Draft January 22, 2007

Developing Integrated Energy Policies in South Asia

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Abstract

The focus of energy policy in the South Asian countries after they achieved independence from the United Kingdom during the 1940s has been on increasing energy supplies to meet the growing demand for energy. Except for oil imports, most of the energy from other sources was supplied from resources within the individual countries --- biomass and hydropower in almost all of the countries, and coal in India. In spite of a tripling of the region's population, and a doubling of per capita income, the South Asian countries have supplied their energy requirements largely from domestic resources. The discovery of oil and natural gas fields in Pakistan, India, and Bangladesh, contributed to a relatively high level of energy self-sufficiency for those countries. However, the great increase in the use of biomass and coal (in India) were major factors in rising air pollution, land degradation, and loss of ecosystems. The switch from "traditional" forms of transportation to motor vehicles that used oil products contributed not only to air pollution but to much higher dependency on imported oil. Further, it helped change the nature of South Asian cities by following the pattern of industrialized countries in the form of urban sprawl, clogged roads, and long commutes.

As in many other parts of the world, policies in South Asia are usually designed on a sector-wide basis, e.g. there is a policy for energy, one for environment, another for transportation, and yet another for technology. Further, the relations

between the South Asian countries were usually determined by political issues, rather than by economic development concerns, and energy is an important factor in the latter.

This paper suggests a more integrated approach to energy policy, both in terms of integration across sectors, and across the countries of South Asia, defined here to include the seven member countries of the South Asian Association for Regional Cooperation (SAARC) --- Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka.

Introduction

The pace of economic and technological development in South Asia has accelerated during the early years of the 21st Century. The acknowledgment of India and Pakistan as nuclear weapon states has been followed by the recognition of India as a powerhouse in the Information Technology area, and an awareness that it is now competing with the industrialized countries in ensuring its energy supplies for the future. Although India is by far the largest country in the region, the combined populations of Bangladesh and Pakistan equals that of the United States. Even excluding India, the total population of the member countries of the South Asian Association for Regional Cooperation (SAARC) is comparable to that of the European Union.

The availability of energy is an important consideration for the further economic development of South Asia. How much more energy will the region need during the next 10-30 years, and in what form will this energy be supplied? The latter question depends strongly on which other considerations are factored in, such as improving environmental quality, meeting transportation demand, the use of newer energy technologies, and the extent of the cooperation between the South Asian countries.

Energy and Economic Development

The per capita use of energy in South Asia is still small, about half a ton per year, only one-tenth of that in most European countries, and about 6% of that in the United States[i]. These roughly parallel the Gross National Incomes (GNI) of the countries mentioned, as shown in Table 1. Starting from a relatively low base, the GNI in the South Asian countries is growing at a rate exceeding 5% per annum. Increasing, or even maintaining this rate of growth will require considerable increases in energy use.

Table 1. Energy and Economic indicators for the South Asian Countries

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Country	Population[1]	Energy Use			Energy Use	Gross National Income[1]	
		Commercial[3]	*Biomass*[2]	*Total*	*Per Capita*	*Traditional*	*PPP*
	(millions)	(million tons oil equivalent)			tons oil equivalent	(US$ per capita)	
Afghanistan[2]	22.2	0.4	6.9	7.3	0.33	186	N.A.
Bangladesh	139.2	16.4	16.6	33.0	0.24	440	1,970
Bhutan[2]	0.7	0.2	0.3	0.5	0.71	1,400	N.A.
India	1,079.7	376.1	106.0	482.1	0.45	620	3,120
Maldives[2]	0.3	0.3	0.2	0.5	1.67	1,800	N.A.
Nepal	26.6	1.1	7.4	8.5	0.32	250	1,480
Pakistan	152.1	49.8	23.4	73.2	0.48	600	2,170
Sri Lanka	19.4	3.8	3.6	7.4	0.38	1,010	4,210

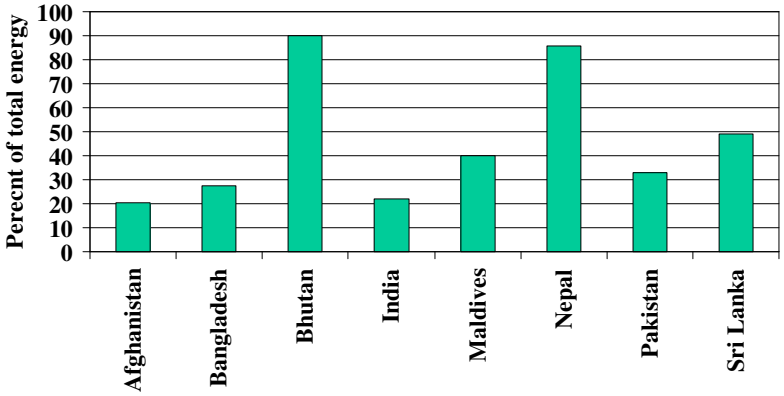
Note: All data are for 2004, unless stated otherwise.
N.A. = Data are not available.
 # Purchasing Power Parity.

Sources
1. World Bank (2006) for data on population and Gross National Income.
2. SARI/E (2005) for all data for Afghanistan, Bhutan, and Maldives, and commercial energy data for Nepal and Sri Lanka.
3. BP (2006) for commercial energy data for Bangladesh, India, and Pakistan.

It should be noted that Table 1 includes commercial as well as “traditional” biomass fuels, mainly firewood, agricultural wastes, and animal wastes. Biomass

fuels still provide more energy than commercial energy sources in Afghanistan, Bhutan and Nepal, and a substantial share of the total energy in the remaining South Asian countries, as shown in Figure 1.

Figure 1. Share of total energy supplied by biomass in South Asia



Toufiq Siddiqi, East West Center, based on data from SARI/E (2005) and BP (2006)

In discussions of energy policy, the focus is usually on oil, but in the context of South Asia, we have to address the question of ensuring the availability of adequate amounts of energy in the rural areas as well, which rely heavily on firewood and agricultural wastes. Biomass supplies are not increasing, and frequently decreasing due to changes in land use from forests to agriculture and housing. As the population of the rural areas also increases in absolute numbers, in spite of the migration to urban areas, the rising energy needs of the rural areas also will have to be met. In what form will the energy be supplied to these areas? Does the infrastructure exist to provide it as liquefied petroleum gas (LPG) or natural gas? Do the countries have enough resources available to provide such an infrastructure? Can the rural populations pay for more than a token amount of electricity, if it could be provided at market rates? These questions need to be

addressed as much as the securing of oil supplies for the transportation sector and for industry, but we shall not do so in the limited space available here.

With respect to commercial energy, every major source of energy is used in South Asia, but the relative importance of each varies from one country to another. The amount of energy provided by each commercial source is shown in Table 2. The Tables reflect the most recent data available for each country. The data for the three most populous countries, Bangladesh, India, and Pakistan, are for 2005, from BP (2006)[ii], whereas those for the other countries are for 2003-2004 from SARI/E (2005)[iii] and EIA (2006)[iv]. The contributions of wind and solar energy are not included in the Tables, since these are still quite small, although increasing at a fast rate, particularly in India.

Table 2. Consumption of Primary Commercial Energy in South Asia

Country	Oil^	Nat. Gas	Coal	Hydro	Nuclear	**Total Coml.**
			(million tonnes oil equivalent)			
Afghanistan	1.8	0.3	0.1	0..1	0.0	2.2
Bangladesh	4.2	11.9	0.4	0.3	0.0	16.8
Bhutan	0.1	0.0	*	0.1	0.0	0.2
India	119.3	28.9	204.8	19.0	3.8	375.8
Maldives	0.3	0.0	0.0	0.0	0.0	0.3
Nepal	0.8	0.0	0.2	0.2	0.0	1.2
Pakistan	14.4	23.1	3.2	6.1	0.5	47.3
Sri Lanka	3.0	0.0	0.0	0.8	0.0	3.8

*= small amount.
^ oil includes oil products

Sources: BP (2006) for data on Bangladesh, India, and Pakistan for 2005.
ADB (2006) for Afghanistan data for 2002.
SARI/E (2005) for data on Bhutan, Maldives, Nepal, and Sri Lanka.

Coal is by far the largest source of commercial energy in India, whereas oil plays this central role in the commercial energy supply of Afghanistan, Maldives, Nepal

and Sri Lanka. Natural gas is the largest source of commercial energy in Bangladesh and Pakistan. Bhutan relies about equally on oil and hydropower.

Options for Meeting Future Energy Needs

Energy use in South Asia has been increasing at over 5% per annum during recent years. The countries of the region are still a very long way from the economic stage where the growth rate of energy use can be expected to decline. Thus energy use is likely to approximately double by 2020 when compared to that in 2005, resulting in a projected consumption of about 1,200 million tons oil equivalent (Mtoe) of energy per year by 2020.

The South Asian countries have generally relied on domestically available sources such as biomass, coal, and hydropower for meeting their energy needs. The exception, for several decades, has been oil, which always had to be imported. The rise in oil prices during the last two years has put a put a severe strain on the resources of all the South Asian countries, with the possible exception of India, where the booming exports of Information Technology services have been a mitigating factor. The energy imports of the South Asian countries are shown in Table 3, along with the cost of the oil imports during the past year for the three most populous countries of the region – India, Pakistan, and Bangladesh. With the price hovering around $60 per barrel at present, the import bills for the current year are likely to be even higher.

Table 3. Fossil fuel imports by South Asian Countries

Country	Quantity (Mtoe)			Imported energy as %	Est. cost of imports (million $)		
	Oil^	Nat. Gas	Coal	of total comm'l energy	Oil^	Nat. Gas	Coal
Afghanistan	1.40	0.00	*	32			
Bangladesh	3.70	0.00	0.00	30	2,000		
Bhutan	0.04	0.01	*	24			
India	107.40	11.60	13.30	29	44,640		
Maldives	0.27	0.00	0.00	100			
Nepal	0.77	0.00	0.17	87			
Pakistan	14.40	0.00	2.50	26	6,500		265
Sri Lanka	3.00	0.00	0.00	78	1,640		

*= small amount.
^ oil includes oil products

Sources: BP (2006) for energy consumption data on Bangladesh, India, and Pakistan for 2005.
ADB (2006) for Afghanistan data for 2002.
HDIP (2005) for Pakistan import data for 2004-05
SARI/E (2005) for data on Bhutan, Maldives, Nepal, and Sri Lanka.

The amount of LNG imported by India during 2005 is from BP (2006).

The costs of oil imports are for the fiscal year 2005-06, and are from the following sources:
Bangladesh: Daily Star (April 27, 2006).
India: Rediff India Abroad (May 10, 2006). “India’s oil import bill shoots to $44.64 billion”.
Pakistan: Daily Times (May 13, 2006). “Trade deficit doubles in first ten months”.
Sri Lanka: Razib Ahmed (May 17, 2006). "Oil price hurting Sri Lankan economy", southasiabiz.com, accessed Oct. 4, 2006.

Afghanistan, Maldives, Nepal, and Sri Lanka depend on imports for more than half of their commercial energy supply, a very high level by any standard. Each of the countries in South Asia has a somewhat different situation with regards to meeting future energy needs, and this is discussed here briefly before moving on to regional approaches.

Afghanistan

A quarter century of conflict has left Afghanistan in a very difficult situation with respect to all sectors, including energy. Power plants and transmission lines have been damaged, and only about 10% of the population currently has access to electricity[v]. There are natural gas fields in the Northern part of Afghanistan, but it has not been possible to undertake further exploration and development. Even the three fields that had been in production at one time are now shut down. The rehabilitation of these fields, and the start of new fields, and additional exploration, could go a long way towards reducing Afghanistan's imports of energy. Such developments are contingent on a degree of peace and stability in the country, and until that happens, Afghanistan will continue to depend on oil imports to meet its growing energy demand.

Bangladesh

There is a good possibility that Bangladesh can keep on increasing its production of natural gas for many more years. About 94% of the 3.6 GW installed electrical capacity in the country is based on natural gas[vi]. Only 20% of the country's population has access to electricity at present, and natural gas will continue to be required for additional electricity generation, as well as for domestic cooking, and other needs. As in the other countries of the region, the number of vehicles in the country is growing rapidly, and almost all of them are dependent on oil products for their operation. Oil imports are likely to continue growing, but the energy import bill can be reduced by exporting some natural gas to India, or permitting the transit of gas from Myanmar to India. This has become a politically sensitive issue in Bangladesh, and we shall return to that topic later.

Bhutan

Bhutan is in the fortunate position of having a large hydropower potential, estimated at more than 30,000 MW[vii]. Only 445 MW of this potential has been

tapped so far[viii]. The domestic demand for electricity can be met by 105 MW, and the remaining electricity generated is exported to India. Bhutan's growing, but still modest requirements for oil could be met by imports through India, and it is expected that additional hydropower would be generated for export to India and possibly beyond.

India

Coal is India's largest source of commercial energy, and the country has sufficient domestic reserves to increase production further during the coming decades. There are several factors limiting the additional amount of coal that can be used by India: (1) Most of the coal is located in the Eastern part of the country, more than a thousand kilometers away from many of the major demand centers near Delhi, Mumbai, Bangalore and Hyderabad. The rail transportation system is already running at full capacity, and it would take a considerable amount of time, before it can be greatly expanded; (2) Much of Indian coal has an ash content exceeding 40%, which creates difficulties for burners, as well as for transportation. The Indian Government has recently promulgated a regulation that coal transported over long distances should have an ash content that is less than 40%; (3) Coal combustion is one of the principal sources of air pollution in the country, as discussed later in this paper. Further, it is the largest source of carbon dioxide emissions from the country, the greenhouse gas that is the largest contributor to global climate change.

The total number of motor vehicles in India has been growing very rapidly, increasing from about 1.9 million in 1971 to about 67 million in 2003[ix]. Such growth ensures that India's imports of crude oil and oil products will continue to grow for at least the next few decades. Since 2004, India has also been importing liquefied natural gas (LNG) from Qatar, and has signed an agreement with Iran to import additional amounts of LNG. It is importing some hydropower from Bhutan, and can expand the imports substantially from that country as well

as Nepal. India also has a very active wind power program, with the fourth largest installed capacity in the world.

Maldives

Maldives has no domestic sources of energy other than biomass, and relies on imported oil for all its commercial energy. Even though there are initial efforts to make use of wind and solar energy, the country's heavy reliance on oil imports is not likely to change much in the near future. Fluctuations in the price of oil thus have an especially great impact on the economy of the Maldives, which is heavily dependent on tourism.

Nepal

Nepal has a theoretical hydropower potential estimated at 83,000 MW, of which 42,000 MW can be economically developed at present[x]. This amount is way beyond the country's expected demand in the foreseeable future. This vast resource can be used for the benefit of Nepal, as well as India and Bangladesh, if satisfactory agreements can be worked out. At the same time, Nepal has no oil deposits of its own, and will continue to depend on oil imports for its transportation needs, which are growing. Nepal has, with international assistance, launched an innovative program that is replacing oil-based three-wheelers with electric vehicles in the Kathmandu valley, to reduce severe air pollution. It is difficult at present to expand this system to the country as a whole, where the population is dispersed and service centers for recharging batteries are not available.

Pakistan

Pakistan was the first country in the region to make extensive use of natural gas, and this is now its largest source of energy in the country. Natural gas production is beginning to level off, while the demand is expected to keep growing for the

foreseeable future. Thus Pakistan will have to start importing natural gas from Iran, the Gulf States, or Central Asia. It will also need to increase its oil imports to cope with the rising number of motor vehicles, whose number increased from about 2.7 million in 1990 to roughly 5.4 million in 2005[xi]. To reduce oil imports and to improve air quality, Pakistan was one of the first countries in Asia to develop an extensive program to expand the use of compressed natural gas in vehicles. It is now the third-largest CNG-using country in the world, with more than 700,000 thousand vehicles in the country that run on this fuel. Most of these are converted vehicles that formerly ran on gasoline.

Pakistan obtains about 13% of its commercial energy as hydropower, and has the potential to expand energy from this source. However, there has been considerable opposition to many of the large hydropower proposals, not only from the people who might be displaced, but from the Provinces downstream who fear a further reduction in the waters of the Indus that are available to them for agricultural use.

Sri Lanka

Sri Lanka is another country in South Asia that is heavily dependent on oil imports for meeting its commercial energy needs. About 20% of the total commercial energy is provided by hydropower, but the scope for increasing this is limited. Electricity from the grid is available to more than 73% of the population. An additional 3% of the households access electricity from solar power, community hydro, wind or biomass[xii]. The country has recently started examining the full potential for making use of these sources. Since the existing rail system is antiquated, roads are by far the dominant transportation mode. The number of vehicles in the country has increased from about 600,000 in 1991 to about 1.5 million by 2004. Thus Sri Lanka's dependence on oil imports is likely to keep increasing for several decades.

Air Quality and Energy Use in South Asia

If serious air quality problems in South Asia were not a major and growing concern, one could continue with the recent trends in energy use and transportation. India could, for example, meet most of its non-transportation energy needs from coal. The cities of the region could go on with the use of two-stroke engines and diesel based buses and trucks. However, most of the larger cities in South Asia suffer from serious air pollution, most of which is caused by coal combustion or by the oil products used for transportation. Much of the air pollution concern in South Asia relates to the very high levels of total suspended particulate matter (SPM) in the air, as well as the respirable suspended particulate matter (RSPM), which can go deep into the lungs. The ambient levels of SPM and RSPM in a number of Indian cities are given in Table 4.

The levels of other important air pollutants such as sulfur dioxide and nitrogen oxides in the Indian cities are rising, but are still within the Indian standards most of the time (TERI, 2004)[xiii]. Carbon dioxide and several other pollutants are being monitored at only a few sites.

High levels of air pollution exist in other South Asian cities, including Dhaka, Karachi, Kathmandu, and Lahore, but systematic data for these cities are only partly available. In Dhaka, for example, annual average levels of particulate matter less than 10 microns in diameter (PM_{10}) in the ambient air increased from about 115 micrograms per cubic meter ug/m^3 in 2002 to about 160 ug/m^3 in 2006[xiv]. The corresponding numbers for particulate matter less than 2.5 micron in diameter ($PM_{2.5}$) are 70 ug/m^3 and 85 ug/m^3. These greatly exceed the guidelines established by the World Health Organization as well as Bangladesh itself, which are 50 ug/m^3 for PM_{10} and 15 ug/m^3 for $PM_{2.5}$. In Pakistan, a study undertaken by ENERCON and UNDP for six cities in Pakistan showed high levels of PM10 exceeding WHO guidelines for all the cities, with the highest 48-

hour mean levels of 290 ug/m^3 being shown in Quetta, 260 ug/m^3 in Lahore, and about 200 ug/m^3 in Karachi.

Table 4. Ambient levels of particulates in selected cities of India

City	Total Suspended Particulate Matter (SPM)*	Respirable Suspended Particulate Matter (RSPM)#
	(micrograms per cubic meter)	
Jalandhar	364	287
Jamshedpur	262	206
Lucknow	367	169
Ahmedabad	256	154
Delhi	355	151
Pune	395	142
Jaipur	307	133
Kolkata	251	121
Chandigarh	275	106
Varanasi	302	97
Chennai	155	86
Bangalore	163	76
Hyderabad	164	64
Cochin	118	58
National Ambient Air Quality Standards in India		
Residential areas (annual average)	140	60
Industrial areas (annual average)	360	120

Source: TERI (2004). All data are for 2003.

* SPM data are annual averages of all the monitoring stations in the city mentioned, for which data are available.

are average annual concentrations of particulates smaller than 10 microns, at all stations in the city for which data are available.

The health impacts of air pollution have become large enough in terms of mortality, morbidity, and the associated economic loss that policymakers are under pressure to address the problem. This would require a combination of

limitations on coal use in or near urban centers, and the widespread use of clean coal technology, as well as switching to cleaner fuels wherever feasible.

Indoor air pollution, primarily from the burning of fuel wood and other biomass, is a very serious problem in much of South Asia, particularly for women who usually cook at home, and for the young children nearby. Substantially more than 70% of the total energy consumed in the rural areas of South Asia comes from firewood, as well as agricultural and animal wastes. Alternate and cleaner forms of energy, such as natural gas or solar cookers, need to be supplied to these areas to protect the health of the people, as well as the loss of forests, partly for energy.

As mentioned in earlier sections of this paper, the transportation sector is the fastest growing energy user in essentially all the countries of South Asia. The combustion of petrol and diesel in the vehicles of the sub-continent is, in most cities, the largest source of air pollution. Switching to less polluting fuels would not only reduce oil imports, but also contribute greatly to the improvement in air quality in the region.

Due to the wide availability of natural gas since the 1960s, Pakistan was the first country in the region to encourage compressed natural gas (CNG) as an energy source for buses, taxis, and private vehicles, and has one of the largest such programs in the world. In India, the highest court has required that all buses in New Delhi run on CNG. Bangladesh is also pursuing this path, whereas Nepal has been very active in replacing highly polluting motor rickshaws in Kathmandu with electric powered vehicles.

An accelerated use of CNG for transportation, combined with electric vehicles in areas with adequate supplies of electricity, would result in cleaner air for South Asia, as well as reducing the rate of growth of greenhouse gases from the region. These would also enhance energy security by making the region less dependent on imported oil.

Enhancing Regional Cooperation for Energy, Environment, and Transportation

There has been only limited cooperation between the countries of South Asia during the first fifty years of independence from British rule. The tense relationship between India and Pakistan, the separation of Bangladesh from Pakistan, and the ongoing civil war in Sri Lanka, have all contributed to deter regional cooperation in almost all fields. Recent improvements in the relations between the two largest countries of the region, and strengthening of the South Asian Association for Regional Cooperation (SAARC) could contribute to improving the situation. Two illustrations of large-scale projects that could improve the energy, environment, and transportation concerns in the region are provided below.

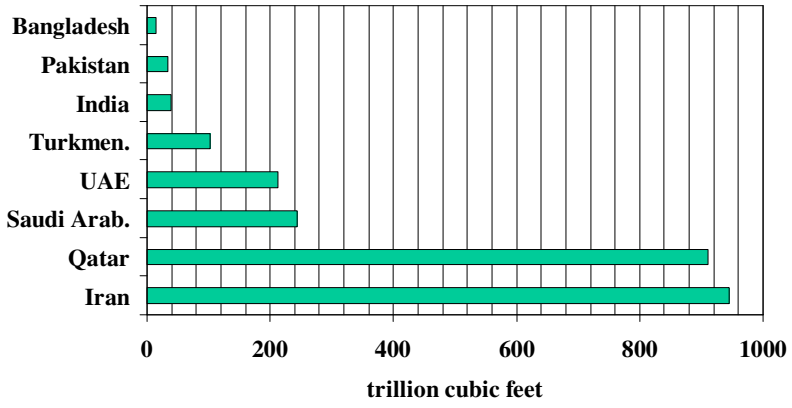
Building a Natural Gas Pipeline linking Pakistan and India

Natural gas has been contributing to the energy supply of Pakistan since 1955. Several other fields have subsequently been discovered, with the result that natural gas is now the largest source of commercial energy in the country. However, the production is beginning to level off, and the country is expected to have to import this fuel by the end of this decade.

In India, natural gas has been produced in Gujarat and Assam since the 1960s, but its use accelerated greatly with the start of production from the offshore Bombay (Mumbai) area in the late 1970s. The demand for this clean and easily transported fuel has always exceeded supply, but the availability of cheap coal and oil did not provide adequate incentives for importing it. This situation began to change during the 1990s, when a combination of coal transportation bottlenecks, a rise in oil prices, and growing awareness of environmental pollution made it attractive to consider importing natural gas.

Natural gas use has increased dramatically in India and Pakistan during the past two decades, and demand already exceeds supply. Consumption in India increased from 19.4 Billion cubic meters (Bcm) in 1995 to 36.6 Bcm in 2005. During the same period, natural gas consumption in Pakistan increased from 14.6 Bcm to 29.9 Bcm, and in Bangladesh from 7.4 Bcm to 14.2 Bcm. The current proven reserves of natural gas in South Asia are relatively modest, compared to their demand, and the reserves available in some of the neighboring countries, as shown in Figure 2.

Figure 2. Proved Reserves of Natural Gas in South Asia and Potential Supplier Countries



Toufiq Siddiqi, East-West Center, based on data from BP (2006)

India imported about 6 Bcm of liquefied natural gas (LNG) during 2005, with imports likely to keep growing for a long time. However, transporting natural gas via pipelines is substantially cheaper than importing it in liquefied form. The cost differential is usually of the order of 25-30%. The possibility of bringing natural gas from Oman, Iran, Qatar, or Turkmenistan to India and Pakistan has been discussed for more than a decade[xv], and several Memoranda of Understanding (MOU) have been signed with potential suppliers. Tensions between India and

Pakistan delayed the implementation of the projects for several years, but the two countries are now in agreement on the need to build one or more common pipelines for the benefit of both.

In the meantime, the U.S. has initiated the imposition of sanctions on Iran, resulting from suspicions that the latter is interested in developing nuclear weapons. It has been exerting pressure on India and Pakistan to forego the option of building a natural gas pipeline from Iran, and to concentrate on imports from Turkmenistan through Afghanistan. India has been offered advanced reactor technologies by the United States for meeting a greater share of its electricity needs through nuclear power. Even though there is no officially stated link between this U.S. offer and the natural gas pipeline, some observers believe that an informal understanding to that effect may exist.

Pakistan's efforts to seek a similar agreement with the U.S. for a civilian nuclear technology have not been fruitful. It has stated that it would go ahead and build an Iran-Pakistan pipeline, even if India does not join in. A new complicating factor is that the price that Iran is now asking[xvi] for its natural gas is almost double what India is willing to pay. Iran is also asking for a revision in the $22 billion agreement with India to export natural gas to that country as LNG over a period of 25 years starting in 2009.

The pipelines projects, if and when they are built, will be large undertakings, with far-reaching implications. As an example, we can consider the Iran-Pakistan-India pipeline, which has been examined in greater detail than the other options. The length of the pipeline from Iran to India would be about 2,600 km. The cost of building it is estimated to be around $8 billion. If the pipeline can be completed by 2010, Pakistan would initially expect to import about 10 million standard cubic meters per day (MMscmd), rising to 60 MMscmd by 2015. India's would initially import 60 MMscmd, rising to 90 MMscmd within three years[xvii].

The feasibility of building a natural gas pipeline from Bangladesh to India has also been extensively discussed in the two countries. Questions about the size of potential reserves and their adequacy for domestic needs have been major obstacles to implementation of the project. While the proven reserves[xviii] of the country have been variously estimated at between 15 trillion cubic feet (Tcf) and only 5 Tcf[xix], the additional reserves in place have been estimated by the U.S. Geological[xx] survey as being about 31 Tcf. According to estimates by Petrobangla, the demand for natural gas is projected to increase from 0.35 Tcf per year in 2000 to 1.3 Tcf per year by 2020. The cumulative demand by 2020 would thus be around 14 Tcf by 2020, an amount comparable to the present proved reserves. If substantial additional reserves are proven, exports to India could become a reality.

India is also exploring the option of importing natural gas from Myanmar, either through Bangladesh, or directly from Myanmar. The 560-mile pipeline through Bangladesh would be more economical than the 870-mile direct pipeline from Myanmar through Northeastern India. Although the Bangladesh government has approved the pipeline through the country, it has asked for trade concessions and other benefits in return, but India has not yet indicated its willingness to accept the terms[xxi].

The current proven reserves of Myanmar are about 18 Tcf, compared to 39 Tcf for India and 34 Tcf for Pakistan. Myanmar currently exports 90 billion cubic feet (Bcf) of gas per year to Thailand, and could export some to India since its own domestic consumption is still relatively small.

Developing the hydropower resources of the Himalayas

Transportation and electricity are the two fastest growing uses of energy in South Asia. We have already discussed the need for ensuring the availability of transportation fuels, as well as natural gas for several purposes, including power

generation. In this section we consider some of the options available to the South Asian countries for meeting their burgeoning demand (Table 4) for electricity.

Table 4. Recent and Projected demand for electricity in South Asia.

Country	Recent Gigawatt-hours	Year	2010 Gigawatt-hours	2020 Gigawatt-hours
Afghanistan	0.87	2003	1.13	3.88
Bangladesh	23.00	2005	31.60	72.80
Bhutan	0.64	2002-03	1.70	6.88
India	679.00	2005	893.00	1,756.00
Maldives	0.15	2003-04	0.36	1.57
Nepal	2.36	2003-04	3.81	8.08
Pakistan	96.00	2005	130.00	251.00
Sri Lanka	7.09	2002-03	11.20	23.90

Sources: BP (2006) for the Bangladesh, India, and Pakistan data for 2005.
EIA (2006) for the Afghanistan data for 2005.
SARI/E (2005) for all other data, and projections.

Nepal, and Bhutan have large potentials for generating hydropower, much beyond their foreseeable domestic demand. Nepal is estimated to have economically available potential of about 43,000 MW[xxii], and Bhutan of about 16,000 MW[xxiii]. (To put this in some perspective, a large nuclear power plant has a generation capacity of about 1,000 MW). Only about 1% of the potential hydropower potential of Nepal and Bhutan has been developed so far. The two countries are thus in an excellent position to contribute to the energy security of the entire region by developing these hydropower resources for their own use, as well as for exports to India, and possibly to Bangladesh and Pakistan.

Until 1988, Bhutan was an importer of electricity from India. Following the completion of the Chukha power plant with the help of India, it is now an exporter of electricity to the latter country. Additional projects with Indian participation are

being implemented. The export of electricity is now the single largest source of revenue for Bhutan.

The International Finance Corporation is providing financial assistance to Nepal to build its second private sector hydropower plant, with the electricity to be used within Nepal. Negotiations between India and Nepal for the sale of electricity from the latter have been going on for a decade, but they have not been able to agree on a sale price for the electricity to be delivered to India.

Like all energy sources, generating hydropower has environmental impacts, mainly the displacement of people living close to the dams and the potential flooding of ecologically valuable lands. With careful planning and the involvement of the people who might be adversely affected, the size of the dams can be selected to minimize the adverse impacts. The potential impacts need to be compared with those from other energy sources, and hydropower usually compares quite favorably with coal- or oil-burning power plants. There will, of course, be sites where the potential social and environmental costs exceed the economic benefits, and the option of building large dams there to generate hydropower may create considerable political opposition. This has taken place, for example, in connection with the Narbada dam in India and the Kalabagh dam in Pakistan. Both countries still have untapped hydropower potential in the North, but the pace of developing these has slowed due to growing environmental and social awareness, and the differing interests of upstream and downstream states and provinces.

Further development of hydropower in Nepal and Bhutan could make a large contribution to the energy security of those two countries, as well as to that of India. If the electrical grid of India could be connected to those of Bangladesh and Pakistan, electric power from Nepal could also be provided through India to the other two large consuming countries of South Asia. This could also help in reducing India’s concerns that Pakistan might disrupt the flow of natural gas via

pipeline at times of political tension, since Pakistan would also be depending on India for continued transmission of electricity from Nepal through India.

Conclusion

Policies for addressing energy needs, environmental quality, and transportation are usually addressed separately in most countries, including those in South Asia. It is important that these policies be integrated so that meeting the needs of one sector does not make it more difficult to meet the goals of the other sectors. To take just one example, the cheapest way to meet the needs of commercial energy may be to use more coal. This, however, would result in making the unsatisfactory air quality even worse. Further, the rail transportation system in South Asia, which is the economic way to transport coal, is already running at full capacity. In contrast, hydropower, if carefully designed to avoid displacing large numbers of people or flooding rare ecosystems, or natural gas brought in by using pipelines, can help in improving air quality, without making use of the overstressed railroad system.

The two fastest growing categories of energy use in most developing countries, including all of those in South Asia, are electricity generation and transportation. Any source of energy can be used for generating electricity, but the transportation system is almost entirely dependent at present on oil products. The hydropower potential of Nepal, Bhutan, and Northern India, could be tapped to meet not only the needs of those countries, but of Bangladesh and Pakistan as well, by linking the electrical grids of those countries.

In contrast to electricity generation, for which any energy source can be used, the transportation sector is almost totally dependant at present on oil products, principally gasoline and diesel oil. South Asia's imports of oil are likely to keep increasing as the number of automobiles keeps growing. Regional cooperation in developing an integrated pipeline system for importing natural gas to South Asia

can not only meet demand for natural gas in households and for electricity generation, but also be of great help in accelerating the switching over of buses, taxis, and private vehicles to this cleaner and more abundant fuel.

Notes

[i] World Bank (2006). World Development Indicators 2006. Washington, DC: The World Bank.

[ii] BP (2006). *Quantifying Energy: BP Statistical Review of World Energy*. London: BP.

[iii] South Asia Regional Initiative/Energy (SARI/E, 2005). *Energy Security for South Asia*. New Delhi: U.S. Agency for International Development.

[iv] Energy Information Administration (2006). Washington, D.C.: U.S. Department of Energy.

[v] Asian Development Bank (2006). *Country Synthesis Report on Urban Air Quality Management: Afghanistan. Manila: ADB, Clean Air Initiative for Asian Cities*, Discussion Draft, December 2006.

[vi] ADB (2006). ibid. Discussion Draft on *Bangladesh.*

[vii] SARI/E (2005). Op. cit.
[viii] ADB (2006). ibid. Discussion Draft on *Bhutan.*

[ix] ADB (2006). ibid. Discussion Draft on *India.*

[x] SARI/E (2005). Op. cit.

[xi] ADB (2006). ibid. Discussion Draft on *Pakistan.*

[xii] ADB (2006). ibid. Discussion Draft on *Sri Lanka.*

[xiii] TERI (2004/2005). *TERI Energy Data Directory and Yearbook*. New Delhi: The Energy and Resources Institute.

[xiv] ADB (2006). ibid. Discussion Draft on *Bangladesh.*

[xv] Toufiq A. Siddiqi (2003). *Energy for Sustainable Development: The India-Pakistan Natural Gas Pipeline*. Honolulu: Global Environment and Energy in the 21st Century.

[xvi] Srivastava, Siddharth (2006). Price Imbroglio Stymies Iran Pipeline. Asia Times Online, accessed Sep. 27 at www.atimes.com/

[xvii] SARI/E (2005). Op. cit.

[xviii] BP (2006). *Statistical Review of World Energy 2006*. London: BP.

[xix] Energy Information Administration (2006). *Country Analysis Briefs: South Asia Overview*. Washington, D.C.: U.S. Department of Energy, EIA.

[xx] Energy Information Administration (2006). ibid.

[xxi] Energy Information Administration (2006). *Country Analysis Briefs: Bangladesh*. Washington, D.C.: U.S. Department of Energy, EIA, July 2006.

[xxii] SARI/E (2005). Op. cit.

[xxiii] Bhutan News Online (2005). Hydroelectric Power Projects of Bhutan, Updated May 5, 2005. Accessed on Sep. 26, 2006 at bhutannewsonline.com/hydro_electricity.html.