

(1997) ASIA

ENERGY DEVELOPMENT IN SOUTHEAST AND NORTHEAST ASIA by Giap van Dang

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1. Introduction

Since the beginning of this decade, a large majority of countries in southeast and northeast Asia have moved forward on a truly remarkable economic growth path. Average annual growth rates ranging from seven to eleven percent have been a common feature of the economic landscape. Several factors have been put forward to explain this phenomenon but the most important is probably the institutional and policy reforms initiated and implemented at the end of the '80s. As a result of economic growth, energy consumption has also increased very rapidly, putting tremendous stress on the energy supply system which has only recently started to regain some degree of stability and sustainability. Initiatives taken by governments of both regions to include the participation of the private sector in the development of the energy system have helped to create a better context for national energy and economic policy management. However, the energy supply and demand systems under construction in both regions are far from ensuring a conflict free strategy aimed at reconciling the requirements for strong, sustainable socio-economic development and the needs of better environmental protection.

Reviewing and analyzing all the impacts of the energy systems in both regions are beyond the scope of this paper. The purpose here is to provide an overview of energy efficiency changes for a selected number of countries in both regions between 1980 and 1994, and the recent policy changes aimed at promoting the consumption of renewable energy sources, such as biomass for co-generation, solar photovoltaics and geothermal for power development, etc. This paper will first discuss the main socio-economic and energy features of the southeast and northeast Asian countries selected. They are grouped into three main types of economies reflecting the wide diversity of situations found in both regions: group 1: "old tigers" economies, i.e. Korea and Taiwan, group 2: "young tigers" economies, i.e. Thailand, Philippines and Indonesia and group 3: "meta tigers" economies, i.e. China.



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2. Southeast and Northeast Asia : Key Characteristics of the Selected Countries

The total population of the six selected countries is about 1.6 billion of people, or about 90 percent of the total population of both regions. The annual population growth rate ranges from about 1 percent for South Korea to 2.3 percent for the Philippines. The highest growth rate was observed in Cambodia (2.8 percent per annum); except for countries in Group 1, most people in Groups 2 and 3 still live in rural areas: 70 percent in the case of China or 90 percent in the case of Myanmar. In terms of Gross Domestic Product (GDP), they represent about 80 percent of the total GDP of both regions which amounted to about US\$ (1994) 1.8 trillion. Per capita GDP ranged from US\$ 400 (China) to US\$ 11,500 (Taiwan), but region-wide, the range is much larger from a low US\$ 200 (Cambodia) to a very high US\$ 25,000 (Singapore). (Table 1)

Group 1 countries (i.e. South Korea and Taiwan) account for the largest amount of final energy consumption per capita (2000-2400 kgoe) compared to the other groups. For group 2 countries (i.e. Thailand, Indonesia and the Philippines), final energy consumption per capita varies greatly, from 200 kgoe to 600 kgoe. Information available for Malaysia, a newly emerging industrialized country, indicates a level of 1400 kgoe per capita. China, in Group 3, posted a level of about 500 kgoe. For poor and very poor countries of the region (i.e. Cambodia, Laos and Myanmar), final energy consumption per capita ranges from 19 kgoe (Cambodia) to 47 kgoe (Myanmar). Singapore has the highest level of final consumption per capita in both regions (6000 kgoe), or 300 times that of Cambodia. (Figure 1)

Total electricity consumption of the six selected countries amounted to about 100,000 ktoe, or about 75 percent of the total consumption of both regions. Per capita electricity consumption of China was about 700 kWh, or about seven times less than that of Taiwan or eight times less than Singapore which has the highest level (5600 kWh). The lowest level of electricity consumption was observed in Cambodia (17 kWh). The electrification rate ranges from a full level (100 percent) for Brunei and Singapore to a very low level of 10 percent in the case of Myanmar.



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3. Energy Resources Endowment and Patterns of Energy Development

The six selected countries offer a representative view of the energy resources endowment which characterizes countries in Southeast and northeast Asia. A preliminary observation that can be made is that many countries in both regions possess a large base of indigenous energy resources. China and Indonesia are also considered to be well endowed with abundant coal, natural gas and oil resources. In China, coal has played a dominant role in the primary energy supply system (about 78 percent) and in the final energy consumption (about 64 percent). China is also a key oil producing country (6th in the world). Indonesia is another major oil producer in the region and a member of OPEP. The country has extensive coal reserves which have recently been developed for the national market as well as for export. Thailand

possesses significant energy resources which were discovered in the early '80s (lignite and natural gas), although the country also has to import substantial amounts of energy to fuel the rapidly growing economy. Vietnam, Myanmar and the Philippines have also recently made significant discoveries of natural gas reserves off-shore. Much of the gas is used to produce electricity either by power plants owned by public enterprises or by plants operated by independent power producers (IPP), a new category of players in the electricity market of both regions. South Korea and Taiwan, on the other hand, are very poor in energy resources. Their energy imports account for nearly the totality of the primary energy supply; 99 percent in the case of South Korea and about 88 percent in the case of Taiwan.

All countries in both regions have recently reformulated their energy policies to take into account the new challenges facing their economies, such as privatization, protection of the environment, energy efficiency, etc. Furthermore, their economies are also becoming gradually less dependent on oil for quite diverse reasons. Country like Indonesia promote the use of coal, natural gas and energy efficiency so that more oil can be saved for exports, whereas countries like Thailand are reducing the uses of oil considerably because the country simply wants to increase its independence from oil which is imported from countries in the Middle East. Thus, Thailand has substituted oil with lignite and natural gas, and for country like the Philippines, hydropower and geothermal are the main candidates for replacing oil but in Taiwan and South Korea, nuclear energy is the main substitute to oil for power generation.

Reducing the consumption of petroleum products is a comparatively slower process. During the period from 1980 to 1994, many countries in Southeast Asia (e.g. Thailand, Indonesia, Philippines, etc.) successfully cut their consumption of petroleum products by more than 10 percent. However, the share of petroleum products in the energy balance of these countries remains significant: 72 percent for Thailand, 66 percent for Indonesia, 81 percent for the Philippines and 68 percent for South Korea. A large share of the petroleum products is used in the transport sector, except for South Korea and China where industry is the main consumer. Within Southeast Asia, Thailand is the country where transport energy consumption accounted for the largest share: about 69 percent of the total petroleum products in 1993 and about 37 percent of the total final energy consumption. This feature of the Thai energy situation is likely to remain prevalent in the near future. In contrast, Indonesia, which accounts for about 40 percent of the total population of the region, the transport sector used only 46 percent of the total amount of petroleum products in 1993; and the share of transport energy represented 20 percent of the total final energy consumption. When both region are taken, China is the country where transport energy consumption accounts for the lowest percentage (about 17.5 percent of the total petroleum product consumption, and 5.5 percent of the total final energy consumption).

Besides transport, other main energy consuming sectors are industrial and residential. Within group 1 countries, energy used by industry accounted for the largest share: about 45 percent in South Korea and about 48 percent for Taiwan. However, this feature is not unique to Group 1. Other countries in both regions also share this same characteristic: in Malaysia for example, energy used in industry represents about 39 percent, followed by transport (34 percent). Vietnam, which is far from being an Asian economic tiger, also has an industrial sector which accounts for the largest share in the final energy consumption (50 percent). Energy used by households comes second (23 percent) followed by transport (20 percent). In China (Group 3), energy consumed by industries accounts also for the largest share (about 66 percent), followed by energy used in the residential sector (about 18 percent). In the poor countries of the region (i.e. Laos, Cambodia and Myanmar), energy used by households represents the largest percentage of the final energy consumption, 87 percent, 62 percent and 88 percent respectively.



4. Trends in Energy Efficiency

A review of trends in energy intensity among the six selected countries yields interesting observations. (Figure 2). China, compared to countries in the other groups, has by far the highest energy intensity. In 1994, the figure was about 1.0 toe/'000 US\$, which was about three times that of Thailand for example. However, it is worth noting that China has achieved considerable success in dramatically reducing energy intensity. In 1980, energy intensity was at the level of about 2.1 toe/'000 US\$ but following economic reforms and an extensive campaign to promote energy conservation, China was able to cut by half the value of energy intensity. It is expected that the downward trend will continue in the near future but not at the pace observed during the first half of the 90s. China is facing tremendous difficulties in modernizing the economy of the rural provinces.

Among "old tigers" economies, i.e. South Korea and Taiwan, the situation is very different not only in terms of trends but also in terms of levels. Taiwan has a trend similar to that of China (i.e. downward, from 0.35 toe/'000 US\$ in 1980 to 0.22 toe/'000US\$ in 1994) whereas in South Korea energy intensity did not change much between 1980 and 1993; 0.50 toe/'000 US\$ vs. 0.48 toe/'000 US\$. The gap between energy intensity in Taiwan and energy intensity in Korea increased dramatically from 30 percent in 1980 to 50 percent in 1993; in other words, today, Taiwan requires about half the energy consumed by South Korea to generate the same amount of '000 US\$ GDP. To some extent, this is not surprising given the industrial structure of the two countries: South Korean economy is more geared towards a medium to large scale heavy industrial ventures (e.g. automobile industry, shipbuilding, etc..) whereas the Taiwanese economy is much more a network of small to medium enterprises (e.g. computer-ware, home-ware, etc..).

For "young tiger" economies, i.e. Thailand, Indonesia and the Philippines, the situation is presented in relatively less marked terms: basically the same pattern of development regarding the energy intensities of the three selected countries. During the first half of the 80s, energy intensities declined by 10 percent to 15 percent depending on the country, but starting from 1987 upward trends were observed, and by 1990, Indonesia and the Philippines were back at the same level of energy intensity of 1980; Thailand has returned to the 1980 level a little earlier (in 1987). In some measure, this behavior is common to ASEAN countries: after the price effects which took place after the second oil crisis, countries in the region experienced an economic boom which started during the second half of the 80s. The case of Thailand is typical here: soon after the second oil price increase, the Government of Thailand launched a bold energy policy aimed at removing all subsidies. A new energy pricing system was put into place and the end results were a reduction of energy intensities. However, in 1987, Thailand entered an unprecedented phase of rapid industrialization and urbanization. The economy was growing at the annual average rate of about 9.5 percent compared to the average 6 percent per annum which characterized the growth path of the 70s and early 80s.

Energy intensity in Group 2 countries varies from about 0.3 toe/'000 US\$ (Thailand) to about 0.4 toe/'000 US\$ (Indonesia) in 1980, and fourteen years later the levels and the range have not changed much, i.e. 0.3 toe/'000 US\$ (Thailand) and 0.45 toe/'000 US\$ (Indonesia). For Malaysia, the level and trend of energy intensity are closer to those observed in Indonesia than those in Thailand or the Philippines. The lowest level of energy intensity in both region is

observed in the Hong Kong economy; about 0.2 toe/'000 US\$.

The effects of structural changes in the economy experienced by countries in both regions are far from negligible. Table 2 gives an overview of the structural changes which occurred from 1980 to 1994 through four snapshots years: 1980, 1985, 1990 and 1994. Generally the period 1980-1985 witnessed limited changes, except for Indonesia and the Philippines and to some extent China. Starting from 1985, significant changes took place in all countries and accelerated dramatically during the period 1990-1994 for many countries. For Taiwan and South Korea, the structures of their economies reflect clearly the industrial strategies chosen by the respective government. For countries in Group 3, the evolution of the Philippines should not lead to the conclusion that the country is gearing towards a tertiary economy. The downward trend of the industry's share is mainly the result of the "collapse" of the industrial sector following the Marcos era and the power crisis period.

Until recently, countries in this group shared fundamentally the same economic strategy but new initiatives have emerged in many countries trying to recast their role in light of the new wave of telecommunications and multimedia based technologies. Leaders in this new venture are Singapore and Malaysia. Thailand and the Philippines will certainly develop a mix-strategy and Indonesia will probably continue with its current economic and industrial strategy.

For China, the country has restructured itself to become a less primary industrial player and moved towards a tertiary industry producer, i.e. focusing more on telecommunication, transportation and commerce. (The weight of the secondary industry remains practically the same). As it can be seen earlier, this strategy has led to a massive reduction of the energy intensity during 1980 and 1994. It is expected that the structure of the Chinese economy will continue to experience significant change but not on the scale observed during the past fifteen years. Nevertheless significant improvements in energy efficiency remain possible as the country has yet entered fully and extensively in the process of upgrading equipment, system improvement, building efficiency and end-uses efficiency management.



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5. Emerging Fuels : Coal, Natural Gas, Nuclear Power and Renewable Energy Sources

During the last two decades, the fuel supply mix of many countries in Southeast and Northeast Asia have changed noticeably. Thus, for most Southeast Asian nations, fuel supply systems has moved from a base predominantly supported by traditional fuels (i.e. fuelwood, charcoal and agricultural residues) and into a system where the key role is played by commercial fuels, such as coal, natural gas, electricity and petroleum products. In 1993, in Thailand for example, traditional fuels accounted for about 30 percent of the Gross Primary Energy Supply (GPES), which represents more than a 50 percent reduction compared to the level of 1975. For the poorer countries of the region, traditional fuels remain the only source of energy (about 90 percent). For Northeast Asian countries, the energy supply system of South Korea and Taiwan today is mainly supported by five fuels: oil, natural gas, coal, hydropower and nuclear power.

Traditional fuels uses have practically disappeared from the energy system. In South Korea for example, the uses of biomass fuels, which include municipal and industrial solid wastes, represent less than 0.5 percent of total final energy consumption. The Chinese commercial energy supply system is mainly dominated by coal and the situation has not changed much. In rural areas, non commercial energy still plays an important role; recent estimates indicate that

in 2000, non-commercial will account for 48 percent; a decline of eleven points compared with 1985.



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These two fuels are expected to become the pillars of the energy supply system of the ASEAN economies.

Coal consumption has increased tremendously in recent years as a result of rapid industrialization and urbanization. From 1980 to 1993, from a small and sometimes non-existent level, coal consumption grew at an average annual rate of about 38 percent in Indonesia, 28 percent in Malaysia, 21 percent in Thailand and 20 percent in the Philippines. In Thailand and Malaysia, the power sector is the main user of coal, whereas in Indonesia and the Philippines, the industrial sector, especially the cement sub-sector, is the major consumer. Indonesia is also trying to promote the use of coal in the residential sector in order to replace kerosene for cooking.

In Southeast Asia, Indonesia, Thailand and Vietnam are three main coal producers, but Indonesia is the only one which exports its coal to Malaysia and the Philippines. Vietnam's exports of coal are negligible and Thailand produces lignite mainly for domestic uses (power generation). Coal production started to take-off only during the second half of the 80s. In 1980, overall ASEAN coal production was less than 1 million tons but in 1993, it went up to about 47 million tons, or about 1 percent of the world production. Besides importing coal from Indonesia, Malaysia and the Philippines also import coal from Australia, which is also an important player on the regional coal market.

In addition to coal, the development of natural gas has been remarkable. In fact, gas is a very strong competitor to coal in the ASEAN region. In the mid-70s and early 80s, large reserves of gas has been found and developed in Thailand, Indonesia, Vietnam, Malaysia and Myanmar. Gas is a preferred choice in many countries, thus in Malaysia, gas is the main fuel chosen for new power plants and it is also the least cost option in power development plans. In Singapore, piped natural gas imported from Malaysia is already being used. In the Philippines, the period 2001 to 2005 has been declared the "natural gas window" during which no non-gas fired base load power plant will be built. In Thailand, the country will import not only natural gas by pipeline from Malaysia and Myanmar but will also bring in imported LNG from other regions.

The current choice for gas is mainly influenced by environmental considerations as well as by resources access. However, future growth of gas utilization in Southeast Asia strongly depend on the development of the infrastructure for gas trade and new findings of gas reserves since a large share of the current gas reserves are already committed to the LNG markets, particularly in Japan, South Korea and Taiwan. ASEAN countries have recently launched a study on the construction of the proposed Trans ASEAN Gas Pipeline (TAGP) but since the reserves available over and above the LNG commitments are limited the project has been shelved for the moment. Besides the pipeline option another solution being considered is the construction of LNG terminals in Thailand, the Philippines and Singapore, but no decision on building them has yet been taken.



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Nuclear power plants have been in operation since 1977 in South Korea and Taiwan and recently in China with the Daya Bay Nuclear Power Plant (1991). Today, in South Korea, the share of nuclear energy in the total primary energy supply amounts to about 11 percent; a significant decrease of about four points from the peak level in 1990. In Taiwan, the share of nuclear energy in the total primary energy supply has also declined. The nuclear option has been regularly discussed by policy makers of Southeast Asian countries, but only the Philippines has built a nuclear power plant - which was then mothballed because of severe technical design deficiencies. No other country has taken the decision to build one although many countries have become equipped with small nuclear reactors for research and training purposes.

However, in recent years, as a result of rapid economic growth and the need to diversify fuel sources for power generation, nuclear energy is seriously considered as an economically and technically viable option for 2010 onwards in several countries in the region. Leading the pack will probably be Thailand and Indonesia, followed by the Philippines, Malaysia and probably Vietnam. For countries in Northeast Asia, South Korea recently decided to start reconsidering building of new nuclear power plants; China will continue its program to equip coastal provinces, where the economies are continuing to grow rapidly, with nuclear power plants. Taiwan is also reviewing its strategy to equip the country with new nuclear power plants.

Thus, countries in both region are slowly and meticulously preparing themselves for a possible new context in the development of their power sector: an enhanced nuclear scenario for the economies of Northeast Asia and a new nuclear scenario for those in Southeast Asia. Many countries in Southeast Asian recently took measures and initiatives to develop technical capabilities in managing nuclear power plants. Strategies are being developed on how to engineer and promote public acceptance of the nuclear option. Environmentalists are an emerging force today in both region and, in some countries, have a record of success in challenging government policies and decisions. Besides the issue of public acceptance, another major roadblocks to the progress of nuclear energy in the region is the question of nuclear wastes treatment.



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Northeast and Southeast Asia have a diversified base of renewable energy sources (RES), from biomass to geothermal energy. RES are not expected to represent a major percentage in the fuel mix of countries in both region in the near future.

However, the role of RES will emerge strongly in numerous contexts given the characteristics of the socio-economic systems of many countries in the region. Thus, several countries (Thailand, Indonesia, the Philippines) are developing programs to promote the use of solar photo-voltaics in rural areas where the majority of people still live. New designs and approaches are being tested for their capabilities to bring down the costs of the equipment. Governments in Southeast Asia have also established special funds to encourage independent power producers (IPP) to build small power plants using PV technology.

The use of biomass based fuels is expected to increase substantially during the next decades in many Southeast Asian countries. In the Philippines for example, bagasse and agricultural residues will grow from about the level of 13 MMBFOE in 1985 to that of about 16 MMBFOE in 2000 and 21 MMBFOE in 2010. However, the share in total fuel mix will decrease from about 9 percent to about 7 percent and 4 percent respectively. In Thailand, the use of biomass in particular and RES in general are strongly encouraged through the framework of the Small Power Producers (SPP) scheme in the context of the on-going liberalization process of the power sector. South Korea's strategy is to increase the current percentage of RES, which is about 0.5 percent, to about 3 percent of the total primary energy needs by the year 2001. Actions are focused on R and D and demonstrations projects for a wide range of RES technologies: solar thermal, solar photo-voltaic, biomass, municipal solid wastes, fuel cells and wind energy.

Micro-hydro and geothermal are also strong candidates for RES development in the region. China has extensive experience in mini and micro-hydro and networks have been developed in the region to promote this technology. Geothermal energy is mainly located in the Philippines. In 1993, the total installed capacity of geothermal plants represented 1018 MW and the Philippines are the world's second largest producer and user of geothermal for power generation. Indonesia is the second country with a large potential of geothermal energy but the country has not started to exploit it yet. The current installed capacity is about 430 MW, or about 3 percent of the total potential.



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6. Evaluation of Impacts

A comprehensive evaluation of the environmental and developmental impacts and risks of the entire energy chain, from extraction to consumption and disposal of wastes remains to be conducted in countries of both region. Some preliminary work recently carried out in selected countries of the region in the context of UNEP's initiatives to develop and test a methodology to study the costs of greenhouse gas abatement strategies highlighted the significant role of countries in the region in the process of climate change. Although the structure of the energy systems has dramatically changed in countries of Southeast Asia, the impact on the environment remains important. Burning fuelwood has been substituted by the combustion of fossil fuels and this is now gradually being replaced by the combustion of coal and natural gas. Coal consumption is expected to increase strongly in the future mainly through the demand from the industrial sector. Deforestation continues in many countries of the region not as a result of fuelwood consumption by poor rural people but as a result of logging activities (legal and illegal) for furniture and building material. Furthermore, as system efficiency is progressing very slowly and clean technologies have to be introduced extensively, the environment of countries in both regions will probably worsen in the coming decade.

In both Northeast and Southeast Asia, environmental issues, which have significant regional consequences (e.g. acid rain) are far from adequately addressed. Locked into the logic of competition to attract private capital to fuel economic growth, governments in the region have not yet developed and agreed a common framework to incorporate environmental aspects into the negotiation process. Another important problem facing countries in the region is the limited fund available to conduct research on the one hand and the huge distances which exist between researchers and policy makers on the other hand. What policy researchers have to say cannot be heard by policy makers whose time and availability are taken up by requests from private sector asking for more detailed discussions and information on governmental policies. Furthermore, given the structural deficit of information and data base in the region, it

is far more difficult for Asian policy researchers to ensure a higher degree of confidence in the solutions suggested. Innovative analytical tools and approaches need to be developed urgently to assist the process of rapid economic development docking into a scheme where overall sustainability can be ensured.

What emerges in the region is the central role played by the market forces in fueling and directing economic growth. A dynamic drive towards modernization now exists and is recognized by all parties involved in developing the market and promoting system efficiencies but past mindsets still prevail, weighting heavily in the process of change. In many countries in the region the rural-urban divide is far greater today than in recent past. As economic progress intensifies more tensions are likely to appear between those living in urban areas and those living in rural areas. Today, when power shortages occur, rural people cannot easily accept cuts in their electricity supply so that the power company can ensure a continuous supply to the urban. Their main threat is to disrupt the distribution system by blocking access or even destroying transformers. Realities at this level need to be added to realities at policy levels affecting the pursuit of system sustainability. Balancing the future energy system between RES which play a more important role in the rural context and fossil fuels for industrialization and transport remains a major challenge for policy makers in countries in both regions.



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7. Concluding Remarks

The recent experience of countries in Northeast and Southeast Asia in managing the complex relationships between economic growth, energy development and environmental protection is limited and certainly cannot be used to elaborate an efficient strategy in the pursuit of system sustainability. Several areas of great concern have emerged in recent years which have increased the risks of seeing further stress and tensions being added on the fragile modern socio-economic structure still under construction and consolidation in the region, especially in countries of Southeast Asia. Thus, the crisis in the transport sector needs to be addressed urgently, just as clean technologies and system efficiencies need to be introduced widely. Last but not least, there must be greater transparency in policy formulation and governance. All countries in the region certainly need the development of a regional capability which will help to guide the process of economic growth docking into a system ensuring environmental sustainability, economic sustainability and social sustainability.

Figure 1: Evolution of Final Energy Consumption

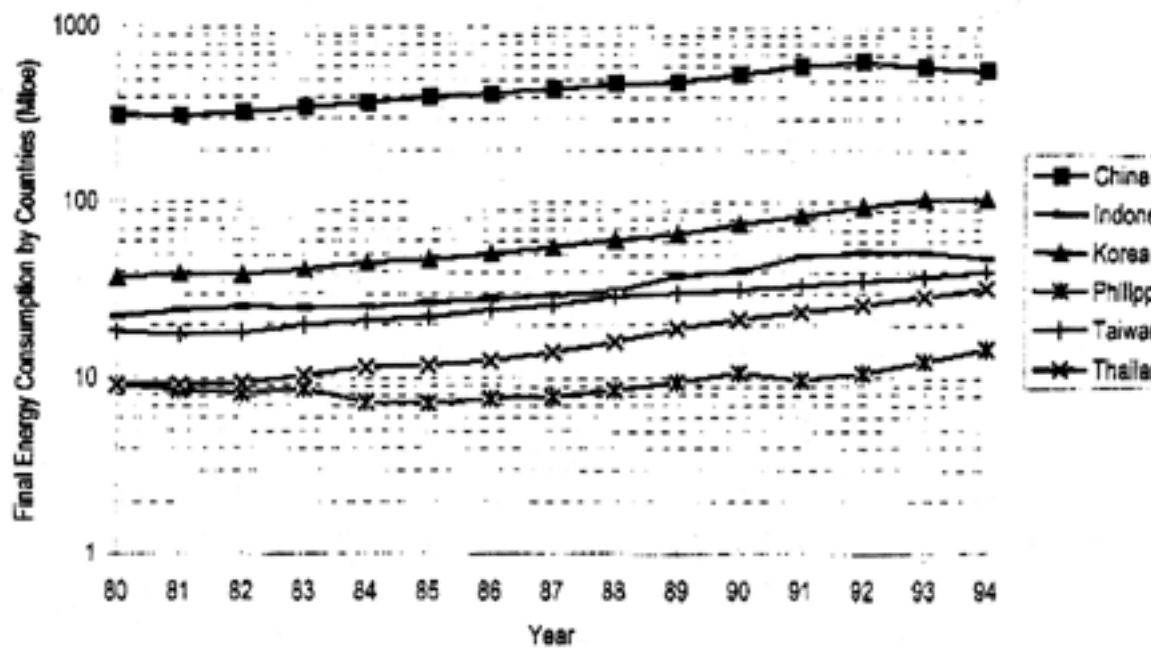


Figure 2: Evolution of Final Energy Intensity

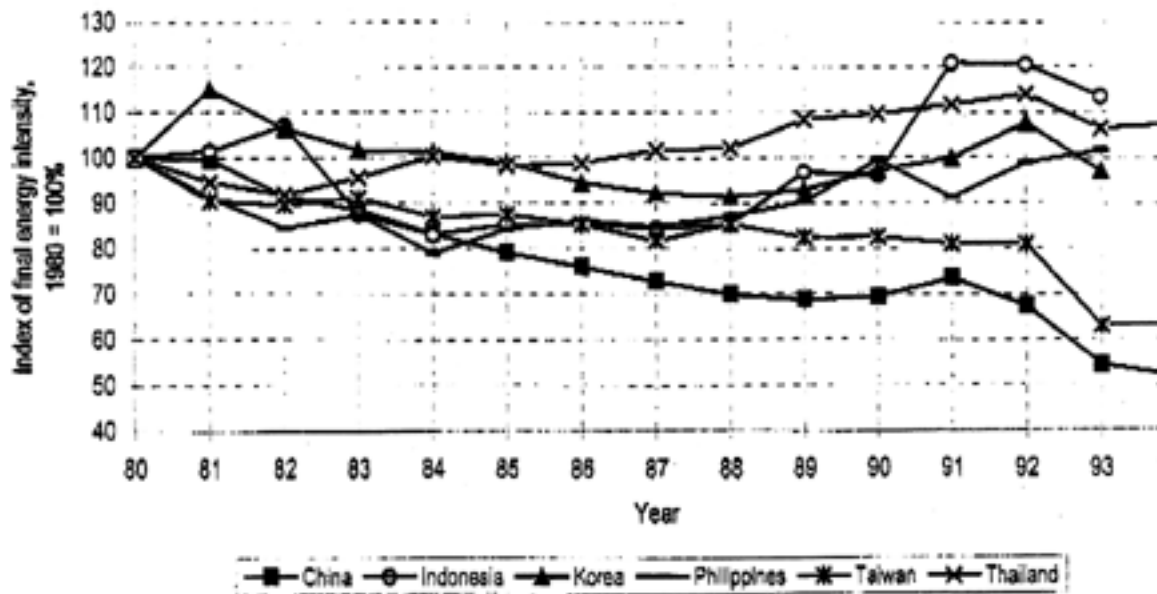


Table 1: Key Indicators of Selected Countries in Southeast and Northeast Asia (1994)

Indicator	Group 1		Group 2			Group 1
	Korea	Taiwan	Thailand	Indonesia	Philippines	China
Population, million	44.5	21.1	58.6	192.2	67.0	1191.8
Population Growth Rate	0.9	1.0	1.5	1.6	2.3	1.2
Urbanization (%)	78.0	58.0	36.0	34.0	46.0	30.0
Per capita GDP, US\$	8564.7	11505.0	2132.1	907.2	807.0	438.1
Average GDP growth rate, 1980-1994	8.5	7.6	7.9	5.8	1.4	9.6
Per capita final energy consumption, kgoe	2371.8	1910.2	554.3	252.9	218.4	480.0
Total electricity consumption, ktoe	11843.0	8498.0	5376.0	3703.0	2171.0	68607.0
Per capita electricity consumption, kWh	3098.6	4677.3	1067.3	224.1	376.6	669.5

Source: ADB 1995, Key indicators of Developing Asian and Pacific Countries
APEC Regional Energy Cooperation Working Group 1996, APEC Energy Statistics 1994

Table 2: Structural Changes of the Selected Countries from 1980 to 1994

YEAR		1980	1985	1990	1994		
G R O U P 1	Taiwan						
		Industry	45.9	45.2	41.4	39.0	
		Agriculture	7.4	5.7	4.0	3.1	
		Service & Commerce	43.9	44.5	48.0	50.2	
		Other	2.7	4.5	6.6	7.7	
		South Korea					
		Industry	37.8	38.2	43.5	43.6	
		Agriculture	14.2	13.9	8.7	6.9	
		Service & Commerce	40.9	41.3	41.8	43.8	
		Other	7.2	6.7	6.1	5.6	
	G R O U P 2	Thailand					
			Industry	30.1	31.6	36.2	40.8
			Agriculture	20.2	19.1	15.8	11.7
			Service & Commerce	32.3	31.3	32.2	34.1
			Other	17.3	18.1	15.8	13.4
			Indonesia				
		Industry	31.0	39.7	37.4	40.8	
		Agriculture	30.7	22.7	20.2	16.7	
		Service & Commerce	35.6	33.9	38.9	39.3	
		Other	2.8	3.7	3.5	3.2	
		Philippines					
		Industry	40.5	35.1	35.5	34.9	
		Agriculture	23.5	24.6	22.3	22.3	
		Service & Commerce	25.9	27.9	29.8	30.3	
		Other	10.1	12.5	12.4	12.5	
G R O U P 3		China					
		Primary Industry	30.1	28.4	27.1	21.0	
		Secondary Industry	48.5	43.1	41.7	47.2	
		Tertiary Industry	21.4	28.5	31.3	31.8	

Source: Asian Development Bank (1995), China Statistical Yearbook (1995)

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1. Introduction

Since the beginning of this decade, a large majority of countries in southeast and northeast Asia have moved forward on a truly remarkable economic growth path. Average annual growth rates ranging from seven to eleven percent have been a common feature of the economic landscape. Several factors have been put forward to explain this phenomenon but the most important is probably the institutional and policy reforms initiated and implemented at the end of the '80s. As a result of economic growth, energy consumption has also increased very rapidly, putting tremendous stress on the energy supply system which has only recently started to regain some degree of stability and sustainability. Initiatives taken by governments of both regions to include the participation of the private sector in the development of the energy system have helped to create a better context for national energy and economic policy management. However, the energy supply and demand systems under construction in both regions are far from ensuring a conflict free strategy aimed at reconciling the requirements for strong, sustainable socio-economic development and the needs of better environmental protection.

Reviewing and analyzing all the impacts of the energy systems in both regions are beyond the scope of this paper. The purpose here is to provide an overview of energy efficiency changes for a selected number of countries in both regions between 1980 and 1994, and the recent policy changes aimed at promoting the consumption of renewable energy sources, such as biomass for co-generation, solar photovoltaics and geothermal for power development, etc. This paper will first discuss the main socio-economic and energy features of the southeast and northeast Asian countries selected. They are grouped into three main types of economies reflecting the wide diversity of situations found in both regions: group 1: "old tigers" economies, i.e. Korea and Taiwan, group 2: "young tigers" economies, i.e. Thailand, Philippines and Indonesia and group 3: "meta tigers" economies, i.e. China.

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The total population of the six selected countries is about 1.6 billion of people, or about 90 percent of the total population of both regions. The annual population growth rate ranges from about 1 percent for South Korea to 2.3 percent for the Philippines. The highest growth rate was observed in Cambodia (2.8 percent per annum); except for countries in Group 1, most people in Groups 2 and 3 still live in rural areas: 70 percent in the case of China or 90 percent in the case of Myanmar. In terms of Gross Domestic Product (GDP), they represent about 80 percent of the total GDP of both regions which amounted to about US\$ (1994) 1.8 trillion. Per capita GDP ranged from US\$ 400 (China) to US\$ 11,500 (Taiwan), but region-wide, the range is much larger from a low US\$ 200 (Cambodia) to a very high US\$ 25,000 (Singapore). (Table 1)

Group 1 countries (i.e. South Korea and Taiwan) account for the largest amount of final energy consumption per capita (2000-2400 kgoe) compared to the other groups. For group 2 countries (i.e. Thailand, Indonesia and the Philippines), final energy consumption per capita varies greatly, from 200 kgoe to 600 kgoe. Information available for Malaysia, a newly emerging industrialized country, indicates a level of 1400 kgoe per capita. China, in Group 3, posted a level of about 500 kgoe. For poor and very poor countries of the region (i.e. Cambodia, Laos and Myanmar), final energy consumption per capita ranges from 19 kgoe (Cambodia) to 47 kgoe (Myanmar). Singapore has the highest level of final consumption per capita in both regions (6000 kgoe), or 300 times that of Cambodia. (Figure 1)

Total electricity consumption of the six selected countries amounted to about 100,000 ktoe, or about 75 percent of the total consumption of both regions. Per capita electricity consumption of China was about 700 kWh, or about seven times less than that of Taiwan or eight times less than Singapore which has the highest level (5600 kWh). The lowest level of electricity consumption was observed in Cambodia (17 kWh). The electrification rate ranges from a full level (100 percent) for Brunei and Singapore to a very low level of 10 percent in the case of Myanmar.

3. Energy Resources Endowment and Patterns of Energy Development

The six selected countries offer a representative view of the energy resources endowment which characterizes countries in Southeast and northeast Asia. A preliminary observation that can be made is that many countries in both regions possess a large base of indigenous energy resources. China and Indonesia are also considered to be well endowed with abundant coal, natural gas and oil resources. In China, coal has played a dominant role in the primary energy supply system (about 78 percent) and in the final energy consumption (about 64 percent). China is also a key oil producing country (6th in the world). Indonesia is another major oil producer in the region and a member of OPEP. The country has extensive coal reserves which have recently been developed for the national market as well as for export. Thailand possesses significant energy resources which were discovered in the early '80s (lignite and natural gas), although the country also has to import substantial amounts of energy to fuel the rapidly growing economy. Vietnam, Myanmar and the Philippines have also recently made significant discoveries of natural gas reserves off-shore. Much of the gas is used to produce electricity either by power plants owned by public enterprises or by plants operated by independent power producers (IPP), a new category of players in the electricity market of both regions. South Korea and Taiwan, on the other hand, are very poor in energy resources. Their energy imports account for nearly the totality of the primary energy supply; 99 percent in the case of South Korea and about 88 percent in the case of Taiwan.

All countries in both regions have recently reformulated their energy policies to take into account the new challenges facing their economies, such as privatization, protection of the environment, energy efficiency, etc. Furthermore, their economies are also becoming gradually less dependent on oil for quite diverse reasons. Country like Indonesia promote the use of coal, natural gas and energy efficiency so that more oil can be saved for exports, whereas countries like Thailand are reducing the uses of oil considerably because the country simply wants to increase its independence from oil which is imported from countries in the Middle East. Thus, Thailand has substituted oil with lignite and natural gas, and for country like the Philippines, hydropower and geothermal are the main candidates for replacing oil but in Taiwan and South Korea, nuclear energy is the main substitute to oil for power generation.

Reducing the consumption of petroleum products is a comparatively slower process. During the period from 1980 to 1994, many countries in Southeast Asia (e.g. Thailand, Indonesia, Philippines, etc.) successfully cut their consumption of petroleum products by more than 10 percent. However, the share of petroleum products in the energy balance of these countries remains significant: 72 percent for Thailand, 66 percent for Indonesia, 81 percent for the Philippines and 68 percent for South Korea. A large share of the petroleum products is used in the transport sector, except for South Korea and China where industry is the main consumer. Within Southeast Asia, Thailand is the country where transport energy consumption accounted for the largest share: about 69 percent of the total petroleum products in 1993 and about 37 percent of the total final energy consumption. This feature of the Thai energy situation is likely to remain prevalent in the near future. In contrast, Indonesia, which accounts for about 40 percent of the total population of the region, the transport sector used only 46 percent of the total amount of petroleum products in 1993; and the share of transport energy represented 20 percent of the total final energy consumption. When both region are taken, China is the country where transport energy consumption accounts for the lowest percentage (about 17.5 percent of the total petroleum product consumption, and 5.5 percent of the total final energy consumption).

Besides transport, other main energy consuming sectors are industrial and residential. Within group 1 countries, energy used by industry accounted for the largest share: about 45 percent in South Korea and about 48 percent for Taiwan. However, this feature is not unique to Group 1. Other countries in both regions also share this same characteristic: in Malaysia for example, energy used in industry represents about 39 percent, followed by transport (34 percent). Vietnam, which is far from being an Asian economic tiger, also has an industrial sector which accounts for the largest share in the final energy consumption (50 percent). Energy used by households comes second (23 percent) followed by transport (20 percent). In China (Group 3), energy consumed by industries accounts also for the largest share (about 66 percent), followed by energy used in the residential sector (about 18 percent). In the poor countries of the region (i.e. Laos, Cambodia and Myanmar), energy used by households represents the largest percentage of the final energy consumption, 87 percent, 62 percent and 88 percent respectively.

4. Trends in Energy Efficiency

A review of trends in energy intensity among the six selected countries yields interesting observations. (Figure 2). China, compared to countries in the other groups, has by far the highest energy intensity. In 1994, the figure was about 1.0 toe/'000 US\$, which was about three times that of Thailand for example. However, it is worth noting that China has achieved considerable success in dramatically reducing energy intensity. In 1980, energy intensity was at the level of about 2.1 toe/'000 US\$ but following economic reforms and an extensive campaign to promote energy conservation, China was able to cut by half the value of energy

intensity. It is expected that the downward trend will continue in the near future but not at the pace observed during the first half of the 90s. China is facing tremendous difficulties in modernizing the economy of the rural provinces.

Among "old tigers" economies, i.e. South Korea and Taiwan, the situation is very different not only in terms of trends but also in terms of levels. Taiwan has a trend similar to that of China (i.e. downward, from 0.35 toe/'000 US\$ in 1980 to 0.22 toe/'000US\$ in 1994) whereas in South Korea energy intensity did not changed much between 1980 and 1993; 0.50 toe/'000 US\$ vs. 0.48 toe/'000 US\$. The gap between energy intensity in Taiwan and energy intensity in Korea increased dramatically from 30 percent in 1980 to 50 percent in 1993; in other words, today, Taiwan requires about half the energy consumed by South Korea to generate the same amount of '000 US\$ GDP. To some extent, this is not surprising given the industrial structure of the two countries: South Korean economy is more geared towards a medium to large scale heavy industrial ventures (e.g. automobile industry, shipbuilding, etc..) whereas the Taiwanese economy is much more a network of small to medium enterprises (e.g. computer-ware, home-ware, etc..).

For "young tiger" economies, i.e. Thailand, Indonesia and the Philippines, the situation is presented in relatively less marked terms: basically the same pattern of development regarding the energy intensities of the three selected countries. During the first half of the 80s, energy intensities declined by 10 percent to 15 percent depending on the country, but starting from 1987 upward trends were observed, and by 1990, Indonesia and the Philippines were back at the same level of energy intensity of 1980; Thailand has returned to the 1980 level a little earlier (in 1987). In some measure, this behavior is common to ASEAN countries: after the price effects which took place after the second oil crisis, countries in the region experienced an economic boom which started during the second half of the 80s. The case of Thailand is typical here: soon after the second oil price increase, the Government of Thailand launched a bold energy policy aimed at removing all subsidies. A new energy pricing system was put into place and the end results were a reduction of energy intensities. However, in 1987, Thailand entered an unprecedented phase of rapid industrialization and urbanization. The economy was growing at the annual average rate of about 9.5 percent compared to the average 6 percent per annum which characterized the growth path of the 70s and early 80s.

Energy intensity in Group 2 countries varies from about 0.3 toe/'000 US\$ (Thailand) to about 0.4 toe/'000 US\$ (Indonesia) in 1980, and fourteen years later the levels and the range have not changed much, i.e. 0.3 toe/'000 US\$ (Thailand) and 0.45 toe/'000 US\$ (Indonesia). For Malaysia, the level and trend of energy intensity are closer to those observed in Indonesia than those in Thailand or the Philippines. The lowest level of energy intensity in both region is observed in the Hong Kong economy; about 0.2 toe/'000 US\$.

The effects of structural changes in the economy experienced by countries in both regions are far from negligible. Table 2 gives an overview of the structural changes which occurred from 1980 to 1994 through four snapshots years: 1980, 1985, 1990 and 1994. Generally the period 1980-1985 witnessed limited changes, except for Indonesia and the Philippines and to some extent China. Starting from 1985, significant changes took place in all countries and accelerated dramatically during the period 1990-1994 for many countries. For Taiwan and South Korea, the structures of their economies reflect clearly the industrial strategies chosen by the respective government. For countries in Group 3, the evolution of the Philippines should not lead to the conclusion that the country is gearing towards a tertiary economy. The downward trend of the industry's share is mainly the result of the "collapse" of the industrial sector following the Marcos era and the power crisis period.

Until recently, countries in this group shared fundamentally the same economic strategy but new initiatives have emerged in many countries trying to recast their role in light of the new wave of telecommunications and multimedia based technologies. Leaders in this new venture are Singapore and Malaysia. Thailand and the Philippines will certainly develop a mix-strategy

and Indonesia will probably continue with its current economic and industrial strategy.

For China, the country has restructured itself to become a less primary industrial player and moved towards a tertiary industry producer, i.e. focusing more on telecommunication, transportation and commerce. (The weight of the secondary industry remains practically the same). As it can be seen earlier, this strategy has led to a massive reduction of the energy intensity during 1980 and 1994. It is expected that the structure of the Chinese economy will continue to experience significant change but not on the scale observed during the past fifteen years. Nevertheless significant improvements in energy efficiency remain possible as the country has yet entered fully and extensively in the process of upgrading equipment, system improvement, building efficiency and end-uses efficiency management.

5. Emerging Fuels : Coal, Natural Gas, Nuclear Power and Renewable Energy Sources

During the last two decades, the fuel supply mix of many countries in Southeast and Northeast Asia have changed noticeably. Thus, for most Southeast Asian nations, fuel supply systems has moved from a base predominantly supported by traditional fuels (i.e. fuelwood, charcoal and agricultural residues) and into a system where the key role is played by commercial fuels, such as coal, natural gas, electricity and petroleum products. In 1993, in Thailand for example, traditional fuels accounted for about 30 percent of the Gross Primary Energy Supply (GPES), which represents more that a 50 percent reduction compared to the level of 1975. For the poorer countries of the region, traditional fuels remain the only source of energy (about 90 percent). For Northeast Asian countries, the energy supply system of South Korea and Taiwan today is mainly supported by five fuels: oil, natural gas, coal, hydropower and nuclear power.

Traditional fuels uses have practically disappeared from the energy system. In South Korea for example, the uses of biomass fuels, which include municipal and industrial solid wastes, represent less than 0.5 percent of total final energy consumption. The Chinese commercial energy supply system is mainly dominated by coal and the situation has not changed much. In rural areas, non commercial energy still plays an important role; recent estimates indicate that in 2000, non-commercial will account for 48 percent; a decline of eleven points compared with 1985.

These two fuels are expected to become the pillars of the energy supply system of the ASEAN economies.

Coal consumption has increased tremendously in recent years as a result of rapid industrialization and urbanization. From 1980 to 1993, from a small and sometimes non-existent level, coal consumption grew at an average annual rate of about 38 percent in Indonesia, 28 percent in Malaysia, 21 percent in Thailand and 20 percent in the Philippines. In Thailand and Malaysia, the power sector is the main user of coal, whereas in Indonesia and the Philippines, the industrial sector, especially the cement sub-sector, is the major consumer. Indonesia is also trying to promote the use of coal in the residential sector in order to replace kerosene for cooking.

In Southeast Asia, Indonesia, Thailand and Vietnam are three main coal producers, but Indonesia is the only one which exports its coal to Malaysia and the Philippines. Vietnam's exports of coal are negligible and Thailand produces lignite mainly for domestic uses (power generation). Coal production started to take-off only during the second half of the 80s. In 1980, overall ASEAN coal production was less than 1 million tons but in 1993, it went up to

about 47 million tons, or about 1 percent of the world production. Besides importing coal from Indonesia, Malaysia and the Philippines also import coal from Australia, which is also an important player on the regional coal market.

In addition to coal, the development of natural gas has been remarkable. In fact, gas is a very strong competitor to coal in the ASEAN region. In the mid-70s and early 80s, large reserves of gas has been found and developed in Thailand.