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PROSPECTS FOR GREATER COOPERATION AMONG SAARC COUNTRIES ON ENERGY

A PUBLICATION OF THE
SRI LANKA ENERGY MANAGERS ASSOCIATION

SRI LANKA ENERGY MANAGERS ASSOCIATION

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The Editorial Board invites papers on energy related issues for publication in the SLEMA Journal.

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ENERGY STATUS AND FUTURE OUTLOOK: SRI LANKA AND MALDIVES

Priyantha DC Wijayatunga, Past President SLEMA

1. Sri Lanka

Sri Lanka's economy grew at a relatively rapid rate in the range of 7-8% a year during the last few years and that growth resulted in a correlated growth in the energy demand. The energy consumption intensity in the economy has been improving over the years and this trend is likely to continue with increased attention paid to energy efficiency and conservation. The island's population of 21.1 million require to be supplied with modern form of energy such and electricity and petroleum, in addition to conventional sources such as biomass. In 2007, the per capita Gross Domestic Product (GDP) in Purchasing Power Parity (PPP) basis was US$ 4,265.

1.1 Energy Resources and Use

Sri Lanka's primary energy supply is dominated by biomass and its contribution was 48% of the total primary energy supply of 10 million tonnes of oil equivalent (toe) in 2007. The other two significant primary sources of energy supply are petroleum and hydropower, which contributed 42.5% and 9.5% respectively. All the petroleum requirements are imported and these imports are rapidly increasing. Therefore the import dependence of supplying the commercial energy needs is extremely high.

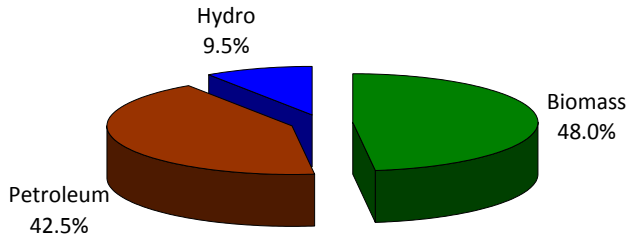

Figure 1: Sri Lanka Primary Energy Mix – 2007

Sri Lanka has no proven fossil fuel deposits as at present. Sri Lanka's entire energy resource development potential is therefore confined to the presently used indigenous sources such as biomass and hydropower and other renewable energy sources, and to the prospects from on-going oil and gas exploration efforts. Nuclear energy has been Completely excluded in the present energy sector policies and strategies and therefore is unlikely to make any inroads into the energy supplies in the foreseeable future.

The 3rd meeting of the Energy Ministers and Senior Officials of SAARC Countries was held in Colombo over January 28-29, 2009. Discussion on the prospects for regional cooperation in Energy was one of the key items in the agenda. This article describes the energy situation in Sri Lanka and Maldives, and the prospects for cooperation with other SAARC countries

It is estimated that the off-shore petroleum resources of Sri Lanka can be about 125 million barrels of oil equivalent (boe) in total. But the feasibility of extracting these resources is yet to be established. The country presently sources its petroleum requirements in the form of crude oil and refined products, and operates a 50,000 barrel per day refinery to process crude oil. Petroleum demand grows in the range of 3-5% per year. The burden on the petroleum industry to supply fuel for power generation would remain high for a few more years, until the planned coal-fired power plants come into operation.

With the estimated total hydropower potential in the country being around 2,000 MW, another 650 MW of hydropower capacity is available for future development. Considering the land area available for energy plantations and other constraints a total technical potential of 1,200 MW of biomass based electricity generation is possible in Sri Lanka, subject to technological, environmental and socio-economic considerations. As for the wind resources in Sri Lanka, a combined total exceeding 24,000 MW of technical potential of wind power is estimated to be available at excellent and good wind resource areas alone. The solar power potential in Sri Lanka is significant with solar insolation varying in the range 4-6 kWh per square meter per day.

Sri Lanka stands out among the South Asian countries in two aspects: the high rate of

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household electrification achieved (exceeding 80% from the grid, 2% from off-grid services) and the high cost of electricity production. With a declared target of 95% of household electrification to be reached by year 2015, Sri Lanka is moving fast to provide electricity to all households, either by the grid or through off-grid services. For certain districts, the Government has declared a 100% electrification target. With the new major power plants under construction (Norochcholai and Upper Kotmale), and several other lower-cost power plants being planned, electricity consumers in Sri Lanka should be able to enjoy a competitively-priced electricity supply from year 2011 onwards.

On the renewable energy front, 40% of Sri Lanka's grid electricity supply was provided with hydroelectricity in year 2007, which too is an achievement. One tenth of that hydroelectricity was provided by small (less than 10 MW) power plants built and operated by the private sector, under the standardised power purchase agreements. Sri Lanka has declared her intention to reach a goal of providing 10% of the grid electricity supply from non-conventional sources of energy, which will be achieved through a mix of small hydro, wind, biomass and waste-fired power plants. Attractive tariffs have been declared to encourage the private sector to build renewable energy projects up to 10 MW. The remaining medium and large hydroelectric projects will be built by the Government using various sources of funding.

1.2 Challenges and Growth of Energy Sector

Energy Policy and Strategies of Sri Lanka (2008) clearly identified the interventions required in the energy sector during the next 15 years. Increased attention to supplement energy supply with renewable energy forms with parallel emphasis on energy conservation and management and related research, development and technology transfer are identified as strategies to meet the challenges faced by the energy sector in the country. Further, the ongoing off-shore oil exploration activities in Sri Lanka demand bilateral and regional cooperation to address technical as well as geopolitical issues.

2. Maldives

Maldives is located in the Indian Ocean and consists of over 1,000 islands with a total land area of 300 square kilometres. Only about 200 islands are inhabited, with another 80 islands with tourist resorts. Maldives is a small country with only a population of 386,000 (2008 estimate). The population in Maldives grew at an estimated rate of 5.6% in 2008. The economy also grew at a rate in the range of 7-8% a year during the last few years. The 2007 per capita GDP of Maldives in PPP basis was US$ 4,603. The energy intensity in the economy is determined by the dominating tourist industry, and during last few years, the energy intensity has been stagnant.

Figure 2: Aerial View of Male – the Capital of Maldives

2.1 Energy Resources and Use

99% of the energy needs of Maldives come from petroleum and only about 1% from biomass. Petroleum requirements are imported and these imports are rapidly increasing. Therefore the import dependence of supplying the country's commercial energy needs is extremely high.

As at present Maldives does not seem to possess any petroleum resources within its territories. The resource development potential of Maldives is confined only to the renewable energy sources such as solar power and wind power. The wind power potential is estimated to be high. It has a good wind power potential from North Thiladhunmathi Atoll to Male Atoll. Even in the other southern atolls, a moderate level of wind power potential is available. Solar power potential is significant with solar insolation varying in the range 4-6 kWh per square meter per day.

2.2 Challenges and Growth of Energy Sector

Maldives, as a country importing its entire commercial energy requirement, will have many benefits to reap from better regional energy cooperation and knowledge sharing. Utilisation of wind and solar energy and energy efficiency

will have a significant role to play in the overall energy sector development in Maldives when moving towards a more secure and cost effective energy future.

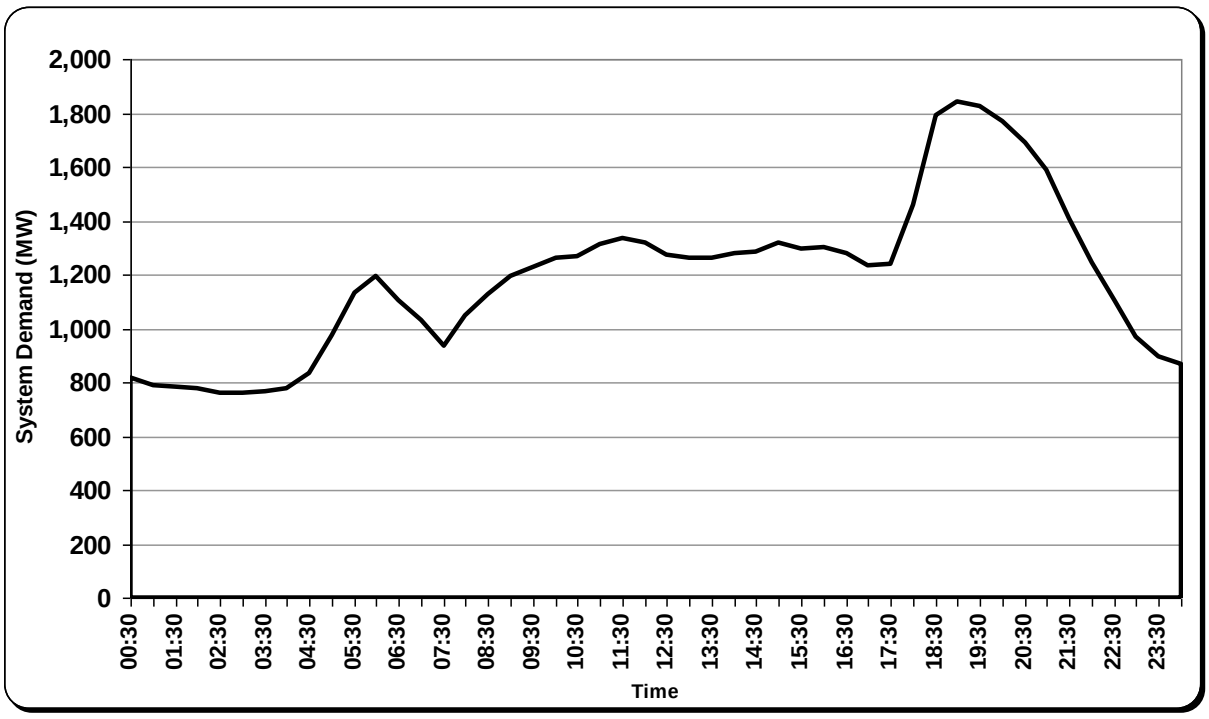
3. Prospects of Regional Corporation for Sri Lanka and Maldives

Sri Lanka and Maldives, being importers of all of their fossil fuel requirements can benefit greatly from energy cooperation in the region. Such cooperation will increase the security and economy of procuring the fossil fuel requirements of the two countries. Cooperation, both in terms of hard investment and soft options such as knowledge sharing, will have a significant role to play in the overall energy sector development in the South Asia when moving towards more secure and cost effective energy supplies.

In the electricity sector, Sri Lanka has already embarked on a joint study with India to examine the feasibility of interconnecting the power grids of the two countries. The prospects for mutual benefits through such an interconnection are considered to be high, which will be studied in detail. Indian investments in major power plants too, are being negotiated. In the petroleum sector, Indian Oil Corporation is already operating one third of the country's filling stations.

From the Sri Lanka National Energy Database:

Sri Lanka Electricity System Load Profile on 28 Nov 2007 (the day on which the annual peak demand of 1842 MW occurred)



ENERGY STATUS AND FUTURE OUTLOOK: INDIA AND BHUTAN

Prasanna Laknuwan, Member SLEMA

1. India

1.1 Area, Geography, Population and Economy

India is the seventh-largest country in the world, with a total land area of 3,287,263 square kilometres and a population of over 1.1 billion, which is the world's second largest population. In terms of occupation, two-thirds of the Indian workforce earns its livelihood directly or indirectly through agriculture in rural villages. However, towns and cities account for over two thirds of the Indian economy in terms of Gross Domestic Product (GDP). The 2007 per capita GDP in Purchasing Power Parity (PPP) basis was US$ 2,563. Major exports include petroleum products, textiles, gems and jewellery, engineering products, chemicals, leather products while major imports include crude oil, machinery, fertilizer, and chemicals.

1.2 Energy Resources and Use

India's energy use is mostly based on fossil fuels. Five different types of energy are being mainly used in India, which are; coal, oil, gas, hydro, and nuclear. There is also a growth in the renewable energy sector through wind, biomass and small hydro plants. Their contribution to the total energy demand is, however, still low.

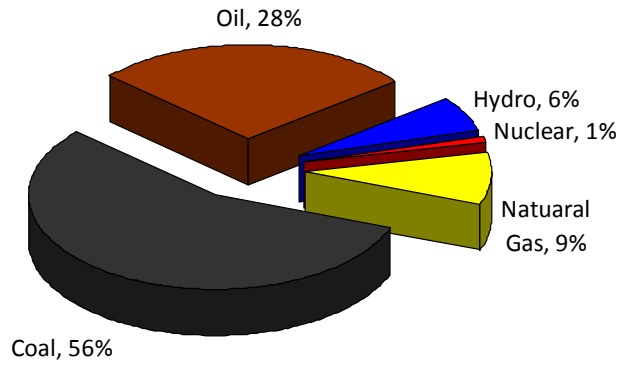


Figure 1: India's Energy Resource Mix – FY 2006

Coal has been the dominant source of energy for a long time and meets about 56% of India's energy demand. India is also the third largest coal producer in the world, though some metallurgical coal and thermal coal are imported to meet the shortfall in domestic production.

Petroleum products meet about 28% of total energy demand and about 75% of the crude oil required is imported. India itself has sedimentary basins which need a lot of exploratory effort before being commercially used. There are proven and indicated recoverable natural gas reserves of about 1,100 million cubic meters, sufficient for another five years at the current consumption rate. However, India started importing natural gas in 2004 in the form of Liquefied Natural Gas (LNG) to meet the shortfall between natural gas demand and local production. For importing gas, there are two operating terminals in Dahej & Hazira in Gujarat, another nearing completion at Dhabol in Maharashtra and another under construction in Kochi-Kerala.

By March 2007, the Indian power system had a total installed capacity of 132,330 MW, which is the third largest in Asia after China and Japan. The generation mix is predominantly thermal-65% followed by hydro electricity-26%, nuclear-3% and the balance 6% is from solar, wind, biomass etc. However, there is still a gap between electricity demand and the supply, indicating the potential for more private sector involvement in power generation. There are five regional transmission grids covering the North Eastern, Eastern, Northern, Western and Southern regions. Power Grid Corporation of India is responsible for them.

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Coal India Ltd is the largest mining company in India which accounts for about 80% of total coal supply (431 million tonnes in FY 2007) in the country. The contributions from Singareni Collieries Company Ltd. and Neyveli Lignite Corporation Ltd. are also significant in meeting the coal demand of the country.

Indian oil refining industry can be identified as equally dynamic as its coal industry, possessing some of world's largest refineries and being a significant net exporter of petroleum products. There are 19 refineries with a total refining capacity of 150 million tonnes per annum. State-owned Indian Oil Corporation (IOC) is the major player while some other private companies such as Reliance and Essar have commissioned their own refineries.

Figure 2: India's refining hub in Jamnagar will be the largest in the world

1.3 Challenges and Growth of Energy Sector

The existing infrastructure and resources are not adequate to meet the increasing energy demand in the country. Improving energy infrastructure and importing energy sources to meet the shortfall and to do away with load-shedding, are essential requirements in the short to medium term. Increasing power generation and transmission capacities, reducing the network losses and improving the reliability and quality of supply are the particular challenges faced by the electricity utilities of India, which have a major role to play in the growing economy.

2. Bhutan

2.1 Area, Geography, Population and Economy

Bhutan is a land-locked country located in the Eastern Himalayas, spread over 38,394 sq. km. Its population in 2003 was estimated by the United Nations at 2,257,000. Bhutan is rich in hydropower potential. Hydro electricity is its major export to India and the foreign exchange earned is a major positive influence on economic growth of Bhutan.

2.2 Energy Resources and Use

Traditionally, firewood has been the major source of energy for a large number of rural and urban households in Bhutan. Biomass accounts for 91% of residential energy use. Overall, the residential sector emerges as the largest energy consuming sector, accounting for 47% of the total energy consumption. Hydroelectricity is now the main source of commercial energy. In the past, electricity generation was based on small diesel generation and mini/micro hydropower generation, providing a limited supply of electricity supplemented by imports from India. However, after commissioning of some major power plants, Bhutan was able to increase its electricity generation substantially and became a significant exporter of electricity to India.

The present installed capacity of mainly run-of-river type hydropower feeding into the grid is 1,480 MW. However, during the lean season (winter months – November through April) the generation capability goes down to about 350 MW. Tala (1,020 MW), Chhukha (336 MW), and Kurichchu (60 MW) can be identified as the major contributors to the generation capacity. In addition to these large hydropower stations, there are some mini and micro hydropower stations providing a combined generation capacity of about 8 MW.

Total installed diesel generation plant capacity is about 16 MW and these supply the areas where grid power is not available. The government provides a subsidy for diesel generation in these areas.

The present maximum national electricity demand is 160 MW. It is estimated that, about 12% of the population will have to be supplied electricity through off-grid electrical systems, due to the difficulty in electrifying them through a common grid. Mini/micro hydropower and solar home lighting systems are the two main options available for such off-grid electrification.

Bhutan has no identified petroleum reserves or a refinery for crude oil processing. The Royal Government of Bhutan has a long term agreement with the Government of India for the

supply of petroleum products. However, a limited quantity of coal is available in the eastern part of Bhutan and is mined and used in the local industry to supplement the imports.

Bhutanese distributors directly import petroleum products from Indian petroleum suppliers. At present, there are three such petroleum distributors in Bhutan. Diesel, petrol, kerosene and liquefied petroleum gas (LPG) are the main petroleum products imported from India

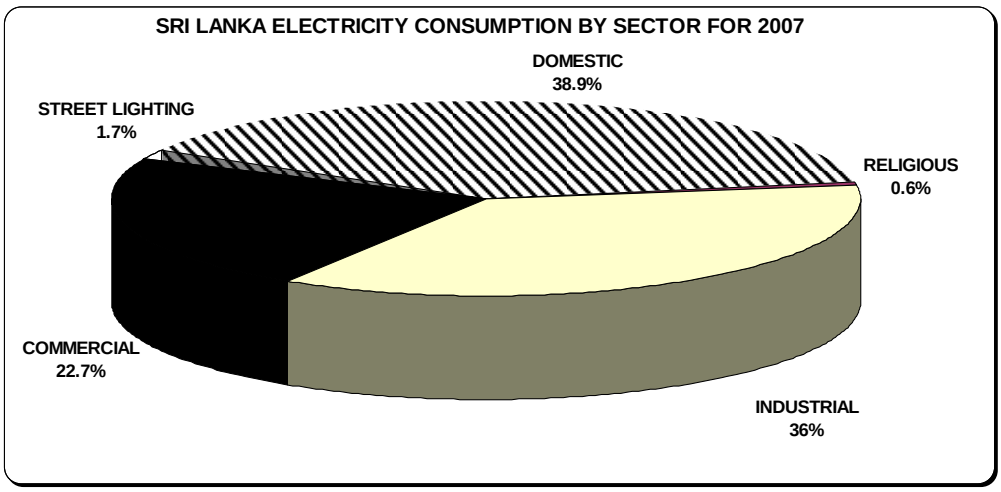
Figure 3: Bhutan's Kurichchu Hydropower plant-60MW

2.3 Challenges and Growth of Energy Sector

Bhutan envisages developing 3,500 MW of additional hydropower capacity by 2020. Pre-construction activities of the Punatsangchhu-I Hydroelectric Project with a capacity of 1,095 MW and Dagachhu Hydroelectric Project with a capacity of 114 MW have already been started as part of this development drive. Development of planned electricity infrastructures including hydropower plants and transmission lines would enable Bhutan to increase its electricity exports and further strengthen its economy in the future.

The vast renewable energy resource in Bhutan offers good prospects for that country to make energy one of their exports, not only to India but to other SAARC countries as well, once SAARC countries agree on a common mechanism to facilitate such electricity trade. India's capacity to reach economy of scale in energy projects, both the in the petroleum sector and the power sector, offer excellent opportunities to other SAARC countries to explore avenues for securing the energy requirements of their respective countries at more competitive prices.

From the Sri Lanka National Energy Database:



ENERGY STATUS AND FUTURE OUTLOOK: BANGLADESH AND NEPAL

Chandrabhanu Opathella, Member SLEMA

1. Bangladesh

1.1 Area, Geography, Population and Economy

Bangladesh is located in the north-eastern part of South Asia. The country is bordered with India on the western, northern and north-eastern sides, with Myanmar on the south-eastern side and with Bay of Bengal on the south. The land area of the country is 147,570 square kilometres with the greater part of the country comprising of flat river basins and deltas. Due to this geographic formation, Bangladesh has been vulnerable to natural calamities such as floods and cyclones. In 2005, population of Bangladesh was about 140 million and this figure is expected to reach 150 million by 2010. The 2007 per capita Gross Domestic Product (GDP) in Purchasing Power Parity (PPP) basis was US$ 1,311. Bangladeshi economy is heavily reliant on service sector, agriculture and light industries. An average economic growth rate of about 5.5% was maintained during the last decade. However, the high level of population growth (exceeding 1.5% p.a.) had put continuous pressure on the country's growing economy.

1.2 Energy Resources and Use

Bangladesh is a SAARC member country blessed with fossil fuel deposits. Natural Gas and Coal extracted from these deposits are being used to meet part of the energy requirement of the country. Natural gas supplied 74% of all commercial energy needs in 2006 financial year while petroleum products supplied 22% (used primarily in the transport sector).

The energy sector is governed by a hierarchy of state organizations and the Ministry of Power, Energy and Mineral Resources (MOPEMR) functions at the top of this governing structure. There are two divisions within the ministry, managing the petroleum and power sectors separately. There are many state and private sector organizations operating under the supervision of these two divisions of the Ministry.

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Figure 1: A busy Street in Dhaka - Bangladesh

Natural gas in Bangladesh was first discovered in 1957. The proven gas fields are estimated to contain approximately 8 trillion cubic feet (tcf) of natural gas deposits. In addition to these proven reserves, a further 12 trillion cubic feet of unproven natural gas resources are estimated to be available within the country. According to the latest estimates, Bangladesh has about 3,300 million tons of coal resources out of which 880 million tons are proven reserves. Coal extraction started quite recently and the use is primarily for the power generation. Though smaller in quantity compared to gas and coal reserves, oil deposits (of about 40 million barrels) also have been discovered in Bangladesh. Due to the natural flat terrain, the hydroelectric potential is relatively small and is estimated to be around 330 MW, out of which 230 MW have already been developed. Apart from the use of these indigenous energy resources, liquid petroleum fuels are imported, mainly for the transportation sector.

In 2006 financial year, the total electricity demand was 22,741 GWh and this was supplied by a

combined power plant capacity of 5,275 MW. 88% of the fuel used for power generation came as natural gas. Bangladeshi power system has been able to provide electricity to only 40% the households in the country, and these residential consumers account for 44% of the total electricity demand. Industrial sector is also a significant consumer category accounting for 42% of the total electricity demand.

1.3 Challenges and Growth of Energy Sector

With the expected development of the country in the coming years, the energy demand of Bangladesh is also expected to grow at a rapid pace led by electricity demand projected to grow at about 8% a year. To cater to this energy demand growth, the depleting natural gas resource would have to be increasingly supplemented by coal. Minimising losses and improving efficiency of energy use would also be significant contributors to meeting the future challenges faced by the energy sector of Bangladesh.

Providing the electricity services to the remaining 60% of households in the country, in the midst of limited indigenous energy resources, is a challenge Bangladesh would have to address in the coming years.

2. Nepal

2.1 Area, Geography, Population and Economy

Nepal is a SAARC member country to which many tourists are attracted to, being the gateway to Mount Everest and the birth place of Load Buddha. It is a land locked country bordered by India and China. The land area is about 147,181 square kilometers. It has a diversified land structure ranging from altitudes of 60m to 8,848m. Nepal is blessed with about 6,000 rivers with a high hydro power generation potential which can provide a sound basis for the economic development of the country as an energy resource and a foreign exchange earner. According to a census done in 2001, population of Nepal is about 24 million and the average annual growth rate of population is 2.2%. The 2007 per capita GDP in PPP basis was US$ 1,078.

Ministry of Water Resources oversee the power sector and hydro resources development of the country. Nepal Electricity Authority and Nepal Oil Corporation are the two main energy sector organizations in the country.

2.2 Energy Resources and Use

Nepal has an untapped hydropower potential of 83,000 MW. 43,000 MW of this potential has been identified as economically and technically attractive for development. At present the power system of Nepal is harnessing only bout 560 MW of this potential while the majority of the population is yet to be electrified. The total installed capacity of Nepal power system is about 600 MW. But the effective capacity is lower due mainly to hydropower plant operating constraints. Apart from the hydro potential, small amounts of fossil fuel deposits have been discovered, in the form of natural gas and coal.

Figure 2: Hydroelectric potential being developed in Nepal

In the total energy mix, share of traditional energy (fuel wood and other biomass) is about 85%. The share of electricity in the total energy mix is only 9% and the balance is sourced as petroleum products imported from India. Households are the main energy consuming sector in the country and it accounted for 89% of the country's total energy consumption in 2006. Industrial and transport sectors consume 4.5% and 3.7% respectively of the total energy demand of Nepal. The level of electrification is about 40% of the population. Even with the lower availability, commercial energy sources such as petroleum, coal, and electricity are gradually replacing the traditional non-commercial fuels.

2.3 Challenges and Growth of Energy Sector

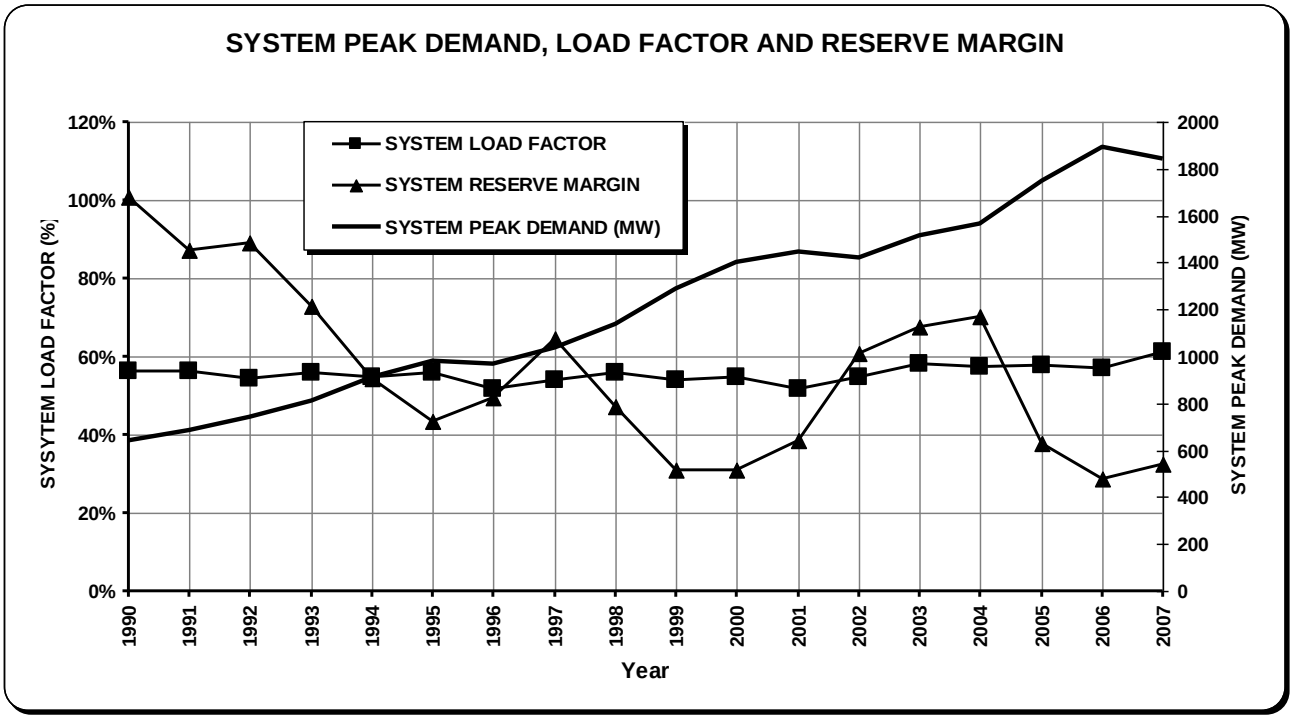
Nepal's Ministry of Water Resources has taken positive steps to improve the supply of commercial energy. Licenses have been issued for the development of several major hydro projects totalling to over 2,000MW. The primary objective is to harness the abundant hydro resources and export the generated electricity to the Indian market.

Being a landlocked country, the inability to have its own petroleum refining facilities is also a hindrance to the energy security of Nepal.

The higher rate of economic growth resulting in increased per capita income and a corresponding change in life style is expected to raise the energy demand, particularly in the industrial and transport sectors. Developing the vast hydro resource and exporting electricity to India are essential to maintain economic growth and ensure energy security.

Similar to Bhutan, Nepal offers a high potential for renewable energy development and trade with SAARC countries, for which an agreed mechanism requires to be established.

From the Sri Lanka National Energy Database:



ENERGY STATUS AND FUTURE OUTLOOK: PAKISTAN AND AFGANISTAN

Chandrabhanu Opathella, Memeber SLEMA

The 3rd meeting of the Energy Ministers and Senior Officials of SAARC Countries was held in Colombo over January 28-29, 2009. Discussion on the prospects for regional cooperation in Energy was one of the key items in the agenda. This article describes the energy situation in Pakistan and Afganistan, and the prospects for cooperation with other SAARC countries.

1. Pakistan

1.1 Area, Geography, Population and Economy

Pakistan, with a land area of 803,940 square kilometres, is the second largest country in the South Asian region. Pakistan is bordered by India and China to the east, Afghanistan and Iran to the west, and Arabian Sea to the south. Pakistan's population was estimated at 168 million in 2008. The economy grew at more than 6.5% annually for the last five years. The 2007 per capita GDP on a Purchasing Power Parity (PPP) basis was US$ 2,594. With the expected high economic growth, a correlated growth in energy demand is also expected.

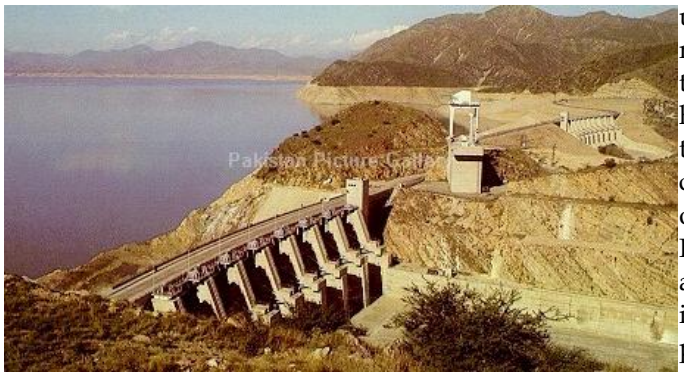


Figure 1: Tarbela Dam - Pakistan

1.2 Energy Resources and Use

The Ministry of Water and Power oversee the electricity sector with several regulating authorities and electricity companies operating under this ministry. In addition to the public sector organizations, independent power companies are also operational within the sector. The Petroleum sector functions under the control of Ministry of Petroleum and Natural Resources. Similar to the electricity sector, regulating authorities and public and private sector organisations operate under the supervision of the line ministry.

Pakistan is rich in natural resources. These include fossil fuel resources such as oil, gas and coal and renewable resources such as hydropower and wind. Pakistan has the sixth largest coal resource in the world. The coal deposits discovered up to 2006 amounts to 185,175 million tonnes. Though smaller in energy quantity compared with coal resources, the oil reserves in Pakistan also play an active role in the energy supply. By mid 2006, about 560 million barrels of petroleum had been used out of the estimated total deposits of 880 million barrels. By the same time, a cumulative total of 20.1 trillion cubic feet (tcf) of natural gas had been used out of the proven reserves of 54.7 tcf. Despite hydro power potential also being considerably large (approximately 40,000 MW), only 6,460 MW have been developed by 2005. However, most of the identified hydro resources are at different stages of development. This includes 14,220 MW of major hydro power projects along the Indus River at planning stage and 735 MW of medium sized hydro power projects at implementation stage. Apart from the hydroelectric energy, there is a considerable potential for wind power and other renewable energy resources, which await development.

In 2006, the industrial sector was the major energy consuming sector in Pakistan with a share of 43%. Shares of transport and domestic sectors were also significant (28% and 21%, respectively). Commercial and agricultural activities contributed to the balance share of 8%. This total energy demand was mainly supplied by natural gas (indigenous) and oil. Respective shares of these two energy supply sources were 39.3% and 32.0%. Imported coal, nuclear and hydropower collectively accounted for the balance portion of energy supply.

1.3 Challenges and Growth of Energy Sector

According to the power development plan, Pakistan's electricity generation is expected to be

more diversified in the future. By 2030, the total electricity generation capacity is planned to be increased to 162,590 MW with contributions from Gas-83,760 MW, Coal-19,910 MW, Nuclear-8,800 MW and Oil-7,760 MW. Along with these thermal power generation facilities, development of renewable energy resources is planned in the form of Hydroelectricity-32,660 MW and other renewable forms- 9,700 MW. Pakistan is planning to increase the combined capacity of the refineries from 12.73 million tons per annum to 18.73 million tons per annum.

Rapidly increasing energy demand of Pakistan makes timely implementation of the existing resource development plans extremely important to ensure adequate and secure energy supply to the country.

2. Afghanistan

2.1 Area, Geography, Population and Economy

Afghanistan is the latest member to join SAARC. The land area of Afghanistan is 652,000 square kilometres and is estimated to have on a population of 32.7 million in 2008. Most parts of Afghanistan are mountainous and the altitudes vary from 400m to 5,600m. The per capita GDP of Afghanistan in PPP basis was US$ 733 in 2007 and the economy grew at 7.4% in 2007.

2.2 Energy Resources and Use

The Inter-Ministerial Commission for Energy is at the top of the organisational hierarchy of the country's energy sector. The energy sector responsibilities are distributed among Ministry of Energy and Water, Ministry of Economy and Ministry of Finance. Ministry of Energy and Water oversee the power sector of the country while Ministry of Commerce and Industries is in charge of the petroleum sector. Natural Gas and Coal developments are handled by the Ministry of Mines and Natural Resources.

Transport sector is the highest energy consuming sector and its share was 32% of final energy consumption in 2006. Shares of household, commercial, agriculture and industrial energy consumptions were 22%, 15%, 11% and 10%, respectively. Other sectors accounted for the balance 10%. At present, the national electricity grid covers only some urban areas and the coverage is around 6%-7% of all households. In the energy supply side, biomass accounts for more than 80% of the total energy consumption. The commercial energy supply

Figure 2: Afghanistan, a Land with Many Resources

composition of Afghanistan is less diversified. The share of petroleum products was 77% in 2005. Use of coal (17%) and natural gas (6%) were also significant.

Afghanistan is estimated to have 6,500 MW of hydroelectric potential. Around half of this potential is considered to be economically and technically un-attractive for development. At present, only about 5% of the total hydroelectric potential is being used. In addition to hydroelectric potential, Afghanistan also possesses considerable amounts of coal, oil and natural gas deposits. In 1978, reserves containing 2,876 million tonnes of coal were estimated to be available out of which about 150,000 tonnes were annually consumed to meet the energy needs of the country. Natural gas is the next significant fossil fuel source in Afghanistan. According to 1978 estimates, 1,585 million cubic meters of natural gas was available in the country. The present rate of consumption of natural gas is 285 million cubic meters per annum. In addition to the above, 41,000 tonnes of oil is produced annually from the Afghan oil reserves estimated to contain 165 million tonnes of oil in total.

2.3 Challenges and Growth of Energy Sector

Affected by war for more than two decades, and the continuing civil strife, Afghanistan faces many challenges in its development drive. Several projects are already in the pipeline for rehabilitation and expansion of the power grid and the gas pipelines. With proper infrastructure development, Afghanistan would be able to exploit its resource base and provide a secure energy supply to support the envisaged economic growth.

PROSPECTS FOR GREATER COOPERATION AMONG SAARC COUNTRIES ON ENERGY

Swetha Perera, Member SLEMA

The 3rd meeting of the Energy Ministers and Senior Officials of SAARC Countries was held in Colombo over January 28-29, 2009. Discussion on the prospects for regional cooperation in Energy was one of the key items in the agenda. Challenges and opportunities are many, as described in the article.

1. A glance at the Region

The eight member states of SAARC (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka) span a land area of 4,428,119 square kilometres with a population of 1,484 million people (2006 mid year population). As a region, in 2006, SAARC countries consumed 481 million tons of oil equivalent (toe) of commercial energy to produce a total Gross Domestic Product (GDP) of US$ 3.44 trillion. Among the eight nations, India consumed the most energy, 402.5 million toe, and contributed largely to the regional GDP, US$ 2.75 trillion. Pakistan and Bangladesh followed India with contributions of US$ 375.4 billion and 180.1 billion respectively, consuming 55 million toe and 18 million toe of commercial energy. India, Pakistan and Bangladesh, being geographically larger and highly populated (95% of the region's population lives in these three countries) compared with other member states uses 98.8% of regional energy consumption and produce 96.2% of the regional GDP. The region's GDP experienced an annual growth rate of 5.6% during the period 1995 to 2005.
In 2007, Bhutan recorded the highest per capita GDP on Purchasing Power Parity (PPP) basis among member states, with a per capita GDP of US$ 4,862. Maldives and Sri Lanka followed with US$ 4,603 and US$ 4,265 respectively while Afghanistan recorded the lowest of US$ 733.

The ASEAN region and the European Union are two regions with approximately the same land area as the SAARC region. But these two regions are far less populated than the SAARC, 566 million and 493 million respectively compared with 1,484 million of SAARC region in 2006. Furthermore, ASEAN and European Union regions have recorded higher per capita GDP figures of US$ 4,545 and US$ 31,020 in 2006 compared to US$ 2,318 of SAARC region.

2. Present Status of Region's Energy Sector

The SAARC region fulfils its energy requirement through fossil fuels, both imported and domestically produced, and renewable sources. The region as a whole has consumed 481 million toe of commercial energy in year 2006. Commercial energy consumption of the eight member countries and their per capita commercial energy consumption are as follows.

Table 1: Commercial energy consumption and per capita commercial energy consumption

Country	Commercial Energy Consumption (million toe)	Per Capita Commercial Energy Consumption (toe)
Afghanistan	0.72	0.03
Bangladesh	18.04	0.13
Bhutan	0.05	0.09
India	402.48	0.36
Maldives	0.17	0.58
Nepal	1.04	0.04
Pakistan	54.88	0.35
Sri Lanka	3.58	0.18

Coal, oil, natural gas and renewable sources supply the commercial energy needs of the regional countries. Except for India and Pakistan, all other countries heavily rely on a single form of energy. Sri Lanka, Afghanistan, Nepal and Maldives rely heavily on oil while Bhutan and Bangladesh rely on hydro power and natural gas, respectively. India and Pakistan have a better mix in their energy supplies.

India and Pakistan are the richest in terms of energy resources with the majority of coal and natural gas resources of the region being available within their territories. Being highly populated with a correspondingly higher energy use, energy needs of India and Pakistan are a lot more than what is locally available. Apart from the fossil fuels, the region has a vast hydropower potential. Due to geography, Nepal and Bhutan are the richest in hydropower

potential. At present, Nepal and Bhutan export electricity generated in hydropower stations to India, fulfilling some of India's electricity needs. Further exploitation of this would indeed, support the energy supplies, increasing energy security of the region.

It is estimated that Pakistan and India have coal reserves of 185 billion tons and 90 billion tons, respectively. The proven reserves of Pakistan though are much lower and are about 2 billion tonnes. Government of Pakistan has decided to introduce coal into power generation along with the development of coal fields. Furthermore, industries in Pakistan have switched to coal fired kilns from furnace oil kilns, increasing the demand for coal. Both Indian and Pakistan coal industries would need to invest in new technologies to harvest the resources better and improve the quality of coal. It is calculated that at the present rate of exploitation, Indian coal reserves will be exhausted within the next 45 years.

Afghanistan, Bangladesh, India and Pakistan have natural gas resources amounting to 95 trillion cubic feet (tcf). Natural gas production and consumption in India, Pakistan and Bangladesh are expected to grow. Transmission and distribution infrastructure is also growing along with the increasing number of natural gas users. Studies to investigate new natural gas reserves are being carried out by each country.

Among the regional countries, India and Pakistan account for the majority of oil reserves. India alone has almost 90% of the oil reserves of the region. Despite these oil reserves, India too depends heavily on oil imports. In 2005, 60% of the oil requirement of India was imported. Oil exploration activities are carried out across the region hoping to arrest this import dependence to some extent.

In the recent past, except in India, investments in refining capacities and technological upgrades in refineries have been overlooked, causing the oil sector of the region to lag considerably behind the rest of the world. Limitations in refining capacities have forced regional countries to import finished products, to some extent, instead of crude oil. This has adversely affected the economies in the SAARC region.

It is also important to draw our attention to the electrification levels of the SAARC countries, as electricity has become a vital energy source to meet day-to-day needs. Among the countries, Sri Lanka has the best electrification rate of 78% (2007) followed by Pakistan and India with rates of 60% and 56%. Electrification rates of Afghanistan and Nepal are as low as 20% and 25% while Bhutan and Bangladesh record figures of 40% and 42%. Low electrification level is a hindrance to the development activities of the region. Investments required for grid expansion, shortages in generating capacity and poverty are the main causes behind the low electrification levels.

3. Challenges to Growth in Energy Sector and Provision of Energy Services to People of SAARC Countries

Energy sectors of SAARC countries face many challenges that hold back their growths as well as development of respective countries. Lack of technology, infrastructure and finance are major obstacles faced by the region. The region is rich with renewable energy resources. Though some forms are abundantly available, harnessing to the optimum level is hindered due to cost and technological barriers. Solar energy and wind energy are two such forms of renewable energy, which are abundantly available but least harnessed. Most potential sites for hydro power plants are located in remote areas where road access and power transmission facilities are not available. Lack of infrastructure and high development costs have caused cleaner and more efficient projects based on indigenous resources to be less viable and has become the main barrier in delivering energy from such projects.

Rising dependence on imported fuels is another hurdle to growth in the energy sector. As mentioned earlier, the region highly depends on imported fossil fuels to fulfil energy needs. High import bills paid by SAARC countries consume most of the export earnings resulting in delays in infrastructure development and developments in other forms of energy sources. Also, import dependency makes the region vulnerable in terms of energy security.

All the SAARC countries presently face difficulties in meeting their energy needs causing adverse effects in the economies, quality of life and social development. Development of locally available alternate fuels and promoting efficient use of energy will resolve this issue to some extent. In the long run, national and regional policies should be developed to promote and develop indigenous energy resources.

Lack of coherent energy policies, regulatory frameworks and competitive market environments in member countries are also obstacles for the development of the energy sector of the region.

4. Prospects of Regional Energy Trade

The first cross border electricity transfer in the region dates back to 1961, when Jaldhaka Hydroelectric Project of India supplied electricity to border towns of Bhutan. Since then India and Bhutan have been cooperating in developing hydroelectric projects and electricity infrastructure. The first major hydroelectric project in Bhutan, Chukha Hydroelectric Project with 336 MW installed capacity (commissioned in 1986), was initiated in 1974 with the assistance of the Government of India under a bilateral agreement to export the surplus to India. Confidence gained in Chukha Hydro Electric Project lead to the joint ventures between the two countries to develop Kurichhu Hydro Electric Project (60MW) and Tala Hydroelectric Project (1,020MW). Benefits reaped by India and Bhutan with the cross border electricity transfers are immense. Electricity export to India has earned a great amount of foreign exchange to Bhutan while India's power shortages were relieved considerably. Furthermore, India and Bhutan have signed agreements to develop Punatsangchhu-I hydroelectric Project (1,095MW) and studies are being carried out for many more projects with the objective of India importing a minimum of 5,000 MW of electricity from Bhutan by 2020. Another important characteristic of these developments is that they are being carried out under the clean development mechanism with expectations of arresting carbon emission levels of India.

Though, India's involvement in development of Nepal's electricity sector dates back to 1950s, first cross border electricity transfer between the two countries happened in 1971 with 5 MW. This figure gradually grew over the years to 150 MW by 2001. Nepal, despite being a country with a huge hydro potential, has an installed capacity of only 600MW. Studies have shown that projects of about 42,000 MW are economically feasible in Nepal. The main barrier at present for increased power transfer between India and Nepal is the limitations in transmission facilities. Developments in transmission network would help Nepal to export power to India during the wet season and import power from India in the dry months, during which time Nepal faces a shortage of about 100 MW. Identifying this, MoUs have been signed between the two countries to develop four 400/220kV transmission lines. In terms of new power generation, the 750 MW West Seti storage Hydroelectric Project in Nepal is under the development with the idea of exporting power to the north of India. Furthermore, Budhi Gandaki Project (600 MW), Upper Karnali (300 MW), Arun III (402 MW) and Lower Arun (300 MW) are under the consideration of development in Nepal with the objective of exporting power to India.

Sri Lanka and India are seriously looking at a 400kV HVDC 1,000MW transmission line between the two countries. The line would have an initial capacity of 500 MW and later another 500 MW would be added. This line connecting Madurai and New Anuradhapura substation is to be 385 km in length including a 30 km submarine cable. Though it is expected that this cable will mostly, carry power from India to Sri Lanka, the everse could also happen occasionally based on the seasonal variation and load profiles.

There are possibilities for Bangladesh to tie up with India for power transfers. Western grid of Bangladesh and eastern region of India can look into cross border transfers, which will benefit both countries immensely. The electricity peak demand time difference and the weekly and seasonal holiday difference make it possible for the two countries to exchange power. This allows Bangladesh to use power from Indian hydro and coal power plants as base load instead of more costly gas plants, and Bangladesh to contribute to India during peak hours using gas fired power plants. This way, Bangladesh could add more diversity to their electricity supply mix.

Apart from electricity, India supplies 100% of the petroleum products consumed in Nepal and Bhutan. Furthermore, Indian Oil Company is actively involved in petroleum products retailing and storing in Sri Lanka adding energy security to Sri Lanka.

SAARC region is surrounded by countries that are rich with energy resources compared to the SAARC countries. Energy supplies from surrounding countries will greatly increase the energy security of the SAARC region. Since 1990, pipelines to import natural gas from Iran, Myanmar and Turkmenistan to India have been considered. Recently, Iran and Pakistan have agreed to go ahead with the pipeline from Iran

up to Pakistan and Indian participation on this line would improve the economics of the project.

While striving for diverse energy supplies and interconnected transmission and distribution networks to improve energy security, the regional countries should work towards improving energy efficiency at the points of supply and use. Working out a regional policy for efficient use of energy, introducing novel technology to where conventional technologies are used such as in cooking, promoting energy efficient appliances and introduction of a building code system and a labelling system for appliances are some measures the eight countries can work together as a region. Soft options such as knowledge sharing will also have a significant role to play in the overall energy sector development in South Asia when moving towards more secure and cost effective energy supplies.

From the Sri Lanka National Energy Database: