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Energy Requirements and Energy Options for Industrial Development in Asia and the Pacific in the 1990s

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Main Abbreviations

ASEAN	Association of South East Asia Nations (Brunei, Indonesia, Malaysia, the Philippines, Singapore and Thailand)
bcm	billion cubic metres
GWh	gigawatt-hours
GDP	Gross Domestic Product
GJ	gigajoule
IEA	International Energy Agency based in Paris, France
kg	kilogram
kWh	kilowatt-hours
LNG	Liquified natural gas
mtoe	million tonnes of oil equivalent
mWh	megawatt-hours
NIEs	Newly Industrialized Economies (Hong Kong, Republic of Korea, Singapore and Taiwan Province of China)
OECD	Organization for Economic Co-operation and Development based in Paris, France
toe	tonnes of oil equivalent
TPER	Total Primary Energy Requirements = total energy demand
ttoe	thousand tonnes of oil equivalent
TFC	Total Final Consumption

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I Introduction

The ESCAP developing region is one of the fastest growing areas in the world in terms of industrial output and economic growth. In the past two decades, rapid changes in its industrial capacity, range of products and trade have transformed their economies. Being heavily export-oriented, many industrial sectors have had to stress their comparative advantages in their drive to be competitive in world markets and, gauging by the results, the region has been very successful to date. Yet, as the momentum for global trade increases and as comparative advantages change, there is greater need to ensure that as the industrial sector grows, it maintains or increases its competitiveness. There is also a need to ensure that industrial restructuring occurs in a way that will not put undue strain on the energy system. Adequate and diversified energy supplies and their efficient use gain importance as both industry and society as a whole become more energy dependent.

The Asia and Pacific region is one of contrasts more than similarities. Countries range from the most populous in the world to islands with very small populations. There are countries that are relatively wealthy per capita to some that are amongst the poorest in the world. Some are heavily industrialized while others are mainly agrarian or resource-based. The same is true in the energy area. Some are endowed with vast energy resources allowing them to evolve their economies around their energy base while others are highly dependent on imports.

Although economic and industrial growth rates have been impressive and the trends are for continued rapid expansion, the issue of energy becomes increasingly important. Without a stable and secure energy system, future economic and industrial growth will be affected. The region has considerable energy resources and several countries have based their economies on energy trade. Most economies, though, are highly dependent on energy imports and the forecasts are for growing dependence. This aspect increasingly has to be considered in developing future industrial strategies.

This chapter focusses on the major energy trends and issues which can have an impact on the extent and direction of future industrial development. Are current energy policies and trends adequate to support the expected rate of industrial development? Are changes in either energy policies or industrial policies necessary to ensure a robust future? What energy options are available?

The chapter reviews the current energy situation both in the major countries and for the region as a whole in terms of both supply and demand and analyzes the main factors that will influence the future energy situation. These factors include the current trends in restructuring the industrial sector. It considers what new indigenous energy supplies are expected to be available by the year 2000 and what likelihood there is for energy efficiency improvements. The chapter follows with a review and analysis of current and possible future energy policies which directly influence industrial development and some of which can be fully integrated into industrial policies. This

chapter concludes with recommendations for achieving a stable, secure energy system which will enhance industrial development.

But what does it mean to have a stable, secure energy system? The industrialized world has been tackling that question since the first oil crisis in 1973. Like most of the ESCAP countries, many industrialized countries are not endowed with abundant energy resources and are highly dependent on energy imports. Yet they have built enough flexibility into their energy strategies to be able to weather most, even crisis, situations and still sustain industrial and economic development. In general, this was done without shying away from energy imports. The main components of an effective energy strategy include: exploitation of indigenous sources, fuel substitution away from oil, diversifying to avoid dependence on single suppliers, market-based energy prices and efficient use of energy.

a) Overview of Energy Situation in Asia and the Pacific

As shown in Table 1, energy demand for the entire region grew sharply between 1975 and 1988 at a rate of 5.6 per cent per year[1]. It grew at an even faster rate of 5.8 per cent between 1985 and 1988. Eight countries grew at an annual rate above 8 per cent, led by Brunei at 12.6 per cent. Only Viet Nam experienced a drop in total demand over the period. Table A-1 in the Annex provides a country-by-country comparison of total energy demand.

Table 1
Energy Supply and Demand
in the Developing Countries of the
Asia and Pacific Region
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	834479	1082113	1213375	2.9
Imports	121543	194654	259847	6.0
Exports	364087	270285	281779	-2.0
TPER	576298	985581	1168355	5.6
TFC	449602	763518	880371	5.3

Source: International Energy Agency, *World Energy Statistics and Balances 1971-1987,1985-1988*

While the region remains energy self-sufficient in aggregate terms, the trend is towards greater imports with energy exports actually decreasing over the period. As seen in Table A-14 in the Annex, the ratio of self-sufficiency has dropped from 1.45 in 1975 to only 1.04 in 1988, meaning that the region is just maintaining its self-sufficiency after having been a major exporter. However, of the 19 countries reviewed, only five are net exporters. The problem is exacerbated because some major energy exporters, such as Indonesia, are expected to be net energy importers early in the new century. A country-by-country comparison is available in Section II.

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[1]The data do not include non-commercial fuels such as fuelwood and biomass.

Energy Supply

Table 2 shows the breakdown by energy sources and how that has evolved between 1975 and 1988. The region remains highly dependent on coal and oil although there has been a trend away from oil. In comparison, the industrialized countries of the International Energy Agency (IEA)[2] are more balanced in their energy demand, although more dependent on oil. In 1988 oil represented almost 43 per cent, coal and other solid fuels 24.7 per cent, natural gas 19 per cent, nuclear 7.2 per cent and hydro 6.4 per cent.

Table 2
Fuel Shares in Total Energy Demand (TPER)
for the Developing Countries
in the Asia and Pacific Region - 1975-1988
(%)

	1975	1988
Coal	56.1	59.4
Oil	34.7	28.7
Gas	4.3	5.0
Hydro/other	4.7	5.3
Nuclear	0.1	1.6

Source: International Energy Agency, *World Energy Statistics and Balances 1971-1987,1985-1988*

Table 3 presents the growth rates in Asia and the Pacific of the various energy supplies for the 1975-88 period. Oil production decreased during the period, mainly in Iran. More detail is available in the Annex. Of energy production, coal is by far the most important, representing 58.4 per cent of total production in 1988, followed by oil at 25.4 per cent.

Table 3
Energy Production Growth Rates
1975-88 (% per annum)

Oil	-0.8
Hard Coal	5.3
Lignite	6.8
Natural Gas	8.4
Electricity	8.4
Vegetal Fuels*	1.7

* Not included in other data

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[2] The IEA is the industrialized world's main energy organization formed in 1974 after the first oil crisis. There are 21 member countries including Australia, Austria, Belgium, Canada, Denmark, Germany, Greece, Ireland, Italy, Japan, Luxembourg, the Netherlands,

Energy Demand

As shown in Table 1, total energy demand grew at a very robust rate of 5.6 per cent and total final consumption of the end-use sectors[3] at a rate of 5.3 per cent between 1975 and 1988.

In particular, there is high growth in transport fuels and electricity, both of which will cause concern for both increased infrastructure and imports. Almost all countries experienced strong growth in oil and electricity consumption (see Annex). For the entire region oil consumption grew at an annual rate of 4.6 per cent between 1975 and 1988. Electricity grew at a rate of 8.4 per cent.

In 1985, the industrial sector was the largest consumer of commercial fuels. Industrial consumption represented 55.8 per cent, followed by residential/commercial at 30.2 per cent and transportation at 12.7 per cent.

Overall, energy intensity (as measured by energy demand per unit of GDP) increased in most countries (see Annex), due largely to the trend towards more energy-intensive industry. Of the 10 countries for which data are available, oil intensity (as measured by total oil consumption per unit of GDP) actually decreased in half of them, most rapidly in Hong Kong and the Philippines (see Annex).

Per capita energy consumption is very low compared to industrialized countries. Only eight countries have per capita energy consumption above the lowest IEA country (Turkey) and only two countries (Brunei and Singapore) were above the West European average (3.11 tonnes of oil equivalent (toe) in 1988). Of the countries examined, per capita energy consumption ranged from 0.02 toe per capita in Nepal to 3.72 toe in Brunei. The IEA average, by comparison, was 4.92 toe per capita in 1988. (See Table A-15 for per capita energy consumption in 1988).

b) Major Factors Influencing Energy Supply and Demand

While energy demand has been growing at a high, steady rate, there are several factors that affect current demand and will continue to affect future demand. These include among others:

• *strong economic growth:* the Asia and Pacific region is economically one of the fastest growing regions in the world. A recent ESCAP report[4] states that the Asia and Pacific region as a whole is expected to grow at a rate of 5.1 per cent, down from 5.4 per cent for the past two years. The decrease is a result of the Gulf crisis, with increased oil import costs, and the failure of the recent GATT negotiations. However, both ESCAP and Japan's Institute of Developing Economies[5] see strong growth ahead for the ASEAN countries (the Japanese institute puts ASEAN growth at 7.1 per cent, down from 8.0 per

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New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States.

[3]The difference between total primary energy requirements and total final consumption is the energy consumed in the transformation sector (primarily electricity production and oil refining).

[4] Reuters Wire Service Report, in International Herald Tribune, December 21, 1990.

[5] Ibid.

cent in 1990). It is expected that relatively high growth for the region will be maintained throughout this decade.

• *high population growth:* the region is the most populous in the world and its population growth rate is also exceptionally high, especially compared to industrialized countries.

• *industrial expansion:* UNIDO has recently forecast that the average annual growth rate for manufacturing value added for 1990-2000 will be 6.1 per cent in the Indian Sub-Continent and 7.5 per cent in South-East Asia. South-East Asia is expected to be the fastest growing region in the world throughout the nineties. Industrial expansion implies there will be new plants and facilities which should be more energy efficient. This will be discussed in more detail in Section III.

• *modernization:* paralleling industrial expansion is the need to modernize existing facilities. Investment in modernization allows the introduction of more energy-efficient technologies for both operating and production requirements.

• *environmental concerns:* high industrialization and high use of coal and petroleum in particular will increasingly create difficulties as global environmental policies are implemented. There are also growing difficulties in commissioning nuclear and hydro-electric facilities because of environmental concerns.

• *rural electrification:* there is a growing trend towards expanding the availability of electricity. Many countries still have a great number of regions and households without electricity.

• *urbanization:* growing urbanization creates a need for more transport fuels and electricity. It also generally means less consumption of non-commercial fuels.

• *private transport:* the number of vehicles per capita is growing rapidly, creating a strong demand for gasoline and diesel fuels.

• *increased standard of living:* with more industrialization and economic growth, average incomes are increasing, albeit slowly in many countries. This leads to increased standard of living which demands more consumer products such as vehicles and household appliances and also often means a switch from non-commercial to commercial fuels. All of these lead to an increase in energy consumption.

• *energy security:* the current Gulf crisis and the oil crises in the 1970s show the vulnerability of energy economies which depend on imports. Imports cannot be avoided if a country is to maintain a path of development. In fact, some of the most successful industrialized countries, such as Japan, are very dependent on energy imports. Reliance on imports, however, requires an efficient, flexible energy system as a cushion against unexpected events. The ESCAP region is much better able to cope with the current crisis because of policy measures that have already been undertaken. These include stockpiling and fuel switching. Nevertheless, the current oil crisis is expected to have an adverse effect, with a lowering of total economic growth, primarily in oil-importing countries. There had been many fears of shortages of both crude and oil products but those fears have been allayed by considerable surpluses as of December 1990.

Gulf Crisis Effects

The OECD in its December 1990 **Economic Outlook** estimated that the terms-of-trade loss for the NIEs is $8 billion (1 1/2 to 2 per cent of GDP) compared to a loss of 1/2 per cent on average for OECD countries. The terms-of-trade losses for all oil-importing developing non-OECD countries amount to more than 1 per cent of GNP (about $20 billion).

Higher oil prices also mean a slowdown in trade because OECD demand for imports from non-OECD countries will slow down 2 per cent below the baseline in 1991, according to OECD **Economic Outlook**, if there is a $10 per barrel oil price increase maintained.

Countries such as India, which were dependent on Kuwaiti and Iraqi oil, are obliged to make deals with countries such as Iran for oil. It is estimated that foreign exchange reserves in India dropped from $3.3 billion in March 1990 to $2.04 billion in October 1990, largely because of the crisis.

The Gulf crisis also means a loss of workers' remittances from Iraq and Kuwait. This particularly affects Bangladesh, India, Pakistan, the Philippines and Sri Lanka. For example, India had 170,000 workers in Kuwait before the invasion. Bangladesh estimated that it will lose $600 million in 1990 because of lost remittances and the loss of $56 million in Kuwaiti aid. India estimated losing $200 million in remittances and the Philippines $250 million in 1990.

The most vulnerable countries, according to Soloman Brothers, are those with high inflation rates (the Philippines, the Republic of Korea and Thailand). They believe the Philippines is the most vulnerable because of high inflation rates combined with poor energy efficiency and rising trade deficits.[6]

• *energy pricing policies:* subsidized or regulated prices which do not reflect true costs do not give the correct signals to consumers. This affects the rate of fuel substitution and the introduction of energy-efficient technologies.

• *foreign debt:* countries in a high debt situation will have increasing difficulty financing more expensive oil imports. There is also a problem adequately financing needed electricity generation capacity and importing new energy-efficient technologies.

• *foreign exchange:* countries dependent on energy imports are vulnerable to changes in exchange rates. The same also holds true for importing energy-efficient technologies.

• *inflation:* countries with high inflation will be some of the hardest hit by increased oil prices.

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[6] *Power in Asia*, September 24, 1990.

c) Regional Trends to 2000

All recent forecasts agree that there will be rapidly increasing energy demand and a need for more energy imports. Linked with the high economic and industrial growth, energy demand is expected to increase although at a slower rate, thus showing a lowering of energy intensity.

The World Bank published a report this year on the prospects of future energy demand which included seven countries from the Asia and Pacific region.[7] The study shows energy demand growing 4.3 per cent per year for the seven countries, led by nuclear at 9.0 per cent and natural gas at 6.7 per cent per year. Oil is forecast to grow by 4.4 per cent per year. The residential-commercial sector is expected to be the fastest growing end-use sector.

A separate World Bank report[8] estimates that electricity installed capacity will grow 7.7 per cent per year in the Asia region between 1989 and 1999. Growth rates over that period are shown below:

Percentage Growth of Electricity Capacity

Bangladesh	12.0
Burma	7.9
China	6.8
Fiji	4.6
India	9.1
Indonesia	12.3
Rep. of Korea	6.8
Laos	14.1
Malaysia	7.2
Nepal	8.1
Papua New Guinea	4.9
Philippines	5.8
Sri Lanka	7.5
Thailand	7.7

The IEA forecasts total energy demand in all developing countries will grow by 4.6 per cent per year between 1987 and 2005[9]. While there is no regional breakdown provided, it can be assumed that the Asia and Pacific region will grow by more than that rate because of its rapid economic growth.

ESCAP has recently prepared energy forecasts for the years 2000 and 2010 in conjunction with its work on the climatic effects of fossil fuels[10]. Three scenarios were

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[7] Mudassar Imran and Philip Barnes, *Energy Demand in the Developing Countries, Prospects for the Future*, World Bank Staff Commodity Working Paper, Number 23, August 1990. The Asia-Pacific countries reviewed include China, India, Indonesia, Malaysia, Pakistan, the Philippines and Thailand.

[8] E.A. Moore and George Smith, *Capital Expenditure for Electric Power in the Developing Countries in the 1990s*, World Bank Energy Series Paper No. 21, February 1990.

[9] IEA, *Energy Policies and Programmes of IEA Countries, 1989 Review*, OECD, Paris, 1990.

[10] ESCAP, *Energy Policy Implications of the Climatic Effects of Fossil Fuel Use in the Asia-Pacific Region*, draft prepared in July 1990 for December 12-14, 1990 Symposium in Tokyo, Japan. The years covered in the scenarios were 1986 to 2000 or 2010.

developed: a base case, an efficiency case where efficiency improvements are introduced into the industrial sector, and a low carbon case which has the efficiency improvements of the second scenario and improvements in the supply sector and shifts to low-carbon fuels (the third scenario was only developed for 2010). Table 4 shows the forecasts for total energy demand for the 14 ESCAP countries analyzed.

While the growth rates are quite high in the base case, the introduction of greater industrial energy efficiency in the second scenario clearly shows the impact of energy conservation efforts in industry. From an energy policy perspective, it is important to know what is required to achieve those improvements and whether, in fact, greater improvements are possible.

Table 4
ESCAP Annual Growth Rates
Total Primary Energy Requirements
(%)

	1986-2000 base case	1986-2000 efficiency case
Bangladesh	4.6	3.6
China	4.1	3.0
Hong Kong	2.9	1.9
India	5.0	4.8
Indonesia	5.3	6.3
Korea, DPR	3.1	1.7
Korea, Rep. of	6.1	5.5
Malaysia	5.6	5.4
Pakistan	5.8	4.9
Philippines	6.6	6.3
Singapore	2.6	2.4
Taiwan Province	4.7	3.6
Thailand	9.2	9.1
Viet Nam	5.0	4.6

Source: ESCAP

II Availability and Consumption of Energy in the Asia and Pacific Region: A Stock-taking

Before trying to analyze what future energy options and requirements are available and needed, it is necessary to examine the current situation. This section briefly reviews the main energy data of the major ESCAP developing countries between 1975 and 1988. These countries combined supply and consume over 99 per cent of energy requirements in the developing region of ESCAP.

a) Country Review

Bangladesh

Table 5
Energy Balances
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	493.3	2469.0	3880.5	17.2
Imports	1378.5	1684.4	2130.5	3.4
Exports	46.6	96.6	83.5	4.6
TPER	1794.9	4059.2	5916.5	9.6
TFC	1394.8	2798.2	3750.1	7.9
Industry	705.1	1395.5	2003.6	8.4
Transport	232.0	512.8	N.A.	
Other	426.9	840.9	N.A.	

Table 6
Fuel Shares in Energy Demand
1975-1988
(%)

	1975	1988
Coal	7.0	2.0
Oil	63.7	34.4
Gas	23.9	61.1
Hydro/other	5.4	2.5

Highlights:

- exceptionally high rate of growth of total demand (it reached 13.4 per cent per year between 1985 and 1988) with strong growth in natural gas.
- Bangladesh has highest share of gas in TPER in all Asia-Pacific
- energy intensity rose at a rate of 5.5 per cent p.a. between 1975-88

Brunei

Table 7
Energy Balances
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	13750	16434	15020.0	0.7
Imports	35	40.1	39.0	0.8
Exports	13907	14940.1	12957.0	-0.5
TPER	192	621.1	896.0	12.6
TFC	117	342.4	365.3	9.2
Industry	37	76.1	77.5	5.9
Transport	53	182.9	184.0	10.0
Other	23	78.7	99.0	11.9

Table 8
Fuel Shares in Energy Demand
1975-1988
(%)

	1975	1988
Coal	--	--
Oil	64.1	25.1
Gas	35.9	74.9

Highlights:

- has one of highest per capita income levels in the world
- economy almost completely depends on oil and gas exports
- government trying to prepare for post-oil era
- very strong growth in TPER

Burma

Table 9
Energy Balances
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	1256.8	2507.1	1977.3	3.5
Imports	150.3	117.2	31.1	-11.4
Exports	9.6	17.3	--	--
TPER	1507.8	2405.2	2008.4	2.2
TFC	1261.9	1882.7	1546.1	1.6
Industry	551.5	1149.8	N.A.	--
Transport	463.5	637.7	N.A.	--
Other	223.0	N.A.	N.A.	

Table 10
Fuel Shares in Energy Demand
1975-1988
(%)

	1975	1988
Coal	10.3	2.8
Oil	70.9	36.8
Gas	10.4	47.9
Hydro/other	8.4	12.5

Highlights:

- significant effort to reduce dependence on oil and imports in general

China

Table 11
Energy Balances
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	333916	592212	661102	5.4
Imports	191	2436	5311	29.1
Exports	12723	41085	41345	9.5
TPER	321385	539888	625133	5.3
TFC	257367	448713	503980	5.3
Industry	N.A.	261391	N.A.	--
Transport	N.A.	24536	N.A.	--
Other	N.A.	159102	N.A.	--

Table 12
Fuel Shares in Energy Demand
1975-1988
(%)

	1975	1988
Coal	73.4	76.4
Oil	21.1	17.7
Gas	2.4	1.9
Hydro/other	3.1	3.9

Highlights:

- energy shortages generally idle high percentage of manufacturing capacity (sometimes 25 per cent)
- strong efforts to improve energy efficiency in industry
- investment in new supply production is a major concern
- net oil exports are expected to decline over the next decade although coal exports are expected to double

Hong Kong

Table 13
Energy Balances
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	--	--	--	--
Imports	4690.3	8499.4	12553.6	28.3
Exports	106.4	345.8	1204.0	20.5
TPER	4212.2	7490.6	10266.1	7.1
TFC	2973.7	4776.1	6681.7	6.4
Industry	1170.6	2022.8	2796.1	6.9
Transport	1092.7	1417.9	2172.7	5.4
Other	647.1	1229.8	1607.3	7.2

Table 14
Fuel Shares in Energy Demand
1975-1988
(%)

	1975	1988
Coal	0.2	55.5
Oil	99.8	45.7
Hydro/other	--	-1.2

Highlights

- total energy demand grew at a rate of 11.1 per cent per year between 1985 and 1988
- completely dependent on imports
- energy and oil intensity decreased between 1975-88

India

Table 15
Energy Balances
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	67991	122885	146124	6.1
Imports	16219	19612	23823	3.0
Exports	393	3919	2382	14.9
TPER	80803	137195	166303	5.7
TFC	56560	88196	102709	4.7
Industry	30812	48759	N.A.	
Transport	16157	21890	N.A.	
Other	7976	15011	N.A.	

Table 16
Fuel Shares in Energy Demand
1975-1988
(%)

	1975	1988
Coal	59.2	55.3
Oil	29.7	32.0
Gas	1.2	4.6
Hydro/other	9.2	7.3
Nuclear	0.7	0.8

Highlights:

- endowed with large reserves of coal, oil and natural gas
- coal reserves are eighth largest in the world
- while aggressively trying to expand oil production, it will remain increasingly dependent upon imports
-natural gas playing a more important role
- continuing problem to have sufficient quantities of coal supplied by rail to power stations. This leads to regular shortfalls in electricity generation
- energy and oil intensity grew significantly between 1975 and 1988

Indonesia

Table 17
Energy Balances
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	66881.8	92979.9	103107.3	3.4
Imports	5699.5	6724.9	6822.9	1.4
Exports	59389.2	68443.3	71687.4	1.5
TPER	13852.7	31715.5	38113.4	8.1
TFC	11356.7	23190.6	27111.4	6.9
Industry	3552.7	9004.1	9414.7	7.8
Transport	3983.0	7243.3	9133.3	6.6
Other	3720.2	6732.9	5473.0	3.0

Table 18
Fuel Shares in Energy Demand
1975-1988
(%)

	1975	1988
Coal	0.9	6.6
Oil	92.3	68.0
Gas	3.7	20.7
Hydro/other	3.0	4.7

Highlights:

- OPEC member and world's largest exporter of LNG
- low oil prices in late 1980s significantly hurt economy
- government trying to reduce dependence on oil and gas exports
- also trying to increase use of gas in energy demand but difficult because most gas fields are far from urban areas and industry
- trying to reduce domestic oil consumption in order to save it for export
- very low rate of electrification throughout country
- retail energy prices are controlled
- high rate of energy intensity growth between 1975-88

Iran

Table 19
Energy Balances
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	290475	128121	133318	-5.8
Imports	60	5375	9259	47.3
Exports	252883	77397	77918	-8.7
TPER	32562	54497	63197	5.2
TFC	27342	44186	51333	5.0
Industry	11463	17128	21428	4.9
Transport	8356	6162	11664	2.6
Other	6376	19477	15869	7.3

Table 20
Fuel Shares in Energy Demand
1975-1988
(%)

	1975	1988
Coal	2.1	1.4
Oil	64.3	69.5
Gas	31.3	26.5
Hydro/other	2.4	2.6

Highlights

- OPEC member
- plans for gas to reach 40 per cent of TPER by 2003
- discussions to export gas to Pakistan, India and Bangladesh but implementation seems remote
- high rate of growth of energy intensity between 1975 and 1988

Democratic People's Republic of Korea

Table 21
Energy Balances
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	27146	35279.5	36327.9	2.3
Imports	1452	4844.2	4785.4	9.6
Exports	25	30.7	30.7	1.6
TPER	28551	40093.0	41082.6	2.8
TFC	22490	28902.8	29939.6	2.2
Industry	20533	24702.6	25410.0	1.7
Transport	938	2206.8	2333.4	7.3
Other	1019	1993.5	2196.3	6.1

Table 22
Fuel Shares in Energy Demand
1975-1988
(%)

	1975	1988
Coal	82.9	76.8
Oil	4.2	7.4
Hydro/other	12.9	15.8

Highlights:
- continued high dependence on coal

Republic of Korea

Table 23
Energy Balances
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	8644.7	14927.6	20929.9	6.8
Imports	17211.2	43340.3	59587.6	10.0
Exports	1043.2	3576.9	4248.8	11.4
TPER	24554.7	53511.4	73095.4	8.8
TFC	19647.6	42580.5	56464.3	8.5
Industry	8438.3	17123.9	23734.0	8.3
Transport	2551.2	7045.9	11156.2	12.0
Other	8407.6	17805.9	20826.2	28.4

Table 24
Fuel Shares in Energy Demand
1975-1988
(%)

	1975	1988
Coal	32.8	34.3
Oil	65.7	48.7
Gas	--	3.7
Hydro/other	1.5	1.1
Nuclear	--	12.3

Highlights:

- very high energy demand growth due to expanding economy
- highly dependent on energy imports
- strong nuclear electricity production
- energy sector under strong government control
- has one of highest energy intensities in region but growth between 1975-88 has been moderate

Malaysia

Table 25
Energy Balances
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	5372.0	31116.4	41711.2	17.1
Imports	4479.3	6643.8	6414.9	2.8
Exports	3992.9	24837.6	30852.1	17.0
TPER	6144.5	13198.8	17120.7	8.2
TFC	4751.5	8739.5	10685.9	6.4
Industry	2105.1	3672.9	4530.9	6.1
Transport	1981.7	3550.2	4334.1	6.2
Other	540.8	1151.6	1475.3	8.0

Table 26
Fuel Shares in Energy Demand
1975-1988
(%)

	1975	1988
Coal	0.3	1.3
Oil	91.9	60.6
Gas	4.2	30.7
Hydro/other	3.7	7.4

Highlights:

- TPER grew at even faster rate of 9.1 per cent per year between 1985 and 1988
- strong growth in indigenous production
- major net exporter: oil and gas export revenues represent about 20 per cent of total export earnings

Nepal

Table 27
Energy Balances
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	17	74.6	125.8	16.6
Imports	107	211.1	283.0	7.8
Exports	--	0.5	23.0	--
TPER	124	285.2	385.8	9.1
TFC	102	216.0	275.4	7.9
Industry	30	61.7	62.0	5.7
Transport	32	76.7	81.0	7.4
Other	40	73.8	91.8	6.6

Table 28
Fuel Shares in Energy Demand
1975-1988
(%)

	1975	1988
Coal	22.6	13.8
Oil	61.3	52.4
Gas	--	--
Hydro/other	16.1	33.8

Highlights:

- strong growth in indigenous production but still highly dependent on imports

Pakistan

Table 29
Energy Balances
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	5469.0	13695.2	17121.2	9.2
Imports	4071.1	7148.9	8277.3	5.6
Exports	228.6	168.8	132.2	-4.1
TPER	9069.8	20666.8	25252.8	8.2
TFC	6882.3	14652.6	18108.0	7.7
Industry	3004.1	6936.3	N.A.	--
Transport	1659.4	3619.8	4682.1	8.3
Other	2028.7	3808.5	N.A.	--

Table 30
Fuel Shares in Energy Demand
1975-1988
(%)

	1975	1988
Coal	6.8	7.5
Oil	43.7	38.7
Gas	37.3	32.1
Hydro/other	10.7	21.1
Nuclear	--	0.6

Highlights:
- good gas pipeline infrastructure
- natural gas provides about half of industrial energy demand of which half is for chemical industry
- almost one-third of electricity generated from natural gas
- major government effort to increase use of coal, especially in power generation and cement production
- strong energy conservation program financed by US AID
- strong growth in energy intensity between 1975 and 1988

Philippines

Table 31
Energy Balances
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	561.1	3394.2	3554.1	15.3
Imports	10209.2	8254.3	11733.5	1.1
Exports	245.5	128.5	253.7	0.3
TPER	10676.2	12060.5	13834.5	2.0
TFC	7382.0	7534.6	8243.5	0.9
Industry	2972.8	3221.3	2570.2	-1.1
Transport	2292.4	1639.1	987.0	-6.3
Other	1873.5	2517.8	3084.4	3.9

Table 32
Fuel Shares in Energy Demand
1975-1988
(%)

	1975	1988
Coal	0.6	11.2
Oil	94.6	70.2
Hydro/other	4.8	18.6

Highlights:
- second largest geothermal production in world but otherwise not energy rich
- serious problem with electricity shortages
- main policy issue is to reduce dependence on imported oil

Singapore

Table 33
Energy Balances
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	--	--	--	--
Imports	27211.9	40105.4	55320.1	5.6
Exports	15152.7	29768.7	32933.9	6.2
TPER	4158.3	7840.1	9544.5	6.6
TFC	1902.7	4377.9	5225.5	8.1
Industry	389.1	1551.9	1906.3	13.0
Transport	961.1	2202.3	2540.1	7.8
Other	233.9	508.5	635.2	8.0

Table 34
Fuel Shares in Energy Demand
1975-1988
(%)

	1975	1988
Coal	0	0.1
Oil	100.0	99.9

Highlights:

- completely dependent on imports
- almost completely dependent on oil
- large oil refining industry
- energy conservation efforts very strong, especially to reduce vehicle use

Sri Lanka

Table 35
Energy Balances
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	246	535.0	580.1	6.8
Imports	1623	1908.1	2043.2	1.8
Exports	298	316.0	339.2	1.0
TPER	1139	1733.8	1876.6	3.9
TFC	889	1296.9	1370.3	3.4
Industry	125	171.5	182.5	3.0
Transport	445	798.6	831.4	4.9
Other	312	291.3	319.0	0.2

Table 36
Fuel Shares in Energy Demand
1975-1988
(%)

	1975	1988
Coal	0.2	--
Oil	79.3	69.1
Hydro/other	20.5	30.9

Highlights:
- high dependence on oil imports

Taiwan Province of China

Table 37
Energy Balances
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	4640.4	10293.6	10232.0	6.3
Imports	10385.4	24621.4	35248.6	9.9
Exports	694.1	2362.6	2245.5	9.5
TPER	15096.8	32885.7	41356.6	8.1
TFC	10627.7	22088.6	28766.2	8.0
Industry	6073.5	12457.3	16545.7	8.0
Transport	1752.8	4178.6	5587.4	9.3
Other	2417.5	4524.4	5659.6	6.8

Table 38
Fuel Shares in Energy Demand
1975-1988
(%)

	1975	1988
Coal	14.3	26.7
Oil	69.3	50.7
Gas	8.6	2.7
Hydro/other	7.8	3.3
Nuclear	--	16.6

Highlights:
- strong nuclear industry
- electrification virtually complete in country
- high growth in energy demand
- significantly reduced dependence on oil
- still has energy price controls

Thailand

Table 39
Energy Balances
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	887.6	7100.2	9648.1	20.1
Imports	8160.2	9531.5	12309.2	3.2
Exports	79.4	473.1	689.9	18.1
TPER	8893.1	16170.0	21751.6	7.1
TFC	7077.2	12074.4	16347.2	6.0
Industry	1942.2	2987.3	3736.9	5.2
Transport	3158.0	6513.4	9224.3	8.6
Other	1750.5	2410.5	3222.8	4.8

Table 40
Fuel Shares in Energy Demand
1975-1988
(%)

	1975	1988
Coal	1.6	9.9
Oil	89.7	66.0
Gas	--	20.1
Hydro/other	8.7	4.0

Highlights:

- significant introduction of natural gas
- very strong growth in total energy demand, indigenous production and electricity generation
- poor fuelwood availability led to development of bottled LPG sales network

Viet Nam

Table 41
Energy Balances
(ttoe)

	1975	1985	1988	Growth rate 1975-88 p.a. (%)
Indigenous Prod.	3310	3683.9	3890.8	1.3
Imports	3146	1450.8	1488.2	-5.6
Exports	375	307.5	307.5	-1.[illegible]
TPER	6080	4827.2	5071.4	-1.4
TFC	5539	3786.1	3993.3	-2.5
Industry	2717	2475.3	2632.7	-0.2
Transport	2568	735.0	786.1	-8.7
Other	245	497.8	526.6	6.1

Table 42
Fuel Shares in Energy Demand
1975-1988
(%)

	1975	1988
Coal	46.5	62.0
Oil	51.6	29.2
Hydro/other	1.8	8.8

Highlights

- energy demand decreased over the period
- coal replaced oil as most important energy source

b) Regional Energy Trade

There is thriving trade in energy sources amongst ESCAP developing countries. While it is not possible to be fully comprehensive, the following are some examples:

- oil
  - India is obtaining oil from Iran
  - ASEAN oil-importers receive oil from ASEAN oil-exporters
  - Hong Kong imports oil from China
  - the Republic of Korea receives oil from Brunei, Indonesia, Iran and Malaysia
  - Taiwan Province obtains oil from Brunei, Indonesia and Malaysia
  - Singapore receives oil from China, Indonesia, Iran and Malaysia
  - Singapore meets about 40 per cent of the product import requirements of the Asia and Pacific region

- natural gas
  - Singapore will be receiving gas from Malaysia
  - Indonesia exports LNG to the Republic of Korea and Taiwan Province
  - discussions are underway for Bangladesh, India and Pakistan to import gas from Iran.

Conclusions

What is most noticeable is the diversity within the region, ranging from countries with very small energy requirements (Nepal, Brunei and Burma) to some very large consumers (China, India, Republic of Korea and Iran).

Many countries are highly dependent on one or two fuels, with very few showing a balanced approach amongst the range of fuels.

Only four countries are energy net exporters (China, Indonesia, Iran and Malaysia) although the region as a whole is a net exporter.

III Industrial and Technological Restructuring Trends and their Impact on Energy Demand

Particularly over the past two decades there has been considerable restructuring of the industrial sectors in many ESCAP developing countries. Restructuring has been most prevalent in the NIEs, the ASEAN countries, China and India. Continued restructuring is expected in the future.

In section I, industrial development and modernization were identified as important aspects affecting future energy demand Undoubtedly, the size and structure of industry have a considerable impact on a country's energy consumption. As seen in the last section, this is especially true because industrial energy consumption is often the largest energy end-use sector (for commercial fuels) with very high growth rates. Understandably, a move towards or away from energy-intensive industries or energy-using technologies will have an important impact on both sectoral energy use and thus total energy demand.

This section first examines recent trends, the likely prospects for the future and the implication of this shifts for future energy demand, energy intensity and energy efficiency.

Given the enormous diversity in the region, it is difficult to make general comments about the entire region. The region ranges from tiny islands with virtually no industrial base to large, powerful industrial producers. Wherever possible, examples will be given for individual countries or groups of countries.

a) Recent Trends

As shown in Table 43, there has been significant shifts in many ESCAP countries towards the industrial sector. Only Hong Kong has shifted away from industry to services. Most of these economies also experienced strong industrial growth, although the Philippines experienced a decline between 1980 and 1987 and Indonesia had relatively slow growth, mainly because of lower oil prices. Indonesia had the highest rate of growth in the share of industry in GDP. All of the countries selected shifted away from the agriculture sector.

Table 43
Economic Structure of Selected Developing ESCAP Economies
1965-1987

	Distribution of GDP		Average annual growth rate of industry	
	Industry			
	1965	1987	1965-80	1980-87
Low-Income				
Bangladesh	11	13	3.8	4.7
China	38	49	10.0	13.2
India	22	30	4.0	7.2
Indonesia	13	33	11.9	2.1
Nepal	11	14	--	--
Pakistan	20	28	6.4	9.1
Sri Lanka	21	27	4.7	4.2
Middle Income				
Malaysia	25	--	--	5.8
Papua New Guinea	18	26	--	5.3
Philippines	28	33	8.0	-2.8
Thailand	23	35	9.5	5.9
Upper middle high income				
Hong Kong	40	29	--	--
Korea, Rep. of	25	43	16.5	10.8
Singapore	24	38	11.9	4.0

Source: adapted from World Bank, World Development Report, 1989 (Washington, D.C. 1989) quoted in ESCAP Background Paper: *Challenges and Opportunities of Restructuring the Developing ESCAP Economies in the 1990s, with Special Reference to Regional Economic Co-operation.*

As shown in Table A-13 in the Annex, several countries (Hong Kong, the Philippines, Republic of Korea and Thailand) showed a decline in industrial energy intensity. This would be explained primarily by improved energy efficiency, fuel switching and a move towards service industries.

A recent World Bank survey[11] points out that industrial energy efficiency is still very low by international standards. They state, for example, that Chinese production techniques and equipment are at the condition of those in the industrialized countries in the 1950s. They give one example where synthetic ammonia plants consume per unit of

[11] Mudassar Imran and Philip Barnes, op. cit. The Asia and Pacific countries reviewed include China, India, Indonesia, Malaysia, Pakistan, the Philippines and Thailand.

production about three times above a modern plant. They also state that Pakistan has "numerous small and antiquated factories."[12]

Countries such as China, India and Pakistan have very high industrial energy intensities, showing the emphasis on more energy-intensive industries. Within the manufacturing sector, the general trend has been for the share of light industries (agro-processing, textiles and clothing, etc) to decline whereas the share of capital goods, in particular the engineering branches (metalworking, industrial and electronic machinery, transport equipment, etc) is increasing.

Table 44 shows the five major industries in selected ESCAP countries. There is still a heavy emphasis on food processing, textiles and apparel.

[12] Ibid., p. 21.

Table 44
Five Major Manufacturing Industries
(in terms of highest value added)
in Selected ESCAP Developing Economies, 1987

Bangladesh
- Food
- Tobacco
- Textiles
- Industrial Chemicals
- Other Chemicals

Fiji
- Food
- Beverages
- Wearing Apparel
- Other Chemicals
- Other Non-metal Minerals

Hong Kong
- Textiles
- Wearing Apparel
- Plastic
- Metal Products
- Electrical Equipment

India
- Food
- Textiles
- Iron and Steel
- Non-electrical Equipment
- Electrical Equipment

Indonesia
- Food
- Tobacco
- Textiles
- Wood
- Petroleum

Republic of Korea
- Food
- Textiles
- Iron and Steel
- Electrical Equipment
- Transport

Malaysia
- Food
- Industrial chemicals
- Rubber
- Other metal
- Electrical equipment

Pakistan
- Food
- Tobacco
- Textiles
- Industrial Chemicals
- Other Chemicals

Philippines
- Food
- Beverages
- Tobacco
- Other Chemicals
- Petroleum

Singapore
- Other Chemicals
- Petroleum
- Non-electrical Equipment
- Electrical Equipment
- Transport

Sri Lanka
- Food
- Tobacco
- Textiles
- Petroleum
- Other Metals

Thailand
- Food
- Beverage
- Textiles
- Wearing Apparel

Source: UNIDO, Industry and Development, Global Report 1989/90, Vienna, Statistical Annex, quoted in ESCAP Background Paper: *Challenges and Opportunities of Restructuring the Developing ESCAP Economies in the 1990s, with Special Reference to Regional Economic Co-operation.*

b) Future Trends

There are several trends which are expected to continue into the future:

• the NIEs are planning to gradually upgrade their industrial base by shifting out of labour-intensive industries into more capital and skill-intensive industries where there is a higher value added. One of the reasons for this move is because of growing protectionism in industrialized countries against the labour-intensive products of this region and the sizeable current account surpluses of the NIEs. The Republic of Korea, for one, has earmarked petrochemicals and electronics as new growth industries in its current five-year plan. The Republic of Korea is also intensifying its R&D efforts to support industrial growth (particularly in the areas of aerospace, new materials, mechatronics, microelectronics and fine chemicals).

• ASEAN countries are in a state of more energy-intensive industrial development. Indonesia, the least industrialized country in ASEAN, has plans to export garments and footwear and develop selective high technology industries such as aircraft and jet foils. Malaysia will continue with its current emphasis on heavy industry or those with downstream linkages such as iron and steel, machinery and engineering, electronics components, telecommunications, petrochemicals, fertilizer and automobiles. Natural gas will play an increasingly important role, particularly for petrochemicals and fertilizer. The Philippines has diversified away from heavy industry and encourages exports of textiles, paper and plastic products and electrical appliances. Industry has been stagnant due to political instability. Thailand is moving away from agro-based and light industries towards intermediate and engineering industries. It is trying to move away from assembly subcontracting to more finished products for export. Thailand is also trying to promote regional industrial development and move out of cheap-labour-based industries where it is now losing its comparative advantage.

• South Asia is emphasizing capital-intensive industries such as industrial chemicals, oil refining, plastic products, non-electrical machinery and transportation equipment. India is reorienting its industry to emphasize exports.

• China is still emphasizing major capital goods. There have been major shortages of power which have often idled industry (sometimes as much as 25 per cent has been idled at one time). China has put emphasis on energy conservation projects and is expanding less energy-intensive industries. There has been a trend towards small enterprises in the countryside which often use inefficient equipment discarded by medium and large factories. For example, between 1985 and 1988, small coke plants have increased production from 12 million tonnes to 15 million tonnes, using inefficient equipment[13]. The use of discarded equipment is against government policy.

• Many ESCAP countries are orienting their industries away from import-substitution to export. This is following the lead of the NIEs who were so successful over the past two decades. This development will require infrastructure investments in roads, port facilities, airports and telecommunications.

• Because of the strain on current industrial areas, there is a trend towards more decentralization. This will lead to the build up of secondary industrial centres which will also require more infrastructure for electricity, roads, etc.

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[13] see Mark D. Levine and Liu Xueyi, *Energy Conservation Programs in the Peoples Republic of China*, Lawrence Berkeley Laboratory, August 1990.

• Environmental issues are gaining importance and greater stress is being given to environmentally-benign technologies. However, as seen in China above, discarded equipment is often used in smaller, inefficient plants, exacerbating the environmental problems.

• Although the trends and plans are to expand rapidly in many ESCAP countries, there are several bottlenecks quite apart from energy which could constrain growth. This include such as: foreign investment, inflation, development of infrastructure, social reforms, education, labour shortages, pollution and political instability.

c) Impact on Future Energy Demand

As the World Bank points out[14], it is very difficult to analyze industrial energy use, largely because of the quality of data. Many industries, for example, still heavily rely on traditional fuels for which it is difficult to measure the energy consumed. Traditional fuels can represent as high as 60 per cent of industrial energy use (for example in Pakistan and Indonesia). Indonesia also has over one million small-scale enterprises throughout the country, representing about 80 per cent of the manufacturing work force. As is common in many developing countries, modernization programs are generally geared towards large-scale industries and thus small-scale operations often remain quite inefficient.

In analyzing the impact on future energy demand, there is both the absolute level of demand to consider and the efficiency of energy use both at end-use and at transformation (for example to produce and distribute petroleum products or electricity). Of course, total energy demand is affected by the level of energy efficiency.

High energy efficiency has a related but separate importance for industry because reducing energy costs through fuel substitution or energy efficiency improvements is an important way of reducing total production and operating costs, thus ensuring better competitiveness.

From the current and future trends in industrial restructuring, several points can be made about the impact on future energy demand:

• In several countries (particularly China, India and Pakistan) the use of coal in industry hinders efficiency gains because often the quality of coal is poor (most of the coal used in China is not even washed) and boilers are antiquated. Poor quality coal combined with inefficient systems also leads to high emissions which are harmful to the environment.

• High economic and industrial growth will lead to new plant facilities which will be modern and highly energy-efficient because industries, particularly those which are export oriented, have to maintain international competitiveness.

• High economic and industrial growth will also lead to high rates of growth in total energy demand (see Section I).

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[14] Mudassar Imran and Philip Barnes, op. cit., p. 19.

• New plant facilities are becoming more capital-intensive and, while being energy-efficient, are generally more energy consuming than labour-intensive companies, even if energy represents a small percentage of total costs.

• Of the seven ESCAP countries analyzed by the World Bank[15], investment in energy-intensive industries is expected to continue in all but the Philippines and Thailand. This will lead to increased energy intensities. The report states, however, "if manufacturing output grows at past rates the bulk of plant will be of state-of-the-art technology by the end of the century. Thus, the mix of plant should be more efficient than that in the OECD countries with their substantial stock of old technology plant. Such technological leapfrogging is critical to improving future efficiencies."[16]

• The trend towards more modern plant facilities leads towards greater electricity intensity. This causes a strain on current infrastructure. Already there are severe power shortages in several ESCAP countries and plans are underway to expand and improve current capacity, transmission and distribution. The World Bank estimates that the capital costs for the 14 Asian countries reviewed will come to a sizeable $455 billion for the 1990s (35 per cent provided by foreign investment)[17].

• There are still many small enterprises in ESCAP countries. Generally, they do not receive the same level of policy attention as large-scale enterprises (such as energy audits, training, technical information, etc) , but when aggregated their impact on total energy consumption can be considerable. They are difficult to address because they generally do not monitor their energy use or have someone in management technically competent to undertake or recommend needed efficiency improvements.

• Regionalization of industrial development can bring both energy "benefits" and "costs" depending on how the regional expansion takes place. Amongst the benefits, regional expansion can put factories closer to local supplies of energy (hydropower, natural gas, biomass, geothermal, etc) and thus reduce transmission and distribution costs. This is quite normal for very energy-intensive industries such as aluminium. Regional expansion can reduce the congestion in a central, industrial metropolis (such as Bangkok) and thus reduce the strain of energy infrastructure requirements. Amongst the costs, however, regional expansion can mean being placed away from energy sources and thus, for example, having to expand an electricity or gas grid to reach the location. It can also mean increased transportation costs (in energy terms) to bring in raw materials or take goods to markets.

• The industrial restructuring trends allows more fuel substitution to fuels which can be used more efficiently and which are inherently less polluting. This is particularly true for switching to natural gas.

d) Implications for Energy Policy

The industrial restructuring trends show a move towards more energy and capital intensive industries. The following table shows the relative importance of energy costs in total production costs for selected industries. Many of these industries are expanding in

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[15] Ibid., p.23.
[16] Ibid., p.23.
[17] E.A. Moore and George Smith, op. cit., p.26.

the ESCAP region. Even for an industry such as textile finishing, energy costs are not insignificant, particularly as these industries move towards more automation.

Table 45
Energy Costs Relative to Total Production Costs for Selected Industries (%)

Cement	55
Ammonia	50
Aluminium	30
Steel	30
Glass	30
Fertilizer	25
Paper	25
Ceramics	20
Metallurgical	15
Textile Finishing	12.5
Food Products	10
Oil Refining	7.5

There are two basic choices:

1) keep expanding energy supply to meet rapidly growing needs:

2) expand energy supply but ensuring all other options are exhausted in order to reduce total costs (both to individual enterprises and the country as a whole). This primarily means to ensure that industry and the energy transformation sector (mainly electricity generation) are as energy efficient as economically feasible.

Realistically, the second option should be pursued primarily because most ESCAP countries are net energy importers and because the cost to society for expanding energy supply is enormous.

Overall energy intensity will likely increase, even if a move is towards less energy-intensive industries is followed because countries are still in a state of industrialization and rapid expansion. Industries are also moving away from labour-intensiveness which undoubtedly means more energy use per unit of output.

This is not a need for undue concern in pure energy terms if an energy framework based on a balanced approach is pursued. Before setting out conclusions on an energy strategy, however, it is important to see what energy supply and demand options are available in the future in the ESCAP developing country region.

IV Potential for New Energy Supply and Energy Conservation in the 1990s

a) Energy supply

It is useful to review some of the estimates for future energy supply expansion in the ESCAP region.

- coal

According to one World Bank report[18], China's coal production could surpass 1200 million tonnes by 2000. The IEA publication *Coal Information 1990*[19] estimates China's coal production could reach 1003 million tonnes by 2000 (up from 980 million tonnes in 1989), growing at a rate of 3.4 per cent between 1987 and 2000. The IEA also forecasts Indonesian coal production to increase from 2.4 million tonnes in 1987 to 43 million tonnes in 2000. The World Bank sees that India could double production by 2000 (production was 194 million tonnes in 1989). Other ESCAP developing countries show limited growth.

While China is the world's largest coal producer, productivity is very low and there is very poor infrastructure for getting coal to both domestic and international markets. Indonesia is expected to export 7-9 million tonnes a year by 1994. India is limited in export potential because of the high ash content of its coal.

- oil

Many believe that China, Indonesia and Malaysia could all be net importers of oil by the turn of the century unless, as one World Bank report states, "effective efforts are made to conserve and substitute for oil."[20] Indonesia production will decline unless there is investment in secondary recovery and new discoveries are made. Malaysia will reach a production level of 500,000 barrels per day and then decline in the mid-1990s unless there are new discoveries. If current oil prices are maintained, exploration efforts should increase.

The newest oil producer in the region appears to be Papua New Guinea. Development currently underway will have Papua New Guinea an exporter by 1992. It is expected that production will reach 130,000 barrels per day by the end of 1992. Domestic consumption is only 16,000 barrels per day.

China hopes to have production at 4 million barrels per day by 2000, up from between 2.7 and 2.9 million barrels per day now. There is every likelihood of new discoveries but the marginal cost of production is increasing because of the aging of some oil fields and new wells are more expensive.

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[18] Mudassar Imran and Philip Barnes, op. cit., p. 33.

[19] IEA, *Coal Information 1990*, OECD, Paris, 1990, p. 67. This estimate is taken from Japan's Institute of Energy Economics.

[20] Mudassar Imran and Philip Barnes, op. cit., p. 36.

- natural gas

Table 46 shows proven gas reserves and reserves/production ratios in selected countries in the ESCAP region as of the beginning of 1989. Natural gas is expected to be very important and there are discussions to build a natural gas grid in the ASEAN region.

Indonesia is now the world's largest exporter of LNG. Exports are mainly to Japan (which receives over 90 per cent of exports), the Republic of Korea, Taiwan and the United States. If current growth rates in natural gas continue, it could surpass crude oil in importance by the middle of the 1990s. Malaysia is expected to be a major producer of natural gas and is currently building a domestic gas grid.

China wants to expand production from 13.9 bcm in 1988 to 30 bcm in 2000. India is expecting production to reach 27 bcm in 1994-95 and 33-36 bcm in 2000 from 15 bcm in 1989. It is expected that Pakistan will reach 22 bcm by 1993 from the 1988 level of 12.6 bcm.

Table 46
Proven Gas Reserves and
Reserves/Production (R/P) Ratio
(1 January 1989)

	Gas Reserves (bcm)	R/P Ratio
Bangladesh	350	76
Brunei	322	36
Burma	267	
China	1000	73
India	1050	81
Indonesia	2464	58
Iran	14200	
Malaysia	1472	89
Pakistan	651	52
Taiwan Province	24	
Thailand	212	35

Source: CEDIGAZ

- hydroelectricity

China plans to expand hydro capacity from 30 GW to 80 GW by the year 2000. A recent World Bank study estimates that China will reach 70 GW. Cost is the major factor holding back development[21]. There is considerable potential remaining in other ESCAP countries. For example, Pakistan has exploited 10 per cent, India 13 per cent and Thailand 36 per cent of potential. The Philippines has developed 11 per cent of its geothermal potential.

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[21] E.A. Moore and George Smith, op. cit., p.69.

Throughout the 1990s, India is expected to lead in the expansion of hydroelectricity capacity, gaining over 37 GW. The entire region is expected to expand its hydroelectric capacity by 78.3 GW[22].

- nuclear

China is building two nuclear plants to be completed in the 1990s. The Republic of Korea has nine nuclear plants and will be adding 7 more in the 1990s (totaling 6700 MW of additional capacity above its current 7616 MW). The Republic of Korea is the tenth largest nuclear producer in the world. Taiwan Province of China has three nuclear plants and is the twelfth largest in the world. Development of new facilities were put on hold after a fire at one of the existing facilities and the Chernobyl accident.

India has plans for expansion but delays are expected. It is currently negotiating with the French to purchase two 900 MW light water reactors. India also has an intergovernmental agreement with the Soviet Union to build two 1000 MW nuclear plants in the state of Tamil Nadu. Pakistan is also negotiating with France for a 937 MW nuclear plant.

- renewables

Already traditional fuels such as firewood, crop residues and charcoal play a major role in total energy demand (see Table A-6 in Annex). In India, Indonesia and Pakistan their use can reach around 50 per cent. It is expected that, if anything, the share of traditional fuels in total energy demand will drop because of urbanization, improved standard of living, etc.

All reports, however, lead to the same conclusion that new and renewable sources of energy, such as solar and wind, will not make a significant inroad in the 1990s. Geothermal could expand, particularly in countries such as the Philippines where there is significant remaining potential.

b) Potential for Energy Conservation in Industry

Accurate estimates for remaining energy conservation potential cannot be made without detailed analysis of individual industrial sub-sectors, primarily at the plant level. This is mainly achieved by detailed energy audits of individual plants.

Assessing the potential for energy conservation is not a static analysis because it is dependent on energy prices and price assumptions and the trends in technology development. Generally, potential is defined in terms of its economic viability because investments are normally based on cost-effectiveness. However, it is often difficult to assess the cost-effectiveness of a certain investment if the lifetime is 20 or 30 years.

This all leads to the point that discussion on potential is often confusing because of its lack of absolute precision. The following table shows the "economic" potential of a number of technologies in the OECD. All the studies were made under different assumptions, but they lead to the same conclusion: there is significant improvements to be gained even from the new stock average efficiency. The IEA is currently undertaking

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[22] E.A. Moore and George Smith, op. cit., p.69.

a major study to assess the full potential to see what contribution energy conservation can make to reducing global climate change but that study will not be available until later in 1991.

Table 47
Energy-Efficient Technologies and the Economic Potential for Conservation in Industry

Energy End-Use Technology	Existing Stock Average Efficiency (Units)	New Stock Average Efficiency (% savings)	Best Available Technology (% savings)
Chemicals			
- U.K. (inorganic)			-13%
Iron and Steel			
-U.S./Japan/U.K. Netherlands	22-24 (GJ/tonne)	17-18 (-20-25%)	At least -20-25%
Non-ferrous metals			
-OECD (Aluminium)	15-17(mWh/tonne)	13.5 (-10-20%)	At least -10-20%
Paper			
- U.K. (Paper and Board Making)			-30%
Stone, Clay and Glass			
-U.S./France/Switz /U.K. (Bricks/ Pottery)	2.5 (MJ/kg)	1.5-2.0 (-20-40%)	At least -20-40%
-France/U.K./ Switz./Germany (Cement)	3.6-3.8 (MJ/kg)	3.3 (-8-13%)	At least -8-13%
Electric Motors	75-90% (% converted to motive power)	80-92% (-2-7%)	-15-30%
Central and On-Site Electricity Generation			
-U.S. (Gas Turbines)	30% (% converted to electricity)	35% (-15%)	-25%

Source: adapted from International Energy Agency, *Energy and the Environment: Policy Overview*, OECD, Paris, 1990, pp.116-118.

Section I presented future forecasts for the Asia and the Pacific region. The industrial energy conservation scenario in the ESCAP projections assumed improvements of 20-30 per cent. Improvements gained momentum between 2000 and 2010. These improvements were "assumed to be in part price-induced and in part through other interventions. A further assumption . . . is that these efficiency improvements occur equally across all industrial fuels, i.e. they are fuel independent."[23]

The World Bank, in its study of seven ESCAP countries, estimates that the end-use potential for energy savings in industry is 26 per cent.[24] The potential savings in transport is 11 per cent and in residential services 8 per cent.

Thus, while analysis could definitely be more precise, there are significant cost-effective savings to be achieved by energy conservation efforts. The policy dilemma is how to achieve that potential through a combination of market and non-market means. The following section will consider the range of energy policies that are, to some extent, already in place but can be used to develop an efficient energy framework to ensure long-term industrial development.

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[23] ESCAP, op.cit., p. 17.

[24] Mudassar Imran and Philip Barnes, op. cit., p. 69.

V Integrating Energy and Industrial Development Policies

One of the major problems for energy policy is to find the right balance between supply development and energy conservation in order to develop a stable environment for continued industrial development Energy supply policies are pursued to develop indigenous resources, ensure imports, switch away from expensive, insecure energy resources and ensure reliable useful energy such as electricity. Even countries without indigenous resources have a role in developing an adequate energy supply system, regardless whether it is left completely out of the hands of government. Governments provide some form of regulatory regime to ensure the smooth functioning of the energy supply systems, particularly for electricity and gas.

a) Energy Supply

As we have seen, those countries with indigenous resources are developing them wherever possible. There is still much potential for expanded production for many energy sources as we saw in the previous section.

One of the major constraints, however, is financing. For example, as seen above, one World Bank study shows electricity expansion in the 1990s amounting to $455 billion if growth is 7.7 per cent per year. This is a very high growth rate and very expensive. Nevertheless, as rural electrification continues, consumer appliances increase and industrial uses for electricity expand, the need for more and reliable electricity will become more important.

For oil, many countries have mandatory stock levels and oil sharing agreements in case of oil shortages. The refining industry has also been expanded, although for commercial more than strategic reasons.

ASEAN also has ASCOPE, the ASEAN Council for Petroleum. Under ASCOPE there are programs in:

- co-operation in petroleum exploration
- co-operation in petroleum production
- manpower requirements and training
- sharing of petroleum products
- co-operation in systematizing the storage, collection, dissemination, transmission and format of petroleum data.

For the Emergency Petroleum Sharing Scheme the three oil producers (Brunei, Indonesia and Malaysia) will supply the oil importers (the Philippines, Singapore and Thailand) in the event of an oil shortage (less than 80 per cent of normal supply). The importers also buy from the exporters during periods of over-supply. While this system has not yet been activated, ASEAN officials were recently discussing preparations for its use if a Gulf war breaks out.

Natural gas is seen to be an important energy source for the future and ASEAN countries are discussing having a gas grid. Malaysia is already building a pipeline

system which will be the most comprehensive gas development scheme in the world. The third phase will have it reaching Singapore. The gas will largely be used for electricity production and petrochemical and fertilizer projects. The pipeline could form the core of the ASEAN system for which in November, 1990, ASEAN Energy Ministers recommended further study.

Coal will undoubtedly play a major role in the future and development is continuing.

Many countries are continuing the switch away from oil. As seen in Table 2, this policy has been quite successful but the region as a whole has increased its dependence on oil.

Most Asia and Pacific countries have done little to promote renewable energy. China did subsidize the retrofit of half of the country's 40 million wood stoves to increase their efficiency from 10 to 20 per cent. China also has about 70,000 solar stoves and 250,000 square metres of solar water heating surfaces. China exports solar panels it cannot use domestically. China is also planning to build small windmills.

b) Energy Conservation

Efforts to encourage industrial energy conservation have been pursued in many ESCAP developing countries. There are different types of policies for energy conservation but most of them centre around providing energy consumers with the necessary encouragement to undertake energy conservation investments or management practices. These are done by a combination of information programs, financial incentives, standards and regulations, and research and development.

One of the important aspects of industrial energy conservation policies is that they can be integrated into other government policies which encourage industrial restructuring and development because, in many ways, they are pursued with similar methods. In fact, it has been found in many countries, both industrialized and developing, that energy conservation measures have been useful for improving competitiveness, management techniques, quality control, cost control, etc. and thus are quite compatible with industrial development objectives.

Even if prices give the right signal to the consumer, energy conservation does not happen automatically. There are many market barriers which hinder consumers from making energy efficiency improvements[25]. Without going into detail, these barriers can include:

Information
- Awareness
- Lack of Technical Knowledge
- Lack of Technical Skills
- "Invisibility" of Energy Use and Conservation Results
- Education

Financial
- Access to Capital
- Return on Investment

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[25] For more detail see IEA, *Energy Conservation in IEA Countries*, OECD, Paris, 1987.

Technology Introduction
- Confidence in New Technologies
- Service/Distribution Industries

Institutional
- Lack of Government Commitment
- Lack of Co-ordination
- Budgetary/Requisition Procedures
- Government Administrative Procedures
- Government Disincentives and Regulations
- International Funding Procedures and Policies

Without market barriers, presumably the potential identified in the last section would be achieved without any government policies and intervention. However, such is not the case. **What is important from a policy perspective is how much of the potential will not be achieved, in the absence of any further government policies, at least in the near term.**

This requires detailed analysis at the national, regional, sectoral and plant levels of what the cost-effective energy conservation potential is and why it is not being achieved. The important lesson is that one needs first to understand clearly **what the problem is** before deciding how to solve it.

In many countries, one of the major problems has been the lack of a mature, effective service industry which can undertake the necessary energy audits and studies, provide new energy-efficient technologies and retrofit existing equipment. This service industry was slow in developing in industrialized countries, but once it did develop, it made government policies that much easier to implement. However, in many countries, governments have had to take the lead in encouraging and promoting the development of the service industry.

Table 48 shows the basic types and examples of energy conservation programs available[26].

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[26] For more detail see IEA, *Energy Conservation in IEA Countries*, OECD, Paris, 1987, Chapter VIII and IEA, *Energy and the Environment: Policy Overview*, OECD, Paris, 1990.

Table 48
Energy Conservation Policy Measures
for Industry

Information

General publicity campaigns
Energy Audits
Labels and Guides
Technical Handbooks
Advisory Services
Training and Education
Demonstration Programs
Technology Transfer

Financial Investment Incentives

Grants
Tax Incentives
Loans

Regulations and Standards

Minimum Efficiency Levels
Boiler Maintenance Requirements
Mandatory Energy Consumption Data Reporting
Mandatory Energy Managers in Factories

Many ESCAP developing countries already have implemented energy conservation measures.

Information

• several countries have energy audit programs or requirements (for example, India, Indonesia, Pakistan, Republic of Korea, Taiwan Province).

• training programs exist in China, India, Indonesia, Pakistan. the Philippines, the Republic of Korea, Taiwan Province

• The Republic of Korea established KEMPCO, the Korean Energy Management Corporation, which conducts energy audits, provides training and technical assistance. Pakistan set up ENERCON, the National Energy Conservation Centre which provides information, training, audits and demonstrations.

Financial Incentives

• Thailand provides low interest loans for industrial energy conservation projects and reduced tariffs on energy-efficient technologies. The Philippines provides tax credits and

the Republic of Korea provides loans, tax credits and accelerated depreciation allowances for energy-efficient technologies.

• China has investment funds specifically for energy management and energy efficiency. The Sixth Five-Year Plan, 1981-1985 allocated 10 billion yuan in total (in 1985 the exchange rate was 2.9 yuan to the US$). These were allocated between technology modernization projects (such as waste heat utilization and renovation of industrial boilers) and capital equipment projects (e.g. cogeneration, renovation of cement kilns, processing scrap).

Regulations

• The Republic of Korea has the 1980 Energy Management and Efficiency Law which empowers the Ministry to order the replace of inefficient equipment and set efficiency standards for industry.

• Taiwan Province of China has a 1980 energy management law for large industrial energy consumers which provides the authority to targets and establish energy audit systems. After the 1979 oil crisis, Taiwan Province also prohibited the establishment or expansion of energy-intensive industries.

From the experience in industrialized countries, some useful points about these measures:

Information

• Energy audits are very popular and useful. There are different types of audits, from simple "walk-through" to highly instrumented audits which can take several days. Many countries have used the "energy bus" which provides a computerized energy audit of factories. Some countries use the bus not so much for a detailed analysis as for creating awareness. Energy buses can be very useful for small and medium sized companies. Energy audits can be subsidized by governments or they can be available by consulting or engineering firms. Industries should be made aware of the importance of energy audits.

• Technical handbooks and brochures can be useful for providing information about energy conservation techniques and technologies. They are also relatively inexpensive.

• Training is very useful to transfer technical information to plant engineers and technical staff. There is a need for continually upgrading skills because energy conservation techniques need to be given special attention and there are many specialized topics to be covered. Training is necessary, not only on the technologies themselves, but on energy management techniques.

• Demonstration projects are important to disseminate information about new energy-efficient technologies which have not had significant market penetration. Demonstrations are an important element in a technology development strategy which ranges from research through to market introduction. However, demonstrations are also useful for countries which do not undertake research but simply obtain the technologies from other countries. Demonstrations are important in overcoming consumer hesitation to new technologies.

Financial Incentives

• Financial incentives have proven to be very effective in promoting energy conservation in industry. Countries can choose between loans, grants and tax credits or depreciation allowances to fit in with the array of incentives already offered to industry. Of the subsidy programs evaluated in the mid-1980s in IEA countries, those for industrial programs had the highest benefit/cost ratio, partially because they can be targeted to both specific technologies and specific industries.

Regulations and Standards

• Regulations and standards are used more in the residential/commercial and transport sectors where there is more standardization of equipment. Industry uses many technologies in a single plant and it is very difficult to verify compliance.

• They can be useful in requiring energy managers in large, energy-consuming factories, establishment of energy management and data collection procedures, efficiency rates for boilers and preparation of energy conservation plans to be submitted upon application for construction of new facilities.

c) Energy Pricing

Arguably, one of the major reasons why energy conservation efforts showed good results in the IEA and why energy intensity decreased, was the de-regulation of energy prices in many countries. Many governments only passed part of the price increases from the first two oil crises through to consumers. This, in effect, dampened the price effect and reduced or slowed down the incentive to invest in energy efficiency.

IEA Ministers "agreed on the need for energy pricing policies which permit consumer prices to reflect world market prices. Where world markets do not exist, Ministers agreed that prices should reflect long-term costs of energy supply and which interfere as little as possible with the operation of market forces, particularly through direct controls or subsidies."[27] Now, there are relatively few price controls in the IEA region.

Of course, it is difficult in determining long-term prices and it is even more difficult in implementing them. But many ESCAP developing countries still regulate prices through taxation and subsidy policies. These are often done to meet other economic or social objectives.

While prices are regulated, many ESCAP developing countries are now passing the prices of imported fuels fully to the consumer. Generally, taxes are used most on "luxury" fuels such as gasoline. Some countries use taxation as a means of reducing petroleum demand.

Electricity and gas rates have usually been below long-term costs for social and political reasons. It is estimated that electricity rates in China represent only 60-70 per cent of marginal supply costs.[28] This is true in many other countries as well. Some

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[27] IEA, *Energy Conservation in IEA Countries*, OECD, Paris, 1987, P.86.

[28] Mudassar Imran and Philip Barnes, op. cit., p. 46.

countries such as Thailand are developing tariff structures to shift demand to off-peak periods.

d) Integrating Energy Objectives into Current Institutional and Administrative Practices

Because of the inherent importance of energy, due consideration should be given to integrating energy objectives into industrial administrative practices and industrial development procedures. Some examples are:

• Ensuring that energy objectives (both supply and conservation aspects) are given due consideration in feasibility studies for new industrial development projects.

• Procurement policies should be designed to ensure that new leased or purchased equipment be as energy-efficient as economically feasible. Table 47 showed some examples of the difference in efficiency of current practice and best available energy-efficient technologies. Because these technologies often have a lifetime of 10 to 30 years, it is important to stress the efficiency aspect. However, the most energy-efficient technologies are generally not the lowest price available and thus procurement procedures should take this into consideration.

• Several countries have state-owned industries. The government can set an example by instituting energy conservation procedures within them and can ensure that budgetary, administrative practices do not hinder energy conservation efforts.

• Leasing arrangements should be designed so there is an incentive for the user to save energy and for the landlord to invest in energy-efficient improvements.

• University and technical education programs should be oriented to stress energy efficiency. Of course, training plant engineers and technicians in energy efficiency is important, but it is even more effective to integrate energy efficiency into the school curriculum.

• Energy objectives should be one criterion in the location of new industrial development, particularly when there is a major decentralization of industry. Aspects that should be considered include: availability of local sources of energy (coal, natural gas, biomass, etc); quality and capacity of electricity grid and the cost of extending it to new regions and other related infrastructure such as roads that lead to increased energy consumption to get materials to and from markets.

• National subsidy programs, for industrial development or energy conservation, often do not take into full account other national objectives. This is often because of split authority amongst ministries. There is a need to fully integrate all national objectives when developing and implementing programs. Sometimes this means only a minor re-orientation of programs to meet all objectives. This integration also reduces confusion on the part of industry.

• Similar to the national subsidy programs, aid programs, both bilateral and multinational, often are designed with single purposes without due consideration to other objectives.

VI Conclusions

a) Why Energy Objectives Must Be Given Increased Consideration in Industrial Development Policies

The economies in general and industrial output specifically of the ESCAP developing countries have grown at phenomenal rates in the past two decades and there is every reason to believe that above-average growth rates will continue at least well into the next century. This growth is bringing about changes in society in the form of better distribution of wealth and other social reforms. Changes in society also mean more consumer goods such as electric appliances and private cars and more demand for services such as electricity. These rapid changes undoubtedly create strains on the ability to provide the needed useful energy to provide these goods and services.

The industrial structure is changing accordingly, largely away from labour-intensive industries to those where more value is added. There is also more emphasis on producing goods for domestic consumption while at the same time improving competitiveness in international markets.

These changes in society and industry are putting a tremendous strain on the energy system. Whether it is for new cars or televisions or modern plants, the demand for reliable energy becomes more pronounced. It becomes more obvious in the industrial sector where brownouts, blackouts or shortages of any kind affect output, both in quantitative and qualitative terms. In quantitative terms, energy shortages means lower production or having to schedule other times to make up production shortages. In qualitative terms, shortages or brownouts can affect the quality of the products, particularly in the electronics and other sophisticated industries.

Yet the costs of building up the energy infrastructure are enormous and the engineering requirements in a relatively short time are staggering. For example, the World Bank estimates electricity growth to be 7.7 per cent per year in the 1990s for the Asia developing region. Their estimate is for 244,355 MW of added capacity this decade with coal growing by 139,745 MW, hydro by 78,301 MW, nuclear by 14,114 MW, gas by 13,371 MW and geothermal by 1,929 MW (oil decreases by 3125 MW).[29] From needed lead times, engineering capability, transmission and distribution requirements, this will be very ambitious and costly.

ASEAN is also exploring the possibility of a transnational gas grid which will also take time and enormous funding.

There is also the trend towards greater energy imports. As stated above, even the region's major energy exporters could be net energy importers early next century. The entire region could be a net energy importer in the relatively near future.

What this means is that the energy used must be done so as efficiently as possible. ESCAP forecasts show the benefits of a strong industrial energy conservation

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[29] E.A. Moore and George Smith, op. cit., pp.21-27.

program (see Section I) The following table shows what total energy demand is forecast to be under the two scenarios.

Table 48
TPER in 2000
Baseline and Industrial Energy Conservation Scenarios
(mtoe)

	Baseline Scenario	Industrial Energy Conservation Scenario
Bangladesh	9.6	8.4
China	986.3	841.3
India	300.8	293.3
Hong Kong	11.7	10.2
Korea, DPR	62.6	52.1
Korea, Rep of	136.0	125.3
Malaysia	28.2	27.6
Pakistan	47.4	41.8
Philippines	27.6	26.4
Singapore	17.5	17.0
Taiwan	67.7	57.5
Thailand	57.5	56.9

Source: ESCAP

The benefits are very noticeable and the pressure to find new sources of energy is greatly diminished if strong energy conservation efforts are made.

The Japanese model becomes apparent. While many industrialized countries after the first two oil crises believed energy conservation to be a constraint on growth, the opposite attitude prevailed in Japan. Energy conservation was seen to be an opportunity to examine current practices to improve efficiency in more than just energy and to reduce operating costs. Table 45 shows the relative importance of energy costs in total production costs in a number of industries which exist and are expanding in the Asia and Pacific region. Saving anywhere from 10 to 30 per cent can mean tremendous production cost savings which means lower costs per product and better productivity.

For a company, however, energy conservation is important because:

- the payback period for many investments is very low and thus very attractive;
- there can be productivity improvements due to the discipline of the energy management process which can lead to improved utilization of raw materials, labour and equipment; and
- there can be environmental benefits.

For the country, energy efficient practices reduces or delays the need for expanded production and investment in energy conservation at the margin often provides a better return than investment in energy supply. For the country as a whole, energy conservation can be an important element in the strategy to address the growing

environmental issue. Energy conservation also means lower energy imports and thus better balance of payments.

It is important to realize that industrial development policies and energy conservation policies are not in conflict. Energy conservation does not mean curtailment of energy but rather using energy efficiently -- having the same production output with less energy input.

b) How to Achieve The Energy Supply/Conservation Potential

The need to increase energy supply is a major concern for governments in the ESCAP developing country region because of the tremendous growth that is taking place. Undoubtedly, priorities will be placed on providing secure, reliable energy to consumers. While trying to implement energy supply policies, however, governments should not lose sight of trying to provide services at the lowest cost. This, in many ways, means through energy conservation, because it is often the cheapest form of supply. It also means producing electricity, for example, using more efficient technologies such as cogeneration when appropriate. Because of the high cost estimates for new supply, it is essential to reduce them wherever possible.

The last section described many of the energy conservation measures which are being used in ESCAP developing countries and industrialized countries. It is not the purpose of this report to go into detail but to show what options are available. Implementing measures effectively is not easy but when done so the benefits can be significant. However, more importantly, it is essential to ensure that the right measures are being used when necessary. This requires a lot of detailed analysis usually by or through a central body which has the authority to analyze and implement. As seen above, both the Republic of Korea and Pakistan have such organizations.

Important types of analysis includes:

- supply/demand balance
- potential for energy savings by industrial sub-sector
- detailed examination of why the potential is not being achieved
- evaluation of existing energy conservation measures and government policy/implementation framework
- setting priority sub-sectors by potential savings and where government involvement could produce the best results.

Only after identification of the problems can solutions be found. Too often countries have implemented, for example, a subsidy program costing millions of dollars a year when the real problem was awareness of energy options which could possibly have been addressed by brochures, seminars and conferences and energy buses.

From the identification of problems, there is an array of solutions and a body of literature which will help the analyst determine which is the best measure or group of measures which would address the problems in the timeframe determined by government.

It is important to re-state that energy conservation measures for industry should be integrated into other government industrial development programs so that there is no conflict or confusion on the part of industry. Energy conservation is a means of doing

something better, more efficiently. There is no inherent incompatibility with other industrial development policies.

c) Potential and Prospects for Further Regional Co-operation

The region is very heterogeneous but in many ways that is its strength. Countries are at different stages of development and thus they have the ability to help each other by learning from experiences.

There are already several examples of regional co-operation:

- The last section described the efforts of ASCOPE within the ASEAN region. That effort focuses on the petroleum sector.

- ESCAP has the Regional Energy Development Program (REDP) to assist countries in the areas of planning and management of energy programs. ESCAP also has the Pacific Energy Development Program to assist Pacific island nations in securing energy and the Biomass/Wind Energy Network which provides an exchange of data on biomass, solar and wind sources.

- The Asia and Pacific Development Center under the aegis of ESCAP concentrates on technology development and industrialization. In energy, it prepared an impressive three-volume textbook on integrated national energy planning. In 1985 the Asian and Pacific Energy Planning Network was created to help strengthen national capabilities in energy planning.

- The Asian Development Bank has funded many projects and has sponsored much analysis.

However, there are several areas where further regional co-operation could be very useful and productive:

- Developing an effective technology transfer and information system to let energy consumers and energy service industries know what technologies are available. This could include regional technology fairs.

- Regional data collection and analysis of both industrial trends and energy consumption. This would help develop effective efficiency indicators for regional industrial sub-sectors.

- Regular conferences and seminars for government policy analysts and program implementers to upgrade their policy development and program implementation skills and to share experiences. This is particularly important for analysts working in energy conservation because energy ministries will tend to be highly weighted on the energy supply side because of current priorities.

- Regional meetings or organization for industrial energy consumers to let them share experiences in energy management and to better understand the importance of the subject.

• Information, training and other related programs designed for small and medium-sized industries.

• Regional efforts to build up an effective energy service industry in individual countries.

Statistical Annex

Table A-1
Total Primary Energy Requirements
(ttoe)

	1975	1985	1988	Growth Rate 1975-88 p.a. (%)
Bangladesh	1794.9	4059.2	5916.5	9.6
Brunei	192.0	621.1	896.0	12.6
Burma	1507.8	2405.2	2008.4	2.2
China	321385.0	539888.0	625133.0	5.3
Hong Kong	4212.2	7490.6	10266.1	7.1
India	80803.0	137195.0	166303.0	5.7
Indonesia	13852.7	31715.5	38113.4	8.1
Iran	32562.0	54497.0	63197.0	5.2
Korea, DPR	28551.0	40093.0	41082.6	2.8
Korea, Rep. of	24554.7	53511.4	73095.4	8.8
Malaysia	6144.5	13198.8	17120.7	8.2
Nepal	124.0	285.2	385.8	9.1
Pakistan	9069.8	20666.8	25252.8	8.2
Philippines	10676.2	12060.5	13834.5	2.0
Singapore	4158.3	7840.1	9544.5	6.6
Sri Lanka	1139.0	1733.8	1876.6	3.9
Taiwan Prov	15096.8	32885.7	41356.6	8.1
Thailand	8893.1	16170.0	21751.6	7.1
Viet Nam	6080.0	4827.2	5071.4	-1.4
Other	5501.0	4436.9	6149.1	0.9
Total	**576298.0**	**985581.0**	**1168355.0**	**5.6**

Source: International Energy Agency, ***World Energy Statistics and Balances***

Table A-2
Hard Coal Production
(million tonnes)

	1975	1985	1988	Growth Rate 1975-88 p.a. (%)
Bangladesh				
Brunei				
Burma				
China	460.8	840.0	940.5	5.6
Hong Kong				
India	99.7	154.2	188.3	25.6
Indonesia	0.2	1.5	4.5	27.1
Iran	1.0	1.3	1.3	2.0
Korea, DPR	32.0	39.0	40.0	1.7
Korea, Rep. of	17.6	22.5	24.3	2.5
Malaysia				
Nepal				
Pakistan	1.3	2.2	2.7	5.8
Philippines	0.1	1.3	1.3	21.8
Singapore				
Sri Lanka				
Taiwan Prov	3.1	1.9	1.2	-7.0
Thailand				
Viet Nam				
Other	5.5	5.9	6.4	1.2
Total	**621.3**	**1069.8**	**1210.5**	**5.3**

Source: International Energy Agency, ***World Energy Statistics and Balances***

Table A-3
Lignite Production
(million tonnes)

	1975	1985	1988	Growth Rate 1975-88 p.a. (%)
Bangladesh				
Brunei				
Burma				
China				
Hong Kong				
India	3.0	7.8	8.7	8.5
Indonesia				
Iran				
Korea, DPR	9.0	12.0	12.5	2.6
Korea, Rep. of				
Malaysia				
Nepal				
Pakistan				
Philippines				
Singapore				
Sri Lanka				
Taiwan Prov				
Thailand	0.5	5.2	7.3	22.9
Viet Nam				
Other	2.6	6.1	7.0	7.9
Total	**15.1**	**31.1**	**35.5**	**6.8**

Source: **International Energy Agency, *World Energy Statistics and Balances***

Table A-4
Marketed Gas Production
(ttoe)

	1975	1985	1988	Growth Rate 1975-88 p.a. (%)
Bangladesh	384	2223	3613	18.8
Brunei	4278	7955	7875	4.8
Burma	153	783	962	15.2
China	7416	10843	11991	3.8
Hong Kong				
India	932	4103	7667	17.6
Indonesia	506	24197	30532	37.1
Iran	17172	12241	16740	-0.2
Korea, DPR				
Korea, Rep. of				
Malaysia	251	7888	13577	35.9
Nepal				
Pakistan	3321	6676	8100	7.1
Philippines				
Singapore				
Sri Lanka				
Taiwan Prov	1275	1075	1130	-0.9
Thailand	--	2607	4364	--
Viet Nam				
Other	2347	2391	2450	0.3
Total	**38036**	**82982**	**109001**	**8.4**

Source: International Energy Agency, ***World Energy Statistics and Balances***

Table A-5
Crude Oil and NGL Production
(million tonnes)

	1975	1985	1988	Growth Rate 1975-88 p.a. (%)
Bangladesh				
Brunei	9.2	8.3	7.0	-2.1
Burma				
China	77.1	124.9	136.8	4.5
Hong Kong				
India	8.3	30.2	32.3	11.0
Indonesia	64.5	64.8	66.8	0.3
Iran	266.5	111.8	112.0	-6.5
Korea, DPR				
Korea, Rep. of				
Malaysia	4.8	22.0	26.3	14.0
Nepal				
Pakistan	0.3	1.7	2.1	16.1
Philippines				
Singapore				
Sri Lanka				
Taiwan Prov				
Thailand	--	2.2	2.4	--
Viet Nam				
Other	1.2	1.9	1.3	0.6
Total	**431.9**	**367.8**	**387.0**	**-0.8**

Source: International Energy Agency, ***World Energy Statistics and Balances***

Table A-6
Production of Vegetal Fuels
(ttoe)

	1975	1985	1988	Growth Rate 1975-88 p.a. (%)
Bangladesh	4971	5507	5890	1.3
Brunei	18	18	18	--
Burma	3079	3760	4038	2.1
China	33401	42373	43771	2.1
Hong Kong	34	42	40	1.3
India	64297	73227	76149	1.3
Indonesia	23859	29535	31657	2.2
Iran	589	678	705	1.4
Korea, DPR	768	920	N.A.	--
Korea, Rep. of	3420	2031	1164	-8.0
Malaysia	1444	1811	1942	2.3
Nepal	2753	5116	8039	8.6
Pakistan	3690	5426	6346	4.3
Philippines	6988	7605	8313	1.3
Singapore	--	--	--	--
Sri Lanka	1531	1954	1889	1.6
Taiwan Prov	N.A.	N.A.	N.A.	--
Thailand	9713	11337	10890	0.9
Viet Nam	4057	5155	5406	2.2
Other	5219	5836	5923	1.0
Total	**169831**	**202331**	**212180**	**1.7**

Source: International Energy Agency, ***World Energy Statistics and Balances***

Table A-7
Electricity Production
(GWh)

	1975	1985	1988	Growth Rate 1975-88 p.a. (%)
Bangladesh	1627	4870	6546	11.3
Brunei	230	906	1030	12.2
Burma	978	2120	2272	6.7
China	195840	410700	545100	8.2
Hong Kong	7363	19230	25501	10.0
India	85926	188479	229653	7.9
Indonesia	8424	30564	37010	12.1
Iran	15333	39220	47600	9.1
Korea, DPR	26000	48000	53000	5.6
Korea, Rep. of	19837	58007	85462	11.9
Malaysia	5788	14914	19349	9.7
Nepal	88	362	589	15.7
Pakistan	11780	30220	38041	9.4
Philippines	13670	22909	24538	4.6
Singapore	4176	9960	13018	9.1
Sri Lanka	1149	2464	2799	7.1
Taiwan Prov	23914	54803	74782	9.2
Thailand	8866	24179	33339	10.7
Viet Nam	2428	5000	5300	6.2
Other	5677	9160	10275	4.7
Tctal	**439094**	**976067**	**1255204**	**8.4**

Source: International Energy Agency, ***World Energy Statistics and Balances***

Table A-8
Energy Intensity (TPER/GDP)* for selected countries

	1975	1985	1988	Growth Rate 1975-88 p.a. (%)
Bangladesh	0.14	0.21	0.28	5.48
Brunei				
Burma				
China				
Hong Kong	0.22	0.17	0.17	-1.96
India	0.47	0.53	0.55	1.22
Indonesia	0.21	0.27	0.28	2.24
Iran	0.21	0.33	0.41	5.28
Korea, DPR				
Korea, Rep. of	0.49	0.52	0.52	0.46
Malaysia	0.33	0.39	0.41	1.68
Nepal				
Pakistan	0.43	0.54	0.55	1.91
Philippines	0.35	0.30	0.31	-0.93
Singapore	0.45	0.41	0.40	-0.90
Sri Lanka				
Taiwan Prov				
Thailand	0.35	0.33	0.37	0.4
Viet Nam				

*** GDP defined in real 1985 US$**

Source: International Energy Agency, ***World Energy Statistics and Balances;*** IMF International Financial Statistics

Table A-9
Oil Consumption
(thousand tonnes)

	1975	1985	1988	Growth Rate 1975-88 p.a. (%)
Bangladesh	1142.9	1622.6	2033.0	4.5
Brunei	123.0	298.6	527.0	11.8
Burma	1069.1	1246.0	739.6	-2.8
China	67755.0	93910.0	100464.0	3.1
Hong Kong	4204.0	4181.6	4689.4	0.8
India	23983.0	44374.0	53179.0	6.3
Indonesia	12789.8	23485.7	25902.0	5.6
Iran	20925.0	40185.0	43926.0	5.9
Korea, DPR	1203.0	3111.7	3052.9	7.4
Korea, Rep. of	16124.0	26809.4	35590.3	6.3
Malaysia	5647.5	9700.7	10376.7	4.8
Nepal	76.0	157.0	202.1	7.8
Pakistan	3962.9	8147.7	9767.1	7.2
Philippines	10104.7	8237.8	9713.6	-0.3
Singapore	4157.2	7833.9	9531.5	6.6
Sri Lanka	953.0	1196.9	1296.6	2.4
Taiwan Prov	10466.2	16704.8	20983.9	5.5
Thailand	7976.1	11130.2	14357.2	4.6
Viet Nam	3139.0	1441.0	1478.4	-5.6
Total	**199938.0**	**305856.0**	**360566.0**	**4.6**

Source: International Energy Agency, ***World Energy Statistics and Balances***

Table A-10
Oil Intensity
(oil consumption per unit of GDP)

	1975	1985	1988	Growth Rate 1975-88 p.a. (%)
Bangladesh	0.09	0.09	0.10	0.81
Brunei				
Burma				
China				
Hong Kong	0.22	0.09	0.08	-7.49
India	0.14	0.17	0.18	1.95
Indonesia	0.19	0.20	0.19	--
Iran	0.14	0.24	0.29	5.76
Korea, DPR				
Korea, Rep. of	0.32	0.26	0.25	-1.88
Malaysia	0.30	0.29	0.25	-1.39
Nepal				
Pakistan	0.19	0.21	0.21	0.77
Philippines	0.33	0.20	0.22	-3.07
Singapore	0.45	0.41	0.40	-0.9
Sri Lanka				
Taiwan Prov				
Thailand	0.31	0.23	0.24	-1.95
Viet Nam				

Source: International Energy Agency, ***World Energy Statistics and Balances;*** IMF International Financial Statistics

Table A-11
Electricity Consumption
(ttoe)

	1975	1985	1988	Growth Rate 1975-88 p.a. (%)
Bangladesh	98.0	272.3	352.3	10.3
Brunei	20.0	71.3	81.3	11.4
Burma	60.5	125.4	141.0	6.7
China	13895.0	29294.0	38618.0	8.2
Hong Kong	552.3	1369.4	1806.3	9.5
India	5635.0	11884.0	15278.0	8.0
Indonesia	652.1	2350.2	2838.9	12.0
Iran	1124.0	2786.0	3381.0	8.8
Korea, DPR	1892.0	3506.2	3870.0	5.7
Korea, Rep. of	1387.7	4284.9	6306.3	12.4
Malaysia	425.4	1077.0	1393.0	9.6
Nepal	7.0	26.6	40.5	14.5
Pakistan	578.0	2085.2	2699.5	12.6
Philippines	1066.3	1565.3	1643.7	3.4
Singapore	277.4	682.4	924.8	9.7
Sri Lanka	83.0	178.4	203.9	7.2
Taiwan Prov	1776.3	4004.6	5472.4	9.0
Thailand	673.1	1801.6	2484.4	10.6
Viet Nam	163.0	335.4	352.6	6.1
Total	**30845.0**	**68077.0**	**88268.0**	**8.4**

Source: International Energy Agency, ***World Energy Statistics and Balances***

Table A-12
Industrial Energy Consumption
(ttoe)

	1975	1985	1988	Growth Rate 1975-88 p.a. (%)
Bangladesh	705.1	1395.5	2003.6	8.4
Brunei	37.0	76.1	77.5	5.9
Burma	551.5	1149.8	N.A.	--
China	N.A.	261391.0	N.A.	--
Hong Kong	1170.6	2022.8	2796.1	6.9
India	30812.0	48759.0	N.A.	4.7*
Indonesia	3552.7	9004.1	9414.7	7.8
Iran	11463.0	17128	21428	4.9
Korea, DPR	20533.0	24702.6	25410.0	1.7
Korea, Rep. of	8438.3	17123.9	23734.0	8.3
Malaysia	2105.1	3672.9	4530.9	6.1
Nepal	30.0	61.7	62.0	5.7
Pakistan	3004.1	6936.3	N.A.	8.7*
Philippines	2972.8	3221.3	2570.2	-1.1
Singapore	389.1	1551.9	1906.3	13.0
Sri Lanka	194.0	171.5	182.5	-0.5
Taiwan Prov	6073.5	12457.3	16545.7	8.0
Thailand	1942.2	2987.3	3736.9	5.2
Viet Nam	2717.0	2475.3	2632.7	-0.2
Total	**101368.0**	**N.A.**	**N.A.**	

* growth rate 1975-85

Source: **International Energy Agency, *World Energy Statistics and Balances***

Table A-13
Industrial Energy Intensity
(Industrial energy consumption/GDP)

	1975	1985	1988	Growth Rate 1975-88 p.a. (%)
Bangladesh	0.06	0.07	0.10	4.0
Brunei				
Burma				
China				
Hong Kong	0.06	0.05	0.05	-1.4
India	0.18	0.19	N.A.	0.5*
Indonesia	0.05	0.08	0.07	2.6
Iran	0.07	0.10	0.14	5.5
Korea, DPR				
Korea, Rep. of	0.17	0.08	0.08	5.5
Malaysia	0.11	0.11	0.11	--
Nepal				
Pakistan	0.14	0.18	N.A.	2.5*
Philippines	0.10	0.08	0.06	-3.9
Singapore	0.04			
Sri Lanka				
Taiwan Prov				
Thailand	0.08	0.06	0.06	-2.2
Viet Nam				

* growth rate 1975-85

Source: International Energy Agency, ***World Energy Statistics and Balances;*** IMF International Financial Statistics

Table A-14
Indigenous Production/TPER

	1975	1985	1988	Growth Rate 1975-88 p.a. (%)
Bangladesh	0.28	0.61	0.66	6.8
Brunei	71.6	26.5	16.8	-10.6
Burma	0.83	1.04	0.98	1.3
China	1.04	1.10	1.06	0.2
Hong Kong	--	--	--	--
India	0.84	0.90	0.98	0.4
Indonesia	4.83	2.93	2.71	-4.4
Iran	8.92	2.35	2.11	-10.5
Korea, DPR	0.95	0.88	0.88	-0.6
Korea, Rep. of	0.35	0.28	0.29	-1.4
Malaysia	0.87	2.36	2.44	8.3
Nepal	0.14	0.26	0.33	6.8
Pakistan	0.60	0.66	0.68	1.0
Philippines	0.05	0.28	0.26	13.5
Singapore	--	--	--	--
Sri Lanka	0.22	0.31	0.31	2.7
Taiwan Prov	0.31	0.31	0.25	-1.6
Thailand	0.10	0.44	0.44	12.1
Viet Nam	0.54	0.76	0.77	2.8
Total Asia	**1.45**	**1.10**	**1.04**	**-2.5**

Source: International Energy Agency, ***World Energy Statistics and Balances***

Table A-15
TPER Per Capita
(toe)

	1988
Bangladesh	0.06
Brunei	3.72
Burma	0.05
China	0.57
Hong Kong	1.81
India	0.21
Indonesia	0.22
Iran	1.20
Korea, DPR	1.88
Korea, Rep. of	1.74
Malaysia	1.01
Nepal	0.02
Pakistan	0.24
Philippines	0.24
Singapore	3.61
Sri Lanka	0.11
Taiwan Prov	1.92*
Thailand	0.40
Viet Nam	0.08
IEA Average	4.92
IEA Pacific	3.48
IEA Europe	3.11
North America	8.00

* 1987

Source: International Energy Agency, ***World Energy Statistics and Balances***