REVIEW ON ASIAN ENERGY RESOURCES AND RELATED ENVIRONMENTAL ISSUES

Prida Wibulswas
School of Energy and Materials
King Mongkut's Institute of Technology Thonburi

Kyi Lwin
Natural Resources Division, ESCAP
Bangkok, Thailand

ABSTRACT

Energy supply profiles in 1985 and 1990 for some Asian countries and ASEAN show that over half of energy supply in Asian developing countries has been satisfied by domestic energy resources namely natural gas, lignite and coal, hydro-power and biomass. Non-commercial utilization of biomass, solar and wind energy have not been included.

Pollutants from the combustion of petroleum products have increased so rapidly that the several governments now enforce new fuel standards with lower lead and sulphur contents in petrol, diesel and fuel oil respectively.

Extensive use of fuel-wood in rural areas leads to over-cutting of already scarce forests in several Asian countries. Agro-industries such as sugar, palm oil and rice mills use biomass solid wastes as boiler fuels. Potential of agricultural residues and industrial wastes should be better exploited through identification and development of viable energy utilization technologies.

Lignite and coal offer economical alternative sources of energy for electric generation and industry. Additional lignite and coal reserves have been found in several parts of Asia. Uses of lignite and coal for power generation and industries have grown so rapidly that better pollution control on sulphur dioxide emission should be seriously considered and implemented.

Though potential of hydro-power in Asia are quite large, only a few large hydropower projects are being considered, since environmental and political constraints have to be overcome. Though many small hydro-power projects have been implemented and identified, thorough feasibility studies are still required prior to installation in the future.

In addition to traditional uses of solar energy in salt production and in sun drying of agricultural products, solar water heaters and solar dryers have been commercialized with limited success. Traditional uses of wind mills for water pumping in salt farms and rice fields are still practiced. Small wind turbine generators have also been commercialized in Asia. Utilization of renewable energy resources which are environmentally clean should be accelerated.

KEYWORDS: Asia, energy, emission, environment, pollution, sources.

INTRODUCTION

Energy supply profiles in 1985 and 1990 for some Asian countries and ASEAN can be summarized as follows: [1,2,3,4]

Table 1 Energy Supply, in MTons of Oil Equivalent.

	China		India		Thailand		ASEAN	
	'85	'89	'85	'90	'85	'90	'85	'90
Petroleum & Products	125	138	30.2	35.9	10.5	19.7	100.9	114.9
Natural Gas	12	14	7.3	16.5	3.3	5.7	51.6	75.9
Hydro Electricity	25	32	18.3	21.4	0.9	1.2	5.1	5.9
Lignite & Coal	436	527	75.5	103.8	1.6	3.7	3.3	10.9
Total Modern Energy	**598**	**711**	**131.3**	**177.5**	**16.3**	**30.3**	**160.9**	**207.6**
Traditional Energy	N.A	N.A	N.A	N.A	11.2	11.0	N.A	N.A
Nuclear Power, MWe	-	-	1.8	2.7	-	-	-	-

Traditional energy in the above table includes firewood, charcoal, bagasse and rice husk. Assessment of non-commercial use of firewood and charcoal is very approximate. Non-commercial uses of solar and wind energy in salt production, drying of agricultural products, etc. are not included. From the above table, the average growth of energy supply in ASEAN from 1985 to 1990 was about 5.1% per annum and the traditional energy still remained considerably significant.

The growth of total energy consumption has mainly been due to the rapid expansion of the industry, buildings, and transport sectors in several Asian countries. As a result, development of domestic energy sources such as natural gas, oil, lignite and coal, biomass, etc., has already been accelerated. However, utilization of domestic resources such as fuelwood, hydropower, lignite and coal, has already led to serious environmental problems in several cases where environmental impacts were not seriously considered at the planning stages.

MINERAL RESOURCES

Natural Gas and Oil

The potential for natural gas and oil in Asia is quite substantial. The largest reserves in Pakistan and Malaysia are about 3,960 and 1,540 billion cu.m [1,4] respectively. Proven reserves of natural gas in China and Indonesia are found to be about 1050 billion cu.m and 1100 billion cu.m respectively [4]. In 1985, natural gas production from ASEAN was about 56.9 billion cu.m,, and in 1990, the production capacity increased to 83.7 billion cu.m, [2]. Methane, ethane and LPG are gemerally separated in gas separation plants and used for electricity generation, as raw materials for the petrochemical industry, as cooking gas and vehicular fuels.

Natural gas generates carbon dioxide, one of the main greenhouse gases, during the gas separation process. Methane, another major greenhouse gas, is also released from natural gas during the production and transportation stages.

Proven reserves of crude oil in China and Indonesia have been identified at about 3.0 and 1.3 billion tons respectively [4]. India and Myanmar proven reserves are about 511 and 202 million tons respectively [1,4]. New oil fields are expected to be found off ASEAN coasts, Andaman Sea and South China Sea and are estimated to have reserves of commercial quantities. The production of ASEAN crude oil increased from 101 in 1985 to 115 Mtons in 1990 [2].

A few environmental problems have already occurred from the use of petroleum products in several Asian countries. Tetra ethyl lead is used to increase the octane number of petrol. At several locations in Bangkok, lead content in the air was monitored and found to be over 6 µg/cu.m. of air while the safe limit is officially set at 10 µg/cu.m [5]. Since January, 1992, the Thai government has issued a new petrol standard to reduce its lead content to 0.15 mg/litre [6]. The same standard has already been implemented in Malaysia, Singapore, Taiwan, etc.[7].

RENEWABLE RESOURCES

Incomplete combustion of diesel engines in trucks and buses causes emission of black smoke. In Bangkok, the average level of particulate matters in the air is more than twice the safe limit set by the World Health Organization, and over 40% of the particulate matters are contributed by the black smoke from diesel engines [5]. In the proposed new standard for diesel oil, in order to reduce the black smoke, the 90% boiling point will be reduced from 357 C to 338 C in 1993 [6].

The maximum allowable sulphur content in Thai diesel oil is 1.0%. Sulphur dioxide emission from the uses of diesel and fuel oils is one of the main causes of air pollution in large cities like Bangkok. The Thai government has already set a new standard to limit the sulphur content in diesel oil to 0.5% and will be enforced in 1993. It is also suggested that the sulphur content should be further reduced to 0.25% in 1995. Sulphur contents in diesel oil in Europe, Japan and USA are only 0.3, 0.2, and 0.1% respectively [8].

Fuel oil in Thailand also contains very high sulphur content up to 3.5%. The sulphur content in the fuel oil should be below 2%. Desulphurization of fuel oil would however increase the refining cost significantly.

Coal and Lignite

In China and India, coal proven reserves are identified at about 760 and 36 billion tons [4]. Estimated reserves of brown coal and lignite in Indonesia, Malaysia and Thailand are about 10, 0.8 and 2.5 billion tons respectively [1,4]. Present proven reserves in Thailand are found to be about 1500 million tons of which over 70% are

located in the North.

Sulphur dioxide emission from combustion of lignite and coal is a serious environmental issue in Asia. In 1986, emissions of sulphur dioxide in China, India and Korea were estimated at about 19.0, 3.2 and 1.2 Mtons respectively [9]. Utilization of domestic lignite in Thai industry and power generation increased rapidly from 5.1 Mtons in 1985 to 9.0 Mtons in 1989 and as a result, the amount of sulphur dioxide emission also increased from about 0.21 to 0.36 Mtons in the corresponding years [7].

With the increasing uses of lignite and coal for electricity generation and industry in Asia, better pollution control on their uses has to be considered. Technologies for clean coal utilization are available for industry and power generation.

Combustion and conversion of fossil fuels generate several gaseous pollutants such as carbon dioxide, carbon monoxide, hydro carbons, oxides of nitrogen, sulphur dioxide, etc.. Furthermore, mining of fossil fuels often creates undesirable environmental impacts such as water pollution, dust, etc. Renewable resources of energy seem to be better alternatives.

Hydro Electricity

The total hydro potential in Asia is estimated at about 610,000 MWe [10]. The current generating capacity of hydro electricity at about 53,000 MWe represents only 9% of the total generating capacity of the region. Hydro potential is thus very much under utilized and can be further developed when serious environmental issues can be resolved in the future.

Four countries in Asia, namely China, India, Indonesia and Turkey, possess 3047 TWh of hydroresources or about 26% of the world's exploitable hydrocapacity [11]. China Which possesses 1923 TWh of hydroresources has expploited only 5.7% of the available resources.

Several environmental issues have arisen from the development of large hydro-power projects. In Thailand, a total forest area over 40,000 hectares was flooded by reservoirs of three installed hydropower projects. Farmers were relocated from fertile low lands to high lands with insufficient water supply for farming. In one hydro-power project, trees and other vegetation were left to rot in the reservoir and polluted water was discharged into the river downstream. At present, three hydro-power projects with a combined generating capacity of 796 MWe have been postponed until environmental protection measures are clarified.

In spite of possible environmental impacts, hydropower generation still has several merits over fossil fuels. For example, it is renewable and does not generate gaseous pollutant; irrigation is often a desirable by-product; etc..

success.During the last five years, about 100,000 acres of eucalyptus have been planted. Large plantations of fast growing trees have been planned by both public and private sectors.

Fast growing trees can be used as a renewable source of fuel for electricity generation. In Philippines, five dendro-thermal power plants fired by fast-growing called trees ipil-ipil have been in operation and generate about 16 MWe [17]. In 1987, the National Energy Administration of Thailand presented a feasibility study of dendro-thermal power systems with a total generating capacity of 1200 MWe [18]. The proposed project would employ over 200,000 families to plant and manage 1.5 million acres of fast-growing trees for the proposed power systems. Another study indicates that an economical size of the dendro-thermal power system based upon eucalyptus should be between 25 and 50 MWe [19].

Several agricultural residues have been used as fuels in agro -industries in Asia. In Thailand, 70 % of the bagasse resource, estimated at about 7.5 million tons per year, is used as boiler fuel in sugar mills [20]. 40% of rice husk annual supply, estimated at about 4.7 million tons are used as boiler fuel in rice mills. About 2.4 million tons are still available as an energy resource for rural industries or electric generation whose technical potential is estimated to be at about 299 MW [21]. Palm oil wastes consisting of fibre, shells and empty bunches are also used as boiler fuel in palm oil mills in Malaysia, Indonesia and Thailand.

Other agricultural residues such as straw, maize stalks, cassava stalks, corn cobs, coconut shells and husk, etc., also have potential as energy resources for rural areas with their total supply of more than 13 million tons in Malaysia and 35 million tons per year in Thailand [22, 23]. Better utilization technologies are being identified or developed.

It is realized that certain types of industrial waste water can be utilized for biogas production. Laboratory scale tests were conducted on waters from tapioca waste, canning food waste, dairy waste, etc. in order to determine their potential for biogas production. Pilot studies of biogas production from pine apple and tapioca wastes has been successfully conducted and industrial plants are under construction at pineapple canning and tapioca factories [24]. Several breweries in Thailand now generate biogas from their liquid wastes. Liquid wastes from sugar mills and palm oil mills are also being considered for biogas generation. In Malaysia, the annual production of palm oil mill effluent is more than 10 M cubic metres from which about 290 cubic metres of biogas are generated [25].

China and India have been very successful in implementing domestic biogas plants as pollution abatement and energy production. In 1988, the number of domestic biogas digesters in China reached 4.7 millions. In India, domestic digesters approached 1 million at the end of 1989 [26].

Solar and Wind Energy

Several countries in Asia are fairly well endowed with solar radiation for

example, about at 17 MJ/sq.m day in South East Asia Peninsula, though about 50% of the global radiation appears as diffuse radiation. Equipment using direct radiation are therefore hardly feasible economically. Solar energy has been non-commercially used in Asia for centuries. Solar energy is used in salt production from sea water, sun drying of paddy rice, agricultural and marine products. There has been little attempt to estimate the amount of non-commercial solar energy utilization.

Solar water heating industry has been established in several Asian countries for more than a decade. Solar collectors have been installed for water heating in hospitals, hotels and private houses. In Japan, more than 30 million solar thermal collectors have been installed. Development of solar dryers has been very active in ASEAN, China, etc. [27, 28] and a few designs of free and forced convection dryers have been commercialized [29] with some success. Several designs of solar stills have been developed including vertical surface solar stills [30]. Several large solar stills for demonstration have been installed.

Generation of electricity by photovoltaic cells has been rapidly developed in Japan which leads the world on photovoltaic sale [13]. A large number of demonstration projects for telecommunication, lighting and water pumping, etc., have been set up the region. In addition to Japan, semiconductor laboratories in several Asian countries such as India, Indonesia, Malaysia, Thailand, etc., conduct research and development on solar cell materials and fabrication. Photovoltaic modules are now locally produced in these countries.

China has been fairly successful in harnessing the wind. 110,000 small wind turbine generators have already been installed and 12 wind farms with the total capacity of about 2000 MW are being planned [31]. India and the central plains of the former USSR have the right conditions for large potential markets of about 100,000 wind machines in each country [32].

In general, potential of wind energy in Thailand does not seem very promising as the average wind speed in the country is only about 2 m/s which is rather low for economical utilization. However, high wind speeds exist in some coastal areas where wind mills have been used for water pumping in salt farms and rice fields in Samut Sakorn, Cholburi, etc. It has been recently shown that traditional sail-type wind mills used for water pumping in salt farms are more economical than diesel-driven water pumps [33]. Demonstration of wind-PV hybrid systems has also been conducted [34].

CONCLUSIONS

Energy security of Asia has been achieved through development of mineral resources namely natural gas, oil coal and lignite. It is expected that more natural gas coal and lignite reserves will be found in the region. Dependency on imported energy for Asian countries should be further reduced.

The high lead content in petrol and high sulphur content in diesel oil and fuel oil have led to serious air pollution in large cities in Asia. New fuel standards with lower lead and sulphur contents are being implemented in several Asian countries.

Biomass, especially fuelwood and agricultural residues, will still remain the main energy resources in most Asian countries for the next two decades. Plantations of fast growing trees can provide an alternative source of energy and help decrease deforestation. Large potential of hydro-power from domestic and international rivers can be utilized once environmental and political constraints are solved.

Lignite and imported coal appear to be the most viable alternative sources of energy for electric generation and industry. Sulphur dioxide emission and acid rain will become serious environmental issues from lignite and coal utilization. Several clean coal technologies have already been identified and should be urgently implemented.

Domestic resources of solar energy and biomass, especially agricultural and industrial wastes, have high potential for utilization. Domestic biogas digesters have been very successful in China and India. Viable biomass technologies are being identified, developed and implemented.

With a rapid economic growth in Asia during the next decade, adequate energy supply for both industrial and rural development will be needed. However, better environmental protection measures must be developed and enforced. Renewable resources offer cleaner energy than mineral resources.

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