



ENERGY FOR
SOUTH ASIA

REGIONAL ENERGY SECURITY FOR SOUTH ASIA

REGIONAL REPORT

**AFGHANISTAN BANGLADESH BHUTAN INDIA
MALDIVES NEPAL PAKISTAN SRI LANKA**

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REGIONAL ENERGY SECURITY FOR SOUTH ASIA

SARI/Energy Program

USAID's South Asia Initiative for Energy (SARI/Energy) is an eight-country program that promotes regional energy security. Begun in 2000, the SARI/Energy program focuses on regional approaches to meet South Asia's energy security needs through increased trade, investment and access to clean energy. SARI/Energy countries include: Afghanistan, Pakistan, India, Nepal, Bhutan, Bangladesh, Sri Lanka and the Maldives.

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DISCLAIMER

This study is the result of an endeavor of six eminent Energy Sector Experts from South Asia. They have analyzed the energy sector plans and critical energy security issues facing the eight South Asian Nations. The study has been funded by USAID under the SARI/Energy Program. The author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

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Abbreviations and Acronyms

AFTA	ASEAN Free Trade Area
ASEAN	Association of South East Asian Nations
bcf	billion cubic feet
CIRDAP	Centre for Integrated Rural Development in Asia Pacific
CNG	compressed natural gas
DFI	development financial institution
DISCOM	distribution company
HDI	Human Development Index
IPPs	independent power producers
MFI	multilateral financial institutions
MMBtu	million British thermal units
MMscmd	million standard cubic meters per day
MRTS	mass rapid transport system
NTPC	National Thermal Power Corporation
PRSP	Poverty Reduction Strategy Program
RGICS	Rajiv Gandhi Institute for Contemporary Studies
SAARC	South Asian Association for Regional Cooperation
SAFIR	South Asia Forum for Infrastructure Regulation
SAFTA	South Asia Free Trade Area
SAIF	South Asia Infrastructure Fund
SAREF	South Asia Regional Energy Foundation
SARI/E	South Asia Regional Initiative/Energy
tbo	tree-borne oil
tcf	trillion cubic feet
toe	tons of oil equivalent
USAID	United States Agency for International Development
VLCCs	very large crude carriers
WEC	World Energy Council

Executive Summary

Overview

This report, entitled *Regional Energy Security for South Asia* (hereinafter referred to as the RES Report), describes the collaborative steps that could be taken by the eight countries of South Asia—Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka—to provide energy security for each individual country and for the region as a whole. Key steps to achieve energy security, which are discussed in the body of this report, include:

- Diversify the sources of fuel supply
- Develop an energy sector master plan, including a hydropower master plan, for South Asia
- Develop a regional power grid for power exchanges/trading within the region and with neighboring countries around the region
- Develop a regional gas grid and promote regional trade in natural gas
- Establish a South Asia Infrastructure Development Financial Institution to promote and facilitate inter-country energy development opportunities
- Strengthen the SAARC Energy Centre (SENER) as an institutional mechanism to share information; facilitate regional planning; provide training, database and research facilities; and promote a common strategy to address regional energy concerns
- Establish mechanisms for joint procurement and transportation of crude and oil products from new sources of supply to take advantage of economies of scale
- Explore development of regional and in-country strategic oil reserves

INTRODUCTION

Global energy demand continues to increase rapidly, driven by growing demand in the U.S. and expanding economies in China, India, and other countries in Asia. Coupled with soaring prices for crude and the political uncertainties in many oil-producing countries, energy users, especially those in South Asia, face a difficult future in meeting their long-term energy needs.

Energy security—the ability of a nation to secure sustainable energy supplies to meet its energy needs at reasonable prices—has thus become a major energy policy imperative. The energy security situation is especially acute for South Asian nations, where energy sectors must typically grow by 2-3% over the GDP growth rate simply to sustain the economy. Each country in the region must therefore address critical energy concerns that will determine not only its national economic expansion plans, but also its ability to bring underserved local populations onto the grid and into the economy.

ENERGY SECURITY IN SOUTH ASIA

Energy and Economic Growth

South Asia, including Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka, is a region of stark contrasts. One of the most populous regions of the world, it has a relatively small land mass and a high incidence of poverty. The countries of the region range in size from India, with a population of over 1 billion, to the Maldives with a population of just

340,000. The per capita GNP ranges from over \$1,800 in the Maldives to less than \$186 in Afghanistan.

Globalization has brought the region to a crossroads. While growing populations have kept the per capita income in the countries of South Asia stubbornly below the world average, their economies are expanding and the demand for energy has soared. These nations are trying to meet ambitious poverty reduction goals while their growing industrial, commercial, and transport sectors and urban and middle-income consumers are using energy at unprecedented rates. To unleash the region's economic potential, every country in South Asia will have to face critical decisions, ranging from depleting indigenous energy resources to developing long-term plans to secure national and regional energy needs.

South Asian countries are highly dependent on imported crude oil and petroleum products. The imports range from 25% of commercial energy consumption in the case of Bhutan to 100% in the case of Maldives. The recent volatility and sharp increase in world oil prices has placed an unexpected and enormous burden on foreign exchange reserves, to the detriment of national economies. While countries like Sri Lanka and Maldives, which lack indigenous fossil fuel sources, are especially hard hit, even countries like India, Pakistan, and Bangladesh now meet less of their demand with indigenous fuel sources and face mounting energy import bills.

The Need for Energy Security

To meet the growing aspirations of the people and economies of South Asian, each of the countries are under immense social and political pressure to secure reliable, sustainable, and reasonably priced energy supplies to meet the ever-increasing demand for commercial energy. Energy security is thus no longer merely a catchphrase but an indisputable reality for vital economic development throughout South Asia. Though each of these countries is trying to evolve its own strategy to address the issue, there is a growing realization of the need to address energy security from a regional perspective. A regional approach facilitates a more comprehensive, cost-effective, and sustainable set of solutions to the challenges of energy security.

REGIONAL ENERGY SECURITY REPORT

In response to these emerging energy realities, a group of energy experts from South Asia¹ examined regional energy needs, energy security concerns, and policy implications by conducting country-specific studies, which are available upon request. Their findings were peer-reviewed by eminent energy experts from the region, whose comments were incorporated.² This regional report presents the key findings and recommendations of the studies in the context of regional energy security. The work of the energy experts was supported by the South Asia

¹ These experts and the countries they studied are: Afghanistan, Mr. Hilal A. Raza; Bangladesh, Dr. Abul Barkat; Bhutan, Mr. T.L. Sankar; India, Mr. T.L. Sankar; Maldives, Mr. T.L. Sankar; Nepal, Mr. Mahesh P. Acharya; Pakistan, Mr. Hilal A. Raza; and Sri Lanka, Prof. Priyantha, D.C. Wijayatunga

² Peer reviewers include: Dr. Kamal Hossain, former Minister for Energy, Foreign Affairs and Law, Government of Bangladesh; Mr. Usman Aminuddin, former Federal Minister of Petroleum, Government of Pakistan; Dr. Kirit Parikh, Member of Planning Commission of India; Dr. Mahendra P Lama; Chairman; Centre for South, Central, South East Asian and South West Pacific Studies; School of International Studies, Jawahar Lal Nehru University; Dr. Binayak Badhra, former Member Planning Commission of Nepal; Mr. Y K K Parera, former Secretary, Ministry of Energy Sri Lanka; and Dr. Joyti Parikh, Chair, Integrated Research and Action for Development.

Regional Initiative for Energy (SARI/E), of the U.S. Agency for International Development. The conclusions and recommendations embodied in this study are entirely those of the authors.

The report and associated country studies are based on the premise that regional cooperation will enhance the energy security of the region as a whole, without compromising the energy security of individual countries. Here, the authors explore the potential for such collaboration, based on an examination of the energy situation, resource endowments, energy growth plans, energy security concerns, and coping strategies of each country. The report examines the common regional energy policy concerns and drivers and then defines options that may be pursued regionally and multilaterally to promote greater regional understanding of the energy problem and to develop mutually beneficial and cost-effective solutions. The report's key findings and major recommendations are summarized in the next few pages.

ENERGY DEMAND AND SUPPLY FORECAST

Energy Demand Forecast

All countries in South Asia rely heavily on non-commercial energy, primarily biomass. Securing and expanding the use of commercial energy is essential, however, for the future economic growth of the region. This energy security report therefore focuses on the future demand for commercial energy, which includes planned shifts to greater use of commercial energy. India, Pakistan, Bangladesh, Nepal and Sri Lanka have developed long-term socioeconomic development plans for the 21st century, which form the basis for their projected energy requirements. Afghanistan and Bhutan currently have no long-term plans. Each country study forecasts energy demand up to 2020, based on an in-depth analysis of future energy plans and prospects. The demand for different forms of energy is also discussed in each study.

The oil consumption growth rate is expected to be over 6% in all countries. Per capita energy consumption ranges from a low of 16 kilograms of oil equivalent (kgoe) in Afghanistan to a high of 759 kgoe in Maldives. Oil imports meet roughly 25% of the commercial fuel demand in Bhutan, India, and Pakistan and 100% of the commercial fuel demand of Maldives. Much of the imported oil products are used as fuel for the transportation sector as well as to meet some urban cooking needs. At the same time, the demand for electricity is growing at a rate of 7% per year in most countries except Afghanistan, Bhutan, and Maldives, which expect growth rates of over 13% in the first decade to meet rural electrification needs.

Energy Resource Endowment and Supply Forecast

The energy resources of the countries in the region were estimated in this report based on various national estimates. Of interest from a national energy security viewpoint are oil, natural gas, hydro, coal, and renewable energy resources, which are presented for each country in Tables 4-1, 4-2 and 4-3 of this report. India with an oil resource potential of 5,576 million tones of oil equivalent (mtoe) stands at the top followed by Pakistan 3,600 mtoe and Bangladesh 0.96 mtoe. Pakistan, Bangladesh, India and Afghanistan have gas resources ranging from 120 billion cubic meters (bcm) in Afghanistan to 7,985 bcm in Pakistan. On the coal front, the resource potential for India is 245,690 million tons, Pakistan 185,000 million tons, and Bangladesh 2,715 million tons (the other countries do not have viable coal resources). Hydropower potential represents one of the largest energy resources in the region, and India's potential is 301,000 MW, Bhutan

50,000 MW, Nepal 42,915 MW, Pakistan 40,000 MW, Sri Lanka 2,000 MW, and Bangladesh 775 MW, totaling 437,000MW of which only 9% has been exploited.

The countries in the region have developed energy use strategies based on the resources available and the expected demand. While Bangladesh intends to meet most of its commercial energy needs from natural gas in the near term, Bhutan and Nepal intend to develop their hydro resources to both meet their energy needs and to export electricity to neighboring countries. Pakistan anticipates that it will have to import gas from 2010 and begin to utilize its lignite/coal resources, while Sri Lanka is planning to develop indigenous hydro and biomass resources and to import coal for power generation. India is focused on optimal utilization of its coal and hydroelectric sources as well as diversifying its supply mix by introducing more renewable energy and nuclear energy, as well as exploring and sourcing oil and gas resources beyond its boundaries.

KEY ENERGY SECURITY CONSIDERATIONS

The energy demand in South Asia through 2020 as presented in this report is based on an in-depth study of the future energy plans and prospects discussed in the country studies. Energy consumption in each country is expected to rise steadily and significantly in order to sustain economic growth rates projected around 6%. As stated, the demand for electricity during the first decade in Afghanistan, Bhutan, and Maldives shows a growth rate of over 13% to accommodate a rural electrification backlog. In other countries, the growth rate is estimated at around 7% per year.

Nevertheless, a significant percentage of South Asians has either no access to electric power or are underserved. The region's average per capita commercial energy consumption is 300 kilograms of oil equivalent (kgoe), a rate that is only one-third of China's 2001 per capita consumption. Most rural areas lack electricity and rely on traditional sources of fuel such as biomass. Traditional fuels meet 95% of the energy demand in Afghanistan, 87% in Nepal, and between 30% and 80% in the other countries in the region.

The region currently faces endemic shortages of electricity that hamper its industrial and socioeconomic growth. Within this context, there is a sustained shift from traditional, non-commercial sources of energy to commercial sources. This shift is being led by India and Pakistan, where traditional fuels meet only about 30% of the energy demand.

South Asia possesses significant indigenous energy resources, but nature has not distributed these resources evenly throughout the region and they remain underdeveloped. South Asia is thus a huge importer of commercial fuels and depends on imported oil products, which are used as fuel for the transport sector, and to meet some urban cooking needs.

To exacerbate the problem, world energy prices have risen sharply over the past two years. Crude oil prices that were routinely benchmarked at under \$30 per barrel in long-term studies have now escalated to over \$65 per barrel and may continue to rise. This will have a debilitating impact on the economies of South Asia, which have relatively meager foreign exchange reserves to meet ballooning fuel import bills. This is a compelling concern for every country in the region. Some, like the Maldives and Sri Lanka, are especially hard hit since they have few alternatives to imported fuels.

The drain on national resources to meet burgeoning energy import bills is a major political and social issue throughout South Asia. Coupled with these sociopolitical pressures is a broad-based misunderstanding of the true impact of energy security risks. This combination has led to policies that do not fully recognize the merits of a regional approach to energy security. Key elements that are absent in current energy policies in the region include:

- Lack of regional energy planning and trade mechanisms to leverage complementary regional energy resources
- Lack of institutional mechanisms to exchange ideas, experience, expertise, technologies, training, and research
- Lack of a common strategy to address regional energy concerns at international forums

ENERGY RISK MITIGATION OPTIONS AND STRATEGIES FOR SOUTH ASIA

While the countries in the region are independently pursuing policy options to mitigate energy security risks, much more needs to be done for the countries to sustainably meet the growing demand for energy to fuel their economies. Given their political exigencies and turbulent histories, a regional approach to mitigate energy risk has yet to emerge. Regional energy experts and eminent persons who prepared this report have identified several options and strategies to mitigate energy security risk factors, including institutional and regional mechanisms. These approaches are discussed below.

Mitigating the Impacts of High Volatility in the Oil Market

Rising energy prices over the past two years have induced a compelling concern for energy security in every country in the region. Measures now under consideration in different countries to mitigate the challenges arising from fuel price volatility include the following:

- ***Creating an oil price contingency fund*** by levying a tax on the sale of oil and oil products to finance the additional cost burden during short price spike periods
- ***Building a strategic petroleum reserve*** over time that would be used during periods of high prices and replenished when prices decline. It could also constitute a strategic stockpile of certain discovered reserves of oil and gas to be activated to full production whenever the prices for crude are too high for the economy to absorb

Diversifying Sources of Fuel Supply—Balancing Trade Dependencies

Currently, South Asia imports most of its oil from the Middle East, a region plagued by security concerns and political risk. Diversifying the sourcing of fuels will help mitigate some of the risks associated with an over dependence on crude and petroleum products from the Middle East. However, given its relatively low energy demand ranking (South Asia accounts for only about 4.5% of world energy demand), the region may not find it easy or cost-effective to source fuels from other petroleum producing nations. To access distant energy markets such as Venezuela, it may be advantageous for the region to pool its petroleum procurement and transport arrangements and negotiate competitive prices for large collective purchases.

Diversifying Supply by Fuel Type—Balancing Single-Source Dependencies

Bangladesh, India, Pakistan, and Sri Lanka are vigorously pursuing measures to diversify their traditional supply mix in the short run. India's oil production is around 30 million tons per annum, with imports topping nearly 100 million tons. This dependency on imported oil is projected to increase at over 4% per year over the next two decades. To address this import dependency, India and Pakistan are endeavoring to acquire oil equity holdings and import liquefied natural gas (LNG) and piped natural gas in neighboring regions. Tripartite negotiations are under way for laying gas pipelines to facilitate such gas imports in the near future. Pakistan plans to utilize its lignite deposits in the Thar area and import gas from its neighbors to mitigate its own dependency on oil imports. India and Sri Lanka have drawn up ambitious plans to increase the use of large-scale renewable energy sources such as biomass, wind energy, and photovoltaic systems for more localized use. Nepal and Bhutan plan to tap their enormous hydropower resources. These options are now being mainstreamed and are being reflected in national energy plans.

Universal Electricity Access—Reducing Poverty and Accelerating Economic Growth

The countries of South Asia have had mixed results in their ambition to increase access to electricity. Bhutan and Nepal are noticeably lagging in achieving their electrification goals, and Afghanistan is understandably so. People living in rural areas have borne the brunt of economic stagnation caused by lack of electrification. The widely acknowledged linkage between energy provision and economic development has spurred governments to develop ambitious plans to increase electricity access to the remotest regions. While these are laudable goals, the challenges are daunting. A key constraint, apart from the sheer magnitude of investment required to finance these projects, is the need for even greater generation of power and the consequent demand for fuel. Even Bhutan and Nepal, which have substantial hydroelectric resources, are constrained during the winter season when water flows are low. Thus, the ambitious social goal of providing universal supply comes at a great cost that has serious implications for energy demand and the need to reduce risks associated with energy security.

It is important that countries pursue both demand-side and supply-side options in their schemes to increase access to electricity supply. Supply-side options should include examining the option of establishing small power exchanges and interconnections across national borders that could help electrify villages at a relatively lower cost compared to expanding the main electricity grid by laying expensive transmission and distribution lines to meet relatively small loads.

Transport Sector Fuel Requirements—Diversifying Single-Source Dependencies

The transport sector is heavily dependent on imported petroleum fuels that are subject to high price volatility, and constitutes an energy security risk for all countries in the region. India, Bangladesh, and Pakistan have introduced compressed natural gas (CNG) as a transport fuel and are actively trying to enhance and expand its use. Many countries are exploring the possibility of biofuels to partially or fully replace petroleum. India has declared a usage standard of 5% ethanol blend in petroleum in nine states and has also formulated plans to grow tree borne oil by utilization of wasteland. Sri Lanka has long promoted the use of dual fuel kits (LPG/gasoline) for fleet transport vehicles, especially taxis. Regional cooperation will help speed up research and

development efforts to make the use of auto-gas and biofuels more cost-effective, and countries in the region could benefit from each other's experience.

Regional Energy Trade—Bridging the Demand/Supply Gap by Diversifying Source and Origin

Regional trade in energy is practically non-existent in South Asia, with the exception of small pockets of bilateral power exchanges between Nepal, Bhutan, and India. Longstanding disputes, political exigencies, and mistrust between the countries of the region have effectively blocked even modest efforts to encourage regional energy trade. This is a sad situation given the complementary opportunities for these countries to capitalize on their energy resource endowments for mutual benefit. While the current climate of spiraling energy prices has triggered renewed interest in regional energy trade, much work remains to be done for it to become a reality. Strategic options for regional energy trade to mitigate energy security risks are discussed below.

Regional Energy Grids—Diversifying Energy Supply

Regional Electricity Grid. A prerequisite for power trading in the region is the establishment of a regional power grid. This concept has been under discussion for quite some time and was adopted as a priority in a South Asia Association for Regional Cooperation (SAARC) declaration issued in January 2004. The SAARC Working Group on Energy is currently considering this concept.

Regional Natural Gas Grid. Limited gas reserves and national priorities have discouraged South Asian countries from exporting natural gas. There is an opportunity for these countries to import gas from outside the region through gas pipelines operated on a common carrier basis, jointly developed and owned by the participating nations. There are a number of proposed gas pipeline projects under discussion, which could lay the foundation for a regional gas grid. However, investment requirements and security concerns must first be addressed before this concept can be fully explored and implemented.

Energy Sector Master Plan—Promoting Indigenous Resource Development

The countries of the region need to develop a regional energy sector master plan that will take a realistic view of energy resources, demand profiles, and growth scenarios. The regional energy sector master plan should also emphasize joint development mechanisms aimed at maximizing investments in shared energy infrastructure and resource development.

For example, South Asia has an economic hydropower potential of over 190,000 MW (Bhutan 23,760 MW, India 84,400 MW, Nepal 43,000 MW, and Pakistan 40,000 MW) which, when developed, would provide an excellent opportunity for energy trade within the region to bridge the demand-supply gap. Even under the current scenario, there is huge potential for cross-border power exchanges due to varying seasonal and daily load curves. Such arrangements would reduce investment requirements, lower transmission losses, improve reserve margins, and enhance the reliability of supply.

Shared Development of Coal Technologies—Benefiting the Region

Coal is one of the largest fuel resources available in the region. However, its development as a fuel has received little attention in the countries of the region except for India, which has a long history of producing and utilizing coal. India also has experience in producing power-generating equipment for coal-based thermal power stations and developing clean coal technologies. Thus, there are tremendous opportunities for sharing technology on low-grade coal/lignite use and coal-based power generation equipment manufacturing. Given that Bangladesh and Pakistan are also serious about utilizing their coal reserves, there is merit in sharing knowledge regionally. Currently, there are no institutional mechanisms for joint development of coal or clean coal technologies.

Sustained Cooperation on Regional Energy Issues

The energy security plans outlined in the regional report and country studies have several provisions for regional cooperation in energy. The SAARC Energy Working Group, SAFIR, and SARI/Energy have been facilitating discussions on energy security issues. However, the existing arrangements and institutions that have been working toward a regional energy security plan are not adequately equipped with a mandate and adequate resources to secure such plans in the foreseeable future. To supplement these efforts in a sustainable manner, there is need to establish a regional facility to support information sharing on techniques and technologies, training, renewable energy research and development, the promotion of a common strategy to address energy security concerns.

RECOMMENDED STEPS

A regional approach to energy security, including coordinated planning and risk mitigation, should yield significant benefits to each country and to the region as a whole. In fact, the report found that the perceptions of risk to South Asia's energy supply security are very similar for each country in the region. This consistent level of concern could well serve as the basis for developing a common regional energy security program. The following key recommendations and action plan were developed based on the findings of this report and the collective wisdom of regional energy experts and eminent reviewers:

- **Strengthen the SAARC Energy Centre (SENER)** At the SAARC Energy Minister's conference in Islamabad in September 2005, it was agreed to establish a SAARC Energy Centre (SENER) in Islamabad, Pakistan. The permanent institution will serve as a representative institution of all member countries in the region. The primary objective of SENET is to facilitate intra-regional energy planning, research, training and trade. Key activities include the assessment of a power interconnection master plan, formation of a regional energy database, and development of relevant information, training materials, studies and position papers to support regional energy cooperation and trade.
- **Establish a South Asia Infrastructure Development Financial Institution** to bring the private sector, entrepreneurs, investors and industrial associations, and investment banks from the participating countries together to identify and promote inter-country development opportunities. The institution would serve to identify mutually beneficial investment opportunities for entrepreneurs in the region and to promote regional economic diplomacy and understanding of the business environment in different countries.

- **Build a strategic petroleum reserve** over time to be used during periods of high prices. One approach is to preserve certain discovered reserves of oil and gas as a strategic stockpile to be activated to full production whenever prices for crude oil and gas are too high for the economy to absorb. In addition, creating an oil price contingency fund may be considered as a means to finance the additional cost burden during short price spike periods.
- **Establish a regional electricity grid** as an infrastructure backbone. This grid is a prerequisite for the rational development of the energy sector in the region. The advantages of a South Asia regional electricity grid are appreciated by almost every country in the region and are specifically listed in the energy security plans of Nepal, Bhutan, and Bangladesh. It is proposed that a working group of eminent persons, supported by a competent technical consultancy organization, study the techno economic feasibility of establishing such a grid.
- **Establish a regional gas grid.** Although an independent regional gas grid is today only a remote possibility, if major pipelines connecting India or Pakistan with Central Asia or the Middle East materialize, the feasibility of expanding the natural gas grid to Pakistan, India, and Bangladesh could be explored as a step towards the development of a regional gas grid. It is proposed that a study group be constituted, at the appropriate time, to examine the techno economic feasibility of establishing a regional gas grid.

CONCLUSIONS

Securing long-term energy supplies to power expanding economies and meet the rising aspirations of a growing populace is no longer a concept. Rather, the need for national and regional energy security has become a compelling reality for South Asia, as evidenced by the fact that each country in the region is seriously exploring avenues and options to meet future energy demand.

At the same time, South Asia possesses indigenous energy resources and high-quality labor, in addition to a well-established governance system. Leveraging these advantages, a platform for action must be created to move quickly toward developing a regional energy market that can alleviate the risks associated with national energy security goals.

Development of regional energy markets will require governments, institutions, academics, and all segments of society to come together to discuss openly and freely the issues involved—including the apportionment of costs and benefits—in a transparent, fair, and equitable manner. Creating a South Asia Regional Energy Foundation would be an important first step in this regard.

Ultimately, what is needed is a regional energy security system that benefits the citizens of South Asia and supports the national development aspirations of each country. South Asia's energy situation represents a tremendous opportunity to design and implement a regional energy strategy that truly strengthens each nation's security.

The South Asian region considered in this report consists of eight countries: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. This region includes countries ranging in population from among the world's smallest (Maldives) to one of its largest (India). The region has a high population density, with 22% of world's population occupying only 4 % of the world' land mass, with relatively high levels of poverty. At the same time, the countries of South Asia have shared a common history during much of the twentieth century and, as a group, are likely to play a strategic role in world affairs in the twenty-first century. All may be categorized as developing economies, while some have very high rates of economic growth, which places significant pressures on their respective energy sectors to fuel that growth. The developments in this region will have special importance for energy issues throughout the world, as South Asia is likely to contribute a major share to the incremental demand for hydrocarbons during the first half of this century.

All the countries of South Asia are highly dependent on the import of fuels, particularly hydrocarbons, and this dependence is likely to increase in the coming two decades. High oil prices, especially when accompanied by sharp and sudden price increases, hurt these economies and negatively impact their balance of payments. Nevertheless, the fuel resource endowments of these countries have certain complementarities, which suggest that intra-regional energy cooperation would greatly help mitigate individual country energy security risks. Thus, there is an urgent need to understand the national energy policies and resource endowments of these countries in order to identify common features and complementarities necessary for a viable regional energy security framework.

The energy security of a country or a region requires the availability of energy at all times, in various forms, in sufficient quantities, and at affordable prices. Any regional energy security arrangement must therefore be designed to conform to national energy security plans. The countries in question vary widely in size, population, and stages of economic growth. But there are several similarities in the paths of development taken by them and their consequent energy consumption patterns. There are also complementarities in the energy sector policies, and these complementarities provide a basis for energy cooperation. The Twelfth South Asian Association for Regional Cooperation (SAARC) Summit held in Islamabad in January 2004 led to the Islamabad Declaration, which specifically mandated a special high-level working group for South Asian energy cooperation, including the concept of an “energy ring.” Various agencies, including the Working Group on Energy within the SAARC, may undertake official level studies. The present report attempts to contribute to the debate by examining energy security issues in terms of an evolving regional energy security framework.

This report represents the synthesis of the studies for eight countries—Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. The gist of the country studies has been summarized in this report, as follows:

- Section 2 presents a detailed comparison of the status of the energy sectors in the countries of the region, including energy supply risks and security concerns as perceived within the countries and their respective policies and programs to secure national energy security.

- Section 3 examines the long-term vision of economic development in these countries and derives a long-term forecast of energy demand and supply.
- Section 4 discusses the energy resources of the countries and identifies the complementarities.
- Section 5 addresses issues and options for regional cooperation in energy security.
- Section 6 sets forth an action plan to help the region move towards enhanced energy security.

The country studies can be found in the appendixes of this report.

The task manager for the team that produced the RES Report and studies is Mr. D. N. Raina, senior energy sector specialist (Nexant, SARI/Energy). The following authors prepared the individual country studies:

- | | |
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The following highly regarded professionals from within the region conducted a peer review of the entire RES package, and their comments are reflected in this final version:

- Dr. Kamal Hossain, former Minister for Energy, Foreign Affairs and Law, Government of Bangladesh
- Mr. Usman Aminuddin, former Federal Minister of Petroleum, Government of Pakistan
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Their work was supported by the South Asia Regional Initiative for Energy (SARI/Energy), of the U.S. Agency for International Development. The conclusions and recommendations embodied in this study are entirely those of the authors.

2.1 KEY SOCIOECONOMIC INDICATORS

Table 2-1 presents the key socioeconomic indicators of South Asia. Populations vary from 0.3 million in Maldives to 1,042 million in India; annual per capita incomes range from US\$186 in Afghanistan to US\$1,800 in Maldives. The median per capita value in the more populous countries is around US\$450 per year for the region, except in Sri Lanka, whose median per capita income is double that figure. The percentage of the population below the poverty line is high—about 40–50% in Nepal and Bangladesh and around 30% in other countries. Life expectancy is above 70 years in Maldives and Sri Lanka, and more than 60 years in other countries, except Afghanistan, where it is about 43 years. With such variations, it is not surprising that the Human Development Index (HDI), established by the United Nations to measure national well being, ranges from a relatively healthy 86 for the Maldives to 170 for Afghanistan.

Table 2-1 Key Socioeconomic Indicators of South Asia, 2002–2003

Item	Unit	Afghanistan	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka
Population	Million	22.2	138.1	0.7	1042	0.3	24.7	146	19.2
GNP	Billion US\$	4.1	55	2.9	568	0.5	6.0	85.0	18.0
Per capita GNP	\$/yr/person	186	398	1,400	534	1,800	243	582	938
Population below poverty line	Percentage	N.A.	49.8	N.A.	28.6	N.A.	42.0	32.6	25.0
Life expectancy	Years	43	62	66	63	73	60	64	74
HDI	Rank in no.	170	139	136	127	86	143	144	99
Per capita commercial energy consumption (2003–2004)	kgoe	16	89	243	351	759	44	355	200

Note: kgoe = kilograms of oil equivalent.

Please see Appendix-I for Source: Compiled by authors from information cited in RES Country Reports

2.2 ENERGY INDICATORS

South Asia has emerged as the world's fastest growing region as well as the region with the highest growth rates in the consumption of commercial energy. The developmental path and resulting energy mix have varied considerably from country to country. Biomass in the form of fuel wood, agricultural waste, and animal waste remains as a primary fuel for the majority of poor people in region, although the spread of electricity and the penetration of fuel products for lighting and cooking, has led to a gradual reduction in the share of biomass in most of these countries. The usage of oil, coal, natural gas, hydroelectricity, renewable energy, and nuclear shows significant variation, as can be seen in Table 2-2.

Table 2-2 Energy Status Indicators of South Asia, 2003–2004, in Primary Units

Item	Unit	Afghanistan	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka**
Traditional fuel biomass	Million tons	22.20*	53.49	0.95	340	0.61	23.8	75.10	11.50
Coal	Thousand tons	2.2	1.0	22.3	381,000	0.0	384.0	6,065.0	0.0
Oil products	Thousand tons	212.0	3,706.5	44.7	124,000	271.0	769.0	15,210.0	3,008.3
Natural gas	Billion cubic meters	0.12	9.20	0.00	30.9	0.0	0.00	30.43	0.00
Electricity hydro	Million kWh	113.0	959.0	604.0	75,242	0.0	583.3	26,944.0	3,475.0
Electricity nuclear/renewable	Million kWh	0.0	0.0	0.0	34,101	0.0	0.0	1,760.0	18.0
Total primary* electricity	Million kWh	113.0	959.0	604.0	109,343	0.0	583.3	28,704.0	3,493.0

*Primary electricity does not include electricity produced from fossil fuels.

Please see Appendix-I for Source: Compiled by authors from information cited in RES Country

** Estimates

In the conversion of primary energy units into tons of oil equivalent (toe), the same factors were not adopted for all countries. The international agencies, such as the United Nations and the World Energy Council, adopt some standard factors, but these do not provide for the low calorific value coal available in South Asia. To make allowances for the coal available in South Asia, 2.23 tons of coal is taken as a ton of oil equivalent (toe). The conversion of electricity generated from primary sources to toe results in very low values, because the conversion factor adopted makes use of the calorific value of electricity, which is 860 kcal per unit of electricity. In Pakistan, the factor of 238.6 toe per million kWh is adopted. This is based on the assumption that to produce a million units of electricity from fossil fuels (with about 34% efficiency of conversion) that quantity of fossil fuel would be used. To give hydroelectricity's share in the total energy supply, an appropriate measurement of this factor has been adopted in this report. The following conversions factors have been used to estimate the total energy consumed in terms of tons of oil equivalent, where Q is the heating value of the fuel:

- Q million tons of biomass = $Q/3.215$ mtoe
- Q 1,000 tons of coal = $Q/2,230$ mtoe
- Q 1,000 of oil = $Q/1,000$ mtoe
- Q billion m³ of gas = $Q \times 0.9$ mtoe
- Q million kWh = $Q \times 0.00024$ mtoe

Table 2-3 gives the energy status indicators (based on the above conversion factors) in comparable common units of measurement, million tons of oil equivalent (mtoe). To make the inter-country comparisons meaningful, all the data has been brought to a common base period, 2003–2004, before being converted to a common measurement scale.

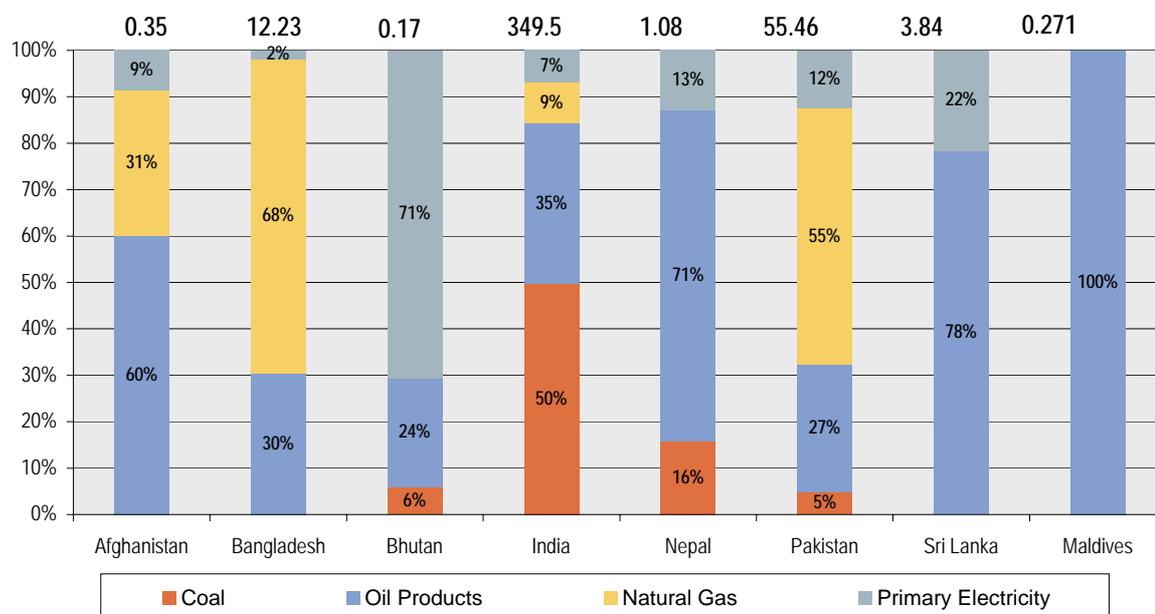
Table 2-3 Energy Status Indicators of South Asia, 2003–2004 (mtoe)

Item	Afghanistan	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka	Total
Traditional fuel									
Biomass	6.91	16.64	0.29	106.00	0.19	7.40	23.36	3.58	164.37
Commercial fuels									
Coal	0.00	0.00	0.01	171.00	0.0	0.17	3.30	0.00	174.48
Oil products	0.21	3.71	0.04	124.00	0.27	0.77	15.21	3.01	147.22
Natural gas	0.11	8.29	0.0	28.00	0.00	0.0	27.39	0.0	63.79
Electricity hydro	0.03	0.23	0.12	18.00	0.00	0.14	6.47	0.83	25.82
Electricity nuclear/ renewable	0.0	0.0	0.0	8.50	0.00	0.0	0.42	0.00	8.92
Total, primary electricity	0.03	0.23	0.12	26.50	0.00	0.14	6.89	0.83	34.74
Total, commercial energy	0.35	12.23	0.17	349.50	0.27	1.08	52.79	3.84	420.23
Total, biomass + commercial energy consumption	7.26	28.87	0.46	455.50	0.46	8.48	76.15	7.42	584.60
% share of biomass in total energy	95	58	63	23	41	87	30	48	33
Per capita commercial energy consumption, kg	16	89	243	335	759	44	355	200	302

Please see Appendix-I for Source: Compiled by authors from information cited in RES Country Reports

2.3 RELATIVE FUEL CONSUMPTION

Figure 2-1 shows the relative share of different fuels in the consumption of energy.

**Figure 2-1 Relative Fuel Consumption Status in South Asia for 2003–2004 (mtoe)**

Please see Appendix-I for Source: Compiled by authors from information cited in RES Country Reports

The demand for commercial fuels throughout South Asia has risen dramatically. The growth of transportation facilities has had a strong impact on oil consumption, which remains the main source of fuel for the transportation sector. All the countries in this region have minimal oil resources, except, to a small extent, India. Bangladesh and Pakistan have modest gas reserves, and the level of utilization of natural gas in these countries has significantly increased. India has abundant coal resources and limited reserves of hydrocarbons. Modest measures for exploring oil and gas resources within India have not resulted in any appreciable discoveries. India is the only country that uses coal to any appreciable degree and that has made some progress in exploiting renewable energy resources. India and Pakistan are the only countries that have nuclear power generation capabilities and nuclear power plants.

The share of biomass consumption as a percentage of total consumption has declined to about one-third in India and Pakistan, remains at two-thirds in Bangladesh and Sri Lanka, and is higher than 85% in Afghanistan and Nepal. All of the countries in the region are attempting to exploit the large-scale commercial use of biomass energy in an environmentally friendly fashion. Table 2-4 indicates how the countries have tried to align their inter-fuel consumption pattern to the fuel endowment of their countries. In India, where coal is abundant relative to oil, coal is a major source of power generation, with some gas and very small quantities of petroleum products (e.g., naphtha and furnace oil). In Pakistan, most of the thermal power is generated by gas. A good beginning has also been made in Pakistan toward the use of natural gas in the transportation sector in the form of compressed natural gas (CNG). In other countries, such as Nepal and Bhutan, hydroelectric power generation dominates the power sector.

The transportation sector depends mainly on oil products for fuel. The rise of the middle class in these countries has exerted strong pressure for personal transportation and consequent pressure on oil demand. The result is dependence on imports for meeting commercial energy demand is over 80% in Nepal and Sri Lanka and around 30% in India and Pakistan.

2.4 IMPORT DEPENDENCE

The import dependence of the South Asia countries is indicated in Table 2-4.

In some of these countries, when imports are weighed against primary energy consumption the import dependence looks very small because of the high level of use of biomass, which is totally indigenous and reduces the dependence ratio. For the purpose of important public policy considerations other than environmental policies, the level of import dependence must be examined with reference to commercial energy consumption. This dependence is about 30% in Bhutan, India, and Pakistan and about 80% in the other countries, clearly indicating the urgency for exploring energy security measures throughout South Asia.

Table 2-4 Import Dependence of Energy Sector in South Asia

Item	Unit	Afghanistan	Bangladesh	Bhutan ⁷	India	Maldives	Nepal	Pakistan	Sri Lanka
Total energy consumption	mtoe	7.26	28.87	0.46	455.5	0.46	8.48	76.15	7.42
Total commercial energy consumption	mtoe	0.35	12.23	0.17	349.9	0.27	1.08	52.79	3.84
Import of coal	mtoe	-	0.0	0.004	11.6	0.0	0.17	1.4	0.0
Import of oil	mtoe	0.21	3.71	0.04	Crude 98.4 Products 9.0	0.27	0.77	12.30	3.01
Import of natural gas	mtoe	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0
Total imports	mtoe	0.21	3.71	0.04	101.4	0.27	0.94	13.70	3.01
Import dependence as a percent of total energy	%	3	13	9	22.0	59	11	18	41
Import dependence as a percent of commercial energy	%	60	30	24	29	100	87	26	78

Please see Appendix-I for Source: Compiled by authors from information cited in RES Country Reports

2.5 STATUS OF ELECTRICITY SECTOR IN SOUTH ASIA

In any assessment of the demand for energy within the region, electricity has to be considered separately as it is a secondary form of energy, obtained partly from the primary energy sources directly and by conversion of coal, gas, and oil. The rising demand for electricity reflects the spread of electricity to larger areas to meet the basic need for lighting. The level of use of electricity is considered an indication of rising economic prosperity. Electricity usage is highly capital-intensive, and most of the countries find it difficult to finance the capital requirements of the industry.

Table 2-5 summarizes the status of the electricity industry in South Asia. The per capita consumption of electricity varies from a low of 19 units per year in Afghanistan to over 540 units in Pakistan and India. Bhutan's per capita consumption of electricity appears high because **50%** of its total consumption is concentrated in only three power-intensive industrial units. Electricity generating capacity varies from a low of 436 MW in Bhutan to over 112,000 MW in India. In all eight countries except Bhutan, thermal generation was higher than the hydro in 2003–2004. Sri Lanka and Nepal have higher hydro generating capacity than thermal generating capacity. However, because of drought conditions and load factor, hydro generation has been falling. Sri Lanka has almost fully exploited its hydro potential. India alone has a sizable coal-based power generation. The ownership of the power generating plants is mostly in the public sector, as are transmission and distribution.

There is an emerging presence of the private sector in power generation in Bangladesh, India, Nepal, and Pakistan, and this presence is likely to grow.

The electricity industry has been a source of great financial drain for most of the region's governments, as these countries are still sorting out the irrational tariff policies and non-focused subsidies that have resulted in electricity being sold at average prices far less than the average cost of supply. Each country has undertaken reform and restructuring of the power industry, and progress has been good in Pakistan and to a lesser extent in India. The availability of electricity

in adequate quantities and at affordable prices is recognized as a precondition of poverty alleviation, employment generation, and socioeconomic development throughout South Asia. In most of the countries, especially Sri Lanka and Maldives, future power generation has to rely on imported fuels that have high price volatility. The managerial efficiency in the power industry in most of these countries is very low. Although each country has initiated measures to improve management and governance, including increasing the role of the private sector, progress is still slow. Regional power generation plants would help most of these countries, as discussed further in Sections 5 and 6.

Table 2-5 Electricity Industry Status in South Asia

Item	Unit	Afghanistan (2002-2002)	Bangladesh	Bhutan**	India	Maldives**	Nepal	Pakistan	Sri Lanka
Electricity sold	mkWh	315	14,777	640	379,531	146	1,778	57,491	6,161
Electricity supply	mkWh	423	19,179	640	588,134	146	2,362	80,827	7,087
Per capita electricity supply	kWh/yr/person	19	139	914	553	429	96	545	369
Generation capacity	MW	454*	4,710	445	112,683	106	628	19,252	2,168
Capacity									
(i) Hydro	MW	261	230	428	29,507	0.0	571	6,491	1,259
(ii) Nuclear	MW	0.0	0.0	0.0	2,720	0.0	0.0	462	0.0
(iii) Renewable	MW	0.0	0.0	0.0	1,870*	0.0	0.0	0.0	0.0
Capacity thermal									
(i) Oil	MW	193	(i) 494	17	3,661	106	57	***	909
(ii) Gas	MW	-	(ii) 3986	0.0	11,840	0.0	0.0	12,149	0.0
(iii) Coal	MW	0.0	0.0	0.0	64,956	0.0	0.0	150	0.0
Share of generation from primary sources	mkWh (%)	113 27	959 5	604 94	95,905 16	0.0 0.0	583 25	28,704 36	3,493 49
Share of generation fossil fuels	mkWh (%)	310 73	18,220 95	36 6	492,229 84	146 100	1,779 75	52,123 64	3,594 51
Capacity public sector	% share	100 %	73	100	90	39	79	100	85
Capacity private sector	% share	0.0	27	0	10	61	21	0	15

*In India, the renewable energy capacity is almost exclusively owned and operated by the private sector and is exclusive of the total installed capacity shown in row 4 in the table.

** In the case of Bhutan and Maldives, for want of data, the quantity sold is also used as quantity supplied.

***In Pakistan, power generation based on oil and power generation based on gas are treated together.

Please see Appendix-I for Source: Compiled by authors from information cited in RES Country Reports

2.6 NATIONAL ENERGY RISKS AND SECURITY PERCEPTIONS

Afghanistan

Afghanistan has had a turbulent and a traumatic recent history. The past few decades have witnessed a Soviet invasion, an almost decade-long war to repel this invasion, a bloody civil war following the Soviet withdrawal, and subsequent turmoil, all of which resulted in the destruction of property and of natural resources. The infrastructure for the provision of power and water as well as health and education services was wrecked and fell into disuse. Today, the prime objective in Afghanistan is to rebuild the country. Afghanistan recently established a government headed by a popular leader through direct vote in the national elections. Foreign aid has started to flow in, and several countries have pledged their support to help by way of personnel, material,

and technology. At present, in addition to the restoration of the destroyed infrastructure, the country is grappling with problems of law and order and governance.

Energy security concerns in Afghanistan focus mainly on rebuilding, restoring, and enhancing production capacity, and operating natural gas resources and the energy supply systems. The country has more than eight natural gas fields in the north, of which three were in production at one time. The government is responsible for coal, oil, and gas, and controls all operations, from exploration to mining, sale, and regulation. A number of government departments are involved in the overall operations, but the coordination between them is poor. One of the main concerns is to develop the gas resources to meet most of the hydrocarbon needs of Afghanistan and also to provide export earnings to finance the other development efforts. The current population of the country is estimated at 22 million, and the development of gas resources not only could meet the country's energy needs, but also could help in developing a good foreign exchange earning sector. Crude oil reserves are limited (barely 12 million tons).

Afghanistan's location between energy hungry South Asia and gas- and oil-rich Central Asia and the Middle East gives the country a special advantage. Simply by providing transit rights and guaranteed transit, Afghanistan could realize returns either in cash or in kind, which should be adequate to satisfy its energy needs for the immediate future.

Afghanistan's location and its gas resources could enable it to play a vital role in the promotion of regional energy security.

Bangladesh

Like other countries in the region, Bangladesh is concerned about the increasing demand for oil products to support the transport sector and the price volatility of crude and oil products in the international market. In Bangladesh, only 32% of the population has access to electricity. As part of the socioeconomic development plan, the government has proposed to have 100% of households supplied with electric by the year 2020. To achieve this, more than 400 to 500 MW of additional annual capacity will be required, which the government may not be able to finance. Thus, the question remains, how do they attract private investment?

There is an imbalance in the demand and supply between the eastern and western regions of the country. Adding an east-west inter-connector is only a partial solution as it can transmit only 150 MW of electricity. The issue is how to make electricity available evenly across both regions. The annual per capita consumption of commercial energy is only 217 kilograms oil equivalent (kgoe), as opposed to the world average of 1,500 kgoe. The government plans to raise this consumption to 1,000 kgoe, but for this level to be reached the economy will have to grow at a very fast pace and will need an immense amount of financial resources.

Bangladesh's strategy for poverty reduction relies heavily on its energy security strategy, which is based on preserving all available gas for use in Bangladesh and not exporting any until more gas reserves are discovered and the demand for the next 20 years is firmed up. The country's energy security strategy also relies on import of hydro-based electricity from Bhutan and/or Nepal, especially in the rainy months when Bhutan and Nepal have a sizable excess capacity and the electricity demand in Bangladesh is higher.

It has been recently announced that attention would be given to exploiting coal resources for power generation, as Bangladesh's coal resources are assessed to be three times the size of their natural gas resources.

Bhutan

Bhutan's energy concern revolves around its growing demand for oil products to support the transportation sector. The country has a huge hydropower potential, far in excess of its own requirements, and there are great benefits to be realized in exploiting this potential for export of electricity to neighboring countries. If a steady sale of about 6,000 MW of electricity to India and other countries in the region can be achieved, Bhutan will have a steady source of income, which will help it to meet all its energy needs as well as the investment requirements for other developmental activities.

Because Bhutan is a land-locked country, bringing in hydrocarbon resources and selling its surplus resources of electricity and other products are constrained by the country's relationship with India. The government of Bhutan is aware that establishing mutually beneficial arrangements to ensure trade and economic cooperation not only between Bhutan and India but also with other neighboring countries would facilitate promoting regional cooperation. To harness the benefits of its hydropower export potential, Bhutan should play an active role in establishing a South Asian regional power grid, as it would help to reduce its exclusive dependence on the Indian electricity market.

India

Oil prices have fluctuated violently in the international market, and India's heavy dependence on oil imports has had a significant impact on foreign exchange requirements. Volatility and high prices in international markets, coupled with potential supply disruptions due to unrest in the Middle East, raise major questions about oil supply security.

Maldives

Maldives has a population of only 340,000. Population growth, even at the present high rate of nearly 3% per year, is not likely to exert serious pressure on energy demand. What is causing pressure on energy demand is the country's modernization and urbanization plans and the vibrant tourism industry. The government's current plans to supply electricity to every household will also increase the demand for electricity. Since Maldives has no fuel resources of its own, it has to import oil using its foreign exchange earnings from the tourism sector. As long as the tourist industry maintains its current rate of growth, the country will not face any major problems in meeting its oil requirements through imports. However, there is a need to adopt all possible energy conservation measures. More efficient use of oil, both for power generation and for transportation, is an urgent necessity. Modern fuel-efficient water transport systems should be used for public transportation between islands and within each major populated island as far as possible. Private transportation should be discouraged. The reduction of pollution by private transportation is essential in preserving the high quality of the environment, which is the major attraction for foreign tourists. Exploitation of renewable energy sources (i.e., wind and solar) should be pursued vigorously. The government of Maldives is aware of the situation and is striving to promote cost-effective renewable energy technologies.

Maldives is also greatly concerned with the emerging scarcity of drinking water. This could be permanently resolved by securing private-public cooperation in building seawater desalination

plants to supply the water needs of at least the major hotels. This, however, would increase the oil import requirements.

Maldives is a very small country and too remote from the South Asian land mass to be able to play a meaningful role in promoting regional cooperation in the conventional areas. However, it would definitely benefit from regional cooperation in the development of renewable energy technologies, and it could participate in and encourage the development of technologies to make wind and solar energy sources commercially viable.

Nepal

In Nepal, the major concerns are:

- **Reducing dependence on forest fuels.** The energy economy is heavily dependent on biomass resources. There are already signs that forests are being depleted, resulting in fuel scarcity.
- **Ensuring price stability in the energy sector.** 74% of commercial energy consumption is from petroleum products, all of which are imported, and the price volatility causes severe shocks to the financial stability of the country.
-

The hydroelectric potential is very high (83,000 MW). Even if consumption increases at the rate of 15%, resources could be used only to a small extent within the country. The problem is how to induce the private sector to support hydropower projects, export power, and bring employment and cash benefits to Nepal.

Pakistan

In Pakistan, the major concern relates to the country's high dependence on imported oil. Since Pakistan has more resources of natural gas than oil, substitution of gas for oil is considered a viable option. Known resources of gas are limited, and electricity demand is increasing as the grid supply is being extended to remote areas and to households in the electrified villages. Plans are being considered for setting up the infrastructure for the development of lignite in the Thar region and to produce electricity in this region starting in 2010.

Current estimates indicate that the demand for gas in Pakistan will exceed the supply by 2010. Thereafter, gas will have to be imported. One of four options for importing natural gas will have to be chosen. These four options are:

- A Turkmenistan-Afghanistan-Pakistan pipeline
- An Iran-Pakistan pipeline
- A Qatar-Pakistan pipeline
- LNG imports

All options are under consideration.

Sri Lanka

Sri Lanka has a limited amount of hydropower resources and limited forest fuels. Its first concern is the import of oil. Currently, oil imports consume 30% of export earnings and about 6% of GDP. Exploration of oil and gas in Gulf of Mannar Basin and other places have not yielded positive results.

Sri Lanka's energy security strategy also provides for farm forestry, which would be attached to biomass-based power generation plants. The government is considering the use of small power stations, based on renewable energy technology that would account for 10% of the country's power generation by 2010.

India, Pakistan, Bangladesh, and Sri Lanka have drawn up long-term plans for their socioeconomic development in the twenty-first century and have projected their energy requirements based on these long-term plans. Afghanistan, Bhutan, Maldives, and Nepal currently have no similar long-term plans. In addition, some countries have included strategies for obtaining the requisite quantity and quality of energy supplies, as this would be one of the major inputs for achieving their socioeconomic goals.

The country studies broadly present the vision of growth and development over various time horizons. To conduct a comparative study of all countries, this report derives patterns of growth and energy demand for all countries up to the year 2020, with 2010 as the mid-point. Energy demand is represented in various units in the country studies and this variation in units is reflected in the data presented in Tables 3-1 and 3-2. Table 3-1 compares the medium-term commercial energy demand forecasts in each country up to 2010 using 2002-2003 as the base. In producing the forecasts, we have assumed the rates of growth as given for the relative period in the forecasts provided in the country studies and applied them to derive the demand for all countries for this specific period.

Most of these forecasts are based on the assumption that the growth rate of the economy would be around 7 to 8%. Given this growth rate, the demand for electrical energy is around 7% in Bangladesh, India, and Sri Lanka, and 8% in Pakistan. The small states, where the extent of coverage of population by electricity supplies is low, are projected to have higher growth rates for electricity (8.3% in Nepal and 15% in Bhutan). In Bhutan, where the total number of households electrified is only 40,000, there is a need to quickly accelerate the spread of electricity, which will result in higher demand. There are also plans to accelerate industrialization by promoting a large number of small and medium enterprises.

Forecasted growth in oil consumption shows a large increase between 2003 and 2010. Pakistan, whose strategy for energy sector management rests on substitution of oil by gas, has indicated a growth rate of only 4.4% for oil products but 6.2% for gas. India, also following a similar strategy, anticipates a growth rate of 4.4% for oil products and 8% for gas. Bangladesh and Sri Lanka have a higher growth rate of 7.4% and 8.2%, respectively, for oil products. Bangladesh supplements the growth of oil products with natural gas consumption, which will grow at 11%, while Sri Lanka has no other fuel supply. Except in India, the base figures of coal consumption are so small that even the high growth rates predicted for Bhutan, Nepal, and Pakistan do not make much of a dent in the overall energy consumption pattern.

The long-term forecast of commercial energy demand is presented in Table 3-2. The electricity demand forecast for 2020 shows that the rate of growth in the decade 2010–2020 is projected to be higher than the rate of growth indicated in Table 3-1. Several countries are projecting substantial increases in oil demand. Bangladesh, India, and Pakistan will strive to increase their gas consumption to the maximum extent possible. Coal follows the same pattern-as in the earlier period; India will lead with 6.1% growth in coal even on a very large base of coal consumption. An interesting feature is that Nepal, Pakistan, and Sri Lanka have included in their long-term energy security strategy the use of coal (based on clean coal technologies) to be introduced after 2010 for power generation. Coal appears for the first time in the fuel consumption package of Sri

Lanka from 2010, and both Pakistan and Nepal will accelerate the use of coal for power generation.

Table 3-1 Medium-Term Forecast of Commercial Energy Demand, 2002–2010

Item	Unit	Afghanistan	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka
Electricity supply	mkWh	423 (01-02)	19,179 (01-02)	640 (02-03)	588,134 (03-04)	146.2 (03-04)	2,362 (03-04)	80,827 (03-04)	7,087 (02-03)
Electricity demand forecast, 2009–2010	mkWh	1,130	31,607	1,702	892,570	356	3,811	129,835	11,158
Growth rate	% yr	13.1	7.4	15	7.2	16.0	8.3	8.2	6.7
Oil consumption, 2003–2004	mtoe	0.21	3.71	0.05	116.0	0.271	0.77	15.20	3.01
Oil demand forecast, 2010	mtoe	1.57	5.70	0.14	150.2	0.535	1.12	19.72	5.23
Growth rate	%	28.0*	7.4	16.0	4.4	12.0	6.5	4.4	8.2
Gas consumption, 2002	mtoe	0.11	8.29	0.00	29.74	0.0	0.00	27.39	0.0
Gas demand forecast, 2010	mtoe	0.33	15.51	0.0	47.19	0.0	0.0	39.21	0.0
Growth rate	%	15.1	9.4	0.0	6.8	0.0	0.0	6.2	0.0
Coal consumption, 2002	mtoe	0.0	0.0	0.01	169.9	0.0	0.17	3.30	0.0
Coal demand forecast, 2010	Mtoe	0.0	0.5	0.07	248.7	0.0	0.27	5.54	0.0
Rate of growth	%	0.0	0.0	5.0	6.6	0.0	8.0	9.0	0.0

For Afghanistan, the quantitative requirements in 2010 were estimated on the basis of past consumption, which was much higher than current consumption. Growth rate is only a derived figure.

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Table 3-2 Long-Term Forecast of Commercial Energy Demand, 2010–2020

Item	Unit	Afghanistan	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka
Electricity forecast, 2010	Million units	1,132	31,607	1,702	892,570	356	3,811	129,835	11,158
Electricity forecast, 2020	Million units	3,877	72,791	6,876	1,755,685	1,571	8,076	251,039	23,867
Growth rate	%	13.1	8.8	15	7.0	16.0	7.8	6.8	7.9
Oil forecast demand, 2010	mtoe	1.573	5.7	0.14	150.2	0.535	1.12	19.72	5.23
Oil forecast demand, 2020	mtoe	3.483	11.6	0.62	246.9	1.661	1.61	30.94	7.82
Rate of growth	%	8.3	7.4	16.0	5.1	12.0	3.7	4.6	4.1
Gas forecast demand, 2010	mtoe	0.33	15.51	0.0	47.19	0.0	0.0	39.21	0.0
Gas forecast demand, 2020	mtoe	0.92	44.03	0.0	101.88	0.0	0.0	72.75	0.0
Rate of growth	%	10.8	11.0	Nil	8.0	0.0	0.0	6.4	0.0
Coal forecast demand, 2010	mtoe	0.0	0.5	0.07	248.7	0.0	0.27	4.71	0.83*
Coal forecast demand, 2020	mtoe	0.0-	0.9	0.11	447.6	0.0	0.78	13.9	7.0*
Rate of growth	%	0.0-	5.8	5.0	6.1	0.0	11.2	11.2	24

Sri Lanka has proposals to start a serious of coal- based power plants from 2010.

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Section 4

Energy Resources of South Asia

Before drawing up a framework for cooperation between the countries of South Asia for regional energy security, one must first carefully examine the energy resources of these countries. These energy resources are not evenly distributed, either with respect to population or land size. To obtain a clear assessment, the energy resources of these countries have been extracted from the country studies and are presented in a comparable form in Tables 4-1 and 4-2.

4.1 OIL, GAS, COAL, AND HYDRO RESOURCES

Oil and gas are the resources that cause the greatest energy security concerns, but data on these resources is not always readily available. Overall resource potential, proven resources, and current production for these resources have been obtained and have been compared against current consumption and the reserve/production ratio in terms of number of years for which the resource will last (based on the current demand level). For those countries that are projecting steep increases in the use of energy resources (e.g., Bangladesh or India), data should be used carefully. The resources picture for oil and gas is examined in Table 4-1

Table 4-1 Oil and Gas Resources of South Asia

Item	Unit	Afghanistan**	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka
Oil									
Resource potential	mtoe	*	0.96	0.0	660	0.0	0.0	3,600	0.0
Proved resources	mtoe	*	0.96	0.0	1,570	0.0	0.0	107	0.0
Used so far	mtoe	*	0.10	0.0	830	0.0	0.0	68	0.0
Available resources	mtoe	*	0.86	0.0	740	0.0	0.0	39	0.0
Current annual production	mtoe	*	0.0	0.0	33.0	0.0	0.0	3	0.0
Resource/ production ratio	years	*	-	0.0	22.4	0.0	0.0	13	0.0
Gas									
Resource potential	bm ³	120+ 1,000 (deep wells)	814.5	0.0	63***	0.0	0.0	7,985	0.0
Proved resources	bm ³	120	578.3	0.0	1,380	0.0	0.0	1,284	0.0
Used so far	bm ³	NA	144.1	0.0	460	0.0	0.0	488	0.0
Available resources	bm ³	120	434.2	0.0	920	0.0	0.0	795	0.0
Current annual production	bm ³	0.176	11.9	0.0	32	0.0	0.0	34	0.0
Resource/ production ratio	bm ³	Over 600	36	0.0	29	0.0	0.0	23	0.0

** Regarding Afghanistan, information is not validated and resource evaluation is being carried out.

*** Does not include new gas finds in deep-water wells.

bm³ = billion cubic meters

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The two other resources of importance are hydroelectric and coal. The situation for coal resources is presented in the same way as for oil products and gas. In the case of hydro, however, an attempt has been made to express the resources potential in terms of power capacity in megawatts as computed by the different countries themselves. The potential resources and the extent of utilization are given in Table 4-2.

Table 4-2 Coal and Hydro Resources of South Asia

Item	Unit	Afghanistan	Bangladesh*	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka
Coal									
Resource potential	mt	*	2,715	0.0	245,690	0.0	5.0**	185,000	0.0
Proved resources	mt	*	724	0.0	91,631	0.0	5.0	3,300	0.0
Used so far	mt	*	0.0	0.0	NA	0.0	0.1	~ 200	0.0
Available resources	mt	*	724	0.0	91,631	0.0	4.9	3,100	0.0
Current annual production	mt	*	1	0.0l	~ 410	0.0	0.1	3.3	0.0
Resource/ proved ratio	Years	*	724	0.0	~ 200	0.0	49	939	0.0
Hydro potential									
Resource potential	MW	*	775	50,000	301,000	0.0	42,915	40,000	2,000
Utilized resources	MW	*	230	420	29,500	0.0	527	6,500	1,250
Used so far	%	*	30	1.4	10.2	0.0	1.2	16	62.5

*Regarding Afghanistan, resource evaluation is in progress mt = million tons

** Gross estimates

NA = not available

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4.2 RENEWABLE ENERGY RESOURCES

An attempt to collect and tabulate, on a comparable basis, the known information on renewable energy resources has been non-productive. None of the countries in the region has succeeded or has even attempted to draw a clear picture of potential availability of biomass and other renewable resource such as wind, solar, mini-hydro, or biomass. Although official Indian agencies in the renewable energy field have begun publishing some data, the validity of this data has not been established. The wind and solar energy potential of Sri Lanka and Maldives has been assessed with the assistance of the SARI/Energy program sponsored by the United States Agency for International Development (USAID). Almost all countries in the region have set up agencies to popularize and commercialize renewable energy technologies, but very few of them have tried to evaluate the total potential for different renewable energy technologies. India is the only country that has attempted to evaluate this potential. The available information is summarized in detail in Table 4-3.

Because of the poor quality and quantity of the data in Table 4-3, there is an urgent need to undertake a regional survey of the availability and adequacy of traditional fuels (e.g., fuel-wood and agricultural waste) and the potential for exploiting new and renewable energy technologies. There is scope for regional cooperation in this area.

Table 4-3 Renewable Energy Resources of South Asia

Item	Unit	Afghanistan	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka
Biomass potential	mt/yr	NA	NA		≈ 400		NA	~25	12.0*
Consumption	mt	22.2	53.5	0.95	340	0.61	23.8	~20	11.5
Renewable energy resources									
Wind potential	MW	NA	NA	NA	45,000	NA	NA	1,100–40,000	24,000
Solar energy	MW	NA	NA	NA	50,000	NA	NA	v. Large	Large
Mini/micro hydro	MW	NA	NA	NA	15,000	NA	NA	~1,000	300
Biogas plants	Nos.	NA	NA	NA	2 million	NA	NA	NA	NA
Ocean thermal	MW	NA	NA	NA	50,000	NA	NA	NA	NA
Sea wave	MW	NA	NA	NA	20,000	NA	NA	NA	NA
Tidal	MW	NA	NA	NA	9,000	NA	NA	NA	NA

NA = not available.

* 1.2 million hectares @10 t/hectare

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4.3 EVALUATION OF RESOURCE ADEQUACY

The status of resources analyzed in this section must be compared against the anticipated requirements for different fuels discussed in Section 3. The known resources of oil are inadequate to meet even the current requirement. Pakistan and India currently have resources to meet part of their oil needs from indigenous sources, but these sources will be fully exploited by 2020. The import burden for oil imports will steeply increase in most countries. Only Pakistan and Bangladesh have natural gas resources to meet the current demand. Pakistan's gas resources can meet its demand up to 2010 and Bangladesh's resources can meet its demand up to 2020. India has attempted to contain the gas demand to the level of availability, but the pressure of internal demand for gas for power generation has been very high, and gas imports as LNG began in 2004. The economic fuel choice for power generation in India will continue to be indigenous or even imported coal.

There are uncertainties regarding the extent of natural gas reserves in India following several recent (after 2003) gas discoveries made by private companies that had blocks allotted to them for deep offshore wells. The delivered price of gas from such deep wells is not yet clear. Indian oil companies with government support are also pursuing efforts to build a pipeline to import gas from Central Asia and the Middle East in collaboration with Pakistan and to import piped gas via Bangladesh. The cost of the gas from the different sources will decide the pattern of fuel consumption in India in the power sector. The demand for power in India is growing rapidly. The availability and price of Indian coal, imported coal, indigenous gas from private sector wells, and imported gas obtained as piped gas or LNG will determine the ultimate pattern of fuel usage. Regional cooperative efforts as they emerge in the next few years will determine the outcome of several of these issues.

Coal resources are abundant in India and Pakistan. India has steadfastly followed a policy of using coal as the primary commercial fuel for power generation. By so doing, it has achieved extensive expertise in mining coal of poor quality and using it efficiently for power generation. India has become the third largest coal producer after China and the United States. However, its coal production is only about 400 million tons as compared with China's 2,000 million tons and the United States' 1,000 million tons. This is partly due to legal restrictions since only public sector companies in India can mine coal. This coal policy is under revision, and the new policy may encourage greater use of coal from captive mines by large power companies.

As seen in Table 4-2, Pakistan has large lignite resources in the Thar area. Pakistan has taken a strategic decision to develop its lignite resources and to build power plants in the area. It is planning to begin lignite-based power generation in 2010. Bangladesh has limited coal reserves, which have not yet been developed, but it is planning to develop these deposits in the coming years. Sri Lanka, with a view to diversify fuel imports, is planning to import coal in 2010 to produce power. These developments in the coal sector suggest that regional cooperation can benefit most of the countries that are planning to use coal as a power fuel.

All the countries of the region, except for Maldives, have some hydro resources. The largest of these are in Nepal and Bhutan, which are far in excess of their current demand for electricity and the likely demand for the next two decades. The optimal utilization of these hydro resources, taking into consideration the surplus and deficits in the different countries, can be of great benefit to the region. This issue is discussed in greater detail in Sections 5 and 6.

Section 5 Regional Cooperation for Energy Security— Issues and Options

In this section, commonly shared energy security concerns in the eight countries of South Asia are discussed to identify opportunities for regional energy cooperation. Common concerns regarding energy supply in all the countries of this region revolve round the following questions:

- What are ways to cope with short-term supply risk due to sharp and sudden increase in oil prices?
- What are the ways of addressing contingency and structural risks?
- How can different sources of supply be developed and diversified? To diversify the forms of fuel supply, natural gas must be substituted for oil products, but in most cases natural gas has to be imported either through a pipeline or as LNG. Will it be possible to obtain long-term supply contracts at affordable prices to help ensure greater price stability?
- Electricity is essential to enhance the pace of socioeconomic development and to improve the quality of life. Will it be possible to make electricity available to all households within a reasonable period?
- Will the biomass supplied by forests be adequate to meet the gradually declining but still significant demand for energy from such sources? What about other biofuels?
- How can the demand-supply gap be bridged with regional trade? In electricity? In natural gas? In coal?
- How can cooperation on regional energy issues be implemented?

5.1 COPING WITH THE HIGH VOLATILITY OF THE OIL MARKET

In the past few years, the principal common concern of all countries of the region has been the high volatility of the world oil market. Short-term supply disruptions due to very sharp, sudden spikes in the price of crude and petroleum products, which last for a few weeks, have occurred several times in the recent past. Such spikes have taken place in spite of long-term and even medium-term forecasts of a fairly reasonable and steady increase in crude oil and products. The fluctuations in the price of Arabian light crude oil are shown in Table 5-1. Note the sharp increase between January and April of 2005.

Table 5-1 Movement of Oil Price in US\$, 2002–2005

Description	Jan 4, 2002	Jan 2, 2003	Jan 2, 2004	Jan 7, 2005	April 1, 2005
Crude oil (Arabian Light)	18.90	27.39	27.08	34.05	49.94

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Although the medium-term forecasts of the International Energy Agency (IEA), the International Monetary Fund (IMF), and the U.S. Department of Energy's Energy Information Agency (EIA) predicted a reduction in 2005 prices compared with 2004 prices; in reality, the prices have increased and fluctuated between US\$50 per barrel and US\$65 per barrel in the past 5 months. Figure 5-1 illustrates the changes in crude oil price during the period 1997–2005. Figure 6-2 illustrates the higher volatility in 2005.

The national planners in South Asia are concerned that market watchers are still unable to predict crude and petroleum products prices. The determinants of oil price in the international market are well known. There is widespread consensus that crude oil prices in the world market are determined largely by the balance between production of OPEC and non-OPEC nations and the world demand. Global oil demand was expected to register very strong growth in 2004–2005. The world demand for crude in 2002 was 75 million barrels per day of which 28 million barrels per day was met by OPEC. The normal increase in a year is about 1.2 million barrel per day. In comparison, the 2004 demand increase was 2.6 million barrels per day, and in 2005 and it is anticipated to be over 1.8 million barrels per day.

The sudden spike in demand is due to the increase in demand in China. Such increases in the past have been met by increased production from OPEC, of which Saudi Arabia was the usual major supplier, as it had a large reserve capacity. OPEC normally accounted for 40% of the total world crude production. While global oil demand has been increasing, the spare capacity of OPEC has been diminishing owing to lack of new capacity additions. IEA estimates that the sustained production capacity of OPEC is 30.3 million barrels per day. Some experts put the additional production capacity of OPEC to be lower than the IEA estimates. In 2004, OPEC production reached a peak of 28.2 million barrels a day with some difficulty. The extra capacity available with Saudi Arabia is rather limited.

In the short term, China's demand is viewed as the main driver for high oil prices in 2004–2005. China accounts for 31% of the additional crude oil demand in the international market in 1992–2002. Demand in 2004 alone was more than 20% of the demand in 2003. In the context of India, analysts say that the demand increase is due to an acute fuel shortage in the power industry and the spurt in demand in the transportation sector, where four-wheelers are replacing both two-wheelers and bicycles at a very rapid pace.

On the supply side, while the political uncertainties continue in Iraq, Saudi supplies have become a concern after the revelation of the involvement of Saudi nationals in the 9/11 attacks on the United States and the consequent strain in the U.S.-Saudi relationship. Russian oil has become entangled with the affairs of the country's large oil firm, Yukos. While oil exports in 2004 were at record levels, the sustained and steady supply of oil or gas from Russia is considered unreliable.

All these factors have raised doubts about the long-term forecasts, which predicted the following developments based on detailed national assessments:

- Crude oil demand growth would slow down from 2.6 million in 2004 to around 1.4 million through 2006
- Non-OPEC production would increase, mainly in Russia, by 1 to 1.2 million barrels per day
- OPEC production capacity would expand to 33 million barrels per day in 2005
- The incidence of supply instability from producing countries, mainly Iraq and Saudi Arabia, would be limited



Figure 5-1 Crude Oil Prices—1997–2005

Source: Website <http://futures.tradicharts.com/chart/CO/M>



Figure 5-2 Crude Oil Prices—June–October 2005

Source: <http://futures.tradicharts.com/chart/CO/M>

Still, highly respected institutions such as IEA, IMF, and others predict low oil prices in the long run. An IMF spokesman declared in April 2005 that their forecasts suggest, “while oil price would be a rocking forward in the short run, the inflation adjusted oil price would reach only \$34/barrel in 2010 and \$39 to \$50 in 2030.” Opinion within OPEC is also divided. Venezuela, Saudi Arabia, and Libya like to believe that oil price should (and could) be maintained at a high level. Indonesia, on the other hand, advocates a lower oil price, for two reasons: (1) Indonesian production is not able to keep up with its increasing domestic demand, exports have suffered, and imports may need to be considered; (2) Indonesia believes that high oil prices could lead to civil unrest in many countries where the domestic retail price of kerosene and even diesel is lower than the international price even with government subsidies.

Taking advantage of these conflicting forecasts, a new player has emerged in the oil market, namely, the speculators or non-commercial players. In 2003, nearly 60,000 trades of oil per day occurred; in 2004, that number multiplied. Speculators who thrive on volatility bet billions of dollars on future oil prices. This has led to some forecasters making “interested” forecasts. In March 2005, Goldman Sachs came out with a forecast that predicted that the international oil market was going through a “super-spike” period which might see crude prices reaching US\$105 a barrel. The Financial Times of London immediately hinted that the Goldman Sachs forecast might have been influenced by their desire to look for earnings of 30% for U. S. energy stocks in 2005 and 28% in 2006!

Given this confusing picture of oil price futures, national planning in South Asia can only be based on moderate and long-term forecasts by respected international agencies. If, suddenly, in a few weeks the price shoots up by 40%, the incremental export bill is bound to create a great deal of disturbance to the economic activities of the country. The main energy security issue that the countries are now worried about is the contingency risk of having to finance short-run sharp increments in the price of crude and products. The physical availability of crude or oil products might not be problem as the demand for South Asia is only about 4.5% of the world trade in oil (and of this, the largest share goes to India). Countries in the region are examining ways to cope financially with short-term oil price spikes. Some of the measures under consideration are:

- Opening an oil price contingency fund collected by a levy over all oil consumption throughout the year and using it to finance the increments during short price-spike periods (a levy of 4% on overall oil sales collected over 12 months could cover the sudden increases in price by 50% for 4 weeks in a year)
- Building over time a strategic petroleum reserve that could be used during high price periods and could be replenished by future imports when prices return to normal rates
- Retaining a certain quantity of the discovered reserves of oil and gas in the ground as a strategic reserve that could be extracted whenever prices are considered too high for the economy to absorb

At the regional level, oil price volatility could be managed by sharing the risk among the countries through bilateral arrangements and creating strategic petroleum. The appropriate course for each country would depend on several country-specific factors. Because all eight countries would be affected equally by increased prices, there are no easy ways of finding a regional solution. The measures for preventing such volatility in the oil market could be met as a regional energy security issue, but finding the money to meet the increased price would remain a national energy security issue to be resolved in each country.

5.2 ADDRESSING CONTINGENCY AND STRUCTURAL RISKS

Besides volatility of prices, all countries foresee two other types of risks: contingency risk and structural risk.

Contingency risk is the risk of disruptions in energy supply for short periods due to (1) war, civil strife, or any major disturbance in the fuel exporting country, (2) disruptions in the transportation arrangements, or (3) a sudden spike in crude and product prices.

Structural risk is the risk of non-sustainability of energy supplies due to the mismatch between energy demand and the level of energy available from indigenous energy resources. This mismatch could be caused by the effect on supplies of changes in market conditions and/or an increase in the fuel import bill becoming too large to be accommodated from the export earnings of the countries.

Contingency risk of physical supply disruption for South Asia could arise because major portions of crude oil and oil products are imported by these countries from countries of West Asia and the oil traffic has to pass through the vulnerable constriction at the Strait of Hormuz. The political problems in the countries of that region could result in supply disruptions or threat of disruption from time to time.

Possible arrangements to manage contingency risk are:

- Seeking energy supply from other regions
- Sharing the risk with other countries through bilateral or regional arrangements
- Creating petroleum strategic reserves at the national level
- Striving for a regional petroleum strategic reserve

5.3 DEVELOPING AND DIVERSIFYING THE SOURCES OF FUEL SUPPLY

The large oil importing countries of the region—Bangladesh, India, Pakistan, and Sri Lanka—are vigorously pursuing measures to diversify sources of supply in the short run. India has very limited domestic reserves of oil, and the limits to production have already been reached and are around 30 million tons per year. The crude and petroleum product imports are nearly 100 million tons and are likely to increase steadily at about 4%. India is attempting to take an equity position in exploration and production companies in over a dozen countries to ensure the availability of oil. India has plans to increase the availability of natural gas through import as LNG and as piped gas from Iran or Oman on the west and from Myanmar in the east. An Indian oil company has a significant share in Myanmar's deposits. The pipelines from West Asia have to pass through Pakistan on the west and through Bangladesh on the east. Negotiations have already been initiated with Pakistan and Bangladesh. Pakistan's plans for addressing such risks focus on increasing the production of natural gas and the use of coal-based power generation. It is encouraging that all these countries have aggressive plans to develop domestic fuel resources. But these measures take a long time to yield results and are part of the efforts to deal with the structural risks.

The option of diversifying the sources of supply of oil and obtaining more oil from other countries (including from faraway Venezuela) has serious logistic problems due to the long distances over which oil has to be transported and the uncertainties and volatilities of freight

rates. Using very large crude carriers (VLCCs) to bring crude from Venezuela and other distant places and reshipping from a deep-sea port in the region is an option that could be considered. A techno economic evaluation of these options needs to be carried out by a research institution from within the region. Proposals that could be examined for regional energy security are:

- Setting up a joint venture by the countries of the region (on a voluntary basis) for transporting oil from distant locations, purchased by one or more countries through VLCCs to a deep-sea port (e.g., Colombo), and reshipping the oil to other countries in the region
- Using such a joint venture to jointly procure crude to meet the demand for the member countries from the international market

The only quick and sure solution, however, is to hasten the arrangements for setting up a national strategic petroleum reserve in the different countries. India has been examining various alternatives for establishing such reserves. The quantity that should be held as a reserve and the method of financing the huge investment and maintenance cost have been debated for several years. The plan to create a 5 million ton strategic oil reserve at the cost of Rs 66 billion was approved in 2004. (At today's oil price, the capital needs may be over Rs100 billion.) A high-level committee has looked into these issues and has recommended that a strategic oil reserve could use cavern storage options, such as abandoned rock and salt mines and depleted oil fields, and the availability of these storage options is being examined. It has also been suggested that strategic stock should meet at least 30 days of consumption needs and the cost of starting up and maintaining the reserve stock could be defrayed by a special levy for the purpose of all oil consumption. The option of creating a natural gas strategic reserve is also under consideration. Studies aimed at exploring the desirability of establishing a regional strategic petroleum reserve need to be conducted. All countries that join the effort should make arrangements for keeping a strategic reserve at a level of crude oil products in proportion to their annual consumption, say, a 30-day consumption level. The economies of scale in storing and managing the strategic stocks could be examined in detail.

5.4 PROVIDING UNIVERSAL ACCESS TO ELECTRICITY

None of the countries in South Asia region has been able to supply electricity to all the households in the country. A large number of villages are yet to be electrified through power grid interconnections. Although the major cities, towns, and even small urban household are grid-connected in almost all these countries, the households in rural areas do not have access to grid-supplied electricity. Even in villages that are connected by the grid, the number of electrified households is limited because the cost of obtaining an electricity connection is high relative to the ability to pay by a large proportion of the rural community.

Table 5-2 presents the details of electrification in these countries.

Table 5-2 Details of Electrification of Households in South Asia

Country	Population (Millions)	% of Population That Is Rural	Total No. of Households (Millions)	% of Electrified Households	No. of Households to Be Electrified (Millions)
Afghanistan	22.2	80	4.4	6	4.1
Bangladesh	143.8	78	28.76	33	19.3
Bhutan	0.7	79	0.14	31	0.1
India	1,064	72	199.7	56.0	79.9
Maldives	0.34	90	0.068	90	0.007
Nepal	23.15	84	4.63	31	3.2
Pakistan	148.7	80	29.74	50	14.9
Sri Lanka	19.3	84	3.86	67	1.3

Note: In Pakistan, 80,988 out of 125,083 villages have been electrified (67%). Out of the remaining 44,097, about 13,000 villages are proposed to be electrified by 2010.

Please see Appendix-I for Source: Compiled by authors from information cited in RES Country Reports

In India, only 45% of rural households are electrified; whereas 88% of urban households are electrified. 81% of 587,556 villages have been electrified leaving 112,401 villages to be electrified. Many of the eight countries have established target dates by which time every village will be electrified and the target date by which time all households will be electrified. A detailed study conducted in Bangladesh under the Poverty Reduction Strategy Program (PRSP) clearly showed that the electrification of villages has immense potential in accelerating the process of economic growth, poverty reduction, and human development in these villages. In its efforts to electrify all villages and habitations and to provide electricity to all households and free electricity connections to families below the poverty line,^{*} India takes the position that that electrification of rural areas would accelerate rural development, generate employment, and eliminate poverty through increased irrigation, small scale and cottage industries, cold storage for fruits and vegetables, health care, education, and information technology.

The Bangladesh study has established that electrifying non-electrified houses will have a significant impact not only in reduction in income poverty but also in various dimensions of human poverty through its impact of improved health education and enhancement of women's empowerment and status.

The program for electrifying all villages and households is a part of the energy development and energy security plans of many South Asian countries. Bangladesh has set no specific targets, but its PRSP strongly emphasizes extending transmission lines to all villages to support income-generating activities for the rural poor. Bhutan has plans to electrify all households by 2020. India has set an ambitious target of electrifying all villages either by grid extension or through stand-alone distributed generation by 2017 and to electrify all households by 2020. Pakistan plans to reach over 13,000 additional villages out of the total 44,000 villages by 2010. Sri Lanka proposes to electrify 75% of households by 2007 though it has not set any target date for total electrification. The energy policy emphasizes the importance of meeting basic energy needs and seeks modalities for extending power supply to all through grid extension and off-grid systems and to supply power to rural consumers at compensation prices.

^{*} Rajiv Gandhi Grameen Vidyutikaran Yojana, April 2005.

Providing electricity access to all will result in higher electricity demand from a new group of consumers who are least able to pay for the service. To offset this, either electricity costs must be drastically reduced or substantial funds must be provided by governments to subsidize poor households. Under power sector reforms, most governments aim to transfer the responsibility for power sector ownership/management to the private sector. The power generation plans of all countries attempt to avoid costly fuels with unpredictable price tags.

If the foregoing issues are to be resolved, policies and plans formulated at the respective national levels would need to be coordinated at the regional level through cooperative initiatives to reduce the cost of power generation and supply to the poor. It might be useful and less expensive to supply power to villages in the border areas of certain countries from the grid of neighboring countries. Technical and commercial arrangements for these would have to be settled in advance, preferably as part of a regional electricity master plan.

5.5 MEETING TRANSPORTATION SECTOR FUEL REQUIREMENTS

In all South Asia, the major import cost is the cost of importing liquid fuels, which are primarily used in the transportation sector. The percentage of total commercial energy and liquid fuels used as transportation sector fuel in different countries are given in Table 5-3.

Table 5-3 Cost of and Dependence on Imported Oil

Country	Commercial Energy Consumption (mtoe)	Oil Consumption (mtoe)	Oil Imports, mtoe	Oil Import Expenditures (\$ million)	Oil Imports as % of Export
Afghanistan	0.35	0.21	Nil	Nil	-
Bangladesh	12.23	3.23	3.23	805.4	17
Bhutan	0.17	0.038	0.038	15.0	13
India	335.66	111.0	78.0	18,918.0	30
Maldives	0.271	0.271	0.271	120	20
Nepal	1.08	0.840	0.840	138	23
Pakistan	55.46	15.21	12.28	3,138.0	26
Sri Lanka	3.84	1.685	1.685	402	16

Please see Appendix-I for Source: Compiled by authors from information cited in RES Country Reports

Even in countries where the foreign exchange implications of oil importation is not very severe, the specter of oil price increases or sudden fluctuations in oil prices has made it necessary for all the countries in South Asia to give priority to conserving liquid fuels. Equally worrisome in these countries is the danger to the economy due to the heavy reliance of the transportation sector on liquid fuels, whose prices are highly volatile. All countries are proposing to take up measures to improve the efficiency in the use of liquid fuels and to diversify the fuel consumption package in the transportation sector.

Urban transportation has become a nightmare in many cities of South Asia. The public transportation system is already overcrowded. In addition, because of road congestion and the lack of potential for road expansion, there is not much scope for increasing the number of vehicles. The only alternative is to develop mass rapid transport systems (MRTS) and/or light rail transport systems. All countries are examining these options. India has made a good beginning with a 55-kilometer MRTS for New Delhi, and two more such systems, with private

participation, are likely in Hyderabad and Bangalore. Several other cities in the region are also considering MRTS, including Dhaka.

Several steps have been taken to substitute compressed natural gas (CNG) in place of liquid fuels for commercial vehicles in Pakistan, India, and Bangladesh. In Pakistan, about 80,000 vehicles are using CNG as a fuel. The necessary infrastructure facilities, including 750 natural gas filling stations, have been established all over the country. New Delhi has become the only city in South Asia to have all commercial vehicles run on CNG.

5.6 USING BIOFUELS TO REPLACE PETROLEUM-BASED FUELS

In addition to the substitution of liquid fuels by natural gas, many countries are exploring the possibility of biofuels as partial or full replacement of petroleum-based fuels, which up to now have dominated the transportation industry. There are two types of biofuels: ethanol and biodiesel. In its initial stages, the transportation industry relied entirely on ethanol and biodiesel. Henry Ford's first automobiles in 1908 used ethanol. Ford was convinced that renewable energy was the key to the success of automobiles, and he invested in a plant to make ethanol. When Rudolf Diesel first demonstrated his compressor ignition engine in the 1909 world exhibition in Paris, he used peanut oil, the original biodiesel.

Pure ethanol can be easily produced from plant products like sugarcane and can be used as a transportation fuel. It is estimated that about 68% of the alcohol produced globally is used as a transportation fuel, either as power ethanol or as an extender of petroleum fuels. In Brazil, 12 billion liters are used each year in the transportation sector, and the United States uses about 8 billion liters annually.

Biodiesel is an alternative diesel-like fuel that can be produced from vegetable oil and from non-edible oils derived from tree-grown non-edible oil seeds. Biodiesel can be produced from plants such as jetropah. Jetropah is a drought-resistant plant that can grow in saline, marginal, and infertile land. It is estimated that this plant can yield 2.00 tons of biodiesel per year per hectare. The use of biodiesel as an alternative to petroleum-based fuels reduces the emission of particulates and carbon dioxide into the atmosphere. Pressure from environmental groups has created a demand for biodiesel, and it is estimated that in the European Union alone, biodiesel demand will be 10.5 billion liters by 2010.

The oil price increases of 1973 and 1979 led to renewed interest in biofuels. Today, over 200 major fleets in the United States, including the postal service, military, and commercial transportation systems, use biodiesel. Another interesting entrant in the transportation fuel market is fryer oil that has been recycled after being used to fry vegetables, especially potato chips. Today, fast food is one of the largest industries that uses light-oil for frying chips and other items. In Europe, a number of retail filling stations offer biodiesel as an alternative to diesel. It is reported that there are more than a thousands such facilities in Germany alone.

The Government of India has required the use of 5% ethanol blend in petroleum in nine states. Plans have been formulated for growing biofuels by using wasteland tree-borne oil (tbo), and Indian Railways has successfully conducted an experiment using tbo. In India, it is estimated that there are nearly 113 million hectares of saline land and degraded forestland. Cultivation of these areas could provide employment to over 100 million people. A biofuel screw press for squeezing

oil from oil seeds could be produced and maintained by village blacksmiths. The oil extracted could be used in transport vehicles, tractors, and even agricultural irrigation pumps. Other countries in the region are also showing a great deal of interest in biofuels.

5.7 BRIDGING THE DEMAND-SUPPLY GAP WITH REGIONAL TRADE

All countries of the region have an inadequate supply, current or potential, of some energy form or other, while some of the countries have certain forms of energy far in excess of their demand in the foreseeable future. The countries are eager to have common or collaborative plans to meet the shortages and also to deal with the surplus energy. The energy security plans of these countries indicate that all the countries are eager to develop and increase the energy trade within the region. Some of the larger countries are also proposing joint action to explore and procure energy resources, especially hydrocarbon resources, from areas outside the region. There is also the possibility of jointly procuring some fuels, which could result in economies of scale in transaction and transportation costs. The feasibility of these suggestions is explored below.

5.7.1 REGIONAL ELECTRICITY TRADE

The preferred regional cooperation efforts lie in promoting cross-border electricity trade from the large hydroelectricity resources of Bhutan and Nepal to India or through India to Bangladesh, Pakistan, and Sri Lanka. There are potential opportunities for short-term and long-term exchanges of small quantities of electricity between contiguous areas in India and neighboring countries.

All of Bhutan's large hydroelectric power projects are designed to export surplus power to India. Though these power exports are almost equal to Bhutan's total electricity production, southern Bhutan nevertheless imports small quantities of power from West Bengal and Assam in India. Nepal has a generation capacity of 630 MW, which meets a peak load of about 572 MW. About 57 MW is thermal and the rest is hydro. Nepal's electricity demand has been growing at an annual rate of up to 9% and is projected to grow by about 8.2% per annum through 2020. Small quantities of power are exchanged between India and Nepal for meeting the demand of isolated villages on the two sides of the international Indo-Nepal border. These power exchanges are on the order of 50 MW.

The long-term power trade potential between India and Bhutan is well recognized. The current energy trade between India and Bhutan is very unusual. Bhutan built the 336 MW (4 x 84) Chukkha hydropower project with financial assistance, mostly in the form of a grant from India. The project is fully managed and controlled by Bhutan. Bhutan also has other smaller projects adding over 100 MW of capacity to meet local demand. Since the national demand is less than 150 MW, a substantial part of Chukkha's energy is sold to India. The price is fixed as a "friendship price," which was settled through negotiations. For the 1,020 MW (6 x 170) Tala hydropower project, about 60% of the cost is defrayed by India as a grant and the rest as soft loans. The tariff for the energy sold from this project will be settled through the same mechanism as was used for Chukkha.

Bhutan has other hydro resources, estimated at more than 30,000 MW. An additional capacity of at least 200 MW per year can be readily developed for export. Bhutan is planning to develop these resources through international investors and independent power developers.

Nepal's total hydroelectric resources are very large. The theoretical hydropower potential has been estimated at 83,000 MW by some researchers. It is reported that 66 projects are found to be economically feasible with a total generating capacity of 42,000 MW. In addition to the schemes in operation, Kaliganaki (144 MW) and other projects totaling 280 MW are under consideration. Another 385 MW of capacity, including 240 MW of upper Kanali, is also under consideration. There are a number of treaties already in existence between India and Nepal involving projects such as Mahakali Pancheswar and the Karnali and Kosi high dams. The capacities under the treaties add up to 1,000 MW. Negotiations are ongoing concerning the high cost of these projects and the ultimate cost of the power, which can be sold to India, Bangladesh, or other neighbors. Bangladesh's energy security strategy focuses on the potential for seasonal power trade between Bangladesh and Nepal or Bhutan. During the summer months, when there is surplus power in Nepal and Bhutan, Bangladesh has a high power demand. Bangladesh has proposed that it could import power from Nepal and Bhutan during that season. The region west of the Jamuna River in Bangladesh has chronic energy shortages, and the proposed power imports could mitigate this shortage. Initially, Bangladesh could import about 150 MW. Given the geographical location of India, it would have to facilitate the power trading between any two countries in the region, except for Afghanistan and Pakistan, which are contiguous. While such power trading would help both the power importing as well as the exporting country, India would benefit from the wheeling charges for the utilization of its transmission system for power wheeling between these countries. Another option for India would be to provide transit rights for building of dedicated transmission systems for power trading in the subcontinent. Similarly, power exchanges between India and Pakistan could be facilitated to meet demand in the areas close to the India-Pakistan border and would also enhance the grid stability in both countries.

Bangladesh could also examine the potential of power exchange and trade with India. India's power generation facilities in the eastern region are operating at a lower plant load factor owing to less demand within the region. One possibility is to operate these power plants at full capacity and export the surplus power to Bangladesh's western grid to meet the demand in that region. In turn, Bangladesh could supply an equivalent quantity of power from its generation facilities in its eastern region to India's northeastern region, which is facing a deficit. Another option for Bangladesh is to establish a large gas-based generation facility in its western region to meet domestic demand and export the surplus power to India. Feasibility studies for such exchanges have already been conducted. The results of these studies have shown that in addition to meeting the demand in the respective regions of both the countries, substantial economic, social, and technical benefits that can be realized for both the countries. Such exchanges not only would help meet demand in the most economical manner, but would also ensure the security of supply on both sides of the India-Bangladesh border. One study conducted recently under the SARI/Energy Program supported by USAID reported that small exchanges of power between these countries could be facilitated through small transmission interconnections requiring very nominal investments.

The future of the power trade between India and Nepal and Bhutan should be reexamined taking note of some recent changes in the electricity policy in India based on the new Electricity Act of 2003 and the electricity policy announced subsequently. In India, there are now several distribution companies within each state in place of a single electricity board, and these companies are empowered to purchase power from any source. Incremental demand during each year in the distribution companies (DISCOMs) will be small compared with the large demand from the large electricity boards. India has introduced mechanisms for power trading within the

country through several trading licenses. These traders in the public and private sectors are acting as intermediaries seeking the cheapest sources of power from generators within and outside the country and making the best offer to the distribution companies. These provisions would open up opportunities for small- and medium-scale hydro power stations to be set up in Bhutan and Nepal as independent power producers (IPPs). The new Electricity Act of 2003 has, however, eliminated the provision that allowed power traders to take advantage of the high industrial tariff (which included cross-subsidies used by the utilities to subsidize some selected category of consumers). The recent electricity policy changes in India have made it mandatory that the bulk purchasers who directly obtain supplies from generators or traders should pay a surcharge equal to the cross-subsidy to the distribution company. This has removed the incentive, which was available, to sell directly to the bulk consumers.

The Government of India has launched a major hydropower initiative to identify 50,000 MW of the cheapest hydropower projects. It is reported that over 7,000 MW of capacity in terms of specific projects has been identified with generation costs of Rs2.00–Rs2.20 per kWh, the government will play only a minor role in supporting the negotiations. The governments of the region should freely allow the power trading companies to negotiate commercial agreements to develop the regional power sector at an accelerated pace. It would be appropriate if the principles on which the price should be negotiated were based on sound commercial principles and made public. The exporting countries (Nepal and Bhutan) could then indicate up-front to investors the likely price that they could obtain by exporting power to India. This could lead to the identification of medium-size hydro plants with bright prospects for export of power to India.

The costs of hydroelectric projects are highly location-specific, and the electricity supply costs to the consumer/buyer consist of the cost of power purchase at the generation plant plus the cost of electricity transmission (wheeling) plus the cost of power dissipated as transmission loss. For each of the major hydro projects in Nepal or Bhutan, in the future the cost to the consumer will have to be assessed with reference to the location of the demand that the purchase order seeks to meet. Therefore, projects will have to take into account not only the cost of generation but also the cost of power at the point of delivery. Thus, it is necessary to have an integrated planning mechanism to identify the sources of hydro power that will meet at least cost the power needs of India, Nepal, Bhutan, Bangladesh, and, if possible, Pakistan. Only a detailed hydropower master plan for South Asia, specifying hydropower locations, and potential generation costs, and transmission requirements can facilitate rational utilization of regional hydro resources. A discussion of Afghanistan-Pakistan power trade would at this time be premature since both countries are in a state of deficit and Afghanistan requires a great deal of time to rehabilitate and rebuild its power system.

A South Asian electricity master plan should weigh the advantages of establishing a South Asian regional electricity grid connecting all countries of the region, except Maldives. The feasibility of such a grid, the technical problems of constructing and operating the grid, and the grid's costs, benefits, and the organizational set-up should be examined in detail.

5.7.2 Regional Trade in Natural Gas

There are two issues regarding the regional trade in natural gas in South Asia: (1) the possibility of surplus quantities of natural gas in the countries of the region and the possibility that this surplus can be traded with mutual benefit, and (2) the importation of natural gas from outside the

region through pipelines, which might pass through countries of the region and bring in gas for use by one or more countries of the region.

Trading Surpluses

Only Bangladesh, Pakistan, and India have gas resources. Afghanistan's situation is very unclear and might remain so in the near future. Pakistan's resources are limited, and the long-term forecast of energy demand and supply indicate that Pakistan would need to import natural gas from 2010 on.

In Bangladesh, a longstanding debate has been conducted on the pros and cons of exporting gas, and the jury is still out. Public opinion, which is opposed to exports, rests on the official data of reserves of natural gas and the future demand for natural gas projected by Petrobangla that suggests that export is not advisable. Petrobangla has estimated that the gas demand in Bangladesh will increase from 346 billion cubic feet (bcf) annually in 2000 to 1,310 bcf annually by 2020. The Natural Gas Committee (2002) for Bangladesh conceded that it is an extremely difficult task to project gas demand because economic growth, which is the main driver for energy growth, is difficult to predict in Bangladesh. The Natural Gas Committee came up with several forecasts with different scenarios of economic growth. The work of the committee confirmed that Petrobangla's estimate would be consistent with a GDP growth of 4.7% per year and the cumulative gas demand would be 13.5 trillion cubic feet (tcf) by 2020. Assuming a GDP growth of 7% per year, the estimated cumulative demand for natural gas in Bangladesh could be 18.1 tcf by 2020 and might increase to 141–152 tcf by 2050. The various estimates of undiscovered gas resources now place the quantity of recoverable reserve at 66 tcf. The experts who oppose the proposals to export gas from Bangladesh share the view that the country should plan for higher rates of growth and use all known gas within the country. Supporters of exportation accept the estimates of the undiscovered potential gas reserves at a low statistical confidence level and conclude that Bangladesh gas resources will last for 200 years at the current level of use. Given the gas exportation debate within Bangladesh and the fact that the country's energy security plan does not support gas exportation, any future examination of regional gas trading potential should exclude Bangladesh from consideration. The issue can be reopened only when the recoverable reserves of gas from undiscovered areas have been ascertained and assessed through adequate exploration activities.

Importing Gas

Any energy trade by surface routes within the region has to pass through India, since India's land mass occupies the central space between the region's major countries. Transit facilities may also be required if a country proposes to purchase energy in the form of electricity or gas from areas outside the region such as the Middle East. Natural gas trade between these areas and India via Pakistan or Afghanistan would require gas pipelines in the latter two countries. Importing gas from Myanmar to India would require pipeline transit through Bangladesh. Countries providing transit facilities could also access gas for their own use.

Currently, the discussions regarding the importation of natural gas via pipeline through Pakistan is under active discussion. Pakistan is committed to importing gas to meet its own import requirements beyond 2010 and is considering the relative benefits and costs of three gas pipeline projects:

- Turkmenistan-Afghanistan-Pakistan pipeline

- Iran-Pakistan pipeline
- Qatar-Pakistan pipeline

The cost of extending the gas pipelines from Turkmenistan and Qatar from Pakistan to Indian demand centers would be incremental, but the benefits to both the economies would be immense. In recent months, oil diplomacy has gained a stronger foothold in the region. Efforts are under way to explore the possibilities of establishing a regional gas grid that would help facilitate transmission of gas from the western neighbors of the region to even the southwestern parts of China. However, one of the prime issues for such ventures would be the wellhead price of gas and the landed cost to the consumers. The price at which the gas is offered by Iran seems to be under negotiation, as the Indian agencies are finding it too high. Pakistan has announced that it is likely to take up the question of a Turkmenistan-Afghanistan Pakistan pipeline, even if India does not join as a partner. But given the energy requirements of India, it is expected that both countries are seriously considering all options to meet their energy demand.

There are some issues that dampen the enthusiasm for such piped gas proposals in receiving countries. For example, in India the demand for natural gas in the production of fertilizers or petrochemicals is rather limited; on the other hand, the demand for gas in the power sector is high, but this sector has alternative fuels. Therefore, Indian agencies claim that they cannot agree to a price for gas that would result in power produced from gas becoming costlier than the power produced from other sources. The largest producer of thermal power in the country, the National Thermal Power Corporation, has taken the stand that it will not be in a position to use gas for power generation if the gas delivered at the generating plant is priced at more than US\$3 per million British thermal units (MMBtu). The lowest possible cost of piped gas delivered in India is now indicated by the exporting agencies to be higher than US\$3.5 per MMBtu. Hence, the negotiations are becoming prolonged.

Price is not the main issue in importing gas from Myanmar through Bangladesh since Indian Oil has an equity share in some Myanmar gas wells currently in production. India and Bangladesh are at present negotiating a range of issues related to the Myanmar-Bangladesh-India gas pipeline proposal.

Natural gas imports from any other country within the region or outside will have a beneficial effect on energy security only if the price and conditions of sale are right. If the gas price is linked to an automatic index of crude oil price on a day-to-day basis, it does not resolve the risk of crude price volatility. The quantity of gas required depends on the uses. In South Asia, little gas is used for petrochemicals and fertilizers and this gas is limited to a few countries (India, Pakistan, and Bangladesh). Except for Pakistan, which has a vast national gas transmission and distribution infrastructure, increasing the use of gas as transportation fuel would take some time and would likely occur only in the more populous countries of the region. The high demand for gas forecasted in India and Pakistan is predicated largely on its use as a fuel for the power industry, which has several options for setting price caps on imported gas. If gas prices are linked to oil prices in the international market, there would be no risk mitigation, since oil products could be substituted for gas if prices are not a constraint. The total quantities of oil required if gas is not available would still be small compared to the volumes traded on the international oil market. There is, therefore, little risk of supplies running out. Additionally, gas that is imported via pipeline has diminished attractiveness as a risk mitigation option due to the “take or pay” policy adopted by gas sellers.

5.7.3 Regional Trade in Coal

Coal is one of the large energy fuel resources available in the region, but, except for India, coal mining has received very little attention in these countries. Opportunities exist for regional cooperation in the mining and utilization of indigenous coal. India has emerged as the third largest producer of coal in the world after China and the United States. Its total production is 400 million tons as compared with 2,000 million tons for China and 1,100 million tons for the United States. Partly because of the easy availability of oil and the low prices that prevailed for several decades, other Asian countries have not pursued energy development based on coal. However, the high price of oil coupled with price volatility has led some countries of the region (e.g., Pakistan and Sri Lanka) to build the increasing use of coal and lignite into their future energy consumption projections. Coal reserves have been identified in India, Pakistan, and Bangladesh. Table 5-4 presents the coal reserves of South Asia.

Table 5-4 Coal Reserves of South Asia

	Known Resources (billion tons)	Proved Recoverable Resources (billion tons)	Production (million tons)
India	204	84	360
Pakistan	185	3.3	3.3
Bangladesh	2.715	0.204 to 0.764	Nil

Please see Appendix-I for Source: Compiled by authors from information cited in RES Country Reports

Because Indian coal is one of the poorest quality coals in the world with a very high ash content, it is used mainly for power generation. But because it has low sulfur content, it is eminently suitable for power generation. In India, power generation based on coal exceeds 75,000 MW, which is nearly 70% of the total installed capacity. Pakistan's coal is mostly in the form of lignite, which is located in the Thar region, where mining conditions are very difficult because of poor infrastructure and scarce water. But Pakistan's energy security plan clearly places great importance on the future development of coalmines in Thar by providing the necessary infrastructure to produce large quantities of electricity. This electricity would help reduce the additional demand for gas and oil now used to generate power. Pakistan has undertaken a study on exploiting this resource, which indicates that it would produce 1 million tons of coal per year for power generation beginning in 2005, reaching about 16.5 million tons by 2015 and thereafter. Sri Lanka's energy security proposals include establishing a 300 MW coal-based power plant each year between 2010 and 2015.

Cooperation between the countries of the region could involve trading coal, sharing coal-mining experience, and participating in coalmine development in neighboring countries. India has experience in producing power-generating equipment for coal-based thermal power stations. There are possibilities for sharing the technology of low-grade coal/lignite use and for equipment manufacture for coal-based power generation plants.

In a master plan for hydroelectric power generation and a regional power grid, the advantages of having coal-based power generation for supplying base-load requirements and meeting the peak load from hydro generating stations could be considered. This could be an important issue to be included in the master plan for power development in the region.

5.8 COOPERATING ON REGIONAL ENERGY ISSUES

The energy security plan of each country in the region clearly indicates a willingness to cooperate with the other countries of the region. Present functioning of institutions such as the SAARC Energy Working Group, the South Asia Forum for Infrastructure Regulation (SAFIR), SARI/Energy, the World Energy Council, and other agencies have created opportunities for periodically meeting and discussing the issues, but have not provided adequate follow-up. Another problem is that in all these groups the governments are partners. This makes it difficult for any of these organizations to take speedy concrete action, as many of the proposals get mixed up with non-energy political issues and concerns of the countries. Analyzing issues on economic and technical considerations and working toward economic and commercial cooperation between the countries would be possible if an active body involving not only the government but also other stakeholders in the energy sector in the region participated. Some of the issues that need to be discussed in depth and on which actions need to be taken are:

- Identifying arrangements for common procurement, strategic stocking, and storing petroleum products in appropriate locations
- Establishing regional energy projects such as very large hydro projects or very large coal- or gas-based thermal projects
- Establishing a regional facility for training, equipment testing, and developing renewable technology applications
- Discussing emerging issues in the energy sector and evolving a common plan of action for these countries for presentation to international bodies
- Exchanging information on new technology, including renewable energy technology, hydrogen fuel development, and utilization of gas hydrates
- Exchanging geological information between neighboring countries to facilitate expeditious development of fossil fuels
- Setting up and operating the South Asia Infrastructure Fund (SAIF), which would be owned and operated mostly by corporate leaders from all the regional countries

To pursue these ideas, a permanent body would have to be created. This body should be a research institution as well as a high-level think-tank backed by the governments, which would bring together people from various countries of the region to examine, in depth, specific issues and would recommend proposals that could be adopted by countries of the region. Such an institution could insulate energy-related issues from undue political interference.

The collaborative work of scientists, engineers, technologists, academics, leaders, public opinion makers, media, and parliamentarians from the region could help create an environment of mutual trust and cooperation in the energy sector. This is necessary not only for the development of the energy sector but also for the subsequent improvement of the socioeconomic status of all these countries. A neutral institution entitled, for example, the “South Asia Regional Energy Foundation” could be set up. The member countries would make contributions to this institution, which could further be supplemented through donations from multinational agencies and energy companies from the region. All the member countries would have equal rights in this institution, irrespective of their contribution. The institution could have a permanent secretariat of its own. Eminent energy sector professionals from within and outside the region would staff and govern this institution.

5.9 CONCLUSIONS

All stakeholders clearly see the logic and need for cooperation between the countries of South Asia, but their long-shared history has led to several doubts and misgivings. Therefore, energy cooperation in South Asia has to be approached in a step-by-step manner. First and foremost is the need for the participating countries of the region to spell out detailed energy cooperation plans that have long-term demonstrable gains. Cooperation between the participating countries could range from exchange of experience to complete integration of the operation of electric power and gas networks in the countries of the region. A gradual approach is to be followed starting with limited exchanges that can build mutual trust and confidence.

An in-depth study of all possible aspects of cooperation is a prerequisite before identifying specific areas of cooperation. Such cooperation would become possible if based on agreed principles, which include:

- Adoption of only sustainable options that benefit all participants
- Gradually building confidence among the players and gradually increasing the degree of cooperation
- Equitable sharing of benefits and balanced development of participating countries

The institutions to be created and action plans to be initiated for achieving these are detailed in the next section.

The countries of South Asia have similar perceptions regarding the risks to their energy security and are trying to address these risks through their respective country plans. In this section, an action plan that evolved from the studies and discussions of the national energy security concerns and the national and global perception of the energy futures is presented. Important elements in the action plan are as follows:

- Strengthening the SAARC Energy Centre (SENER), developing it along the lines of the ASEAN Energy Centre in order to create institutional mechanisms to exchange ideas, experience, expertise, and technologies; provide training and research facilities; and provide a common strategy to address energy concerns at international forums
- Establishing a South Asia Infrastructure Development Financial Institution (SAIDFI) to finance regional projects. Private sector investors with assistance from regional governments and multilateral financial institutions could facilitate access to funding sources via the SAIDFI mechanism. This would expedite project implementation, help create stakeholders with interests across the region, raise the level of confidence of regional governments, and mitigate political risk
- Organizing intergovernmental committees and working groups to study and report on the feasibility of the following:
 - Setting up a regional electricity grid
 - Setting up of a regional natural gas grid
 - Developing a master plan for the rational utilization of the region's hydro resources

The elements of the action plan are elaborated below.

6.1 REGIONAL ENERGY INSTITUTIONS

6.1.1 Two Categories of Institutions Working on Energy Security

Currently, there are a number of institutions and organizations working to promote regional cooperation on issues concerning energy security or socioeconomic development. They fall under two categories.

- Non-government, academic, and private organizations
- Groupings and associations of countries with official representatives of the governments

In the first category, the organizations are bilateral or multilateral friendship societies or academic associations working for economic development in general or for specific sectors of economies of these countries. These have very little in the way of resources and are noticed only when they hold occasional regional meetings or international conferences. Such events serve a useful purpose of stimulating interest on specific issues. However, there is no follow-up action. In the second category, the most important organizations include SAARC (established under charter by the member governments), SARI/Energy (sponsored by USAID), and SAFIR (sponsored by the World Bank). Membership in SAARC is essentially the official nominees of

the member countries, usually high-level officers. SARI/Energy and SAFIR in addition to the official country representatives also invite some individuals with no direct link to government. Academic and professional institutions can become members of these groupings voluntarily. SAARC, SARI/Energy, and SAFIR hold formal meetings periodically when specific studies have to be undertaken or training programs are to be conducted. In all SAARC proposals, there is in principle a convergence of interest, but some non-energy issues become linked with energy issues and action gets stalled. In 1997, in the Ninth SAARC Summit Meeting, the Group of Eminent Persons, while commenting on the political dimension of the SAARC process acknowledged that cooperation has often been hindered by a lack of political will and hampered by vicissitudes of political climate. However, the Twelfth SAARC Summit held in Islamabad in 2004 has constituted a Working Group on Energy with the mandate of working for regional energy cooperation leading to the creation of an “Energy Ring” in South Asia. This has been a major step forward demonstrating intent on the part of the SAARC leaders to foster long-lasting cooperation in the energy sector.

6.1.2 SAARC Energy Centre (SENER)

At the SAARC Energy Minister’s conference in Islamabad in September-October 2005, it was agreed to establish a SAARC Energy Center (SENER) in Islamabad, Pakistan. The permanent institution would serve as a representative institution of all member countries in the region.

The primary objective for the establishment of SENNER is to have a regional institution of excellence for the initiation, coordination and facilitation of SAARC programs in Energy. The proposed goals of SENNER are defined as follows:

- To strengthen the region’s capability in addressing global and regional issues in the energy by enhancing the coordination of energy strategies of the SAARC Member States.
- To facilitate intra-regional trade in energy through the establishment of interconnecting arrangements for electricity and natural gas within SAARC such as the proposed power grid and transnational gas pipeline.
- To promote SAARC cooperation in energy efficiency and conservation as effective mechanism for demand-side management.
- To promote the development of new and renewable energy resources in the region as an instrument towards sustainable energy development in the SAARC Member States over the long term.
- To serve as energy information network and exchange center at both regional and global scales.
- To enhance the development of SAARC expertise in energy development and management.
- To promote private sector investment and participation in energy activities of the region.
- To undertake other related activities in connection with the above objectives.

SENER may draw lessons learned from the Association of South East Asian Nations (ASEAN) Energy Centre as a regional energy research center and from the Centre for Integrated Rural Development in Asia Pacific (CIRDAP) in Dhaka, which has helped increase understanding of rural development problems. SENNER could take advantage of the experiences of CIRDAP in

organizing mutually beneficial ‘action research’ programs, especially for the smaller countries of the region.

Selected activities that SENTER may consider include the following, as proposed by the SAARC Working Group on Energy:

- Develop a SAARC Energy Database to provide statistics for petroleum and natural gas, clean coal, electricity, and new and renewable energy for all member countries. These statistics may address energy resource base, production and generation, refining and processing, transmission, supply and consumption, including imports and exports.
- Create specialized study reports and position papers on energy issues, including technical and policy issues, pricing questions, etc.
- Promote energy trade throughout South Asia and encourage the development of a power interconnection master plan
- Promote renewable energy and clean coal policies, research, and technologies
- Develop information materials and mechanisms, including a possible website, to disseminate research, lessons learned and policy recommendations
- Develop training materials for upgrading skills in different areas of energy policy development, planning, energy conservation, energy efficiency, and the technical and financial aspects of energy generation, transmission and distribution

6.2 SOUTH ASIA INFRASTRUCTURE DEVELOPMENT FINANCIAL INSTITUTION

In the past 20 years, the South Asian countries have undertaken various measures to liberalize their economies and globalize their economic activities. This effort has unleashed enormous entrepreneurial capability in the private sector in most of the countries of the region.

Except in a few cases, where political unrest has disrupted growth temporarily, the South Asian countries have shown rates of economic growth comparable to or even greater than world growth rates. Although all the countries are seeking foreign direct investment and many industries in India, Pakistan, and Bangladesh are now multinational companies, there have been no efforts to increase the investment opportunities from one country to the other. SAARC has set up a number of committees to work on relevant issues. The South Asia Free Trade Area (SAFTA) Committee of Experts has been meeting regularly to work out the details of free trade agreements. At one of the regional meetings of the chambers of commerce and industry, the formation of a South Asia Infrastructure Development Financial Institution (SAIDFI) was proposed. With such an institution, the private sector, entrepreneurs, investors and industrial associations, and investment banks from the participating countries could become partners to promote inter-country development opportunities.

SAIDFI would have two wings: one to promote regional economic understanding, the other to promote regional investment. The first function would be to promote regional economic diplomacy and understanding of the business environment in different countries by the leading industrialists and development financiers of the region. Industrialists, political leaders, and national level executives would be brought together to discuss the issues relating to some specific sector and to identify investment opportunities for entrepreneurs in the region that would be to the mutual benefit of the concerned countries. Some attempts have already been made to informally bring together senior leaders of public opinion and political parties. For example, a group of distinguished citizens from India and Pakistan gathered at Nimrana Fort in the State of Rajasthan to discuss some pending issues between India and Pakistan and the way these issues

could be resolved. Similarly, the Rajiv Gandhi Institute for Contemporary Studies (RGICS) organized a dialogue on resource sharing issues for India and Bangladesh. The goodwill that such isolated efforts have brought about shows the potency of such initiatives. The SAIDFI could organize a series of such dialogues between industrialists, bankers of the region, and financiers outside the region.

The second function of SAIDFI would be to act as an investment promotion institution to arrange for visits of leaders of particular industries from one country to another in order to discuss opportunities for collaborative investments. SAIDFI could conduct detailed investigations of large, specific projects of regional interest, such as a regional refinery or regional hydrocarbon-shipping corporation, which could be set up either as an investment from one country to other or as joint ventures.

It would be most useful if SAIDFI could be essentially a private sector initiative in which the chambers of commerce of all the countries and the leading industrial houses and investment bankers became the driving force. The U.S. Chamber of Commerce and other international organizations of commerce and industries could also become members. While SENTER is the think tank for new ideas, the SAIDFI could be the promotion and development arm of the private sector entrepreneurs in the region.

6.3 REGIONAL ELECTRICITY GRID

Establishing a South Asia regional electricity grid is an issue requiring urgent consideration. A grid operated by a mutually approved management structure, preferably by an independent system operator, has major advantages that have been identified in the energy security arrangements proposed for the future in many countries (see Section 5). First and foremost, two countries in the region, Nepal and Bhutan, have hydroelectric potential far in excess of their current needs and the needs foreseen in the period up to 2025. Table 6-1 shows the hydropower potential and likely capacity requirements of Nepal and Bhutan.

Table 6-1 Hydropower Potential and Likely Capacity Requirements of Nepal and Bhutan

Country	Hydroelectric Potential (MW)	Installed Capacity, 2003–2004 (MW)	Installed Capacity Likely in 2025-2026 Assuming 10 % Annual Growth	Likely Capacity in 2025–2026 as % of Total Hydro Potential
Nepal	42,915	527	4,290	10
Bhutan	30,000	150 (for Bhutan's use)	1,221	4

Please see Appendix-I for Source: Compiled by authors from information cited in RES Country Reports

As discussed in detail in the country studies, both countries consider their hydroelectric resources as the major resource for meeting their energy needs and for providing the investment capital for carrying out the socioeconomic development programs using the export earnings from the hydroelectric resources. Both countries are landlocked and surrounded by the Himalaya Mountains and India. Given these facts, the case for developing specific hydroelectric projects in Nepal and Bhutan, along with the associated transmission capacity for the sale of power to India, has been pursued for a long time. In such a situation, an asymmetry of bargaining power exists in

India's favor. The perception, especially in Nepal, is that the terms of sale of hydropower to India sought by India are unfair to Nepal, and this perception (which has been encouraged by interested parties in India and Nepal) has prevented collaborative agreement being reached between the two countries.

After protracted negotiations in February 1996, an umbrella agreement was signed between India and Nepal allowing any government, semi-government, or private sector developer in India or Nepal to buy or sell power to each other on terms and conditions mutually agreed upon between buyer and seller. But after nearly a decade of signing this agreement, there has been little progress in establishing projects where there is no government involvement. The lack of infrastructure required to move the small quantities of power under this initiative has been the major hurdle. The setting up of a regional power grid would help small and medium projects to be carried out without government intervention.

The electricity demand patterns in South Asia vary with time of the day and season. There are possibilities of trading power for a few hours in a day or exchanging power with another country at different times in the same day. The trade could be organized in such circumstances as a regional power pool. The power pool could also bring about a more efficient distribution of power among the countries in each season. For example, Bhutan and Nepal, which have large surpluses of hydropower potential, face serious power shortages in certain months of the year when the flow of waters in the Himalayan Rivers is reduced to a fraction of their flow in winter months. During these drier months, they may be unable to export power, may have to restrict their power export, or may have to import power from neighboring countries. As discussed in Section 5, Bhutan and Nepal could export power to Bangladesh in the months when Bangladesh has severe power shortage and the hydro projects of Bhutan and Nepal have surplus power. A regional power grid would make these transactions possible.

Long-term arrangements of power sales to countries other than India would still need India's support since the transmission lines would have to pass through India. The uncertainties about the availability of transmission capacity and the willingness of India to participate would have to be addressed by negotiation on a project-by-project basis. The consequent delay in the project completion time would also increase the cost of transmission. A regulated regional electricity grid with transparency regarding the availability of transmission capacity in different segments of the grid and the costs of transmission on any segment would help enable many projects of small and medium capacity to be implemented quickly. The sales and purchase arrangements could be finalized by the parties to the transaction without having to resort to lengthy negotiations with governments and government agencies. Bhutan and Nepal could negotiate power sales to all countries in the region.

The advantages of a South Asian regional electricity grid are appreciated by almost all countries in the region. These advantages are cited in the energy security plans of Nepal, Bhutan, and Bangladesh. The design of the regional grid would involve several complex technical problems and elaborate administrative agreements. Technically competent agencies and politically influential leaders of public opinion would be needed to work out these details. A working group of eminent persons with the requisite knowledge and influence should be organized, supported by a competent technical consultancy organization, to report on the concept, feasibility, and costs of setting up the grid. This group would also be responsible for working out the financial

requirements for launching the grid and suggest ways of mobilizing the funds. The time frame for this effort could be 12 to 18 months.

The creation of a regional energy grid would pave the way for the preparation and implementation of a common regional hydroelectricity master plan and even a regional electricity and energy master plan. This grid would constitute one of the elements of a regional energy infrastructure backbone and would be a prerequisite for the comprehensive development of the South Asian energy sector.

6.4 REGIONAL GAS GRID

The discussions in Section 5 and the country studies for Bangladesh, Pakistan, and India indicate that present and future opportunities for trading surplus gas from one country in the region to another are not good. But a gas grid in the region could still help these countries obtain gas from other countries in Central Asia, the Middle East, and elsewhere. Significant surpluses are available in many countries to the east and west of the region. Natural gas from the Middle East and Central Asia could be imported by pipeline through Afghanistan and Pakistan, and gas from Myanmar could be similarly imported through Bangladesh. Gas from Indonesia, Australia, and the Middle East could be imported as LNG. Though technically LNG could be offloaded at any designated location where a re-gasification unit is present, it would be more convenient to offload the LNG at economically optimal locations in each country and move the gas along the regional grid to any desired consumption point.

An independent gas grid would be difficult to develop at this stage, but once major pipelines in the west are constructed connecting India or Pakistan with Central Asia or the Middle East, the possibilities and economics of expanding the natural gas grid in Pakistan and India could be explored. Connecting these two national grids with the gas grid in Bangladesh could serve as the beginning of a regional gas grid. At this stage, a study group could be organized to examine and report on the technical feasibility, costs, and sequencing of decisions for a gas grid.

6.5 CONCLUSIONS

Various strategies pursued independently in the countries of the region are in the right direction and can improve the energy security of the country involved. As the energy security of different countries improves, the energy security of the region will also improve. However, unilateral actions may sometimes negatively impact regional energy security. Energy security efforts made by individual countries can result in conflicts of interest. For example, the struggle to secure uninterrupted oil or natural gas supply could give rise to serious inter-country competition and conflict. Furthermore, it is obvious that the cost of unilateral national efforts to ensure energy security would be greater than the cost of collective efforts to achieve the same result. The energy situation in South Asia presents a great opportunity to design and implement a regional energy security strategy that fully supports the evolving plans for such security at the national level in the countries of the region. This could be a real win-win proposition.

The countries of South Asia have reasonable levels of energy resources, adequate and even surplus high-quality human resources, and fairly well established administrative and governance systems. These advantages could be leveraged to move quickly toward developing an efficiently functioning, regional energy market system. The players in the energy market would ensure that

energy investments and transactions are commercially and economically optimal for the region. This could be achieved if the governments, institutions, academics, and civil society would come together to discuss openly and freely the issues involved, including the apportionment of costs and benefits in a transparent, fair, and equitable manner. Such dialogue could be prolonged, but crucial technical and economic studies on the relevant questions prepared by objective experts could help allay misgivings and expedite decisions. Hence, there is need for a permanent mechanism to keep the process moving steadily towards solutions. Strengthening and expanding ENTER and establishing SAIDFI are the minimum prerequisites to set in motion efforts toward developing the appropriate regional security system for South Asia.

Energy Security for South Asia – Afghanistan is one of eight country studies³ that form the basis for the Regional Energy Security report, which reviews critical energy supply-demand issues for South Asia and advocates a regional approach to national energy security concerns. The Afghanistan study reviews the country's energy requirements and resources and recommends measures to secure sustainable energy supplies for the future.

Afghanistan's economy and infrastructure are in a state of disrepair caused by two decades of conflict, a shortage of expertise and unavailability of spare parts and equipment. International donors have pledged more than \$4.5 billion in assistance while the Government of Afghanistan presented a seven-year economic development program valued at \$28 billion. The overall economy is expected to grow by approximately 20% in 2005 after periods of negative growth in previous years. Nevertheless, the country remains very poor, with GDP per capita less than half that of Bangladesh 2003, and will require extensive redevelopment, including the energy sector, going forward.

Energy Profile and Resources – Afghanistan has one of the lowest rates of per capita energy consumption in the world, at 13 kWh per capita in 2003, and only 6% of the population has access to electricity. Traditional fuels such as fuel wood, animal dung and agricultural wastes meet over 85 % of energy needs and the remainder is met by commercial sources of oil, gas, coal, and hydropower, much of which is imported. Recovery, reconstruction, and long-term development needs are extensive and will require substantial new investment. The country does, however, have indigenous energy resources including about 120 bcm of natural gas reserves (with additional potential of 1,000 bcm), coal deposits estimated at 125 million tons, and hydroelectricity potential as high as 23,000 MW. oil, natural gas and coal. Moreover, the country's location between energy rich Central Asia and the Middle East and the high demand nations of South Asia allows Afghanistan to become a major transit route for both electricity and natural gas.

Key Issues – To promote sustainable economic growth, improve the lives of its citizens and achieve political and social stability, Afghanistan must repair and expand its domestic energy infrastructure and increase energy trade with its neighbours. To address these issues, Afghanistan must pursue a policy that utilizes donor assistance to rebuild needed infrastructure and management capacity, exploit existing energy resources, and develop its potential as a regional energy transit corridor. The Regional Energy Security study provides recommendations in key areas to address these issues.

1. **Develop Afghanistan as a power transit route** – By providing guaranteed transit rights for electricity, Afghanistan could seek transit fees (either in cash or in kind), to help it meet its energy needs for the immediate and longer-term future. A study underway to assess the potential for large power export to Pakistan (1,000 MW or more) includes potential routes through Afghanistan. Estimated wheeling/transit fees for Afghanistan is approximately \$26M annually (\$150M over a 20-year contract).

³ The Energy Security for South Asia country studies includes Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka.

2. **Serve as gas pipeline corridor** – A natural gas pipeline from Turkmenistan’s Dauletabad-Donmez gas basin via Afghanistan to Pakistan (TAP) is under consideration. If developed, the project could generate more than US\$ 100 million per year in transit fees for Afghanistan, while creating thousands of jobs in the country. The main issues in the implementation of the project are the need to authenticate the natural gas reserves available for the project in Turkmenistan, security issues and the physical conditions of transit through Afghanistan. A comprehensive gas sector development master plan is also being prepared that will guide and promote the development of Afghanistan’s gas infrastructure over the next 10 years.
3. **Address hydropower and coal potential** - Severe droughts have limited Afghanistan's hydro production in the past, but investment in small and micro hydro facilities could help reach isolated areas of the country without access to electricity. Information and technology sharing with India, Bangladesh and Pakistan in the coal sector could help speed development of clean coal technologies, improve utilization and reduce environmental impacts.
4. **Develop renewable energy options** – The country has substantial hydropower potential in addition to its installed and partially destroyed 430MW capacity. The country also has wind and solar energy resources. Collaboration among the countries of South Asia to share technologies and expertise and to develop technical standards would provide major benefits.
5. **Address policy and capacity issues** – Afghanistan requires not only funding, but a viable policy framework and critical capacity building to rebuild the energy infrastructure needed to exploit its energy resource and transit potential. Key areas include restructuring of those ministries involved with oil, gas and electricity, regulatory reform and development of viable regulatory bodies, reform of taxation regimes to encourage energy investment and renewable energy, and extensive training and capacity building at the managerial and technical level throughout the energy sector.

Energy Security for South Asia – India is one of eight country studies⁴ that form the basis for the Regional Energy Security (RES) report, which reviews critical energy supply-demand issues for South Asia and advocates a regional approach to national energy security concerns. The Bangladesh study reviews the country's energy requirements and resources and recommends measures to address sustainable energy supplies for the future.

Although Bangladesh has achieved progress in reducing infant mortality rates, increasing the rate of literacy and maintaining self-sufficiency in food production, it remains one of the poorest countries in the world. The economy has been growing at an average annual rate of 5% since 1990, but could achieve higher growth by addressing endemic corruption, weak institutional capacity, and vulnerability to natural disasters. The government has begun to address these issues, yet the country is not expected to meet its Millennium Development Goals (MDG),⁵ which will require a sustained annual growth rate of 7%-8%.

Energy Profile and Resources: Bangladesh has one of the lowest per capita energy consumption rates in the world. Like most developing countries, biomass is a major source of energy as 55% of the total energy consumed in Bangladesh comes from biomass. Natural gas meets 24% of the country's total fuel need while hydroelectricity provides another 2%. Yet two-third's of the country's commercial energy consumption is met from natural gas while the remainder is from oil augmented by hydropower and coal. Only 32% of the total population (22% of rural population) has access to electricity. Accordingly, Bangladesh's economic development future is inextricably linked to its management and usage of natural gas.

Key Issues: Two fundamental energy issues face Bangladesh: improved energy access to the general population and the proper management of its natural gas resources. Bangladesh needs reliable and affordable access to energy, especially electricity, in order to keep its economy growing and to bring a greater portion of the population into a productive economy. According to estimates by the World Bank, the economy loses \$1 billion annually due to unreliable electricity supply.⁶ With respect to natural gas, Bangladesh has the potential to become a major producer and could produce enough for export, which would, provided needed foreign exchange. However, the actual size of the country's natural gas reserves is unclear and there is substantial opposition within the country to the prospect of exporting this commodity. The RES country study for Bangladesh includes the following recommendations to address these issues.

1. **Encourage private sector development of natural gas reserves** – Bangladesh has entered into agreements with international companies to explore and develop its natural gas reserves. There has been opposition to gas exports, which are driven by concerns regarding adequacy of supplies for domestic use. Accordingly, the government must undertake an accurate assessment of the gas reserves and develop a plan that balances the energy needs of Bangladesh with that of foreign investors.

⁴ The Energy Security for South Asia country studies include Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka.

⁵ World Bank Country Brief. July 2005.

⁶ United States Department of Energy. Energy Information Association. August 2005.

2. **Develop coal resources** – Coal reserves have been found in Bangladesh in five locations and there was limited production in 2003. Petrobangla has launched the establishment of a marketing and distribution network throughout the country. By expanding its coal production, Bangladesh can reduce its reliance on energy imports and diversify away from natural gas. The country should exploit these reserves by encouraging domestic and foreign investment, following a model used by international oil companies involved in natural gas exploration and extraction.
3. **Develop renewable energy technologies:** There is limited potential for wind and solar in Bangladesh due to resource and cost constraints. However, there is scope to increase biomass-based energy through advanced technologies such as bio-gasification. The government must undertake programs to encourage renewable technologies such as improved cook stoves, biogas plants and gasifiers.
4. **Explore regional electricity and gas grid** – The region, especially Nepal, Bangladesh and India, can benefit tremendously from a regional electricity grid. Nepal is projected to have excess hydroelectricity in the future, which it can export to India and to Bangladesh through India. Bangladesh could potentially import natural gas and gas-based electricity to India if the infrastructure to do so is established. Such an arrangement would promote regional stability and lead to increased cooperation in other areas such as trade.
5. **Support institutions to explore and promote regional energy security options** – Given the related energy challenges faced by other countries in the region, there is mutual benefit to examining opportunities for regional cooperation in a systematic and coordinated manner. The establishment of a SAARC Energy Center (SENER) to share information coordinate energy planning and promote regional energy trade and investment is an important step toward furthering regional energy cooperation.

The *Energy Security for South Asia – Bhutan* study is one element of the Regional Energy Security Report, which reviews critical energy supply-demand issues for eight South Asia country studies⁷ and recommends a collaborative approach for meeting the region's energy requirements. The Bhutan study reviews the country's energy requirements and resources and recommends strategies to secure sustainable energy supplies for the future.

Bhutan was isolated from the rest of the world until the 1960s when it began efforts to reduce poverty and increase the standard of living for its population. The success of Bhutan's development programs is evident by the fact that it now has one of the highest per capita Gross National Incomes (GNI) in South Asia (\$760). Yet Bhutan is still primarily an agrarian economy with 85% of the population depending on agriculture for their livelihood.

Energy Profile and Resources – Only 40% of the total population and 30% of the rural population in Bhutan has access to electricity. At the same time, the country has one of the higher energy consumption rates in South at 214 kWh per capita in 2003, more than three times that of Nepal. Yet the country has significant energy resources with an estimated hydropower potential of 30,000 MW that can be exploited to further national economic development objectives.

Key Issues – As part of efforts to improve living standards, Bhutan is seeking to expand electricity access while keeping it affordable to stimulate economic activity. To fund its social development programs, the Royal Government of Bhutan (RGOB) is heavily dependent on revenues from hydroelectricity exports, especially from the Chukha Project. A key issue for Bhutan will be ensuring that benefits accruing from the country's natural hydropower potential reach targeted sectors of the economy, particularly the rural areas. The Regional Energy Security report recommends the following actions.

1. **Encourage development of hydropower resources** - Bhutan generates almost all of its electricity through hydropower and hydroelectric power exports constitute the largest source of revenues for the country. Further investment in this resource is consistent with the country's goal to provide affordable electricity to all and to lower dependence on oil imports. This is particularly critical as Bhutan has no known reserves of hydrocarbons and is entirely dependent on imports to meet its oil requirements.
2. **Promote cross-border electricity trade** – In 2003, Bhutan exported 70% of its hydroelectricity to India, which continues to be Bhutan's biggest trading partner. As India's electricity demands are expected to double over the next decade, Bhutan has a strong opportunity to increase hydel trade between the two countries. The benefits of such trade are mutual. India will have access to clean and affordable electricity while Bhutan generates additional revenues to finance key socio-economic improvement programs. Moreover, as Bhutan has a close relationship with India, it should be able to further leverage trade relations to obtain technical expertise and capital to expand its hydropower resources.

⁷ The Energy Security for South Asia country studies include Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka.

3. **Expand electricity access** – Rural electrification (RE) is a priority for Bhutan as it seeks to provide economic opportunity for its people, but high transport costs and low population density means such development will be very expensive. By developing hydropower resources, Bhutan can help to finance its RE programs. Hydroelectricity trade may also allow for some diversification of the agrarian economy as increased energy access supports a broader range of economic activities. In the meantime, biomass will remain the primary source of energy for the majority of the population.
4. **Expand hydroelectricity trade** - Bhutan can play a significant role in enhancing the energy security of the region by developing its hydropower resources. The region faces electricity shortages that are impeding growth, particularly in India, which must increase generation electricity supply, in order to keep pace with growing national demand. There is also high seasonal demand for energy in Bangladesh, which coincides with the period of high hydropower generation in Bhutan. By developing its hydropower capacity, Bhutan can increase its exports to both these countries and support a strong regional energy alliance. Expanding the capacity of the current transmission lines between India-Bhutan and India-Bangladesh will allow larger quantities of electricity to be exported.
5. **Support SAARC Energy Center** – Bhutan needs markets to develop its hydel export capacity. A regional institution such as the SAARC Energy Center will serve as an important conduit to promote such trade, improve coordinated energy planning and assist technology transfer and information sharing that can help Bhutan’s national energy development and diversification efforts.

Energy Security for South Asia – India is one of eight country studies⁸ that form the basis for the Regional Energy Security report, which reviews critical energy supply-demand issues for South Asia and advocates a regional approach to national energy security concerns. The India study reviews the country's energy requirements and resources and recommends practical measures to secure sustainable energy supplies for the future.

India's GDP growth rate has more than doubled from a steady 2-3% over the last two decades to more than 6 % in recent years. Such growth is critical if the country is to raise local living standards and contribute to mutually beneficial economic development throughout South Asia. In achieving this growth, India has become one of the largest consumers of commercial (coal, oil, gas and electricity) and traditional (wood, waste) energy resources in the world. On a per capita basis, however, India ranks below Pakistan and is only one third that of China. The country has also managed to reduce the ratio of energy consumption to GDP by 18% over the last decade, although China lowered this ratio by over 45% over the same period. Nevertheless, rising overall energy demand and vulnerabilities associated with external sources of supply has become a major security issue for the country.

Energy Profile and Resources: India has ample indigenous energy resources including: Approximately 40 billion tons of proven coal resources, enough to meet projected coal demand for 50 years; economic hydropower potential of 84,044 MW (with plans to develop 50,000 MW in the next 15 years); experience with nuclear power; and is a leading proponent of renewable energy with over 2,000 MW of installed wind power capacity. Nevertheless, fuel import dependency, as a percentage of total energy demand, has risen from 23% to 30 % over the last two decades. Moreover, India's dependence on imported oil has increased dramatically to 73% over the same period and is projected to grow to 91.6% by the year 2020. These increases place significant pressures on India's balance of payments and on the economy as a whole.

Key Issues: To fuel future growth, India must add approximately 100,000 MW of additional capacity by 2012 and meet energy demands that are projected to expand 6% per year through the same period and beyond. India has little choice but to develop both indigenous energy supplies and to expand regional and international trade arrangements necessary to sustain its economic growth and to improve the livelihood of a large population. The India country study identifies key strategies to meet the country's growing energy demand in a national and regional context.

1. **Increase clean coal power generation** –To exploit India's huge coal potential, the government must address calls to deregulate coal production, encourage equitable private sector participation and investment, and promote clean coal technologies. India also has Coal Bed Methane (CBM) reserves for the next 15-20 years that can be exploited.
2. **Exploit hydel power potential throughout the region** – India is a major user of renewable energy resources and is the only country to have a separate ministry for renewable energy.

⁸ The Energy Security for South Asia country studies includes Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka.

India's hydroelectric potential is high and the government recently launched a program to develop capacity over the next 15 years. Opportunities for cross-border hydropower development and trade also exist with enormous potential trade benefits to Nepal and Bhutan.

3. **Encourage private sector development of offshore oil reserves** – In order to ensure oil supplies, India launched a program in 1999 to encourage national oil companies to acquire equity stakes in oil and gas properties abroad. India should complement this policy by encouraging national and international oil companies to explore and develop oil reserves in areas around India as a means to increase indigenous supplies and to reduce fuel transport costs to other countries in the South Asia market.
4. **Expand natural gas supplies** – To make expensive LNG investment cost-effective, India must harness existing demand – through a combination of regional or bi-lateral transit and sales arrangements, by developing power and fertilizer plants that utilize natural gas, and by building a larger consumer market by linking gas sales to Compressed Natural Gas (CNG) retailers and building urban demand through pipelines to households.
5. **Develop wind, solar and other renewable energy sources** – India has taken a lead role in developing solar and wind energy resources, with the latter exceeding 2,000 MW in 2003 according to the Ministry of Non-Conventional Energy Sources. The government should expand development financing by the Indian Renewable Energy Development Agency (IREDA) and encourage private investment in wind power, which has been successful.
6. **Improve production and utilization efficiency** – India can save 4% to 5% of its oil supply by improving extraction recovery methods. At the same time, end use technologies including, for example, cooking stoves, irrigation pumps and automobiles, should be modified to raise energy efficiency by at least 3% to 5%. In the electricity sector, supply side efficiency improvements include lower transmission and distribution losses, improving heat rates at power stations, better maintenance, and the use of clean coal techniques to increase fuel efficiency in power plants up to 45%. On the demand side, load management, end-use efficiency and pricing reform can have important financial and environmental benefits.
7. **Develop strategic reserves and partnerships** – A plan to create a 5 million ton strategic oil reserve at the cost of Rs 6600 Crores was approved in 2004 and should be explored. India should explore regional and bilateral institutional arrangements to supplement these reserves and reduce the risks of global energy price volatility.
8. **Explore regional electricity and gas grid** – Plans have been formed to create a national electricity grid, which links the country's five regional grids, that would be operated by an independent system operator. A similar institutional arrangement could be developed for construction and operation of a South Asian regional electricity grid that builds on the limited number of cross-border linkages currently in place. Likewise, regional gas grid should be considered as cross-border gas pipelines are developed.
9. **Develop institution to explore and promote regional energy security options** – Given the related energy challenges faced by other countries in the region, there is mutual benefit to examining opportunities for regional cooperation in a systematic and coordinated manner. The formation of a regional SAARC Energy Centre (SENER) is an important step toward improved information sharing, coordinated energy planning and the promotion and development of regional energy trade and investment opportunities.

The *Energy Security for South Asia – Maldives* study is part of the Regional Energy Security Report, which reviews key energy supply-demand issues for eight South Asia country studies⁹ and recommends a collaborative approach for meeting the region's energy requirements. The Maldives study reviews the country's energy requirements and resources and recommends strategies to secure sustainable energy supplies for the future.

The Republic of Maldives is comprised of 1,190 islands in the Indian Ocean and has a population of 340,000. The economy, which is dominated by tourism and fishing, has experienced steady economic growth for the past two decades. Tourism and associated revenue from import duties net over 90% of the government tax revenues. As a result, the government must prioritize the use of clean affordable energy to sustain this critical sector of the economy.

Energy Profile and Resources – Maldives has no hydrocarbon resources or hydropower potential and is entirely dependent on imports for its energy needs. The country consumed the equivalent of 3,200 barrels of oil in 2001, all of which was imported in refined form, which is expensive. Rural areas and poor households use biomass for most of their energy needs though, in recent years, there has been greater use of kerosene and LPG for cooking.

Key Issues – The State Electricity Company (STELCO) provides most of the electricity for the islands, though several private sources provide electricity to islands reserved exclusively for tourism. Nevertheless, several islands have only irregular access to electricity while others have none. The Government of Maldives has prioritized universal electricity access to improve economic conditions for the population, but the country's geography will make this an expensive undertaking. Another key issue is securing stable clean energy at reasonable prices to fuel the tourism industry. The Regional Energy Security report makes the following recommendations to meet these objectives.

- 1. Reduce dependence on energy imports** – Rising energy demand from the transport sector has increased oil imports and exposed the country to international fuel price fluctuations. Given the limited choice of energy sources, the only feasible way for the country to reduce energy dependence is through the development of renewable energy resources, such as solar and wind power.
- 2. Increased use of solar and wind power** – As an island nation, Maldives cannot cost effectively import electricity from its neighbors. The alternatives include expanding generation to meet local needs or importing expensive fuel. Since tourism is a major driver of the economy, any energy generation program must not pollute the country's beaches or atmosphere. Given these constraints, solar and wind power provide a viable solution for meeting at least some of the energy requirements of the country. Small-scale solar systems are currently in use for applications such as producing hot water for homes, powering communication transceivers and navigation equipment for fishing boats. More significantly, the telecommunications industry has become the largest user of solar power in Maldives. The National Renewable Energy Laboratory (NREL) recently completed

⁹ The Energy Security for South Asia country studies includes Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka.

solar and wind assessments for Maldives, which showed the country could meet a sizeable portion of its energy requirements through these resources.

- 3. Encourage private investment in energy** – Private generators operate throughout the islands, especially on those that are dominated by tourist resorts. The government can further attract private investment by providing incentives such as fuel subsidies. Tax breaks and other economic incentives will attract private investment to solar and wind energy development schemes. In the transport sector, incentives to use more efficient vehicles in public and personal sector should be encouraged.
- 4. Explore regional alliances to develop clean energy technologies** - Renewable technologies can be beneficial to all South Asian countries. Considering the costs of research and development as well as the similarities in the application of these technologies throughout the region, joint collaboration is a viable option. A regional institution, such as the SAARC Energy Center, can further these efforts for the benefit of the entire region.

Energy Security for South Asia – Nepal is one of eight country studies¹⁰ that form the basis for the Regional Energy Security report, which reviews critical energy supply-demand issues for South Asia and advocates a regional approach to national energy security concerns. The Nepal study reviews the country's energy requirements and resources and recommends steps to secure sustainable energy supplies for the future.

The Kingdom of Nepal's economic growth rate is low at 3.6% and, coupled with a population growth rate of 2.2%, is relatively stagnant. Yet the country has sufficient hydroelectric potential to fulfill both domestic consumption needs and export potential to India, Bangladesh, and Pakistan. The demand for clean, renewable energy in Nepal, northern India, and southwest China is expected to at least double over the next decade, providing a promising market for Nepal's hydroelectric resources and a financial base to support continued economic development.

Energy Profile and Resources: Nepal's principal energy resource is its hydropower development potential, estimated to be 43,000 MW. While Nepal has four major types of coal—quaternary lignite, siwalik, cretaceous-eocene, and godawana—the reserves are too small and limited to justify commercial mining. The Kingdom does, however, have a 300-million m³ reserve of methane distributed over an area of 26 km² in Kathmandu that has been deemed viable for both domestic and commercial use. The government has listed petroleum as a priority area and has sought to promote exploration activities abroad given that there are no known deposits in the Kingdom.

Key Issues: Nepal meets 87.4% of its energy needs through traditional fuels, and only about 40% of the population has access to electricity. Thus the per capita consumption of commercial energy is very low at only about 41 kgoe in 2003. At the same time, Nepal is beginning to industrialize and the economy is expected to grow at the rate of 4.3%¹¹ during the 10th Plan period (2002-07.). Accordingly, the demand for commercial energy is expected to grow at a similar rate during this period. The key issues for Nepal are how to deliver reliable energy access to a greater share of the population, for a more productive economy, and to manage the anticipated rise in energy demand. The export of hydropower, if managed carefully, can be part of this solution. The Nepal country study provides the following recommendations.

1. **Further Develop Power Exchange Potential** – All hydropower plants in Nepal except for two are run-of-the-river type, are capable of producing significant surplus energy during the rainy season and less energy during the dry season. The load demands on the Nepal system are seasonally opposite those in India, which is higher during India's dry summer when water is high in Nepal's rivers. This presents an opportunity for Nepal to sell surplus power during the wet season when domestic demand is low, and to import electricity from India when demand is high. This interconnection would contribute to overall system reliability and improve system load factors in both countries.
2. **Encourage Commercially Feasible Trade** – For a trade to take place across borders, availability of a surplus resource is a necessary but not sufficient condition. The trade should be commercially feasible and the price should be competitive. Yet Nepal's hydropower

¹⁰ The Energy Security for South Asia country studies includes Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka.

¹¹ Chapter 5, The Tenth Plan Document, National Planning Commission

development efforts have been largely focused on meeting domestic demand, which is small and not conducive achieving economies of scale needed for competitive export. Nepal should look to develop larger more economical projects over the long term.

3. **Support Regional Electricity Grid** – Nepal’s substantial hydroelectric power potential could be consumed domestically and exported to India, Pakistan, and Bangladesh with the development of a viable electricity grid. By 2027, depending on the growth scenario, 7,500 MW to 19,314 MW of hydroelectricity may be available for export from Nepal. A regional power grid is a pre-requisite to facilitate such trade.
4. **Exploit Differences in Resource Endowments** – When resource endowments differ among countries, power trading can yield tangible benefits. The interconnection of a predominantly thermal system with a hydro-dominated system is likely to result in significant benefits, principally because the hydro system can be utilized to meet the peak requirements of the thermal system during the high-demand season. The thermal system can supply the base load for the hydro system. The reserve capacity margin requirement of the interconnected system can be much lower than that of individual systems operating independently for a similar level of system reliability.
5. **Enhance Security of Supply** –One of the reasons for the poor quality of electricity supply in Nepal is the inadequate generation capacity in the system, resulting in lower power supply reliability. If the supply of electricity is of low quality and characterized by frequent outages (planned or unplanned), poor voltage regulation, and frequency instability, industrial output will be negatively affected in terms of lost output, labor being idle, or the need to install captive generation. An enhanced security of supply will promote a reliable supply and improve its quality.
6. **Increase Energy Access** – Nepal’s 10th Plan document states the main objective of long-term development is to free the nation from the clutches of existing poverty. Specifically, the plan envisages that 80% of the population will have access to electricity, with rural access to energy identified as a priority area. Nepal should promote this process through community-based rural electricity organizations and improved distribution programs.
7. **Diversify Energy Sources** – Diversification of energy sources is very important to ensure reliable supply and to ensure energy security. Within South Asia, there exist complementarities in energy resource endowments – hydropower in Nepal and Bhutan, gas in Bangladesh and Pakistan, and Coal in India. Nepal and Bhutan already have agreements in place to sell power to India on bilateral basis, but the South Asia region’s energy market is so large that other opportunities exist for regional cooperation.

Energy Security for South Asia – Pakistan is one of eight country studies¹² that form the basis for the Regional Energy Security report, which reviews critical energy supply-demand issues for South Asia and advocates a regional approach to national energy security concerns. The Pakistan study reviews the country's energy requirements and resources and recommends steps to secure sustainable energy supplies for the future.

Pakistan's economy is poised for healthy, sustained growth in the future. GDP increased more than 6% last year, per capita income has risen 24% since 2000, and the incidence of poverty has declined over 4% since 2001, aided by strong growth in the manufacturing and services sectors. In line with this growth, energy usage has also risen and is expected to double by 2015 and then double again to 113.52 mtoe by 2025.¹³ These increases are exacerbated by energy intensity levels (kWh per unit of GDP) that are currently higher than both India and China.¹⁴ To sustain projected growth rates of between 6-7%, which are driven by the energy-intensive industrial sector, the country must address its energy supply and demand issues on an urgent basis.

Energy Profile and Resources: In 2003-04, per capita primary commercial energy consumption in Pakistan reached 337 kilograms of oil equivalent (kgoe), which was higher than India but less than the world average of over 1,500 kgoe. About 28% of total commercial energy is imported, and despite a diversity of sources, 80 % of that energy supply is from oil and gas. Dependence on imported fuels is expected to increase and, in conjunction with rising prices, will have a negative impact on Pakistan's foreign reserves. At the same time, Pakistan has vast potential indigenous energy resources, much of which has remained untapped. Only about 2% of coal, 3% of oil, 16% of gas, and 16% of hydropower resources have so far been proven. The government is looking to develop national energy resources while continuing a policy of importing more price stable and environmentally benign natural gas.

Key Issues: To sustain the country's rapid economic growth, Pakistan must address two principle energy security challenges. First, the country must expand energy access in order to bring a wider segment of the population into a productive economy. Second, since increased energy access will necessarily raise energy demand, the government must diversify the country's energy supply and demand mix to reduce the risk of fuel price fluctuations in the global energy market. The Pakistan country study identifies national and regional strategies to address this demand.

1. **Sustain Natural Gas Development** – Commercial energy consumption grew by more than 8% last year, with 80 % of the energy supply coming from oil and gas and 28% of that from imports. To lower dependence on foreign oil, Pakistan has made ambitious investments in natural gas, including an expanded gas network and conversion of oil-fired power plants to natural gas. As a result, over the past 15 years, the share of oil consumption has declined by 10%, while gas has risen by 6.5%. Pakistan should continue this strategy and explore appropriate options for cross-border natural gas pipeline development.

¹² The Energy Security for South Asia country studies includes Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka.

¹³ Note that according "Medium Term Development Framework (MTDF2005)" prepared by the Planning Commission of Pakistan in May 2005, energy demand projections are much higher and are estimated to expand by a multiple of 5 times to 255.37 mtoe by 2025.

¹⁴ According to the Energy Information Agency, energy intensity levels, as measured metric tons oil equivalent/million \$international for 2004 are as follows: Pakistan (262.7); India (226.1); and China (236.7)

2. **Develop Hydel and Coal Alternatives** – Pakistan’s electricity supply has consistently fallen short of demand and commercial energy needs are expected to double in the next 10 to 12 years. To reduce dependence on external energy supply sources, Pakistan should exploit its vast potential energy resources, much of which remains untapped. The Planning Commission is considering increasing coal use by more than twofold to 15% (including imported) of the energy mix by 2025. At the same time, the government is looking to develop more than 40,000 MW of hydroelectric capacity, at roughly 12% of the energy mix by 2025. The government has recently announced a policy to encourage private investment in these indigenous resources and regional assistance and technology sharing can facilitate this process.
3. **Continue oil and gas sector reforms as a model for the region** – In 2000, Pakistan launched an ambitious pro-market reform program designed to revitalize competition and investment in the oil and gas sectors. As important, Pakistan has promoted commercial and industrial demand, particularly in natural gas, needed to support the high capital costs of such investment. By continuing these efforts, Pakistan can sustain supply and become a model for the region.
4. **Increase electricity access to drive the economy** – Ninety percent of Pakistan’s population either does not have access to electricity or consumes less than 60 kw/hrs a month per household and their quality of life is correspondingly low. Pakistan must face the challenge of increasing affordable access to marginalized sectors of the economy while also developing policies and pricing strategies to promote competition and sustain industrial growth. The Government of Pakistan plans for over 12,000 villages to receive electricity by 2010. To electrify the balance of more than 30,000 villages, huge investments are needed.
5. **Develop regional trade and cooperation** – South Asia has one of the lowest per capita rates of electricity consumption in the world and yet is a net importer of commercial energy. As demand increases along with economic growth, energy cooperation becomes essential. Pakistan is a natural conduit for routing pipeline systems (gas as well as oil) from source to demand areas and would benefit from improved access to these energy supplies as well. The country will benefit from bilateral energy cooperation in electricity, oil and gas with neighboring countries that may cover trading, technology transfer, and project development.
6. **Encourage India-Pakistan Cooperation** – With their increasing energy requirements and natural proximity, both India and Pakistan have incentives to increase energy cooperation. An economic analysis by the United Nations Development Program concluded that the tariff cost of a pipeline project could be reduced by 26% through joint Indo-Pak usage of the pipeline. At the product level, Pakistan is deficit in some petroleum products, including high speed diesel (HSD) oil, but has a surplus of motor gasoline. India’s situation is reversed, which creates opportunities for cross-border trade at lower freight costs. Finally, joint exploration for hydrocarbon reserves is possible and examples from Southeast Asia can serve as models for joint development despite boundary disputes.
7. **Develop institution to promote regional collaboration** – Joint energy planning and development, technology sharing and cooperation in coal extraction, renewable energy development and CNG use in the transport sector are areas where Pakistan would benefit from increased regional collaboration. A SAARC Energy Center (SENER) should aid this process and lower planning and development costs throughout the region.

Energy Security for South Asia – Sri Lanka is one of eight country studies¹⁵ that form the basis for the Regional Energy Security report, which reviews critical energy supply-demand issues for South Asia and advocates a regional approach to national energy security concerns. The Sri Lanka study assesses the country's energy profile and reviews necessary measures to secure sustainable energy supplies in light of rising fuel import requirements.

The present political system adopted in Sri Lanka dates back to over 100 years before regaining independence. The process of evolution continued through the post-independence period and successive governments introduced constitutional reforms in order to find solutions to prevalent issues of governance. After independence the earlier economic development plans concentrated on increasing the output of essential food and manufactured goods while reducing dependency on imports and co-operative development in South East Asia. Later more emphasis was given to the development of both agricultural and industrial sectors and diversifying the export sector.

The population of Sri Lanka which was only 2.4 million during its first census conducted in 1871 increased to 12.7 million by 1971. The population growth which was 2.8% a year from late 1940 to mid 1960s dropped to present levels of 1.2%. The GDP growth rate in the country since 1970s varied between -1.5% in 2001 to 8.2% in 1978 and averaged at about 4.5% a year. Further, in comparison to the other developing countries, particularly those in the South Asia region, Sri Lanka's social indicators have improved remarkably well.

Sri Lanka has been a strong founder member of the non-align movement and the South Asian Association for Regional Cooperation (SAARC). Also it has been an active member of the Association of Commonwealth Countries since its independence.

Energy Profile - While Sri Lanka's energy supply is dominated by biomass, petroleum and hydropower constitute the only other two primary energy sources. Further, the end-use energy demand in Sri Lanka consists of three main sources: electricity, petroleum which includes liquefied petroleum gas (LPG) and biomass. On average the demand for energy has increased over the past 25 years at a rate of 2.2% a year.

In 2003 a large portion of the biomass used was by households, commercial and other sectors, which accounted for 72% of total biomass consumption. The transport sector contribution to petroleum consumption dominated at 54% of the total consumption of which the average rate of growth has been 5.7% a year over the last 25 years. The electricity consumption in the country has a historical growth of about 7% a year.

The electricity supply in the country has been a combination of hydropower and thermal plants. Hydropower dominated generation system has been giving way to oil-fired thermal plants in recent years.

¹⁵ The Energy Security for South Asia country studies include Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka.

The electrification of Sri Lanka has risen from less than 10% of households in the early 1970s to about 70% in 2004.

Currently Sri Lanka has no proven fossil fuel deposits and therefore its entire energy resource development potential is limited to indigenous sources such as biomass and hydropower and the on-going oil and gas exploration efforts.

Key Issues – Securing the energy supply at all times and ensuring that the prices of energy sources are affordable to the population are the key aspects of energy security. Sri Lanka as a country is vulnerable in both these aspects.

The Sri Lanka energy security study has identified the following strategies to address these issues.

1. Introducing fuel diversity in electricity generation and in transport by reducing heavy dependence of these sectors on petroleum thereby minimizing energy supply risk
2. Introducing energy industry reforms by separating policy-making, regulation and operation functions for increased transparency and accountability, which in turn will improve investor confidence in the energy sector while ensuring customer protection
3. Paying special attention to the development of non-conventional renewable energy sources such as wind power and biomass electricity generation, which not only increases the local contribution to the energy supply, but also improves the social and environmental impacts of energy sector development
4. Exploiting the remaining hydropower potential by enhancing the indigenous inputs to the conventional energy supply system, thereby reducing the influence of external factors on the energy supplies
5. Encouraging energy efficiency and conservation at all levels, improving on the energy intensity and reducing the overall energy supply cost to the economy
6. Immediate implementation of oil and gas exploration proposals in the off-shore areas already identified by preliminary studies, thereby enhancing indigenous conventional energy supply capability
7. Focusing industrial policy on less energy intensive industries thereby improving on the energy intensity in the economy
8. Promoting regional cooperation in the energy sector by creating opportunities for the sharing of regional energy resources and technological advances

The above strategies addressing energy security in Sri Lanka will eventually contribute to regional energy security. The promotion of regional energy security and cooperation needs be undertaken by regional institutions with the assistance of South Asian countries. In this regard, the South Asian Association for Regional Cooperation (SAARC) should play a major role.

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Afghanistan: Availability and accessibility of data and information on Afghanistan’ energy Sector is very limited. This report has been compiled principally based on data Information, assessments and recommendations from the following sources:

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Compiled by the author from the OPEC data. Created with Super Charts by Omega Research 1997

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Compiled by the author from the OPEC data. Created with Super Charts by Omega Research 1997

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- Afghanistan:** Same as above in Figure-2-1
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- 2-3 Energy Status Indicators of South Asia, 2003–2004 (mtoe) 2-3
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- Afghanistan:** Same as above in Figure: 2-1
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- Afghanistan:** Same as above in Figure: 2-1
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- Pakistan:** Author’s calculations
- Sri Lanka:** Through trend analysis of historical data
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- Sri Lanka:** Through trend analysis of historical data
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