for 85 per cent of that amount, while developed countries accounted for the balance. East and North-East Asia accounted for 46 per cent of the region's energy consumption, followed by North and Central Asia (18 per cent), South and South-West Asia (22 per cent), South-East Asia (10 per cent) and the Pacific (3 per cent). China is the largest energy consumer in the ESCAP region, accounting for 28 per cent of regional energy consumption and 11 per cent of global energy consumption. The Russian Federation, India and Japan are the next largest energy consumers, accounting for 15 per cent, 14 per cent and 12 per cent, respectively, of the region's energy consumption.

Meanwhile, the ratio of energy consumption to supply (TFC/TPES ratio) in the region and in the world was 70 per cent in 2001 (see table 1-3). The developed countries of the region posted a 66 per cent TFC/TPES while the developing countries averaged 71 per cent. Among the countries in the region, those with ratios of 80 per cent or greater are Nepal (99 per cent), Sri Lanka (93 per cent), Myanmar (91 per cent), Viet Nam (90 per cent), Tajikistan (88 per cent), the Democratic People's Republic of Korea (86 per cent), the Islamic Republic of Iran (83 per cent) and Pakistan (81 per cent). Those with the lowest TFC/TPES ratios are Singapore (36 per cent), Kazakhstan (53 per cent), Azerbaijan (56 per cent) and the Philippines (59 per cent).

1.2.3. End-use energy efficiency

In the ESCAP region, the commercial and residential sectors are the heaviest users of energy and they accounted for 40 per cent of total energy consumption in 2001 (see table 1-6 and figure 1-7). This pattern is highly pronounced in South and South-West Asia (52 per cent), South-East Asia (45 per cent), and North and Central Asia (37 per cent).

Meanwhile, the industrial sector of the ESCAP region came in second and accounted for 34 per cent of total energy consumption during the same period. It is the dominant sector in East and North-East Asia (40 per cent).

The region's transport sector accounted for 18 per cent of total consumption in 2001, while other purposes (agricultural sector, unspecified and non-energy uses) accounted for 7 per cent. The transport sector was fairly dominant in the Pacific subregion. Road transport was predominant in most countries of the ESCAP region. On average, it accounted for 73 per cent of energy consumption in the transport sector.

Each sector uses different types of fuels depending on the characteristics and availability of fuel in the different countries. This presents several opportunities for end-use energy efficiency which could be applied by Governments to improve the use of various types of equipment and devices that utilize coal, direct heat, electricity, natural gas, oil and petroleum products as well as combustible renewables and wastes. Table 1-7 shows the sectoral distribution of final energy consumption by type of energy and by subregion.

In the industrial sector, the ESCAP region in general used more coal (28 per cent) in 2001, followed by gas (26 per cent) and electricity (19 per cent). East and North-East Asia was more dependent on coal (39 per cent), while South-East Asia, and South and South-West Asia used more petroleum products (36 per cent and 27 per cent, respectively) in the industrial sector. North and Central Asia used more energy in the form of heat (30 per cent) rather than other types. The Pacific region, meanwhile, used more gas (33 per cent) than any other energy form.

For the transport sector, all subregions except North and Central Asia used petroleum products, which accounted for 96 to 100 per cent of total energy consumption in the sector. Gas and electricity were also used in

Table 1-6. Total final consumption by sector in selected Asian and Pacific countries and areas, 2001

Country/Area	Total (mtoe)	Share (per cent)				
		Industry	Transport	Road (Share in transport)	Commercial and residential	Others[a]
World	**6 995**	**31**	**26**	**79.8**	**--**	**43**
ESCAP region (representative countries/areas)	**2 785**	**34**	**18**	**73**	**40**	**7**
Developing countries	*2 356*	*34*	*16*	*71*	*43*	*8*
Developed countries	*429*	*36*	*30*	*80*	*28*	*6*
East and North-East Asia	*1 287*	*40*	*16*	*73.8*	*36*	*8*
China	785	40	10	63.4	42	8
Democratic People's Republic of Korea	18	68	3	100.0	--	29
Hong Kong, China	12	14	53	52.4	32	1
Japan	342	36	28	82.5	31	5
Republic of Korea	130	45	24	75.8	25	7
South-East Asia	*285*	*26*	*25*	*83.7*	*45*	*4*
Indonesia	118	20	20	88.8	58	3
Malaysia	32	41	40	86.4	17	2
Myanmar	11	8	8	93.5	84	--
Philippines	25	30	33	82.2	31	6
Singapore	11	37	43	46.5	15	5
Thailand	53	38	34	82.6	21	8
Viet Nam	35	14	12	93.5	72	1
South and South-West Asia	*615*	*27*	*16*	*89.2*	*52*	*5*
Bangladesh	17	28	9	61.6	57	7
India	380	26	12	87.9	57	5
Iran (Islamic Republic of)	99	27	27	96.5	38	8

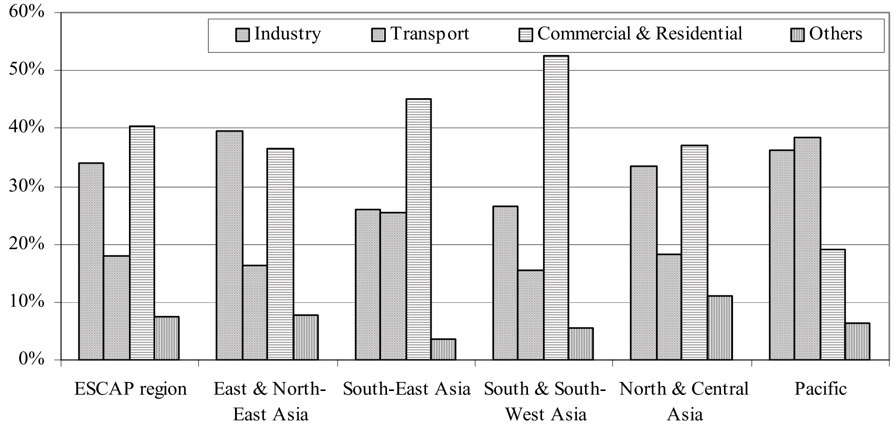
Table 1-6. *(Continued)*

Country/Area	Total (mtoe)	Share (per cent)				
		Industry	Transport	Road (Share in transport)	Commercial and residential	Others[a]
Nepal	8	5	3	84.1	90	1
Pakistan	52	27	17	86.3	54	2
Sri Lanka	7	19	26	80.9	51	4
Turkey	52	32	23	84.9	35	10
North and Central Asia	*511*	*33*	*18*	*47.7*	*37*	*11*
Armenia	1	30	19	73.7	12	39
Azerbaijan	6	25	16	72.5	46	13
Georgia	2	16	21	88.6	58	5
Kazakhstan	21	45	14	68.9	3	38
Kyrgyzstan	2	16	12	84.7	10	62
Russian Federation	427	35	19	45.0	39	7
Tajikistan]	3	18	35	99.0	11	37
Turkmenistan	10	2	7	97.5	1	90
Uzbekistan	38	26	10	52.4	49	15
Pacific	*87*	*36*	*38*	*73.1*	*19*	*6*
Australia	73	35	39	77.7	20	7
New Zealand	14	42	36	46.9	17	4

Sources: International Energy Agency (2003). *Energy Balance of Non-OECD Countries* (Paris, OECD/IEA), and *Energy Balance of OECD Countries* (Paris, OECD/IEA).

Note: [a] Includes the agricultural sector, unspecified and non-energy uses.

Figure 1-7. Energy consumption in the ESCAP region by sector, 2001



most subregions, accounting for less than 10 per cent of energy consumption in transport. In North and Central Asia, owing mainly to the Russian Federation, petroleum products accounted for 63 per cent of energy consumption in transport, with natural gas accounting for 33 per cent.

In the commercial sector of the ESCAP region, more petroleum products were used (39 per cent), followed by electricity (38 per cent) and natural gas (12 per cent). However, the types of energy used varied by subregions. In East and North-East Asia, petroleum products (51 per cent) were dominant in the sector, followed by electricity (36 per cent). South-East Asia, and South and South-West Asia used more electricity (61 per cent and 40 per cent, respectively), followed by petroleum products (30 per cent and 27 per cent). North and Central Asia used more heat (43 per cent) and electricity (26 per cent) in the commercial sector. The Pacific subregion, meanwhile, used mostly electricity (68 per cent) and natural gas (22 per cent).

The residential sector of the ESCAP region was generally dependent on combustible renewables and wastes, which accounted for 55 per cent of the energy consumed in the sector. Natural gas was a far second, contributing 11 per cent of energy consumption, followed by petroleum products and electricity (9 per cent each), heat (8 per cent) and coal (7 per cent). Most countries in East and North-East Asia, South-East Asia, and South

Table 1-7. Sectoral energy consumption by type of energy, 2001

Sector/Subregion	Total final consumption (mtoe)	Share of final energy consumption (per cent) (a)						
		Coal	Crude oil	Petroleum products	Gas	Combustible renewables and waste	Electricity	Heat
Industrial sector								
ESCAP region	*938 951*	*28*	*1*	*26*	*14*	*4*	*19*	*8*
Developing countries	784 434	30	1	23	15	4	18	9
Developed countries	154 517	16	1	41	12	4	26	--
East and North-East Asia	496 911	39	1	30	5	--	21	4
South-East Asia	74 046	17	3	36	16	10	17	--
South and South-West Asia	165 350	21	--	27	21	16	14	1
North and Central Asia	171 031	10	--	11	31	--	18	30
Pacific (b)	31 613	14	--	14	33	11	27	--
Transport sector								
ESCAP region	*503 632*	*1*	--	*91*	*6*	--	*2*	--
Developing countries	374 257	1	--	89	8	--	2	--
Developed countries	129 375	--	--	98	--	--	1	--
East and North-East Asia	209 337	3	--	96	--	--	1	--
South-East Asia	72 246	--	--	100	--	--	--	--
South and South-West Asia	95 812	--	--	99	--	--	1	--
North and Central Asia	92 937	--	--	63	31	--	6	--
Pacific	33 300	--	--	98	1	--	1	--
Commercial sector								
ESCAP region	*161 245*	*5*	--	*39*	*12*	--	*38*	*7*
Developing countries	97 366	7	--	33	13	--	34	11
Developed countries	63 879	--	--	47	9	--	43	1
East and North-East Asia	105 329	5	--	51	7	--	36	1

Table 1-7. *(Continued)*

Sector/Subregion	Total final consumption (mtoe)	Share of final energy consumption (per cent) (a)						
		Coal	Crude oil	Petroleum products	Gas	Combustible renewables and waste	Electricity	Heat
South-East Asia	11 472	2	--	30	6	--	61	--
South and South-West Asia	14 764	9	--	27	24	1	40	--
North and Central Asia	23 678	1	--	5	25	--	26	43
Pacific	6 002	3	--	7	22	--	68	--
Residential sector								
ESCAP region	*965 414*	*7*	--	*9*	*11*	*55*	*9*	*8*
Developing countries	908 173	7	--	8	11	59	6	9
Developed countries	57 241	--	--	29	18	4	48	--
East and North-East Asia	363 971	12	--	9	6	59	12	2
South-East Asia	117 218	3	--	13	1	76	7	--
South and South-West Asia	307 728	2	--	12	8	74	5	--
North and Central Asia	165 862	5	--	3	37	2	9	43
Pacific (c)	10 635	--	--	4	26	19	49	--

Sources: a. International Energy Agency (2003). *Energy Balances of Non-OECD Countries* (Paris, OECD/IEA) and *Energy Balances of OECD Countries* (Paris, OECD/IEA).

Notes: a. The shares were calculated based on IEA data.
b. Hydropower and geothermal accounted for 2 per cent of energy consumption in the industrial sector in Pacific countries.
c. Geothermal accounted for 2 per cent of energy consumption in the residential sector in Pacific countries.

and South-West Asia were highly dependent on combustible renewables and wastes, which accounted for 59 per cent, 76 per cent and 74 per cent, respectively, of total energy consumption in the sector. Petroleum products, electricity, coal and natural gas accounted for less than 15 per cent each in those subregions. Some countries in the region such as China, India, Indonesia, Turkey and the Russian Federation, are large users of coal for domestic purposes. Meanwhile, countries in North and Central Asia used more energy in the form of heat (43 per cent), while countries in the Pacific subregion used more electricity (49 per cent) than any other form of energy.

1.3 Potential and need for improving end-use energy efficiency

1.3.1. Financial and energy savings

There are huge opportunities to improve end-use energy efficiency. According to the *World Energy Assessment* report, adopting cost-effective measures could result in energy savings as follows:[1]

Developed countries	–	25-30 per cent
Transition economies	–	More than 40 per cent
Developing countries	–	30-45 per cent

Studies have shown the potential in selected Asian countries. In Malaysia, for example, industrial energy waste from source to supply (power plants) is about 20 per cent or 163 petajoules (PJ) and from demand (industries) to end use is about 15 per cent (or 98 PJ), as estimated from the total industrial demand of 650 PJ in 2005. The total loss, then, is 261 PJ or 47 million barrels of oil equivalent, or in monetary terms, equivalent to $1.24 billion. Elsewhere, the World Bank estimated in 1993 that transmission and distribution losses represent about 31 per cent of generation in Bangladesh, 28 per cent in Pakistan and 22 per cent in the Philippines and Thailand, as opposed to 7 and 8 per cent in Japan and the United States of America, respectively.

[1] United Nations Development Programme, Department of Economic and Social Affairs, and World Energy Council, *World Energy Assessment: Energy and the Challenge of Sustainability* (New York, UNDP, 2000).

The World Bank also estimated that, at the relatively low energy prices of that time and with the state of the technology, many developing countries could enjoy energy savings of between 20 and 25 per cent but the figure could go as high as 60 per cent if significant investments were made. Several studies by national and international agencies confirm this range:

- A 1999 study by the Energy Conservation Centre of Pakistan estimated the potential savings at about 22 per cent;
- Energy audits of 43 factories by the Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP) in eight industrial sectors showed a potential savings of 23 per cent (see box 1-2);
- The United States Congressional Office of Technology Assessment (OTA) estimates that energy-intensive industries could reduce energy-use by 16 to 37 per cent with existing technology levels.[2]

Based on the above, taking an average potential saving of 20 per cent from the average consumption from 1990 to 2000, each of these countries could save energy costs anywhere between $5 million (Brunei Darussalam) and $18 billion (China) and totalling to $26 billion for 11 Asian countries, if energy efficiency measures were implemented. Of the 20 per cent savings, if it is assumed that half results from zero-investment measures, six per cent from low-cost investments valued at not more than $200,000 and four per cent from high-investment measures.[3] The breakdown of savings is then as follows: $13 billion, $8 billion and $5 billion, respectively.

The World Bank estimates annual energy subsidies in developing countries to be in the region of $100 billion, almost 67 per cent of the total of subsidies granted by the respective Governments. The removal of those subsidies could minimize capital waste and conserve energy resources through proper utilization.

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[2] Office of Energy Efficiency and Renewable Energy, *Toolbook for Financing Energy Efficiency and Pollution Prevention Technologie*s (Washington, D.C., Department of Energy, 1997).

[3] The Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP) energy audit findings (Kuala Lumpur, 2003).

1.3.2. Existing national regulations and policies

Today, energy conservation laws and regulations exist in a number of countries in the ESCAP region. Japan was the first country in the ESCAP region to establish an energy conservation law. In 1979, it introduced the Law Concerning the Rational Use of Energy, which today focuses on energy conservation, energy efficiency, mandatory labelling and voluntary minimum energy performance standards (MEPS). Other countries followed suit and have adopted similar or more vigorous national policies on energy use. Table 1-8 contains an overview of the regulatory policies of selected countries on energy conservation. Boxes 1-3, 1-4 and 1-5 describe the efforts of Indonesia, Malaysia and Thailand, respectively.

Box 1-2. National savings through energy efficiency from reduced subsidies

Findings from 43 factories audited under the Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP)] reveal a potential savings of 5.6 per cent in electricity if the recommended energy efficiency measures are implemented. The following calculation shows how much the Government could save by cutting subsidies for electricity generation.

Total electricity consumption	:	**1 815 GWh**
5.6 per cent savings	:	**102 GWh**
Energy saving on supply side*	:	**1.4 PJ**
Proportion of natural gas in fuel mix**	:	**71.8 per cent**
Equivalent natural gas required to produce 1.4 PJ of energy	:	**889 743 million Btu**
Government subsidy***	:	**$1.77 per million Btu**
Financial gain (through subsidy savings)	:	**$1.6 million**

If such measures are applied nationwide for the eight industrial sectors *(iron and steel, cement, ceramics, rubber, pulp and paper, wood, food and glass)* the expected electricity saving can reach 968 GWh, or a total savings of up to **$15 million per year** in government subsidies. With the removal of subsidies, the energy price will reflect energy costs, thus making energy efficiency activities market-driven.

Source: Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP), 2003.

Notes:
* To produce 1MWh of electricity, 12.86 GJ of energy is required, indicating that power plant efficiency is at 28 per cent.
** National Energy Balance 2001 (Malaysia).
*** Government subsidy is difference between the commercial price of natural gas and the price paid by power producers in Malaysia.

Table 1-8. Energy conservation laws and regulations in certain ESCAP member countries and areas

Year	Country	Law or regulation or plan	Present focus
1979	Japan	Law Concerning the Rational Use of Energy	Energy conservation, energy efficiency, mandatory labelling and voluntary minimum energy performance standards (MEPS)
1979	Republic of Korea	Energy Utilization Act (Law No. 3181), and Amendment (Law No. 3569, 1982)	Energy conservation, energy efficiency, structural adjustments in industries
1980	Philippines	Energy Conservation Law	Mandatory labelling and MEPS
1986	China	Provisional Regulations on the Administration of Energy Resources Saving	National energy conservation, promotion of productivity in industry
1988	Australia (South Australia)	Electrical Products Acts 1988 (with later amendments)	Regulatory framework (for introduction of standards and energy labelling)
1989	Malaysia	Efficiency standard for electric motors	Mandatory labelling in some lighting products
1992, 2000	Singapore	Singapore Green Labelling Scheme	Mostly voluntary labelling
1992	Thailand	Energy conservation Promotion Act B.E. 2535	Energy conservation, energy efficiency
1993	Japan	Energy Conservation Assistance Law	Technical/financial support for energy efficiency
1994	Iran (Islamic Republic of)	Third Five-Year Plan	Mandatory labelling
1995	Republic of Korea (amendment of 1979 Act)	Rational Energy Utilization Act	Promotion of energy conservation and efficiency, enhancement of productivity, product labelling and deregulation
1995	Thailand	Royal Decree on Designated Building and Ministerial Regulations Nos. 1, 2 and 3	Promotion of energy efficiency in (commercial and industrial) building, mostly voluntary labelling

Table 1-8. *(Continued)*

Year	Country	Law or regulation or plan	Present focus
1995	Australia (New South Wales)	Sustainable Energy Development Act	Institutional development for energy efficiency promotion
1995	Hong Kong, China	Voluntary comparative energy efficiency labelling scheme (EELS)	Voluntary energy labelling and voluntary MEPS
1995	Indonesia	Master Plan for Energy Conservation for Indonesia	Voluntary labelling
1996	Russian Federation	Federal Law on Energy Saving	Economic transition, energy efficiency, mandatory MEPS, Voluntary labelling
1996	Hong Kong, China	Voluntary EELS for air conditioners	Voluntary energy labelling
1997	Hong Kong, China	Voluntary EELS for clothes washers	Energy labelling
1997	Uzbekistan	Law on Rational Energy Use	Economic transition, energy efficiency
1997	China	Energy Conservation Law of China	Promotion of energy conservation and efficiency, promotion of productivity in industry, mandatory MEPS, voluntary labelling
1997	Thailand	Royal Decree on Designated Factories and Related Ministerial Regulations	Promotion of energy efficiency in industrial establishments
1999	New Zealand	Joint Australian and New Zealand standards	Mandatory
2001	India	Energy Conservation Act	Energy efficiency, labelling and standards

Sources:
a. Asia-Pacific Economic Cooperation – Energy Standards Information System (APEC-ESIS) < http://www.apec-esis.org > .
b. Bureau of Energy Efficiency, India < http://www.bee-india.com > .
c. Collaborative Labeling and Appliance Standards Program (CLASP) < http://www.clasponline.org > .
d. Joint Australian/New Zealand Standards < http://www.gasa.org.nz/legislation/jointstandards.html > .
e. ESCAP (1999). *Energy Efficiency: Compendium of Energy Conservation Legislation in Countries of the ESCAP Region* (New York, United Nations).

Box 1-3. Energy efficiency efforts in Indonesia

The national strategy is to achieve energy savings and environmental protection through cooperation and networking with energy suppliers, energy equipment producers and energy consumers in the areas of value added technology development, standardization, labelling and demand side management (DSM). The National Master Plan on Energy Conservation ("RIKEN") incorporates the following issues:

a. Sector-specific energy conservation implementation.

b. The barrier, challenges, and opportunity of energy conservation.

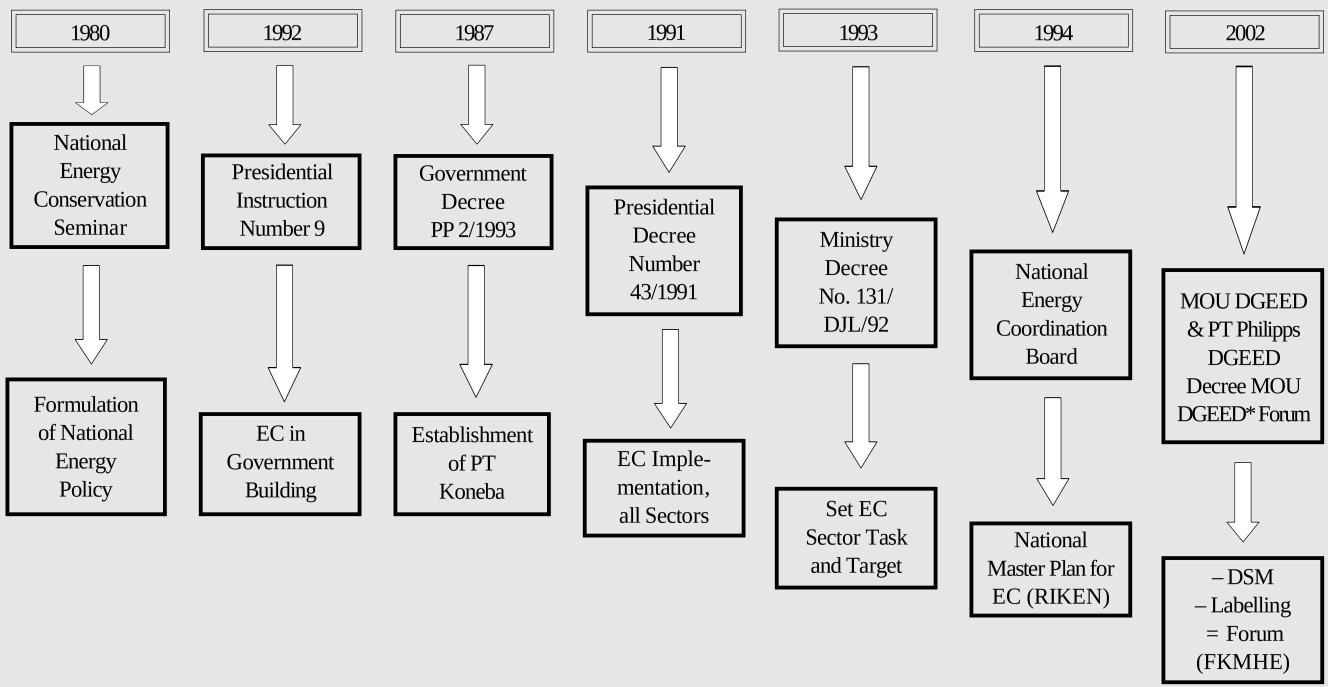
c. The national energy conservation policy measures consisting of policy instrument, energy users, main programme and sector-specific main programmes.

d. Implementation task for 17 departments/sectors and target-setting for 6 institutions which have responsibility for energy use (Ministry of Energy and Mineral Resources, Ministry of Trade & Industry, Ministry of Transportation, Ministry of Public Works, Ministry of Forestry, Ministry of Agriculture).

e. Description task for 6 institutions (Target '96 – '99): (i) energy manager recruitment, (ii) training for energy management and conservation technology, (iii) energy audit, and (iv) implementation.

Policy instruments to be implemented include information, regulation, incentive and energy pricing. Creation of a market for renewable energy and promotion of energy efficiency. "RIKEN" focus on "GREEN ENERGY" policy for energy conservation through information dissemination, regulations, provision of incentives, pricing and tariff. As a part of policy, the final energy consumptions are forecasted with and without consideration of energy conservation. The actual consumption for the years 1993-1994 onwards has been found to be lower than estimated, but have a growth rate of over seven per cent. Energy Efficiency & Economics (ENEFECON) models have been developed to facilitate a follow-through assessment covering technical aspects and macro-economic impact of energy efficiency and to enable assessment of various policy scenarios. It is claimed that the policy initiatives could shift the paradigm for sustainable development from a consumer-oriented approach to a distribution-oriented approach.

Time-line of energy efficiency efforts in Indonesia



Source: Ayuni, Maryam (2002). "Energy Policy and Energy Saving Implementation in Indonesia," presented at the Ad Hoc Expert Group Meeting on End-Use Energy Efficiency towards Promotion of a Sustainable Energy Future, Bangkok, 18-20 November 2002.

Box 1-4. Impact of reforms in Thailand

In addition to strong energy efficiency policies and programmes, Thailand has instituted power sector reform, which involves privatization and restructuring. In privatization, assets are transferred to private ownership in order to introduce commercial objectives into the management and operation of State-owned enterprises. On the other hand, restructuring is achieved through the unbundling of vertically integrated utilities, such as the Electricity Generating Authority of Thailand (EGAT), and their separation into functionally distinct companies providing generation, transmission, distribution and retail services. This would also induce competition by giving independent entities the authority to sell power to the grid and to serve end-users. With the enactment of the Energy Conservation (ENCON) Act and the creation of an Energy Conservation Promotion Fund, energy conservation programmes in Thailand have gained momentum. Compulsory, voluntary and complementary programmes are being introduced. The demand side management (DSM) programme at EGAT has been shifted to the DSM Office in the Ministry of Energy. The energy efficiency programme, in general, has been made market-driven.

Source: Pacudan, Romeo (2002). "*On-going energy/electricity sector reforms and their impact on energy efficiency promotion*," presented at the Ad Hoc Expert Group Meeting on End-Use Energy Efficiency towards Promotion of a Sustainable Energy Future, Bangkok, 18-20 November 2002.

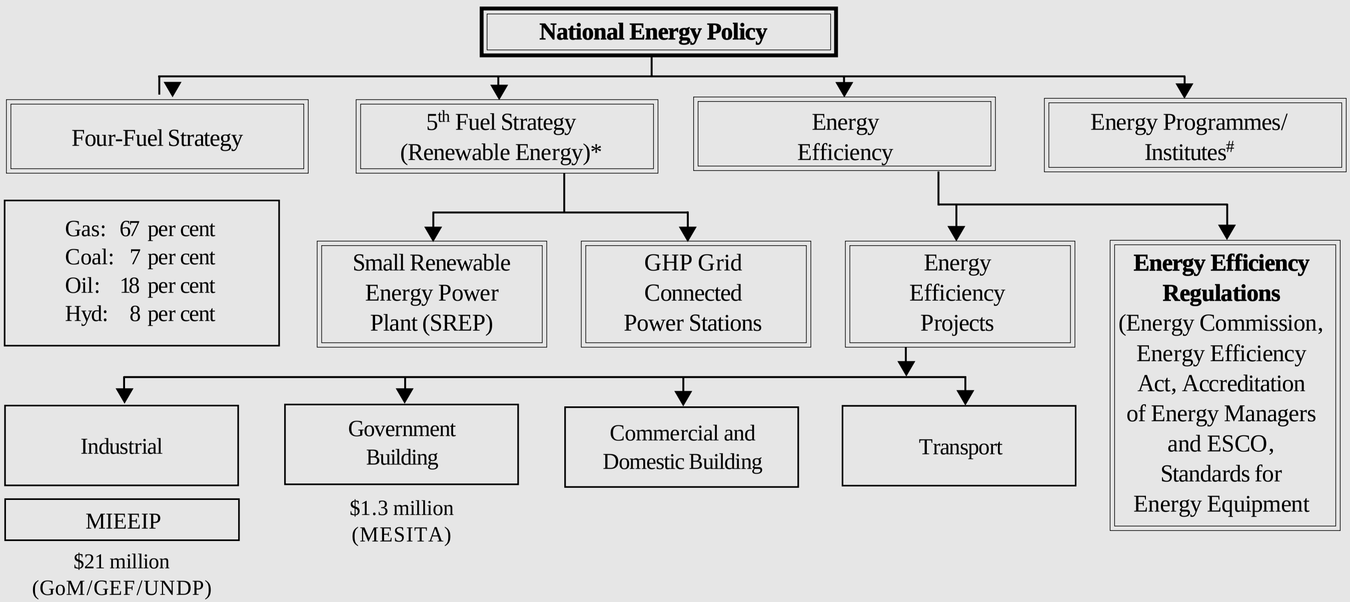
While technological and policy options have already been applied in some countries, several barriers to increased end-use energy efficiency remain, including the following:[4]

- Lack of adequate information, technical knowledge and training;
- Uncertainties about the performance of investments in new and energy-efficient technologies;
- Lack of adequate capital or financing possibilities;
- High initial and perceived costs of more efficient technologies;
- High transaction costs (for searching for and accessing information and for training);
- Lack of incentives for careful maintenance;
- The differential benefits to the user relative to the investor (for example, when energy bills are paid by the renter rather than the property owner);

[4] ESCAP, *Sustainable Energy Future: Policy Options, Barriers and Action Plans* (New York, United Nations, 2001).

Box 1-5. National energy policy of Malaysia

Energy efficiency standards in Malaysia were introduced in 1989. The current national policy is presented by the following diagram.



Notes:
* 5 per cent of national grid.
# Malaysia Energy Centre (PTM), Centre of Excellence and Training in EE and RE (CETREE), Malaysian Energy Professional Associations (MEPA), Malaysian Association for Energy Services Companies (MAESCO).

Box 1-5. *(Continued)*

The policy focuses on industry. Industrial energy demand grew by 5.1 per cent during the Seventh Malaysian Plan (1995-2000) and is estimated to grow by 8.5 per cent during the period 2000-2005. The Malaysian Energy Centre, a not-for-profit company, was formed in 1998 to support industries in energy efficiency activities, such as energy-use benchmarks, energy audits, energy ratings, accreditation of schemes for energy specialists and an energy service company. In 2002, the Energy Commission was formed, replacing the Department of Electricity and Gas Company, to address energy efficiency, Renewable Energy Supply Economy, Energy Research and Safety issues in the industries. These two organizations coordinate the Energy Manager Training Programme in Malaysia. Engagement of energy managers would be mandatory at facilities consuming more 500,000 kWh/yr. A draft regulation is awaiting approval from Malaysian Cabinet. The industry sector is eligible for financial and fiscal incentives, such as exemptions from statutory income tax, tax allowances for qualifying capital expenditure and import duty and sales tax exemptions for energy efficiency and renewable energy project hardware. The following targets have been set:

- Industrial sector energy consumption in 2004 to be 10 per cent lower than the "business as usual" scenario.
- Reduction of energy intensity by 10 per cent in 2004.
- Reduction of GHG emissions from the industrial sector by 10 per cent in 2004.

Source: Rajamanikam, Ponudurai (2002). "Policy options for improvement of energy efficiency in industries: Experiences of Malaysia" presented during the Ad Hoc Expert Group Meeting on End-Use Energy Efficiency towards Promotion of a Sustainable Energy Future, Bangkok, 18-20 November 2002.

- External costs of energy use, not included in energy price;
- Patterns and habits of consumers, operators and decision-makers, which may be influenced by many factors, including ideas of social prestige and professional norms.

For the ESCAP region, realizing the potential for energy savings will depend highly on the policies adopted to promote end-use energy efficiency. Several policy options are presented and discussed in succeeding chapters and summarized in the next section, particularly for the industrial, transport, residential and commercial sectors, the major energy-consuming sectors in the countries of the region.

1.4. Policy options for improving end-use efficiency

There are several ways of effecting end-use energy efficiency in the different sectors of the economy. Each sector has different sets of options owing to the diversity of energy consumption patterns and conditions and the types of energy resources employed.

1.4.1. Industrial sector

The industrial sector consumes a large share of the total primary energy supply (TPES) in the ESCAP region. It also has the greatest scope for significant improvement in end-use energy efficiency, particularly in developing countries and in countries with economies in transition.

For example, in India, about 43.9 per cent of all commercial energy is consumed in the industrial sector, where there is a potential for saving up to 25 per cent of energy consumption. The estimated 7.4 per cent growth rate in the economy would create a similar increase in the demand for energy services. Without further conservation measures, over 100,000 MW of installed generating capacity would have to be added by 2010.[5] The requirement for additional capacity can be lowered by about 36 per cent (i.e., 36,000 MW) if power plant auxiliary consumption and T&D losses are reduced to the level of the regional average of 16.9 per cent from the current 34.9 per cent, as indicated in table 1-3. The additional expenditure for such energy efficiency improvement initiatives is only a fraction of the cost of the additional capacity (36,000 MW) that would otherwise be required.

[5] India, Bureau of Energy Efficiency, <http:/www.bee-india.com>, November 2003.

In Thailand, the average cost of “generating” electricity through DSM energy efficiency programmes is only 2 cents/kWh, compared with 4-6 cents/kWh using conventional generation such as natural gas, fuel oil and coal power plants.[6]

To realize energy savings in the industrial sector, Governments need to create various mechanisms to support the improvement of end-use energy efficiency. These are listed below and discussed in more detail in chapter 2.

Institutional support could be provided for the industrial sector to build up technical capabilities and increase technological know-how among relevant personnel as well as make available information on state-of-the-art technologies. This can be achieved through the establishment of an energy centre that would coordinate all efforts on energy efficiency including promotion, dissemination of information, support for demonstration projects, and capacity-building for all stakeholders (e.g., decision-making, policy making, energy systems and users). In addition, energy-use benchmarking activities, such as collection of best practices, could be conducted to ensure the continuous improvement of energy management activities. Continuously conducting energy efficiency training and development programmes would also be beneficial to the major players of the sector.

Legislative support is needed in the establishment of an institution that would oversee energy-efficiency activities. In addition, legislative backing is needed to set up and administer regulations, standards and programmes to promote energy efficiency. Some of the activities requiring legislative support involve the establishment of equipment standards, the appointment of energy managers, the conduct of mandatory energy audits, the provision of financial and fiscal incentives, the participation of public and private entities, the signing of voluntary agreements, the settlement of targets, reporting and benchmarking, the conduct of research, development and promotional activities, and the strengthening of integrated industrial energy-efficiency policies.

[6] Collaborative Labeling and Appliance Standards Program (CLASP), < http://www. clasponline.org > , November 2003.

Financial support could be provided in the form of subsidies, grants, loans and tax rebates, which are needed by the industrial sector in order to implement activities to improve energy efficiency. National Governments could provide for financial sources, but external sources could be tapped, including the clean development mechanism (CDM), the Global Environment Facility (GEF) and bilateral donors.

1.4.2. Transport sector

Transportation is an important component of the economy. Recent developments in engineering and technology and a phenomenal increase in the size of the sector have brought significant changes to society, not only economically but also environmentally. The increasing amount of pollution, particularly in urban areas, is attributed to a heavy dependence on road transport and therefore fossil fuels. The share of energy consumption in road transport in the ESCAP region is very high.

A growing economy coupled with an increasing population usually results in increased motorization and greater vehicle density. Japan, for instance, has more than 10 times the motorization rate of some developing countries in South and South-East Asia and South and South-West Asia (see table 1-9). Singapore and the Republic of Korea have vehicle densities of 175 and 127 vehicles per capita, respectively, while Bangladesh has only 10.

Recently, however, there has been a rapid increase in the number of road vehicles even among poor developing countries (see figure 1-8). China and Nepal have experienced a growth rate of 12.1 per cent and 10.6 per cent respectively, compared with only 1.9 per cent in Japan. Among developing countries in South-East and South-West Asia with low GNIs, growth rates ranging from 6 to 8 per cent are common and higher than those for countries or areas with high gross national incomes, such as Australia, Brunei Darussalam, Singapore and Hong Kong, China.

Road transport, particularly the use of trucks for moving freight, is not the most efficient mode of transport. Among OEDC countries, road transport, which accounts for less than 50 per cent, is not the dominant mode of transportation (see figure 1-9). The energy intensity of road transport (trucks) varies from a low of 1.8 MJ per ton-km (freight) in the case of Finland, to more than 4 MJ per ton-km (freight) in the case of Denmark and Japan. Therefore, there are tremendous opportunities for developing countries in the region to achieve lower energy intensities in the transport sector by changing their transport mix.

Table 1-9. Motorization and vehicle density in Asia and the Pacific

Country/area	Number of private cars per thousand persons	Vehicle density per route-km	Year
Brunei Darussalam	528.0	55	1998
Australia	504.8	14	1998
Japan	403.9	61	1999
Malaysia	169.6	71	1999
Republic of Korea (a)	167.3	127	1999
Macao, China	107.7	..	1998
Russian Federation (b)	104.9	11	1996
Singapore (c)	103.7	175	1999
Tonga	85.6	..	1997
Kazakhstan	63.5	..	1997
Turkey (c)	63.3	..	1999
Hong Kong, China	57.1	283	1999
Thailand	43.0	112	1999
Philippines	26.4	..	1998
Sri Lanka	15.1	..	1998
Indonesia	14.4	15	1998
Maldives	10.9	..	1999
Pakistan	7.2	15	1999
India (d)	4.9	4	1997
China	4.7	..	1997
Myanmar	3.7	..	1998
Nepal	2.1	..	1998
Bangladesh	0.5	10	1998
Pakistan	..	..	1999
Nepal	..	17	1998

Notes and sources:

a. United Nations and ESCAP Statistical Yearbooks, 2003.

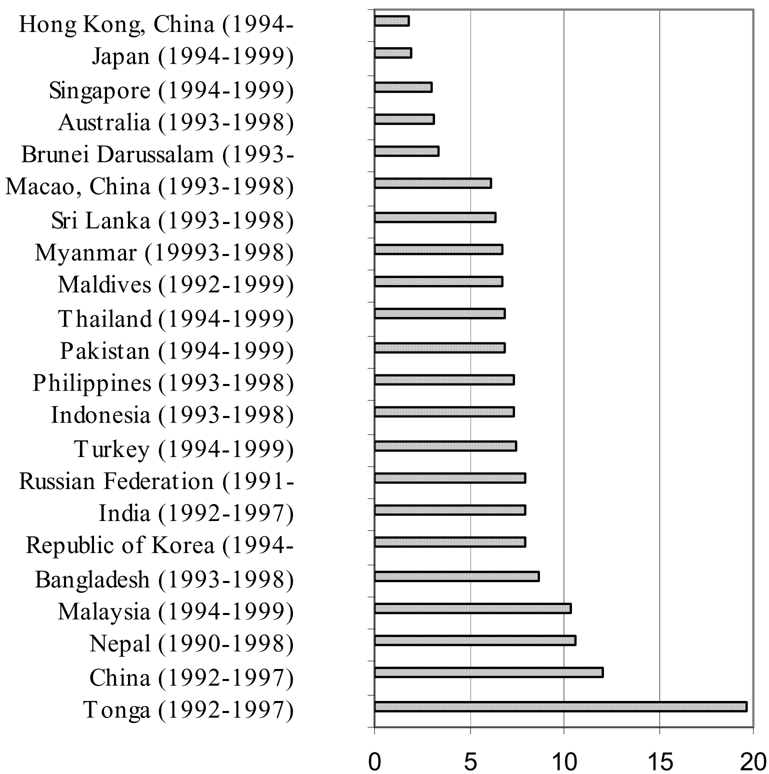
b. Ministry of Construction and Transportation, Republic of Korea: estimates of road vehicle population.

c. Europe Yearbook and World Highways, September 1998.

d. Commercial vehicles for 1999 are ESCAP estimates.

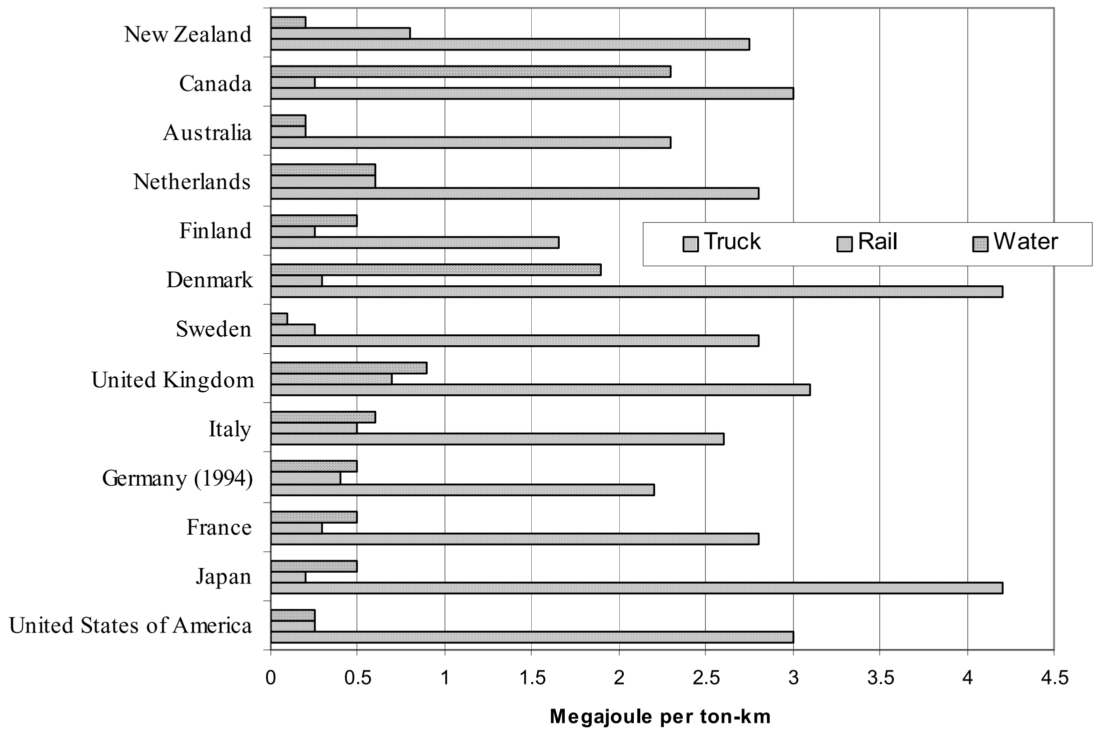
e. India Statistical Abstract 1999.

Figure 1-8. Average annual growth in road vehicle fleets in selected countries and areas of the ESCAP region, 1991-1999



Sources: a. United Nations and ESCAP Statistical Yearbooks.
b. Europe Yearbook and World Highways, September 1998.
c. India Statistical Abstract 1999.
d. Ministry of Construction and Transportation, Republic of Korea..

Figure 1-9. Comparison of modal energy intensities in IEA countries, 1995



Source: International Energy Agency (2001). *Saving Oil and Reducing CO_2 Emissions in Transport: Options and Strategy* (Paris, OECD/IEA).

Thus, policies encouraging the development of other modes of transport with a goal of a balanced transportation network and continued improvement of road transport would be beneficial to the countries of the region. Policy options to improve end-use energy efficiency in the transport sector are discussed extensively in chapter 3 and include the following:

(a) **Passing planning and development laws** that encourage energy efficiency in the transport sectors, such as laws on (i) town planning to encourage urban consolidation, (ii) education and promotion, (iii) greater use of environmental impact assessment, and (iv) implementation of demand management programmes, such as staggered or flexible working hours, ride-sharing and traffic management measures;

(b) **Passing laws that regulate the motor vehicle industry** resulting in reduced fuel consumption and improved vehicle use. Laws could be passed on the establishment of fuel consumption labelling, fuel consumption on model-specific vehicle advertising, fuel economy standards for vehicle manufacturers, and vehicle maintenance programmes;

(c) **Offering fiscal incentives** to improve motor vehicle fuel economy. Such incentives could include skewed sales/goods and service taxes, a feebate system, skewed motor vehicle registration charges, increased petroleum excise taxes, income tax incentives, and grants, loans or loan guarantees to businesses for the lease or purchase of fuel-efficient vehicles;

(d) **Promoting alternative fuels,** such as biomass-based ethanol. This can be achieved through the provision of financial incentives for crop manufacturers, government support for the redesign of vehicle motors, and the removal of legislative barriers to alternative fuels.

1.4.3. Construction and buildings sector

In the construction and buildings sector, there are two kinds of energy consumption:

(a) Energy consumption during the construction process and in the process of manufacturing and procuring the materials for construction. The total amount of energy so used is called the embodied energy of the structure;

(b) Energy consumption after construction is complete, for the day-to-day operation of the structure. Most of this energy is consumed through electrical appliances, such as lights, air conditioning systems, escalators and elevators.

The share of final energy consumption, including combustible, renewable and waste energy, in residential and commercial buildings is 40 per cent in the ESCAP region, higher than the world average of 35 per cent. Table 1-6 shows that the share is the highest in Nepal (90.4 per cent), followed by Myanmar, Viet Nam, Indonesia, Georgia, Bangladesh, India, Pakistan and Sri Lanka. In all of these countries, the share exceeds 50 per cent. Although energy is apparently used directly to operate systems such as those described above, there is a close link between the amount of electricity consumed by such systems and the design and architecture of the structure.

The above mentioned link and related issues along with the subject of embodied energy are discussed in chapter 4. The possible ways of improving the energy efficiency of such appliances are explored in chapter 5.

The higher population growth rate along with economic growth in the developing countries and areas in the ESCAP region have resulted in excessive activity in the construction and buildings sector. This has led to deforestation, urbanization and a rapid rise in energy consumption in this sector. Although the number of studies conducted to find the embodied energy cost of construction is small, estimates compare it with the cost of running a building for 30 years. This is a significant amount in view of the fact that buildings constructed today last, on average, 50 years. A sizable amount of energy can be saved for sustainable use in the construction and buildings sector through the implementation of the policy measures discussed in chapter 5.

Policy options for improving end-use energy efficiency in the construction and buildings sector are as follows:

(a) **Adopting appropriate regulations and legislation** on building codes and minimum energy performance standards (MEPS);

(b) **Increasing awareness and sensitization** of all stakeholders. Information campaigns through mass media can be conducted by national Governments to promote energy-efficient technologies and practices. Other activities could include celebrating energy conservation day or week every year, recognizing best practices and innovation, and granting awards to meritorious persons and entities for their energy conservation initiatives;

(c) **Implementing education and training activities or programmes** (short-, medium- and long-term) to have a qualified workforce at all levels, from architects and engineers to masons;

(d) **Strengthening research, development and deployment** of building prototypes that incorporate the latest innovations in design, materials, products and systems;

(e) **Creating market for energy efficiency** by establishing favourable energy pricing, setting up demonstration facilities to validate the energy efficiency potential of products and processes, encouraging innovative technology procurement, establishing energy service companies (ESCOs), and improving the bidding process for goods and services for buildings owned by the government;

(f) **Providing investment for accelerated adoption of energy efficiency policies** through an appropriate mechanism. Grants and subsidies can be used as flexible and effective solutions for supporting different activities related to energy efficiency. Financial incentives and other instruments could be used to encourage consumers to invest in energy-efficient buildings.

1.4.4. Electrical appliances in domestic and other sectors

As mentioned earlier, the varieties and extent of use of electrical appliances in the construction and buildings sector are so large that the share of electrical energy use in this sector has been increasing in almost every country. As shown in table 1-6, this share can be as high as 90 per cent, such as in Nepal, or a moderate 20-35 per cent in Hong Kong, China;

Japan; the Philippines; and Thailand. It is less than 10 per cent in only a small number of countries, viz. the Democratic People's Republic of Korea, Kazakhstan, Kyrgyzstan, New Zealand, Turkey and Turkmenistan. Substantive research is being conducted to improve the energy efficiency of appliances; as a result, every new product introduced to the market today bears manufacturer's claims of higher energy efficiency. Regulation and consumer awareness in certain countries of the region have played the necessary catalytic role. A number of interesting cases are available for review and possible replication in other countries with the necessary modifications. It is therefore simply a question of time before the energy efficiency of electrical appliances improves in the ESCAP region.

Chapter 5 contains policy options designed to accelerate the move towards a sustainable energy future. These policy options are as follows:

(a) **Providing free or low-cost energy audits** for residential consumers;

(b) **Conducting information campaigns** through the mass media in order to promote energy-efficient appliances;

(c) **Prescribing minimum energy performance standards** (MEPS), which could be voluntary or mandatory, including testing procedures and protocols for manufactured products. Such standards could be applied before the products are introduced to the market;

(d) **Creating equipment rebate programmes** for the purchase or manufacture of energy-efficient products;

(e) **Implementing energy label programmes** to indicate the energy performance of manufactured products;

(f) **Establishing low-interest loan programmes** for the purchase of energy-efficient equipment;

(g) **Providing tax and fiscal incentives** for the purchase or import of high-efficiency appliances;

(h) **Encouraging the formation and operation of energy service companies** (ESCOs) to help clients save energy;

(i) **Establishing an apex body to coordinate** all energy-efficiency activities.

1.5. Putting policies into action

One of the major policy considerations in the ESCAP region, improving end-use energy efficiency will help countries of the region to do the following:

(a) Ensure a sustainable energy future;

(b) Reap financial benefits by minimizing wastage and pollution, utilizing such flexibility mechanisms as the Clean Development Mechanism (CDM);

(c) Control irreversible damage to the environment, through initiatives aimed at controlling carbon dioxide (CO_2) emission and global warming, among others;

(d) Share their experiences and the lessons learned in the development process.

The sectoral policy options outlined in section 1.4 above are not only interrelated but also of great benefit to the countries of the ESCAP region. There is tremendous potential for collaboration as many countries of the region face challenges in formulating policies to achieve sustainable development goals. This untapped potential further corroborates calls for a regional guiding principle for identifying and adopting emerging issues in the respective countries' national policy. The implementation of these policies could be facilitated through regional cooperation in the following:

(a) Establishing regional guiding principles;

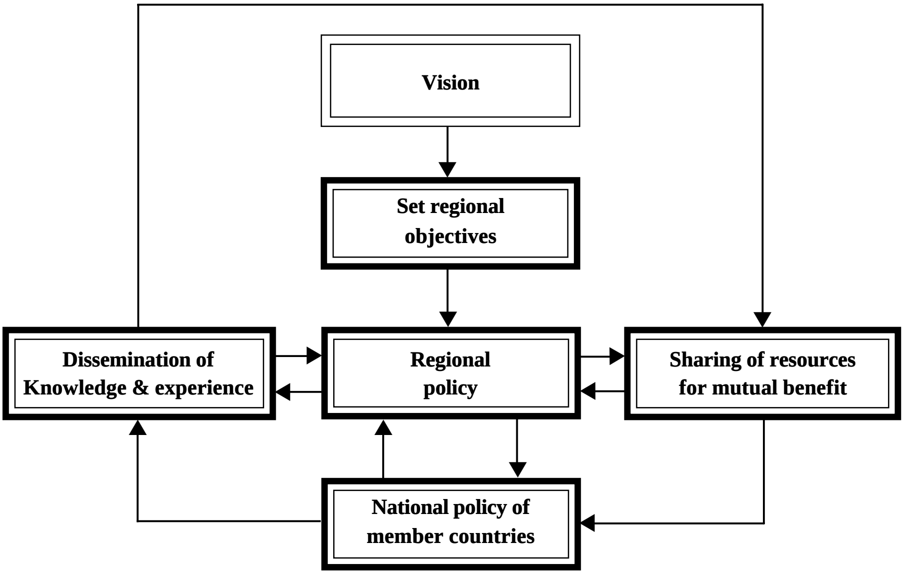
(b) Formulating national policies and plans;

(c) Disseminating and sharing knowledge and experiences;

(d) Sharing resources for mutual benefit.

Improved end-use energy efficiency can be identified as one of the guiding principles in the region, which would require regional cooperation. Cooperation in other areas would also lead to improved regional policies or objectives, as shown in figure 1-10.

Figure 1-10. Regional policy for mutual benefit



An apex body at the national level and, if possible, at the regional level, could coordinate and monitor the multisectoral activities generated through various policy options. This would reduce ambiguity, increase transparency and maintain the necessary momentum for activities. Such a body would also work for the timely enactment of any high-level decision targeting the improvement of end-use energy efficiency through even more effective participation of the stakeholders, even if it were large. For this purpose, the services of NGOs and institutes may be utilized at the state or local or grass-roots level. Ideally, the body would ultimately supervise self-sustained coordinated smaller activities in different sectors targeting the continuous improvement of end-use energy efficiency.

During the Ad Hoc Expert Group Meeting on End-use Energy Efficiency Towards Promotion of a Sustainable Energy Future, organized at Bangkok in November 2002, the above-mentioned sectoral policy options were presented. In addition, a number of areas at the regional level have been proposed where international organizations can participate or contribute (see chapter 6). These include a 10-year regional programme for the promotion of energy conservation and efficiency policies, establishment of a regional information network, establishment of a unified training scheme for energy managers, and continued capacity-building.

Chapter 2

IMPROVING END-USE ENERGY EFFICIENCY IN THE INDUSTRIAL SECTOR[7]

2.1. Introduction

Since the 1950s, a trend towards industrialization has characterized economic development in most developing nations in Asia and the Pacific. Structural and institutional reforms across the region shifted from agriculture towards increased industrialization and urbanization, thus paving the way for rapid economic growth. The growing industrial sector inevitably needed more energy, mostly electricity, oil and/or coal.

A World Bank policy paper noted that, on a global scale, the rate of growth in energy consumption in developing countries in the 1990s was about double that of the member countries of the Organization for Economic Cooperation and Development (OECD).[8] This growth in the industrial sector, while promising a healthy gross domestic product (GDP), has severely affected the ability of these countries to maintain their fuel supply or reserves. For instance, Malaysia is expected to become a net oil importer by 2008, if the current trend in energy supply and utilization persists. Often, dependence on fossil fuels to power industries has cost the environment. In fact, the World Energy Outlook forecasts that by year 2030, the developing countries' share of global carbon dioxide (CO_2) emissions will have escalated to 47 per cent from 34 per cent in 2001.[9] In comparison, the OECD countries' share is expected to drop to 43 per cent by 2030 from 55 per cent in 2001. Unlike the developed countries, where energy demand has been decoupled from GDP growth, developing economies see a continuing link between the two indicators. Nevertheless, many developing countries have started to institute energy conservation measures,

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[7] This chapter was principally drawn from contributions made by Mr. Ponudurai Rajamanikam and his associates Mr. Thiyagarajan Velumail (UNDP), Ms. Kamala Ernest and Ms. Gayathry Venkiteswaran. The case studies are based on contributions made by Mr. M.A. Rashid Sarkar, Mr. Abdolreza Karbassi and Mr. S.M. Sadeghzadeh.

[8] International Energy Agency (IEA), *Energy Balances of Non-OECD Countries, 2000-2001* (Paris, OECD/IEA, 2003).

[9] International Energy Agency (IEA), *World Energy Outlook* (Paris, OECD/IEA, 2002).

both to realize potential financial gains and to minimize the impact of energy sector activities on the environment.

2.1.1. Trends in industrial energy consumption in developing countries

During the past two decades, the average GDP growth rate in the Asian and Pacific region has been between 4 and 6 per cent. Overall, the industrial sector has contributed significantly to the region's economic growth, despite the economic downturns of the 1990s. For instance, in 1990 the industrial sector accounted for 30 to 40 per cent of GDP in China, Indonesia, Malaysia, the Russian Federation and the Philippines. By 2000, China's industrial share had risen to 55 per cent from 40 per cent in 1990, that of Malaysia had increased to around 47 per cent from around 36 per cent, and that of Thailand to 43 per cent from 30 per cent. Even though the Philippines and the Russian Federation experienced a decrease in industrial growth, their industrial sectors still accounted for 32 and 34 per cent respectively of GDP.

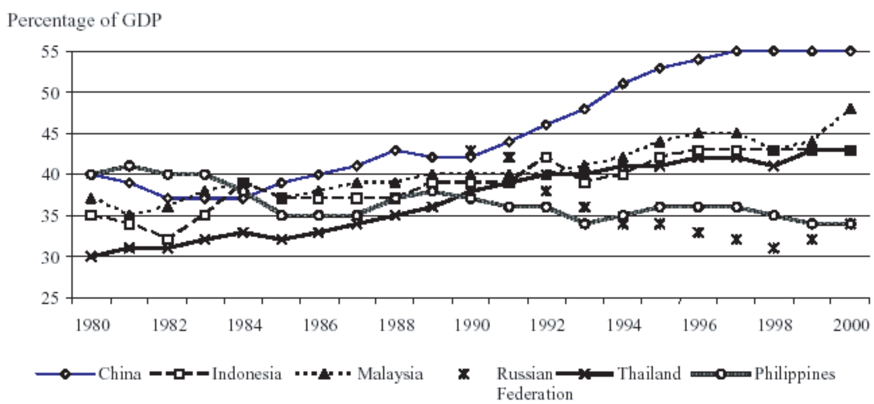
Although there was no great change in the share of the industrial sector in GDP from one year to the next, the energy consumption of industry in selected countries fluctuated significantly, particularly around 1997 when the Asian financial crisis occurred (see table 2-1). The industrial energy consumption of China generally decreased from 1990 to 2000. During most of the 1990s, China began to restructure itself to focus on tertiary sectors, such as telecommunications and commerce, which led to a massive reduction in energy intensity between 1980 and 1994.[10] Energy consumption in the industrial sector in Indonesia, Malaysia and Thailand generally increased but severe fluctuations in consumption were observed from around 1997 when the Asian financial crisis occurred. In the Philippines, energy consumption in industry had been steadily increasing, but there was an enormous drop in 1997 from which there has been only a slight recovery.

Despite the high energy consumption in the industrial sector, particularly in manufacturing, it only generates around 24 per cent of the average GDP growth in selected countries as shown in table 2-1. In these countries, the manufacturing sector is largely (about 85 per cent) made up of small and medium-scale industries (SMI) in all major subsectors (food,

[10] Giap van Dang, "Energy development in Southeast Asia and Northeast Asia", Helio International: Rio + 5 Report, 1998.

textile, foundry, ceramic, etc.). In China, almost all industries are classified as small and medium-scale. Compared with large-scale industries and multinationals, the SMI have lower access to or levels of awareness of energy-efficient technologies and lower productivity rates.

Figure 2-1. Share of the industrial sector in the GDP of selected ESCAP member countries



Source: Asia Pacific Energy Research Centre (2002). *APEC Energy Demand and Supply 2002* (Tokyo, APERC).

Furthermore, energy prices in developing countries are comparatively low, thus making energy savings efforts often uneconomical. The Government of Malaysia, for instance, spent approximately $16 billion to subsidize electricity in 1998. That calculation was based on the assumptions that the commercial price of natural gas was $3.46 per million Btu on average and the subsidized price for power producers was $1.68 per million Btu. The price structure was fixed by the Energy Commission effective 1 October 2002. Prior to that, gas prices has been indexed to the monthly Singapore Posted Price Index for Medium Fuel Oil (MFO), which was higher than the rate used in this calculation. Total natural gas consumption for 1998 was 9,158 ktoe. This amount of subsidy is estimated to have an annual growth rate of 9 per cent.[11]

[11] Malaysian Energy Centre, *National Energy Balance* (Kuala Lumpur, 2001).

Table 2-1. Trends in energy consumption in the industrial sector of selected countries and areas in the ESCAP region

(in ktoe)

Country/Area	1990	1992	1994	1996	1998	2000	Average (1990-2000)
Brunei Darussalam	70	32	185	18	168	131	135
China	586 865	617 874	429 184	492 803	425 966	399 351	482 076
Hong Kong, China	2 424	2 844	2 499	2 063	3 090	2 987	2 599
Indonesia	22 872	27 165	31 881	32 874	35 104	40 848	32 026
Malaysia	9 209	11 101	12 401	16 130	17 048	19 006	14 102
Papua New Guinea	277	272	424	503	535	760	442
Philippines	6 831	6 959	8 467	9 634	6 301	5 202	7 141
Russian Federation	..	..	33 136	31 332	26 694	30 883	30 225
Singapore	611	682	806	89	1 015	..	832
Thailand	10 318	13 390	19 234	26 113	19 330	22 214	18 762
Viet Nam	--	4 330	4 663	35 301	3 500	3 904	3 433

Source: Asia Pacific Energy Research Centre (2002), *APEC Energy Demand and Supply 2002* (Tokyo, APERC).

2.1.2. Greenhouse gas emissions

Since a number of Asian developing countries continue to promote industrialization as an engine for growth, the sector's share of energy demand has increased by an average of 40 per cent, causing the sector to become one of the major contributors to greenhouse gas (GHG) emissions. Studies conducted through the Global Environment Facility (GEF) and the Asian Development Bank (ADB) have shown that an average of 23 per cent of industrial end-use energy is wasted because of inefficiencies resulting from a lack of awareness and proper legal and financial measures, among others. The World Energy Assessment places this value at 33 per cent.[12]

Sulphur, nitrogen oxides and carbon dioxide – GHGs that are the main emissions from fossil fuel combustion – have human disruption indices (ratios of human-generated flows to the natural or baseline flows) of 2.7, 1.5 and 0.05, respectively. The corresponding contributions from commercial energy activities, manufacturing and others are 98, 31 and 82 per cent. Although the human disruption index for carbon dioxide is seemingly small (0.05), its long atmospheric lifetime and other characteristics are causing a 0.4 per cent annual increase in its global atmospheric concentration.

While most of the pollution could be mitigated by using clean energy sources and applying clean and more energy efficient technologies, the long-term challenge will be how to mitigate GHG emissions.

2.1.3. Opportunities for improving energy efficiency in the industrial sector

The industrial sector involves a wide range of activities, including the extraction of natural resources, the production of raw materials and the manufacture of finished products. Energy intensity in the manufacturing sector differs from country to country depending on indigenous resource endowment and local energy prices. The five most energy-intensive industrial subsectors include iron and steel, chemicals, petroleum, refining, pulp and paper, and cement production. These subsectors account for approximately 45 per cent of all industrial energy consumption.

[12] United Nations Development Programme, Department of Economic and Social Affairs, and World Energy Council, *World Energy Assessment* (New York, UNDP, 2000).

Energy-efficiency measures may take the form of "efficiency retrofits", in which existing installations are improved through the replacement of inefficient components with energy-efficient components. Energy-efficiency investments can also occur at the design and planning stage of new plants. At these stages, the choice and installation of energy-efficient technologies is an investment option.

In order to promote energy conservation or efficient use of energy in industries, three different levels of activities could be considered:

Level 1: Active or efficient in-house management of energy efficiency through maintenance and housekeeping measures with only minimal investments or possibly none:

(a) Establishment of in-house energy management committees or groups;

(b) Designation of energy managers;

(c) Data collection;

(d) Improved maintenance;

(e) Safety issues;

(f) Review of operational efficiency.

Level 2: Replacement of selected equipment requiring medium-sized investments:

(a) Improved waste heat recovery;

(b) Combustion control of furnaces;

(c) Co-generation of electricity and process heat;

(d) Improvement of heat exchangers.

Level 3: Modification of entire manufacturing processes, which may require large-scale investments:

(a) Installation or improvements in advanced process controls;

(b) Installation of gas pressure recovery generators (in the iron and steel industry);

(c) Installation of waste heat recovery generators (in the cement industry);

(d) Change from "wet" to "dry" process (in cement industry).

At present, a number of energy-efficiency technologies are available in the market. These technologies, which have been proven to be economically viable in several applications, include efficient fuel combustion systems, efficient heat utilization and recovery facilities, co-generation technology and efficiency lighting systems.

Several recent studies that have assessed the technical potential of energy-efficiency improvements in a number of energy-intensive industrial subsectors have concluded that energy savings of up to 30, 40 or even 50 per cent are technically possible in many industries. Not all energy savings that are technically possible are also economically viable. However, assuming that around half of the afore-mentioned savings are technically and financially sound, then significant savings and conservation could be realized.

2.2. Policy options

Developing countries appear to provide subsidies to regulate energy prices and tariffs even if they produce or import fossil fuels. This strategy, which is usually complemented by low labour costs in these countries, has boosted their GDP growth. This results in the unproductive use of energy in the industrial sector for the manufacture of goods. As affluence sets in, the leverage of low cost labour for lower production cost starts to disappear and manufactures rely more on subsidized energy. From the macro-economic point of view, these scenarios mean that the elasticity of energy growth to GDP gets coupled for the worst, and the production cost escalates.

The following are some measures that have been taken to support industrial energy efficiency in selected developing countries:

(a) Among ASEAN members, Indonesia, the Philippines, Thailand and Viet Nam have legislative frameworks in place for energy conservation, such as standards and regulations, energy auditing, energy benchmarking and mandatory reporting (see box 2-1);

(b) Viet Nam has adopted an aggressive policy by introducing tax/levy and soft loans for energy auditing;

(c) Most countries have implemented promotional activities using the "carrot" approach to introduce energy efficiency and energy conservation to the industrial sector. For example, India's

National Energy Conservation Award Scheme, which was instituted in 1993, gives awards every year for achievements in lowering specific energy consumption and for other energy management activities to more than 30 large, medium- and small-scale energy-intensive industries from 12 categories, such as, aluminium, cement, iron and steel, and textiles.[13]

Box 2-1. Energy plans in South-East Asia

The Philippine Energy Plan (1996-2025) recognizes that new and renewable energy sources (NRES) will contribute about 15 per cent or 214 million barrels of fuel oil equivalent (MBFOE) of the total energy mix by the year 2025. Wood wastes will continue to make a major contribution, amounting to 44 per cent of new and renewable energy contributions. The Plan projects a share of 15 per cent (or 33 MBFOE) for sources such as wind, solar and ocean energy. Municipal waste is expected to be another promising resource, which may contribute about 7 MBFOE by the year 2025.

In Indonesia, oil resources, which dominate primary energy consumption, will be depleted within the next 10 years if no new major discoveries are made. The Government has decided to pursue a National Energy Conservation Master Plan (RIKEN), which defines a multisectoral approach for industry, transport and households. The shift away from domestic crude oil resources is in line with the overall energy policy, which links energy resource diversification with energy conservation.

Source: ASEAN Centre for Energy.

Energy conservation restricts the accelerated depletion of fossil fuels and significantly reduces the production cost of energy-intensive products in particular. Strategic energy policies and regulations are critical not only to promote energy conservation, but also to control the impact of volatile oil prices (in the international market) and environmental pollution, among others.

Studies show that the most effective way to improve industrial energy efficiency is through an integrated approach, whereby a number of policies are combined to create a strong overall industrial energy-efficiency policy that meets a variety of needs in the industrial sector. Strong policies to promote energy conservation and efficiency should be developed in close

[13] India, Bureau of Energy Efficiency, <http://www.bee-india.com>, November 2003.

coordination with the overall energy sector policy. It is essential that these policies be agreed upon by the relevant government agencies, such as ministries of energy, environment, industry, transport and commerce, and the private sector. Policies developed and implemented with the involvement of stakeholders will eventually result in better outcomes.

Policies to encourage the development and wider dissemination of energy efficiency in the industrial sector include institutional, legislative and financial support.

2.2.1. Institutional support

There should be strong institutional support from the Government in order to promote energy conservation and efficiency for industrial development. The industrial sector needs trained personnel with varying kinds of knowledge and expertise on energy conservation, adequate information on energy-efficient technologies, and facilities to conduct their own research and development (R&D), among others. While some industries or companies have ample resources to implement their own energy conservation programmes, the Government could provide some or all of these services in order to facilitate the process and thus reap national benefits as well.

Relevant ministries responsible for trade, industry, environment and energy have similar requirements that would enable them to make and implement the appropriate policies and programmes for promoting energy conservation and efficiency in industries.

The Government could provide the following institutional support: establishing an energy centre, conducting end-use benchmarking and implementing training and development activities.

Energy centres

Implementing an energy efficiency programme involves various government agencies with diverse functions. Coordination among these entities could be difficult, particularly if some agencies have overlapping mandates and conflicting policies. If no agency has taken the lead, the establishment of an implementing agency in the form of an energy centre to coordinate all energy efficiency-related activities would ensure better implementation of policies. The implementing agency should be vested with appropriate authority and clear mandates so that it can promote energy efficiency and provide institutional capacity-building activities for people involved in the decision-making process related to policy and planning, energy systems in various entities and energy use. Such a centre should act as a focal point, which is popularly termed a one-stop-centre for energy. Most of the established centres serve as agents for the private and public sectors to facilitate the implementation of government policies on energy efficiency. For example, the Malaysian Energy Centre or Pusat Tenaga Malaysia (PTM) was established to serve as "guardian/repository of a national energy database, 'think-tank' on energy via consultancy, promoter of energy efficiency, and coordinator and lead manager in energy research, development and demonstration projects".[14]

Lack of information on energy-efficiency technologies is considered one of the main barriers to energy efficiency. Therefore, another important activity of an energy centre or such organization should be to disseminate information and support demonstration projects. Obtaining information on energy-efficiency technologies and practices may be difficult, costly or time-consuming for individual enterprises to gather. Energy centres may also identify and implement demonstration projects that can be replicated across the industrial sector.

Energy-use benchmarking

All holistic approaches for sustainability must start with a complete and proper understanding of the current situation. Energy-use benchmarking – comparing the specific energy consumption (SEC) of a particular sector or subsector with its counterparts within the country – will indicate the status of end-use energy efficiency and would lead to better implementation of industrial energy management activities. Benchmarking can be carried out either by an individual company or a group of companies in the subsector for continuous improvement. To collect relevant data along with energy efficiency best practices for dissemination is essential for continuous improvement of energy management activities.

The promotion of energy-use benchmarking can be incorporated as a daily productivity improvement tool in an institution that is already established for supporting industries in similar development activities. Energy centres can coordinate in the establishment of the corresponding institutional focus.

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[14] Pusat Tenaga Malaysia, <http://www.ptm.org.my>, November 2003.

An example is the memorandum of understanding signed by the Malaysian Energy Centre (PTM) and the Malaysian National Productivity Corporation (NPC), a corporation under the Ministry of International Trade and Industries, in 2003 to pursue energy-use benchmarking as a joint effort, whereby the former provides the technical input and the latter provides the facilities for the dissemination of the related information. This collaboration is primarily aimed at encouraging the voluntary participation of industries in taking the first step towards improvement of energy efficiency. To date, a group of industries in eight sectors has been created and promotions are ongoing.

Energy-efficiency training and development

The lack of skills is considered one of the barriers to industrial energy efficiency. Recently, technical training courses for engineers at the tertiary level of education have included energy efficiency as part of their syllabi. However, there is a greater need to ensure continued education. Training opportunities exist at various levels and for various target groups to raise their capacity and awareness regarding energy efficiency and conservation. Through increased awareness and capacity, a higher level of commitment could be obtained for promoting energy efficiency and conservation.

If training facilities are established at a technical university, it would be possible to take advantage of their research and development capacity to identify suitable requirements to enhance energy-efficiency capabilities. As an educational institution, such a centre can influence the education ministry to include topics on energy management in the curriculum, particularly in electrical, chemical, civil and mechanical engineering as well as architecture.

These centres could also be involved in approving energy-related training and development at various levels. The Government, using these centres as the nodal agency, may implement collaborative programmes to sensitize other government bodies, including the education and other ministries. This systematic approach would also help in identifying short- and long-term needs in energy conservation and significantly contribute to the capacity-building process of all participating organizations.

2.2.2. Legislative support

The implementation of energy-efficiency activities sometimes requires laws and regulations. This ensures that agencies have the proper mandate and authority to administer mandatory energy-efficiency regulations, standards and programmes designed to support national energy policies. The institution should be provided with an omnibus energy efficiency act, which should be flexible enough to accommodate future amendments.

Some of the fields that require legislative support for industrial energy efficiency are discussed in the following sections.

Equipment standards

Standards are applied to specific kinds of equipment, such as motors or boilers, that are used in a variety of industrial processes and are known to be major energy consumers. Additionally, certain industrial equipment and accessories, such as electric arc furnaces, low thermal refractory and rotary kilns, can have regulations and standards. Standards provide the necessary market push, as detailed in chapter 5.

For equipment with operational and process-driven standards, equipment best practice standards can be established to ensure their operation at optimum efficiencies. This, however, would also require perfect grid connectivity and centralized plant load control of power stations in the grid. Apart from, energy efficiency, best practices can also include productive maintenance procedures through interdepartmental coordination, which can contribute to the enhancement of energy efficiency.

Eequipment energy efficiency best practices can be included in the national productivity improvement activities, which are usually handled by the respective institutions incorporated under the trade and industry ministry.

The overall coordination can be handled by the training and development institutes and the energy centres as a joint effort.

Appointment of energy managers

Energy management systems in factories, currently installed in Japan, Thailand and other countries, have been found to be highly beneficial. Some developing countries in the ESCAP region have enacted rules requiring larger industries to utilize the services of certified energy managers and certified energy auditors.[15] The quality and focus of the service is maintained through a national-level certification process. The energy managers, as regular employees of the industry, supervise day-to-day affairs, such as maintaining energy conversion systems and processes, controlling the misuse/wastage of energy, increasing employee awareness, coordinating with other departments and continuously looking into the need for technology upgrade and energy audits.

The energy auditors, on the other hand, are often external experts who assess the energy utilization standard of each energy conversion system as well as processes and the factory as a whole. The auditor, along with the managers, recommends technically and economically viable options in order of priority, and raising the standard to international level with a view to reducing the unit cost of production.

Large and medium-sized organizations have immense opportunities for energy savings, which are unrealized owing to lack of focus. For such organizations, the appointment of qualified energy managers would ensure focus, responsibility and commitment in pursuing energy management as a plant-wide activity. The energy managers would report on energy consumption, specific energy indices, production and energy demand forecast to the organizations and the concerned national authorities. In addition, periodic review of energy management activities will lead to the sustainability of the plants' energy conservation efforts.

Mandatory energy audits

Mandatory energy audits, in the form of walk-through audits, are essential for the industrial sector to have a better understanding of the current status of end-use energy efficiency. A walk-through audit is a basic and cost-effective exercise to identify opportunities for energy cost savings. Detailed audits are required to verify the identified opportunities. The audits, which are usually coordinated by the engineering or facility departments, will not only create awareness among those who are functionally involved in the management of energy but also justify the necessity for the implementation of energy efficiency activities.

[15] India, Bureau of Energy Efficiency, <www.bee-india.com>, November 2003.

Besides, the findings of energy audits will assist the energy managers in charting out plant-wide energy management with proper objectives, goals and road maps. Such programmes, if systematically implemented, will promote energy efficiency as an industrial work culture.

Fiscal policies

Fiscal policies come in the form of energy tariffs, taxes and incentives as well as guidelines in the mobilization or utilization of domestic and foreign funds. In developing countries, many fiscal policies are incentive-oriented. Fiscal policies may also be directed to improve public-private participation. Such policies are often seen as indicators of the Governments' commitment towards public welfare by providing the seed money for energy efficiency improvement activities. A percentage of total fuel income in government or private organizations, for example, can be allocated for energy efficiency programmes, such as auditing, load management, standardization of energy consumption of electrical appliances and establishment of energy management programmes in the factories.

Markets are a powerful and fundamental force in the wide-scale implementation of energy efficiency policies. Subsidies that depress the price of energy can provide a significant disincentive for energy efficiency investments. Unfortunately, government controls on fixing energy tariffs and pricing often act as such disincentives, particularly in developing countries. If such government controls were more market-responsive, then a favourable investment climate could be created to the benefit of energy efficiency. In most cases, gradual elimination of subsidies would bring long-term benefits to the people, ultimately offsetting the immediate difficulty paying more for energy.

Fiscal policies to provide incentives may include: import or sales tax exemptions for energy-efficient equipment and energy efficiency services; subsidies; accelerated depreciation; grants; and the establishment of investment bank lending criteria for promoting energy efficiency. Such policies are effective at removing barriers to energy efficiency by reducing the investment pay-back periods and minimizing the perceived performance risks. More importantly, these incentives bring energy efficiency investments on par with investments in productivity-related improvements. Popular incentives are subsidies for the engagement of energy managers, tax bonuses, soft-loans, grants and credits for energy efficiency investments.

Taxation policies are mandatory means of influencing the introduction of energy efficiency. In addressing climate change issues, taxes on CO_2 emission based on energy consumption, have been introduced in a few countries to promote the efficient use of energy as well as the utilization of cleaner energy. This policy on emission controls or environmental standards may also be found to "enforce" some forms of energy efficiency investments. (The developing countries, as non-annexed countries, are not required to control CO_2 emissions within the commencement period, i.e., 2008 and 2012, of the Kyoto Protocol.)

Taxation is one form of internalizing the externalities (such as social cost, opportunity cost and scarcity cost) in the energy price. By driving the energy price closer to its cost, energy efficiency activities can be made more attractive for market-oriented investments, which are comparatively more results-oriented than those implemented through policies and regulations.

Agreements and targets

Energy performance indicates the level of efficiency at which the various industrial sectors operate in manufacturing their products. Energy cost performance may be misleading since energy prices usually do not reflect the energy costs in industrializing economies.

To encourage industries to improve their energy performance, Governments usually encourage them to make some sort of agreement (even if it is only"voluntary" in nature) to reduce their specific energy consumption (SEC). SECs can be established through joint efforts with institutions that coordinate energy-use benchmarking activities. Caution should be exercised when making external SEC comparisons to avoid "apple-to-orange" comparisons. Ideally, these agreements should be entered into voluntarily, supported by extensive and continuous promotional activities. Industries that actively participate in the agreements can be rewarded through national recognition schemes that reward initiatives in productivity improvement, better environment and quality.

Reporting and benchmarking

The mandatory appointment of energy managers can be used to regulate the system for reporting energy consumption data to the relevant authorities. Currently without proper ownership, the data collected on energy consumption and production do not support the systematic analysis necessary for the proper understanding of industrial end-use energy efficiency, even though the industrial sector is a major energy consuming sector in many developing countries of the ESCAP region. The mandatory regulation requiring the appointment of energy managers should also incorporate functional duties like energy and production data reporting.

Once the data consolidated and analysed, the results can be disseminated to the data providers apprising them of the status of their companies' energy performance. This will place peer pressure on individuals to embark on energy efficiency activities to correct their current disparities. At the same time, care should be taken to maintain the confidentiality of data, where required, through a fair and reliable database management system. National institutions, responsible for the collection of energy consumption and production data, can be upgraded to embark on energy data assessment. The data providers can also have access to their data and their assessment on a regular basis, leading to a win-win situation.

Using the existing institutional capacities may not only obviate the additional financial commitment required for such activities, but may also include energy-use benchmarking as part of the overall improvement in the productivity of the manufacturing operation.

Audits and assessment

Understanding the current situation of end-use energy performance is the key to establishing sustainable plant-wide energy management. An energy audit is the only proven exercise for understanding such a situation. Energy audits conducted with basic energy audit equipment, such as power analysers, flue gas analysers and ultrasonic detectors enable the audit to be presented as "management by facts". This provides the hard facts required by management and the relevant government agencies in undertaking energy management activities.

Regular energy audits and assessment activities by authorized institutions, such as the national centres or energy services companies (ESCOs), which specialize in providing energy management services for industries/ clients, will ensure that industries stay informed of current developments.

Research and development with dissemination

Research and development (R&D) efforts are essential for the continuous improvement of energy efficiency under local conditions. R&D

in developing countries should take into account the quality of raw materials, existing labour costs, power quality, environmental loads, and temperature and humidity in providing energy efficiency solutions. These solutions may differ from those experienced in industrialized countries. Such solutions, after successful demonstration, should be disseminated to various stakeholders.

Integrated industrial energy efficiency policies

The experience of developed countries has shown that integrated approaches to energy policies have high success rates. In an integrated approach, a number of policies are combined to create a strong overall industrial energy efficiency policy that meets a variety of needs in many industrial sectors. Price and others have examined these approaches according to their effectiveness.[16] Section 2.3 contains examples of such integrated approaches as followed in four developed countries.

2.2.3. Financial support

Finance plays a very important role in energy efficiency improvement projects as in any other type of project. In developing countries, a number of successful projects are being completed that have shown a net positive fund flow within two to three years of operation. Nevertheless, suitable fiscal policies for the mobilization of domestic and foreign funds are needed. The most common internal financial support comes in the form of subsidies, grants, soft loans and tax rebates. These are usually driven by the national energy policy and many examples are covered in the previous sections. For example, Austria, India, the Islamic Republic of Iran, Italy and Turkey offer grants for energy audits to be conducted on their industrial facilities.[17] There are also international communities that provide financial support for energy efficiency activities. Some of these international funds can be obtained through the Clean Development Mechanism (CDM), the Global Environment Facility (GEF) and other financial sources.

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[16] Lynn Price, and Worrell Ernst, *International Industrial Sector Energy Efficiency Policy* (Berkeley, Ernest Orlando Lawrence Berkeley National Laboratory, 2000).

[17] International Energy Agency (IEA), *Energy Efficiency Initiative*, vol. 1, *Energy Policy Analysis* (Paris, OECD/IEA, 1998).

Clean Development Mechanism

The Clean Development Mechanism (CDM) is one of the three "flexibility mechanisms" under the Kyoto Protocol that aim to help developed countries meet their environmental obligations at low costs and at the same time contribute towards sustainable development in developing countries. It is project-based cooperation between industrialized and developing countries to protect the environment. The mechanism also opens up opportunities for investment in energy efficiency and renewable energy projects that can contribute to the reduction of GHG emissions. All countries that have ratified the Kyoto Protocol are eligible to take part in the CDM. There are two approaches to the mechanism. First, an industrialized country can invest in an energy project in a developing country and credit the emissions reductions achieved from the project. Second, a developing country can invest in an energy efficiency project and can sell the emissions credit generated to industrialized countries.

Global Environment Facility

One of the mandates of the Global Environment Facility (GEF) is to reduce GHG emission through the removal of barriers to energy efficiency projects, with the active participation of the Governments, NGOs and the private sector in the recipient countries. Some of the projects co-funded by GEF are focused on activities promoting a positive impact on the environment. Energy efficiency improvement projects result in the reduction of CO_2 emission and can be eligible for GEF funding to support a part of the project cost.

Other financial support opportunities

There are a number of financial support that are available on bilateral basis. For example, in the Green Aid Plan (GAP) of Japan, there are three organizations that provide both financial and technical support for energy efficiency activities: the Japan External Trade Organization (JETRO); the New Energy and Industrial Technology Development Organization (NEDO); and the Japan International Cooperation Agency (JICA). Cooperation and coordination can be facilitated by the local office of the organization or the Japanese embassy.

Recipient countries should initiate and pursue the assistance programme on the basis of their needs and the scope of the respective aid organizations.

2.3. Case studies and country experiences

The ministries of energy or equivalent bodies in many developing countries of the ESCAP region have relied on the continued development and use of energy resources to support the accelerated industrialization of the past three or four decades. A number of countries in the region, such as Indonesia, Malaysia, Pakistan and the Philippines, have taken some initiatives on industrial energy conservation. However, the practice of "integrated industrial energy efficiency policies" has not yet matured in these countries.

The experiences of some industrialized countries from outside the region, viz. Canada, Denmark, the Netherlands and Norway are described in this section. Subsequently, the cases of Bangladesh and the Islamic Republic of Iran are presented as practical examples to focus on the relevance of the policy options available to developing countries so that they can seek solutions to their problems by learning from their developed counterparts and gain a competitive edge.

2.3.1. Canadian Industry Program for Energy Conservation

The Canadian Industry Program for Energy Conservation (CIPEC) is based on voluntary collective targets for each industrial sector. This national policy integrates the following components:

- Targets;
- Reporting/benchmarking: annual measuring and reporting; industry mean and best practice benchmarking;
- Audits/assessment: analysis of energy efficiency opportunities.

There are 21 sector task forces representing 31 trade associations and about 3,000 companies. Under the programme, the sector task forces identify energy efficiency opportunities, review and address the barriers associated with these opportunities, and develop and implement strategies for the realization of the opportunities. The programme includes annual measuring and reporting by industry participants. Benchmarking is conducted in which facilities are compared with the industry mean and with a "best practice", which is defined as the top quartile. Since 1990, this programme has seen an average annual energy intensity improvement of 0.9 per cent, while GDP from the CIPEC industrial sector has risen 17.2 per cent and energy use has risen by 10 per cent.

The CIPEC web site (http://oee.nrcan.gc.ca/cipec/ieep/cipec/index.cfm) provides more information.

2.3.2. Danish Agreement on Industrial Energy Efficiency

The Danish agreement on industrial energy efficiency is considered the most stringent of all the popularly known integrated policies. The components of the programme are as follows:

- Regulations: mandatory energy audits/energy management systems;
- Fiscal policies: taxation and subsidies;
- Agreements/targets.

The Danish Government's target to reduce CO_2 emissions by 20 per cent from all sectors by the year 2005 compared with 1988 levels includes a 4.6 per cent reduction in emissions from the industrial sector.

To realize this target, the Government introduced a mandatory carbon dioxide emissions tax. The level of taxation depends on the purpose of the energy use, the type of energy used, and whether an agreement exists between the company and the Danish Energy Agency. The agreements, between the individual company or an association of companies and the energy agency, are made for a period of three years in order to qualify for a lower CO_2 tax rate.

To complement this approach, the programme makes use of other common energy efficiency strategies, such as the mandatory hiring of energy managers and energy audits. Audits, which are conducted either by energy consultants or the energy manager, are verified by an independent certified organization and the findings are used to chart out an energy management programme for the audited facility. That programme will set targets that must be met before the facility can qualify for the lower CO_2 tax rate.

It is also compulsory for the audited facility to implement all "profitable" energy saving projects. Projects with a payback period of four years and below are categorized as "profitable", and receive a 30 per cent subsidy.

More information can be found at the web site of the Danish Energy Authority (http://www.ens.dk/sw1577.asp).

2.3.3. Long-Term Agreement on Energy Efficiency in the Netherlands

The Long-Term Agreement on Energy Efficiency in the Netherlands is voluntary but formal and legally binding between industry associations and the Dutch Ministry of Economic Affairs. The national policy integrates the following components:

- Fiscal policies: investment tax credit;
- Agreements/targets;
- Reporting: energy use monitoring and reporting;
- Audits/assessment: energy conservation plans and audits;
- Information dissemination and demonstration: demonstration programme.

Under this approach the Government was able to attract 26 industrial associations. They represented 863 companies, which accounted for 90 per cent of the industrial energy consumed. Investment tax credits and incentives are offered to companies that come forward for energy auditing and assessment, new energy-efficient equipment and demonstration projects.

Following the current Long-Term Agreement on Energy Efficiency, a new agreement has been developed for energy-intensive industries. In the new Agreement, industry groups agree to strive to be among the world's most efficient producers by 2012. The Agreement will use benchmarking of the region (with a similar production capacity as in the Netherlands) to monitor and verify the results of the industry efforts.

The salient feature of the approach is that the companies are required to monitor and report their energy performance on a regular basis, and the information derived from this exercise can be used for better and more realistic national economic planning.

More information can be found at the web site of the Dutch Ministry of Economic Affairs (http://www.minez.nl).

2.3.4. Norwegian Industrial Energy Efficiency Network

The Norwegian Industrial Energy Efficiency Network (IEEN) is a programme designed for implementing national energy efficiency policies. This national policy integrates the following components:

- Reporting/benchmarking;
- Assessment: sector and technology studies; design and implementation of energy management systems;
- Information dissemination and demonstration: quarterly newsletter and annual report; demonstration.

The IEEN focuses on small and medium- sized enterprises. In 1998, it comprised 534 companies from 13 industrial sectors representing 40 per cent of the industrial energy use in Norway. The programme is basically an information network that disseminates information through a quarterly newsletter and annual report, and provides energy management and analytical support for the members of the network. The IEEN also collects energy use data and performs benchmarking by comparing a facility to its peers. Demonstration projects are financed up to 50 per cent by IEEN, while sector and technology studies are financed completely by IEEN. To date, this programme has seen an average annual intensity improvement of 1.4 per cent among participating sectors. A description of the programme can be found at http://www.worldenergy.org.

2.3.5. Industrial energy efficiency improvement potential in Bangladesh, an energy-deficit developing country[18]

Background

The total coal reserves in Bangladesh are about 1,750 million tons. The country's hydropower potential is 1,500 GWh/year, of which 1,000 GWh/year (230 MW) has been harnessed at Kaptai. The recoverable reserves of natural gas in 22 gas fields are 15.51 trillion cubic feet (TCF). The total amount of gas consumed until June 2001 was 4.27 TCF. The remaining recoverable reserve on July 2001 was 11.24 TCF. The installed capacity of power generation units in 2000-2001 was 4,230 MW, of which the capacity of the Bangladesh Power Development Board and that of independent power producers were 3,420 MW and 810 MW, respectively. The net generation of electricity in 2000-2001 was 16,257 GWh equivalent to 129 kWh/capita/yr.[19]

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[18] Sarkar, Rashid, "Realization of productivity and energy efficiency gains in industrial establishments in Bangladesh", presented at the Ad Hoc Expert Group Meeting on End-Use Energy Efficiency towards Promotion of a Sustainable Energy Future, Bangkok, 18-20 November 2002.

[19] Bangladesh Power Development Board, Annual Report 2000-2001 (Dhaka, 2001).

An overwhelming proportion of the energy requirement in rural households is still met by traditional biomass, such as fuelwood, animal residues and crop residues. The household sector remains the most prominent energy consumer (about 70 per cent) followed by the agricultural, industrial and transportation sectors. Among commercial fuels, kerosene is only being used for lighting. The economic consequences of deforestation and reduced fuelwood supply due to large-scale use of biomass fuels include increased cost of fuelwood and more time spent on fuel collection, particularly for people who cannot afford to buy fuelwood. The vast majority of rural households, especially the poorer sections, find themselves being subjected to increased stress and strain in procuring fuel to meet their basic energy needs.

The adverse impact of energy production and consumption can be mitigated either by reducing consumption or by diversifying energy supply options that support sustainable development objectives.

Opportunities for energy efficiency improvement in Bangladesh

Bangladesh has low energy-use efficiency and its per capita energy consumption is one of the lowest in the world. In 1997, Bangladesh had an annual per capita consumption of only 197 kgoe. There are significant opportunities for increasing energy efficiency and the number of conservation measures in all the end-use sectors, such as domestic, industrial, commercial, transport and agriculture. In spite of significant techno-economic potential, energy efficiency and conservation measures have not been widely applied in the country. Isolated efforts have been made to increase energy efficiency and take conservation measures in some industries, such as the sugar mills, spinning industries, fertilizer factories, processing mills, and cement industries. An energy conservation act is likely to be approved with a view to emphasizing the use of energy-efficient technologies.

The potential for energy efficiency improvement is often much greater in developing countries, such as Bangladesh, than in industrialized countries for several reasons. First, energy-intensive activities grow so rapidly in developing countries that a large fraction of the opportunities for making improvements in energy efficiency is associated with new installations (rather than retrofits of existing installations) in comparison with industrialized countries. Second, energy prices are typically subsidized and therefore low in many developing countries, so the market does not encourage the use of efficient technologies. Third, many energy efficiency technologies have not been readily available in developing countries. Fourth, while capital markets throughout the world tend to discriminate against investment in energy efficiency generally,[20] the difficulty of financing such investments is compounded in developing countries, where domestic capital markets are not as well established as in industrialized countries.

Barriers to energy efficiency in Bangladesh

Some of the factors affecting the profitability of energy efficiency investments in Bangladesh are as follows:

(a) **Pay-back period.** Energy efficiency investments that may be recovered in a short period of time are likely to be supported and implemented by the management. On the other hand, investments that require five years or longer to break even may receive the approval of very few managers. As such, most investments are therefore not regarded as "high priority" issues "requiring urgent action", as energy efficiency retrofit projects require comparatively longer period to recover investment costs;

(b) **Subsidized energy prices.** In Bangladesh, the prices of some energy commodities, such as electricity, natural gas and kerosene in the domestic sector do not reflect the real and full costs of energy, as energy supply establishments are often quasi-government entities and thus receive direct or indirect subsidies. Energy pricing policies obviously have an immediate bearing on the viability of energy efficiency investments. In countries where energy prices are subsidized, underinvestment in energy efficiency occurs;

(c) **Capital availability, capital costs, uncertainty and risk.** Lack of capital, high capital costs, uncertainty and risks are important factors that directly determine the feasibility of energy efficiency investments. Investors procuring equipment from industrialized countries may have to bear the foreign exchange risks during any loan repayment period;

[20] WEC/IIASA, *Global Energy Perspectives to 2050 and Beyond* (London, World Energy Council, 1995).

(d) **Information transaction costs and limitations in access to foreign currency.** In Bangladesh, access to and the relative costs of external financing are a major barrier to potential investments. Information and transaction costs must also be taken into consideration, as these are often significant impediments to energy efficiency investments;

(e) **Possible disruption of production and the related "transition costs."** The implementation of any measure of industrial manufacturing process modification may imply a temporary halt in production. Factory managers may prefer to avert such extra costs or complications;

(f) **Unstable economy with high inflation and unstable exchange rates and taxation.** In Bangladesh, direct or indirect taxation is sometimes high, especially for imported goods. High taxes may increase the first cost differentials between efficient and inefficient products and thus add a further disincentive to energy efficiency investments;

(g) **Lack of skilled personnel or energy managers.** The lack of human resources development in the area of energy efficiency affects activities related to energy conservation in industries, especially in small-scale industries;

(h) **"Invisibility" of the impact of energy efficiency measures.** The rate of return on energy efficiency investments is often seen as too low and its influence on product cost or operational expenses may be regarded as marginal. Investors often prefer items that increase the quality of the product, increase productivity or contribute to comfort. Vendors of energy-efficient technologies face the problem that energy savings cannot always be easily measured. The "invisibility" of the impact of energy efficiency measures makes it sometimes difficult for vendors to convince their potential clients in the industrial sector;

(i) **General aversion of perceived risks.** There are psychological factors affecting investment decisions on energy efficiency. These aspects include "general aversion of perceived risks" involved in "unknown", "new" or "not yet sufficiently proven" technologies.

Observations

In the case of Bangladesh, the main policy options for promoting energy efficiency in general and energy efficiency investments in particular are the following:

(a) **Energy pricing.** As mentioned above, the subsidization of energy carriers in Bangladesh often acts a deterrent to the creation of an investment climate for energy efficiency;

(b) **Optional economic instruments.** Governments have at their disposal a variety of instruments, such as tax credits or subsidized or low-interest loans, through which energy efficiency improvements can be promoted;

(c) **Information and educational programmes.** Programmes, such as energy manager training or training in energy audits, have a leading role in promoting energy efficiency investments in the long-term perspective;

(d) **Other tools.** In addition to the economic instruments, there are a variety of other tools for the promotion of energy efficiency. These other tools include regulatory measures, such as energy conservation laws, prescribing mandatory or voluntary ("voluntary agreements") minimum measures for efficient energy management in industries and minimum energy efficiency standards and environmental standards.

Specific initiatives that also require government intervention include the following:

(a) Removal of barriers (institutional structure, policy and planning, energy pricing and tariff, investment and financing, etc.) to further promote promising energy efficiency and conservation measures in the industrial sector;

(b) The establishment of a national interagency coordinating committee. The Government may also initiate projects that demonstrate the use of advanced technologies in selected public sector enterprises in industrial estates, export processing zones or satellite city centres;

(c) A greater role for State energy suppliers (electricity and gas companies) in the promotion of energy efficiency and conservation measures, which would involve establishing partnerships with potential stakeholders, public or private, in making investments, guaranteeing operation and maintenance, and sharing costs and benefits in the process;

(d) An energy conservation act, emphasizing the use of energy efficiency and conservation measures in industries. To promote energy efficiency and conservation technologies, there should be a dedicated mechanism, to gather and publish information regarding energy efficiency and conservation measures regularly;

(e) The introduction of courses on renewable energy and energy efficiency and conservation in the curriculum of technical education in Bangladesh and the assurance of long-term human resource development;

(f) Large-scale training programmes involving national institutions on different aspects of co-generation. Workshops, seminars and information exchanges are necessary on specialized topics, such as feasibility study, site selection, equipment design, financing and resource management;

(g) A comprehensive survey and pre-feasibility study for all the potential sectors. Feasibility studies for energy efficiency and conservation measures should be done immediately for all the schemes identified and priorities should be set for their implementation. A programme on energy efficiency and conservation measures should be incorporated into suitable existing or future projects in Bangladesh;

(h) International cooperation through bilateral agreements for technical and financial assistance.

2.3.6. The experience of the Islamic Republic of Iran, an energy-surplus developing country[21]

Background

The Islamic Republic of Iran, the world's fourth largest oil producer (3.81 million barrels per day; 5 per cent of the world's production in 2000)

[21] Sadeghzadeh, S.M., "Realization of productivity and energy efficiency gains in industrial establishments in the Islamic Republic of Iran", presented at the Ad Hoc Expert Group Meeting on End-Use Energy Efficiency towards Promotion of a Sustainable Energy Future, Bangkok, 18-20 November 2002.

and fifth largest oil exporter is a high energy-consuming country. The Iranian energy consumption pattern is much closer to the structure of energy demand in industrialized countries: it has very low non-commercial energy demand, a high share of buildings sector energy end-use (heating and appliances) and a high share of electricity. However, the country's energy intensity is higher than that of any European country. Low energy prices in every sector and every usage account for the inefficiency of energy use.[22] Therefore, the available potential for energy efficiency is high. "Available potential" means that a great amount of energy can be saved at a relatively low economic cost, even for "low-price energy" consumers. The amount of energy subsidies for electricity in various sectors in the Islamic Republic of Iran is shown in table 2-2.

Table 2-2. Subsidy paid for electricity in different sectors in the Islamic Republic of Iran

Sector	Amount Million $	Percentage of total
Residential	1 888	40.8
Industry	1 228	26.6
Agriculture	609	13.2
Commercial	198	4.3
Others	699	15.1
Total	4 662	100.0

Today, a sound economy should be based on true prices. Energy prices in the Islamic Republic of Iran may be gradually increased to international levels in the future. It should be noted that, as soon as inflation is mastered, a 20 per cent annual increase in energy prices as decided by the Government would signify the willingness of the Government to match prices to the costs of energy products.

As long as the energy price signal is not fully representative of the oil and gas economy, any public action for improving energy efficiency may be essential and legitimate. It has been observed that "the lower the energy price, the more effective and dynamic the energy efficiency policy needs to be".

[22] World Energy Council (WEC), *Energy Efficiency Policies and Indicators* (London, WEC, 2001).

However, the shift from oil towards the available gas resource has been very important in many sectors (such as power generation, heat supply in industry and in buildings). Unfortunately, this opportunity was not adequately exploited to help improve the efficiency of energy use in the respective sectors. Gas substitution had no impact on the continuous growth of energy intensity.

From the macroeconomic point of view, rationalizing energy consumption is an essential step. The total domestic energy consumption of the Islamic Republic of Iran represents about 40 per cent of total national energy production.

With regard to oil products, the volume of domestic consumption is 30 per cent that of oil production, and it has been increasing year after year. In the Islamic Republic of Iran, the export of crude oil and oil products represents 80 per cent of export income, which in turn represents 25 per cent of GDP.

Because of the importance of oil production in the country's economy, it is essential to improve the availability of oil for export through better management of domestic energy resources, thus reducing the "oil risk". An energy efficiency strategy needs be defined and implemented on a large scale.

In order to reflect the actual cost of energy products and services, the price of electricity and other types of energy has been increased consistently, as shown in table 2-3.

Table 2-3. Increase in the price of energy in the Islamic Republic of Iran

Energy type	Price in 2000 (Rials)	Price in 2001 (Rials)	Growth rate (Percentage)
Benzyn (petrol)/l	385	450	16.9
Kerosene/l	110	120	9.1
Gas oil/l	110	120	9.1
Fuel oil/l	55	64.2	16.7
Electricity/kWh	88.5	96.8	9.4
Natural Gas/m^3	45.7	49.1	7.4

Note: 8 008 Rials = $1.

Summary of activities related to the improvement of industrial energy efficiency

Energy auditing: Energy audits have been conducted in 70 factories, and two national energy efficiency laboratories have been established. One is devoted to research and development in energy efficiency technologies, and the other is installed on a bus and serves as a mobile laboratory for performing short audits.

It is interesting to note that, as a result of energy auditing and subsequently providing industries with "no cost", "low cost" and "high cost" measures, about 85,000 tons of crude oil have been saved in one year.

Energy management section in factories: By law, an energy management department must be established in all large-scale factories. Some factories have already created such a section.

Energy recovery projects: Some pre-feasibility studies on energy recovery were done such as turbo expander installation in power plants and recovery of energy from gas turbines in Kish Island (in the Persian Gulf) for water desalinization. The use of these facilities was scheduled for 2003.

Policy initiatives

Although efforts have been made to reflect the actual cost of energy products and services by increasing the price of energy, an equivalent rise in the inflation rate has almost nullified the impact of the price increase.

It is to be noted that the cheaper energy is, the more stringent the laws and rules need to be in order to improve end-use energy efficiency.

Policy initiatives need to address the long-term and sustainable export of crude oil and oil products, which are the current strength of the Iranian economy.

Domestic energy conservation is urgently needed.

The recent initiatives to improve end-use energy efficiency, particularly in the industry and electrical appliances sector, need to be intensified.

Observations

The underlying objective of introducing the right type of energy policies, prices and regulations is to lay the foundation for sustainable development, and one of its pillars is end-use industrial energy efficiency. Each country needs to develop its own set of energy policies, striking a clear balance between economic growth and environmental enhancement. In other words, the policies must encourage the rational use of energy.

To achieve this, the adaptation and adoption of proven and unproven policies introduced in developed countries are crucial. A selection matrix consisting of the criteria and their ratings will enable policymakers to narrow down the suitability of the policies introduced in developed or developing countries. The latter policies may require very little evaluation. Table 2-4 can be used as a guide for short-listing such policies. This "policy evaluation format" can be effectively used to select and/or modify policy options, some examples of which are listed in table 2-5.

Table 2-4. Policy evaluation format

Title of policy: ....

No.	Main criteria	Rating	Sub-criteria	Actual rating
1	Economics	H/L/M	• Encourages sustainability • Encourages competition • Mobilizes investment • Reduces price distortion	
2	Capacity-building	H/L/M	• Human capacity • Institutional capacity • Transfer of technology • International cooperation	
3	Participation	H/L/M	• Government • Industrial sector • Civil society	
4	Environment	H/L/M	• GHG emission reduction • Use of renewable sources	

Note: H – High, M – Medium, L – Low.

Table 2-5. Existing policy options to support energy efficiency in selected developing countries and areas

Country/area	Policies introduced
China	• Mandatory regulation and standards • Mandatory energy audits • Information dissemination and demonstration
Hong Kong, China	• Incentives and soft loans • Information dissemination and demonstration
Indonesia	• Mandatory regulations and standards • Information dissemination and demonstration
Malaysia	• Information dissemination and demonstration
Philippines	• Mandatory regulations and standards • Mandatory energy audits • Mandatory reporting and benchmarking • Financial incentives and soft loans • Information dissemination and demonstration
Thailand	• Mandatory energy audits • Mandatory reporting and benchmarking • Information dissemination and demonstration
Viet Nam	• Mandatory energy audits • Mandatory reporting and benchmarking • Taxes/levies • Incentives/rebate and soft loans • Information dissemination and demonstration

Chapter 3

IMPROVING END-USE ENERGY EFFICIENCY IN THE ROAD TRANSPORT SECTOR[23]

3.1. Introduction

An inefficient road transport system, particularly in urban areas or cities, affects the people and the environment. In urban areas, the impact is direct and immediate through air pollution, traffic congestion and their consequences, whereas rural areas can be affected by a regional environmental impact, such as acid rain.

Road transport causes vast environmental and social problems in modern society. The increasing dominance of motor vehicles throughout the twentieth century has caused poor air quality in urban areas, deteriorating quality of life in inner city areas as a result of traffic congestion, and a decline in the use of public transport. This has led to increased reliance on private motor vehicles, resulting in massive traffic flow problems. In developed countries, perhaps the greatest effect of motor vehicle usage has been on the design of major towns and cities. The availability of cars has resulted in the creation of sprawling outer suburbs, which are poorly serviced by other forms of transport and services and where life is effectively impossible without motor vehicles.[24]

Road transport is one of the major areas where energy efficiency measures can be applied. An increasing amount of oil is consumed by the transport sector. In other sectors of the economy, oil has been at least partially substituted by other fuels in recent years. For example, oil is seldom encountered today as a source of home or office heating, and most of its commercial and industrial uses, including power generation have been phased out, to a large extent. Transport is the one sector where oil has not

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[23] This chapter was principally drawn from the contribution made by Mr. Adrian Bradbrook. The case studies are based on the contribution made by Mr. Jeong-In Kim and Ms. Jai-Ok Kim.

[24] United Nations Environment Programme, "The Role of the Transport Sector in Environmental Protection" (Background Paper, prepared for the ninth session of the Commission on Sustainable Development, April 2001).

yet been effectively substituted. Various fuel substitutes have been developed, such as ethanol, liquefied petroleum gas (LPG) and compressed natural gas (CNG), but each of these options appears to suffer from various disadvantages or inconveniences. In the long term, hydrogen may prove to be the ideal substitute fuel, but even ardent proponents of a hydrogen economy concede that this will not happen in the near future.[25]

The need for worldwide action to achieve energy efficiency in the transport sector has been recognized by United Nations agencies and other international, governmental and non-governmental organizations. The need for national Governments to take action to reduce the environmental impact of transport and to promote greater energy efficiency in the transport sector is discussed in Agenda 21 (Articles 7.48, 7.52, 9.13, 9.14 and 9.15), the World Energy Assessment (see chapter 6) and the report of the Commission on Sustainable Development on its ninth session.[26] Such issues are also the subject of international conventions. The Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects refers, in Article 9 and the Annex, to the need to develop motor vehicle performance standards and efficient transport infrastructures. The Kyoto Protocol to the United Nations Framework Convention on Climate Change, Article 2, requires each developed country party to enhance energy efficiency by, inter alia, introducing measures to limit and/or reduce greenhouse gas emissions in the transport sector. The most recent emphasis has been made in the Johannesburg Plan of Implementation, adopted by the World Summit on Sustainable Development. Clause 21 states:

> "[The Parties agree to] promote an integrated approach to policy-making at the national, regional and local levels for transport services and systems to promote sustainable development, including policies and planning for land use, infrastructure, public transport systems and goods delivery networks, with a view to providing safe, affordable and efficient transportation, increasing energy efficiency, reducing pollution, reducing congestion, reducing adverse health effects and

[25] United Nations Development Programme, Department of Economic and Social Affairs, and World Energy Council, *World Energy Assessment: Energy and the Challenge of Sustainability* (New York, United Nations, 2000).

[26] Official Records of the Economic and Social Council, 2001, Supplement No. 9, (E/2001/29).

limiting urban sprawl, taking into account national priorities and circumstances. This would include action at all levels to:

(a) Implement transport strategies for sustainable development, reflecting specific regional, national and local conditions, so as to improve the affordability, efficiency and convenience of transportation, as well as improving urban air quality and health, and reduce greenhouse gas emissions, including through the development of better vehicle technologies that are more environmentally sound, affordable and socially acceptable;

(b) Promote investment and partnerships for the development of sustainable, energy efficient multi-modal transportation systems, including public mass transportation systems and better transportation systems in rural areas, with technical and financial assistance for developing countries and countries with economies in transition."

None of the many international documents proposing reforms to promote energy efficiency in the transport sector imposes binding legal requirements on national Governments to take concrete actions. Instead, they constitute non-binding, "soft" international laws, which are for moral persuasion only and the breach of which incurs no legal sanction. To date, developments at the national level have been limited. Perhaps the most noteworthy achievements have been the introduction of fuel economy standards in the United States and Japan, fuel consumption labelling in a number of countries, and fuel substitution (most notably in Brazil).

3.2. Policy options

3.2.1. Guiding principles

It is apparent that the majority of policy discussions on reforms in the transport sector to promote energy efficiency have occurred without any reference to basic guiding principles, which should underlie any changes. As with all issues of sustainable development, it is now commonly accepted that principles should be established to guide future reforms in this sector. Many such principles are now recognized as part of international environmental law.

The following principles, which were first promoted in Australia by the Ecologically Sustainable Development Working Group on Transport through its 1991 report, are good examples for possible adaptation elsewhere.

- Improvement of material and non-material well-being;
- Advancement of inter-generational equity;
- Advancement of intra-generational equity;
- Maintenance of ecological systems and the conservation of biodiversity;
- Accounting for global ramifications, including international spillovers, international trade and international cooperation;
- Caution in dealing with risk, uncertainty and irreversibility.

The policy options described below have been proposed with the above guiding principles in mind.

3.2.2. The options

Planning and development laws

According to a report of the Secretary-General submitted to the Commission on Sustainable Development at its ninth session (E/CN.17/2001/3), the United Nations estimated in 1995 that 46 per cent of the world's population resided in urban areas; that figure was expected to reach 50 per cent by 2006 and to surpass 60 per cent by 2030. The rapid pace of urbanization meant that not only were more people living and working in cities but also more people and more goods were making more trips in urban areas, often over longer and longer distances.

This development has profound effects on the transport sector. The design of cities can directly influence the consumption of transport fuels. If cities are allowed to spread without adequate controls, there is a danger that public transport to the extended areas will be inadequate, necessitating almost exclusive reliance on motor vehicles. This has already occurred in a number of major cities throughout the world. In addition, of course, the spread of cities without adequate planning controls inevitably means more travel and therefore more fuel consumption. Rapid urbanization is probably inevitable. The shape and design of such urban areas can be controlled so as to render such cities efficient in terms of transport usage and fuel consumption. The goal of such planning controls should be to ensure that development occurs in such a way that public transport can provide an adequate service and that the need for travel within urban areas is minimized.[27]

These issues were raised in Agenda 21, which produced the following recommendations. Paragraph 7.52 states:

> "Promoting efficient and environmentally sound urban transport systems in all countries should be a comprehensive approach to urban-transport planning and management. To this end, all countries should:
>
> Integrate land-use and transportation planning to encourage development patterns which reduce transport demand:
>
> (a) Adopt urban-transport programmes favouring high-occupancy public transport in countries, as appropriate;
>
> (b) Encourage non-motorised modes of transport by providing safe cycleways and footways in urban and suburban centres in countries, as appropriate;
>
> (c) Devote particular attention to effective traffic management, efficient operation of public transport and maintenance of transport infrastructure;
>
> (d) Promote the exchange of information among countries and representatives of local and metropolitan areas;
>
> (e) Re-evaluate the present consumption and production patterns in order to reduce the use of energy and natural resources."

Paragraph 9.15 makes the following further recommendations:

> "Governments at the appropriate level, with the cooperation of the relevant United Nations bodies and, as appropriate, intergovernmental and non-governmental organizations, and the private sector, should:

[27] WEHAB Working Group, *A Framework for Action on Energy*, Report produced for the World Summit on Sustainable Development (2002).

(a) Develop and promote, as appropriate, cost-effective, more efficient, less polluting and safer transport systems, particularly integrated rural and urban mass transit, as well as environmentally sound road networks, taking into account the needs for sustainable social, economic and development priorities, particularly in developing countries;

(b) Facilitate at the international, regional, subregional and national levels access to and the transfer of safe, efficient including resource-efficient, and less polluting transport technologies, particularly to the developing countries, including the implementation of appropriate training programmes;

(c) Strengthen, as appropriate, their efforts at collecting, analysing and exchanging relevant information on the relation between environment and transport, with particular emphasis on the systematic observation of emissions and the development of a transport database;

(d) In accordance with national socio-economic development and environment priorities, evaluate and, as appropriate, promote cost-effective policies or programmes, including administrative, social and economic measures, in order to encourage use of transportation modes that minimize adverse impacts on the atmosphere;

(e) Develop or enhance, as appropriate, mechanisms to integrate transport planning strategies and urban and regional settlement planning strategies, with a view to reducing the environmental impacts of transport; and

(f) Study, within the framework of the United Nations and its regional commissions, the feasibility of convening regional conferences on transport and the environment."

These recommendations remain equally valid today as when they were first made at the United Nations Conference on Environment and Development in 1992. They are very wide-ranging and, in some cases, rather general in nature. It would perhaps be helpful to reformulate and modify these recommendations to highlight the most significant and effective policy options for enhancing energy efficiency in the transport sector and to provide suggestions for specific government action. The options described below are suggested for consideration.

Option 1: Changes to town planning laws to encourage urban consolidation

Urban consolidation is designed to use urban land more efficiently in order to improve accessibility to city centres and other important hubs. It can be promoted in a variety of ways, including the following:

(a) By ensuring that inappropriate regulations and processes preventing urban consolidation are removed from local and national building and town planning laws;

(b) By having government authorities conduct assessments of the capability for redevelopment in each local government area through a study of the infrastructure capacity;

(c) By creating, within town planning laws, guidelines or development rules clearly specifying zoning and priorities as to where and how much development should occur in each city area;

(d) By ensuring that attention is paid to the redevelopment of land around key public transport nodes to include dense housing and some commercial activity so that travel is minimized and public transport facilities are made more attractive;

(e) By investigating whether taxation laws can be changed so as to encourage high density housing in areas identified for development by government authorities;

(f) By encouraging dual or multiple occupancy. This is the right to register and rent a self-contained apartment or unit forming part of an existing or new residence, the right to subdivide existing blocks so as to create additional housing units, and the right to sell large backyards of existing blocks for further development.

All these options are designed to reduce travel by allowing more people to live close to established areas where employment and urban facilities, such as shops and entertainment complexes, exist. They will all require amendment of the appropriate planning or building legislation.

Option 2: Education of the public on the need to promote energy efficiency in the transport sector

While the changes to town planning and building laws referred to above are imperative, coordinated efforts by government authorities to educate the public on the importance of energy efficiency in the transport sector are considered indispensable if the scope for improving energy efficiency is to be maximized. This would ideally necessitate the use of mass media campaigns at both the national and local levels and government support for initiatives undertaken by community groups and local councils.

Furthermore, policy measures may be taken in order to extend support to institutions for capacity-building to conduct some of the activities that are currently restricted within government agencies. When such activities as training and energy performance testing are conducted by institutes/NGOs, with authorization from the Government, the dissemination process can be improved not only quantitatively but also qualitatively.

Option 3: Greater use of environmental impact assessments

Environmental impact statements are considered to be one of the most effective legal tools for promoting sustainable development in all sectors of the economy. They would ensure that environmental concerns are taken into account in any development project and of raising awareness in the importance and impacts of the environment. This option would end the practice among the project proponent, the public sector and the public at large of simply ignoring the environmental impact of proposed developments. The use of environmental impact statements is mandated in a limited number of countries, mainly the developed ones. It is recommended that all town planning changes that would actually or potentially impact on public or private transport usage or availability be made subject to a compulsory environmental impact statement as a precursor to approval.

Option 4: Demand management programmes

A variety of demand management programmes have been proposed in various countries in order to reduce the need for travel, the amount of travel and the impact on this travel, without restricting access to urban facilities. Such programmes are wide-ranging in their scope and nature.[28] They include the following:

(a) The use of staggered or flexible working hours and the deregulation of weekend working;

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[28] International Energy Agency (IEA), *Voluntary Actions for Energy-Related CO_2 Abatement* (Paris, OECD/IEA, 1997).

(b) Encouragement of ride sharing (and consequently reduced vehicle and fuel use) with such measures as: high occupancy vehicle lanes; laws requiring employers with more than a specified number of employees to develop increased vehicle occupancy schemes for their employees; the removal of legal prohibitions on payment for ridesharing; "every car a taxi" laws permitting drivers to pick up pedestrians at designated areas;

(c) Improvement of traffic flow by the use of traffic management measures, such as computer-coordinated traffic signals;

(d) Regulatory control of access to city centres for private vehicles, by such means as: vehicle permits to enter city centres; granting access to vehicles with odd or even number plates on alternate days; car-free days; bans on certain classes of vehicles; vehicle taxation according to city access privileges; or lotteries to allocate city access rights;

(e) Increased parking controls, including increased fees and restrictions on the number of parking places available;

(f) Road pricing controls, by imposing fees for vehicle use of certain key roads. This can be achieved electronically by the use of overhead cameras and special computer cards attached to vehicle windscreens, which record when vehicles pass a certain point;

(g) Encouraging residents to use modes of transport other than private vehicles, by: establishing bicycle lanes; the provision of special parking areas outside inner city areas and encouraging people to walk to work or take buses from these areas; fee reductions and/or timetable improvement for public transport services;

(h) Modification of taxation laws to discourage companies from providing their senior employees with company cars, and to make employees liable for income tax on the value of company cars.

Laws regulating the motor vehicle industry

Regulating the motor vehicle industry is one of the major tools available to Governments to promote their policies. In the context of enhancing energy efficiency in the transport sector, the options described below are available to Governments.

Option 5: Fuel consumption labelling

Fuel consumption Labelling assists in promoting consumer confidence in motor vehicles. It enables customers to make an informed choice between various competing products, provides manufacturers with an incentive to design more energy-efficient vehicles, and generally promotes energy conservation.

A number of countries have introduced a compulsory system of labelling for fuel efficiency in motor vehicles. These include Japan, the United Kingdom of Great Britain and Northern Ireland and the United States of America. A voluntary system of fuel labelling exists in many other countries, including Canada, where legislation designed to make the system compulsory has been enacted and will be promulgated if vehicle manufacturers cease to comply with the current "voluntary" scheme.[29]

The proposal to introduce a mandatory system of fuel consumption labelling has been criticized on the basis that the fuel consumption figures achieved under test conditions could never be achieved under road conditions, and that this would lead to a rush of complaints against the manufacturers. While it is certainly true that fuel consumption increases significantly under road conditions, the figure or figures displayed on the label could be modified to take account of this fact.[30] This occurs in the United States, where under the rules produced by the Department of Transportation pursuant to the Motor Vehicle Information and Cost Savings Act, two fuel consumption figures are displayed, one for fuel consumption in city conditions, and one for fuel consumption in highway conditions.[31]

If fuel economy labelling is adopted, it will be necessary for the exact form of the label to be prescribed by law. As the labelling system is designed to be a consumer protection and information measure, it is

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[29] Bradbrook, A.J., "The Development of a Regulatory Framework on Consumer Protection and Consumer Information for Sustainable Energy Use", *Asia Pacific Journal of Environmental Law*, vol. 5, 2000, pp. 239-263.

[30] Beca Carter Hollings and Ferner Ltd, *Vehicle Fuel Economy Labelling and Other Fuel Economy Measures* (Wellington, 1993).

[31] 49 United States Code, Chapter 329, *Automobile Fuel Economy*.

essential that the label be carefully designed so that it discloses the relevant amount of information in a manner that is easy to understand. The label must be neither too vague nor too complex and difficult to understand. It is suggested that the desirable form of label would consist simply of fuel consumption information and would give separate figures for city and highway consumption, appropriately discounted from the figures obtained from standard test conditions. For comparative purposes the label would indicate the range of fuel consumption figures obtained by passenger vehicles and light trucks generally. It is further suggested that a global figure for the estimated annual fuel cost of the vehicle not be included in any new label. The estimated fuel cost is considered to be too vague and misleading from a consumer perspective as the figure will depend greatly on the distance driven in a given year. This will be unknown in each case and will vary greatly between consumers.

Option 6: Including fuel consumption information in model-specific vehicle advertising

Under this option, a system would be established whereby fuel efficiency information would be included in all model-specific motor vehicle advertising. The proposal can be justified in a number of ways:

(a) It would raise public awareness of fuel consumption as a factor in the purchase decision;

(b) It would put fuel consumption information before the prospective buyer at an early stage in the purchasing process;

(c) It would be obviate additional testing, as sufficient fuel consumption data exist;

(d) It would rank fuel efficiency alongside other attributes in the overall image of desirability of ownership delivered by the advertisement.

Legislation of this nature exists in the Republic of Korea, pursuant to the Rational Energy Utilization Act 1995, Article 18(4). It requires all manufacturers, importers and distributors of specified machinery and materials to include the energy consumption efficiency or quantity consumed in the contents of any advertisement for the product.

Option 7: Fuel economy standards for vehicle manufacturers

The practice of requiring vehicle manufacturers to ensure that their fleets comply in any given year with government-prescribed fuel consumption limits is in effect in Japan and the United States of America. It is also the subject of a voluntary agreement between the Government and industry in Australia and Canada.[32]

The standards in the United States are contained in the Corporate Average Fuel Economy standards (CAFE), enacted in 1975 pursuant to the Energy Policy and Energy Conservation Act. The legislation has since been consolidated with other legislation affecting motor vehicles in the form of Title V of the Motor Vehicle Information and Cost Savings Act. The CAFE system involves the establishment by the Government of a precise average fuel economy standard or standards that each vehicle manufacturer must attain each year in respect of all vehicles produced during that year. The CAFE figure for each manufacturer takes into account the fuel economy of each class of vehicle produced and is weighted to take account of the number of vehicles produced in each class in each year. Two separate standards have been introduced, one for passenger vehicles and one for light trucks. In respect of passenger vehicles and light trucks, the standard is currently 27.5 miles and 20.7 miles per gallon, respectively. Manufacturers may earn a credit by exceeding the standard set in any year. This credit can then be applied against the standard for any of the following three years.[33]

The American system could not realistically be adopted in many countries because it is designed to apply to full-line vehicle manufacturers (that is, companies that produce a full range of vehicles, from compact 3-cylinder vehicles to larger 6- or 8-cylinder vehicles). It is implicitly understood that manufacturers will wish to produce some models of large cars which by themselves will exceed the relevant fuel efficiency standard, but this is perfectly acceptable provided that the company produces a sufficient number of smaller vehicles in the same model year to ensure that

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[32] International Energy Agency (IEA), *Voluntary Actions for Energy-Related CO_2 Abatement* (Paris, OECD/IEA, 1997).

[33] United States of America, Energy Information Administration (EIA), "Analysis of Corporate Average Fuel Economy Standards for Light Trucks and Increased Alternative Fuel Use" (SR/OIAF/2002-05) (Washington, D.C., Department of Energy, 2002).

the average fuel consumption for all its vehicles meets the stipulated standard. Except in Japan and the Republic of Korea, there are no full-line vehicle manufacturers within the ESCAP region. Vehicle manufacturers outside these two countries produce only a limited range of models. The lack of a wide range of models means that the averaging process between the fuel consumption of larger vehicles and smaller vehicles cannot operate in these countries.

The Australian and Japanese alternative of establishing a percentage improvement system is more feasible. This proposal would not involve the establishment of a particular fuel consumption standard for vehicles, but would require all manufacturers to improve the average fuel economy performance of their vehicle fleets by a designated percentage over a period of years. If established, such a system would specify the average fuel consumption achieved by the entire fleet produced by each vehicle manufacturer during a specified reference year and would require the manufacturer to improve the fuel efficiency of its fleet by a fixed percentage the following year or within a specified period of years. The establishment of past consumption figures should not be difficult, as this information is regularly supplied by the manufacturers themselves.

Option 8: Vehicle maintenance programmes

Many developed countries have introduced a compulsory system of annual inspections for motor vehicles. In some countries, this applies to all vehicles, while in other countries this applies only to vehicles over a specified age. The primary justification for the introduction of such a system has been safety, as it is designed to ensure that vehicles that are not roadworthy are not registered.

While doubts have been raised from time to time about cost-effectiveness, such programmes can be justified on the quite different ground of fuel consumption efficiency if the prescribed inspection programme includes tuning the engine. While exact figures cannot be produced because of the myriad problems of maintenance, there is no dispute that well-maintained and tuned vehicles maintain a significantly higher level of fuel efficiency than poorly maintained or neglected vehicles. Regular maintenance and inspection programmes would thus improve a country's overall vehicle fuel efficiency. A further benefit from such programmes is that older, less fuel-efficient vehicles would be retired and replaced at an earlier stage by more modern fuel-efficient vehicles.

Fiscal incentives

There are a number of fiscal strategies that Governments may pursue to improve motor vehicle fuel economy. Some of the options are discussed below.

Option 9: Skewed sales/goods and services tax

The essential feature of a skewed sales/goods and services tax is that it imposes higher charges on vehicles with low levels of fuel efficiency. The tax may be levied on the manufacturer or the consumer (at the point of wholesale or retail sale). The penalty may take the form of a lump-sum payment or a higher tax rate imposed on the value of the motor vehicle. Such a tax exists in the United States, where a specified supplementary lump-sum tax is imposed on manufacturers for all new passenger vehicles (except ambulances and police cars) that do not meet prescribed standards of energy efficiency. The system has been in operation since 1978 and is commonly referred to as the "gas guzzler tax".

Alternatively, rather than imposing lump-sum payments, any new legislation could impose differential sales/goods and services tax rates based on motor vehicle fuel efficiency. Under this proposal, the existing sales/goods and services tax rates could be modified so as to increase the rate of tax payable in respect of fuel-efficient vehicles and (possibly) to reduce the rate of tax payable for fuel-efficient vehicles. This approach is more consistent with the current tax regime in many countries, which specifies rates rather than lump-sums.[34]

The imposition of such a system would raise additional tax revenue. However, the reform could be made revenue-neutral if the schedule were modified and expanded so as to give a lump-sum reduction for the sale of each vehicle that meets or exceeds the specified fuel consumption statistics. The introduction of a sliding scale would result in a significant price reduction for the most fuel-efficient vehicles.

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[34] A.J. Bradbrook, and A.S. Wawryk, "Legislative Implementation of Financial Mechanisms to Improve Vehicle Fuel Efficiency", *Melbourne University Law Review* (1998), vol. 22, pp. 537-563.

Option 10: A feebate system

This option would combine higher sales/goods and services tax for inefficient vehicles with tax rebates for relatively efficient vehicles. Such a system would specify a sliding scale of charges for vehicles of lower efficiency ("gas guzzlers") and incorporate a sliding scale of rebates for vehicles of higher efficiency ("gas sippers"). The sales tax (or rebate) would be paid (or received) by the consumer at the point of retail sale and would take the form of a lump-sum payment. This option is commonly referred to in North America as "feebates". In 1990, the government of Ontario, Canada, introduced a system of this nature, entitled the Tax for Fuel Conservation. The additional tax ranges between $75 and $7,000 for vehicles with fuel consumption ratings in excess of six litres per 100 km. A tax rebate of $100 is given to purchasers of vehicles with fuel consumption ratings below six litres per 100 km.[35]

The American Council for an Energy-Efficient Economy has undertaken work on the development of a model formula for the calculation of feebate charges and rebates designed to best encourage energy efficiency.[36]

Option 11: Skewing motor vehicle registration charges towards higher charges on inefficient vehicles

Another tax option is to require the owners of cars with a high rate of fuel consumption to pay increased annual motor vehicle registration charges. Most countries have legislation imposing differential registration fees. While the laws vary, the registration charges are usually based on a number of factors, such as the type of vehicle to be registered, the weight of the vehicle, the number of cylinders and whether the vehicle is to be used for private or commercial purposes. An illustration is Australia, where differing legislation in the various States imposes higher charges on heavier (and more energy-consuming) vehicles according to a sliding scale. This option would replace the existing criteria for determining the applicable rate

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[35] National Round Table on the Environment and the Economy, *Sustainable Transportation in Canada: Backgrounder* (1996).

[36] J. DeCicco, H. Geller and J. Morrill, *Feebates for Fuel Economy: Market Incentives for Encouraging Production and Sales of Efficient Vehicles* (Washington, D.C., American Council for an Energy-Efficient Economy, 1992).

of registration charges by a sliding scale based on the rate of fuel consumption of the vehicle.[37]

Option 12: Increasing the petroleum excise tax

A petroleum excise tax is usually levied directly on the consumers of petrol at the point of sale on a cents-per-litre basis. Such a tax already provides consumers with an incentive to reduce the use of petrol and to purchase fuel-efficient vehicles. The *Study on Potential to Improve Fuel Economy of Motor Passenger Vehicles* suggested that motor vehicle fuel efficiency could be significantly improved in the United States by eliminating or reducing sales/goods and services tax on cars and raising petroleum excise tax to compensate for the lost revenue. Such a reform is consistent with the "user pays" approach and would be more likely to result in reduced driving and thus reduced fuel consumption.[38]

Option 13: Income tax incentives

In most countries, income tax is calculated by applying the appropriate tax rate to the taxable income and then subtracting any rebates or credits allowed by law. Taxable income is determined by subtracting allowable deductions from a taxpayer's assessable income. Governments could offer income tax rebates or credits on the purchase of motor vehicles that meet specified fuel economy standards. This concept is similar to the various incentive programmes in the United States that are designed to stimulate the purchase of alternative-fuel vehicles and the conversion of petroleum-based vehicles to alternative fuels. For example, the State of California enacted legislation in 1990 providing an income tax credit for individuals and businesses that either purchased new alternative fuel vehicles or retrofitted their standard vehicles using an alternative-fuel conversion kit certified by the California Air Resources Board.[39]

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[37] A.J. Bradbrook, "Motor Vehicle Registration Charges as a Means for Improving Fuel Efficiency", *Environmental and Planning Law Journal* (1998), vol. 15, pp. 33-44.

[38] Loxton and Andrews Pty Ltd., *Study on Potential to Improve Fuel Economy of Passenger Motor Vehicles* (Canberra, 1991).

[39] A.J. Bradbrook, and A.S. Wawryk, "Legislative Implementation of Financial Mechanisms to Improve Vehicle Fuel Efficiency", *Melbourne University Law Review* (1998), vol. 22, pp. 537-563.

Such a scheme would require administrative supervision by a government agency. Under this option, the purchaser of a qualifying fuel-efficient vehicle would fill out the appropriate form, giving information as to the type of car purchased. The government agency would approve the application and send a certification letter to the purchaser. This letter would be kept for income tax audit purposes.

Option 14: Offering grants, low interest loans or loan guarantees to businesses for the lease or purchase of fuel-efficient vehicles

Another option to encourage the use of more fuel-efficient vehicles by businesses is government subsidization of the purchase or lease of fuel-efficient vehicles by means of grants, low-interest loans or loan guarantees. In addition, national Governments could provide assistance for local or regional government agencies to lease or purchase fuel-efficient vehicles. The national Government could influence the local or regional government's vehicle mix by making the selection of fuel-efficient vehicles more economically attractive.

Promoting alternative fuels

More than 95 per cent of the fuel used worldwide for transport is petroleum-based. This reliance on petroleum is responsible for the large level of indebtedness of many developing countries. One way of improving efficiency would be to promote alternative fuels. Such fuels include compressed natural gas (CNG), liquefied natural gas (LNG), methanol, ethanol and hydrogen. In the long term, fuel cells may offer the best solution. In the short- to medium-term, however, ethanol is perhaps the best option. It has been extensively used for a number of years in some countries, particularly Brazil. Even without the redesign, motor vehicle engines can use a petrol-ethanol mix with a ratio of nine to one.[40] A number of options can be identified to promote the greater use of ethanol[41] as follows:

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[40] United Nations Development Programme, Department of Economic and Social Affairs, and World Energy Council, *World Energy Assessment: Energy and the Challenge of Sustainability* (New York, United Nations, 2000).

[41] A.J. Bradbrook, and A.S. Wawryk, "Energy, Sustainable Development and Motor Fuels: Legal Barriers to the Use of Ethanol", *Environmental and Planning Law Journal* (1999), vol. 16, pp. 196-211.

Option 15: Financial incentives for crop manufacturers

Ethanol involves the use of cultivated crops to produce alcohol by the fermentation of plant material, such as sugarcane molasses or starch from cassava plants. Such crops grow readily in tropical climates and could be produced in a large number of developing countries.

While an established sugarcane industry exists in some tropical countries, in many countries the development of a large-scale crop industry for the production of ethanol would require considerable investment. In this situation, one option is for the Government to promote the production of ethanol by offering financial incentives to farmers to grow the necessary crops. Such incentives might include direct grants or loans on favourable terms, or modifications to the local income tax legislation to allow for a tax deduction or rebate for the associated costs of development and investment, or an investment allowance.

Option 16: Government support for the redesign of vehicle motors

Research shows that it is comparatively easy to blend motor vehicle fuels with up to 10 per cent ethanol without causing damage to the engine. If ethanol is to make extensive inroads into petroleum use, vehicle design and modification must take place. This development is unlikely to be supported by the motor vehicle industry without some form of government financial support. Again, the choice is between direct grants or loans on favourable terms to the vehicle industry, or modifications to the local company tax legislation to allow for a tax deduction or rebate for the associated costs of motor vehicle redesign, or an investment allowance.

New technologies are being developed that allow vehicles to run on alternate fuel and often with more efficiency and less emission. The use of hybrid fuel vehicles, electric vehicles and fuel cell vehicles may be encouraged through such means as easy registration and permits for access to city centres.

Option 17: Removal of legislative barriers

In many countries, there are a number of legislative provisions that act as legal barriers to the production and marketing of ethanol as a motor vehicle fuel. The barriers consist not only of provisions that apply unfairly and inappropriately to ethanol, but also legal uncertainties as to their application to ethanol. Many of these provisions were never formulated with ethanol in mind, but were enacted for other purposes. Their continued existence, however, affects the manufacture of ethanol in commercial quantities unless they are reformed or repealed.

Broadly speaking, legal barriers to the use of ethanol as a motor vehicle fuel exist in legislation regulating health and safety, competition in trade, customs duties and the distillation of spirits. In Australia, for example, a recent study has shown that the production of ethanol would be hindered or prevented by legislation concerning the storage, handling use and transport of dangerous substances, laws concerning the franchise agreements between large oil companies and service station operators, laws regulating trade practices, laws controlling shop trading hours, alcohol manufacture legislation, and customs duties on beverages, spirits and vinegar.[42] For countries that wish to produce ethanol in commercial quantities, studies may be undertaken on the existence of such legislative barriers to the development of the industry and an appropriate law reform may be introduced to remove the barriers. Without such action, the private sector is unlikely to make significant investments.

3.2.3. Case study: the Republic of Korea

Studying the road transport sector presents greater difficulties in comparison with other sectors. Because factors differ from country to country even within the region, selecting a country becomes problematic. Techno-economic issues, the climate, the available surface area for roads, the availability of alternate modes of transport (rail, sea, air), pubic interest and mandatory environmental standards all affect policy-making. The Republic of Korea,[43] a country with a combination of problems that has nonetheless achieved rapid technological and technical development in the road transport sector, has been chosen because many other developing countries are in a similar situation.

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[42] A.J. Bradbrook, and A.S. Wawryk, "Energy, Sustainable Development and Motor Fuels: Legal Barriers to the Use of Ethanol", *Environmental and Planning Law Journal* (1999), vol. 16, pp. 196-211.

[43] See Jeong-In Kim, "Enhancing efficiency in energy use in urban transportation: experience from the Republic of Korea"; and Jai-Ok Kim, "NGO initiatives for promotion of appliances energy efficiency", papers presented at the Ad Hoc Expert Group Meeting on End-Use Energy Efficiency towards Promotion of a Sustainable Energy Future, Bangkok, 20-22 November 2002.

Energy situation

Over the past 20 years, energy consumption in the Republic of Korea has increased more than four-fold, from 43.9 mtoe in 1980 to 192.9 mtoe in 2000. This makes the country the tenth largest energy-consuming country in world. Per capita energy consumption has also increased significantly as shown in table 3-1 (from 3.34 toe in 1995 to 4.08 toe in 2000). Policy makers have focused especially on ways to conserve energy use (and increase energy efficiency) as 97 per cent of the country's energy is imported.

Table 3-1. Major indicators of the energy economy in the Republic of Korea

	1995	1996	1997	1998	1999	2000
Primary energy consumption (mtoe)	150.4	165.2	180.8	167.4	181.0	192.9
(Growth rate, per cent)	(9.6)	(9.8)	(9.4)	(7.4)	(8.1)	(6.7)
Per capita (toe)	3.34	3.63	3.93	3.57	3.87	4.08
Energy/GDP ratio (index)	100	102.9	107.1	105.4	104.1	101.6
Import dependency ratio	96.8	97.3	97.6	97.1	97.2	97.2

It is forecasted that in 2011 the transport sector in the Republic of Korea, with an average annual growth rate of 3.9 per cent, will account for 23.2 per cent of the country's final energy consumption.[44] Further, as shown in table 3-2, the energy intensity in road transport has increased from 1.88 toe/thousand passenger (i.e., three times of rail transport) to 2.26 toe/thousand passenger (i.e., four times that of rail transport). Therefore, the energy conservation potential in the road transport sector, compounded by the concern about pollution in urban areas, has made this sector a focus area for the improvement of energy efficiency.

Although the number of passengers is decreasing slightly in the road transport sector, energy consumption in the transport sector overall has been steadily increasing, and the number of passengers in general is reaching the

[44] KEEI, The Second National Energy Plan (2002-2011).

saturation point. It has been estimated that the trend will prevail for the next 25 to 30 years, as shown in table 3.3.

Table 3-2. Increase in energy intensity in the road transport sector in the Republic of Korea

(a) Energy use in transportation out of total energy consumption

(in mtoe)

Transport modes	1995	2000
All combined	27.148	30.945
(Percentage of total energy use)	(22.3)	(20.6)
Rail	0.464	0.512
(Energy intensity in toe/thousand passengers)	(0.59)	(0.63)
Road	21.218	23.554
(Energy/intensity in toe/thousand passengers)	(1.88)	(2.26)
Marine	3.618	4.705
Aviation	1.849	2.174

Source: Korea Energy Economics Institute (KEEI), *Energy Report, Each Year* (Seoul, 2002).

(b) Road passenger traffic

(millions of passengers)

	1995	2000
Road	11 290	10 414
Rail	790	814
Subway	1 693	2 235
Air	21	23
All combined	13 794	13 486

Source: "Statistical abstract of transport in Asia and the Pacific" (United Nations, 2002).

Table 3-3. Projections of sectoral share of energy consumption in the Republic of Korea

(in mtoe)

Sectors	1995	2000	2010	2020	2030	Average growth rate 1996-2030
Industry	62.9	85.8	108.8	128.3	144.3	2.4
Per cent	51.7	54.6	50.9	49.8	50.3	
Transport	27.1	31.8	49.8	58.8	62.6	2.4
Residential and commercial	21.5	23.8	34.4	43.4	48.1	2.3
Public	10.2	13.6	20.9	27.4	31.8	3.3
Final energy consumption	121.8	152.4	213.9	257.9	286.8	2.5

Source: Korea Energy Economics Institute (KEEI), *The Third Study of National Actions for United Nations Framework Convention on Climate Change* (Seoul, 1998).

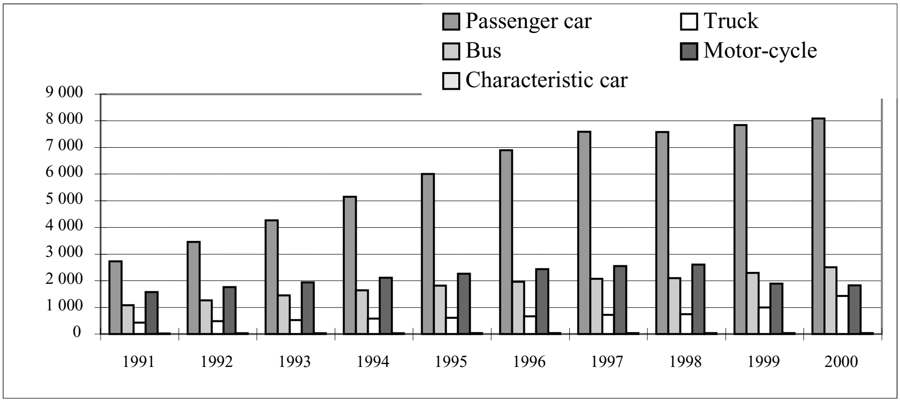
Status of air pollution in main cities

Seoul, the capital, accounts for only 0.6 per cent of the land area but about 25 per cent of the population and 32 per cent of the number of vehicles in the country.[45] The number of passenger cars has steadily increased from less than 3 million in 1991 to more than 8 million in 2000 (see figure 3-1). This has resulted in significant pollution, particularly in cities (see table 3-4). The transport sector is the largest contributor (42.5 per cent) to pollution in the country (see figure 3-2). The following are some vital statistics on the current status of air pollution in the Republic of Korea:

- The concentration of air pollutants such as SO_2 is decreasing: – 0.006 ~ 0.013 ppm (2000);
- TSP (PM10) is showing a downward trend due to strict fuel regulation:

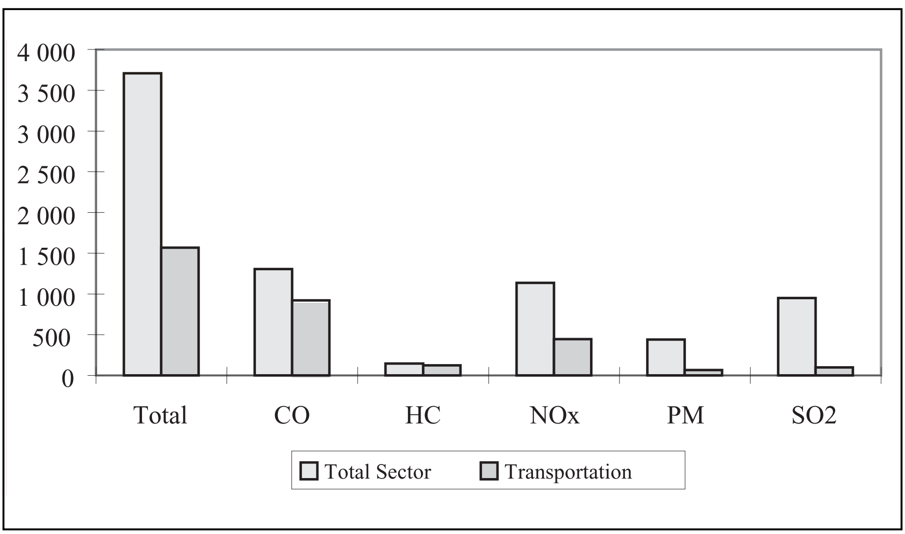
[45] ESCAP, *Energy Transport and the Environment in Asia*, Proceedings of a Sectoral Meeting of Experts and Policy Makers on Energy-Environment Strategies for Urban Transport Systems, May 1994.

Figure 3-1. Number of vehicle registrations in the Republic of Korea



Source: Korea Energy Economics Institute (KEEI).

Figure 3-2. Level of air pollutants from the transport sector in the Republic of Korea, 1999



  - Low unleaded fuel, LNG
    - 65 μg/m^3 (Seoul) – highest;
    - 51 μg/m^3 (Dae Jun) – lowest.
- NO_2 is increasing in 2000 (Seoul): average annual density 0.03 ppm;
- O_3 is also increasing: Pusan (0.022 ppm), Seoul, Kwan-Ju (0.017 ppm), but during the summer season the density is very high in Seoul;
- The concentration of CO continues to decrease: 0.6-1.2 ppm (2000).

The cities in the Republic of Korea are more polluted than other major cities of the world.[46] The SO_2 level is much higher in Seoul, Inchon and Taegu, for example, than in Montreal, Copenhagen and Tokyo, as shown in table 3-4.

Table 3-4. Comparison of SO_2 concentrations in major cities

Country	City	Concentration (ppb)
Canada	Montreal	6.1 (1990)
United States of America	Los Angles	3.2 (1991)
Denmark	Copenhagen	7.1 (1991)
Finland	Helsinki	4.6 (1991)
Sweden	Stockholm	3.0 (1990)
Japan	Tokyo	8.0 (1992)
Republic of Korea	Seoul	13.0 (1996)
	Inchon	12.0 (1996)
	Taegu	23.0 (1996)

It has been estimated that the dominance of road transport in the Republic of Korea will continue for the next 20 to 25 years, as shown in table 3-5. This has serious implications for the country in view of the impact of road transport (see box 3-1).

[46] See Sung-Young, Gong, "Air Quality Management Policy in Korea" (Korea Energy Economics Institute, 1997).

Table 3-5. Projected energy consumption, by transportation mode, in the Republic of Korea

(mtoe)

Transportation modes	1999	2005	2010	2015	2020	Average growth rate 1999-2010	2010-2020
Train (rail)	0.478	0.641	0.783	0.907	1.047	4.6	3.0
(per cent)	*1.7*	*1.6*	*1.6*	*1.7*	*1.8*		
Road	21.175	30.047	35.509	39.785	42.380	4.8	1.8
(per cent)	*74.0*	*73.3*	*74.6*	*73.2*	*71.4*		
Maritime	4.849	6.380	7.593	8.770	9.968	4.2	2.8
(per cent)	*16.9*	*15.6*	*15.9*	*16.1*	*16.8*		
Aviation	2.122	2.913	3.920	4.885	5.983	5.7	4.3
(per cent)	*7.4*	*7.1*	*8.2*	*9.0*	*1 0.1*		
Total	28.625	40.981	47.805	54.346	59.378	4.8	2.2
(per cent)	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*		

Source: Korea Energy Economics Institute (KEEI), 2001.

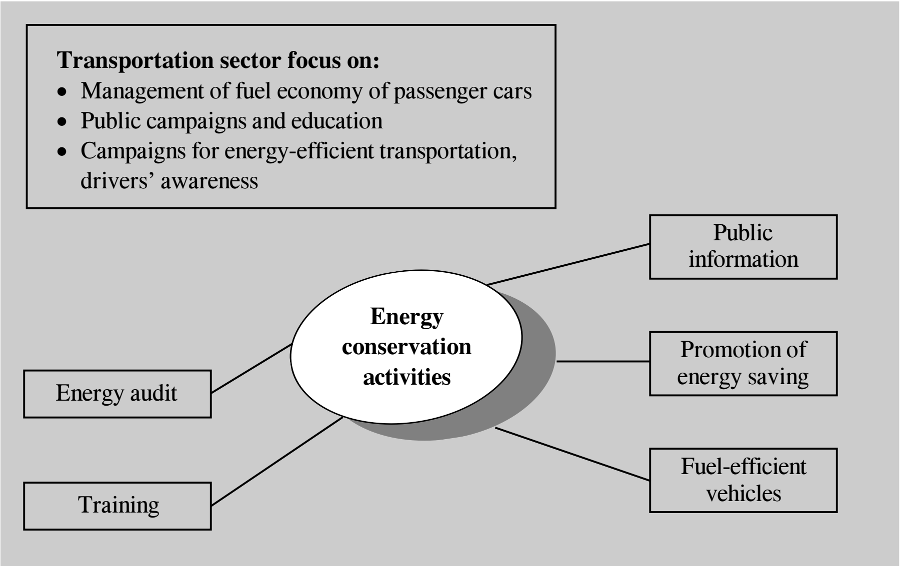
Box 3-1. The social cost of road transport

- 1,200 million people globally are exposed to excessive levels of SO_2
- SO_2 and SPM outdoor concentrations cause about 500,000 deaths
- 1,400 million people are exposed globally to excessive levels of smoke and SPM
- SPM indoor concentrations cause about 2.5 million deaths
- 15-20 per cent of Europeans and North Americans exposed to excessive levels of NO_2
- Excessive levels of CO in half of the world's cities

Urban transportation management policy

In view of the foregoing, countermeasures for the transport sector were implemented, as shown in figure 3-3. The areas so defined are activated through the following instruments:

Figure 3-3. Countermeasures for the transport sector in the Republic of Korea



(a) ***Regulatory measures***

- Exhaust emission and fuel quality standards are enforced through predetermined testing methods;
- Certification process monitors useful life, in-use compliance test (recall test);
- Inspection and maintenance help in the implementation of the above-mentioned laws. This is in line with Option 8 (vehicle maintenance programmes);
- The Rational Energy Utilization Act of 1995, Article 18 (4), calls for fuel information to be included in all model-specific motor vehicle advertising. This is in line with Option 6 (Including fuel consumption information in model-specific vehicle advertising);
- The same Act incorporates provision of the management of hazardous air pollutants (HAPs) and volatile organic compounds (VOCs). It designates a total of 38 such substances;

- Standards are maintained in line with the trend in standards worldwide. EURO3 are being followed from 2003 and EURO4 are expected to be applicable from 2006. In every step, fuel efficiency is given due consideration.

(b) ***Clean and reformulated fuel*** (Refer to Option 3: greater use of environmental impact assessments): the use of low-emission fuels, such as unleaded fuel, ultra low sulphur diesel (ULSD), natural gas (NG) and liquefied petroleum gas (LPG), is allowed. Similarly, the use of LNG in buildings for both business and public purposes in 1988 and a ban on the use of solid fuel at industrial and power plants in 1985 to some extent improved the environment in five cities in the Republic of Korea;

(c) ***Logistics and transport demand management*** are intensively practiced in the Republic of Korea, and are in line with Option 4 (demand management programmes);

(d) ***Obligatory use of clean fuel*** will be enforced. The use of LNG in buildings for both business and public purposes was introduced in 1988. The use of solid fuel at industrial and power plants was banned in 1985 in five cities. This refers to policy Option 3 (greater use of environmental impact assessments);

(e) ***An environmental improvement charge system*** was introduced in 1994 in diesel-powered vehicles and research on diesel particulate filter trap (DPF) was initiated. This also is in line with Option 3;

(f) ***An extended recall system*** was made applicable to diesel passenger cars that either were older than five years or had been driven more than 80,000 km. This refers to Option 8 (vehicle maintenance programmes);

(g) ***Management of hazardous air pollutants (HAPs) and volatile organic compounds (VOCs)*** is required. A total of 16 such substances were designated in the Rational Energy Utilization Act of 1995, and 22 more were added in 1997. Control systems were installed in gas stations and oil storage facilities.

(h) ***Exhaust emission and fuel regulation:*** The standard followed in the Republic of Korea is at par with the world standard. A Low Emission Vehicle (LEV) standard is being followed since 2003 and a Ultra Low Emission Vehicle (ULEV) standard will be implemented in 2006. Similarly, EURO3 was implemented in 2003 and EURO4 will be introduced in 2006, when ultra low sulphur diesel (ULSD) will also be introduced. All these activities in the Republic of Korea are in line with Option 8 (vehicle maintenance programmes).

The road ahead

The policy options identified in the Republic of Korea are the following:

- Reduction of NOx from automobiles, particularly from diesel-engined vehicles;
- Introduction of new laws on:
  - Regional Emissions Allowance and Trading (2005, 2007);
  - Carbon tax or energy tax to reflect social cost.
- Improvement of indoor air quality;
- Control of PM 10 (for suspended particulate matter) from industrial and construction areas;
- Research on health effects and the social cost of the road transport;
- Effective implementation of demand side management (DSM), thus maximizing the use of the transport infrastructure to attain higher end-use energy efficiency;
- Strengthening the weak infrastructure of gas stations.

Observations

The policy options referred to above are as diverse and wide-ranging as the forms of government and legal systems in Asia and the Pacific. Therefore, the means of implementation may differ considerably from one country to another. The following are the forms of implementation that may be used in the transport context:

(a) National legislation: The majority of the reforms will require implementation by means of national legislation or regulation. In countries with a federal system of government, some of the reforms may need to be implemented by state governments, according to the terms of the country's constitution. This is true not only for regulatory reforms, such as vehicle labelling laws or fuel efficiency laws, but also for many fiscal reforms. Many such fiscal reforms will require amendment to the country's income tax, sales tax or goods and services tax legislation;

(b) Local government legislation: In some countries, certain powers are delegated to local or regional governments. The powers of such governments typically include certain matters relevant to the options outlined in this chapter, including, for example, the power to impose road traffic controls;

(c) Government policy decision: Some decisions may be implemented by Governments without the need to reform any law. Some forms of fiscal subsidies may be given without the need to amend any of the fiscal legislation. In addition, changes to the Government's own vehicle fleet and rules can be made simply by executive decision;

(d) Voluntary agreements with industry: Instead of imposing reforms on a reluctant vehicle industry by law, it is possible for Governments to negotiate reforms with the vehicle industry. Such agreements, where successfully negotiated, are likely to be more enthusiastically embraced by the industry. This increases the chances of the reforms being successfully implemented. There is considerable scope for voluntary agreements with the vehicle industry in the context of fuel consumption labelling laws, fuel economy standards and vehicle inspection and maintenance programmes. Some countries, such as Australia, have already adopted this approach;[47]

(e) Consumer education: Education is often the most effective way of achieving change. Education in relation to the need for increased energy efficiency in the transport sector could usefully occur from primary school level right through to adult education. Education often complements legal reform. For example, vehicle-labelling laws are likely to be far more effective if the public is made aware of the importance in today's society of enhancing vehicle fuel economy.

[47] International Energy Agency (IEA), *Voluntary Actions for Energy-Related CO_2 Abatement* (Paris, OECD/IEA, 1997).

Chapter 4

IMPROVING END-USE ENERGY EFFICIENCY IN THE CONSTRUCTION AND BUILDINGS SECTOR[48]

4.1. Introduction

Buildings were initially designed and constructed to provide shelter from the vagaries of nature. Their designs were adapted to the local climatic conditions and the availability of local construction materials. The traditional architectural approach, presently referred to as the bio-climatic architecture, required a thorough understanding of the natural environment in order to devise practical solutions related to the size and shape of the building, its orientation, solar protection, choice of suitable construction materials, etc. Comfort conditions could not, however, be achieved throughout the year. As a result, human activities were somewhat limited to the site constraints; they came to a standstill with the setting of the sun and resumed with the first rays of the daylight.

At the end of the nineteenth century, people were heavily dependent on wood and coal to warm them, cook their food and light their homes. These fuels made their houses dirty and had an adverse impact on human health. The discovery of electricity ushered in a new age of technology and made a tremendous impact on the way people lived. Although today almost a third of the human population still has no access to electricity, those who do have access to it can vouch for the considerable improvement in their living conditions. As a perverse effect of technological progress, many architects no longer bother to design buildings that take into account the climatic constraints and focus more of their attention on aesthetic aspects.[49] Electrical and mechanical engineers claim to be able to provide comfort in any type of building by employing "practical solutions", which invariably

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[48] This chapter was principally drawn from the contribution made by Mr. Brahmanand Mohanty. The case studies are based on the contribution made by Mr. Soontorn Boonyatikarn and Mr. Nguyen Huu Dung.

[49] Mohanty, B. (Ed.), *Energy Efficiency in Buildings*, Proceedings of Workshop, New Delhi (Bangkok, Asian Institute of Technology, 1995).

incorporate high energy-consuming technologies. Myriads of new technologies introduced during the last century have not really solved our global problems, however. At the dawn of the twenty-first century, we still receive our power from highly polluting coal-fired power plants, live in houses that waste energy, and use inefficient lighting, heating and cooling systems and appliances. In poorly designed industrial and commercial establishments, people are complaining of the loss in productivity associated with the so-called “sick building syndrome”.

The increases in the price of fossil fuel-based energies during the last two decades have made us conscious of the need to conserve energy and adopt energy efficiency in our day-to-day activities. Although the movement started with the industrialized countries just after the first oil price hikes in 1973, developing countries followed suit in the late 1980s and early 1990s in order to ensure the pace of their rapid economic development. Most Asian and Pacific nations have formulated energy efficiency policies and implemented practical measures to suit their socio-economic goals.[50] These include creating greater awareness among stakeholders, providing assistance for decision making, triggering markets for efficient technologies and services, introducing innovative financing mechanisms, and establishing regulations and standards to suit the local economy, etc.

While most energy efficiency policies emphasize on ways to reduce the operating energy consumption of the buildings, there is little initiative to address the issue of the energy needed to construct them. Buildings constructed today will last for anywhere between 50 to 100 years. The embodied energy in the building can be equivalent to over 30 years of operating energy use in a typical office building.[51] As buildings become more efficient, the ratio of embodied energy to operating energy will increase. The high embodied energy of the building is partly due to the energy-intensive materials used, the rest being in the form of wastes generated at the construction site. The modular design concept is not as

[50] ESCAP, *Energy Conservation and Efficiency Centres in Asia*, (New York, United Nations, 1997).

[51] *Embodied energy* is defined as the energy consumed by all processes associated with the construction of a building, from the acquisition of natural resources to product delivery, including mining, manufacturing of materials and equipment, transport, etc. There are several researchers around the world involved in assessing the embodied energy and life-cycle analysis of different building materials.

prevalent in developing countries. The construction of custom-made houses generally tends to waste more materials, thus consuming more energy and incurring higher costs.

Well-designed buildings require regular maintenance and upkeep to provide good and reliable services at low cost. Although many buildings may be well designed and constructed, their owners often lack the necessary experience or do not engage competent personnel to ensure the good functioning of the equipment and appliances that provide energy services. As a result, efficient heating and cooling systems perform far below their design conditions and provide poor energy services.

A new dimension has been added to the foregoing concerns with the emphasis on sustainable development and greater awareness of the adverse environmental consequences of our economic activities. This has led to the propagation of the "green building" concept, which considers not only the energy consumed in these buildings, but also the way they are built. The process of green or integrated building design involves the application of bio-climatic architectural principles, conservation of materials and resources, selection of energy efficient appliances for providing building services, use of clean and renewable energies, and adoption of ways and means for water and waste management. While assuring the minimization of the negative environmental impact, green buildings ensure better comfort for the occupants, improved productivity and reduced operating and maintenance costs. It is estimated that, while suitable energy saving retrofits in existing buildings can reduce the energy bill by about 20 per cent, if the buildings are designed with an integrated approach, the energy savings can be as high as 40 to 50 per cent.[52]

4.2. Policy options

4.2.1. Barriers to energy efficiency

By adopting more modern and energy-efficient technologies and practices, potential designers, builders and end-users in Asian developing countries should gain comparative advantages while avoiding the mistakes

[52] Majumdar, M., "Sustainable buildings – Building consciously for a better tomorrow", *The Bulletin on Energy Efficiency (2002)*, vol. 3, Issue 1.

of the industrialized world.[53] However, there are several barriers hindering them from embracing energy efficiency options in their buildings. While barriers such as distorted energy prices, inadequate competition, unavailability of products and services and limited access to financing are common to all economic sectors, those specific to the building sector are elaborated below.

Decentralized nature of the building sector: The building industry is highly decentralized and involves the participation of a very large group of enterprises engaged in the designing, construction, provision and installation of equipment and the renovation of buildings. Each group may be organized to some extent, but there is limited interaction among them. Their knowledge of energy efficiency is often very limited, and they require training in green building concepts and techniques to improve their skills and produce better buildings.

Lack of interaction: Integrated building design needs good planning, interaction and involvement of all stakeholders (owner, contractor, architect, interior designer and mechanical and electrical engineer) right from the start of a project. In reality, tasks are quite segmented and there is not much communication among the different parties. As a result, the desired energy efficiency and cost savings cannot be guaranteed.

Misplaced incentives: The stakeholders who make decisions about the design and construction of a building and the procurement of equipment for it do not necessarily pay its operating costs because they either sell it or rent it out to a third party. They have no incentive, therefore, to minimize the operating costs by incurring a higher initial cost.

Lack of information: Neither the builder nor the consumer has access to updated and reliable information regarding energy efficient technologies and the associated costs and benefits. Generally, consumers do not have information on the cost of operating the equipment they purchase over its lifetime, so they often prefer an appliance with low initial cost, irrespective of its energy efficiency. The cost of gathering information and evaluating options in order to make the right decision may be too onerous for end-users to adopt such a cumbersome procedure.

[53] International Energy Agency (IEA), *Energy Efficiency Initiative, Volume 1: Energy Policy Analysis* (Paris, OECD/IEA, 1997).

Transaction costs: Most project developers are wary of unfamiliar and innovative designs because of the fear that such options will slow down the construction process and increase costs. They fear that any change in regular practice is risky and assume that energy-efficient solutions lead to higher costs, greater risks and delays. Instead of waiting for more efficient equipment to be delivered, they purchase cheaper and less efficient equipment to avoid any delays in the completion of the project and any loss in revenue due to delayed occupancy.

Deficient designing process: The designing process is such that it is easy to fund oversized equipment but hard to fund energy efficiency. By depending more on rules of thumb or nomographs, designing practices encourage oversizing instead of optimizing to suit the local climate. Fees are very often linked to the project size; this perverse incentive encourages expenditure, without linking it to potential savings in operating costs. Moreover, insufficient attention is given to integration and possible competition among various solutions.

One of the major obstacles to the widespread use of energy-efficient technologies is poor market demand and high initial costs, mainly due to the low volume of sales. Comprehensive market transformation initiatives would have to be launched to overcome this barrier. A greater volume of sales will guarantee lower prices and accelerated deployment of the technology. This will eventually lead to lower transaction costs.

4.2.2. Policy options for overcoming barriers to energy efficiency

Regulations and legislation

Energy-efficiency regulations can be important and effective means for a national programme aimed at promoting energy conservation. Performance standards can be prescribed to encourage awareness of the importance of energy-conscious building design and to provide certain degree of control over building construction and operating practices. If building codes prescribe a minimum level of such practices, builders will focus on the most cost-effective way to comply instead of dismissing them as an added cost.

Typical guidelines on energy performance for promoting energy efficiency in buildings include such components as overall thermal transfer value of the building envelope, the use of electric power, efficient lighting and day lighting, improved heating and cooling systems and equipment, building operation and control. For example, the thermal transfer across the building shell or thermal envelope can be either prescriptive or performance-based, expressed in W/m^2. Likewise, the lighting density for a specific building type can be expressed in W/m^2. Building codes should allow builders to trade off measures and optimize their overall designs.

Many new buildings are being constructed or planned in rapidly growing Asian developing countries. All new constructions should aim for a significant shift in energy use as well as production. In zones endowed with abundant sunshine, codes could insist on maximizing the feasible use of renewable energy to meet a certain percentage of the building energy demand. Some municipalities and civic bodies in the region have made it mandatory to incorporate solar water heaters and rainwater harvesting in new residential dwellings.

Recognizing the importance of electrical and electronic appliances in meeting the demands of modern lifestyles, several countries in the Asian and Pacific region have introduced minimum energy efficiency requirements that appliances must satisfy before they can be legally sold. Very promising results have been reported as an outcome of the introduction of such minimum energy performance standards (MEPS). For further details on this subject, see chapter 5.

It is important that building codes and MEPS be revised periodically to reflect technological innovations, building construction practices and the expansion of energy end-uses. In practice, this may not be politically attractive, and it would require more time, a better institutional infrastructure and greater awareness among the stakeholders. In France, three successive revisions of the regulations for new buildings have made it possible to progressively raise the minimum level of energy efficiency required by over 50 per cent over a period of 24 years. Japan's Top Runner Programme allows for a periodic update of MEPS by obliging manufacturers to improve the efficiency of their products to a certain standard over a specified period; the most efficient model already on the market is used to set the standard. The Republic of Korea follows a three-to-five-year updating cycle.

Policy makers face the challenge of adopting stringent yet cost-effective building codes; otherwise, there is little chance of successfully implementing such codes. Consultations should be held with all those who play an important role in promoting improved building energy codes and standards. Having the building codes is not enough; tangible benefits depend on effective enforcement and compliance.

There is considerable scope for using codes to enhance the "green building" movement in the Asia-Pacific region in order to eliminate the need for additional environmentally polluting power plants, thus reducing the threat related to climate change.

Awareness and sensitization

Promoting energy-efficient buildings can be significantly hindered by lack of awareness regarding energy-efficient products and building practices. From the building developer to the equipment supplier to the end-user, all stakeholders should be sensitized through suitable media campaigns in order to encourage construction that exceeds the standards prescribed in building codes. Builders will continue to follow the fast parallel design path and construct wasteful and polluting buildings unless sufficient efforts are made to disseminate practical information on the benefits of bio-climatic architecture and suitable applications of new and innovative energy technologies. Building users will continue to purchase low-quality electrical appliances unless information campaigns are made through communication media, such as television, radio, newspapers and exhibitions to sensitize them about the direct and indirect economic and environmental impacts of their choices.

Some of the awareness and sensitization initiatives in Asian countries include celebrating of energy conservation day or week every year. During these events, exhibitions and contests are held and rallies are organized. In order to recognize the best practices and energy efficiency innovations, energy efficiency awards are given to contestants in different categories of buildings. For example, the ASEAN Centre for Energy, located in Jakarta, coordinates the activities related to the ASEAN Energy Awards. Energy Awards are bestowed annually upon the most energy-efficient buildings of different categories, such as new constructions, retrofitted buildings, buildings adopting cutting-edge or appropriate technologies, and buildings incorporating new and renewable energy projects. The "Divide by Two" campaign in Thailand demonstrates simple ways and means to reduce energy use by half in residential and commercial buildings.

Education and training

Creating awareness alone is not sufficient to guide all those who are involved in the building trade (developers, architects, mechanical and electrical engineers, ventilation and air-conditioning contractors, and equipment installers) in applying know-how and technologies. Education and training are essential because the durability of energy efficiency improvements cannot be guaranteed by technological factors alone. The competence of the workforce is highly important during the construction or retrofitting of a building; it is equally important for the maintenance and upkeep of the buildings and associated energy systems.

A training programme should be comprehensive without excluding any specific category of professionals (with different backgrounds and qualifications) who are involved at inception and in the construction stages, and afterwards in monitoring and maintenance. A good maintenance programme designed to maintain the long-term performance of the building cannot be established without specific indicators that allow property managers to continuously assess performance trends and take the necessary corrective measures when a downward trend begins to appear. These property managers must be trained in their specific fields of responsibility.

Improved education and training will assure the establishment of energy-efficient design and practices as the norm. Educational and training programmes can be tailored to provide a good foundation in the basics of efficient building and equipment operations as well as the introduction of new and innovative integrated technologies and processes. Building professionals can have exposure to the best practices and the best available technologies for enhancing building performance. Much of the training and continuing education programmes can be initiated by and in partnership with building industry associations.

It is crucial to have a qualified and competent workforce at all levels, from architect/engineer to mason, in order to improve overall building energy efficiency, and more important, to maintain this level of energy efficiency on a long-term basis by making it a durable achievement.

The building is not just a physical system whose energy performance can be determined only by considering the physical envelope, outdoor weather conditions and the mechanical and electrical equipment that is commissioned. Much depends on the behavioural patterns of the building users or inhabitants. While users may be sensitized to the need to modify their behaviour patterns in order to achieve energy efficiency goals, those who design and construct the building must be trained to take the behaviour of users into account. For example, what measures can be taken to reduce energy use in an air-conditioned building where the user may decide to keep the windows open?

Mandatory training courses for energy managers and training courses for certificate renewal are already being conducted in some Asian countries. In Thailand, financial assistance is extended for local and international short-term training. However, an education and training policy should not only be designed for immediate and short-term effects. While providing continuing education and vocational training for professionals, the policy should also allow for the development of a curriculum for students and apprentices who will take up professional activities in the near future.

Training should be durable and continuous to guarantee long-term success. Short-, medium- and long- term training strategy should be formulated in partnership with competent institutions so that those who provide the training, design the programme and determine the resources will always take energy efficiency into consideration. Permanent links and exchanges can be established with all professional partners by involving them in the process of defining the energy efficiency objectives, determining the funding and evaluating the action to be taken for their benefits.

To ensure that information is disseminated, and educational/training activities are conducted in an unbiased manner, Governments may establish designated institutions or centres at the national and regional levels; their mandate would be to promote energy efficiency activities through well-targeted information dissemination campaigns and training and educational programmes. In the initial stage, such organizations require financial support, but as the energy efficiency sector matures, they may function as self-supporting and non-profit agencies. Special attention should be given to the training of the staff who will be directly involved in preparing and coordinating energy efficiency training programmes to ensure that they have a good knowledge of the requirements of their activities.

Strengthening research, development and deployment

Governments can play a crucial role in reducing the cost of new technologies by supporting need-based research, development and deployment; thanks to the experience gained during these phases, there can be a multi-fold improvement in the technology performance while costs are reduced sharply. Although public support for energy research and development (R&D) is considered inadequate by researchers in many industrialized countries, there is little evidence of energy R&D spending in Asia.

Asian countries could leapfrog to the technological frontier by ignoring the myth that obsolete technologies better suit their economic conditions and that they cannot afford to take the risks associated with technological innovations. Countries in the region are experiencing rapid growth in the demand for housing and energy services, which provides an excellent opportunity for successful technological changes. They can avoid the polluting development path taken by the industrialized world by adhering to climatically suited architecture and a judicious choice of modern materials and technologies that their industrialized counterparts did not have.

Because of the fragmented nature of the building industry, with its many small enterprises and poor integration of individual efforts, R&D investments in the building sector are generally small. Publicly-funded R&D can therefore focus on strategies to integrate the various building systems and coordinate effectively with stakeholders. Architects, builders, contractors and building equipment manufacturers could be teamed up to work together for designing, building and testing prototypes that incorporate the latest innovations in design, materials, products and systems. Public funds can be dedicated to providing designing expertise, training and testing of innovative products and techniques, activities that are unlikely to be supported by the builders. On the other hand, designers and promoters will invest in the construction of prototype buildings. The successful design and construction of a few model buildings in different climatic conditions will demonstrate the concepts, techniques and benefits of energy-efficient buildings to all building professionals, including architects, builders and contractors; such cost-effective innovations can then be replicated on a large scale.

Using the principles outlined above, the Partnership for Advancing Technology in Housing (PATH) was launched in 1998 by the United States

Department of Housing and Urban Development with support from the Department of Energy (see www.pathnet.org), with a goal to reduce energy use in new homes by 50 per cent and in existing homes by 30 per cent.[54] Similar initiatives taken in China with support from the French Global Environment Facility (FFEM) have led to the realization of a "highly energy-efficient buildings" project. The first phase of the project consisted of the construction of 120 000 m^2 of innovative housing in Harbin Province to achieve a 50 per cent savings in building operating energy costs. Private developers provided all the investment for the project and FFEM provided designing expertise, training and technical know-how, representing a mere six per cent of the total construction cost. Encouraged by the benefits of the projects, developers are presently expanding the scope of the project to other cities in China.

In addition to publicly-funded R&D, Governments may wish to formulate regulations requiring all enterprises to invest in R&D activities to ensure continuous improvement in the performance of products and systems. Such policies will encourage the continuous evolution of product quality without imposing specific conditions on research priorities or the areas in which investments should be made.

Creating a market for energy efficiency

Suppliers and vendors of energy-efficient products and services must have a strong presence in the local market in order to influence decision makers. For this to happen, several hurdles have to be cleared.

If energy pricing does not reflect the actual cost of its provision, it is difficult to promote energy efficiency, which has to compete with the traditional "energy supply" sector. Although the elimination of subsidies in energy pricing may not be attractive for political reasons, developing countries are gradually realizing that it is indeed important for energy utilities to generate adequate funds in order to expand their base and slowing down the rapid growth in energy demand. Of late, many Governments have removed price controls on oil products and are progressively eliminating subsidies on electricity sales. As a result, some energy-efficient products, undesirable for their high initial costs and long pay-back periods, have now become more affordable and attractive.

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[54] Aitken, D., "Putting it together: whole buildings and a whole buildings policy", *Renewable Energy Policy Project (1998)*, Research report No. 5.

Utilities are facing the problem of coping with the high electricity demand during peak hours when the cost of generating power is greater. As a result, they are motivated to introduce time-of-use electricity tariffs in order to curtail peak demand and enhance the sale of electricity during off-peak hours. A utility-driven demand side management measure such as this can trigger a market for niche technologies that are capable of reducing the need for electricity during utility peak hours.

Standard patterns of consumer behaviour are such that most people are averse to risks and would not try a new product or process unless it has proved its worth in the local context. It is here that Governments can play an important role by setting up demonstration facilities to validate the actual energy efficiency potential of products and processes and disseminate the information widely.

Healthy growth in the sales volume has positive effects on product costs. With this in mind, well-planned procurement initiatives can accelerate the growth in volume and make energy-efficient products more competitive. While standards eliminate least efficient products and technologies from the market, innovative technology procurement can accelerate the commercialization of efficient technologies, thus raising the average efficiency of the products that are available in the market. Competitive procurement of results in producers to manufacture efficient products once target characteristics have been set for those products based on the analysis of future demand. The impact of procurement operations on technological change can be quite significant and technological options that are perceived to be risky or too costly or do not seem to have sufficient market demand can be promoted. In the United States, the “Golden Carrot” programme launched the super-efficient refrigerator initiative, demonstrating the effectiveness of promoting innovative technology thanks to a partnership between the public and private sectors. This led to the creation of the Consortium of Energy Efficiency (CEE) and the development of similar initiatives for other appliances.

The Government can encourage equipment manufacturers to negotiate agreements to launch voluntary action for initiating energy efficiency activities. For example, if the energy saving potential from the phasing out of a specific product is found to be substantial, negotiations may be held between the Government and manufacturers of that specific product to replace it with a more efficient one within a mutually acceptable time frame. In Thailand, for example, a voluntary agreement between the Government and the five local manufacturers of tubular fluorescent lamps led to the replacement of 40W fat-tubes with more efficient 36W thin-tubes in a record time of 14 months. Apart from launching an important publicity campaign to promote 36W thin-tubes, the Government did not have to extend any incentive to either the manufacturers or the end-users to achieve this market transformation.

To facilitate a market transformation towards energy efficiency, there is a need to create more commercially oriented entities, such as the energy service companies, widely known as ESCOs. An ESCO acts as a "one-stop shop" for clients to receive a wide range of turn-key energy services, including such options as technical consulting, project and risk management, guaranteeing savings, designing monitoring and verification protocols, as well as performance evaluation. For such ESCOs to survive at the embryonic stage of market development, government initiatives are critical for suitable business and financing models to be developed as well as the legal and institutional framework. Financing of ESCO projects is a key issue as it involves several risks such as creditworthiness, performance risks, project sustainability, cost of transactions and payment security. Government intervention for overcoming these risks through innovative financing mechanisms can be instrumental in expanding the ESCO market. In Malaysia and the Republic of Korea, low-interest or soft-loans are provided for ESCO investment whereas Thailand has created a revolving energy efficiency fund to support ESCO initiatives.

Many buildings are owned and operated by the central, regional or local governments. The normal government practice for procuring goods and services is the bidding process. The Government can set a good example by setting minimum energy efficiency thresholds for all new purchases or retrofits. The Government's enormous purchasing power can stimulate markets for energy-efficient products and technologies. For example, the Federal Energy Management Programme launched in the United States in 1994 aimed at reducing federal energy consumption by 30 per cent between 1985 and 2005. Performance standards to be used for designing buildings and procedures for determining life-cycle energy efficiency measures have been established. Federal agents are expected to procure products in the top 25 per cent of their class in energy efficiency where cost-effective and where they meet the stipulated performance requirements.[55] The recently created Bureau of Energy Efficiency in India has initiated a pilot project that includes planning and mobilization of performance-based energy efficiency service delivery mechanisms involving important government buildings in order to fulfil the Government's commitment to reduce public sector building energy consumption by a target of 30 per cent within five years.

Investment for accelerated adoption of energy efficiency

The demand for energy-efficient building technologies can be low because of the higher initial costs associated with such products, even though their life-cycle costs are particularly attractive. Potential buyers may not have the necessary funds or easy access to funds at reasonable interest rates. An appropriate financial mechanism should be evolved to overcome this barrier.

The means of funding energy efficiency has to take into consideration the different types of action and stakeholders. For example, initiatives may be taken to assist in the development or marketing of energy-efficient products and processes that are mature but costly in comparison with the standard products available in the market. Since the whole society can benefit when such products and processes are well established in the market, efforts may be concentrated on reducing the cost or expanding the market share by targeting product designers, manufacturers, distributors and retailers.

It is widely known that energy users have more difficulty acquiring the capital required for financing energy efficiency investments than do energy producers for expanding their energy generation capacities. Some intervention may be necessary to create a level playing field and encourage consumers to invest in end-use energy efficiency. Sometimes the adoption of energy efficiency makes economic sense at the macro level but may not be financially attractive to the consumer. Some sort of financial incentive may be required to influence the consumer. Typical financial instruments available to the government include grants or subsidies, soft loans and tax incentives. There may be other types of financial incentives, such as

[55] Sustainable Systems Inc. and United States Department of Energy, *Greening Federal Facilities: An Energy, Environmental and Economic Resource Guide for Federal Facility Managers* (Washington, D.C., Greening America, 1997).

a guarantee fund to reduce risks or a favourable framework to promote leasing and third-party financing schemes.

Grants and subsidies represent as flexible and effective solutions for supporting various types of activities related to energy efficiency. Grants can be used as a tool for decision-making; for example, partial support may be extended for carrying out energy audits and feasibility studies. To accelerate the dissemination of proven technologies, subsidies may be provided to reduce the perceived risks to the end-user and to cover the costs of performance monitoring. The Indian Renewable Energy Development Agency (IREDA) and the Thai Energy Conservation Promotion Fund are good examples of systems that Governments can devise to provide financial assistance for the deployment of energy-efficient technologies. In some situations, conditional grants may be made available if a project is innovative in nature; when the project is implemented and found successful, the beneficiary should reimburse the amount of grant. While formulating a strategy for the disbursement of grants or subsidies, one should ensure that procedural complexities are kept to the bare minimum and there is close interaction between the beneficiaries and the fund disburser. When subsidies turn out to be large-scale financing instruments, they can become a major burden on public resources, as has been experienced in the case of diesel and kerosene in some countries.

Grants or subsidies alone cannot have a great impact in an economy where the consumer faces difficulty in mobilizing the funds necessary for project implementation. Lending institutions are accustomed to projects involving investments designed to generate revenue so that the loan can be paid back. The criteria for approving a loan needs to be reviewed in the case of energy efficiency investments, where eligibility has to be based not on the estimated gains in revenue but on the reduction in costs. The Government may decide to encourage energy efficiency investments by providing soft loans for the end-user in the form of interest subsidies.

Various types of tax exemptions can also be used to encourage energy efficiency investments. They are often considered as transitional measures to encourage the introduction of new products into the market or to increase the market share of energy efficient technologies. Policies on extending tax exemptions should be revised periodically to transfer support from the old products to newer, more efficient products. The amount of the tax allowance can be directly proportional to the investment made. Alternatively, the import or sales tax on selected efficient appliances can be waived. Companies wishing to invest in energy-efficient products may avail themselves of the option of accelerated depreciation.

Builders are generally not enthusiastic about adding energy efficiency features, fearing that their additional costs will dissuade some potential buyers. The financial barrier to improving building efficiency can be eliminated by introducing energy efficient mortgages (EEMs), which provide consumers with incentives to improve the energy efficiencies of an existing building or to purchase a new or existing building that is rated as energy-efficient. The Energy Policy Act of 1992 in the United States directs Federal mortgage agencies to offer EEMs. Lenders offer these financing products with the understanding that energy-efficient buildings will generate lower energy bills, saving money that can be used to service the energy improvement loan or the larger mortgage. Buyers interested in purchasing energy-efficient homes can increase their debt-equity ratio above maximum loan limits.[56]

The introduction of more complex financial instruments, such as leasing contracts or third party financing, will enhance the energy efficiency market. The consumer enjoys two main advantages by opting for leasing: no capital investment is tied up with the energy efficiency equipment, and financing of the equipment can be spread over several years. However, the leasing scheme does not guarantee energy savings. If the user expects an energy efficiency performance guarantee, the third-party financing option may be more suitable, but it is more complicated to arrange and manage. A guarantee fund may be set up to cover the risks associated with the receivables of companies that decide to lease energy-efficient products; the insurance premium may be proportional to the value of the goods financed.

When a consumer opts for third-party financing, the third-party investment company finances and executes the energy efficiency project. The savings accrued from the project are recovered by the investor for an agreed period of time. Such types of contracts lead to three-fold benefits for the customer. The customer does not have to provide up-front capital for investing in the energy-efficient system and the repayment is based on the sharing of the savings accrued. The customer does not bear any

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[56] E. Cohen-Rosenthal, M. Schlarb and J. Thorne, "Building it right: cleaner energy for better buildings", *Renewable Energy Policy Project* (2000), Research report No. 10.

technical risk, as it is the responsibility of the third party to carry out all the work and guarantee an adequately functioning system. Thanks to the method of payment used, the customer is insured against not only technical contingencies but also any eventual fluctuations in energy prices. The pay-back period is more or less decided before the project starts; the customer's payment is linked with the quantum of savings.

In the light of the foregoing discussions on financial incentives for builders, equipment suppliers and consumers require funding that needs to be generated by the Government. As there are many buildings owned by the Government, first actions should be started on these facilities. While the Government provides the incentive, the building industry should be invited to support the programmes by aggressively marketing energy efficient products to contractors, equipment suppliers and consumers. In parallel, effective tools should be developed for rating the performance of more energy-efficient buildings to enhance their market value and minimize the risks of investing in energy efficiency.

4.3. Case studies and country experiences

4.3.1. Selection of countries

To augment the policy studies and illustrate the practical implications of those policies, reference has been made to the experiences of developed nations such as United States ("Sick Building Syndrome", "PATH") and Japan ("Smart Live") and developing nations such as Thailand ("Divide by Two") and China ("Highly Energy-efficient Buildings"). These cases have also been mentioned in the discussions on policy issues to help decision makers visualize the possible impact of certain policies.

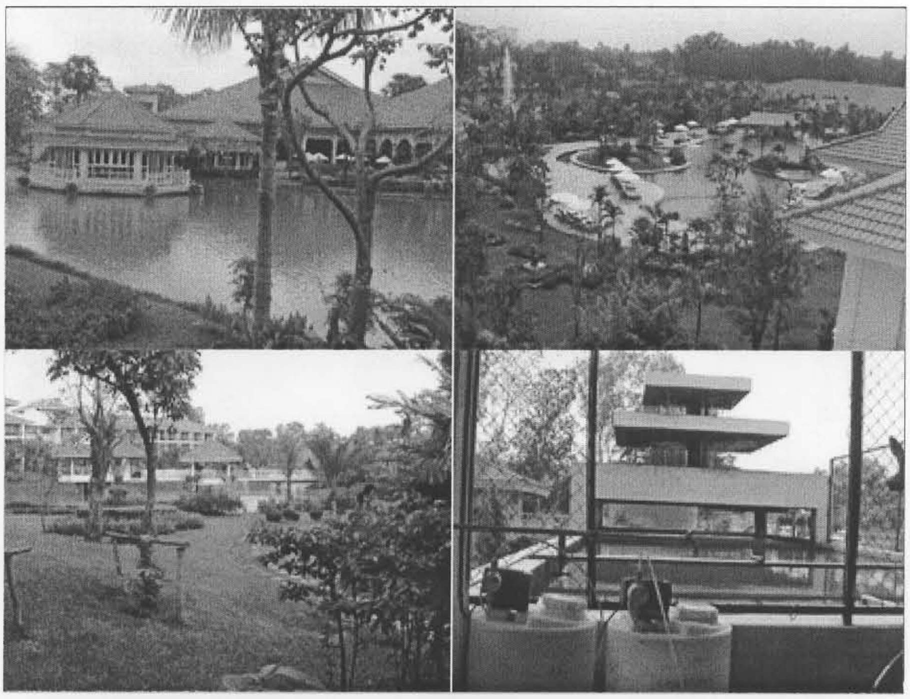
Cases have been selected from Cambodia, Thailand and Viet Nam that could serve as models for many possible future construction projects in many developing countries, particularly those with humid tropical climates.

4.3.2. Cambodia

Background

East and South-East Asia were adversely affected in 2001 by the economic slowdown in the United States, which has been an important export market for the region. However, Cambodia's economy performed relatively well in 2001. The country is at peace after many years of turmoil. As it is being rebuilt, Cambodia's cultural heritage is being rediscovered and tourism is becoming a significant contributor to the economy. Some examples of traditional architecture in Cambodia are shown in figure 4-1. Having joined ASEAN in the late 1990s, Cambodia is becoming involved in regional economic and political initiatives. It has the potential to exploit its diverse sources for growth: agriculture, natural resources and light industry, as well as tourism. However, Cambodia's ability to capitalize on its inherent assets depends on how well it develops its infrastructure and physical and human resources.

Figure 4-1. Examples of traditional architecture in Cambodia



Although the country experienced the most severe flooding in 70 years during the second half of 2000, Cambodia's real GDP grew at 5.4 per cent for the entire year 2000 and continued that pace of growth 5.3 per cent increase in real GDP in 2001. The private sector, particularly in Phnom Penh, is flourishing despite the constraints of an antiquated or non-existent infrastructure, poor legal definition and protection of property rights, lack of a smooth-functioning banking and credit system, and regulatory actions that are often inconsistent and unpredictable.

Cambodia is a net energy importer, and its main import in this respect is oil. The principal domestic resource is hydroelectric power. The Government of Cambodia formulated an energy sector development policy in October 1994 to provide adequate energy throughout Cambodia at reasonable and affordable prices, to ensure a reliable and secure electricity supply at prices that facilitate investment in Cambodia, and to encourage the efficient use of energy and minimize the detrimental environmental impact of energy supply and use. To achieve these goals, the Government has undertaken sector reform measures and rehabilitation of the power sector with the support of multilateral and bilateral agencies. Box 4-1 summarizes the major activities being undertaken by Cambodia under the ASEAN cooperation.

Box 4-1. Activities pursued under ASEAN cooperation

The main objectives of the activities are:

(a) To address the issue of energy security and sustainability for the ASEAN region at both national and regional levels through energy security planning, energy efficiency and conservation, and new and renewable energy promotion;

(b) To assist ASEAN member countries in strengthening their policy, planning and institutional mechanisms towards security and sustainability of energy supply;

(c) To facilitate and promote investment in energy efficiency and conservation and in new and renewable energy development with the active involvement of the private sector;

(d) To enhance cooperation between Japan and ASEAN in the field of energy;

(e) To disseminate "best practices" on the above three programme areas that are in use in the ASEAN member countries and in Japan.

The ASEAN awards for energy-efficient buildings are given on the basis of the following criteria:

(a) Excellent building planning design with one winner;

(b) Excellent building operation and management with two winners;

(c) And excellent building retrofit planning and design;

Box 4-1. *(Continued)*

And is given in the following categories:

(a) New and existing building€ • Overall on-site natural environment consideration • Environmental impact consideration • Passive design concepts • Active design concepts • Management & maintenance scheme • Replicability & sustainability of energy Efficiency concepts • Environmental impact consideration	***(b) Retrofitted building*** • Actual/measured energy saving • Passive design concepts • Active design concepts • Management & maintenance scheme • Replicability & sustainability of energy Efficiency concepts • Environmental impact consideration
(c) Tropical building	***(d) Retrofitted building***

Source: ASEAN Centre for Energy (ACE), <www.aseanenergy.org>, November 2003.

The general objective of the Ministry of Industry, Mines and Energy (MIME) of Cambodia is to increase the efficiency of the power sector in order to make it attractive for investment by the private sector. Attention was focused on capacity-building and strengthening of MIME, Electricit€ du Cambodge (EDC) and the Electricity Authority of Cambodia (EAC). EDC and EAC were created to monitor key indicators of efficiency within the country and to monitor and investigate projects to improve efficiency on a sustainable basis within any part of the country. Further, the project has supported the capacity-building of the Energy Efficiency Office (EEO), within the Energy Technique Department of MIME. Training has been provided and audits have been performed through on-the-job training and to encourage improvement in energy efficiency. Against this backdrop, Cambodia, poised for phenomenal construction and buildings activities, may introduce efficient use of energy in the sector.

Recent experience

The general objectives of the government programmes are: to increase power sector efficiency; to strengthen the capacity of MIME; to promote energy efficiency awareness; and to implement sustainable energy efficiency programmes.

Information for retrofitted buildings

Within the framework of Cooperation with ASEAN, Cambodia has procured a template for gathering information when conducting energy surveys and audits. Table 4-1 shows the format of the template.

Table 4-1. Information for retrofitted buildings

A. General information 1– Name of the building; 2– Name of owner and management company; 3– Address; 4– Telephone, Fax numbers, email.
B. Building physical information 5– Physical building background; 6– Age of building; 7– Any retrofit done; 8– Total number of storeys; 9– Total number of basement floor; 10– Number of car park storeys; 11– Total gross floor area; 12– Car park area; 13– Gross lettable area; 14– Air conditioner area; 15– Non-Air conditioned area; 16– Plot ratio.
C. Building design and practice information 17– Use of vegetation, landscape, topography considerations, optimization of water body utilization, wind and radiation utilization; 18– Use fa€ade made of wood and glass window with curtain, design considerations of window, walls, etc., for maximum utilization of natural flow of energy; 19– Location of service core; 20– Shape of building; 21– The orientation of building; 22– Lighting fixtures; 23– Lighting load; 24– Building air conditioner system; 25– Cooling load.
D. Operation information 26– Occupancy rate; 27– Total number of occupants; 28– Ownership of building; 29– Building operating schedule; 30– Building indoor environment.
E. Energy consumption information 31– Peak demand (monthly); 32– Energy used (monthly); 33– Typical load curve (weekdays, weekends); 34– Energy efficiency index; 35– Energy consumption.

Table 4-1. *(Continued)*

F.	**Energy management information** 36– Building automation system; 37– Energy saving.
G.	**Maintenance information** 38– Maintenance programme.
H.	**Environmental impact** 39– Impacts of wastes; 40– Impacts of noise.
I.	**Additional information for retrofitted buildings (these would not be required for other types of buildings)** 41– Energy savings in air-conditioned area; 42– Energy savings in lighting systems; 43– Retrofitted area.
Source:	ASEAN Centre for Energy (ACE) accessed on November 2003 from < www. aseanenergy.org > .

4.3.3. Thailand

Background

Thailand is a rapidly urbanizing, hot and humid country. Many years ago, with sparse populations spread over the rural countryside, houses were well spaced, leaving plenty of room for trees and cool breezes. In addition, people understood how to use the traditional wooden Thai house, often retreating to the underside and relaxing during the hottest time of the day.

In the overcrowded metropolises of modern times, however, masses of heat-absorbing surfaces, high ambient temperature, high land costs and limitations imposed by land use regulatory mechanisms mean that there is less room for broad landscapes, and such intangible factors as noise, air quality and the need for privacy and security have come to affect energy consumption.

This hot and humid Asian nation has therefore been producing and consuming energy over the past two decades at an alarming rate. For example, in the early 1990s, the country's GNP increased along with higher household incomes and a new, modern class emerged. The result was a rapid increase in the use of air-conditioners and other high-energy-consuming equipment.

With fast growth in energy use, some might suggest that people should go back to live with nature, in the countryside, but many will agree that this is very unrealistic. Decision-makers are therefore trying to first recognize the situation, with its strengths and weaknesses, and then maximize the hidden potential of the country and its people for attaining higher "energy efficiency" in construction and buildings.

A recent constructing that achieve success in connection with the above-mentioned objectives is the Shinawatra University building. This is an interesting demonstration project for replication in countries with climates similar to that of Thailand. In other climates, application of the concepts would be possible with some modifications. Despite the large size of the building, its construction is modular and can thus be replicated on a smaller scale.

Energy factors

The energy consumption of a building results from many factors. Known as "energy factors", they can be divided into three major groups: (a) site and climate; (b) building and systems; and (c) user and operation. Each one affects the other two in a way so complex that it is difficult to identify which one has more or less power.

Energy-efficient construction and buildings in the Thai context

(a) Climate

The tropical climate of Thailand is, in itself, a great challenge.

(b) Materials and methods of construction

The following are some of the characteristics of the construction and buildings sector in Thailand:

- For all practical purposes there are no structural woods in use;
- Structural steel is relatively high cost. What is used is difficult to protect in this climate, and there is a lack of skilled construction workers in this field;

- The cost of high-technology energy-conserving materials, such as insulation, insulating glass and good roof coverings, is still high because many must be imported. If produced in Thailand, they lack market competitiveness.

Currently, the principle construction materials in use in Thailand are reinforced concrete, brick, plaster and concrete roof tiles. There are many reasons for this, including climate, durability and availability of capable construction workers. These materials do last a long time and are easy to build with, but they are not efficient when it comes to energy consumption. A building constructed of such materials is incapable of resisting heat and becomes a virtual heat sink. For this reason a totally new design and construction system needs to be introduced in Thailand.

(c) Lack of skilled people

- There is in general a lack of skilled construction workers who can handle a new design approach and design professionals to construct and supervise all aspects of building an energy conserving structure.

(d) Lack of awareness

Lack of awareness covers not only construction workers and design professionals, but also people in the government and the private sector, academics, the media, and anyone who makes decisions about, or who might have an impact on, clean energy practices and solutions.

Shinawatra University design integration: the solution

The university's philosophy focuses on research, learning, and management, and this is reflected in the university's atmosphere. Moreover, several innovative approaches were integrated into the project to make Shinawatra University a prominent force for education in South-East Asia.

(a) Design concept

Shinawatra University was built with the need for grass-roots solutions in mind. To be energy-efficient, the building needed to be able to withstand the hot and humid conditions of South-East Asia. To reduce energy usage, the building's natural assets and the techniques yielded by research were integrated into the design process. The factors considered were microclimate modification, zoning and activities, building form and system integration, appropriate technology and building performance.

Microclimate modification. Site treatment is performed to improve existing environmental conditions until they enhance energy conservation inside the building. Microclimate modification can reduce temperatures in the surroundings to nearly the same level as the comfort zone. This technique enables specific activities to be carried out in the building without excessive energy requirements. Proper site treatment for the university included:

- Using natural vegetation;
- Taking advantage of water bodies;
- Reducing the footprint of the building;
- Reducing the amount of hard-top surface outside the building.

Zoning and activities. The university's activities fall into three categories (passive, semi-passive and control). Zones with specific conditions were designed to support the requirements of each activity. Lighting level, temperature, relative humidity and wind velocity are the environmental controls that are manipulated to achieve the required effect. As a result, the architect can evaluate energy consumption in each zone and then set the appropriate levels to maintain efficiency. This makes zoning beneficial for conserving energy in the building without disturbing the occupants' quality of life.

Building form and system integration. The University has buildings of different forms to accommodate different functions. These are the lecture building, the skylink building, the laboratory and canteen building and the library building. In the design of the building forms, the purpose of each building and the relation to energy conservation were taken into consideration.

- **The lecture building.** This building is designed to provide indoor comfort at a level suitable for human beings. Energy consumption for air conditioning in the lecture hall is lower than that of typical buildings, but the construction cost is no higher. This is the result of better knowledge of materials and a superior design approach derived from research on how to control factors related to energy conservation inside the building:

- The decrease in the proportion of the surface area and the net area to reduce space that can be influenced by outside heat and solar radiation.
- The use of circular forms to minimize infiltration from the outside.
- The proper use of daylight to maximize the natural illumination in the building, at the same time maintaining minimum heat gain.

▪ **The laboratory and canteen building.** This special building consists of two areas. The first one is the laboratory, which contains both the computer centre and the information technology centre. It needs to be under strict environmental control, much the same as the lecture building. The same concept was used to design both areas. The second area is the canteen, which was designed especially for casual activities, such as dining and socializing. Comfort is achieved by using natural systems in combination with enhancement techniques. The cool air stream around the building is rerouted to ventilate the dining area thoroughly. Heat gain from several sources in the canteen will flow up and be released through the upper openings by means of the stratification effect.

Since this building is located among natural surroundings, concrete was used in the construction because the heat capacity in its mass can maintain thermal stability within the area. Moreover, the engine rooms in the lower part of the building next to the laboratory can present a real-life case study for students of the Engineering Department.

(b) Use of appropriate technologies

(i) Material selection

- Using the Exterior Insulation and Finished System (EIFS) for a building's envelope can reduce heat and moisture penetration from outside. With this system more choices for building orientation are possible;
- Using low-mass materials for the interior can reduce the air conditioning load removing heat and humidity;
- Using glazing material can allow the maximum of light from the visible spectrum into the building while minimiz-

ing the penetration of light of other wavelengths, thus preventing excessive heat gain.

(ii) Design of the air-conditioning system

- Pond cooling is used to release heat from the air-conditioners instead of a cooling tower.
- The air-conditioning system is separate from the fresh air supply system and heat reclamation systems are used to reduce the heat and moisture in the fresh air before it is allowed into the building. This technique can decrease the air-conditioner's cooling load.
- The size of the air-conditioners required will be smaller because of the central air conditioning system being used. This kind of system can supply an alternative amount of cool air to the working area according to different daytime and nighttime requirements.
- Ducts and pipes for several public utilities can be combined together with the campus's main passages to reduce energy waste in these systems.

(iii) Equipment selection

- Choosing lighting fixtures with high illumination potential, as well as the capability to conserve energy, helps reduce electrical power demand. The rate of energy consumption is 6 W/m^2.

(c) Building performance

(i) Estimating costs and reducing the investment

- The use of superior materials and design approaches, as discussed above, allows the investment for the air conditioning system to be reduced although the cost of the building envelope does rise by 25 million baht. However, a comparison of the two investments reveals the following:
  - The air-conditioners required for the University's buildings are smaller, on the order of 1,500 tons, than those required for similarly sized buildings.
  - Assuming a cost of 50,000 baht per ton, the University can save 75 million bath (50,000 baht x 1,500 tons) on the air-conditioning system.

– Once the higher cost of the building's envelope is taken into account, the net saving is 50 million baht.

(ii) Energy conservation potential

Table 4-2 contains a comparison of the electrical energy consumption of the air-conditioning and lighting systems of the University and those of typical buildings. The comparison shows that the lighting and air-conditioning systems of the University consumed one-sixth the electrical energy of typical buildings.

Table 4-2. Comparison of the electrical energy consumption of the air conditioning and lighting systems of the Shinawatra University and typical buildings

(a) Electrical power requirement per square metre (W/sq.m.)

For	Electrical energy consumption in typical buildings	Electrical energy consumption in University buildings
Lighting	16	6
Air-conditioning	105	15
Total	121	21

(b) Annual electrical energy requirement

	kWh/m²/year
Typical buildings	Approximately 290
University	Approximately 50

Conclusion

Actual data show that the project cost was reduced by 50 million baht or approximately $1.25 million while a completely desirable comfort level was maintained. This building design demonstrates that it is possible to conserve energy and maintain an excellent quality of life without driving up the investment cost.

4.3.4. Viet Nam

Background

Viet Nam is a heavily populated developing country. In 2002, its GDP growth rate was over six per cent, even against the background of a global recession. The climate is tropical in the south and monsoonal in the north with a hot rainy season (mid-May to mid-September) and a warm dry season (mid-October to mid-March).

Viet Nam is a net energy exporter. In 1998, Viet Nam exported an estimated 71,000 barrels of oil per day. Other domestic energy resources include natural gas, coal, and hydropower.

Although per capita consumption of electricity in Viet Nam is among the lowest in South-East Asia, demand has been on the rise for the last several years, straining the country's generating capacity. As an emerging market, Viet Nam has experienced rapid commercial growth, mass migration to major cities and rising living standards, all of which have contributed to the country's growing demand for construction particularly in urban areas, and consequently electricity. In 1998, Viet Nam had a total electricity generating capacity of 5 GW.

Currently, attention has been focused on some aspects of high-rise buildings in view of their ever-increasing numbers. Viet Nam is seriously considering the introduction of new building codes to improve energy conservation. Some of the building code development issues have already been identified.

Energy factors

Energy consumption in residential and public buildings accounts for 23 to 24 per cent, the industrial sector 38 per cent and transportation 32-33 per cent of total consumption in Viet Nam. The rate of consumption in the residential building sector increased by 12 per cent annually during the period 1996-2000 and is forecast to rise by 15 per cent or more in the new millennium. High-rise hotels with a gross floor area of more than 10,000 m^2 in Hanoi and Ho Chi Minh City consume electricity in the range of 1 million to 2 million kWh/year. High-rise buildings have high energy consumption rates due to inefficiency.

Surveys of high-rise commercial buildings

The Ministry of Construction of Viet Nam conducted building surveys in two phases. Two organizations, RCAICE and ENERTEAM, implemented the field-level activities. In phase I, from June to September 2001, the survey area was concentrated in Hanoi, Danang and Ho Chi Minh City. In phase II, from June to November 2002, the focus was on Hanoi and Ho Chi Minh City. The following criteria were found to be useful in the selection procedure:

- Built since 1990;
- Functions of the building;
- Building size: gross floor area, number of floors (for hotels, the number of guestrooms);
- Ownership;
- Designer (design team).

The number and type of buildings covered are shown in table 4-3. Some of the apartment units surveyed in Hanoi are shown in figure 4-2.

Results of the survey

The findings of the survey can be summarized as follows:

- There is a trend towards imitating Western architecture without researching solutions suitable for Vietnamese socio-economic conditions;
- There is a lack of concern about insulation from design through to construction;
- No energy audits are conducted in high-rise buildings, even if electricity consumption exceeds 2 million kWh per year;
- There is a lack of energy-efficiency equipment on the market;
- The processing of construction permit applications does not include energy-efficiency checking;
- Building codes have no provision for energy efficiency.

The above findings demonstrate that the promulgation of building codes with energy efficiency provisions is long overdue. It is necessary to publish guides for the design and use of energy-efficient buildings. Experience in other countries of the region shows that a coherent implementation of codes from design to construction to operation could result in energy savings of 15 to 30 per cent.

Table 4-3. Surveys of high-rise commercial buildings

Phase I

Building type	Hanoi No. of buildings	Ho Chi Minh City No. of buildings
1. High-rise office	8	9
2. Hotel	14	8
3. High-rise apartment	7	7
4. Supermarket	2	3
5. Multi-function (mixed)	4	3
Subtotal	35	30

Phase II

Building type	Hanoi No. of buildings	Ho Chi Minh City No. of buildings
1. High-rise office	3	2
2. Hotel	4	3
3. High-rise apartment	2	2
4. Supermarket	2	2
5. Multi-function (mixed)	2	2
Subtotal	13	11
Total	48	41

Figure 4-2. High-rise apartment buildings surveyed in Hanoi

Solutions for the improvement of energy efficiency in high-rise buildings

The survey identified a number of solutions for improving energy efficiency in high-rise buildings. Some of the findings are noted below.

- To the maximum extent possible, bio-climatic design principles, passive cooling, natural ventilation and lighting must be applied on the basis of experience with traditional architecture;
- Local climatic conditions, economic conditions, traditions and customs need to be taken into account in the design of buildings;
- Effective insulation of the building envelope (roof, external walls, windows, doors, floors) prevents heat transfer between the interior and the exterior;
- Proper shading and the maximum use of effects of solar radiation for illumination would be useful;
- High-efficiency equipment, which is comfortable to use and easy to operate, reduces the negative impact on the environment and is essential.

Building code development issues

Building codes should have definite objectives and should be formulated according to appropriate methodologies. There should be enough scope for comparison of different codes and incorporating suggestions in the sphere of energy efficiency and conservation in buildings and construction (EECBC) in Viet Nam. Code should also prescribe voluntary and mandatory regulations. As a first step, a number of issues have been identified:

- Building envelopes;
- Lighting;
- Electricity and its distribution;
- Ventilation and air conditioning (VAC);
- Hot water supply system;
- Financial assessment for improving energy efficiency through the improved operation and renovation of building;
- Simplicity versus technical accuracy and flexibility because the simpler the code, the more it will likely to be used. However,

it is difficult to have a simple code for complex buildings and to have simple requirements to cover a wide range of conditions and building systems.

- Availability of equipment and materials on the local market;
- Windows (special glazing, double-glazing, low-emissivity coatings);
- Insulation;
- Energy-efficient cooling equipment;
- Controls;
- Local cost of equipment and materials;
- Code should use actual construction assemblies to establish criteria;
- Code should specify requirements in easy-to-understand formats;
- For prescriptive requirements, tables of pre-calculated values should be provided;
- Technical data should be consistent, accurate and easily available;
- When available, use standard ratings for windows, skylights, and doors. Example, in the United States, window ratings are assigned by the National Fenestration Rating Council (NFRC);
- Economics: an economic basis should be used to set requirements, such as LCC = (incremental) life cycle cost;
- Avoid installing air conditionings in buildings without central air conditioning;
- Use sufficient openable windows and natural ventilation instead of air-conditioning when climate conditions permit;
- Building form and, when possible, orientation should be taken into consideration.

Conclusion

For hotels and high-rise buildings, energy savings and efficiency must go hand-in-hand with comfort. This is an environmentally friendly solution that would ultimately contribute to sustainable development.

Some countries have initiated "green hotel" programmes with environmental protection requirements. This is an added attraction for tourists from developing and developed countries alike.

4.4. Observations

4.4.1. Strategy to implement energy efficiency policy options

It is not sufficient to have a good set of policies if there is no proper strategy for implementing those policies or enforcing regulations. National policy makers should work in close collaboration with the agencies in charge of the housing and construction sector to define such a strategy.

Targets should be well identified on the basis of their technical potential for energy efficiency improvement. There are proven methods for assessing such potential. A good understanding of the subsectors and their structure is then important in order to classify the actions that need to be taken. The building sector can be broadly divided into the residential, commercial and service subsectors. For the residential subsector, buildings can be classified into new and old buildings, or individual and collective housing. Collective housing can be of two types: social housing and private sector housing. On the other hand, buildings in the commercial and service subsectors can be classified according to sectoral activities: administration, health, hospitality, education, commerce, etc.[57]

As the main objective would be to maximize the use of the resources available for public action, several criteria should be applied to select the combination of targets and actions. As a result, some actions may be retained for application in some subsectors but withheld for others. Finally, it is crucial to outline a combination of instruments suitable for each subsector.

Criteria for selecting priority areas and actions

After the subsectors are defined and the main actors are identified, the criteria for selecting the priority targets and actions should be decided by the public and private partners. One of the criteria could be the evaluation of the overall potential for energy efficiency and reduction in environmental pollution in each subsector.

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[57] B. Laponche, B. Jamet, M. Colombier and S. Attali, *Energy Efficiency for a Sustainable World* (Paris, ICE Editions, 1997).

It is necessary to start with the evaluation of the relationship between the investment needed for implementing each action and the estimated savings. The actions can then be ranked according to their merits and the information obtained can be combined with that of the observed potential. If necessary, environmental costs can also be internalized in the assessment of economic values. Some actions may be less highly ranked from a purely economic perspective but may represent a higher economic stake from the collective viewpoint.

The economic effectiveness of actions may be judged by assessing the cost to the community of using mandatory or incentive measures. For example, the owner of a rental property may not see the usefulness of incorporating energy saving measures if the rent cannot be raised. Likewise, a tenant will hesitate to perform any retrofits for improving a property that does not belong to him/her. The different solutions needed to tackle this situation could be to either renegotiate the leases or provide incentives in the form of tax reductions or grants in favour of one of the parties. Because such solutions can significantly reduce the public budget, they can be less attractive than other options.

For the sake of credibility, the rate at which the potential savings can be achieved should be taken into consideration. Sometimes, the demonstration effect of actions taken can be important; it is particularly interesting to implement energy efficiency actions in the social housing sector.

Programmes may be designed to satisfy several criteria. Actions may be taken to support disadvantaged families who cannot invest in energy efficiency to reduce their energy bills. If these families receive subsidies in their energy bills within the framework of social services, it may be worthwhile to work with those services to define and implement suitable energy efficiency programmes.

Choice of energy efficiency instruments

The foregoing sections show the wide variety of options for promoting energy efficiency. These can be broadly classified as regulatory or incentive instruments.

Governments tend to emphasize mandatory regulations because they are inexpensive from the public viewpoint. However, the practical applicability of mandatory measures must be assessed. Because of poor enforcement regimes, such regulations have been largely ineffective in many countries. In applying mandatory measures, it is assumed that a minimum standard of quality can be defined with precision. This may be successively applied to new buildings, but the requirements for existing buildings cannot be easily defined owing to their heterogeneous nature. However, it is possible to introduce mandatory measures that are different from those applied to new constructions. For example, periodic energy audits of buildings and their components can be made mandatory; such an activity would generate concrete improvement proposals.

Regulations should be acceptable to all major stakeholders. Regulations can represent a compromise among enhanced energy efficiency requirements, technological feasibility, the know-how of professionals and the cost of construction. Therefore utmost care should be taken when transposing the regulations from one country to another. To be effective, all stakeholders should cooperate to define regulations that should be introduced along with other accompanying measures. Regulations should gradually evolve towards stricter requirements to keep pace with the positive impacts of sensitization, training and widespread use of innovative technologies.

Two parameters will influence the way regulations can be applied. The first is the uniformity of the targeted sector, and the second is the flexibility given to the designer in meeting the requirements of the regulations. Prescriptive standards define a list of energy efficiency measures to be implemented, whereas performance standards allow the consumer to adopt any measures as long as they do not exceed a given threshold of energy consumption for a specific type of building.

As mentioned earlier, the construction sector includes many different actors with interests that are, at times, divergent. Therefore, a good understanding of the strategies and the interests of all concerned is essential for formulating and implementing policies well.

Evaluation of energy efficiency incentives

While formulating incentive measures, it is important to analyse all possible barriers to the dissemination of energy efficient technologies. If the objective is to open up the market, it may be effective to abolish taxes and subsidies on certain products. On the other hand, if the market share of an energy efficient product is low in comparison with the actual potential, it may be advisable to explore incentive measures, such as undertaking innovative projects in partnership with manufacturers, as was done in the "Golden Carrot" programme in the United States.

Households that are normally interested in the symbolic rather than the absolute value of incentives would find fiscal incentives appealing. On the other hand, bank lending should be adapted to energy-saving investments that have the potential to offset loan payments. Government support can be extended in the form of reduced interest rates, particularly in favour of social housing.

Incentive measures can be combined into a single action to complement regulations or standards and facilitate their enforcement. As was found in the FFEM-supported energy-efficient building programmes in China, demonstration programmes that include design assistance and training programmes can play a pivotal role in testing and improving innovative technologies while helping the architecture and building industry to accept such technologies. Similarly, a good awareness programme combined with quality training of professionals on selected energy-efficient products will attract financial and fiscal investment.

In the drafting of new building codes or regulations, financial incentives for the utilization of new technologies in large institutional buildings will increase demand for such technologies and thus help lower the cost of acquiring them.

4.4.2. Policy and strategy options

Policies and measures for promoting energy efficiency in the building sector should be maintained over a long period of time to avoid uncertainties and to provide the stability needed to foster a higher level of capital investment. The high economic growth rate and rapid capital stock expansion in the construction sector of the Asia-Pacific region provides a great opportunity to widen the scope for using advanced technologies provided additional investment is made available to cover the incremental costs. As buildings are designed to last decades, opportunities not seized during the design and development stages will lead to the economy being saddled with higher energy costs and environmental emissions from long-lasting infrastructures and capital stocks. In this context, research should be focused on finding ways and means to reduce the embodied energy in buildings.

Chapter 5

IMPROVING THE END-USE ENERGY EFFICIENCY OF ELECTRICAL APPLIANCES[58]

5.1. Introduction

Appliances and equipment (e.g., lamps and ballasts) in homes account for a significant portion of end-use energy, in particular electricity. Although in developing countries electricity demand in the residential sector may not be as high as in the industrial and commercial sectors, it is rapidly growing in proportion to the rising income, as more rural and urban consumers purchase their first appliances (e.g., refrigerators, air conditioners, rice cookers and televisions).

Electrical appliances are perceived as convenience items, but have gradually evolved into necessities in most households in industrialized countries. Almost every home in industrialized countries has lights, a refrigerator and a stove, and these items are increasingly seen as necessities in developing countries. Most homes in industrialized countries also have air-conditioning systems, dishwashers, clothes washers and clothes dryers. In the United States, for example, appliances account for most of the energy consumed in homes (if space conditioning is included), and energy use in the residential sector accounts for about one-fifth (19.8 per cent) of the total.[59]

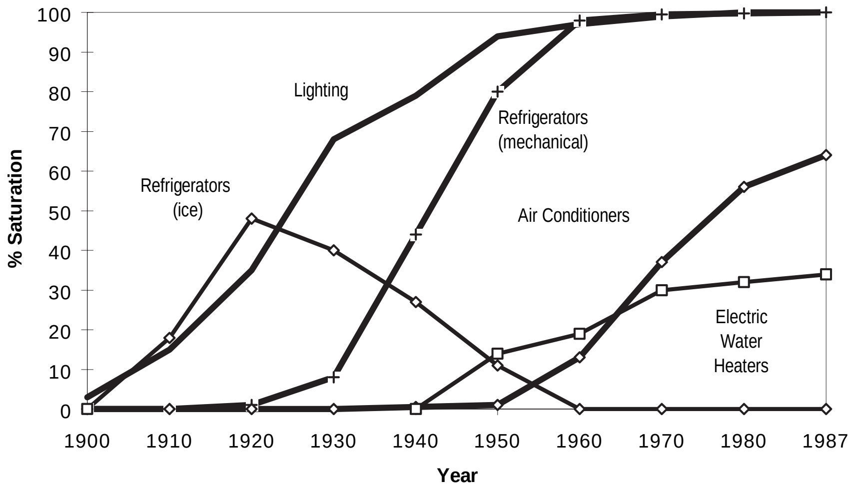
The increasing use of four of the five main home appliances in the United States is shown in figure 5-1. (Note: a fifth appliance, heating systems, is not included owing to the difficulty in comparing the many different types of heating systems, such as wood, coal, gas, oil and electric.) Along with motors for factories, the electric light was the first electric end-use device that the electric utilities marketed in the late 1800s

[58] This chapter was principally drawn from the contribution made by Mr. Peter du Pont. The case studies are based on contributions made by Ms. Jai-Ok Kim, Mr. A.R. Karbassi, Mr. S.M. Sadeghzadeh and Mr. Sat Samy.

[59] "The United States of America energy use". *Statistical Abstract of the United States of America* (1997: 584).

to create a market for their product (Clark, 1977; Hughes, 1983; Marcus and Sega1, 1989).

Figure 5-1. Increase in saturation of electrical appliances in the United States, 1900-1987



Sources: Data for electric lighting and refrigerators from Lebergott (1993). Data for air conditioners and electric water heaters from *Statistical Abstract of the U.S.* (1940, 1950, 1960, 1970, 1980, 1990); Lebergott, S. (1993). *Pursuing Happiness: American Consumers in the Twentieth Century* (Princeton, Princeton University Press).

Note: The share of air conditioners in 1987 was 30 per cent room and 34 per cent central; 47 per cent of homes in 1987 had gas water heaters. The use of cool storage via “ice boxes” peaked around 1920 but these were quickly replaced by mechanical refrigerators. Gas water heaters are not shown in this figure. The saturation of water heaters overall is divided roughly evenly between electric and gas water heaters.

Appliances will become an increasingly significant contributor to future energy demand worldwide. The trend of appliance uptake is now repeating itself in the developing world, as income rises and manufacturers systematically seek out emerging markets. Global sales of “white goods” (refrigerators, dishwashers, clothes washers, clothes dryers, and cooking appliances) increased by 15 per cent annually during the 1990s, reaching $77 billion by the year 2000. Roughly 85 per cent of sales of white goods take place in the United States, Western Europe and South-East Asia.[60]

Worldwide, the use of energy in buildings, and the appliances and equipment within them, accounts for about one-third (34 per cent) of global energy consumption.[61] At the same time, end uses of energy account for more than a quarter (25-30 per cent) of energy-related CO_2 emissions globally.[62]

China, which has the largest population in the world, has seen a phenomenal increase in both appliance usage and production. The penetration of refrigerators rose from almost zero in 1980 to about 65 per cent of urban Chinese households in 1997, and that of clothes washers increased from 5 per cent to 90 per cent in the same period in urban China. The use of colour televisions rose rapidly in the mid-1980s and, by 1997, virtually all urban Chinese households owned at least one colour TV. A similar trend has been observed for air conditioners as well, although in a much shorter time frame. Sales of air conditioners reached about 8 million in 1997 from a miniscule level of 250,000 in 1990. Today, China is one of the largest producers of many home appliances and lighting products in the world.[63]

It is shown in figure 5-2 why it is so important for energy efficiency policies to focus on the efficiency of equipment being manufactured and sold in the coming years. *Simply put, nearly all of the energy use and the related environmental impact from appliances will result from appliances not even on the market today* (note: more than 90 per cent of appliance energy use in the United States will be from "new" appliances not yet installed in houses; the corresponding figure for China is more than 95 per cent). This

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[60] *Euromonitor*, cited in I. Turiel, "Present Status of Residential Appliance Energy Efficiency Standards: An International Review", *Energy and Building*, vol. 3, March 1997.

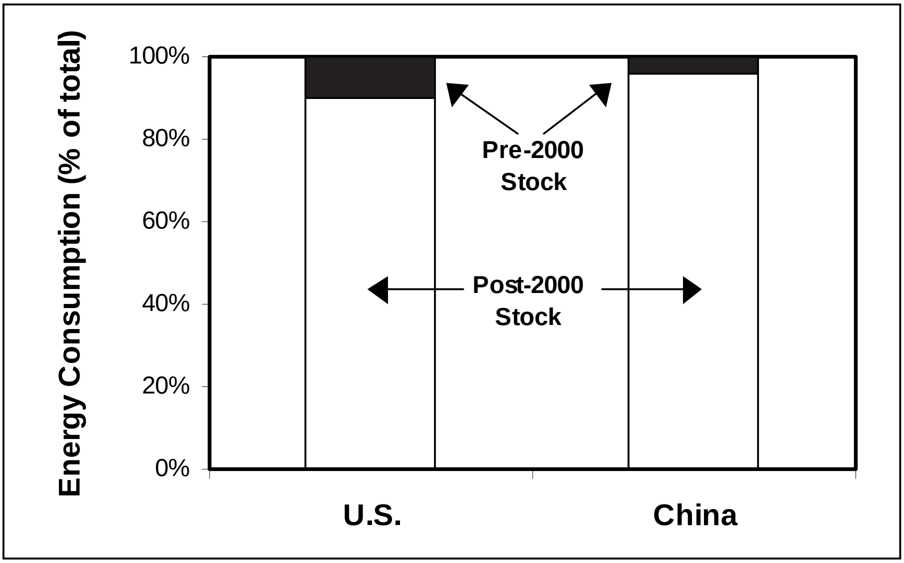
[61] Price (1998) cited in S. Wiel, "Introduction", *Energy-Efficiency Labels and Standards: A Guidebook for Appliances, Equipment, and Lighting*, S. Wiel and J.E. McMahon, eds. (Washington, D.C.: Collaborative Labeling and Appliance Standards Program (CLASP), February 2001) and L. Price and others, "Sectoral Trends and Driving Forces of Global Energy Use and Greenhouse Gas Emissions", *Mitigation and Adaptation Strategies for Global Change* (Berkeley, Lawrence Berkeley National Laboratory, 1998).

[62] S. Wiel, and others, "The Role of Building Energy Efficiency in Managing Atmospheric Carbon Dioxide", *Environmental Science and Policy* (1998), 1: 28-29.

[63] Turiel and others, *China Statistical Yearbook 1998* (Berkeley, Lawrence Berkeley National Laboratory, 1998).

holds true even for mature markets in industrialized countries, such as the United States. The reason for this is that appliances typically last in the range of 10-20 years; so very few of the appliances being used today will still be operating 20 years from now.

Figure 5-2. End-use energy consumption in 2020 for "existing" and "new" appliances



Source: S. Wiel, (2001). "Introduction", *Energy-Efficiency Labels and Standards: A Guidebook for Appliances, Equipment, and Lighting*, S. Wiel and J.E. McMahon, eds. (Washington, D.C., Collaborative Labeling and Appliance Standards Program (CLASP)).

Clearly, energy used to power appliances will become a growing international problem in terms of the capital required to finance and fuel power plants and the pollutants that they emit. Given the large and growing impact of appliances, it is necessary to gain a better understanding of how energy policies can be designed and applied to limit their impact on future energy demand.

A recent Government of the United States study of climate-change mitigation potential provides a glimpse of the potential savings that can come from improving the efficiency of appliances and equipment. In the advanced scenario, shown in figure 5-3, the study applied approximately 50 policies.[64] The 10 most important policies are listed below, by sector:

Buildings:

- Energy-efficiency standards for equipment;
- Voluntary labelling and deployment.

Industry:

- Voluntary programmes;
- Voluntary agreements with individual industries and trade associations.

Electric utilities:

- Renewable energy portfolio standards and production tax credits;
- Electric industry restructuring.

Transportation:

- Voluntary fuel economy agreements with manufacturers;
- "Pay at the pump" auto insurance.

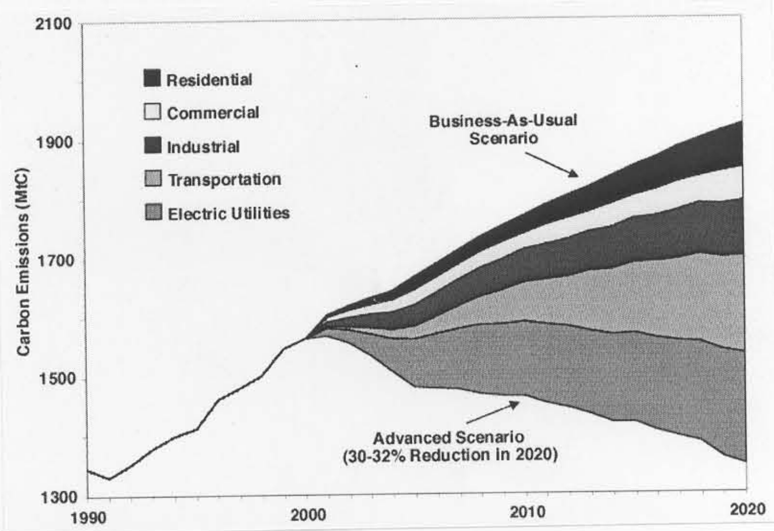
Cross-sector policies:

- Doubled federal R&D;
- Domestic carbon trading system.

Figure 5-3 shows that roughly one quarter of the potential savings in the advanced scenario comes from measures in residential and commercial buildings. These measures addressing appliances and equipment have the most energy-saving potential.

[64] Wiel, S., "Energy Efficiency Experiences: Standards, Labels and Other Energy Efficiency Policies", presentation at the APEC Symposium on Energy Efficiency Standards and Programmes under Energy Market Restructuring, 1998.

Figure 5-3. Climate change mitigation potential in the United States



Source: S.Wiel, (2002). "Energy Efficiency Experiences: Standards, Labels and Other Energy Efficiency Policies", Presentation at the APEC Symposium on Energy Efficiency Standards and Programmes under Energy Market Restructuring.

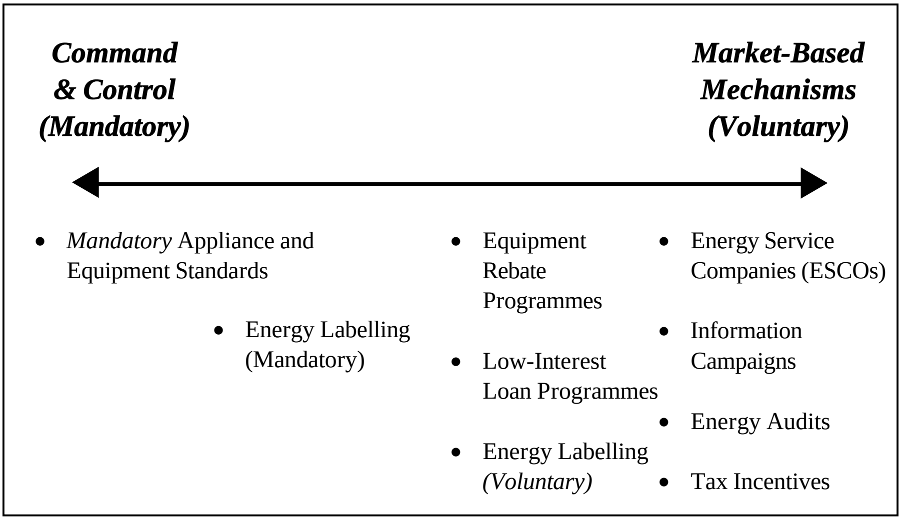
Note: This graph shows the potential CO_2 reductions under the advanced scenario.

5.2. Policy options

5.2.1. Types of energy-efficiency policies

Over the past 25 years, since the aftermath of the two major oil crises in the 1970s, there has been a wealth of experience with energy-efficiency policies and programmes for appliances. The major types of policies are shown in figure 5-4, which places them along a spectrum ranging from mandatory to voluntary.

Figure 5-4. Spectrum of policy options for improving appliance efficiency from command and control to market-based



5.2.1.1. Energy audits

Since "you cannot manage what you cannot measure",[65] free or low-cost energy audits are often the first element of energy conservation programmes in a country. In the United States, a major programme called the Residential Conservation Service ran throughout the 1980s to provide free or low-cost audits for tens of thousands of residential customers nationwide. There has been little definitive research to evaluate the impact of such audits on actual improvements in household energy efficiency.

5.2.1.2. Information campaigns

Information campaigns cover a wide range of activities: from bill-stuffers and brochures enclosed in utility bills to provide energy-saving tips; public-service announcements and advertisements on radio and television; brochures and booklets given out and mass-mailed to consumers; point-of-sale signs and marketing gimmicks designed to encourage consumers to take energy-efficiency into account when they purchase a new appliance. A regulation indicating that all equipment (local and imported) sold must

[65] This statement, a management truism, has been widely attributed to Jack Welch, the former Chief Executive of General Electric Corporation.

have a detailed catalogue or operating manual in the local language is also desirable.

5.2.1.3. Minimum energy performance standards

Minimum energy performance standards (MEPS) are sets of procedures and regulations that prescribe the minimum energy performance of manufactured products. MEPS can be either voluntary or mandatory but tend to be mandatory. Mandatory MEPS prohibit the manufacture and sale of products that do not meet the minimum efficiency levels laid out in the standard. MEPS have been the single most effective policy for improving the energy efficiency of appliances in the United States. However, it is important to note that MEPS are not used in isolation: testing procedures and protocols are required in order to be able to reliably measure and report the efficiency of appliances on the market; energy labels are important to provide information to consumers and as an incentive to manufacturers to produce more efficient units; and rebate programmes are often designed to reward manufacturers of models that exceed the MEPS efficiency levels by a certain amount.

Recognizing the importance of electrical and electronic appliances for modern lifestyles, several countries in the Asia-Pacific region have introduced minimum energy efficiency standards that all appliances must meet before they can be legally sold. Very promising results have been reported as a result of the introduction of such standards. In the Philippines, there was a 25 per cent increase in the average efficiency of air-conditioners one year after a mandatory standard was introduced. In the case of Thailand, a voluntary labelling programme for refrigerators led to a reduction of 65 MW of electrical power demand in three years.

It is important that MEPS be revised periodically to reflect technological innovations and the expansion of energy end-uses. This may not be politically attractive in practice and would require more time, a better institutional infrastructure and the creation of greater awareness among the stakeholders. Japan's Top Runner Programme allows for a periodic update of MEPS by obliging manufacturers to improve the efficiency of their products to a certain standard over a specified time period; the standard is set using the most efficient model already available on the market.

5.2.1.4. Equipment rebate programmes

These are programmes in which a subsidy or incentive is given to a customer or manufacturer for the purchase or sale (respectively) of an energy-efficiency product. Such rebate programmes have formed the core of many demand side management programmes implemented in the United States over the past 20 years. Since the mid-1990s, however, utility funding for demand side management (DSM) programmes, per se, has fallen off, and energy-efficiency programmes tend to be funded through public benefits funding based on a small fee. The trend in the United States has been away from traditional "DSM" programmes and toward more broadly defined "market transformation" programmes.

5.2.1.5. Energy labels

These are labels affixed to manufactured products to indicate the energy performance of the product, often in relation to other products on the market. The three basic types of energy labels are information-only, comparative and endorsement labels. Within the comparative category, there are two broad kinds of labels: (a) labels that use a bar or graphic to show the energy use of an appliance relative to other products on the market; and (b) labels that use categories denoted by letters, numbers, or stars to show a comparative rank. Energy labels can be either voluntary or mandatory.

5.2.1.6. Low-interest loan programmes

Like rebate programmes, low-interest loan programmes are intended to overcome barriers to the financing and purchase of energy-efficiency equipment, which tends to be more expensive to buy than standard-efficiency equipment. While such programmes can be effective, they are not widely used for the purchase of appliances, because of the relatively high transaction costs associated with approval and paperwork for a bank loan.

5.2.1.7. Tax and fiscal incentives

These are policies or regulations that favour the purchase or import of high-efficiency appliances and equipment. Types of incentives include: a reduction on duties for the import of high-efficiency equipment; a tax reduction or write-off for the purchase of an energy-efficient appliance or product; and accelerated depreciation for the purchase of energy-efficient equipment (usually applicable only to the commercial or industrial sectors).

A part of the subsidies, given directly to regulate the cost of energy in many developing countries, may be judiciously utilized to provide such tax and fiscal incentives.

5.2.1.8. Energy service companies

Energy service companies (ESCOs) provide their clients with a variety of options for increasing the efficiency with which the client consumes energy. ESCO clients include everything from agricultural enterprises to industrial factories to public buildings to individual homes. To help a client save energy, ESCOs can design, implement, and potentially finance a vast array of high-efficiency technologies, such high-efficiency air conditioning systems, fluorescent lighting and variable speed drives, each of which is applicable to the needs of a certain type of client. Most ESCO activity worldwide is in the commercial, government and industrial sectors. There is little ESCO activity in the residential sector, although there have been a number of ESCOs providing "shared savings" financing arrangements for residential homes in the United States.

5.2.1.9. Apex body

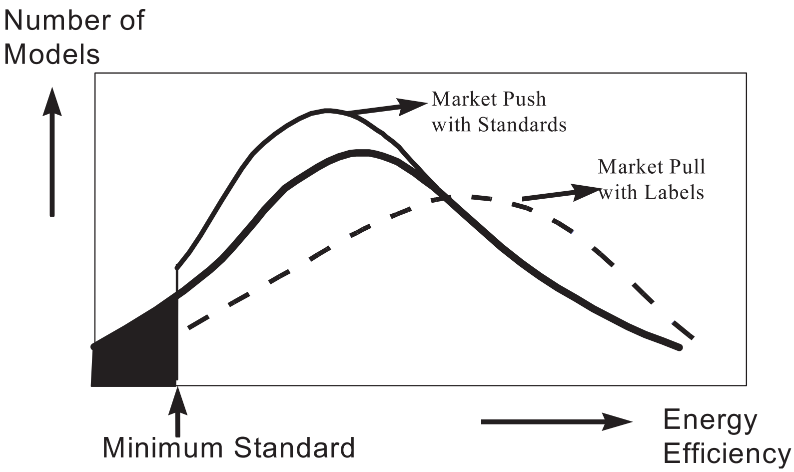
A powerful apex body should coordinate and monitor the activities generated through the foregoing energy-policy policy options. This would reduce ambiguity, increase transparency and maintain the necessary momentum of activities. Thus, any high-level decision aimed at improving end-use energy efficiency could be implemented in a timely manner and would be effective in the target zone, with even more effective stakeholders participation. For this purpose, the services of NGOs and institutes may be utilized at the State, regional or grass-roots level.

5.2.2. How MEPS and energy labels can work together

It is generally recognized that energy performance standards (i.e., MEPS) and energy labelling are the most cost-effective policies that a country can adopt to improve the efficiency of appliances sold on the market. The reason is that these policies cover all appliances on the market at once, thus making a significant impact on market transformation. Such policies contrast, for example, with rebate programmes, which impact appliances one at a time and may entail a larger unit cost.

Figure 5-5 shows how MEPS and labelling can work together to improve the average efficiency of models sold on the market. The basic approach is as follows:

Figure 5-5. Energy labels and MEPS working together to improve the average efficiency of appliances in the market



Source: Wiel, S. 2001. “Introduction”. Chapter in Wiel, S. and J.E. McMahon, eds. *Energy-Efficiency Labels and Standards: A Guidebook for Appliances, Equipment, and Lighting*. Washington, D.C.: Collaborative Labeling and Appliance Standards Program (CLASP).

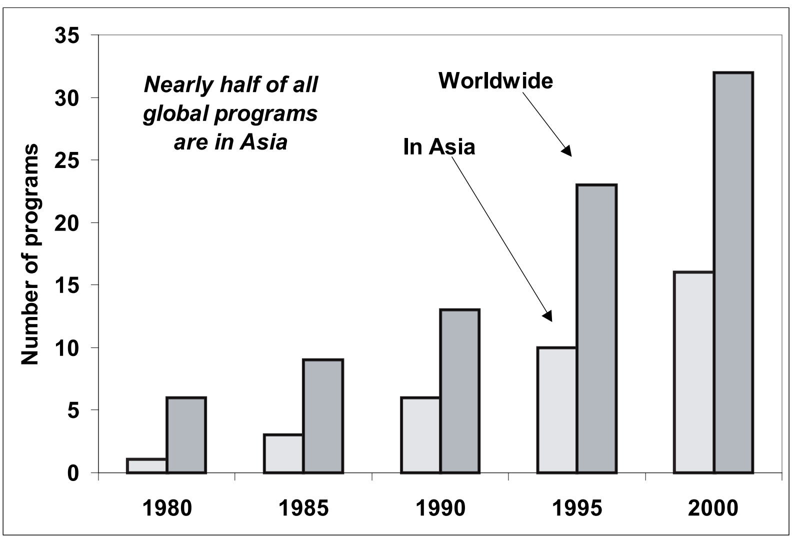
First, an energy labelling programme is introduced so that all appliances on the market have an energy rating, and consumers can use this information, if they wish, to choose a more energy-efficient model. The introduction of an energy labelling programme can influence the decisions of environmentally or energy-conscious consumers, thus creating a “market pull”. This moves the average efficiency of models sold on the market slightly to the right, as shown by the dashed line.

Once an energy labelling system is in place and there has been an upward shift in the efficiency level of products on the market, a minimum energy performance standard (MEPS) can be enacted to remove the most inefficient products from the market. This effect is a “market push”, which also increases the average efficiency of the models on the market. In this way, energy labels and MEPS can be used to “pull and push” the market towards higher efficiency levels.

5.2.3. Growth of MEPS and energy labelling programmes internationally

Internationally, the number of countries implementing MEPS and labelling programmes has more than quadrupled since 1980 and has more than doubled in the past decade (see figure 5-6). Nearly half of all programme experience with standards and labelling programmes is within Asia.

Figure 5-6. Cumulative number of standards and labelling programmes in Asia and worldwide



Source: Collaborative Labeling and Appliance Standards Program (2001). *Energy-Efficiency Labels and Standards: A Guidebook for Appliances, Equipment, and Lighting*. Wiel, S. and J.E. McMahon, eds. (Washington, D.C., CLASP).

5.3. Case studies and country experiences

5.3.1. Selection of countries or areas

Today's consumers have a number of electrical appliances available to them; there are also many ways to improve energy efficiency. Research and development activities on such improvement are driven more by market push, with standards, and market pull, with labels.

Customer satisfaction and sentiment play a more direct role in this sector than in any other. Therefore, the methods employed to improve energy efficiency differ even for the same product in the same country or area. One country may have mandatory or voluntary standards for some appliances but not for others. Similarly, different countries may have different practices with regard to standards, labelling, equipment rebates, low-interest loans, tax incentives, the dissemination of information or the role of ESCOs. Most developing countries in the region have begun to take the initiative in one form or another, and it is probably the best time to implement standards and labelling programmes.

The countries and areas showcased here have been selected to cover the different aspects of the above-mentioned practices and to elucidate the situation in the ESCAP region. The objective is to generate observations and ideas regarding the methodologies for the implementation of such practices to improve the energy efficiency of appliances for a sustainable energy future.

Mention can be made of associations working to promote energy efficiency in electrical appliances to place before the member countries/areas some examples of subregional and regional cooperation having yielded a win-win situation for the participating nations. These associations are the Association of Southeast Asian Nations (ASEAN), the European Union (EU) and Asia-Pacific Economic Cooperation (APEC).

Since more than 30 MEPS and energy labelling programmes have been implemented in more than 40 countries, an exhaustive review is not possible here. However, it is possible to review the experience of selected industrialized and developing countries in North America, Europe and Asia.

Country/region reviewed	Type of programmes
Asia-Pacific Economic Cooperation (APEC)	Energy labels
China	MEPS, certification labels, and comparative energy labels
European Union	Energy labels, followed by MEPS
Islamic Republic of Iran	Energy labels
Republic of Korea	Energy labels, MEPS
Thailand	Energy labels, followed by MEPS
United States	Energy labels, followed by MEPS

5.3.2. European Union: development of energy labelling and MEPS for appliances[66]

Background

Prior to the formation of the European Union, 14 developed countries in Europe had national energy programmes. Today, the coordinated approach to energy conservation practice is a good example for any regional/subregional association of countries/areas. In particular, the introduction of labelling and MEPS has shown impressive results. The average efficiencies of refrigerators and freezers have increased by 27 per cent in about 10 years.

Energy labelling for appliances

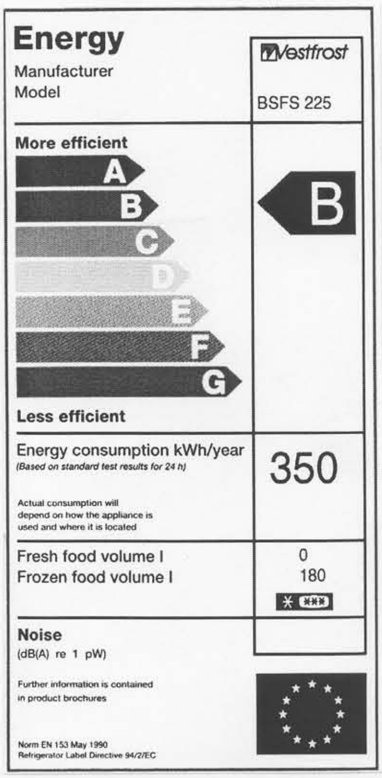
In 1992, the European Union enacted a *Framework Directive* authorizing the European Commission to issue mandatory energy labels for a range of energy-consuming household appliances. This directive provides the overall guidelines for the labelling programme. It sets out the justification, definitions, terms of reference, powers, responsibilities, and additional criteria for the overall labelling programme. However, it does not provide the details for any particular product.

Appliance-specific *implementing directives* or related legislation provide technical specifications that include how to calculate label ratings

[66] P. Waide, "International best practice for equipment standards and labelling programmes", presentation at the International Energy Agency (IEA) Conference on Energy Efficiency, Beijing, China, December 2001.

(A to G, with A as the most energy efficient and G as the least efficient), the comparative energy consumption (the energy number that appears on the label), details on the number of units to be tested, supply of supporting documentation, the design and shape of the energy label and how the label is to be affixed to the appliance. Implementing directives have been issued for refrigerators and freezers (1994), clothes washers (1995), dryers (1995), washer-dryers (1995), dishwashers (1998) and household lamps (1998). Meanwhile, draft energy label implementing directives are under consideration for ovens, air-conditioners, storage water heaters and TVs as well as updated versions of the refrigerator and clothes-washer labels. Figure 5-7 shows the current version of the EU energy label for refrigerators.

Figure 5-7. The EU energy label for refrigerators

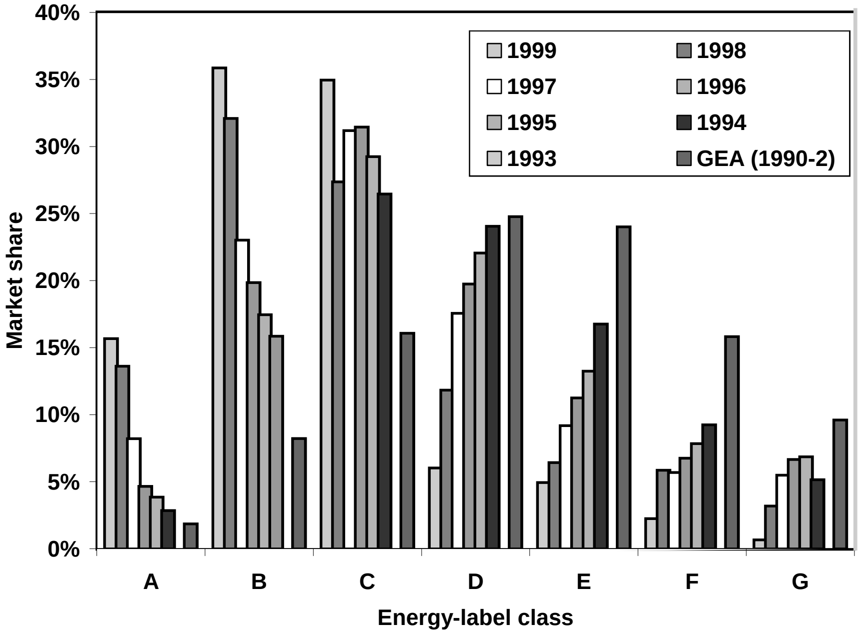


The energy label could be mandatory, exclusive (any additional conflicting or confusing labels are prohibited) or comprehensive (i.e., supplied with all appliances of the specified type, must be affixed on the front of display models or included in mail order catalogues).

Evaluation of the EU labelling programme

The EU labelling programme has been evaluated and results show the considerable impact in influencing the efficiency of the equipment in the European market and the success of this policy instrument. Since the introduction of labelling and MEPS, the efficiency of refrigerators and freezers has improved by 27 per cent and much of this gain can be attributed to the labelling programme (see figure 5-8). The enormous impact of the labelling programme can be attributed to the following factors:

Figure 5-8. Impact of energy labelling and MEPS for European refrigerators, 1992-1999



Note: The shift towards more efficient models (A, B and C) and that the percentage increase of "A" models from 1.5 per cent in 1992 to 16 per cent in 1999 is shown in this figure.

- The label design allows information about the relative energy-efficiency performance of different appliances to be conveyed effectively to consumers, retailers and manufacturers; in particular, the use of a categorical efficiency scale sets clear efficiency targets for manufacturers and facilitates the comparison of efficiency for consumers.

- While the term "efficiency" used in the label rewards efficient appliances, it recognizes the nature of the appliance's primary function. The inclusion of information unrelated to the appliance's energy performance reveals whether lower energy consumption has been achieved by degrading the functioning of the appliance. This creates an incentive for the manufacturer to remain engaged with the scheme.

- The label has been supported by a variety of related additional measures at the local level, such as advertising and information campaigns, retailer training and rebates.

These features are not incidental. The original label design was produced after research was conducted into what type of label design would be most effective at communicating energy performance and efficiency concepts to consumers. The research showed that comparative categorical labelling was more likely to achieve this than other designs and outlined some basic tenets of the current design. Furthermore, for each new energy label, MEPS regulations and/or voluntary agreements are determined after a thorough study to investigate the energy savings potential of a particular end-use and the policy measures best able to bring this about. In Europe, these studies are paid for by the European Commission and are usually conducted by a working group that includes independent experts, national energy agencies, academic institutions and industry representatives.

Despite the analytical strength of the European standard-setting and labelling process, the programme as a whole contains a number of weaknesses. These are as follows:

- There is no legislative framework enabling MEPS to establish its own standards. Each new MEPS regulation has to be negotiated and passed at a primary regulatory level. This is time-consuming and the results are de-italicize *ad hoc*, which makes it difficult to know the outcome of each proposal at the time it is made.
- As a result, the Commission tends to prefer to negotiate voluntary agreements with industry; however, these agreement often prescribe significantly weaker efficiency levels than the independent studies recommend owing to the difficulty of negotiating a challenging efficiency requirement. Furthermore, voluntary agreements can take a long time to negotiate, and they may have weaker compliance than MEPS due to the lack of formal penalties for non-compliance. A final weakness is that the agreements usually only involve the members of the primary industry association and hence seldom cover the entire market.
- The regulatory structure for establishing labels lacks a clear time frame, which means negotiations and discussion often require an excessively long period.

- Industry is fully represented in the regulatory process for setting MEPS, voluntary agreements and labels, but advocates for more stringent efficiency requirements, such as energy efficiency and environmental advocacy organizations, are not; the result of this imbalance is that the independent study recommendations are regarded as the most ambitious potential policy outcomes, the final outcome always to be negotiated downwards, rather than a well-balanced policy outcome in their own right, as their authors intend.
- The net result of all these limitations is that new regulations take too long to develop and their goals are often significantly less ambitious than what would serve the best interests of consumers, the environment and society as a whole.

However, developing countries could overcome such limitations by forming an apex body that would coordinate and monitor activities related to MEPS.

5.3.3. United States: development of standards and labelling

Background

The United States covers 7.2 per cent of the surface of the Earth and is home to 4.7 per cent of the world's population. It accounts for 27 per cent of the world's electrical energy use. The per capita CO_2 emission of the United States is 3.77 tons per year per capita, or 5.2 times the world average.[67]

More energy management practices have originated in the United States than probably any other country in the world. In 25 years of a consolidated effort, the United States reduced the average electricity consumption of refrigerators by nearly three quarters (from 1,825 kWh in 1974 to 475 kWh in 2001). Today, there are mandated minimum efficiency levels for products that represent 96 per cent of the energy used in residences in the United States.

[67] World Bank, *World Development Indicators* database, accessed November 2003 from < http://devdata.worldbank.org/data-query/ > .

Development of standards and labelling and their application

In the late 1970s, there was much interest in the United States of America and Canada in information campaigns and an attempt to influence consumer behaviour through the use of public relations, marketing materials and voluntary energy labelling programmes. In the United States, for instance, the National Energy Conservation Policy Act of 1978 required the Federal Trade Commission (FTC) to mandate energy consumption labels for appliances. In November 1979, the FTC promulgated a regulation requiring the manufacturers of seven major home appliances to place energy labels on their appliances.[68] It was subsequently expanded to include central air conditioners and heat pumps (FTC, 1979). The Energy Guide labels began appearing on appliances sold in stores throughout the country in the mid-1980s.

When it became apparent that campaigns relying solely on information and labelling could achieve only limited success in terms of actual energy savings, individual states in the United States began developing mandatory minimum energy performance standards (MEPS). Environmentalists and energy efficiency advocates lobbied for national efficiency standards for appliances in the early 1980s and failed. After these groups succeeded in convincing a number of states to pass their own minimum efficiency standards, appliance manufacturers became alarmed by the growing patchwork of different state efficiency standards. They then joined with the United States Department of Energy and the advocacy organizations (led by the Natural Resources Defense Council) to negotiate a set of national, minimum efficiency standards for a range of residential products. The "consensus standards agreement" also established a timeline for regular review and update of the standards through the year 2007. These standards were enshrined in law in the National Appliance Energy Conservation Act (NAECA) of 1987, which covered 13 classes of residential products. Lamp ballasts were added to this list in a 1988 amendment to NAECA. An additional 12 categories of products, mostly commercial and industrial, were included in the Energy Policy Act (EP Act) passed in 1992. The two acts now mandate minimum efficiency levels for products that represent 96 per cent of energy use in the residential sector, 70 per cent in

[68] The 1979 rule covered refrigerators and refrigerator-freezers; freezers; dishwashers; water heaters; clothes washers; room air-conditioners; and furnaces.

the commercial sector and 20 per cent in the industrial sector.[69] Such achievements could be made possible through policy guidelines, such as those mentioned in section 2.1.3.

The lifetime benefit of MEPS for nine United States products from 1987 to 2001 can be summarized as follows:[70]

- Federal spending = $2 per household;
- Efficiency investments stimulated = $400 per household;
- Energy bill savings = $1,100 per household;
- *Net savings to the United States economy = $700 per household;*
- Average benefit/cost ratio = 2.8:1;
- *Primary energy* savings = 7-8 per cent of 2020 residential energy use;
- *Peak power* savings = 10 per cent of 1990-2020 growth;
- Cumulative net dollar savings = $130 billion;
- Annual *carbon reductions* = 33 million metric tons of carbon (in 2015).

The vast improvements in energy efficiency achieved for refrigerators in the United States since the first oil crisis in 1973 are summarized and shown in figure 5-9. While some of the improvements are due to market-based factors, such as manufacturer innovations, some are due to voluntary consumer selection of more energy-efficient models, the majority of improvement is due to the enactment of a series of state and later national MEPS. The overall result is that a typical refrigerator sold today in the United States uses roughly one-quarter of the energy (475 kWh) used by a typical model sold in 1974 (1,825 kWh/year).

Such achievements could be made possible through policy guidelines as discussed earlier (see sections 2.1.2, 2.1.3, 2.1.4 and 1.2.5).

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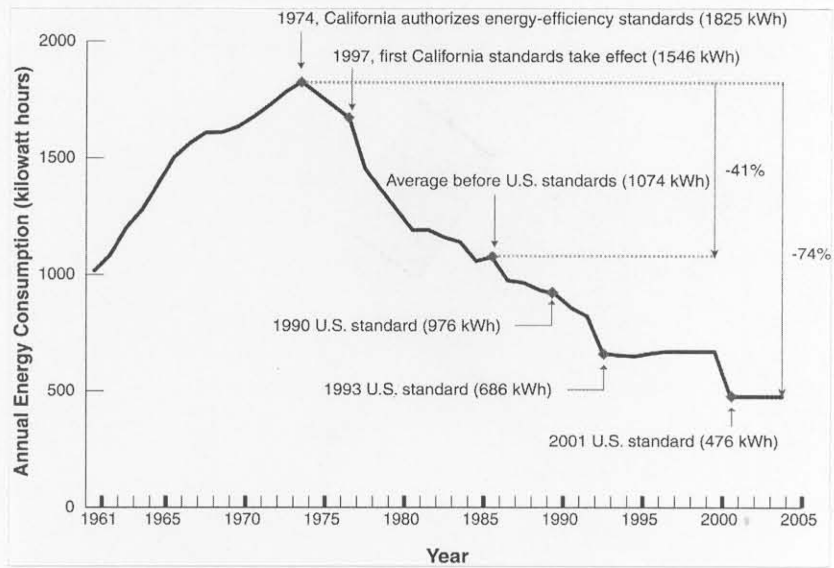
[69] Duffy, J., "Appliance Efficiency Standards: Review and Recommendations. Background Memo", (College Park, Maryland, University of Maryland, 1995).

[70] Wiel, S., "Energy Efficiency Experiences: Standards, Labels and Other Energy Efficiency Policies", presentation at the APEC Symposium on Energy Efficiency, 2002.

Figure 5-9. Reduction in the energy consumption of refrigerators sold in the United States of America



Source: Wiel, S., 2001. "Introduction", *Energy Efficiency Labels and Standards: A Guidebook for Appliances, Equipment, and Lighting,* S. Wiel and J.E. McMahon, eds. (Washington, D.C., Collaborative Labeling and Appliance Standards Program (CLASP)).

5.3.4. China: development of energy conservation certification and labelling schemes

Background

One of the most striking features of the booming Chinese economy has been the explosion of consumer demand for home appliances and lighting products as shown in table 5-1. There has been a stupendous rise in the sale of air-conditioners (from 250,000 in 1990 to 8 million in 1997), and there is at least one colour TV in virtually all households in urban China; these are two of the reasons why today China is one of the largest producers of many home electrical appliances. This also has resulted in almost 16 GW of new capacity annually since 1990. Yet, the average Chinese household consumes only about 5 per cent as much electricity a typical household in the United States. These two extremes mean that there is tremendous potential for growth in the electrical appliances sector in China.

Table 5-1. Estimates of energy consumption for major appliances in China, 1997

	Saturation percentage		Stock (millions)	Average unit consumption (kWh/yr)	Energy use (TWh/yr)
	(urban)	(rural)			
Refrigerators	73	9	95	408	38.6
Freezers	5	..	5	387	1.8
Air-conditioners	16	..	17	450	7.5
Clothes washers	89	22	143	55	7.9
Microwave ovens	5	..	5	52	0.3
Colour TVs	100	27	166	124	20.6
Electric fans	166	45	276	20	5.5

Source: Turiel and others (1998). *China Statistical Yearbook 1998* (Berkeley, Lawrence Berkeley National Laboratory).

The schemes

The dramatic increase in ownership and use of home appliances has led to large increases in residential electricity consumption in China – around 16 per cent per year on average since 1985. The potential for further growth in household electricity use is enormous.

While increasing its electricity-generating capacity, China is pursuing a number of initiatives aimed at increasing the efficiency of electric appliances and equipment. These include a programme to improve the quality and efficiency of compact fluorescent lamps, a programme to improve the efficiency of domestic refrigerators, and development of minimum efficiency standards for a range of products. Some of the ongoing efforts to develop energy-labelling schemes for the market in China are summarized below.

Energy labelling in China

The basis for energy labelling in China is the "Law on energy conservation in China", which took effect in 1998. The law sets the basis for measures to develop energy efficiency standards and energy labelling for appliances and equipment. The Government also developed plans to take energy efficiency into account in its own equipment purchasing.[71]

Originally, China was developing updated refrigerator standards in 1997 and concurrently developing a mandatory label that would provide a categorical ranking of refrigerator energy use, modelled directly on the categorical energy label in use in the European Union. The Government eventually decided not to use the refrigerator label but rather to develop a consistent national policy on mandatory labelling. The former State Economic and Trade Commission (SETC) received the mandate to perform this work.

At the same time, the Government decided to issue a voluntary endorsement label, similar to the United States Energy Star labelling programme. The design was created early in 1999, and the SETC established the China Standard Certification Centre (CECP). The endorsement label was formally launched in September 1999 with the awarding of 103 labels to refrigerator manufacturers.

The CECP was founded in 1998 under the initiation of the SETC. It was authorized by the China State Bureau of Quality and Technical Supervision but was established as an independent, non-profit organization. CECP now has 20 staff members and a number of consultants assisting it in carrying out its certification programme.

The goal of the certification programme is to develop requirements in order to certify products as safe, high-quality and energy-saving. CECP develops certification criteria based on relevant international and national standards and technical requirements. Products that meet the criteria are designated as energy-conserving products and receive an "energy conservation product certificate". They are also legally permitted to bear the energy conservation products symbol, shown in figure 5-10.

The basic requirements for certification are as follows:

- The manufacturer must have a quality management system that meets CECP requirements;

[71] Tienan, L., "China energy conservation product certification", presentation at the Regional Symposium on Energy Efficiency Standards and Labelling, organized by the Collaborative Labeling and Appliance Standards Program (CLASP) and the Economic and Social Commission for Asia and the Pacific (ESCAP), Bangkok, 29-31 May 2001.

- Product performance must satisfy national regulation requirements for product performance and safety (in accredited test laboratories);
- The energy efficiency of the product must meet the technical specifications set by CECP for that product (in accredited test laboratories).

Figure 5-10. CECP certification logo for energy conservation products

Currently, CECP has active certification programmes for refrigerators, fluorescent ballasts, air-conditioners and wave traps. It is planning to expand the certification programme to cover a wide range of additional technologies, such as air compressors, electric water heaters, water pumps, washing machines, electric cookers, microwave ovens, fluorescent tube lamps, self-ballasted lamps, audio-visual products, information technology products and construction materials. CECP also plans an initiative to certify products with low stand-by losses, which represent a large waste of electricity in many household appliances.

Unified energy-labelling programme

China is currently developing plans for a unified energy-rating label that will be applied to a range of appliances and equipment used throughout the economy. The programme is led by the SETC and is receiving international financial and consulting assistance. While the programme is still under development, the basic elements are outlined below.

Promulgation of an energy-labelling framework:

- Development of an energy-labelling implementation plan;
- Development of the associated product energy performance testing infrastructure;
- Development of energy-labelling legislation.

Design of a unified energy label:

- Selection of targeted appliance types;
- Development of energy consumption and performance metrics;

- Establishment of energy performance test procedures;
- Determination of the desired informational content needed in the label;
- Determination of the presentational format and design of the energy label.

The goal of the programme is to lay the legislative foundation for an energy labelling programme that will apply consistently to all energy-using products sold in the country. It is intended to support and complement the CECP certification programme mentioned above, which rewards the most energy-efficient products in any one category. Consumer and market research is seen as an important element in the design of a unified label format that is well understood by consumers while also acceptable to stakeholders such as government officials and manufacturers.

Impact of MEPS and energy labels in China

MEPS has been a cornerstone of China's policy for improving energy efficiency. The first MEPS were enacted in 1980, and there are now more than 30 separate MEPS regulations for appliances and equipment in China, with two to three being added each year. The combination of MEPS, certification labels and comparative energy labels are being aggressively pursued by the Government. It is projected that the savings derived from the MEPS and energy-labelling programmes will amount to 46 per cent of projected residential electricity use by 2020. These programmes will help China to cut the projected growth in residential electricity demand over the next 20 years by roughly 70 per cent compared with a business-as-usual scenario.

5.3.5. Islamic Republic of Iran: Energy labelling initiative in an energy-surplus nation

Background

The Islamic Republic of Iran is a major fossil-fuel producer and a large energy consumer. The country's energy consumption pattern is very similar to that of industrialized countries, i.e., very low non-commercial energy demand and a high rate of energy use attributed to electrical appliances. The inefficiency of energy use in the Islamic Republic of Iran is largely attributed to the low price of energy. The Government has decided to increase the price of energy by 20 per cent annually so that the price will match the cost of energy products and services. It may be noted that export of crude oil and oil products represents 80 per cent of export income and 25 per cent of GDP. The experience of the Islamic Republic of Iran, particularly in the area of energy labelling and energy auditing, would be of interest to many, particularly the oil producing countries in the region. The Iranian energy consumption pattern and some characteristics have been explained in section 3.3.6.

Activities related to the energy efficiency of electrical appliances are summarized below:

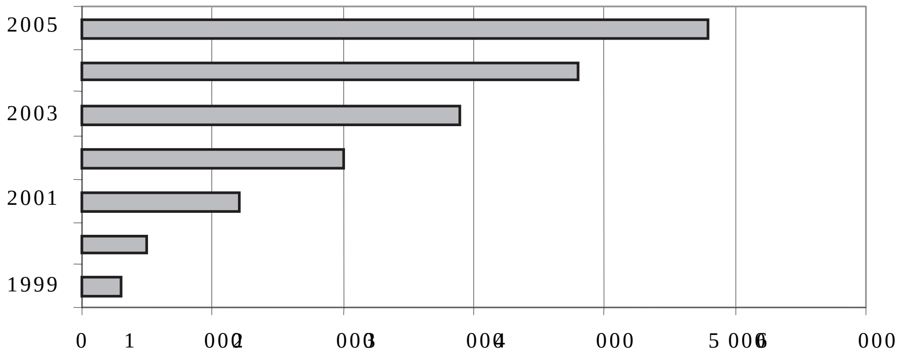
Energy pricing. According to the third five-year plan (1993-1997), prices of energy products, such as oil, gas and electricity, were increased by 20 per cent per year. With an inflation rate of more than 20 per cent per year, however, real prices have decreased. The Government should set realistic tariffs and mechanisms to calculate long run marginal cost (LRMC) for assessing prices.

Legislation and regulation. In the second five-year plan, the Government suggested an independent section for the energy sector. Paragraph V was approved for energy efficiency: 0.2 per cent of total fuel income was allocated for energy efficiency programmes, such as auditing, load management, standardization of energy consumption of home appliances and establishment of energy management programmes in factories.

Household appliances standardization and labelling. Since 1994, a technical committee has approved standards and labelling for refrigerators, with the cooperation of Iran Standards Research Institute (ISRI), and some studies are being carried out on air conditioning systems, coolers, water heating equipment, iron, electrical fireplaces, chillers, pumps, compressors and water cooling equipment. The estimated energy saving potential is shown in figure 5-11.

It is interesting to note that labelling activities for freezers and refrigerators have been very successful in the Islamic Republic of Iran. The amount of electricity saved in the past two years almost equals 450 million kWh. The promotion of various products, particularly refrigerators and freezers, to a higher grade (better efficiency) as a result of labelling activities is noteworthy.

Figure 5-11. Energy savings potential through appliance labelling in the Islamic Republic of Iran



Energy efficiency testing and auditing. Energy audits have been conducted in 70 factories and two national energy efficiency laboratories have been established: one is stationary and devoted to research and development on energy efficiency technologies; the other is installed in a bus and serves as a mobile lab for performing short audits. This has enabled the testing of electrical appliances in remote places. The programme has already resulted in an energy savings equivalent to about 85,000 tons of crude oil per year.

Education. There are continuous short-term training programmes in energy efficiency, as part of the capacity-building process, with trainers from abroad (in cooperation with ESCAP) and Iranian instructors. More than 1,500 experts have been trained, and four training courses in energy auditing have thus far been offered by ESCAP.

Policy initiatives

The following policy options may be considered effective and necessary for the purpose of improving the energy efficiency of household appliances in the Islamic Republic of Iran:

(a) Labelling of the most energy-consuming appliances should continue;

(b) Continual checking of all labelled products should be carried out and a greater number of samples should be selected for performance testing;

(c) The manufacturers of the most energy-efficient products should be granted access to low-interest loans;

(d) Some high-efficiency electric motors and other devices that can contribute significantly towards reduced energy consumption should be exempted from import taxes;

(e) Once all home appliances reach an acceptable level of energy consumption, electricity prices should be increased.

5.3.6. Republic of Korea: an effective MEPS and labelling programme

Background

Over the past 20 years, energy consumption in the Republic of Korea has increased more than four-fold from 43.9 million toe in 1980 to 192.9 million toe in 2000. This makes the Republic of Korea the tenth largest energy-consuming country in the world. Policy makers especially focused on ways to conserve energy use and increase energy efficiency because 97 per cent of the country's energy is imported.

Much of the focus of the country's policy was placed on ways to reduce energy use, including in automobiles. (It is the first country in Asia to set minimum efficiency standards for passenger automobiles.) Electricity use in households and commercial buildings accounts for more than one third (37 per cent) of total electricity consumption as shown in table 5-2. The rate of increase is about 8 per cent annually.

Table 5-3 shows a dramatic increase in the numbers of various common household appliances between 1981 and 1991. This increase is a main driver of energy demand in the residential sector.

Table 5-2. Trends in electricity consumption in the Republic of Korea (mtoe)

Consumption by sector	1996	1997	1998	1999
Industry	9.179	10.009	9.359	10.394
Household and commercial	5.464	6.090	6.122	6.793
Transportation	0.145	0.151	0.136	0.149
Public, etc.	0.904	1.017	1.022	1.086
Total	15.692	17.267	16.639	18.422

Source: Republic of Korea, Ministry of Commerce, Industry and Energy.

Table 5-3. Increase in the number of household appliances in the Republic of Korea

Appliance type	Saturation (percentage of households)		Per cent increase
	1981	1991	
Refrigerators	43	110	156
Air-conditioners	1	9	900
Televisions	15	127	747
Video players	0.6	51.6	8 500
Clothes washers	15.2	86	466
Microwave oven	< 1	32	> > 3 000

Source: Sun-Keun Lee (2001). "MEPS Experience in Korea". Paper presented at the Regional Symposium on Energy Efficiency Standards and Labelling, organized by the Collaborative Labeling and Appliance Standards Program (CLASP) and the Economic and Social Commission for Asia and the Pacific (ESCAP), Bangkok, 29-31 May 2001.

Note: More than 100 per cent saturation indicates that the number of appliances is more than the number of households.

History of labelling and standards in the Republic of Korea

In 1992, the Government approved a regulation on energy efficiency standard-setting and rating labelling. This initially applied to six items:

- Refrigerators and refrigerator-freezers;
- Room air-conditioners;
- Incandescent lamps;
- T-10 fluorescent tube lamps;
- Fluorescent lamp ballasts;
- Passenger cars.

In 1999, regulations were added to cover three additional products: screw-based compact fluorescent lamps (CFLs), clothes washers and household gas boilers.

The legislation calls for the following steps:

- In the first year, mandatory energy labelling goes into effect and minimum energy performance standards (MEPS) are announced;

- In the second year, MEPS come into effect (mandatory);
- In the third year, target energy performance standards (TEPS) come into effect (voluntary).

The legislation established a five-rank system for labelling the energy use of appliances. The most energy-efficient models receive a *Grade 1* rating, and the least efficient receive a *Grade 5* (see figure 5-12). [It may be noted that this is the *opposite* of the classification system used in Thailand.] Generally, *Grade 1* products can effect an energy savings of 30 to 40 per cent compared with *Grade 5* products.

Figure 5-12. Energy label for a fluorescent ballast in the Republic of Korea

The goal of MEPS is to *push* the market by prohibiting the sale of the manufacture and sale of the lowest grade (least energy-efficient) products. The MEPS target is usually based on *Grade 5*, the lowest rating. The grade classifications are adjusted upwards (made more efficient) every three years.

One innovation in the MEPS policy is that it applies to the shipment-weighted average efficiency of each manufacturer. In this, the Republic of Korea differs from other countries, which set a minimum efficiency level for any individual product. The philosophy behind the MEPS is that it can be attained with existing technology or technological innovation, at little or no extra cost. The goal of MEPS is to *push* the market by promoting a *voluntary* higher-efficiency target that can be achieved by manufacturers within a given time period and reduce current energy consumption by 10 to 30 per cent.

Table 5-4. Improvement in average appliance efficiency levels in the Republic of Korea

Appliance type	Measurement units	1993 energy use (market average)	2000 energy use (market average)	Per cent improvement in efficiency
Refrigerator-freezers	kWh/month/litre	0.113	0.065	74
Air-conditioners	Coefficient of performance	2.4	3.7	54
Incandescent lamps	Lumens/W	10.0	11.0	10
Fluorescent lamps	Lumens/W	65.0	90.0	39

Source: Sun-Keun Lee, (2001). "MEPS experience in Korea", paper presented at the Regional Symposium on Energy Efficiency Standards and Labelling, organized by the Collaborative Labeling and Appliance Standards Program (CLASP) and the Economic and Social Commission for Asia and the Pacific (ESCAP), Bangkok, 29-31 May.

Impact of the labelling and standards programme in the Republic of Korea

By any measure, the energy labelling and standards implemented by the Republic of Korea has been successful. There is a very high awareness of the energy label – 85 per cent of general consumers and 96 per cent of appliance shoppers are aware of the label.

The programme has led to a substantial market transformation: the proportion of energy-efficient appliances on the market (grade 1 or grade 2) has increased from 55.4 per cent in 1993 to 66 per cent in 2000 (even with adjustments in the label ranking scheme). The improvement in average efficiency levels for some of the appliances regulated is shown in table 5-4. These corroborates the policy options described in sections 2.1.3 and 2.1.5.

Role of NGOs

Civil society groups, such as the Citizens' Alliance for Consumer Protection of Korea (CACPK), have been playing an exemplary role in the Republic of Korea in raising the level of awareness of the energy efficiency of appliances among manufacturers, users and shoppers through multi-pronged activity programmes, including the following:

- The Energy Winner Award;
- Research and testing;
- Educational campaigns;
- Publications;
- Lobbying.

The Energy Winner Award, established in 1997, has come to involve a large number of people in the Republic of Korea. This is due in no small part to the purposefulness, organization and transparency of the implementation process.

Purpose of the Energy Winner Award:

- To show the path towards sustainable energy;
- To encourage increase in the distribution of energy-conserving products and systems in the market;
- To foster a change to sustainable energy consumption patterns.

Implementation:

- The Award is granted for energy-conserving products;
- Private and public sector entities are eligible;
- The event is co-organized by Hankuk Ilbo (a prominent daily newspaper in the Republic of Korea) and CACPK;
- The event is sponsored by the Ministry of Commerce, Industry and Energy, the Ministry of Environment, the Korea Energy Management Corporation and ESCAP.

A group of 25 highly experienced experts comprised top 25 professionals and representatives of relevant departments/committees at the governmental level selects the winners on the basis of the following criteria:

- Innovation;
- Appropriateness;
- Energy efficiency;
- Economics;
- Energy conservation potential.

Apart from the award, CACPK conducts energy-efficiency tests for refrigerators, rice cookers, vacuum cleaners, washing machines and electric irons. This helps the stakeholders to justify the use of a product and aids the process of energy labelling.

Seminars and educational campaigns regularly conducted by CACPK serve as platforms for quick dissemination of knowledge and best practices. All these activities are backed by research on sustainable sources of energy. More information can be obtained from www.cacpk.org.

5.3.7. Thailand: an effective voluntary labelling programme leads the way to standards

Background

In November 1991, Thailand became the first Asian country to approve a nationwide, comprehensive demand-side management (DSM) programme. The Thai DSM Master Plan called for a total five-year investment of $189 million to achieve a peak demand reduction of 238 MW and energy savings of 1,427 GWh/yr at less than half the utilities' long-run marginal cost of production.

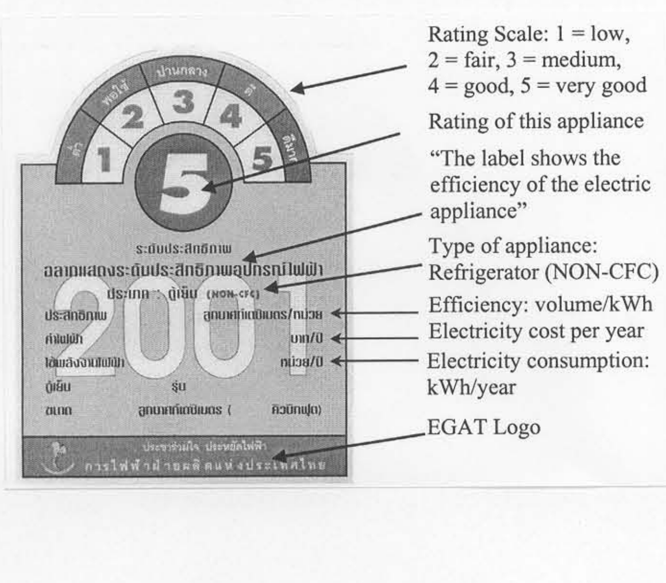
The original DSM Master Plan called for a broad range of programmes that were based on DSM experience in North America, and relied on a combination of incentives and programme marketing to spur a shift towards more energy-efficient products and services (note: the Thai DSM Master Plan relied on a combination of customer rebates and incentives for manufacturers. The majority of the DSM programmes implemented in North America during the 1980s provided rebates to the consumer or end user and not to the manufacturer). As actually implemented, the Thai approach to DSM has since 1993 been to seek voluntary agreements with manufacturers and to supplement these agreements with nationwide advertising campaigns and interest-free loans for customers where necessary. The initial focus of the programme was a voluntary agreement with the manufacturers of fluorescent lamps. This was followed by the introduction of a voluntary energy-labelling programme for refrigerators and room air conditioners. The results of these two labelling programmes are summarized below.

Refrigerators

In early 1994, the Electricity Generating Authority of Thailand (EGAT) approached the five manufacturers of household refrigerators and quickly gained their cooperation for a voluntary energy-labelling programme for the largest category of Thai refrigerators, which range from 4 to 6 cubic feet. The efficiency scale on the energy labels ranges from 1 to 5, with 3 as the average and 5 as the most efficient. A selection of the models in this size range was tested during the fall of 1994 to establish the average efficiency level. Models that fell within 10 per cent of the mean are rated at 3; models that are 10-25 per cent more efficient than the mean are rated at 4; and models that are over 25 per cent more efficient than the mean are rated at 5. One such label is shown in figure 5-13.

The energy-labelling programme began as a voluntary programme. There is no "penalty" for having an inefficient unit, since the manufacturer is not required to apply a label. Rather, the manufacturers of energy-efficient units rated at 4 or 5 have an incentive to place the label on the product and market it as an energy-efficient model.

Figure 5-13. Updated Thai refrigerator label introduced in 2001



Air-conditioners

A similar labelling programme for air-conditioners began in early 1996. The negotiations with manufacturers were more difficult because of the diverse and fragmented nature of the Thai air-conditioner industry. Air-conditioners produced by multinational corporations received the highest ratings. These firms launched large promotional campaigns touting the energy-saving benefits of their air-conditioners.

Programme extension

The voluntary programme for refrigerators was gradually extended. In early 1998, the DSM Office worked with the Thai Consumer Protection Agency to make the energy labels mandatory for single-door refrigerators. The DSM Office also reached agreement with the manufacturers to raise the efficiency categories on the label for single-door refrigerators by 20 per cent, effective in January 2001 (see figure 5-13).

The success of the energy labelling programme led the Government to fund the development of minimum energy performance standards (MEPS) for six types of products: refrigerators, air conditioners, compact fluorescent lamps (CFLs), fluorescent tube lamps, ballasts and electric motors.[72] This study was completed by ERM-Siam in 2000, and the Government is expected to adopt the proposed standards beginning in 2004.

Programme impacts and lessons learned in Thailand

Thailand also has a staff of more than 200 professionals implementing Asia's first comprehensive set of DSM programmes. The impact of the appliance labelling programmes has been significant: more than 150 peak MW has been achieved, and more than 200 additional MW of peak demand reductions are expected by 2005.[73]

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[72] Resanond, A., "Minimum Energy Performance Standards (MEPS), Thailand", presentation at the Regional Symposium on Energy Efficiency Standards and Labelling, organized by the Collaborative Labeling and Appliance Standards Program (CLASP) and the Economic and Social Commission for Asia and the Pacific (ESCAP), Bangkok, 29-31 May 2001.

[73] Phumaraphand, N., "Evaluation Methods and Results of EGAT's Labelling Programmes", presentation at the Regional Symposium on Energy Efficiency Standards and Labelling, organized by the Collaborative Labeling and Appliance Standards Program (CLASP) and the Economic and Social Commission for Asia and the Pacific (ESCAP), Bangkok, 29-31 May 2001.

The savings effected through the DSM programme as of mid-2000 is shown in table 5-5. Both of the energy labelling programmes (refrigerators and air-conditioners) far exceeded their targets. In fact, the peak reductions achieved by both programmes were more than three times higher than expected. The benefit-cost impact for the refrigerator and air conditioner programmes were rated at 1.6 and 1.1 using the total resource cost test.[74]

The refrigerator programme has successfully transformed the single-door refrigerator market, increasing the market share of the most efficient units (level 5) from 12 per cent in 1995 to 96 per cent in 1998. The air-conditioner programme had a slower market transformation effect. The market share of energy-efficient air-conditioners (level 5) increased from 19 per cent in 1996 to 38 per cent in 1998. Given this rapid increase in the

Table 5-5. DSM programme savings through June 2000 in Thailand

Programme	Launch date	Savings targets		Evaluated results		Per cent of taget achieved	
		Peak (MW)	Energy (GWh/yr)	Peak (MW)	Energy (GWh/yr)	Peak	Energy
Lighting	9/93	139	759	399	1 973	287	260
Refrigerators	9/94	27	186	84	849	310	456
Air-conditioners	9/95	22	117	84	318	381	272
Motors	12/96	30	225	..	..	..	..
Commercial buildings	10/95	20	140	..	..	..	..
Total		238	1 427	566	3 140	238	220

Source: Singh, J. and C. Mulholland (2000). "DSM in Thailand: A Case Study", Joint UNDP/World Bank Energy Sector Management Assistance Programme (Washington, D.C., World Bank).

[74] Phumaraphand, N., "Evaluation Methods and Results of EGAT's Labelling Programmes", presentation at the conference on *Lessons Learned in Asia: Regional Conference on Energy Efficiency Standards and Labelling*, organized by the Collaborative Labeling and Appliance Standards Program (CLASP) and the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), Bangkok, 29-31 May 2001.

market share of energy-efficient units, a market share of 50 per cent should be quite attainable.[75]

The lesser presence of labels for air-conditioners reflects the fact that the air-conditioner industry has a much wider range of efficiency levels and a much larger number of manufacturers and distributors. As a result, it was harder for the DSM Office to attain the same level of compliance in this market.

The different results in the refrigerator and air-conditioner programmes have shown that voluntary labelling programmes are not as effective as mandatory programmes, since they do not provide incentives for manufacturers to place labels on the lower efficiency models.[76]

In Thailand, as noted above, the energy label has also paved the way for the introduction of MEPS, which will take effect beginning in 2004. Hence the energy label option is not sufficient; the MEPS option becomes essential for developing countries.

Clearly, however, Thailand is setting an example for other developing countries that are considering energy labelling and efficiency standards as a cost-effective means of obviating or forestalling the need to invest in more power plants.

5.3.8. APEC's energy standards information system: A new tool for tracking end-use standards and labels

One of the real difficulties in the area of appliance and equipment efficiency programmes is keeping track of the many ongoing programmes, the types of policy approaches, and the relative success and lessons learned from the programmes. Since many countries are implementing or planning very similar types of programmes, it makes sense to use the Internet as a tool for sharing information on programmes under design, in implementation and under revision. In this way, policymakers can more easily access

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[75] Sulyma, I.M. and others, "Taking the Pulse of Thailand's DSM Market Transformation Programmes", Conference proceedings of the *ACEEE Summer Study on Energy Efficiency in Buildings*. *Volume 8: Consumer Behavior and Non-Energy Effects* (American Council of an Energy-Efficient Economy, Washington, D.C., 2000), pp. 8,379-8,394.

[76] Singh, J. and C. Mulholland, "DSM in Thailand: A Case Study", Joint UNDP/World Bank Energy Sector Management Assistance Programme (Washington, D.C., World Bank, 2000).

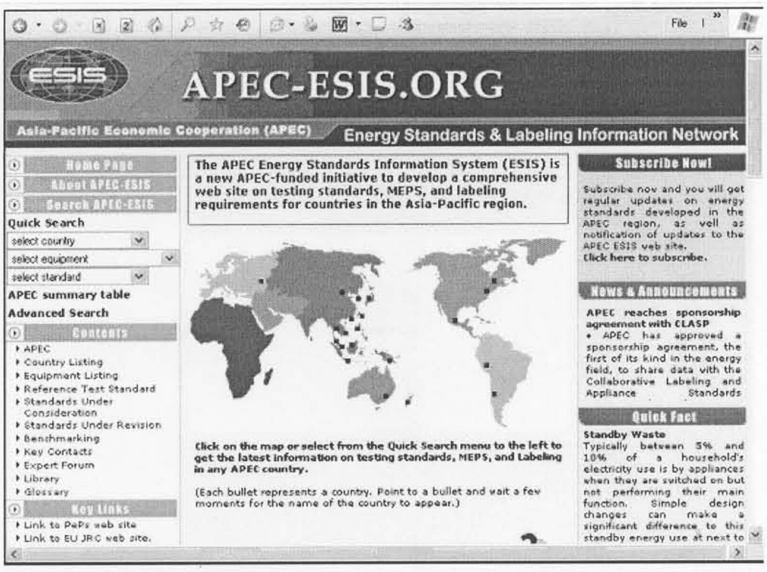
relevant information and use this information to develop effective programmes in their country or region.

The Asia-Pacific Economic Cooperation (APEC) forum has had an active programme of cooperation on energy standards for nearly 10 years. In 2001 APEC gave its highest priority for energy-related funding to the establishment of an important new database on energy performance testing standards, energy labels and MEPS for the 21 economies in the APEC region. The purpose of APEC's Energy Standards Information System, called APEC-ESIS, is to establish a system for systematically and simply tracking and updating information on energy-efficiency performance standards that are either in use or under development. APEC-ESIS was established by an international project team from New Zealand and Thailand, in collaboration with the Collaborative Labeling and Appliance Standards Program (CLASP).

APEC-ESIS (see figure 5-14) is an interactive database that has been designed from scratch for easy periodic updating and expansion. It is designed for wide use by officials, regulators, researchers, manufacturers and others in the APEC region and throughout the world. While the database was initially developed for the APEC economies, the aim is to expand it as soon as possible so that it can become a prominent and widely used web site populated by energy performance standards from all the key regions of the world.

An important feature of APEC-ESIS will be the development of a standards notification procedure, which will proactively inform energy policy officials, manufacturers and other interested parties of new energy standards and regulations under development and revision in APEC economies. It will thus allow these stakeholders to readily and simply monitor international standards processes and to track developments that affect international trade in energy-using equipment and appliances.

Figure 5-14. Screen shot of the home page of APEC's Energy Standards Information System (www.apec-esis.org)



5.4. Observations

In developing countries, the use of appliances is increasing, as is the share of total final energy consumption in the residential and commercial sectors. Therefore, a good number of developing countries have initiated the introduction of standards and the labelling of electrical appliances in particular. However, the information on energy consumption of equipment being made available to users is not sufficient, which means that the proper way to present such information is perhaps more important, even in developing countries where a significant level of awareness of energy efficiency has already been reached. In spite of an increasing number of already very large varieties of electrical appliances, the difficulty of standardization and labelling them in different countries can be overcome by the sharing of experiences supported by a proactive policy. The foregoing narrative indicates the benefits derived not only by developed countries, but also by some developing countries in the region from the adoption of energy-efficiency policies. A balanced policy could therefore lead to the introduction of the necessary directives in the relevant sectors, such as construction and buildings sector, where electrical appliances are used extensively.

Chapter 6

CONCLUSIONS AND RECOMMENDATIONS

The various policy options discussed in chapters 2 to 5 were presented during the Ad Hoc Expert Group Meeting on End-use energy efficiency towards promotion of a sustainable energy future, which was held in Bangkok from 18 to 20 November 2002. The conclusions and recommendations that follow were made by the experts who presented their papers and/or participated in their own capacity during the meeting. Two sets of recommendations were made, the first for national implementation by countries in the region, and the second on proposed areas of activities by international organizations.

6.1. Conclusions and recommendations concerning national implementation by countries of the region

6.1.1. General

The Expert Group Meeting concluded that specific national policies to promote end-use energy efficiency were needed in respect of each of the major sectors of the economy. New policies should be adopted in the light of the following general considerations:

- Improvement in end-use energy efficiency, apart from many other benefits, would enhance the capacity of developing countries in particular to generate more GDP through better utilization of energy resources and thus reduce energy intensity to the level of developed countries. The developing countries and areas in the region should gain comparative advantages while avoiding the mistakes of the industrialized world;

- Capacity-building in energy management is viewed as a very important factor in promoting energy efficiency in all sectors of the economy;

- Energy pricing should be rationalized;

- Programmes to promote public awareness are crucial for informing decision makers and consumers on available technologies and product options. Such programmes are needed to ensure that relevant information reaches consumers before purchasing decisions are made;
- While many policies can be adopted as either optional or mandatory requirements, research has shown that mandatory requirements are likely to be more effective in reducing energy consumption;
- In many cases the most effective policies are those that offer incentives or threaten penalties ("carrot and stick" approach). Regulation can ensure a minimum level of energy efficiency, and further efficiencies can be achieved through the use of fiscal incentives.

6.1.2. Industry

In the light of the rapid growth of energy consumption in the industrial sector in many developing countries of the region, policies promoting energy efficiency and conservation should be adopted as a matter of urgency. Such policies should utilize both supply and demand side management techniques. The Expert Group Meeting favours the following policies:

- Energy managers should be established in all energy-intensive enterprises. A system of national accreditation must be established for such managers, together with rules for their appointment. Training courses must be offered;
- High energy-consuming materials and equipment should be identified in each of the major industries and should be targeted for retrofitting or replacement;
- Cogeneration and other technologies should be promoted wherever possible;
- A system of energy auditing should be established in order to identify current patterns of energy usage and to point out areas of potential energy savings;

- Minimum energy efficiency standards and energy labelling systems should be established wherever possible for high-energy consumption equipment and materials;
- Import duty and sales tax exemptions should be granted for energy-efficienct equipment and materials;
- Income and company tax incentives should be granted for expenditure related to energy-efficient equipment and materials;
- A system of credible energy service companies (ESCOs) should be established;
- Energy use benchmarking should be used in all energy-intensive enterprises, on the basis of best practices.

6.1.3. Road transport

This sector is recognized as the most difficult to resolve because petrol still constitutes a large share of transport fuels worldwide, and very little progress towards fuel efficiency or fuel switching has occurred. With this background in mind, the Expert Group Meeting proposed the following recommendations:

- Planning and development laws should be modified so as to promote urban consolidation and to reduce the need for urban travel and thereby conserve energy. This can be achieved in a variety of ways, including the repeal of inappropriate regulations and processes that prevent urban consolidation, the creation of guidelines or development rules that provide clear zoning and priorities as to where and how much development should occur in each city area, the changing of tax laws to encourage high-density housing in areas identified for development by authorities, the encouragement of dual or multiple occupancy of buildings, and the redevelopment of land around key public transport nodes to include dense housing and some commercial activity in order to minimize travel and to make public transport activities more attractive;
- Laws regulating the motor vehicle industry should be modified to enhance energy efficiency as follows:

  - Fuel consumption labelling should be introduced in order to enable consumers to make an informed choice between various competing products. The exact form of the label must be prescribed;
  - Fuel-efficiency information should be included in all model-specific motor vehicle advertising;
  - Fuel economy standards should be adopted so that vehicle manufacturers are required to ensure that their fleets conform in any given year to government-prescribed fuel consumption limits;

- Governments should pursue fiscal incentives to improve motor vehicle fuel economy. Such measures might include the following:
  - The imposition of a skewed sales/goods and service tax in order to impose higher charges on vehicles with low levels of fuel efficiency;
  - Higher motor vehicle registration charges could be imposed on fuel-inefficient vehicles;
  - The standing government taxes on motor vehicles could be reduced and the petroleum excise tax could be raised;
  - Grants, low-interest loans or loan guarantees could be given to businesses for the lease or purchase of fuel-efficient vehicles.

- Governments should consider policy options to encourage fuel switching. In the short to medium term, ethanol represents the most viable alternative fuel source for motor vehicles. Bio-fuels could be promoted through the following measures:
  - Financial incentives for crop manufacturers;
  - Financial support for the redesign of vehicle motors to allow the use of a petrol-ethanol fuel blend;
  - The removal of legislative provisions in the field of health and safety and alcohol consumption that have the unintended

effect of hindering the production of ethanol in commercial quantities.

6.1.4. Buildings

The Expert Group Meeting concluded that there was considerable scope to improve energy efficiency throughout the building sector, including both commercial and residential buildings. Of the many possible reforms, the most significant were considered to be the following:

- The lack of adequate collaboration between stakeholders from the concept design phase is perceived as a significant barrier to improving energy efficiency and should be addressed. Enhancing the education of architects in energy efficiency is considered important;
- The application of an integrated approach to building design should be promoted, taking into account local climatic conditions;
- The introduction or enhancement of energy efficiency provisions in national and local building codes and regulations is essential. Such provisions should be formulated in each case to take account of the prevailing local climatic conditions;
- Home energy rating programmes should be established in order to encourage the design of energy-efficient homes, including solar passive designs with proper orientation, roof overhang, insulation and energy-efficient appliances;
- Income and/or company tax incentives should be offered to reduce the cost of installing insulation and other energy-saving devices in new buildings. Fiscal policies should be adopted to encourage the retrofitting of existing building with energy-efficient materials;
- Demonstration projects for energy-efficient low-cost housing should be initiated and funded by Governments or other entities.

6.1.5. Appliances and equipment

Collectively, energy appliances represent a significant and rapidly increasing source of energy consumption in countries of the region. Energy efficiency and conservation in this sector can best be promoted through the following measures:

- The gradual introduction of minimum energy performance standards for all major categories of appliances;
- A comprehensive system of energy-efficiency labelling. Such labels should be attached to and prominently displayed on all specified new appliances. Labels should be of an approved design that best enables consumers to draw comparisons between the energy consumption of similar types of appliances;
- While voluntary energy labelling schemes can be effective in some cases, international experience has shown that the gradual introduction of mandatory programmes is desirable in the long term;
- Energy performance testing laboratories for appliances should be established where appropriate. In many cases, however, laboratory accreditation and mutual recognition agreements can be used to reduce the need to re-test products sold in several countries. The results of energy performance tests of appliances and equipment should be made available to the public;
- International agencies or a government can provide a platform for the sharing of best practices and experiences of countries in the region;
- Energy consumption information should be included in all advertising for specified model-specific appliances;
- APEC's Energy Standards Information System (see www.apec-esis.org) is a useful web-based tool for accessing information on energy testing standards, minimum efficiency standards, and energy labelling programmes in the Asia-Pacific region. Countries in the region can use this tool to identify existing and proposed standards in the region.

6.2. Conclusions and recommendations concerning the proposed areas of activity of international organizations

The Expert Group Meeting concluded that the following represents the most appropriate areas of future activity by international organizations to improve energy efficiency:

- A 10-year programme should be developed to promote energy conservation and efficiency policies throughout the region. Such a programme would include the establishment of dedicated sustainable funding to support energy efficiency activities by non-governmental organizations;
- Regional information networks should be established on energy efficiency in each sector of the economy;
- The establishment of a unified training scheme for energy managers in countries of the region may be promoted;
- Continued capacity-building and information advisory services in countries of the region should be supported;
- In countries where the electricity sector is restructured, the promotion and protection of energy efficiency is essential.

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