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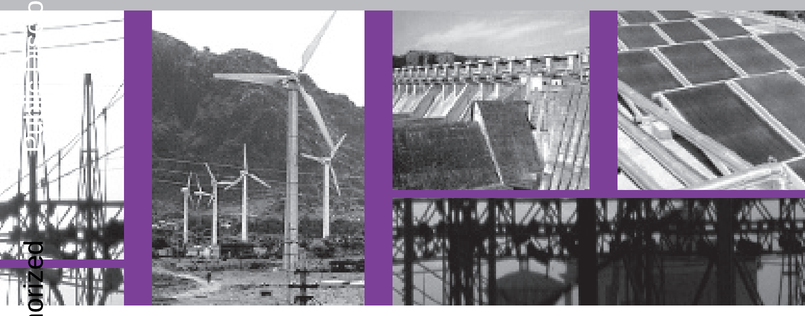

# Potential and Prospects for Regional Energy Trade in the South Asia Region

August 2008

ESMAP

Energy Sector Management Assistance Program

South Asia Regional Cooperation Program

## Energy Sector Management Assistance Program (ESMAP)

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The Energy Sector Management Assistance Program is a global technical assistance partnership administered by the World Bank and sponsored by bilateral official donors since 1983. ESMAP's mission is to promote the role of energy in poverty reduction and economic growth in an environmentally responsible manner. Its work applies to low-income, emerging, and transition economies and contributes to the achievement of internationally agreed development goals. ESMAP interventions are knowledge products including free technical assistance, specific studies, advisory services, pilot projects, knowledge generation and dissemination, trainings, workshops and seminars, conferences and roundtables, and publications.

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# Potential and Prospects for Regional Energy Trade in the South Asia Region

Energy Sector Management Assistance Program
and the South Asia Regional Cooperation Program

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ESMAP Reports are published to communicate the results of ESMAP's work to the development community with the least possible delay. Some sources cited in this paper may be informal documents that are not readily available.

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# Foreword

South Asian region is enjoying unprecedented economic growth. The growth, however, is becoming constrained by significant shortages in energy supply, and unless corrective steps are urgently initiated and implemented, it may be difficult to sustain the achieved growth rates. The region's political leaders and its business community are increasingly recognizing the need to foster cross-border energy investments and promote regional energy trade in order to take full advantage of the energy resources available within the region. This study describes the potential and identifies the main opportunities for development of regional trade in electricity and gas. The study also identifies the policies that the governments should pursue to promote cross-border energy trade and describes the supporting role of the international financing institutions. We hope that the study will stimulate further interest and contribute to development of energy trade within South Asia Region and between the region and its neighbors.

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# Abbreviations and Acronyms

| | |
|---|---|
| ADB | Asian Development Bank |
| AES | American Electric Systems (of the United States) |
| BEA | Bhutan Electricity Authority |
| BERC | Bangladesh Energy Regulatory Commission |
| BHPC | Basochu Hydro Power Company |
| BOO | Build, Own, and Operate |
| BOT | Build, Operate and Transfer |
| BPC | Bhutan Power Corporation |
| BPDB | Bangladesh Power Development Board |
| CAR | Central Asia Republics |
| CASA 1000 | Central Asia–South Asia Electricity Transmission and Trade Project 1,000 MW Phase |
| CASAREM | Central Asia–South Asia Regional Electricity Market |
| CEA | Central Electricity Authority (of India) |
| CEB | Ceylon Electricity Board (of Sri Lanka) |
| CERC | Central Electricity Regulatory Commission (of India) |
| CHPC | Chukkha Hydro Power Company |
| CNG | Compressed Natural Gas |
| DABM | Da Afghanistan Breshna Mossesa |
| DESA | Dhaka Electric Supply Authority |
| DESCO | Dhaka Electric Supply Company |
| DfID | Department for International Development (of the UK) |
| DOE-EIA | Department of Energy–Energy Information Agency (of the US) |
| EBRD | European Bank for Reconstruction and Development |
| ECO | Energy Cooperation Organization |
| EIA | Environmental Impact Assessment |
| ERCA | Energy Regulatory Commission Act |
| ETFC | Electricity Tariff Fixation Commission (of Nepal) |
| EU | European Union |
| GAIL | Gas Authority of India Limited |
| GEF | Global Environment Facility |
| GDP | Gross Domestic Product |
| GOA | Government of Afghanistan |
| GOB | Government of Bangladesh |
| GOI | Government of India |
| GOP | Government of Pakistan |

| | |
|---|---|
| GOSL | Government of Sri Lanka |
| GOTJ | Government of Tajikistan |
| GSA | Gas Supply Agreement |
| GTCC | Gas Turbine Combined Cycle |
| HPDP | Hydropower Development Policy (of Nepal) |
| IDA | International Development Association |
| IA | Implementation Agreement |
| ICB | International Competitive Bidding |
| IDB | Islamic Development Bank |
| IFI | International Finance Institutions |
| IPI | Iran–Pakistan–India (gas pipeline) |
| IPP | Independent Power Producer |
| JBIC | Japan Bank for International Cooperation |
| KESC | Karachi Electricity Supply Corporation |
| KHPC | Kurichu Hydro Power Company |
| LECO | Lanka Electricity Company |
| LLA | Land Lease Agreement |
| LNG | Liquefied Natural Gas |
| MOP | Ministry of Power (of India) |
| MOU | Memorandum of Understanding |
| MTI | Ministry of Trade and Industry (of Bhutan) |
| NEA | Nepal Electricity Authority |
| NERA | National Economics Research Associates (of the United States) |
| NEPRA | National Electric Power Regulatory Authority (of Pakistan) |
| NTPC | National Thermal Power Corporation (of India) |
| PFC | Power Finance Corporation (of India) |
| PGCB | Power Grid Company of Bangladesh |
| PGCI | Power Grid Corporation of India |
| PPA | Power Purchase Agreement |
| PPP | Public Private Partnership |
| PSMP | Power System Master Plan (of Bhutan) |
| PTA | Power Trading Agreement (between India and Nepal) |
| PTC | Power Trading Corporation of India, since renamed as PTC Limited |
| RAO UES | RAO United Energy System (of the Russian Federation) |
| REC | Rural Electrification Corporation (of India) |
| REMP | Rural Electrification Master Plan (of Bhutan) |
| RER | Renewable Energy Resources |
| REDCO | Regional Electricity Distribution Company/ies |
| ROR | Run-of-River |
| SAARC | South Asia Association for Regional Cooperation |
| SARI | South Asia Regional Initiative (of the USAID) |
| SEB | State Electricity Boards (of India) |
| SERC | State Electricity Regulatory Commission (of India) |
| TAP | Turkmenistan–Afghanistan–Pakistan (gas pipeline) |
| UCTE | Union for the Co-ordination of Transmission of Electricity |
| USAID | United States Agency for International Development |
| VIU | Vertically Integrated Utility |
| WAPDA | Water and Power Development Authority (of Pakistan) |

# Currencies and Exchange Rates

| | |
|---|---|
| Af | Afghani: $1.00 = 49 Af (2004 average) |
| Nu | Ngultrum of Bhutan: $1.00 = 44.42 Nu (as of March 30, 2006) |
| NRs | Nepalese rupees: $1.00 = 74.84 NRs (as of March 30, 2006) |
| PRs | Pakistan rupees: $1.00 = 59.83 PRs (as of March 30, 2006) |
| Rs | Indian rupees: $1.00 = 44.69 Rs (as of March 30, 2006) |
| LkRs | Sri Lanka rupees: $1.00 = 102.93 LkRs (as of March 30, 2006) |
| Tk | Bangladeshi taka: $1.00 = 73.04 Tk (as of March 30, 2006) |

*Note:* (1) In this report, dollars (US$) and cents refer to U.S. dollars and cents. (2) In many countries in the South Asia region (such as India, Pakistan, Nepal, Bhutan, and Bangladesh), the fiscal year spans parts of two calendar years. In this report, the fiscal year ends in the year indicated. Thus, FY 2006 denotes the fiscal year that ends in the course of calendar year 2006. (3) The Indian rupee has recently strengthened to Rs 40 to a dollar. This new rate has been used in many places in this report.

# Measurement Units

| | |
|---|---|
| bcm | billion cubic meters |
| bcf | billion cubic feet |
| EJ | exajoule ($10^{18}$ joule = 0.95 quad = $0.95 \times 10^{15}$ Btu) |
| ft | foot |
| $ft^3$ | cubic foot |
| GJ | giga-joule ($10^9$ joule = 0.95 million Btu) |
| GWh | Gigawatt-hour (one million or $10^6$ kWh) |
| koe | kilogram oil equivalent |
| kV | kilovolt |
| kWh | kilowatt-hour |
| m | meter |
| $m^3$ | cubic meter |
| MJ | mega-joule ($10^6$ joule = 847.8 Btu = 0.0238 koe) |
| Btu | British thermal units |
| Mcf/d | million cubic feet per day |
| Mtoe | million tonnes of oil equivalent (1 Mtoe = 39.68 trillion Btu = 41.8 PJ) |
| MW | Megawatt |
| PJ | peta-joule ($10^{15}$ joule) |
| t | tonnes (metric, equal to 1000 kilograms) |
| tcf | trillion cubic feet |
| tcm | trillion cubic meters |
| toe | tonne of oil equivalent |
| t/y | tonnes per year |
| TWh | terawatt-hour (one billion or $10^9$ kWh) |

*Note:* To avoid confusion from the multiplicity of units and prefixes used in energy reports of various countries and agencies, the unit-usage in this report follows the rules of the Système International (SI). In this system, prefixes indicate as follows (letter case is significant):

m: $10^{-3}$ (mili)
k: $10^3$ (kilo)
M: $10^6$ (mega)
G: $10^9$ (giga)
T: $10^{12}$ (tera)

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# Executive Summary

After decades of insignificant volumes of cross-country electricity trade and absence of any trade in natural gas through pipelines among the countries in the South Asia, regional political leaders and businessmen have recently evinced a great deal of interest and enthusiasm in cross-border electricity and gas trade, not only within South Asia but also with its neighbors in the west (Central Asia and Iran) and in the east (Myanmar). This brief study welcomes this political commitment and advocates the rapid commencement (in the short term) of such trade in the simpler bilateral form, making the best use of the immediately available opportunities and the expansion and development of such trade into a more integrated regional energy market with multiple buyers and sellers over the medium to long term.

## The Rationale for Regional Energy Trade

Such widespread regional energy trade provides a win-win situation to all the participants and is a logical and rational public policy choice, for the following reasons:

- *The mismatch between energy demand growth and energy resource endowments.* Relatively smaller economies (Tajikistan, Kyrgyzstan, Nepal, Bhutan, Myanmar, and Turkmenistan) and Iran have hydropower or hydrocarbon resources far in excess of their energy demand. In the remaining countries (India, Pakistan, Bangladesh, Sri Lanka, and Afghanistan), energy demand growth is far outstripping domestic supply, and in the foreseeable future, the demand–supply gap will become wider unless the domestic supplies are supplemented by imports.
- *Implications of trade to energy security.* Reliance on energy trade for meeting a part of the domestic demand can actually enhance national energy security by diversifying energy forms and supply sources and lowering the cost of energy supply.
- *The substantial benefits to the smaller exporting economies.* Energy exports could make dramatically significant contribution to the GDP growth of economies like Bhutan, Nepal, Myanmar, Tajikistan, and Kyrgyzstan and enable their export-led growth. For example, Bhutan's electricity export in FY 2007 is expected to constitute nearly 25 percent of its GDP and 60 percent of its state revenues.
- *The significant relief from energy constraints to rapid economic growth.* This is especially true in the importing economies, India, Pakistan, and Afghanistan. For example, in India alone, the volume of unserved electricity in FY 2007 is estimated at 54,916 GWh valued at $12.1 billion on the basis of the short-term marginal cost in the Indian grid. The value of the corresponding industrial production forgone would be several times more.
- *The environmental imperatives.* This is especially relevant for India, which relies heavily on domestic coal. Its carbon dioxide emissions will rise from 4 percent of the world total today to about 13 percent by 2030 unless low-carbon strategies are adopted. Imported hydropower and natural gas would help in moderating this increase to some extent.

- *Climate change imperatives.* Carbon emissions are increasing and Himalayan glacial resources are shrinking. The management of regional water resources and the use of other primary energy sources have to be optimized for the benefit of the region as a whole, and trade enables such optimization for the benefit of all.
- *Reduction of supply costs.* Trade could reduce system development costs and enable lower-cost supply. Nepal, for example, could dramatically reduce its cost of power supply (compared to its attempt to meet its demand by the expensive all-hydro generation option) by optimizing its power system with sale of hydropower to, and import of thermal power from, India.
- *Cash flow implications.* Often energy import options improve cash flow and enable postponement of lumpy and large domestic capital investment needs that would otherwise crowd out other important investment needs (the classic make or buy choice).

## Scope of the Study

This study seeks to highlight the potential and prospects for such trade, analyze the factors that have inhibited the trade so far, and take note of the emerging favorable trends in the region. It not only recognizes that trade is a logical corollary to the availability of opportunities for arbitrage and can take place under a variety of sector policies, structures, and conditions (including the current conditions in the region), but also recognizes that capacity building and sustained sector reforms would help to expand and sustain trade and enable the evolution of a more integrated regional energy market. Against this perspective, it seeks to outline the regional trade opportunities and to identify the role of the regional governments as well as the multilateral and bilateral development partners in promoting such trade, taking fully into account both global concerns (such as environmental impact and climate change) and regional concerns (such as optimal management and use of water resources and primary energy resources and benefit sharing among all participants).

## Energy Constraint to Economic Growth

In the last several years—driven by first-generation reforms relating to the correction of macroeconomic imbalances and the adoption of more liberal regimes relating to trade, investments, and exchange rates—South Asia has become one of the fastest-growing regions in the world. India is targeting an annual growth rate of 10 percent, and Pakistan, Bangladesh, and Sri Lanka are following close behind. Such buoyancy of growth is expected to continue through 2015, halving the regional poverty levels.

Such a dynamic growth in the past had been driven by global, rather than regional, integration. The intraregional trade in South Asia was only about 2 percent of its GDP, compared to more than 20 percent in East Asia in 2005. Per capita income in the region was still less than $700 in 2005, and the region's growth has to encompass not merely the services sector (in which remarkable progress had been registered), but also the industrial and agricultural sectors. The key impediment to achieving and sustaining such broad-based growth at the targeted rates is the lack of adequate infrastructure, which is especially acute in the energy sector and in the larger economies of India, Pakistan, and Bangladesh, as well as in Afghanistan.

Lack of adequate and reliable energy is proving to be a major constraint to growth in production and productivity. Relieving this through the sustainable provision of a secure energy supply remains a significant challenge.

## Mismatch between Resource Distribution and Demand Growth Distribution

The region has an installed power-generation capacity of about 152 GW and an annual generation of the order of 740 TWh. Demand is expected to grow annually in the range of 6.6 percent to 11.5 percent during the next 15 to 20 years, if supply growth can keep pace with the demand growth. Bhutan, Nepal, Myanmar, and the Central Asian economies (such as Tajikistan and Kyrgyz Republic) have energy resources far in excess of their domestic needs. Total hydropower potential of these five countries exceeds 170,000 MW, of which less than 6 percent has been developed. The combined peak demands of their systems amount to no more than 60 percent of the developed capacity. The development of even a part of their undeveloped resources for export would enable the export-led growth of these relatively smaller economies.

India and Pakistan had a total annual gas consumption of the order of about 2.5 tcf (in FY 2006), divided approximately equally between them. Gas demand in India and Pakistan are forecast to grow annually at the rate of 8 percent and 7 percent, respectively, in the next 25 to 30 years. In Pakistan, supply shortfall would be about 4 percent to 10 percent until FY 2010 and thereafter will widen to 20 percent or more. India's import dependency for gas is expected to increase from the modest level of 7 percent to 49 to 58 percent by FY 2032. Total gas reserves of Turkmenistan, Iran, and Myanmar exceed 1,000 tcf. Bangladesh is also believed to have significant potential for export of gas or gas-fueled electricity.

India and Pakistan could provide the major import markets for the surplus energy from these countries, as well as from Iran and Turkmenistan, and could secure additional energy supplies to relieve shortages and sustain economic growth.

## Existing Level of Trade

Currently, there is no cross-border pipeline or trade in natural gas. Cross-border electricity interconnections and electricity trade are insignificant, except for the following:

- Bhutan exported 5,664 GWh in FY 2007 to India from three hydropower projects with total generating capacity of 1,416 MW, constructed with substantial grant assistance from India.
- Afghanistan imported about 430 GWh (or about 28 percent of the total supply) from Iran, Turkmenistan, Uzbekistan, and Tajikistan.
- Nepal imported 266.23 GWh (or 9.6 percent of its total supply) from India, and exported 101 GWh (or 5 percent of its total sales) to India.
- Pakistan imported about 25 MW of power from Iran to the isolated grid of Baluchistan near Gwadar deep-seaport.

## Factors that Inhibited Trade in the Past

The most important among the factors that inhibited regional energy trade in the past relate to the political tensions, security issues, and the past economic policy choices:

- Prolonged political tension between India and Pakistan over Kashmir, warlike conditions in Afghanistan, internal armed conflicts in Sri Lanka and Nepal, as well as the political turmoil in Bangladesh, were not conducive to develop regional cooperation and trade.

- The previous inward-looking, import-substitution–based policy was aimed at the elusive goal of national self-sufficiency. This approach regarded energy imports as diluting energy security.
- There was a lack of cross-border transmission links and a lack of adequate transmission infrastructure even for transferring power among the various regions within the large countries such as India, Pakistan, and Bangladesh. The dilapidated and war-damaged infrastructure in the key transit country of Afghanistan was a major constraint to trade between Central Asia and South Asia.
- Poor operational efficiency and lack of creditworthiness (arising from inadequate tariffs, high system losses, and poor collections) of most power utilities in the region did not encourage trade with them, as payment risks with them were perceived as unmanageable.
- Pervasive state ownership of the utilities, their poor earnings, and their inadequate internal cash generation to finance their own domestic needs—let alone the investments for export infrastructure—proved a major handicap for the development of regional trade.

In addition, in a large country like India progress in sector restructuring, open access to transmission systems, and fair and transparent sector regulation—at least at the level of national and regional grids—as well as the emergence of licensed power trading firms were needed even for stimulating internal trade among the various regions of the country.

## Emerging Favorable Factors

Since the late 1990s, several new factors favorable to trade emerged. The most important of these factors is the change in the political mindset of the politicians away from inward-looking import-substitution–based development strategies relying on controls on trade, investment, and exchange rate regimes. Newer approaches to growth led by liberalized trade and investment regimes—and with an expanding role to the private sector and the markets—are coming into vogue, resulting in a greater degree of global integration and significant growth dynamism, and increasing foreign exchange earnings and reserves, which, in turn, enable further liberalization. Increasing growth rates translate into rapidly increasing energy demand and the urgent need for timely supply augmentation to meet such demand, both from internal and external resources. Other key factors include the following:

- *National transmission companies in India, Pakistan, and Bangladesh, are emerging, with special attention to increased interregional transfer capacities within the country.* In India, such transfer capacities have nearly doubled from FY 2002 to FY 2006 to reach 9,450 MW. It would increase to 16,540 MW by the end of FY 2007 and further to 37,150 MW by FY 2012. This would effectively enlarge the markets for imports, by giving the exporter a substantially wider choice of buyers.
- *National and regional power markets are emerging in India, enabled by the new Electricity Law of 2003.* The law has enabled the creation of regulatory bodies, the phased open access to the national and regional transmission grids, and the emergence of licensed and regulated energy trading companies. The adoption of availability-based tariffs (ABTs) with a frequency linked unscheduled interchange (UI) charge in the national and regional grids has led to the emergence of lively electricity trade and a spot market sending reliable price signals to the market. Such trade became possible, in part, because of the special steps taken by the government and the central bank to reschedule the past debts of provincial power utilities and to enforce payment discipline.
- *The private sector is playing an increasing role.* The private sector has a total generation capacity of nearly 24,000 MW (or about 16 percent of the total installed capacity) in the region. Distribution systems in Delhi, Orissa, Bombay, Calcutta, Surat, Ahmedabad, and Karachi are in the private sector or have recently been privatized. The privately owned tiny distribution system in the city of Ghazni in Afghanistan and the rural electric cooperatives in Bangladesh are heart-warming

examples in an otherwise bleak environment of the sector in these countries. The 400 kV transmission link between eastern and western regions of India (enabling the absorption of Bhutan power imports) has been constructed by a joint venture between a private investor and the Power Grid Corporation of India. There are more than 20 privately owned and licensed power-trading companies in India besides the PTC Limited (in which both public sector and private sector hold shares). Indian private investors are actively looking for opportunities to invest in export power projects in Bangladesh, Bhutan, and Nepal. Majority state-owned NTPC of India is considering investing in a large thermal power plant in Sri Lanka. The Tata group is pursuing investment in a 1,000 MW plant in Bangladesh.

- *Commercialization of the distribution segment, through enterprise reform, privatization and through regulatory prodding is going ahead in India, Pakistan, and Bangladesh.* Unfortunately, this is often frustratingly slow.
- *Structural changes involving the separation of transmission from generation and distribution functions, open access to transmission, and creation of independent regulatory bodies are progressing at different speeds.* India is leading the pack, followed closely by Pakistan and Bangladesh.
- *Political tensions between India and Pakistan are shrinking through a series of high-level talks and confidence-building measures.* Internal conflicts in Nepal have subsided, and conflict in Afghanistan still seems to be under control.
- *There is increasing interest in discussing energy-related cooperation, cross-border energy investments* and trade possibilities in a range of regional cooperation organizations such as SAARC, ECO, and BIMSTEC.

## Evolution of the Regional Trade

The nascent bilateral energy trade is expected to increase among the countries in the region and with its neighbors. India, Pakistan, and possibly Bangladesh would emerge as major importers, while Central Asia, Iran, Nepal, Bhutan, and Myanmar could emerge as significant exporters. Afghanistan would be both an importer and the important transit country. Experience and confidence gained through bilateral trade are expected to help the evolution of regional energy markets with multiple sellers and multiple buyers.

It is envisaged that initially trade would be clustered around two energy markets—a *western energy market* (in which Central Asia and Iran would sell electricity and gas to Afghanistan and Pakistan and possibly to India) and an *eastern energy market* (in which Nepal, Bhutan would export hydropower to India, and Myanmar would export both natural gas and hydropower to India. Bangladesh could also export gas or gas-based power and could import some hydropower from Nepal, Bhutan, and Myanmar. Eventually, interconnection of the grids of India and Pakistan would create the full regional electricity and gas market serving a population of 1.5 billion people. This market would be one of the largest in the world, whose sheer size would make it easier to mitigate the various risks, bear external shocks, reduce cost, create additional and more profitable trading opportunities, and attract investments.

## Opportunities in the Western Energy Market

The following energy trade opportunities are currently being discussed or pursued:

- *Power imports to Afghanistan.* Afghanistan's power demand is expected to grow to the level of 905 MW by 2020, and agreements in principle have been reached to import 300 MW each from Tajikistan, Uzbekistan, and Turkmenistan. Arrangements for the reinforcement of transmission links with Tajikistan and Turkmenistan are in place, and the link to Uzbekistan is being reviewed and is likely to be pursued in the context of projects to decongest the Uzbek grid. Imports from Iran of 60 MW to 100 MW to serve the Herat and Nimroz provinces would continue. Adequate transmission links for this have already been constructed. Funding is in place and construction is in progress for the North East Power System in Afghanistan to transmit the imported power to various load centers.

- *Power import from Iran to the Gwadar port area in Pakistan* will increase from about 25 MW now to about 100 MW when the proposed 220 kV link is completed.
- *Hydropower import from Central Asia to Afghanistan and Pakistan.* This prominent multilateral trade project is being currently discussed and formulated with the help of multilateral and bilateral development partners led by the World Bank. It relates to the export of 1,000 MW of power from Tajikistan and Kyrgyz Republic to Pakistan and Afghanistan. A World Bank study (2004) showed that the completion of the partially constructed Central Asian hydropower projects (including new transmission links) would enable Tajikistan and Kyrgyzstan to supply power to Afghanistan and Pakistan at a delivered cost lower than the marginal cost of generation in Pakistan. Pakistan's current power demand at the generation level of about 14,000 MW is expected to reach 20,000 MW by FY 2010 and 44,700 MW by FY 2020. Among the several options to meet such growing demand import of power from Central Asia has a prominent place. About 670 MW would come from the Sangtuda I hydropower project under construction by a joint venture between RAO UES of Russia and the Tajik government. Surplus power from the existing generating stations of Tajikistan and Kyrgyz republic would supply the remaining 330 MW. A memorandum of understanding (MOU) among the four governments has been signed, and a council of ministers and a multicountry working group have been set up to coordinate further efforts. Studies for the dedicated transmission line, and other technical, legal, commercial, and risk-mitigation studies are ongoing under technical assistance provided by the World Bank and the Asian Development Bank. Private participation in the transmission component is also envisaged. Should this initial project prove cost-effective and reliable, Pakistan is expected to increase its import from Central Asia to about 4,000 MW in the second stage.
- *Natural gas import by India and Pakistan from Iran (IPI Gas project).* This project, which is in an advanced state of negotiation, is for importing annually (for 30 years) 33 bcm of gas by India and 21.7 bcm of gas by Pakistan from Iran in two phases. In the first phase, one pipeline with a diameter of 56 inches would be built to transport 21.7 bcm of gas. In the second phase, the pipeline capacity would be doubled to transport the remaining gas. Iran would build the pipeline up to the Pakistan border, and Pakistan would build it further up to the Indian border. Pakistan would buy the entire gas at the Iran–Pakistan border and transport it across its territory and sell to India the latter's share of gas at a price which would include Pakistan's transmission charges and transit fees. The total distance involved is about 2,670 km. Total pipeline costs are believed to be about $7 billion. Many private investors appear to be interested in participating in the project. Russian Gazprom has also expressed interest in investing in this pipeline. Completion of the first phase is expected by 2013.
- *Natural gas import by Pakistan from Turkmenistan via Afghanistan (TAP Gas project).* This project involves the construction of a 1,680 km long 56-inch-diameter pipeline at a cost of about $5.3 billion to supply about 30 bcm of gas per year from Turkmenistan to Pakistan via Afghanistan. India has also been invited to join this venture, and it has attended the steering committee meetings as an observer. Further progress would depend on the robustness of the gas reserves data, certification of the reserves, extent of possible private interest, ability and willingness of Turkmenistan to fulfill its commitments to Gazprom of Russia and still supply Pakistan and India, and finally on the gas pricing.

The overall prospects for energy trade in the western energy market in the near term are summarized in Table ES 1.

| **Table ES 1** | Summary of the Trade Prospects in the Western Energy Market | | | | | |
|---|---|---|---|---|---|---|
| **Importing Countries** | **Exporting Countries** | | | | | |
| | **CARs** | **Turkmenistan** | **Iran** | **Afghanistan** | **Pakistan** | **India** |
| **CARs** | x | Some gas exports are possible; mutual electricity support | Unlikely (uncompetitive) | No scope | Limited (some emergency support possible) | No scope |
| **Turkmenistan** | Mutual electricity support | x | Unlikely (similarity of resources—gas; little scope in electricity) | No scope | No scope | No scope |
| **Iran** | Limited power exports possible | Power exports are ongoing | x | No scope | No scope | No scope |
| **Afghanistan** | Power exports are ongoing and should grow | Power exports are ongoing and should grow | Power export ongoing and may grow | x | Small cross-border power export possible | No scope |
| **Pakistan** | Potential for power exports | Significant potential for gas exports | Significant potential for gas export; cross-border electricity trade could grow | No scope for trade; transit of electricity and gas | x | Mutual short-term trading support in power |
| **India** | Gas and power exports possible | Significant potential for gas exports | Significant potential for gas exports | No scope; transit of gas | Mutual short-term trading support in power; transit of gas | x |

*Note:* CARs in this table denote Tajikistan, Uzbekistan, Kyrgyz Republic, and Kazakhstan only. Dark gray color denotes that trade prospects are significant and are either being exploited or can be brought to fruition in the short-to-medium term. Medium purple color denotes that prospects of the trade are good and may materialize in the medium term. Light gray color denotes that prospects for the trade are more limited and may materialize in the medium-to-long term, and light purple color denotes that the prospects for the trade are weak.

*Source:* Krishnaswamy et al. (2006).

## Opportunities for Trade in the Eastern Energy Market

Rapid increase in the peak power demand of India (from 93,255 MW in FY 2006 at an annual rate of about 7 percent through FY 2032) and the country's inability to meet it fully from domestic resources are key drivers for energy trade in the eastern market. Indian policy makers envisage import of hydropower from Bhutan, Nepal, and Myanmar and gas-based power from Bangladesh, as well as import of gas from Myanmar and Bangladesh. Key opportunities for trade in the eastern market include:

- *Hydropower exports from Bhutan*. Bhutan's unexploited hydropower potential exceeds 23,000 MW, and there is a wide shelf of projects from which to choose. Bhutan's power system master plan envisages the construction of six new hydropower projects with a total capacity of 4,484 MW through 2024. The government has also signed an umbrella agreement with the government of India for the preparation of projects and feasibility studies for several hydropower projects and many of the studies are ongoing. Most large Bhutanese projects are run-of-the-river type with little firm energy and with substantial wet season energy. They tend to have high capital costs and modest internal rates of return not likely to be attractive to private investors. However, the evolution of the power-trading market in the Indian grid provides an opportunity for Bhutan to choose the part of India that has a demand pattern matching its supply pattern and marginal costs exceeding its supply cost. Major increase in Bhutan's power exports to India in the medium to long term could materialize, mostly in the context of the continuation of the current financing arrangement under which the Indian government provides a grant to cover 60 percent of the capital cost and soft loans for the remaining 40 percent. Modest increases through medium-sized projects could come through investments by private investors.
- *Hydropower exports from Nepal.* Construction of two 220 kV links between India and Nepal would help increase the modest level of power exchange between the two countries and would also enable many of the privately owned IPPs in Nepal to export their surplus power to India. Nepal's unexploited hydropower potential exceeds 43,000 MW, and it has a large shelf of proposals for run-of-the river and storage projects of large and medium sizes, which have been studied over the last several decades. They have not made much progress, as intergovernmental agreements were not easy to reach. The situation has dramatically changed with the emergence of private-sector investors with keen interest in investing in Nepal projects for exports to India. The government has recently invited RFPs to participate in three hydropower projects (Upper Karnali, Arun III, Buri Gandaki) totaling about 1,300 MW, and several major Indian investors—some, in collaboration with international investors—have responded. The current focus on the simpler run-of-the-river projects needs to shift to storage hydropower projects to realize better values in the Indian market. In this context, it is heartening to note that after efforts lasting over 12 years, the 750 MW West Seti storage hydropower project, sponsored by SMEC of Australia, appears likely to achieve financial closure in the next few months with equity participation from Australian, Chinese, Indian, and Nepalese investors and debt substantially from China. Ninety percent of the electricity output (2,970 GWh) had already been contracted for export to India at a price of 4.95 cents/kWh.
- *Grid interconnections*. Interconnection of the grids of India, Nepal, Bhutan, and Bangladesh through the junction of their borders has been shown by studies to be beneficial for all four parties to improve the reliability of their systems. Similar benefits are expected from the proposed interconnection between the Indian and Sri Lankan grid across the sea, for which preliminary intergovernmental agreement has recently been reached.
- *Export of hydropower from Myanmar.* Myanmar has unexploited hydro potential of about 39,000 MW and is developing about 10,400 MW of new capacity through joint ventures with Thai and Chinese businessmen and utilities mainly for export of power to Thailand. Indian and Myanmar governments have a history of cooperation in designing and building hydropower projects in Myanmar and are again collaborating in the design and formulation of Tamanti

multipurpose project located near the Indian border, initially with a power component of 1,200 MW, essentially for export to India. This is likely to be developed as a joint venture between Myanmar and Indian power entities.

- *Power and gas exports from Bangladesh*. Several proposals have been made by public and private sector entities of India and other countries for establishing large gas-fired combined cycle power projects in Bangladesh mainly for export to India, but perceived uncertainties about the volume of gas reserves in Bangladesh have led its government to hesitate to concur. Recent discoveries and development of coal in Bangladesh and the expected changes in the political condition of the country could perhaps lead to an early concurrence. Most observers believe that Bangladesh has abundant gas reserves, with the potential for significant gas exports to India. However the Bangladesh government is not yet fully convinced about the adequacy of its reserves.
- *Gas exports from Myanmar*. ONGC and GAIL of India have invested in successful gas exploration in two blocks in Myanmar. In order to transport gas from those blocks to India, they have designed alternative gas pipelines from Myanmar off-shore fields to India—one passing through Bangladesh and other bypassing that country. Depending on the outcome of discussions with Bangladesh, one of these pipelines is expected to be selected. Meanwhile, the government is also considering piping gas to China and exporting gas as LNG. Final decisions would be taken after the evaluation of the reserves in both the blocks during the next several months.

The overall prospects for energy trade in the eastern energy market are summarized in Table ES 2.

## What the Governments Need to Do to Promote Energy Trade

As noted earlier, trade is a corollary to the availability of opportunities for arbitrage. Energy trade can take place even under the *current circumstances* and under a wide range of sector policies, structures, and conditions and their levels of development and sophistication. The regional governments should make use of the political consensus on the need for developing regional energy trade, in the light of the strong commitment expressed at the highest levels at the recent SAARC conference (April 2007) and SAARC energy ministers' meeting (March 2007).

Some of the trade opportunities described in the earlier sections should be within reach. Based on their state of preparation, the priority deals for such immediate action would include: (1) Central Asia–South Asia (CA–SA) 1,000 MW electricity trade project; (2) West Seti hydropower project in Nepal; (3) Iran–Pakistan–India gas pipeline project; (4) strengthening transmission interconnections between Nepal and India; and (5) the *four-borders* transmission interconnections linking the power systems of India, Bangladesh, Bhutan, and Nepal. These projects could jump-start regional energy trade and lead the way for more active regional cooperation whose benefits would spill over into other economic areas.

Although these and possibly other energy trade projects could be implemented under the current circumstances, to facilitate a more vigorous pursuit of regional trade opportunities, the governments may have to focus in the *near term* on a number of measures:

- Articulate further and strengthen the public support for the emerging policy approach of treating energy imports as enhancing energy security in the major importing countries such as India, Pakistan, and Bangladesh and treating energy exports as driving rapid economic growth in the exporting and transit countries.

| Table ES 2 | Summary of the Trade Prospects in the Eastern Energy Market | | | | | |
|---|---|---|---|---|---|---|
| Importing Countries | Exporting Countries | | | | | |
| | India | Bhutan | Nepal | Bangladesh | Sri Lanka | Myanmar |
| India | x | Significant quantities of hydropower (H) | Significant hydropower export possible | Significant amounts of gas or power possible; some resource uncertainty | Some peak power support possible | Significant gas and power supply possible |
| Bhutan | Dry season support | x | Unlikely; similarity of resources and seasonal shortages | Small amounts of thermal power and gas; connection via India (L) | No scope | Unlikely (far off; too small market) |
| Nepal | Thermal power support. Dry season support | Unlikely. Similarity of resources and seasonal shortages | x | Small amounts of thermal power and gas; connection via India (L) | No scope | Unlikely |
| Bangladesh | Sharing reserves; electricity swaps | Some hydropower; connection via India (L) | Some hydropower; connection via India (L) | x | No scope | Unlikely (although some potential in hydropower) |
| Sri Lanka | Dry season and thermal power support | Unlikely (far off) | Unlikely (far off) | Unlikely (far off) | x | Unlikely (far off) |
| Myanmar | No scope | Uncompetitive | Uncompetitive | Uncompetitive | No scope | x |

*Note:* Dark gray color denotes that trade prospects are significant and are either being exploited or can be brought to fruition in the short-to-medium term. Medium purple color denotes that prospects of the trade are good and may materialize in the medium term. Light gray color denotes that prospects for the trade are more limited and may materialize in the medium-to-long term, and light purple color denotes that the prospects for the trade are weak.
*Source:* Krishnaswamy et al. (2006).

- Encourage both national and international private sector to play a major role in the form PPP structures in cross-border investments on export projects, as they have better credibility and are perceived as more neutral than pure state-ownership-based arrangements.
- Subscribe to, and become members of, the Energy Charter Treaty, as Pakistan has done, in order to place the cross-border energy trade on a firmer multilateral footing in relation to investment protection, regulate cross-border energy infrastructure and flows, provide additional comfort and confidence to all participants, and minimize the political risks to prospective investors.
- Reduce political tensions within and across the countries, with special attention to the integrity of transit countries (such as Afghanistan) and the viability and operational stability of their energy systems. Trade flourishes under peaceful conditions.

- Adopt a sustainable commercial approach to trade (rather than a political ad hoc approach), and use standard commercial contracts that allocate risks fairly. Let the private investors and market forces play a major role in actual buying and selling.
- Create the capacity in smaller economies such as Afghanistan, Bangladesh, Kyrgyzstan, Nepal, and Tajikistan to prepare, negotiate, monitor, and enforce such commercial contracts. Solvent and regulated energy traders may have a very useful role to play.
- Keep the price expectations realistic based on reliable market signals and ensure that both the buyer and seller see advantage in the trade.
- Let the momentum of political commitment built by the recent SAARC summit drive the prioritized available opportunities toward the conclusion of inter-governmental agreements and trade contracts.

To sustain and expand energy trade and minimize trade risks and to enable the evolution of a more integrated and more efficient regional energy market in the *medium to long term*, governments need to deepen and advance sector reforms aimed at creating appropriate sector structures, financially viable entities, and an environment of predictable and neutral regulation. The governments may have to focus on the following initiatives:

- Review and reoptimize the least-cost power and gas development plans of the individual countries, with energy trade as an explicit option to meet part of the demand, minimize carbon emission, and identify on the basis of such re-optimization priority regional energy projects to be constructed and operated.
- Carry out detailed feasibility studies, among other things, to quantify trade benefits and to proceed with implementation.
- Construct the essential transmission links to move the imported energy to the demand centers—including the essential trans-border links—and facilitate the technical coordination of interconnected systems and harmonization of grid codes and operational practices. Make the best use of the Energy Working Group of SAARC and its Energy Center, securing for this purpose technical assistance and cooperation with UCTE, if needed. The same forum could be used to harmonize the regulatory practice and the evolution of a regional regulatory body.
- Complete the ongoing energy sector restructuring process, especially in separating the transmission systems (from generation and distribution) and ensuring their open access and enabling the evolution of national energy markets in which the buyers (distribution entities, large consumers and energy traders), could choose their suppliers and negotiate contracts with them. India's lead in the power sector in this regard is noteworthy. Similar reforms in the gas sector are urgently needed in India, Pakistan, and Bangladesh.
- Improve the operational and commercial efficiency and financial viability of the distribution entities through enterprise reform, among other things, making the best use of technology such as remote/smart metering and GPS technologies and through privatization/concessions.
- Adjust tariffs and cross subsidies to enable financial sustainability of the sector and to shift subsidies from the utility to state budgets and to evolve sustainable and targeted social protection schemes. This needs to be done both in exporting and importing countries to sustain trade.
- Make the best efforts to conclude international river basin agreements on a priority basis, because storage hydropower projects are badly needed in the region to provide firm power and meet peak demands. These agreements, which have a broader focus than mere power generation, have to take into account the concepts of benefit sharing and the imperatives of global concerns such as climate change and the need to adopt low-carbon strategies and the regional concerns such as integrated river basin management involving the regional optimization of the use of water and primary energy resources.

## Possible Role for Multilateral and Bilateral Development Partners

Neutral parties such as the International Financing Institutions (IFIs) and their development partners have the significant role of an honest broker in facilitating cross-border investments for export and associated trading arrangements. A World Bank study (2004) identified the electricity export potential of Central Asia and demonstrated that export of power from Central to South Asia would be a win-win situation for both parties. This led to the relevant four countries coming together and pursuing the 1,000 MW export project with the help of WB, ADB, and other development partners.

The multilateral agencies have a key role in the structuring of PPP type projects and their financing arrangements, and also in devising ways for mitigating a wide range of risks faced in such projects based on their worldwide experience. They could help the smaller low-income exporting countries to participate with some equity in the PPP arrangements. The presence of multilateral agencies in the project as equity holders and lenders (even with small amounts) discourages the parties from nonperformance of contract obligations and thus provides a source of major comfort for both parties. They can also use their guarantee instruments to reduce a range of investor risk. MIGA could tailor transit-country political risk cover to suit the needs of the project. Partial credit guarantees could extend effectively the maturity of debts and improve the cash flow of the projects.

The multilateral agencies could use their lending and nonlending services to do the following:

- Build capacity in the governments and the public- and private-sector energy entities of smaller economies such as Nepal, Bangladesh, and Sri Lanka to negotiate, implement, monitor, and enforce energy export contracts.
- Promote the separation of the transmission (from generation and distribution) and its operation under an open-access regime.
- Help expand the interregional transmission capacity in large markets such as India, Pakistan, and Bangladesh, and promote the evolution of national markets.
- Help the regulatory regimes to mature.
- Encourage pricing reforms and support the enterprise reform and privatization of distribution entities.
- Help SAARC Energy Working Group and its Energy Center to secure UCTE or other suitable assistance for technical coordination of regional power systems and also to develop regional regulatory oversight of the interconnected grids.

The multilateral and bilateral agencies need to give adequate priority to regional trade initiatives in their assistance strategies and need to fully coordinate among themselves to improve the synergy of their operations. The regional trade agenda should be appropriately integrated into the country strategies and country programs. Regional energy projects, as a rule, have higher risk profiles and may benefit from the involvement of the international agencies, which have complementary instruments that can collectively cover a wider range of risks, as well as help spread the risk over a large number of participants.

Reduction of political tension is usually considered a key requirement for cross-border investment and trade. Conversely, the world experience appears to demonstrate that cross-border investments and trade and associated business interests help to lower political tensions. Entrepreneurial investment initiatives with imaginative financing and risk mitigation strategies—possibly with the involvement of multilateral financing institutions in some projects as neutral parties to help build the confidence and mitigate risks—could help to start and strengthen the virtuous circle of trade growth and regional peace.

India, with its geographic position and the size and the buoyancy of its economy, plays a unique and critical role in regional integration in South Asia, including in the energy sector. Bilateral energy trade between India and its neighbors is a key building block of the integrated regional energy market. Although it would be useful and perhaps necessary to develop an upfront understanding at the regional (SAARC) level as to how such regionwide energy systems (regional electricity and gas grids) and trade could evolve, the pace of regional integration will be in large part determined by the pace of development of energy trade with India, especially on the eastern side of the region. In this context, it is very encouraging to see the reforms that are taking place in the Indian energy sector and the efforts that India is taking to strengthen its domestic electricity transmission grid. It is also encouraging to see that similar reforms are either under way or being planned in other countries in the region. This, with increased political consensus among the countries on the need to encourage regional integration in general, and regional energy trade in particular, should bode well for development of regional energy trade.

# 1 Introduction

## Context

This report seeks to review the potential and prospects for regional trade in the electricity sector in the South Asia Region (SAR), which—for the purpose of the report—includes Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka.[1] Geographically, the region is bordered by the Himalayas in the north, the Baluchistan Desert on the west, and a chain of mountains toward Myanmar on the east. Politically, the region borders with Iran and the three Central Asian states—Turkmenistan, Uzbekistan, and Tajikistan—on the west, with China on the north, and with Myanmar on the east.

India accounts for about 75 percent of the population and 64 percent of land area of the region. It shares common borders with all other countries in the region, except Afghanistan. Bangladesh, India, and Pakistan make up 95 percent of the region's population and GDP.

The region has a population of nearly 1.5 billion people (or about 23 percent of the world population), but a combined GDP of only US$996 billion in 2005 (or less than 3 percent of the world GDP). Although the region faced low rates of economic growth from 1950 to the late 1980s, largely on account of the pursuit of inward-looking import substitution strategies, it has experienced dynamic growth rates averaging 5.5 percent a year during the last two decades. Outward-looking, export-oriented reforms and liberalized trade, exchange rate, and investment regimes have accelerated growth rates (especially in the services sector) in the recent years. In 2005, the region registered a GDP growth rate of 8.1 percent. It is now one of the fastest-growing regions in the world, with India targeting annual growth rates of 10 percent and with the growth rates of Bangladesh and Pakistan exceeding 7 percent. Such buoyancy in growth is expected to continue through 2015, leading to the halving of the regional poverty levels.

Such economic growth was driven by global rather than regional economic integration. Adverse factors such as the long-standing dispute over Kashmir between India and Pakistan, internal political instabilities in Afghanistan, Nepal, and Sri Lanka, and other political problems had overshadowed favorable factors such as geographic contiguity and shared languages, culture, and history of the countries in the region, and inhibited the growth of regional trade.[2] Such a lack of regional trade is much more conspicuous in the networked energy subsectors (such as electricity and natural gas), since the necessary prerequisites such as electrical interconnections and natural gas pipelines across borders are practically nonexistent or are limited to only a few instances. The situation of energy trade between the region and its immediate neighbors is not very different from that of the intraregional trade.

[1] Maldives, which also belongs in the SAR group of countries, is not considered in this report, given its geographic position that rules out electricity interconnections with other countries.

[2] The intraregional trade in South Asia was only about 2 percent of its GDP, compared to more than 20 percent in East Asia in 2005.

Per capita income (based on World Bank Atlas methodology) in the region was still less than $700 in 2005, and lack of investment resources and institutional constraints have resulted in supply constrained energy systems.[3] In order to sustain dynamic growth rates in the medium to long term, growth has to be broad-based, covering industrial production and productivity. For this, lack of adequate infrastructure—especially in the energy sector—is proving a significant constraint.[4]

Securing adequate energy supply, thus, is one of the most important challenges facing most of the SAR countries, increasingly so, as their own significantly increasing energy demand growth is matched by neighboring countries such as China. Although an adequate supply of coal and oil requires active participation in the *global* coal and oil markets, *regional* energy trade, especially in electricity and natural gas, is an important untapped resource that could be exploited to ensure energy security of the energy importing countries or add to economic development of those with energy export potential, offering win-win opportunities for all countries involved.

There are pronounced differences in energy resource endowments and energy consumption needs among the countries of the region and its neighbors. Nepal and Bhutan have hydropower potential far in excess of their domestic needs. Bangladesh and Myanmar are considered to have substantial reserves of natural gas that could be exported either as fuel and/or developed to generate electric power for export. India, Pakistan, and to some extent Bangladesh provide major electricity and gas markets with considerable and growing demand. Further to the west and north, Iran holds significant oil and gas reserves, as do the Central Asian Republics—Turkmenistan (gas), Uzbekistan (oil and gas), and Kazakhstan (coal, oil, and gas). Tajikistan and the Kyrgyz Republic have large, untapped hydropower resources relative to their needs, which could potentially be developed into competitive regional power plants. From the point of view of the energy resource endowments and energy markets, prima facie there appears to be a significant potential for electricity and gas trade within the region and with its neighbors on the east and the west.

The governments in the region are becoming increasingly aware of this potential and the win-win opportunities it offers. Modest bilateral electricity trade had been taking place between Nepal and India, Iran and Pakistan, and Afghanistan and its Central Asian neighbors, as well as Iran. India had financed three medium to large hydropower projects in Bhutan, dedicated for power exports to India. Pakistan, and Afghanistan are actively pursuing the possibility of importing 1,000 MW of power from Tajikistan and Kyrgyz Republic. Similar initiatives with respect to gas imports from Central Asia and Iran are being discussed. Regional energy trade is a priority item in the Economic Cooperation Organization (ECO), as evidenced by the discussions in regional meetings.[5] Similarly, energy trade within South Asia has been highlighted during the annual summit meetings of the South Asian Association for Regional Cooperation (SAARC) and related bilateral and regional meetings.[6] In 2004, the seven countries agreed to create a South Asia Free Trade Area (SAFTA), which came into

[3] For example Pakistan, Bangladesh, and Russia have comparable populations, while the power-generation capacity of Pakistan at about 19,000 MW is about 10 percent of that of Russia. The generation capacity of Bangladesh at 5,500 MW is less than 3 percent of that of Russia.

[4] Business surveys indicate that most responding firms have identified poor energy services as the most significant business constraint.

[5] ECO (Economic Cooperation Organization) was created in 1985, first including Iran, Turkey, and Pakistan. The other seven members—Afghanistan, Azerbaijan, Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan—were added in 1992.

[6] SAARC (South Asian Association for Regional Cooperation) includes Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka and, since 2005, also Afghanistan. The Islamabad Declaration of the SAARC Summit states: "A study on creating a South Asia Energy Cooperation including the concept of an Energy Ring should be undertaken by the Working Group on Energy."

existence on January 1, 2006. SAFTA aims to reduce tariffs and other trade barriers to promote regional trade among member countries. Energy ministers representing SAARC countries have endorsed the concept that regional energy trade is a key element in ensuring energy security. The region appears to be poised for exploiting the latent energy trade potential.

## Objectives and Scope

In this context, the current study of the potential and prospects for energy trade in the region is considered timely. Its objective is to highlight the opportunities for increasing cross-border energy trade, examine the factors that have inhibited such trade so far, take note of the emerging factors in the region that are conducive to such trade, and identify the conditions that are necessary for increased regional cooperation in energy trade and investment.

The report is essentially a desk study, based on the readily available materials produced by the Bank and other aid agencies in the course of their operations. Its main focus is on electricity trade, but it also deals briefly with natural gas trade by pipeline, which, in addition to being a relevant element of regional energy trade in its own right, holds particular significance in conjunction with electricity trade, given the trade-off between transporting natural gas and transmitting electricity generated using natural gas (see Box.1.1).

The main report covers the following objectives:

- Review the resource base, existing sector status and current level of energy trade;
- Analyze the factors inhibiting trade and emerging factors conducive to future trade in the potential importing, exporting and transit countries;
- Identify and prioritize emerging regional energy trade opportunities;
- Discuss the priority actions and initiatives that the governments need to take to promote regional trade; and
- Outline the role of international financial institutions (IFIs) and the aid community in facilitating regional energy trade and related investments.

Country profiles for each of the seven countries in the region were prepared by the World Bank staff on the basis of the reports and documents available in the Bank, reports produced by national institutions and authorities and also taking into account major studies and reports prepared by other IFIs and donors.[7] Much of the information used here is based on these country profiles.

[7] For example see "Regional Electricity Export Potential in Central Asia," November 2004, of the ECA region of the Bank. It deals with export potential of the Central Asian Republics (Kazakhstan, Kyrgyz Republic, Tajikistan, and Uzbekistan) and analyzes electricity markets in the neighboring countries (Afghanistan, China, Iran, Pakistan, and Russia). Bank's other work, such as on the India–Nepal hydropower trade, has provided important inputs, as has the work performed by USAID (under the South Asia Regional Initiative–SARI), ADB, and IsDB, as well as by other bilateral and multilateral agencies involved in the region's energy sector (JBIC, DfID, EU).

### Box 1.1 Electricity and Gas Transport Alternatives

Gas transport by pipeline is considered economic in relation to gas transport as LNG up to distances of about 3,500 km. Further, pipeline option confers greater supply security to the importer, since it is not easy for the exporter to shift the pipeline to some other country, which offers a better price. However the choice between import of gas by pipeline and import of electricity produced at the wellheads using gas is not always straightforward.

If at the importing end gas has multiple uses (such as electricity generation, industrial and domestic use, and fertilizer production, etc.), then clearly gas transport by pipeline is the only solution. If, however, at the importing end the only use for gas is for electricity generation, comparative studies indicate that generating gas at the wellhead and transmitting power through HVDC lines to load centers as far away as 1,000 km to 5,000 km is less expensive than transporting gas to the load center and generating power at the load centers.[8] This is especially true with respect to small gas fields located far away from the load centers.

The choice between the two options is influenced by gas prices, gas volumes for transport, the distances, and the various risks, including security. Gas pipelines have major economies of scale for carrying large volumes of energy. As a rule of thumb, gas pipelines tend to be more economic for distances greater than 1,000 km and volumes above 5 to 10 bcm of gas. In a recent study titled "Study of Electricity Trade Potential in the Black Sea Region," carried out for the World Bank in 2006, consultants found that for distances of 1,000 km and volumes below 5,000 MW (about 7 bcm of gas/year), electricity transmission is more economic. For larger volumes such as 13,000 MW (or 16 to 18 bcm/year) gas pipelines are more economic even at distances of 500 km and became even more so for longer distances.

However in the South Asian energy trade environment, cases requiring a choice of this kind are unlikely to arise. In India and Pakistan, there are severe shortages of both electricity and gas, and gas is required for multiple uses. Currently, import of electricity options focus on low-cost hydropower from Central Asia and India's neighbors such as Nepal, Bhutan, and Myanmar. Hydropower imports confer also significant environmental advantages from the point of low carbon strategy. When thermal power imports develop from Central Asia to South Asia, they are most likely to be from low-cost coal-fired power stations of Kazakhstan and Kyrgyzstan, and such power, in conjunction with the seasonal hydropower, will enable Central Asia to supply "firm power" and improve their export value.

[8] See Alessandro Clerici and Andrea Longhi, "Competitive transmission systems as alternative to pipeline gas transport for electricity delivery," World Energy Council available at http://www.worldenergy.org/wec-geis/publications/default/tech_papers/17th_congress/2_2_08.

*Source:* Krishnaswamy et al. (2006)

# 2 Status of the Electricity Sector and Trade

## Electricity Sector Dimensions

The South Asian region consists of low-income developing economies, growing at a rapid rate. The GDP elasticity of electricity demand in such economies tends to be higher than 1, with electricity demand growing at rates faster than the economic growth rate. In addition, unlike in the case of Central Asian states, the extent of electrification, both in terms of geographical coverage and in terms of the population coverage, has still a long way to go to reach 100 percent. Given the constraints relating to financial resource and institutional capacity, supply growth tends to lag behind the demand growth, resulting in the operation of supply-constrained electricity systems. While the per capita consumption of electricity is very low by world standards, electricity consumption for each dollar of GDP tends to be high.

In 2003, for example, the region had 23 percent of the world population, but produced only 2.1 percent of the world GDP. Its per capita gross national income (GNI), at $524, was less than 10 percent of the world average ($5,552). The region produced only about 4 percent of the world's electricity, while the average annual electricity consumption per capita at 394 kWh was only one-sixth of the world average (2,348 kWh) (see Table 2.1).

**Table 2.1** South Asia: Select Economic and Energy Indicators

| Country | Population (million) | Land Area (square km, in 000s) | GDP ($billion) | GNI per Capita ($) | Electricity Consumption at the Generation Level TWh (year) | Per Capita Annual Electricity Consumption (kWh) | Overall Energy Use per Capita (kgoe) |
|---|---|---|---|---|---|---|---|
| Afghanistan | 30 | 652 | 4.6 | n/a | 1.59 (2005) | 53 | n/a |
| Bangladesh | 137 | 144 | 51.9 | 400 | 21.14 (2004) | 128 | 159 |
| Bhutan | 1 | 47 | 0.6 | 720 | 0.67 (FY04) | 665 | n/a |
| India | 1,064 | 3,287 | 600.6 | 540 | 540.74 (FY03) | 425 | 520 |
| Nepal | 20 | 147 | 5.9 | 230 | 2.26 (FY03) | 68 | 336 |
| Pakistan | 148 | 796 | 82.4 | 520 | 76.66 (FY04) | 408 | 467 |
| Sri Lanka | 19 | 66 | 18.2 | 930 | 7.66 (2004) | 325 | 421 |
| Total SAR | 1,425 | 5,139 | 764.2 | 524 | 650.72 | 457 | 474 |
| Total World | 6,290 | 133,941 | 36,835.2 | 5,552 | 15,852.41 | 2,348 | 1,734 |

*Notes:* (1) All data are from World Development Indicators for 2003 unless otherwise indicated. (2) Electricity consumption data are from country profiles. World consumption is from US DOE/EIA database. (3) Electricity consumption is given at the generation level (4) GNI per capita is on the basis of World Bank Atlas methodology.

*Source:* Krishnaswamy (2006).

The region had a total installed capacity of about 152 GW, of which about 27 percent (or 41.6 GW) was hydroelectric subject to highly fluctuating seasonal and annual water flows. The availability of a substantial portion of the thermal power capacities was somewhat low on account of age of some of the units and problems arising from the use of poor-quality coal with high ash and low calorific value. Although Pakistan has been having some surplus capacity during the last few years, most other countries (and notably India) have suffered from capacity and energy shortages arising from inadequate generation capacity, network problems, fuel-related problems, or lower than anticipated water flows in hydropower facilities. The overall regional load factor at 74 percent is high, but is still only partially indicative of the suppressed demand situation (see Table 2.2).

Under the severely supply-constrained situation, demand growth can only follow the growth in supply capacity. Within this limitation, demand for electricity at the generation level had been growing in the range of 5 percent to 11 percent during the last several years, but is expected to grow at a faster rate in the range of 6.6 percent to 11.5 percent in the next 15 to 20 years, if supply growth can keep pace. In most cases, this is based on GDP growth forecasts and the associated GDP elasticity of electricity demand.

To meet a demand growth of this order, substantial investments need to be made in generation, transmission, and distribution facilities. The various options to increase the level of electricity supply include: (1) reducing the high level of technical and nontechnical losses in the power systems; (2) rehabilitating the existing assets to restore their original capacity and prolong their useful lives; (3) increasing the transfer capacities in the national backbone transmission systems to enable better utilization of the existing generation capacities; and (4) constructing new generation assets. Imports from the countries within the region and from neighboring power and gas systems had remained on the back burner until recently—largely on account of the pursuit of national self-sufficiency objectives—but lately this option has been discussed in national and regional policy circles with some enthusiasm.

The energy resource endowments of the countries in the region and those of the region's neighbors in the east and the west would be a major set of determinants in the consideration of policy options based on intra and interregional trade. This aspect is addressed in the following section.

## Resource Endowments

The energy resource endowments of the region and its neighbors are substantial, but are unevenly distributed among countries. This makes energy trade among them, prima facie, desirable for deriving optimum benefits from such a resource base. Readily available information on the energy resources of the region is summarized in Table 2.1.

India and Pakistan have considerable energy resources by way of hydropower potential, coal, and natural gas, but these are considered inadequate to meet the rapidly growing demand for the energy requirements of their large economies. Bhutan and Nepal have hydropower resources far in excess of the possible requirements of their modest power systems and economies, and only a very small percentage of these resources have so far been developed. Investments in most of the identified large potential hydropower projects in Nepal (e.g., Karnauli, Pancheshwar, Sapta Koshi and West Seti) and Bhutan (e.g., Tala and Punatsangchu) would make sense only in the context of export of power to India and possibly to Bangladesh (see Table 2.3).

Bangladesh is widely believed to have very substantial natural gas reserves. Recent studies by U.S. Geological Survey concluded that the country has undiscovered reserves of 935 bcm (32.1 tcf) and that on this basis has a reserves-to-production ratio of more than 104 years. The country may thus have a notable potential for export of gas or export of power generated using the gas.

The energy resource endowments of the neighbors of the region—Myanmar, in the east and the Central Asian Republics and Iran in the

**Table 2.2** South Asia: Select Indicators of Electricity Sector Dimensions

| Country | Installed Generation Capacity (MW) | Peak Demand (MW) | Electricity Generation (GWh) | Imports and or Exports (GWh) | Past Annual Demand Growth Rate (%) | Forecast Annual Demand Growth Rate (%) | Access to Electricity |
|---|---|---|---|---|---|---|---|
| **Afghanistan** | Total 475 MW (of which hydro is 261 MW). Available capacity 270 MW | 215 MW (Suppressed Demand) 363 MW (Unsuppressed demand estimate) | 839 GWh | 323 GWh import | n/a | 6.6% through 2020 | 26% of the population |
| **Bangladesh** | Total 4,120 MW (hydro 218 MW ) | 3,592 MW (FY 2005) | 21,162 GWh (FY 2005) | None | 9% (1996–2003) | About 8.2% per year through 2020 | 38% by area and 20% by population |
| **Bhutan** | Total 481 MW (hydro 469 MW) | 105 MW (2003) | 2,355 GWh (FY 2005) | Imports 25 GWh Exports 1764 GWh | 7.3% (FY 1998 to FY 2003) | 11.5% through 2012 | 40% of the population |
| **India** | Total 124,287 MW (hydro 32,300 MW) | 93,255 MW (FY 2006) actual peak demand met: 81,792 MW | 617,510 GWh (FY 2006) | Imports 1764 GWh (Bhutan) export 241 GWh (to Nepal) | 4.2% during FY 2000 to FY 2004. | 6.7% to 7.5% through 2032 | 55.8% of the households (census of 2001) |
| **Nepal** | Total 684 MW (hydro 627 MW) | 557 MW (FY 2005) | 2,643 GWh (FY 2005) | Import 241 GWh export 111 GWh | 11% FY 1997 to FY 2005 | 7.6% through FY 2020 | 40% of households (2001 census) |
| **Pakistan** | Total 19,505 MW (hydro 6,500 MW) | 14,091 MW (FY 2005) | 87,114 GWh (FY 2005) | Import 25 MW (from Iran) | About 5% (FY 1994–FY 2003) | 7.9% through 2025 | 55% to 60% of the population |
| **Sri Lanka** | Total 2,426 MW (hydro 1,247 MW) | 1,516 MW (2003) | 7,662 GWh (2003) | None | 5.1% 1999 to 2003 | 7.8% through 2024 | 73.4% of the population |
| **Region** | Total 151,978 MW (hydro 41,622 MW) | 113,479 MW | 739,285 GWh | | | | |

*Note:* (1) Source mostly country profiles and updated data from utility web sites. (2) It is estimated by the CEA that India had a capacity shortage of 12.3% and energy shortage of 8.4% in FY 2006.(3) Since data may relate to different years for the member countries, the regional totals, while not accurate, are indicative of the order of magnitude. (4) Regional peak demand is an arithmetical total of the peak demand of the countries and thus may tend to overstate the peak demand.

**Table 2.3** Energy Resource Endowments of the Region

| Country | Oil Reserves (Mt) | Oil Production (Mt/y) | Gas Reserves (bcm) | Gas Production (bcm/y) | Coal Reserves (Gt) | Coal Production (Mt/y) | Hydropower Potential (MW) | Hydropower Developed (MW) |
|---|---|---|---|---|---|---|---|---|
| **Afghanistan** | 10–15/ 100 | 0.025 | 28.3/142 | 0.114 | 0.1 | 0.044 | 745 | 262 |
| **Bangladesh** | 7.8 | 0.340 | 580/810 | 13.8 | 2.2 | n/a | 755 | 230 |
| **Bhutan** | 0 | 0 | 0 | 0 | 0 | 0 | 23,760/ 30,000 | 468 |
| **India** | 786 (2005) | 33.000 | 948 | 32.680 | 25/285 | 409.000 | 84,000/ 150,000 | 32,300 |
| **Nepal** | 0 | 0 | 0 | 0 | modest | 0 | 43,000/ 83,000 | 600 |
| **Pakistan** | 105 | 3.100 | 1,300/570 0 | 28.000 | 185 | 3.300 | 54,000 | 6,500 |
| **Sri Lanka** | 14–18 | 0 | 0 | 0 | 0 | 0 | 9,100 | 1,250 |

*Notes:* (1) Under Oil and Gas reserves, proven / probable reserves are shown where available. Under hydro, economically viable potentials / technical potential are shown. (2) Production data relate to the most recent year data available during 2003 to 2005. (3) With the commissioning of all units of Tala hydropower project, hydro capacity developed in Bhutan will soon be 1,488 MW in 2006. Coal data include lignite.

*Source:* World Bank documents.

| Table 2.4 | Energy Resource Endowment of the Region's Neighboring Countries | | | |
|---|---|---|---|---|
| **Country** | **Oil** | **Natural Gas** | **Coal** | **Hydropower** |
| **Kazakhstan** | Reserves: 29 billion bbl Production: 1.3 million bbl/day | Reserves: 65 to 70 trillion cubic feet (tcf) Production: 0.570 tcf/yr | Reserves: 37.5 billion tons Production: 95 million tons (2004) | Potential: 20,000 MW Developed: 2,000 MW |
| **Turkmenistan** | Reserves: 546 million bbl Production: 260,000 bbl/day | Reserves: 71 tcf Production: 2.1 tcf/year | Modest or negligible | Potential: Modest |
| **Uzbekistan** | Reserves: 594 million bbl[9] Production: 150,000 bbl/day | Reserves: 66.2 tcf Production: 2.07 tcf/year | Reserves: 4 billion tons Production: 2.8 million tons | Potential: Modest Developed: 1,700 MW |
| **Tajikistan** | Modest or negligible endowment | Modest or negligible endowment | Reserves: 3.6 billion tons Production: 32,000 tons (2002) | Potential: 40,000 MW Developed: 4,000 MW |
| **Kyrgyz Republic** | Modest or negligible endowment | Modest or negligible endowment | Reserves: 0.8 billion tons Production: 400,000 tons (2003) | Potential: 26,000 MW Developed: 3,000 MW |
| **Iran** | Reserves: 132.5 billion bbl Production: 4.2 million bbl/day | Reserves: 971 tcf Production: 3.5 tcf/year | Reserves: 461 million tons Production: 1.1 million tons | Potential: 42,000 MW Developed: 2,000 MW |
| **Myanmar** | Reserves: 3.2 billion bbl Production: 7.3 million bbl (During 11 months of 2005 to 2006) | Reserves: 18 tcf Probable: 89.7 tcf Production: 362 bcf (10.53 bcm) Exports: 0.28 tcf (8.06 bcm ) (During 11 months of 2005 to 2006) | Reserves: Modest Production: Modest | Potential: 39,720 MW Developed: 747 MW |

*Source:* World Bank documents and U.S. DOE/EIA Country Briefs.

west—are summarized in Table 2.4. Myanmar and three Central Asian Republics (Kazakhstan, Turkmenistan, and Uzbekistan), as well as Iran, have notable gas or (gas- or coal-based power) export potential, while two Central Asian Republics (Tajikistan and Kyrgyz Republic) have substantial hydropower export potential.

Kazakhstan, Kyrgyz Republic, Tajikistan, and Uzbekistan, which constitute the Central Asian Power System, have a combined generation capacity of 38,000 MW and annual generation in excess of 135 TWh. Their surplus generation is of the order of 11 TWh, occurring mostly in the spring and summer seasons. This annual exportable surplus could increase to 30 TWh in next 5 years and to 50 TWh in the next

[9] An Australian company exploring the Fergana valley area in Uzbekistan believes that area itself may have reserves of 1.2 billion barrels of oil and 5.5 tcf of gas.

10 years if the envisaged investment program is implemented.[10] About 20 percent of this would be available in all seasons of the year.

Turkmenistan has an installed generation capacity of 3,000 MW and annual generation of 12.3 TWh, of which it exported 10.5 percent to Iran, Turkey, and Afghanistan. Iran's own generating capacity is about 34,000 MW, with an annual generation in excess of 149 TWh. Its power system operates in the form of three isolated power systems, which are to be interconnected in the near future. In 2005, Myanmar had a total installed generation capacity of 1,667 MW and annual generation of 6,064 GWh. Its main interest is in finding export markets for its abundant natural gas resources, as well as for hydroelectricity from 10,398 MW of hydropower projects, which are either under development or will be developed during the next 15 years.[11]

The nature of supply-demand situation in the region and the distribution of energy resources in the region and its neighboring countries, prima facie, seem to warrant consideration of electricity trade (both intraregional and interregional) as one of the options to enhance energy security of the countries in the region.

## Existing Interconnections and Electricity Trade

All over the world, interconnection of contiguous electricity grids (with adequate transfer capacity) and electricity trade among them are regarded as enhancing the energy security of the consumers, as they provide for a diversification of energy sources and energy suppliers. Equally, sole or substantial dependence on such imports is regarded as diluting energy security, because of the possibility of supply disruptions. Such interconnections generally lead to several other substantial benefits (see Box 2.1).

### Box 2.1 Benefits of Interconnected and Integrated Operation of Electricity Grids

Apart from enabling the sale of electricity from the surplus to the deficit grids, interconnections and integrated operations[12] of the grids help to accomplish the following:

- Exploit differences in resource endowments and their development and operating costs.
- Exploit differences in seasonal load and supply patterns.
- Pool uncertainties: As demand and supply vary stochastically, the larger the system the smaller the fluctuations arising from imbalance (based on the law of averages). Thus, it helps to improve the reliability of the system (and the load following capability) at a lower cost by ensuring a better balance between hydropower and thermal power units, and among base load, intermediate load, and peak load units.
- Lower the system capital costs by lowering the reserve margins for the given level of system reliability.
- Lower the system operating costs by enabling the substitution of generation from units with high marginal costs of one grid by generation from units in other grids with lower marginal costs.
- Lower emission levels by enabling substitution of generation from units with a high level of emissions/kWh of one grid with generation from units in the other grids with a much lower level of emission/kWh.
- Enable the construction of large hydropower projects, which would make better economic sense in such interconnected grids and the larger markets they provide, than in the smaller individual grids.
- Enable less expensive peak load management, especially when the interconnected grids are located in different time zones with different peak hours.

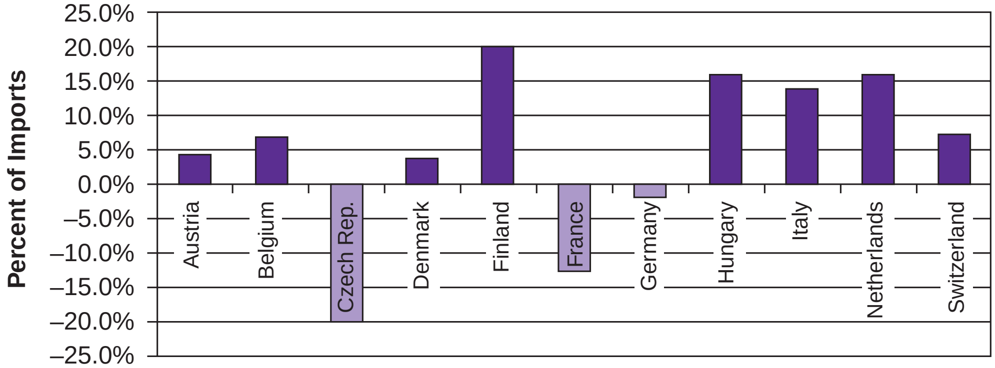
*Source:* Krishnaswamy (2006).

[10] Central Asian Republics: Regional Exports Potential Study, World Bank, December 2004.

[11] See presentation made on behalf of Myanmar in the BIMSTEC conference in New Delhi, India, during October 30–31, 2006. See also News Item "Myanmar, Russia, India to explore gas in Myanmar" in People's Daily Online—http://english.people.com.cn/.

[12] Many of these benefits would accrue only in the case of synchronized and integrated operation of the interconnected grids. This involves the use of common grid codes and common rules of use and procedures designed to optimize the system operation and maximize benefits for the system participants.

**Figure 2.1** Selected European Countries (2005) Imports (+)/Exports (–) as a Percentage of Available Energy




*Source:* www.ucte.org

A well-known example of this worldwide trend of interconnecting contiguous electricity systems and enabling their integrated operation through suitable agreements is the Union for the Coordination of the Transmission of Electricity (UCTE) in Europe, which covers most of the grids of the countries in Western Europe. Many of the Eastern European countries have also recently joined the UCTE, and many others are working toward such membership. In 2004, international exchanges in electricity within UCTE were about 300 TWh. Other notable examples include New Jersey–Delaware–Maryland Power Pool, South African Power Pool, West African Power Pool, Nordic Power Pool, and the Interconnected Electricity Systems of the Six Central American Countries (SIEPAC). In the South East Asia, electricity interconnections exist and electricity trade takes place among Thailand, Laos, Cambodia, Vietnam and the southern provinces of China.

Appendix 1 provides details of such interconnections and energy trading projects. As an example, the level of exports and imports in the European electricity market and in the South African Pool are given above. Figure 2.1 indicates the net annual imports or exports of select European countries as a percentage of their total available power for consumption. Several countries have net imports amounting to 10 to 20 percent of their total consumption. France and Czech Republic export 10 to 20 percent of their available power. These data represent only the net annual exchange, while the actual exchanges during several parts of the day and the year are substantially higher.

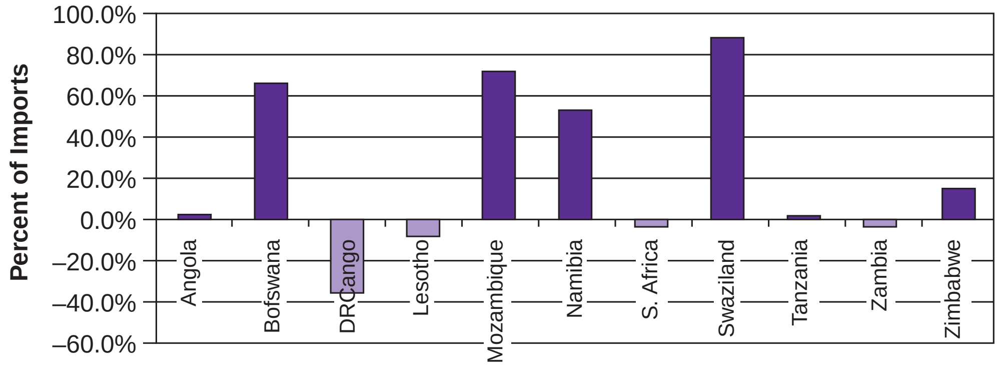
Figure 2.2 provides similar data with respect of the South African Power Pool. Even under economic and political circumstances very different from that of Europe, electricity trade is flourishing in this part of the world, with some member countries making use of imports to the extent of 50 percent to 80 percent of their total annual requirements.

Compared to such wide reliance on electricity trade in the various parts of the world, trade in the South Asian region had so far been modest. The details of the existing interconnections and electricity trade are discussed next.

## Afghanistan

The war-ravaged and fragmented power systems of Afghanistan rely significantly on imports of electricity from Iran, Turkmenistan, Uzbekistan, and Tajikistan. In 2005, such imports amounted to about 27.8 percent of the total supply, and this share is expected to increase with the rehabilitation of the associated transmission links and the construction of the country's backbone transmission system called North-East Transmission System (NETS). The

**Figure 2.2** South Africa Power Pool (2004) Imports (+)/Exports (–) as a Percentage of Available Energy




*Source:* The Website of South African Power Pool, www.sapp,co.zw

details of the existing interconnections and the volume of power imports are summarized in Table 2.5.

## Bhutan

The eastern part of Bhutan is linked to Bongaigon and Rongia of the State of Assam in India by 66 kV and 33kV lines, and the western part of Bhutan is linked to Siliguri in West Bengal state of India by a 220 kV line. Through these lines Bhutan exports a substantial portion of the outputs from the hydropower station at Chuka (336 MW), Kurichu (60 MW), and Basochu (64 MW). The export amounted to 1,764 GWh in FY 2006. Through 11 kV and 33 kV interconnections, Bhutan imports about 25 GWh a year from India. A large new hydropower project (Tala 1,020 MW) has been completed recently, and the first unit of 170 MW had become operational.[13] When all the remaining five units are commissioned during FY 2007, the project will generate 4,865 GWh of energy each year, of which 3,900 MW is destined for exports to India. Two double-circuit 220 kV lines connect the power station to Siliguri in West Bengal from where the construction of a 400 kV double-circuit line (1,200 km long, 3,000 MW transfer capacity) was completed in August 2006 by Powerlinks Transmission Limited, a joint venture between Tata Power and Power Grid Corporation of India (51:49), among other things, to transfer Tala power to the eastern and northern regions of the Indian power system. This will result in the annual export of Bhutan to India rising to about 5,664 GWh in FY 2007.[14]

## Nepal

Nepal's power system is interconnected with the power systems of the states of Uttar Pradesh and Bihar in India by one 132 kV line, eleven 33 kV lines, and one 11 kV line. Most of them have limited transfer capacity and, in FY 2005, Nepal exported to India a total of 110.7 GWh (or about 5.6 percent of its total sales) and imported from India a total of 241.39 GWh (or about 9 percent of its total energy supply).

[13] Chuka, Kurichu and Tala hydropower projects were financed by the Government of India with 60 percent of the cost as grant and 40 percent as long-term debt.

[14] See Pricewaterhouse Coopers of India, *Hydropower Sector Study: Opportunities and Strategic Options,* July 2006 and also the presentation by Powerlinks Transmission Limited in the India Electricity–2006 Conference (Plenary Session III—Transmission), New Delhi on May 12, 2006.

**Table 2.5** Afghanistan: Existing Electricity Interconnections and Imports

| Electricity Interconnection Details | Electricity Imports (GWh) | | |
|---|---|---|---|
| | FY 2005 | FY 2006 | FY 2007 (3 months only) |
| Tajikistan: Geran (Tajikistan) to Kunduz (Afghan) 110 kV single-circuit line, operated at 35 kV on the Afghan side | 28.99 | 39.22 | 23.33 |
| Uzbekistan: Termez (Uzbek) to Khulum (Afghan) and on to Mazar-e-sharif 220 kV line double-circuit operated at 110 kV | 118.18 | 149.71 | 24.18 |
| Turkmenistan: Gushby (Turkmenistan) to Herat (Afghanistan), 120 km, 220 kV single-circuit line completed in May 2004, but operated at 110 kV | 49.27 | 95.63 | 35.39 |
| Turkmenistan: Turkmenistan to Andkhoy-Jawzjan-Sheberghan, 110 kV line in poor condition with high voltage drops | 48.57 | 69.72 | 12.28 |
| Iran: Torbat-e-jam (Iran) to Herat (Afghanistan) 150 km 132 kV double-circuit line commissioned in January 2005. Financed by Iran<br>Iran: Tayyebat (Iran) to Herat 2 x 20 kV single-circuit lines; financed by Iran | 26.72 | 57.85 | 21.48 |
| Iran: Zabol (Iran) to Zaranj (Afghanistan) 20 kV single-circuit opened in March 2004 | 11.55 | 17.99 | 9.52 |
| **Total Imports** | 283.28 | 430.12 | 126.18 |

*Source:* DABM data. FY 2007.

*Notes:* (1) The Fiscal year of Afghanistan ends on March 20. (2) According to the statistics of the Central Dispatch Center of the Central Asian Power System in Tashkent the exports of Uzbekistan to Afghanistan were 33.5 GWh, 129.6 GWh and 148 GWh in the calendar years of 2003, 2004, and 2005. (3) The Tajik power utility reports exports of 10.4 GWh, 27.7 GWh and 39.2 GWh during the calendar years 2003–2005, respectively. In the first 6 months of 2006, the exports amounted to 23.3 GWh.

## Pakistan

Pakistan's electricity imports from Iran serve demand in the country's border areas of Balochistan, which are isolated from the main integrated national electricity grid. One 132 kV single-circuit line and two 20-kV lines provide the cross-border interconnections between the two countries. The maximum allowed supply as per contract of 2002 was 39 MW. Maximum actual import recorded was 25 MW in December 2005. In June 2006, Pakistan's main power utility, WAPDA, signed an MOU with Iranian authorities for increasing the supply maximum to 100 MW to meet the forecast increase in demand in the Gwadar area, where a deep seaport is being constructed with Chinese assistance. For this purpose, a new 170-km-long, 230 kV line is planned. Iran's portion is 70 km and Pakistan's is 100 km.[15]

The power systems of Bangladesh and Sri Lanka have no cross-border power interconnections. Similarly, Pakistan's power system is not interconnected to those of India or Afghanistan. There are also no cross-border gas pipelines in the region.

[15] Presentation made by WAPDA in the Central Asia/South Asia Electricity Trade Conference, May 8–9, 2006, in Islamabad. See also www.gulf-times.com, news item dated June 15, 2006, which among other things indicates that the price agreed for new supplies may have gone up to 6.25 cents/kWh. For the existing supply the price is 5 cents/kWh.

# 3 Factors Inhibiting Trade in the Past

## Political and Security Considerations

A wide range of factors have hitherto inhibited the growth of intraregional and interregional energy trade. The most important among them relate to the political and security situation prevailing in the region and its neighbors. Afghanistan is a key transit country sandwiched between the other South Asian countries on the east (potential markets for the imported energy) and the Central Asian Republics and Iran on the west (potential major energy exporters). The unstable political situation and armed conflicts in that country lasting for over three decades had been a major factor inhibiting energy trade between Central Asia and South Asia. The dispute over Kashmir had soured the relations between India and Pakistan for more than half a century. The political instabilities and circumstances in Nepal, Sri Lanka, Bangladesh, and Myanmar had not provided an environment conducive for the evolution of regional energy trade. Central Asia itself had only recently recovered from the economic decline and political instabilities it faced upon the dissolution of the Soviet Union toward the end of 1980s.

Discussions that began in FY 1999 on the possible export of surplus power from the IPPs in Pakistan to India are believed to have stalled, partly on account of concerns over possible supply disruptions due to political uncertainties.[16] There was a proposal to construct a pipeline through Bangladesh for transporting natural gas from an offshore field in Myanmar (in which two Indian state-owned entities had a 30 percent stake) to India, but it was stalled by Bangladesh's reluctance, largely on political grounds. Proposals for export of gas (or power or fertilizer produced using gas) to India from Bangladesh by several international and Indian investors also did not materialize—again, largely on account of the hesitancy of the Bangladesh government.[17]

## National Policies and Political Mindset

National policies and the political mindset towards the concept of energy security also proved to be major inhibitors of energy trade. Till recently the region followed inward looking import substitution strategies which regarded energy trade as reducing energy security by creating import dependency and by enhancing disruption risks. Macroeconomic policies pursued resulted in a persistent shortage of foreign currency resources which did not allow the countries to think in terms of discretionary imports. On the whole there was a pervasive perception which regarded national self-sufficiency as a synonym for energy security. Energy trade was strictly limited to the inevitable import of oil and oil products only. Despite the serious problems faced by Indian power companies in the use of poor quality domestic coal, import of good quality coal

[16] There were also other concerns, such as price and the ability of IPPs to offer firm and long-term supplies with penalties for failure to supply. Further, the surplus situation in Pakistan was perceived, with some justification, to be temporary, lasting only for a few years.

[17] Also, the government of Bangladesh had concerns about the adequacy of the country's gas reserves to meet domestic demand and export obligations.

from abroad for blending took several decades to materialize. Nepal has the highest average tariff in the region at about 9 cents/kWh and still is unable to cover its cost of supply, mainly on account of its choice to operate a high cost all hydro system, avoiding import of thermal power from India to balance its hydropower system or to encourage the construction of large hydropower plants, which will be cost effective on the basis of export of power to India.

## Infrastructure Constraints

The absence of infrastructure in the region by way of electrical interconnections and gas pipelines across the borders (except in the case of the few interconnections between India and Nepal, India and Bhutan, and between Afghanistan and Central Asia and Iran) is a physical constraint to the energy trade. This is not attributable to any difficult terrain, except perhaps in the border areas between India and China and to a lesser extent between Pakistan and Afghanistan. There is no special geographical reason for lack of interconnections between India and Pakistan or between India and Bangladesh.

Such infrastructure constraints exist even within the large power systems of India, Pakistan, and Bangladesh (the potential markets for imports). Power interconnections and power transfer capacities between the east and west zones of Bangladesh, between the north and the south of Pakistan, and among the five electrical regions of India (northeast, east, west, north, and the south) until recently was inadequate to enable the best utilization of the domestic generation capacities, let alone handling the transport of imported power from one part of the country to another.

After several years of investment, the interregional power transfer capacity in India (a country with an installed capacity of over 124,000 MW) reached 9,450 MW by FY 2006. Similar constraint exists to a great degree in Afghanistan, the major transit country. The main backbone 220 kV double-circuit Northeast Power System (NEPS) is still under construction and will be operational perhaps in a couple of years, as a partial solution to the problem. Within the Central Asian Power System bottlenecks in the national transmission networks have to be eliminated, and links to Afghanistan strengthened to enable trade growth (especially in relation to Uzbek power exports to Afghanistan). Currently, the capacity of the national power systems to coordinate dispatch, maintain voltage and frequency, and keep international flows within the prescribed contract limits and to maintain the stability of the interconnected systems in the region is inadequate to manage large trade flows.

## Poor Operational Efficiency and Lack of Creditworthiness of Utilities

Absence of solvent utilities is a major constraint to trade. Power systems in the region operate in a supply-constrained environment with a level of quality and reliability substantially lower than international utility standards. Load shedding and power outages are common during peak hours and during certain seasons of the year. Electricity utilities are used as vehicles of social policy, and average tariffs are kept substantially lower than supply costs. Households and agricultural consumers are heavily cross-subsidized by industrial and commercial consumers, who pay some of the world's highest prices for a very poor quality of supply. Consequently, theft of power and nonpayment are extensive, and most utilities are not solvent enough to access commercial sources of funds except on the basis of expressed or implied sovereign guarantees. Nonpayment of electricity bills by government entities had been a significant problem.

*Afghanistan* is estimated to have a system loss level of 35 percent to 45 percent of the total available energy (generation plus imports) due to technical losses in the transmission and distribution systems and nontechnical losses arising from theft and poor metering and billing practices. Collection efficiency is estimated at

60 percent to 70 percent of the value of the bills issued. Its average tariff is believed to cover only about 50 percent of the cost of supply.[18]

*Bangladesh* operates a power system with a total system loss level in the range of 20 to 32 percent, and collection efficiency is in the range of 80 percent to 90 percent. Its average tariff at about 5.2 cents/kWh is inadequate to cover the cost of supply, and the key sector entities (BPDB and DESA) are insolvent.[19] Bulk supply tariffs have not kept pace with the average of the cost of generation and the cost of power purchased from the IPPs. The financial losses of the BPDB alone were estimated at $100 million in FY 2005 and may have increased to about $110 million in FY 2006. The accumulated financial losses of BPDP at the end of FY 2006 were about $841 million.[20]

*Bhutan* operates a very small power system in which the system losses are contained at around 13.5 percent. Power supplied to the Bhutan Power Corporation is priced substantially lower than the export price to India. For example, power from Chukka Hydropower Company is sold to India at 4.65 cents/kWh, while the sale price to BPC is around 0.78 cents. Still, BPC makes only marginal cash surplus and makes book losses.

*Nepal* had a total energy loss level of about 25 percent in FY 2005, of which a significant portion is attributed to theft of power. Despite an average tariff of about 9 cents/kWh (which is perhaps the highest in the region), the Nepal Electricity Authority had a net financial loss of about $25.9 million in FY 2005 and faced liquidity problems. Although its collection of bills from other consumers were reasonable at a ratio of about 95 percent, collection from municipalities and other government entities was poor, and arrears mounted to about $20.3 million.

*India* operates a large power system in which the electricity-distribution responsibilities are handled by the government-owned electricity boards in most states.[21] Most of them face high levels of system losses (a substantial part of which is theft of power) and low levels of collection. Also, unmetered supplies are provided to a variety of consumers such as agricultural pump sets and small rural households. Sales on the basis of metering ranged from 70 percent of the total energy input into the system in West Bengal to about 45 percent in Haryana and Rajasthan.

As it is difficult to separately estimate the technical losses and commercial losses under these circumstances, the concept of aggregate technical and commercial losses (ATC losses) is used.[22] In well-run utilities, this should not exceed 10 to 12 percent. In India, ATC losses in 2005 were higher than 40 percent in eleven electricity boards, 30 to 40 percent in seven electricity boards, and 20 to 30 percent in eight electricity boards. Only in two electricity boards (Tamil Nadu and Goa) were the ATC losses less than 20 percent.[23] Tariffs lag substantially behind cost of supply. The Central Electricity Authority of India estimates that the average cost of supply/kWh in FY 2005 was 5.6 cents, while the average revenue/kWh was only 4.62 cents, or about 82.5 percent of the cost of supply.[24] The total losses made by all electricity boards in FY 2005 amounted to $4.9 billion, or about 1.2 percent of the GDP. Apart from the inadequate level of tariffs, the structure of tariffs is highly skewed in favor of agricultural pumps and household consumers and penalizes

[18] Afghanistan's electricity tariffs have recently been increased substantially.

[19] See The Final Report of the consulting firm Nexant to ADB under T.A No. 4379-BAN Power Sector Development Program II, June 2006.

[20] Based on information in the BPDB web site http://www.bpdb.gov.bd/index.htm.

[21] Provinces in India are called states with their own elected governments and legislatures. India is a Union of such states.

[22] ATC loss = [1 minus (Billing ratio × Collection ratio)], where Billing ratio = Energy input into the system in GWh/ energy billed in GWh and Collection ratio = Energy billed in money terms/ collection in money terms.

[23] See *State Power Sector Performance Ratings, Final Report to the Ministry of Power, Government of India,* June 2006, (prepared by CRISIL and ICRA leading rating agencies of India) available at the web site of the Ministry www.powermin.nic.in.

[24] See *Annual Report of the Central Electricity Authority of India for FY 2005–2006* available at its web site,www.cea.nic.in. The cost of supply is likely to be an underestimate and the gap may actually be wider.

industrial consumers, severely eroding their competitiveness and inducing high levels of theft.

In 2002, the industrial consumers of India had a tariff of 47 cents/kWh, compared to 20 cents in China, 17 cents in Brazil, 12 cents in Japan, 5.5 cents in the United States, and 5 cents in Germany.[25] It is estimated that about $4.5 billion of budget and cross subsidies are channeled through India's power sector, mainly to farmers (who account for 25 percent of total consumption) and households (who account for another 20 percent), with monthly consumption ranging from 50 to 250 kWh. Of this, $2.3 billion came from the budget of the state governments, and the rest came from cross subsidies. In many states, subsidies for power supply exceed public expenditures on health and education.[26]

*Pakistan* also faced significant system losses and financial losses. During the 10 years between FY 1996 and FY 2005, WAPDA's total system losses (including auxiliary consumption of generation plants, transmission, and distribution losses) ranged between 24.13 percent (the lowest in the period) in FY 1997 and 27.55 percent (the highest in the period) in FY 1999. KESC's system losses during the same period ranged between 35.14 percent in FY 1996 and 47.39 in FY 2003.[27] Theft of electricity and nonpayment of bills were so rampant in KESC area that the army was called in to prevent theft and enforce collections.

Collection had been particularly difficult in the Federally Administered Tribal Areas also. Tariffs have traditionally lagged behind costs of supply, and both WAPDA and KESC had been accumulating substantial losses despite periodic financial recovery packages. One estimate placed the annual financial losses of WAPDA and KESC at about $585 million in the early years of this decade. Moreover, the losses in the power sector are increasing since WAPDA's losses alone were estimated at $817 million for FY 2006.

*Sri Lanka* had a relatively moderate system loss at around 17.2 percent during 2004 and 2005. Its overall average revenue/ kWh covered only about 88 percent of the average cost in 2003. Its average revenue in 2004 at about 7.66 cents/kWh produced a net loss and a negative rate of return of (–)5.11 percent on average net fixed assets in operation. Its internally generated cash was inadequate to service its debt.[28] Households, religious institutions, street lighting, and low-voltage industrial consumers were cross-subsidized by the remaining categories of consumers, mostly commercial and large industrial consumers.[29]

On account of such poor operational and financial performance of the power utilities and their lack of creditworthiness, the entry of independent power producers (IPPs) for generation in most cases could be only on the basis of "take or pay" obligations fully covered by sovereign guarantees. Even in such cases, the inability of the utilities to absorb the rising cost of power from IPPs (indexed to variations in fuel prices, exchange rates, domestic inflation, and similar variables) resulted in disputes, cancellation, or renegotiations, which soured the investment climate. This environment was clearly not conducive for electricity trade among the countries.

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[25] See *Integrated Energy Policy Report of the Expert Committee*, August 2006 of the Planning Commission, government of India, New Delhi, available at www.planningcommission.nic .in. The data are calculated using PPP exchange rates. When market exchange rates are used, the gap between India and USA would be narrower, but still substantial, and Indian rate for the industrial consumers remains the highest.

[26] See South Asia Running Brief, pages 29–31 available at the World Bank South Asia Web site, www.worldbank .org. [27]WAPDA Power System Statistics, NTDC, Lahore, December 2005.

[28] See CEB web site at www.ceb.lk and also the presentation by A. Perera of CEB in the BIMSTEC conference on hydropower during October 30–31, 2006, New Delhi, India. A slight increase of average revenue/kWh to 7.71 cents in 2005 enabled CEB to achieve a debt service ratio of 1.07, though the rate of return still remained negative at (–) 1.15 percent.

[29] Electrowatt-Ekono Study, 2003 for the Energy Supply Committee Tariff Study.

## Ownership Structures and Contracting Practices

The power sector in the region is predominantly state owned. Until recently, participation of the private sector was generally limited to a number of generation projects with sovereign guaranteed cash flows, established under the build, operate, transfer (BOT) or build, own, operate (BOO) models. Private-sector involvement in the distribution segment is limited to a few states and cities in India. Given the poor financial performance of the utilities, investment resources had to come primarily from the state funds, which were scarce and which faced numerous other competing claims. In this context, it was politically difficult for the governments to find funds for export-oriented power projects or for investing in a power project of another country (even on the basis of least cost considerations) for securing power imports.[30]

In Nepal and Bangladesh, the domestic power sector was perpetually facing supply shortages. In this context, politicians could not focus on power projects for exports. India's aid for the construction of a few small hydropower projects in Nepal was essentially to help Nepal and not for generating power exports to India. India's substantial grants and loans to finance one large and two medium-sized hydropower projects (Chukka, Kurichi and Tala) in Bhutan for securing import of hydroelectric power can be considered an exception rather than the rule. The countries with export potential (Bhutan, Nepal, Bangladesh) were relatively small economies[31] with no investment resources of their own and with poor access to international capital and debt markets. Even their ability to raise resources from multilateral development banks and other sources of concessional funds was so limited that they could not finance large export projects, because of the limited allocations and prudent lending limits of these institutions (and the competing claims on them). Thus, the ownership structure of the sector was not conducive to seize profitable export-import opportunities. In order to unlock the power export potential in small countries, new types of ownership structures and new financing structures for the projects are needed. These take time to emerge.

Even the few transactions, such as those between India and Bhutan, India and Nepal, and Afghanistan, Central Asia, and Iran are more political than economic or commercial in character. There are no long-term contracts with "take or pay" or "supply or compensate" obligations, long-term price adjustment mechanisms and formulae, and dispute resolution mechanisms.[32] Prices are valid for short periods only and are subject to periodic negotiations. Such political agreements are acceptable in the nascent stages of trade, but unless they quickly evolve into sustainable commercial arrangement, they are not conducive to growth in trade.

## Sector Structures and Regulation

Trade between integrated utilities is possible and has been taking place in a small way (as indicated in Chapter 2) based on the availability and transfer capacity of the interconnection. In order to facilitate more widespread trade within and across large power systems (such as that of

[30] In the democratic polity of India, for example, various states compete furiously for ensuring that the power project sites in their state secure the scarce investment resources of the central government. In this context, it is difficult for the central government to invest in projects abroad, while there are still plenty of potentially good sites within the country.

[31] In Nepal and Bhutan, the cost of any single major hydropower project may be as high as the GDP of the country or even larger. The capital cost of Tala hydropower project was more than 1.6 times the GDP of Bhutan in 2004.

[32] Even though India has financed the hydropower projects in Bhutan on such generous terms as 60 percent grant and 40 percent long-term loan, the price/kWh for power from Chuka had been changed from Rs 0.19 in 1988 to Rs 2.00 in 2006 through several negotiations and the price for Tala power has not yet been agreed upon, though the project had been commissioned in 2006 and power is being exported.

India), it is generally considered advantageous to unbundle the utility operation and the electricity tariff by function (generation, transmission, and distribution) and provide for third-party access to the transmission system and for transparent and predictable transmission tariffs. This is also especially important in transit countries.

It goes without saying that at least the large consumers and distribution companies should have the freedom to choose their supplier in any of the interconnected systems and contract for their supplies. Regulation of the retail tariffs, enforcement of supply contract conditions, and resolution of the disputes are to be handled by independent regulatory bodies. In South Asia, restructuring in this direction commenced in the mid-1990s and had been progressing very slowly. Progress became somewhat noticeable only in the last few years, especially after the enactment of the new electricity law in India in 2003. The slow rate of progress in sector restructuring had been considered by many as an impediment to growth in electricity trade, both within the large systems and across the systems. The actual progress and outlook are discussed in the next chapter, which identifies and analyzes the emerging factors that would improve the prospects for electricity trade within the region and with its neighbors in the near future.

# 4 Emerging Factors Conducive to Electricity Trade

Since the mid- to late-1990s, major changes have taken place in the region, resulting in a greater degree of global integration and increased growth dynamism. In this context, several factors have emerged that improve the prospects for electricity and gas trade within the region and with its neighbors. These are discussed in relation to the countries with import potential, countries with export potential, and transit countries.

## Changes in the Development Approach and Growth Dynamism

During the last decade, there has been a major change in the politicians' mindset. The approach to development is no longer dominated by inward-looking import substitution strategies, propped up by restrictions and control of trade, exchange rates, and investment regimes. Development approaches have a new, outward-looking orientation with greater reliance on trade encouraged by liberalization of trade, exchange rate, and investment regimes. In the mixed economies of India, Pakistan, and Bangladesh, private investments and market mechanisms are making major headway, while the role of central planning approaches are becoming much more limited. Imports are no longer considered a necessary evil, but as inputs and stimulants for increasing the competitiveness of domestic production in the internal and export markets. Such an approach has resulted in greater growth dynamism and increased foreign exchange earnings and reserves,[33] which, in turn, enables a greater degree of liberalization of trade and investment regimes. Thus, the economies have gotten into a virtuous cycle in which growth and liberalization mutually reinforce one another. India is looking at the prospect of an annual GDP growth of 10 percent for the next 10 to 15 years. Pakistan is looking at 7 to 8 percent growth, while Bangladesh hopes to grow at around 5 to 6 percent.

The magnitude and urgency of such growth rates translate into the urgency of increased and timely availability of electricity and gas (among other energy forms). On the basis that the GDP elasticity of electricity demand would fall from 0.95 during FY 2004 and FY 2012 to 0.85 during the next 10 years and further to 0.78 during the last 10 years, India estimates that average annual electricity demand growth at the generation level would be at 7.5 percent through the FY 2031 to support an annual GDP growth rate of 9 percent. For supporting a 10 percent annual GDP growth rate, electricity generation has to increase even faster. Pakistan and Bangladesh are also envisaging similar growth rates for electricity needs.

Given the natural resource constraints and time constraints to develop them, Indian policy makers advocate the import of electricity from Nepal and Bhutan and gas through pipelines from Myanmar, Bangladesh, Iran, and Central

[33] As of April 2007, the total foreign exchange reserves of India, Pakistan and Bangladesh have exceeded $230 billion equivalent nearly to a year's import requirement.

Asia.[34] Such imports supplementing LNG imports, coal imports, and acquisition of equity oil and gas in the foreign fields are seen as diversifying energy forms and supply sources and thus enhancing energy security of the country.[35] Based on an analysis of its electricity demand growth and supply options, Pakistan has also come to the conclusion that importing electricity from Central Asia to the extent of 1,000 MW to start with and then growing to 4,000 MW in the next stage makes economic sense. The emergence of a political mindset that regards electricity and gas imports as practical options to enhance national energy security is an important phenomenon that improves the prospect of regional trade.

Bhutan's development strategy is clearly based on achieving power-export-led economic growth, and it has recently commissioned a study to examine its options for the diversification of its export markets and the strategies for obtaining the best value for its exports in the medium to long term. Tajikistan and Kyrgyz Republic have decided in the last few years to pursue vigorously their hydropower export-led growth options and diversify their export markets into South Asia.

## Increases in Power Transfer Capacities

In the countries with import potential, there is a major ongoing effort to increase significantly the capacity of the backbone transmission systems to transfer power from one part of the country to the other parts. Thus, India, Pakistan, and Bangladesh have set up separate state-owned power grid corporations that are making significant investments in the expansion of the backbone transmission system and dispatch facilities with assistance from World Bank, Asian Development Bank, and bilateral donors.

The total interregional transfer capacity among the five regions of India (north, northeast, east, west and south) was about 5,050 MW in 2002. It had reached 9,450 MW by FY 2006. At the end of FY 2007, the capacity was expected to reach 16,450 MW upon completion of ongoing projects. By 2012, the interregional transfer capacity is expected to reach 37,150 MW. This is being done to enable a much better utilization of the hydro and thermal capacity, facilitate the implementation of the open-access transmission policy laid down in the new Electricity Act of 2003, and assist in the evolution of a national power market. Three regions (east, northeast, and west) are already integrated and operate synchronously. The northern region will get integrated in FY 2007. The southern region is connected to eastern and western region in asynchronous mode with HVDC linkages. Further enhancement of this interconnectivity and synchronization with the rest of the national grid will take place in the medium term.[36]

The most recent example of interregional transfer capacity enhancement, facilitating the absorption of 1,020 MW of power from Bhutan, is the construction of a 1,200-km-long, 400 kV double-circuit transmission line linking Siliguri in the eastern region to Mandaula in the northern region. It has enabled the power-deficient northern region to receive power from the Tala hydropower project of Bhutan (see Box 4.1).

A 765 kV transmission system overlay (with 5,200 km in length and 24,500 MVA in transformation capacity) on the 400 kV backbone system is expected to be in place by FY 2012, further enhancing the transfer capacity and reliability. In addition, 800 kV HVDC lines are planned for, among other things, receiving large volumes of power from Bhutan in the future.

Developments of this kind enlarge the market for imports. Developers of hydropower projects in Bhutan need not be constrained by the power surplus situation in the eastern region, and can look for markets in the northern, western, and southern regions. This is clearly

[34] See *Integrated Energy Policy—Report of the Expert Committee*, Planning Commission, Government of India, New Delhi, August 2006, available at www.planningcommission.nic.in.

[35] India has three LNG import terminals at Dahej, Hazira, and Dhabol. One more terminal at Cochin would be commissioned in 2009 (India Country Analysis Brief available at www.eia.doe.gov).

[36] See Annual Report of the Central Electricity Authority of India (FY 2006), available at its Web site, www.cea.nic.in.

**Box 4.1 Transfer Capacity Enhancement Facilitates Absorption of Power from Bhutan**

As a part of the Tala hydropower project in Bhutan, two double-circuit 220 kV lines will bring Tala power up to Siliguri in the state of West Bengal in the Eastern region, which has a substantial energy surplus. The northern region has substantial shortage of energy and peak capacity. Thus, the 1,200-km-long, double-circuit 400 kV line linking the eastern and northern regions with a transfer capacity of 3,000 MW and a capital cost of about $358 million enables the absorption of the imported energy. This line is also noteworthy from the point of view of its construction on a BOOT basis by Powerlinks Transmission Limited, a joint venture between Tata Power—a private sector company (51 percent)—and Power Grid Corporation of India Limited—the central government owned national grid company (49 percent). This is the first case of private-sector involvement in the transmission segment. The joint venture raised funds from IFC and ADB and from domestic financing institutions (SBI and IDFC).

*Source:* The presentation by Powerlinks Transmission Limited in the India Electricity-2006 Conference (Plenary Session III-Transmission), New Delhi, on May 12, 2006.

a major factor conducive to external as well as internal trade in India. Similar efforts in Pakistan to improve the north–south transfer capacity and in Bangladesh to improve the east–west transfer capacity represent positive development that favors regional trade.

## Evolution of National Power Markets

The evolution of a nascent national power market in India in the last few years is a factor that will significantly improve the prospects of exports to India. This was facilitated by the enactment of the new Electricity Act in 2003, which unbundled power trading from power transmission, provided for open access in transmission, and recognized power trading as a separate licensed activity. It was also aided by the emergence of new, solvent and creditworthy power-sector institutions (such as Power Grid Corporation and Power Trading Corporation), the adoption of availability-based tariffs (ABT) for bulk power sales in the national grid (mainly by central-government–owned large generating stations to the state electricity boards), and the special efforts to enforce payment discipline on the part of the electricity boards.

The Power Grid Corporation of India owns and operates the countrywide backbone transmission system at 400 kV level and above[37] and enables transfer of power from state to state and region to region. It has undertaken the responsibility to provide open access and is adopting an electronic bidding system to resolve capacity congestion arising from demand from multiple short-term customers. Power Trading Corporation is a joint stock company listed in the Bombay stock exchange. It buys power from surplus states and sells to deficit states. Its presence in the national power market has greatly helped to increase the traded volume (Box 4.2).

**Box 4.2 Power Trading Corporation of India: A Major Solvent Buyer in the Market**

Power Trading Corporation of India Limited is a listed company in the Bombay Stock Exchange. Its shareholders include promoters such as NTPC, NHPC, PFC, PGCIL, and DVC (39%), and financial institutions such as IDBI, IFCI, IDFC, LIC and GIC and Banks (14%), mutual funds (5.6%), Tata Power Company (10%), other private corporate bodies (4.6%), foreign investors (10.8%), and the general public (16%). In FY 2006, it traded 10,119 GWh with a turnover value of $695 million, and made a profit before tax of $12.7 million. Its IPO in FY 2004 was oversubscribed to the extent of 42 times and its share is trading consistently at more than five times its face value.

*Source:* World Bank, *Project Appraisal Document for a Loan to Power Grid Corporation of India*, December 2005.

[37] As of March 2005, Power Grid Corporation of India owns operates and maintains one of the largest extra high voltage systems of the world, with more than 51,000 km of both AC and DC transmission network up to 765 kV level, and 85 substations with a total capacity of over 50,000 MVA. It also owns and operates five Regional Load Dispatch Centers. Over 45 percent of the power generated in India is transmitted through this national system, which routinely operates at more than 99 percent availability each year (see World Bank, *Project Appraisal Document for a Loan to Power Grid Corporation of India*, December 2005).

After the enactment of the new Electricity Act in 2003 that recognized electricity trading as a separate activity to be licensed, the Central Electricity Regulatory Commission had issued 20 licenses for power trading. About eight of them, including Power Trading Corporation, are authorized to trade more than 1,000 GWh annually. The more prominent among them include NTPC Power Trading Company, Reliance Energy Trading Company, Tata Power Trading Company, and Adani Exports Limited. Although Power Trading Corporation continues to be a dominant player, other companies are making headway and had secured a market share of 27 percent by FY 2005. The traded volume rose to about 3 percent of the total volume of power transmitted in the national grid. The existence of such credible, solvent, and regulated trading companies in the market would greatly facilitate export of electricity to the Indian market. In fact, Power Trading Corporation is heavily involved in the cross-border power trade among the utilities of India, Bhutan, and Nepal.

The introduction of the availability-based tariffs (ABT) for bulk supplies in the national grid since mid-2002 has led to the emergence of significant trade in electricity within India (see Box 4.3). Trade in electricity in FY 2007 amounted to about 15,000 GWh, or about 3 percent of the total volume handled by the national grid. Traded prices ranged from 12.5 cents/kWh (off-peak) to 13.7 cents/kWh (peak) in the third quarter of 2006. Payment discipline of the state electricity boards have improved substantially since the conclusion of a tripartite agreement (TPA) of May 2001 among the states, the government of India, and the Reserve Bank of India. This was based on the one-time waiver of 60 percent of the interest/surcharges on delayed payments/dues as of September 30, 2001, and the securitization of the remaining balances through the issue of state-issued tax-free bonds (with an interest rate of 8.5 percent and a maturity of 15 years, including a moratorium of 5 years).

Twenty-eight states have signed the TPAs and have issued bonds for a total value of $6.64 billion. The TPAs provide for incentives for the prompt settlement of future monthly bills. When payment default occurs, the supplier is expected to reduce the level of supply. If the default continues, the supplier is expected to approach the Ministry of Finance of the government of India for direct payment of the dues by the Reserve Bank of India from central government's allocation of funds to the defaulting state. As a result of these arrangements, payment discipline by the state electricity boards have greatly improved, and most central government-owned power entities report collection efficiencies of about 98 percent. Such an improvement in the payment discipline of the electricity boards, which have long been considered major credit risks, is a factor that should favor the prospects of increased trade.

## Increasing Involvement of the Private Sector

A greater degree of private-sector involvement in the power sector is likely to improve the prospects of trade, as private businesses are constantly on the lookout for cost-effective supply additions and attractive markets to increase the volume of their business and their profits. During the last 15 years, private-sector involvement in the power sector of South Asia region has grown notably, though not as much as in other regions. In Pakistan, Bangladesh, Nepal, and Sri Lanka, the private sector is involved to the extent of 20 to 30 percent of national generation capacity (see Table 4.1). India's percentage is lower at 12.1 percent, but the capacity, in absolute size, is large. Further, the data do not include about 18,740 MW of captive generating capacity owned by other businesses.

Under the Electricity Act of 2003, generation activity no longer requires a license, and transmission licensees are obliged to transmit electricity from captive generation units to other customers or to the grid to sell their surplus power. The Power Finance Corporation is putting together several "ultramega projects" (4,000 MW to 6,000 MW each) for possible development, either as private projects or in the form of public–private partnerships. Some

### Box 4.3 Availability-Based Tariffs Promote Trade in the National Grid in India

Central government-owned generating companies (such as NTPC and NHPC) own and operate about 39,900 MW, or about 32 percent of India's total installed generation capacity. The capacities of their various large generating units are allocated to the relevant state electricity boards at the time of their construction. The tariff for the sale of this electricity in the past used to be designated in terms of a composite kWh charge only, and billing was on the basis of monthly net energy drawn from the national grid. This was not conducive to discourage the electricity boards from drawing substantially more or less than the allocated capacity. They could overdraw during peak hours and under-draw during off-peak hours without any financial consequences. This greatly interfered with the merit order dispatch and adversely affected the frequency in the grid. Also, it provided no incentive to the states to trade the unwanted portion of their allocated capacity.

To overcome these problems, the concept of availability-based tariffs was introduced in mid-2002. This involves: (1) a fixed capacity charge/kW/month payable by the electricity board, based on the capacity allocated to it and linked to the availability of the plant; (2) a regulated variable energy charge based on the actual scheduled consumption; and (3) a special unscheduled interchange (UI) charge for deviations from schedule.

The UI charge is linked inversely to the frequency in the grid and is high at Rs 6.00/kWh (or 14.3 cents), when the frequency goes down to 49.02 Hz (high demand situation). It becomes zero when the frequency is at 50.5 Hz or higher (low demand situation). For this purpose, the energy is metered in 15-minute blocks, and the average frequency is taken into account. In the range 50.5 to 49.02 Hz, the UI charge increases from 0 by Rs 0.08 for each reduction in frequency by 0.02 Hz in a linear fashion.

Since the states pay a fixed capacity charge based on the capacity allocated to them, they have a strong incentive to draw the allocated energy or to sell the unwanted portion of such energy to other buyers. Overdrawing during high demand periods (frequency lower than 50.5 Hz) penalizes them heavily through a high UI charge. Similarly, generators get high UI charge for extra generation during periods of high demand and have no incentive to generate extra energy during periods of low demand, since the UI charge becomes zero.

The introduction of ABT has greatly improved the frequency conditions of the national grid, promoted intelligent load management of the part of electricity boards, enabled a more meaningful merit order dispatch, and above all, facilitated the emergence of a significant volume of energy trade in the national grid (which grew from 1,617 GWh in FY 2002 to greater than 15,000 GWh in FY 2007).

The maximum UI charge at 49.02 Hz was fixed in FY 2003 at Rs 4.2/kWh, based on the cost of electricity from generating sets using high-speed diesel (with a fuel cost of Rs 13.33/liter) as representing the short-term marginal cost.

With changes in high-speed diesel prices, the UI charge went up to Rs 6/kWh, and then came down to Rs 5.7 in 2004. On the same basis, the UI charge should be Rs 9.3 (23.25 cents) for FY 2008, but to avoid too steep a revision, the Central Electricity Regulatory Commission has fixed it at Rs 7.5/kWh (18.75 cents) with effect from April 30, 2007, as an interim measure, based on the cost of generation from combined cycle power stations using naphtha as fuel.

*Sources:* Bhanu Bhushan, "ABC of ABT, A Primer on Availability Based Tariff," June 27, 2005, and CERC Order dated April 5, 2007, in Petition No. 15/2007, available at www.cercind.gov.in

of them will be based on domestic coal and will be integrated units with their own block of captive coal mines. Others will be based on imported coal. The experience that South Asian countries have gained in dealing with BOT/BOO entrepreneurs and in the varied contracting and guarantee and risk mitigation mechanisms should be of great relevance while they negotiate import and export contracts.

The emergence of large and reputed business houses of India (such as Tata, Reliance, and many others with global reach) as key players in the energy scene, and the emergence of many reputed and regulated private-sector

**Table 4.1** Private Participation in South Asia Power Sector

| | Private Sector Involvement | | |
|---|---|---|---|
| Country | Generation (percentage of national capacity) and Capacity in MW | Transmission | Distribution |
| Afghanistan | 0 | 0 | 0[38] |
| Bangladesh | 30% (1,260 MW) | 0 | Rural areas handled by RECs |
| Bhutan | 0 | 0 | 0 |
| Nepal | 21.75% (148.7 MW) | 0 | 0 |
| India | 12.1% (15,431 MW) Source: www.powermin.nic.in | 1,200 km 400 kV double-circuit line | States of Delhi, Orissa; cities of Bombay, Calcutta, Surat, and Ahmedabad |
| Pakistan | 31% (6,045 MW) | 0 | KESC privatized as a VIU (11% of consumers and 14% of sales of Pakistan) |
| Sri Lanka | 28.2% (718 MW) Leased 6.3% (160 MW) | 0 | 0 |

*Source:* Krishnaswamy et al. (2006).

power-trading companies in recent years improves the prospect of increased private-sector involvement, not only in the domestic private sector, but also in investments abroad (for example in Nepal, Bhutan, Bangladesh, and Myanmar) in projects dedicated for exports to India, mitigating to a major extent the problem of public-sector involvement discussed earlier.

The proposal the Tata Group made in FY 2005 to invest $2 to $3 billion in Bangladesh in a 1,000 MW gas-fired combined-cycle power plant, a 500 MW coal-fired power plant, a fertilizer factory using gas and a steel finishing mill using gas—which would also involve export of electricity to India—illustrates the possibilities of cross-border investment and trade in relation to gas and electricity. Among other things, the proposal would also enable the extension of gas pipeline to this westernmost part of Bangladesh, enabling the conversion of a few oil-fired power plants there into gas-fired power plants. The government has not yet responded.[39]

## Proposals to Improve the Commercial Performance of Utilities

As a part of a major public enterprise reform effort, the government of India wants to reorient the Accelerated Power Development and Reform program (APDRP).[40] The reorientation has seven key elements:

1. Automatic meter reading devices will be installed on all distribution transformers, and a geographical information system that maps the distribution system will be used to

[38] There is one small exception. Privately owned Omar Electric Company with an installed capacity of 1.0 MW supplies about 8,500 consumers in the city of Ghazni (see *Lack of Access of Power (Energy) in Afghanistan*, World Bank, November 2006).

[39] See "India /Bangladesh: Tata Deal Breaks Integration Barriers," *Oxford Analytica* (August 25, 2004), and also the "Country Analysis Brief on Bangladesh" (July 2005), available at www.usdoe.eia.gov. See also press reports in India and Bangladesh during September to November 2006.

[40] This section is drawn from "Integrated Energy Policy—Report of the Expert Committee," Planning Commission, Government of India, New Delhi, August 2006, available at www.planningcommission.nic.in.

pinpoint the exact locus of power theft and the offender, combined with staff incentives for the resulting additional revenue.

2. These data will be used to split the ATC losses into its components, technical losses, billing losses, collection losses, and theft losses to design corrective measures for each.
3. Bifurcate agricultural pumping load from nonpumping load in all rural feeders and devise methods of measuring agricultural pumping load.
4. For all loads above 50 kW, introduce intelligent or smart meters that enable real-time, remote recording of consumption data, and allow remote control over the power supplied through each meter.
5. Introduce time-of-day metering using the capability of the smart meters.
6. Link all assistance to the state power sector from the central government exclusively to loss reduction and viability improvement.
7. Use the key baseline data thus generated for determining the transition funding needs under outcome-driven privatization models that seek to restore the viability of distribution systems.

Pursuit of the efforts along these lines would improve the financial viability of the electricity boards, which is seen as a key for the sector health and for improving the prospects for electricity trade. Similar efforts could be relevant in Pakistan and Bangladesh, too.

## Structural and Institutional Changes with Potential to Favor Trade

Sector reforms based on the concepts of distancing the government (separation of policy making, regulatory, ownership, and operation functions); unbundling vertically integrated utilities into separate entities responsible for different business functions such as generation, transmission, and distribution; introduction of the concepts of third-party access to the transmission and distribution wires services; and liberalization involving the provision of the choice of supplier to at least distribution companies and large suppliers are all known to be conducive to internal and external electricity trade. Such reforms in their simpler forms have been going on for over a decade in the region. Though they have been progressing somewhat slowly and, in the eyes of many observers, somewhat ritualistically, they nevertheless represent a move in the right direction, improving the prospects of national and regional trade. The situation in the region in this respect is summarized in Table 4.2.

In the Indian national grid, the dispatch is largely based on the bilateral contracts (long-term PPAs based on prices regulated by central regulatory commission) between central-government–owned generating companies and the state electricity boards. As explained already, the adoption of ABT and UI charges and the presence of power-trading companies have led to lively interstate trading in electricity and the emergence of real-time spot markets and short-term contracts, with UI rate acting as the price signal. Within the state grids, the transmission companies had been acting as the single buyer buying from IPPs, central- and state-government generating companies, and selling to distribution companies and large consumers in the state at the bulk supply tariffs approved by state regulatory commissions. Recently, the transmission companies have been asked to transfer this trading function to an appropriate trading body. In Pakistan, National Transmission and Dispatch Company (NTDC) acts as the single buyer, though there is provision for future trading among the distribution entities, generators, and large consumers. In Bangladesh, BPDB acts as the single buyer, buying power from all generators and selling it to DESA, DESCO, and RECs at bulk power tariffs. It has also substantial distribution responsibilities of its own. When the structural reforms take root and become fully operational in the three countries with major import potential, they will clearly improve the prospects of regional trade.

**Table 4.2** Status of Sector Structural and Institutional Reform

| Country | Distancing the Government | Unbundling | Third-Party Access to Wires Services | Regulation |
|---|---|---|---|---|
| **India** | Completed at the federal level. Reform is formally completed in most states. | Completed at the federal level and in most states. Reform is ongoing in the remaining few states. | Approved for national grid. Ongoing for state grids (early stages). | Central regulatory commission is functional. State regulatory commissions are functional in 27 of 29 states. |
| **Pakistan** | Reform is formally completed. | Power wing of WAPDA had been unbundled into four generation companies, one transmission company, and nine distribution companies. KESC had been privatized as a VIU. | Not yet | Regulatory body NEPRA is operational. Its capacity for sector oversight is still evolving. |
| **Bangladesh** | Reform is formally completed. | Partially completed. The transmission function has gone to PGCB. Substantial generation and distribution is still combined in BPDB, although Dhaka area has DESA and DESCO. Rural area distribution is handled by rural cooperatives. | Not yet | Regulatory body established, but not yet fully operational. |
| **Bhutan** | Reform is formally completed recently. | No vertical unbundling. The four generating companies also handle some local distribution. BPC handles some generation, transmission, and distribution. | No | Bhutan Electricity Authority created under a 2001 law has recently become operational. |
| **Nepal** | Formally completed | No. NEA is still a vertically integrated utility. | No | NETFC exists. Its capacity and autonomy appear limited. It does not regulate bulk supply tariffs. |
| **Sri Lanka** | Regulation has not been separated yet. | No final decisions yet. CEB is still a VIU. LECO handles distribution in a small area. | No | Due to frequent change of governments, no decision had been taken yet. |
| **Afghanistan** | Not yet | Not likely in the short term. | No | No, though there are plans for the future. |

*Source:* Krishnaswamy et al. (2006).

Structural reforms of this kind have been delayed in Sri Lanka on account of the frequent change in government and the differences in their approaches. Afghanistan's situation needs to be stabilized before it could start sector reforms. However, such reforms are crucial in this important transit country for promoting trade between Central Asia and South Asia. In such small systems as Nepal and Bhutan, structural reforms of this type may not be an urgent need.

## Efforts to Lessen Political Tensions

Efforts are going on to reduce the political tension between India and Pakistan by undertaking a series of high-level dialogues and confidence-building measures, such as enabling travel of businesspeople, road, rail and air links, and common and cooperative programs to fight terrorism. Trade barriers are being reviewed to minimize their impact and facilitate trade. In Nepal, the insurgency appears to have been overcome and the prospect for a stable democratic regime appears bright. After the elections of Bangladesh in early 2007, political disturbances are expected to subside and major decisions on cross-border investments are likely to be made. Afghanistan, which appeared to be moving toward stabilization in the last year or two, seems to be facing a potential reversal of that trend. On the whole, however, regional political tensions appear to be lessening.

## A Surge in Regional Cooperation Efforts

The South Asian Association for Regional Cooperation (SAARC), in which all the seven countries covered by the study plus the Maldives are members, has been taking special interest in the energy cooperation in the recent years. In the Islamabad summit held in January 2004, a decision was made to establish a working group on energy to study South Asia Energy Cooperation, including the concept of an *energy ring*. The Council of Ministers meeting held at Islamabad during July 20–21, 2004, approved the report of the working group containing a range of topics related to energy cooperation. The working group thereafter decided to pursue action with respect to (1) exchange of energy information, (2) environmental friendly energy, (3) creation of a regional power grid, and (4) cooperation on renewable energy.

SAARC Energy Center had been established in Islamabad to carry out studies and coordinate energy cooperation and trade among the member countries. In the most recent SAARC Heads of State summit meeting (April 3–4, 2007) and the SAARC Energy Ministers meeting (March 7–10, 2007) the rapidly increasing energy demand to meet developmental needs and the role of regional energy trade to meet such demand figured prominently. The government leaders expressed strong support to regional energy trade and reiterated their political commitment to promote such trade. They endorsed the concept of energy ring (which among other things, focuses on electricity interconnections among the member countries). The Energy Center will carry out a study on the concept of the Energy Ring with help from Asian Development Bank. The Second SAARC Business Conclave, a gathering of private-sector business associations in the region, took place in Mumbai during February 17–18, 2007. Its Mumbai Declaration calls for increased energy cooperation to enhance energy production and transmission among SAARC countries. There is strong private-sector interest to make cross-border energy sector investments, provided sector policy reforms are fully implemented, and mechanisms for managing cross-border investments are put in place.

The Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC), in which Bangladesh, Bhutan, Nepal, Myanmar, India, Sri Lanka, and Thailand are currently members, is also active in the field of energy. The first Energy Ministers' Conference held in Delhi in October 2005 approved a BIMSTEC vision of trans-border power exchange and grid interconnections country by country to enable eventual flow of electricity across the member countries. It also resolved to: (1) evolve a common regulatory framework for developing grid interconnections; (2) develop the hydropower potential of the region to support economic growth; and (3) further enhance cooperation in the development of various hydropower projects.

The ECO (Economic Cooperation Organization) was created in 1985, first including Iran, Turkey, and Pakistan. The other seven members—Afghanistan, Azerbaijan, Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan—were added in 1992. ECO has had a number of meetings devoted to energy trade, most recently in Bishkek, in May 2004, and in Teheran, in June 2005. The latter meeting was organized in cooperation with the World Bank and with participation of other donors such as Asian Development Bank (ADB) and Islamic Development Bank (IsDB). The participants agreed to pursue energy trade initiatives through two broad sets of activities: (1) promoting specific projects whose potential has already been demonstrated through analytical work; and (2) undertaking additional analytical work on the investment and policy fronts. ECO has launched a study of electricity interconnections among the ECO countries, financed by IsDB. Another study, titled *Trading Arrangements and Risk Management in International Electricity Trade in ECO Countries*, is being carried out under the World Bank financing.

The regional Economic Cooperation Conferences in Kabul (2005) and Delhi (2006) discussed at length regional energy cooperation opportunities, and the Kabul and Delhi declarations called for continued efforts to interconnect electricity systems and promote electricity trade within the region, as well with the western neighbors of the region.

There are also several other regional cooperation organizations such as Shanghai Organization for Security and Cooperation in which Iran, India, and Pakistan have observer status. It is increasingly focusing on economic cooperation, in addition to security matters.[41] Such a surge in discussions on the regional cooperation in the electricity and gas sectors augurs well for regional electricity trade. Most of these organizations are making only limited tangible progress, mainly on account of the political tensions in the regions. Once the political tensions subside, the existence and the activities of such organizations would lead to faster progress in regional trade.

[41] See William Byrd, Martin Raiser, and others, "Economic Cooperation in the Wider Central Asia Region," World Bank Working Paper No. 75, 2006, for a fuller listing of the various organizations.

# 5 Opportunities for Regional Energy Trade

In Chapter 2 we discussed the distribution of energy resources in the region and its neighbors, and also, briefly reviewed the energy use and the supply-demand situation and outlook. The opportunities for electricity trade emerging from these would fall under three groups:

- Central Asia to South Asia electricity trade.
- Nepal, Bhutan, India, Bangladesh and Myanmar electricity trade.
- Other opportunities such as Central Asia and Afghanistan bilateral trade, Pakistan and Iran bilateral electricity trade, India and Sri Lanka bilateral electricity trade, and India and Pakistan bilateral electricity trade.

Similarly, the opportunities for gas trade would fall under the following groups:

- Gas could be imported through pipelines into India and Pakistan from Iran and Central Asia (Turkmenistan, Uzbekistan, and possibly Kazakhstan).
- Gas could be imported from Myanmar and Bangladesh into India and possibly to Bhutan and Nepal.

Most of the trade (except the envisaged Central Asia–South Asia electricity trade and gas trades) would be bilateral at least to start with, and could later evolve into regional markets with multiple buyers and sellers. Bilateral cross-border trade is a natural starting point and an important long-term feature of regional trade, even in well-developed multilateral regional markets. It helps develop physical infrastructure and commercial relationships in a gradual fashion, allowing participating countries to adjust, develop institutions and experience, build confidence and mutual comfort, and minimize risks.

One may envisage in this context the evolution of the regional market in the following geographic terms:

- The western energy market, in which energy trade would be among Central Asia, Iran, Afghanistan, Pakistan, and India.
- The eastern energy market, in which the energy trade would be among India, Nepal, Bhutan, Bangladesh, Myanmar, and possibly Sri Lanka.

India being in both would enable the eventual evolution of an integrated regional energy market.

Given the economic realities and outlook, as well as the resource distribution across the region, India, Pakistan and perhaps Bangladesh would emerge as major importers, while Central Asia, Iran, Myanmar, Bhutan, and Nepal would emerge as major exporters. Afghanistan and Pakistan would be key transit countries in the western energy market, while Bangladesh could play that role in the eastern energy market. Bangladesh has also the potential to emerge as an exporter of gas and electricity. (See Map in Annex 5.)

## The Western Energy Market

As can be discerned from Table 2.4, Central Asia and Iran have considerable natural gas resources and surplus electricity to export. Kazakhstan, Kyrgyz Republic, Uzbekistan, and Tajikistan,

### Box 5.1 Comparative Advantages of Central Asian Republics in Electricity Exports

- Dramatic decline in electricity demand upon the dissolution of the Soviet Union rendered their generating capacity excessive. Annual generation of electricity, although increasing, still lags considerably behind the pre-1990 level.
- Tajikistan and Kyrgyz Republic have huge hydropower potential. They operate predominantly hydroelectric power systems, have large surplus generation available for export in spring and summer, and face supply deficits in winter due to lack of thermal-generation capacity or lack of fossil fuels.
- Generating facilities, including those whose construction had been initiated but then stopped after the break-up of the Soviet Union, were designed or optimized on the basis of large regional markets within the Soviet Union, and became excessive to the needs of newly independent republics.
- There were a number of large power projects, the construction of which commenced during the Soviet regime and later were suspended after incurring considerable amounts of sunk cost, for want of funds to complete them. When completed, their outputs would be far in excess of the needs of the host countries, and thus their completion would make economic sense only if export markets could be found. Because of the large sunk costs already incurred in the Soviet era, the marginal cost of generation based on incremental investments could be attractive to prospective importers.
- Similarly, the incremental generation costs from the moth-balled thermal generating assets in Kazakhstan (upon their rehabilitation) would also be attractive.[43] Export of surplus thermal power from Kazakhstan, Turkmenistan, and Uzbekistan (with significant and developed fossil-fuel resources) could complement the hydropower exports from Tajikistan and Kyrgyz Republic to make part of the supply firm year round.

*Source:* World Bank, Central Asian Regional Electricity Export Potential Study (2004).

which currently constitute the Central Asian Power System (CAPS),[42] have a combined generation capacity of about 38,000 MW and an annual generation in excess of 135 TWh. Their comparative advantage in terms of electricity exports arises from the factors summarized in Box 5.1.

In these countries, practically 100 percent of the households have access to electricity. Based on current high per capita consumption levels, income elasticity, and effective price elasticity, the demand for electricity in these four countries during 2005 to 2025 is expected to grow at a very modest annual average rate of about 2 percent, if the tariffs are to increase to full cost-recovery levels and commercial discipline is strictly enforced.[44] Supply options such as system-loss reduction, rehabilitation of generating units, and completion of the large projects that are currently languishing for want of funds could produce enough electricity to meet the forecast demand and leave substantial surpluses for export. Currently, the surpluses are of the order of 11 TWh, but almost the entire surplus is in the spring and summer months. In winter, there is actually a shortage of about 1 TWh. The total annual surpluses could exceed 30 TWh in the next five years and 50 TWh in the next 10 years if the envisaged investment program is

[42] Turkmenistan's power system also used to operate synchronously with the system of the other four Central Asian countries. During the time of the Soviet Union, the power systems of the five countries were developed as an integrated system, operated from a regional dispatch center in Tashkent (Uzbekistan). Since May 2003, the Turkmenistan system has been operating synchronously with that of Iran and not with the rest of the CAPS.

[43] AES the owner of Ekibastuz Thermal power plant in Kazakhstan and related coal fields estimates power generation costs of 1.0 to 1.2 cents per kWh upon rehabilitation of units 3–7 (300 MW) (2005–2007), less than 2.0 cents/kWh upon rehabilitation of unit 8 (500 MW) (2009), 2.0 to 3.0 cents/kWh upon rehabilitation of Unit 2 (500 MW) by 2011 and unit 1 (500 MW) by 2013 (presentation by Dale Perry of AES in Istanbul conference "Electricity Beyond Borders" on June 13, 2006).

[44] Price increases and substantial improvements in metering, billing, and collection system and procedures to enforce payments, reduce theft and other commercial losses, should limit demand increase.

**Table 5.1** Comparison of Marginal Cost in the Export Market with Import Costs from Central Asia (Cents/kWh)

| Target Market | Marginal Generation Cost in the Target Market | Generation Options in Central Asian Republics (CARs) | Cost of Supply from CARs |
|---|---|---|---|
| **Afghanistan** | >10 | Sangtuda I, Rogun I, Talimardjan I, and II | 2.26 to 3.43 |
| **Iran** | 3.6 | Sangtuda I, Rogun I, Talimardjan I, and II | 2.29 to 3.46 |
| **Pakistan** | 5.6 | Sangtuda I, Rogun I, Talimardjan I, II, and Kambarata II | 2.26 to 3.75 |
| **China** | 3.6 | Sangtuda I, Talimardjan I | 2.47 to 3.16 |
| **Russia** | 3.0 | Sangtuda I, Talimardjan I | 2.30 to 2.99 |

*Source:* World Bank, *Central Asian Regional Electricity Export Potential Study* (2004).

implemented. The major portion of the surpluses would continue to be in spring and summer, while surpluses in fall and winter would be lower by about 10 TWh in comparison.

Further, the World Bank's Central Asian Regional Electricity Export Potential Study (2004) demonstrated that electricity exports from the projects (partially completed during the Soviet rule) would be competitive in possible export markets such as Afghanistan, Pakistan, China, Russia, and Iran (see Table 5.1). These estimates were made on the basis of Central Asian fuel prices at $35 per 1,000 cubic meters of natural gas and $20 per ton of coal. The world oil price levels at that time were around $35/barrel.

Turkmenistan has installed generation capacity of nearly 3,000 MW. In 2005, it generated 12.3 TWh, of which nearly 10.5 percent was exported to Turkey, Iran, and Afghanistan. Given its substantial natural gas resources, it could step up its capacity and generation for exports at an attractive marginal cost.

Iran has an installed power-generation capacity exceeding 34,000 MW and an annual generation of over 149 TWh. It operates three isolated power systems. The northeastern power system in Khorasan province and the southeastern power system in Sistan-Baluchistan province adjoining Turkmenistan, Afghanistan, and Pakistan are isolated from the much larger western grid. Imports of power to these areas from Turkmenistan in 2003 were substantial (230 GWh), and there were small exports to Afghanistan (17 GWh) and Pakistan (47 GWh).

Iran and Turkmenistan have substantial natural gas resources for export, and both (especially the latter) are looking for opportunities to diversify their markets and extend towards South Asia. Uzbekistan and Kazakhstan also envisage a rapidly growing production of natural gas and looking eastward for new markets. Kazakhstan is also rich in low-cost, good-quality coal and could offer competitively priced electricity generated from such coal for export. For Tajikistan and Kyrgyz Republic, export of hydroelectricity could be a key driver of their economic growth. Such exports would also enable the two countries, heavily relying on hydropower, to pay for the fossil-fuel imports needed to mitigate their winter supply shortages.

## Central Asia–Afghanistan Bilateral Electricity Trade

Afghanistan's modest-sized and extensively damaged power system is fragmented and includes four main isolated grids clustered around areas of Kabul in the east, Mazar-e-Sharif in the north, Herat in the west, and Kandahar in the south. Estimated unsuppressed demand at 363 MW outstrips the available capacity of about 270 MW, and relentless daily load shedding has become inevitable. In the first eight months of 2006, electricity imports from Iran and Central Asia constituted 31 percent of the supply mix. Electricity peak demand is forecast to grow to 905 MW by 2020 at an average annual rate of 5.7 percent. Similarly, electric energy consumption is forecast to grow from 1,295 GWh to 3,868 GWh during 2004 to 2020 at an average annual rate of 6.6 percent.[45]

Import of power is expected to remain an important cost-effective component in Afghanistan's supply mix for the foreseeable future, both because of its comparative cost advantage and the fact that reliance on imports would leave more funds to be available for electrification and distribution and transmission network extension.[46]

Afghanistan's current levels of imports from Iran, Turkmenistan, Uzbekistan, and Tajikistan are given in Table 2.5. In order to increase the volumes of import and absorb them, Afghanistan needs to build its first-stage backbone 220 kV transmission system called North East Power System (NEPS), which will enable the flow of power to the key load centers. Various parts are under construction under the financing provided by a range of donors (WB, ADB, USAID, KfW, India, and others). Afghanistan expects NEPS to be completed by FY 2008–2009 (see Figure 5.1). Also, transmission links within the Central Asian countries must be strengthened. The details with respect to each country exporting to Afghanistan are discussed below.

*Tajikistan* has substantial surplus generation capacity during the spring and summer seasons and is looking for export opportunities. It has also partially completed large hydro projects such as Sangtuda I and Rogun, which when completed would provide very large volumes of surplus power for exports. It has a weak interconnection from Geran to Kunduz (Afghanistan) at 110 kV, operated at 35kV on the Afghan side. In a memorandum of understanding (MOU) signed in April 2005 and the subsequent agreements signed in December 2005, Tajikistan has agreed to supply to Afghanistan 300 MW in spring and summer and whatever quantity it can in fall and winter and to construct a 220 kV double-circuit line from Geran (Tajik) to Sherkhanbander (Afghan) to enable larger volumes of export. The double-circuit 220 kV line from Sherkhanbander to Kunduz and then on to Pul-e-Khumri would be constructed by the Afghan side under ADB financing and would become a part of the backbone of the NEPS by FY 2009 (see Figure 5.1).[47] Tajikistan would also supply power from its system to some of the Afghan border towns. In addition, Tajikistan was planning to construct a double-circuit 220 kV line from Lalazar to Kulab within Tajikistan, one circuit of which would be made available for extension into the Faizabad area in the Badakshan province of Afghanistan and perhaps eventually for interconnection with Kabul. Since the supply from Tajikistan would be seasonal, it may have to be supplemented by imports from Uzbekistan and Turkmenistan during fall and winter.

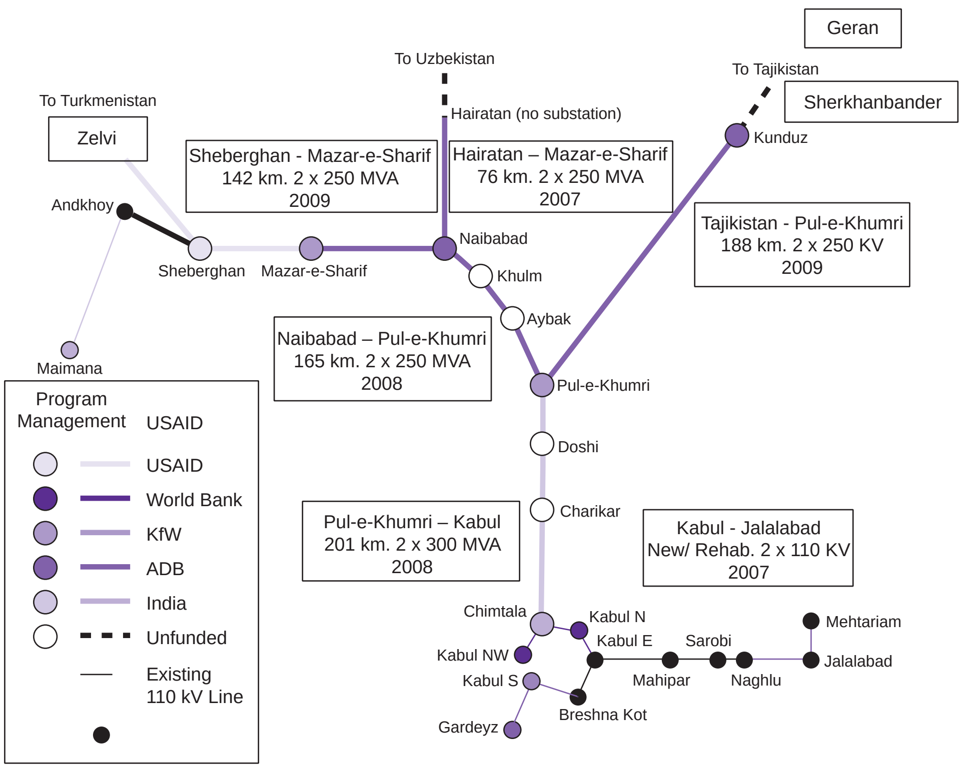
*Uzbekistan* has an installed capacity exceeding 11,500 MW and an annual generation exceeding 49 TWh and a peak demand of about 7,700 MW. It has recently commissioned the first 800 MW unit of Talimardjan Thermal Power plant, and expects to construct three more units of the same size in the medium term. Uzbekistan has considerable natural gas and coal resources, and its generation mix is predominantly thermal. Unlike Tajikistan and Kyrgyz Republic, it could provide year-round firm supply of electricity to Afghanistan. Uzbekistan exports electricity through a 220 kV double-circuit line from

[45] "Power Sector Master Plan, Transitional Islamic State of Afghanistan," October 2004; prepared by Norconsult and Norplan.

[46] Though the Power System Master Plan (2004) of Afghanistan calculates the long term average incremental cost of power generation at 5.0 cents/kWh, realistically short to medium term marginal cost of generation is most likely to be the economic cost of production by diesel generators, at around 10 to 15 cents per kWh. Imports from Central Asia and Iran presently are priced in the range of 2.0 cents to 2.65 cents per kWh, which probably reflects their short-term marginal cost and, at least in case of Iran, may contain a subsidy element as a form of external assistance. Given the general surplus of electricity in Central Asia, imports should remain cost-effective options for Afghanistan.

[47] ADB is also financing a dedicated 220 kV line from a substation near Sangtuda I to connect to the line in Afghanistan at Sherkhanbander.

**Figure 5.1** Evolution of the North East Power System (NEPS)




*Source:* IRP Afghan Energy Information Center (AEIC).

Termez to Mazar-e-Sharif currently operated at 110 kV. The supply that was suspended in 1999 during the Taliban rule was resumed in August 2002. In May 2003 a Protocol of Intentions was signed between the Afghan Ministry of Water and Power and Uzbekenergo, which indicated that Uzbekistan would provide up to 150 MW for a 10 year period. The price during the first year would be 2.0 cents/kWh. Prices for subsequent years had to be negotiated.[48] An Afghan delegation visited Tashkent in July 2006 with a request for imports up to 300 MW and for the establishment of the technical conditions. Uzbekenergo indicated the specific transmission constraints in its system that limit the supply capability to 85 MW. The Afghan side is following up with the Uzbek government for undertaking investments to eliminate these constraints to enable supply of 300 MW.

*Turkmenistan* is well endowed with natural gas resources and has a power system (with entirely thermal generation) capable of providing firm year-round supply. With an installed capacity of nearly 3,000 MW and a production level of 12.34 TWh of electricity in 2005 (an 8 percent increase from 2004), Turkmenistan exported electricity in 2005 to Turkey (534.6 GWh), Iran (598.9 GWh), and to Afghanistan (160 GWh). Its total exports at 1.3 TWh were 13.8 percent more than in 2004. Turkmenistan is thus a good source of firm power to Afghanistan's western and northwestern provinces. In October 2003, Turkmenistan is reported to have signed an agreement with Afghanistan for supplying 165 GWh via the 110 kV line to Andkhoy–Jawzjan–Sheberghan area and another 160 GWh via the Gushby-Herat line (220 kV operated at 110 kV) to Herat area at a price of 2.0 cents per kWh.

Under the MOU of April 25, 2006, Turkmenistan has agreed to extend 220 kV lines to border towns of Afghanistan and supply power. In principle,

[48] Price was increased to 2.3 U.S. cents the following year and currently is 2.65 U.S. cents per kWh.

Turkmenistan signed the MOU for the supply of 300 MW of firm power. On June 7, 2006, the Ministries of Energy of the two countries signed a protocol for the supply of 200 MW in the first stage. However actual imports reported by DABM amounted only to 97.9 and 165.3 GWh in FY 2005 and FY 2006, respectively.

In the first three months of FY 2007, the imports amounted to 47.7 GWh.[49] In order to increase the imports at least to the levels covered by the protocols, the operation of the Gushby to Herat line needs to be upgraded to 220 kV level and the proposed new 220 kV line from Zelvi (Turkmenistan) to Mazar-e-sharif should be completed. The plan is to build the 130 km long 220 kV double-circuit line from Zelvi (Turkmenistan) to Sheberghan and then on to Mazar-e-sharif (Afghanistan) under USAID financing. The feasibility study for this would be completed in 2007. At that time, a solution will need to be found to resolve the situation arising from Turkmenistan operating synchronously with Iran and not with the rest of the Central Asian Republics.

*Iran* has an installed power-generation capacity exceeding 34,000 MW and a generation exceeding 149 TWh. However, the power systems in the provinces of Khorasan and Sistan Va Baluchistan adjoining Afghanistan are isolated from the much larger interconnected western grid and actually import 599 GWh from Turkmenistan (2005). Nonetheless, supply of the relatively small volumes contracted so far (50 MW and 6MW) to Afghanistan has not presented a problem. Iran supplies power now through a double-circuit 132 kV line (150 km) from Torbat-e-jam to Herat, which it financed and constructed and commissioned in January 2005. In addition, power flows to the Herat area through two 20 kV lines from Iran. Furthermore, Iran supplies Zaranj, a border town in the Nimroz province, through a 20 kV line opened by Iran in March 2004.

[49] The financial year of Afghanistan government ends on March 20.

Khorasan province of Iran is already importing notable quantities of power from Turkmenistan. Iran has recently signed an agreement with Tajikistan to invest in the construction of Sangtuda II hydroelectric project (270 MW run of river scheme), the output of which will go to Iran (Mashad area of Khorasan province). The related transmission line would most probably pass through Afghanistan, providing the latter an opportunity to earn transit fees. It may also provide an opportunity to integrate the Herat grid with NEPS. In 2006, Iranian power was being supplied at a price of 2.25 cents/kWh.

Actual imports of electricity in Afghanistan appear to run well behind agreed volumes of power, largely on account of transmission and distribution constraints. Donors are doing their best in providing timely funding for the needed improvements. Construction seems to be impeded by the cost and time needed to clear the areas of mines, as well as by the need to ensure that compensation amounts for the right of way are paid fully and recorded in a timely manner. Some special efforts appear to be needed to reduce the cost and speed up the operation. Costs of de-mining need to be more fully incorporated into the cost structure of the projects.

## Iran–Pakistan Bilateral Electricity Trade

The details of the existing import of power by Pakistan from Iran were given in Chapter 2. The supply by 132 kV line is mainly for the area around the deep-seaport of Gwadar in Pakistan. Anticipating an increase in demand induced by the port-related developments, WAPDA has negotiated for increased supply levels up to 100 MW and has made arrangements for a new 220kV link. Gwadar is the only deep-seaport, other than Karachi in Pakistan, and growth in its hinterland is likely to be substantial. The import price of power appears to have risen from 3 cents to about 6.25 cents/kWh. When the Iran–Pakistan–India gas pipeline project materializes, it will pass through this area, and a gas-based combined cycle power plant could be constructed to meet the likely demand growth.

## Pakistan–India and Pakistan–Afghanistan Bilateral Electricity Trade

Toward the end of the 1990s, Pakistan faced a surplus power situation when demand did not grow as forecast, and when WAPDA faced financial problems arising from the take or pay contracts with a significant number of IPPs. In that context, both Pakistan and the IPPs explored the possibility of exporting surplus power to India. Despite a great deal of discussions at various levels, the trade did not materialize because of the big difference in the power price WAPDA wanted (7.5 cents/kWh) and the price that the Power Grid Corporation of India was willing to pay (2.25 cents/kWh). It was, however, recognized at that time that interconnections and operating agreements would present no major problems.[50]

Currently, there are no electrical interconnections and no electricity trade between the two countries. The western and northern regions of the Indian national grid, which adjoin Pakistan's grid in Punjab and Sind Provinces, currently have peak capacity shortages of 6,000 MW and 3,700 MW and energy shortages of 25TWh and 21TWh, respectively. The Pakistan grid is short of firm power and suffers from peaking shortages in summer. The seasonal variations in demand are about the same on both sides. There is thus no immediate export/import advantage to either side by interconnecting the grids. Medium- or low-voltage links could help border villages and settlements. However, strong extra high voltage links (400 kV or above) from the Pakistan grid to both northern and western regions of the Indian grid would be warranted in the context of major power imports from Central Asia, perhaps in the context of stage II of the proposed CA–SA electricity trade project.

Apart from enabling the import of Central Asian power, the two grids would have the advantages associated with synchronous operation of adjoining grids, namely better system security and reliability at a lower cost and better ability to take care of unanticipated outages arising from accidents, as well as better ability to balance the systems in real time. Such interconnections could conceivably enable Nepal (and possibly Bhutan) to diversify their export markets to Pakistan in the context of the transfer capacity in the Indian grid being stepped up to more than 30,000 MW in the medium term. The thaw in the political tensions between the two countries and the progress in confidence-building measures would seem to indicate that future development along these lines is likely.

Pakistan–Afghanistan bilateral electricity trade had been discussed on several occasions, and WAPDA had even prepared proposals for several cross-border interconnections at 20 kV. However, none of them materialized. Pakistan appears to be concerned about the payment risks. Pakistan is finding it difficult to collect payments and disconnect nonpayers from its own federally administered tribal areas adjoining Afghanistan. In this context, disconnecting supply to the customers in Afghanistan might become a politically sensitive issue. Thus, the bilateral trade may have to wait until the CA–SA trade arrangements materialize.

## Central Asia–South Asia Multilateral Electricity Trade

During Soviet rule, the power systems of the five countries of Central Asia (Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan) operated synchronously. Upon the dissolution of the Soviet Union, this multilateral "pool" was replaced by a system of bilateral cross-border transactions. As a result, the volume of trade declined by about 68 percent during the 1990s, from about 25 TWh to 8 TWh. The decline was caused by a range of reasons that included a dramatic decline in electricity demand, the use of barter of electricity for fossil fuels, and the quick rise in the traded fossil fuel

[50] Presentation by Dr. Mahendra P. Lama of Jawaharlal Nehru University, New Delhi, *Economic Reforms and Power Sector in South Asia: Scope and Challenges for Cross Border Trade* available at the Web site of USAID SARI-E Program, www.sari-energy.org

prices to world traded level, while electricity prices stagnated. However, the most important reason was the breakdown of the traditional regional water-sharing agreements and the associated electricity trading arrangements. These impediments have to be overcome to improve the volume of mutually beneficial trading among the Central Asian countries. However, electricity surpluses are there in all Central Asian countries, and internal trade among them and trade with Afghanistan alone cannot absorb the exportable surplus.[51] It is in this context that the idea of exporting the surplus to Pakistan and in the later stages possibly to India in a multilateral framework emerged.

Pakistan's peak demand now exceeds 14,000 MW and the current installed capacity of 19,500 MW (33 percent hydro, 65 percent thermal, and 2 percent nuclear) has become inadequate on account of the wide variations in the water availability that greatly reduces the firm capacity available. The economy had been growing at around 6 to 7 percent in the past four years and is expected to maintain such growth rates during the next several years. Electricity demand at the generation level is forecast to grow at 7 to 8 percent per year to about 20,000 MW by FY 2010, and 44,700 by FY 2020. The country, which had a comfortable supply position during the last several years, has already started experiencing shortages during peak periods and it is anticipated that if no new capacity is added, firm power shortages would amount to 5,500 MW by FY 2010. By FY 2011 energy shortages would amount to about 35 TWh. The array of options considered to meet this demand include supply efficiency, demand management, addition of new hydro and thermal power capacities under both public and private ownerships, *as well as electricity imports from Central Asia, starting with 1,000 MW in the initial phase.* If the imports prove reliable and competitive, the volumes could rise substantially in the second phase. The particularly attractive feature of this proposal is that Pakistan's peak demand occurs in summer, when the Central Asian power systems have large surpluses from their hydroelectric generating stations.[52]

Efforts to develop the first transregional electricity trade project commenced at the regional conference in Islamabad, in May 2006, which was attended by the experts of power utilities and governments officials of Afghanistan, Kyrgyz Republic, Pakistan, and Tajikistan as well as representatives of a number of IFIs and bilateral donors (World Bank, IFC, Asian Development Bank, Islamic Development Bank, and USAID) and interested private sector investors (AES of the United States and RAO UES of Russia). In this conference, Pakistan formally expressed its interest in importing 1,000 MW of power from Tajikistan and the Kyrgyz Republic. Should the arrangement for the first stage prove reliable and competitive, Pakistan indicated it would consider further increasing the import volume, perhaps as high as 4,000 MW. Tajikistan and the Kyrgyz Republic confirmed their desire to export, and Afghanistan agreed to enable the transit of power and also to eventually import some quantities for its own market. A Multi-Country Working Group (MCWG) was set up to initiate analytical, institutional, organizational, and other activities for the preparation of this Central Asia–South Asia 1,000 MW (*CASA 1000*) project with assistance from IFIs, led by the World Bank. The World Bank has financed the consulting services to assist the MCWG in the initial stages of the work. An important outcome of this meeting was the shared recognition that there are significant opportunities for, and advantages from, expanding the trade over time to include other countries both on the selling and buying sides, creating an integrated regional electricity market. At the subsequent regional conference in Dushanbe (October 26–28, 2006), the four countries signed a memorandum of

[51] For a more detailed discussion of these aspects see "Water and Energy Nexus in Central Asia," World Bank (February 2004) and "Central Asia: Regional Electricity Export Potential Study," World Bank (December 2004).

[52] Pakistan also experiences supply shortages in winter months too, when natural gas supplies are diverted from electricity production to household use.

understanding on project development for building a high-voltage transmission line between Tajikistan and Pakistan via Afghanistan, and created a ministerial Council to coordinate the effort.

Several developments preceding the Islamabad conference are indicative of the potential for development of a broad-based electricity trade in the region:

- RAO UES of Russia has formed a joint venture (75 percent RAO UES and 25 percent Tajik government) that has obtained the right to take over and complete the construction of the run-of-river hydroelectric project Sangtuda I (670 MW, energy 2,700 GWh/year, 60 percent of which would be in summer). The construction is under way, to be completed in 2009. The joint venture has approached the IFIs for possible equity participation and debt financing.[53] The output is targeted for exports, mainly to Pakistan.
- AES, a U.S.-based strategic international investor in the power sector, which already has assets in Central Asia and South Asia, has reportedly signed an MOU with the Tajik government for undertaking transmission investments and hydropower station rehabilitation investments and also offering to handle the export of 1,500 GWh (about 300 MW) from the existing summer surplus of Tajikistan to Afghanistan and South Asia.
- A study by NESPAK, a Pakistani consulting firm, completed a preliminary evaluation of possible electricity transmission routes between Tajikistan and Pakistan. Two main routing options were considered: (1) a 650 km route passing through Kunduz and Kabul/Jalalabad in Afghanistan, with 170 km of the route passing through Tajikistan, 430 km through Afghanistan, and 50 km through Pakistan; and (2) a 700 km route that would minimize the length of transmission through Afghanistan, with only 30 km passing through the narrow Wakhan corridor, with the rest of the route going through Tajikistan (360 km) and Pakistan (310 km). The technological options included 500 kV and 765 kV AC lines and 250 kV and 400 kV DC lines. The Wakhan route was estimated to be costlier by 40 to 60 percent on account of the very high elevation and the extremely difficult nature of the terrain and weather conditions.

It may be noteworthy to mention some other developments indicative of the interests of the countries and private sector in regional electricity projects:

- Iran has signed an MOU with Tajikistan to set up a joint venture to develop a run-of-river hydroelectric project, Sangtuda II (220 MW, 990 GWh). The output is intended for export to Khorasan province of Iran via Afghanistan.
- A large aluminum producer of Russia, Rusal, has evinced interest in investing in the Rogun storage hydroelectric project (3,600 MW, 13,000 GWh, incremental investment exceeding $2 billion) and has carried out feasibility studies by a German consultant. As a storage hydro project, Rogun would need inter-governmental agreement among riparian states on water use and reservoir-operating regimes and might therefore may take a longer time to materialize.

In order to supply 1,000 MW to Pakistan, other suppliers may have to join the Sangtuda Joint Venture Power Company, which can provide only up to 670 MW. The summer surpluses of the existing Tajik system may provide another 300 MW even after setting apart the 300 MW that it had agreed to provide for Afghanistan through the 220 kV lines (discussed earlier in the chapter). Golovnaya Hydropower station in the Nurek cascade of Tajikistan could provide an additional 80 MW to 100 MW after its rehabilitation. Summer surpluses from the Kyrgyz system

[53] Most probably, the equity of Tajik government would remain at 25 percent. RAO UES may divest a portion of its 75 percent shares to IFC and EBRD, but is expected to keep at least 50 percent of the shares for itself.

could provide up to 600 MW, provided that the current transmission constraint of the lines passing through Uzbekistan is eliminated by constructing a bypass 220 kV line (capital cost estimated at $45 million) within the territories of Kyrgyz Republic and Tajikistan.

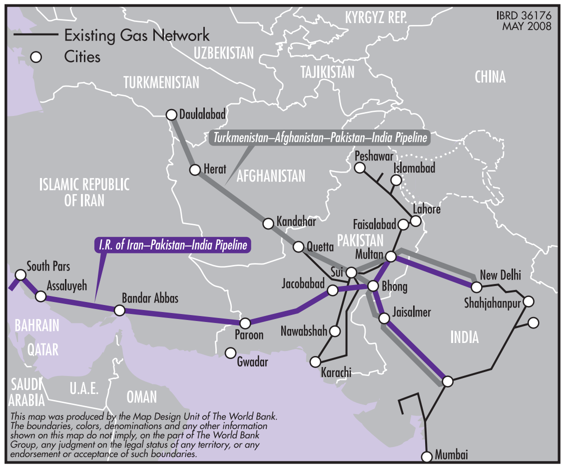
Attractively priced thermal power from the northern parts of Kazakhstan (such as Ekibastuz) could flow to the Kyrgyz Republic through the second north–south 500 kV line, currently under construction in Kazakhstan, although it remains to be seen how much capacity would be available for exports versus supplying the southern Kazakhstan. However, it could flow further south only if the bypass line is upgraded to 500 kV level. In order to enable the Kazakh power and the Kyrgyz power to reach the Nurek cascade in the southern part of Tajikistan, a north–south 500 kV line has to be constructed in Tajikistan, and this line has already been funded by the Chinese export credits of $267 million and is expected to be ready by FY 2008–2009**.** Thermal power supplies from Kazakhstan could help to increase the volume of firm (year-round) power supply to Pakistan. Rogun storage hydro could provide this type of support, if and when the plant is built. Uzbekistan and Turkmenistan also may have a potential to add thermal power to the export surplus of the region.

The CASA 1000 project, as agreed at the Islamabad and Dushanbe conferences, will start with analytical studies to examine the merits and the scope of the potential trade and commercial options for structuring the project as a public-private partnership (PPP) arrangement. One study would focus on technical, economic, and safeguard issues, while another one would examine institutional, financial, legal, and risk-mitigation issues of the possible commercial structural options.

Apart from carrying out the usual due diligence needed to satisfy the potential financiers (which may come both from the private and public sectors), the two proposed studies would analyze and enable decision making with respect to some key issues:

- *The assessment of trade potential and th*e associated benefits. The studies should establish the volumes of electricity available for export over time (including through additional investments in generation), the cost range for these exports, demand in the importing countries, and the price range that the importing markets could or would be willing to bear.
- *Selection of transmission corridor and technology.* Connecting a number of disparate power systems over difficult terrain would present significant technical challenges. The options involving high voltage direct current (HVDC) technology may minimize initial problems, but are costlier and less flexible for further expansion in comparison with the high voltage alternate current (HVAC) technologies. The trade-off would need to be carefully evaluated.
- *Institutional, financial, and regulatory issues.* There would be a number of potential exporters: Sangtuda Power Company, Barki Tajik, and the Kyrgyz Power Generation Company, to start with, and at a later stage private trading companies set up by investors; and possibly other countries (Kazakhstan and Uzbekistan). The importers would be the Pakistan power utilities, with the possibility of Afghanistan's DABM also becoming an importer, perhaps at a later stage. The trade volume would increase over time, and there may be a need to expand the transmission capacity. Other issues to consider include structuring the trade with multiple sellers and, at a later stage, multiple buyers; determining responsibility for transmission investments; allocating the transmission risk; dealing with nonpayment risks; ensuring the neutrality of the transmission system planning, ownership, operation, and maintenance; allocating the transmission capacity among the sellers (and buyers); determining, administrating, and overseeing transmission access rules; payment clearance and settlement; and, last but not least, the method of resolution of the potential dispatch conflicts between regional and domestic transactions.
- *Risk-mitigation strategies.* The project would face a number of risks, some of them unique

**Figure 5.2** Gas Pipeline Proposals from Turkmenistan and Iran to South Asia




*Source:* ADB presentation in the Delhi Conference of November 2006.

to this case, such as the nature and the level of security risks through Afghanistan and innovative risk-mitigation strategies they would call for, combining financial risk-mitigation instruments with social, technical, and operational measures.

- *Intergovernmental agreement*. An overarching intergovernmental agreement may have to be concluded, covering the key aspects on which government approvals and cooperation are needed. The agreement, among other things, would deal with institutional and regulatory arrangements, coordination and harmonization of policies and regulations, right of way issues, coordination of water releases and electricity generation, risk mitigation, and the rules for expanding the arrangements to additional players and volumes of trade. Laws may have to be enacted and rules under them may have to be issued in the relevant countries to enable the construction, ownership, and operation of the project by transnational entities or their subsidiaries.

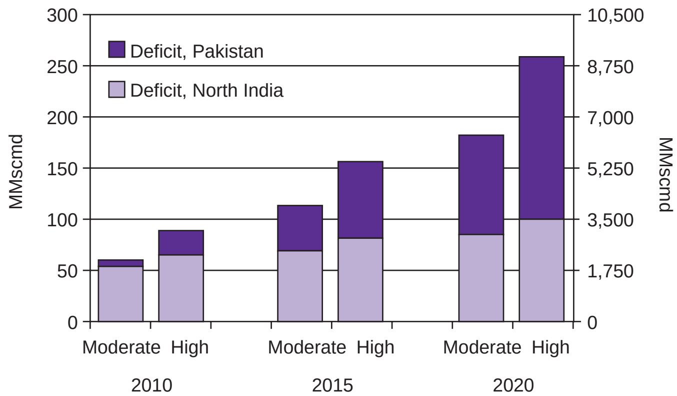
These are complex issues that need to be thoroughly investigated and analyzed to inform decision makers on the available options and their trade-offs. A number of similar projects carried out elsewhere in the world could offer valuable lessons and guidance. The region itself also has some relevant experience and expertise. Pakistan has extensive experience in dealing with private investors and IPPs in the power sector. The Tajik government also has some experience in dealing with the private sector on the basis of the PPP arrangements in the Gorno Badakshan area with respect to Pamir Power Project. Central Asia has experience in operating interconnected systems. Considering the poor access of most of the countries to the capital markets and the limitations of the resources that the IFIs could offer, some form of public–private partnership appears highly desirable and even inevitable for the project to materialize and operate dependably. Private interests have already materialized in the generation component and have been evinced for the transmission and trading components as well.

## Turkmenistan, Afghanistan, and Pakistan Natural Gas Trade (TAP)

The governments of Turkmenistan, Afghanistan, and Pakistan have been examining since 2002 a gas pipeline project to enable Turkmenistan to export about 30 bcm of gas per year to Pakistan via Afghanistan (see Figure 5.2).[54] A series of related studies have been carried out with Asian Development Bank assistance.

[54] This section is drawn from the presentation made by ADB in the Second Regional Economic Conference for Afghanistan held in Delhi in November 2006, available at the Web site http://meaindia.nic.in/srec/frame.php?s=internalpages/rbusiness.htm.

**Figure 5.3** Natural Gas Deficit Projections in Pakistan and India




*Source:* ADB presentation in the Delhi Conference of November 2006.

The pipeline with a diameter of 56 inches would be 1,680 km long and is estimated to cost $3.3 billion. It would have the capacity to transport 30 bcm of gas per year. Gas will come from the Daulatabad fields of Turkmenistan, which is estimated to have a reserve of 1.4 trillion cubic meters of gas. Its current level of production is 20 bcm a year, while it is capable of producing 45 bcm of gas per year. In November 2006 the Turkmenistan government announced the discovery of a new gas field near Mary with a reserve of 1.0 trillion cubic meters. The TAP pipeline project would transport about one trillion cubic meters of gas over its life span of 30 years.

Gas market reviews in Pakistan indicate that Pakistan's gas demand alone can support an import project of only 20 bcm per year (see Figure 5.3). The participants therefore are desirous that India should join the project as an importer to improve the economics of the project with a transport capacity of 30 bcm per year, and formally extended an invitation to India when it attended the steering committee meeting on February 9, 2006, as an observer.[55]

The study finds that the pipeline option compares favorably with LNG option and the option of importing gas from Qatar. Based on the gas input price at Turkmenistan of $58 to $51 per thousand cubic meters of gas (corresponding to $1.63 to $1.44 per million Btu) and sale price in Pakistan of $77.5 to $71.04 per thousand cubic meters (or $2.18 to $2.0 per million Btu), the project FIRR was estimated at 10.1 percent and 10.4 percent, respectively. Using early 2005 range of border and end user prices, FIRR seems to be around 15 percent. Afghanistan hopes to earn transit fees in the range of $100 million to $300 million and has promised full cooperation.

Some of the key issues to be sorted out include the robustness of the reserves data in Turkmenistan and the need to have it properly certified; possible need to associate Uzbekistan and Kazakhstan to provide supplemental gas resources; the ability and willingness of Turkmenistan to feed this pipeline while fully honoring its earlier commitments to Gazprom for the European and former Soviet Union markets; and the extent of possible private-sector interest.[56] Further, the sharp increases in gas prices delivered to the European markets could make the option of exporting to South Asia less attractive to Turkmenistan, and thus the export price could also become a major issue.

[55] Integrated Energy Policy Report (2006) of the government of India envisages import dependence for natural gas from 0 to 49 percent during the period through FY 2032, depending on the price of natural gas. At prices higher than $4.5 per million Btu, natural gas is not believed to be competitive with coal (which remains at $2.27 per million Btu even after blending with imported coals), even for peaking power.

[56] Bridas Corporation of Argentina, China National Petroleum Corporation, Gazprom, and OMV of Austria are believed to have shown interest in the project at different times.

### Box 5.2 Gas Sector in Pakistan

Proven natural gas reserves of Pakistan as of January 2005, are reported as 26.83tcf (759.2 bcm) by the *Oil and Gas Journal*. The Web site of the Ministry of Petroleum and Natural Resources, however, reports a slightly higher reserve figure of 28.51 tcf (807.4 bcm) as of June 2005. More recent reports suggest a reserve level of 32.8 TCF (929.2 bcm). Production in FY 2005 amounted to 38.26 bcm. Total length of transmission pipelines was at 9,183 km and that of distribution and service lines amounted to 72,434 km as of March 2006. There were 4.5 million consumers, with a total consumption of 32.89 bcm in FY 2005 and a consumption of 25.9 bcm in the first nine months of FY 2006. The largest share of consumption went to power (43.7 percent), followed by general industry (19.5 percent), fertilizer (16.4 percent), households (14.8 percent), commercial consumers (2.3 percent), and transport (2.1 percent). Gas losses in the system amounted to about 7 to 7.5 percent of the total input into the system.

Past demand growth in gas consumption was at about 8.5 percent a year. Future demand growth is forecast at about 7 percent a year. It is estimated that the domestic production will peak in FY 2010 and start declining rapidly after FY 2013. Supply shortfall is expected to be between 4 and 10 percent of the demand by 2010 and would thereafter increase rapidly to 20 percent of the demand. It is in this context that import options through pipelines from Iran, Central Asia, and Qatar and LNG imports are being pursued. An LNG terminal with a capacity of 3.5 million tons will be built in Karachi by a project developer to be selected on a competitive basis. First shipments of LNG are expected by 2011. Attempts are also being made to discover new gas fields and improve yields from existing fields. An agreement has been concluded with Gazprom for research and development regarding future gas fields.

As per the tariff prevailing on January 1, 2006, the end-use gas tariffs per million BTU for the lowest block (below 100 cubic meters per month) and the highest block (above 300 cubic meters per month) of household consumption were $1.35 and $5.13, respectively. The tariffs for commercial consumers and general industries (including power) were at $4.53 and $4.03, respectively. Supply to the fertilizer industry for use as feedstock was at rates from $0.61 to $1.48. The tariff for the power companies at around $3.95 does not appear to be unduly subsidized. The first block of household tariff covered 82 percent of the consumption in winter and 54 percent of the consumption in the remaining months. The tariffs for this block and for fertilizer factories were heavily subsidized and did not cover even the commodity cost of gas, let alone the transmission and distribution margins. In FY 2003, the total subsidy for these two categories amounted to Rs 23 billion (or $397 million).

In the tariffs revised on June 30, 2006, one new block was introduced for households. The lowest block had a consumption ceiling of 50 cubic meters/month. The price for this block was increased by 5 percent, while the prices for all other categories were increased by 10 percent. However, in the revised tariffs notified effective from February 1, 2007, price for this category had been reduced by 7.8 percent. Commercial consumers had a reduction of 10 percent. In the context of the need for the expensive imports of piped gas and LNG, further domestic price corrections would be necessary.

*Sources:* www.mpnr.gov.pk, www.dawn.com/2006/07/29/top16.htm, www.orga.org.pk, Country Analysis Brief of U.S. DOE available at www.usdoe.eia

Challenges include determining how to mitigate the security risk in Afghanistan, improving India–Pakistan relations, and minimizing or phasing out fuel subsidies in both countries. An additional challenge is whether the pipeline can withstand competition from LNG in the long run (see Box 5.2).

## Iran–Pakistan–India Natural Gas Pipeline (IPI)

The possibility of import of natural gas from the South Pars gas field of Iran to Pakistan and India by a 2,670-km-long 48-inch-diameter overland pipeline passing through Iran, Balochistan, and Punjab provinces of Pakistan, and then on to India at a cost of around $7 billion (see Figure 5.2 that shows IPI in white line and TAP in Blue line) has been discussed for over a decade now. It was originally intended to supply 150 million cubic meters per day (or 54.75 bcm/year) of gas to India and 60 million cubic meters/day (or 21.9 bcm/year) of gas to Pakistan for a period of 25 years. Gazprom of Russia (with whom Pakistan has an agreement for research and development of future gas fields) has expressed interest in investing in this project.

A joint working group of the three governments was working out the details while financial, technical, and legal consultants were advising each of the three governments. Pricing appeared to be a major issue in concluding the negotiations. Iran's approach seemed to adopt the same level of pricing at which the government of India concluded a deal with the National Iranian Oil Company in January 2005, for the import of 5 million tons per year of LNG (later rising to 7.5 millions tons/year) for a period of 25 years commencing from FY 2010.[57] The buyers did not accept this approach to piped gas. As of November 28, 2006, the price for piped gas had not been agreed upon and the buyers had requested that the consulting firm engaged by Iran come up with a revised offer.

However, in January 2007, Pakistan and Iran signed a bilateral agreement in terms of which Iran will supply for a period of 30 years 2.1 bcf/day (21.7 bcm/year) of gas in the first phase and an additional 3.2 bcf/day (33.1 bcm/year) in the second phase to the Iran–Pakistan border at a price of $4.93/mmBtu.[58] Iran has already commenced the construction of a 56-inch-diameter gas pipeline from the Assaluyeh gas field (located 80 km north of the South Pars field) to Iran Shehr located within Iran 200 km west of the Pakistan border to meet the demands of its eastern provinces with a completion date of 2010. The supply to Pakistan border will be by one 56-inch-diameter pipeline in the first phase. In the second phase, the pipeline will be doubled.

Pakistan has proposed that it will construct a 1,036-km-long pipeline in its territory from its Iranian border to the Indian border (at an estimated cost of $3.5 billion and a completion date of 2013) and supply Iranian gas to India as shown in Table 5.2.

Pakistan has proposed that India pay a transit fee and a transmission charge to Pakistan, since it will transmit the gas through its territory and will be responsible for the safety and protection of the pipeline. India appears to have made a counterproposal (see Table 5.3). These are still under discussion and are likely to be settled in the near future.

The issue of price thus seems to be close to a resolution. The problem of transit through Balochistan seems to have been lessened by Pakistan assuming responsibility for transport and protection of the pipeline. The project seems to be poised for implementation on a priority basis. Other matters to be resolved would include the implications of the U.S. law that bars transactions with Iran valued at $20

[57] The FOB price of LNG per million Btu was stipulated in the contract as 6.5 percent of the average Brent crude price in dollars per barrel at the time shipping (subject to a maximum crude price of $31 per barrel) plus a fixed charge of $1.2 per million Btu. On this basis, the maximum FOB price of LNG would be $3.215 per million Btu. In the context of the massive increase in oil prices since then, Iranian government stated in August 2006, that the Supreme Economic Council had not approved the deal and wondered whether the contract was effective. Thus, these prices are likely to be renegotiated, especially in the context of Iran having concluded a contract subsequently with China for supplying 3 million tons/year of LNG for 25 years at a price of $5.0 per million Btu. It is understood that the Indian government has proposed the ceiling price to be adopted for Brent crude at $55 per barrel, resulting in the maximum FOB price of LNG at $4.775 per million Btu. The Iranian side seems to be bargaining for a maximum LNG price of $5.425 per million Btu adopting a ceiling price of $65 per barrel for Brent crude. In addition, LNG transportation cost from Iran to India, computed at $0.30 per million Btu, has to be paid.

[58] The pricing formula is similar to that proposed for LNG export. It consists of a variable part linked to the specified crude oil price, a fixed component and a transmission charge. The variable part is 6.3 percent of the Japanese Crude Cocktail Price in the range of $30 to $70/barrel. Currently, it is $3.78/mmBtu, corresponding to the crude price of $60/barrel. The fixed charge is $1.15/mmBtu and the transport charge to Pakistan border is $1.0/mmBtu. This results in the quoted price of $4.93/mmBtu for Pakistan. When crude price is below the range of $30 to $70, the fixed price will increase to $1.54/mmBtu. When it is above the range, the fixed price will be $2.06/mmBtu. This has been found acceptable to both India and Pakistan (see http://timesofindia.indiatimes.com/articleshow/msid-186370 news item, April 6, 2007).

| Table 5.2 | Planned Supply of Gas from Iran to India and Pakistan (mmcfd) | | |
|---|---|---|---|
| **Phase** | **Share of Pakistan** | **Share of India** | **Total from Iran** |
| Phase 1 | 1.05 | 1.05 | 2.1 |
| Phase 2 | 1.05 | 2.15 | 3.2 |
| Total (both Phases) | 2.1 | 3.2 | 5.4 |

*Source:* http://timesofindia.indiatimes.com/articleshow/msid-186370 News of April 6, 2007.

| Table 5.3 | Price Proposal for the Supply of Iranian Gas to India ($/mmBtu) | | | |
|---|---|---|---|---|
| **Country Proposal** | **Gas Price at Iran/Pak Border** | **Pakistan Transit Fee** | **Pakistan Transmission Charge** | **Total Landed Cost at the Indian Border** |
| Pakistan's proposal | 4.93 | 0.49 | 1.57 | 6.99 |
| India's proposal | 4.93 | 0.25 | 0.50 | 5.68 |

*Source:* http://timesofindia.indiatimes.com/articleshow/msid-186370 News of April 6, 2007.

million or more, and the UN sanctions regime, as these might discourage the participation by international contractors. To sustain this trade on a commercial basis and to expand trade on similar lines, Pakistan and India may need to improve their domestic gas price regimes and minimize subsidies (see Box 5.2 and Box 5.3 and also Chapter 6).

A substantial body of public opinion exists both in India and Pakistan that this would be a *peace pipeline* somewhat like the gas pipeline between Egypt and Turkey, creating mutually beneficial economic interdependencies and thus paving the way for speedier normalization of bilateral relations.

The project was first put together by BHPBilliton, a subsidiary of BHP of Australia, and subsequently several parties such as Petronas, Total, Shell, British Gas and Chinese National Petroleum Corporation have expressed investment interest in the project at different points in time.[59]

[59] This section is based on various sources including www.indiadaily.com/editorial/3149.asp, www.petroleum.nic.in, www.atimes.com/atimes/South Asia/GA11Df07.html, www.hinduonnet.com (August 12, 2005) and (August 5, 2006), www.atimes.com/atimes/South_Asia/HC28Df06.html (May 28, 2006), www.dawn.com/weekly/encounter/encounter3.htm, www.stratfor.com.

## Qatar-Pakistan-India Submarine Gas Pipeline

Another proposal to construct a gas pipeline from the Dome gas field of Qatar to India via United Arab Emirates, and Karachi of Pakistan had also been considered for a long time. The 1,830 km pipeline from Dome to UAE would be under the sea. As planned, it would cross UAE on land and go under the sea up to Karachi and then again go under the sea until it reaches the west coast of India. It has the advantage of avoiding the risk of possible supply disruption faced by surface pipeline passing through Balochistan, but is considered expensive in relation to the overland pipeline alternative, and even in relation to the LNG option. It is worth noting that India has already concluded contracts with Qatar for the supply of 7.5 million tons of LNG per year for 25 years commencing from 2003. Qatar has recently indicated that most of its gas is committed for LNG trade and the country could not spare the 2.6 bcf/day of gas required for the pipeline project during the next 8 to 10 years.

## Summary of Prospects in the SAR Western Energy Market

The collection of the bilateral electricity trade deals and the emergence of the multilateral projects such as CASA–1,000 could become the

## Box 5.3 Gas Sector in India

Indian natural gas reserves were estimated at 1,101 bcm in FY 2006. With annual production of about 32.2 bcm the reserve-to-production ratio is about 34 years. In addition, LNG imports have just commenced at the rate of 2.3 million tons/year. The largest share of the total gas consumption was in the power sector (37 percent), followed by fertilizer (35 percent), transport (9 percent), steel (6 percent), and others (14 percent).

About 79 percent of the gas production in the country is by the state-owned companies Oil and Natural Gas Corporation (ONGC) and Oil India Limited (OIL). The remaining 21 percent is by the private investors and joint venture companies. The reserve data do not include the significant and recent discoveries in the Krishna Godavari basin off India's eastern coast. In this basin, Reliance Industries Limited (RIL) and Gujarat State Petroleum Corporation (GSPC) are believed to have reserves of 396.6 bcm and 566.57 bcm, respectively. RIL would produce 29.2 bcm of gas per year. Production of GSPC would be about 25.5 bcm per year.

On the basis of GDP growth rate of 9 percent per year, the demand for natural gas is forecast to grow at the compounded annual growth rate (CAGR) 8.0 percent from 31 bcm in FY 2004 to 267 bcm in FY 2032. Gas demand for power would grow faster at 9.34 percent from 11 bcm to 134 bcm, while the gas demand for nonpower uses would grow at 7.0 percent from 20 bcm to 133 bcm during the same period.

The Integrated Energy Policy Report of the Expert Committee of the Planning Commission of India (August 2006) conservatively assumes that the annual domestic gas production would increase to about 111 bcm by FY 2032. On this basis, the import dependency would be about 156 bcm, or about 58 percent. At 8 percent annual GDP growth rates, the import dependency may fall to about 108 bcm, or 49 percent. The recent sharp increases in the price of oil and the associated price of traded LNG, as well as piped gas from abroad, may affect the gas demand growth, especially in the power sector, as, at prices of $4.5 per million BTU of gas or higher, gas is not considered competitive in relation to coal, even for peaking power, as long as coal price remains at $ 2.27 per million BTU ($45/ton of imported coal with 6000 kcal/kg).

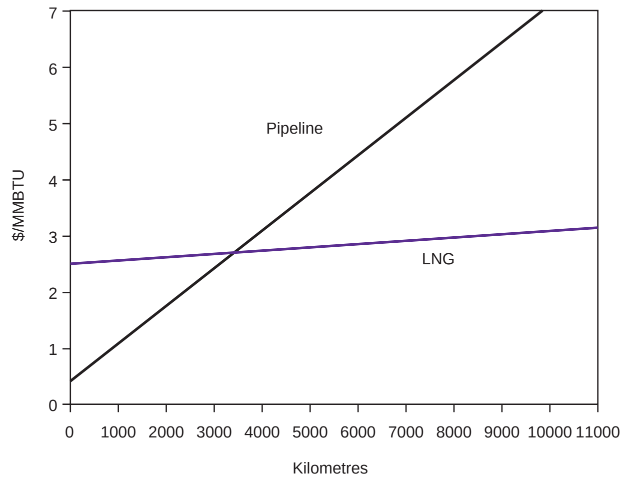
The gas pipeline infrastructure in India is rapidly expanding. GAIL is constructing the various links to create the national gas grid to handle the expanding domestic gas production, as well the gas from the several terminals importing LNG. Reliance is constructing the pipelines to transmit gas from Krishna Godavari basin area to Mangalore in the south, Jamnagar in the west, and Dadri in the north. RIL, GAIL, and ONGC are forming a joint venture to set up gas distribution projects. Reliance has applied for gas distribution rights in 100 cities. Many other domestic and foreign investors too have applied for distribution rights in other cities. GSPC will carry out gas distribution and CNG distribution (for vehicles) in 40 cities and towns of Gujarat.

LNG terminals at Dahej (5 million tons/year) and Hazira (2.5 million tons/yr) are in operation. The one at Dabhol (5 million tons/yr) is expected to be in operation any time now. The terminal in Cochin (5 million tons/yr) will be in operation by FY 2009 and that in Ennore (2.5 million tons/yr) and Phase II of Dahej during 2009–2012. By 2010, LNG re-gasification capacity is expected to be 25 million tons/year. One half of this is already tied up through long-term contracts with Qatar and Iran. The rest will be tied up by FY 2010.

ONGC of India is involved in exploration, development, and production of oil and gas in at least 12 countries abroad. These countries include Myanmar, Russia, Vietnam, Qatar, Sudan, Nigeria, Ivory Coast, Libya, Egypt, Syria, Iraq, and Iran. In Myanmar, GAIL of India is also involved in exploration and production of offshore gas. Equity oil and gas from these investments are expected to improve the energy security of India. In addition, the supply strategy relies also on imported LNG and imported piped gas from Myanmar, Iran, Central Asia, and possibly also from Bangladesh.

*Source:* Integrated Energy Policy Report of the Expert Committee of the Planning Commission of India (August 2006).

**Figure 5.4** Gas Transport Economics (Piped Gas vs. LNG)




*Source:* "Options for Gas Supply for Sri Lanka – Presentation by Nexus" (June 2003) available at www.sari-energy.org/resourcereports.asp?cat=2

stepping stones for the eventual creation of an integrated Central Asia–South Asia Electricity Market (CASAREM), which could, over time, extend from the Central Asian Republics and Iran to Afghanistan, Pakistan, and possibly India (see Figure ??, linking with the large neighboring markets of Russia and China and creating a new paradigm for regional development and integration in the once-divided region. The same hope holds good for the emergence of a similar gas market also, especially when the distance between Iran or Central Asia and India is less than 3,500 km. For distances shorter than 3,500 km gas import through pipeline is competitive with LNG imports and re-gasification (see Figure 5.4).[60]

A summary of the prospects for the energy trade in the western energy market is given in Table 5.4 and the main cross boundary energy flows are indicated in the Map in Appendix 5.

## The Eastern Energy Market

In the potential eastern energy market, Bhutan, Nepal, and Myanmar have significant undeveloped hydropower potential and are likely to emerge as major exporters of hydroelectricity—mainly to India and possibly to Bangladesh (to a small extent). Major gas resources of Myanmar and Bangladesh could enable them to export natural gas mainly to India and to a much smaller extent to the border areas of Bhutan and Nepal.

The Indian power market is large and the demand growth is constantly outpacing supply growth. In FY 2007, India faced a capacity deficit of 13,727 MW (or 11.9 percent) and an energy shortage of 54,916 GWh (or 7.6 percent). Within India only the eastern region had an energy surplus of 8,500 GWh (or 12.2 percent) and all other regions had shortages of capacity and energy. The deficit is expected to widen in the foreseeable future.

Internal trade induced by the ABT and UI rate regime discussed in Chapter 4 on the national grid amounted to about 15,000 GWh, or 3 percent of the total volume handled in the national grid. The average traded price ranged from Rs 5.5 (12.5 cents/kWh) (off-peak) to Rs 5.75 (13.7 cents/kWh) (peak) in the third quarter of 2006. Bids under ICB for large power stations based on indigenous coal from captive mines indicate a levelized price of Rs 1.196/kWh (2.99 cents/kWh), and such bids for plants based on imported coal show levelized price of Rs.2.29/kWh (5.72 cents/kWh). Gas-based power with gas prices of $7/mmBtu is expected to cost Rs 3.7.kWh (9.25 cents/kWh). Prices from large hydro projects constructed or under

[60] "Options for Gas Supply for Sri Lanka—Presentation by Nexus" (June 2003) available at www.sari-energy.org/resourcereports.asp?cat=2.

**Table 5.4** Summary of the Trade Prospects in the Western Energy Market

| Importing Countries | Exporting Countries | | | | | |
|---|---|---|---|---|---|---|
| | CARs | Turkmenistan | Iran | Afghanistan | Pakistan | India |
| CARs | x | Some gas exports are possible; mutual electricity support | Unlikely (uncompetitive) | No scope | Limited (some emergency support possible) | No scope |
| Turkmenistan | Mutual electricity support | x | Unlikely (similarity of resources—gas; little scope in electricity) | No scope | No scope | No Scope |
| Iran | Limited power exports possible | Power exports are ongoing | x | No scope | No scope | No Scope |
| Afghanistan | Power exports are ongoing and should grow | Power exports are ongoing and should grow | Power export ongoing and may grow | x | Small cross-border power export possible | No scope |
| Pakistan | Potential for power exports | Significant potential for gas exports | Significant potential for gas export; cross-border electricity trade could grow | No scope for trade; Transit of electricity and gas | x | Mutual short-term trading support in power |
| India | Gas and power exports possible | Significant potential for gas exports | Significant potential for gas exports | No scope; Transit of gas | Mutual short-term trading support in power; transit of gas | x |

*Note:* CARs in this table denote Tajikistan, Uzbekistan, Kyrgyz Republic, and Kazakhstan only. Dark gray color denotes that trade prospects are significant and are either being exploited or can be brought to fruition in the short-to-medium term. Medium purple color denotes that prospects of the trade are good and may materialize in the medium term. Light gray color denotes that prospects for the trade are more limited and may materialize in the medium-to-long term, and light purple color denotes that the prospects for the trade are weak.

*Source:* Krishnaswamy et al. (2006).

construction range from 3.5 to 6 cents/kWh. Although domestic coal will continue to play an important role in India, it will not be possible to meet the entire demand for power in the country by domestic coal alone because of the difficulties relating to the expansion of coal mining and transport bottlenecks. The need for imported fuels (coal, LNG, and piped gas) and imported electricity will remain significant. Thus, India is an attractive power market from the point of view of volume and power prices.

## Bhutan–India Bilateral Electricity Trade

Bhutan–India bilateral trade had been going on for several decades and is the largest in the region in terms of volume. Bhutan exports more than 75 percent of its generated electricity to India. Power export receipts constituted 45 percent of the Bhutan government revenue and 12 percent of Bhutan's GDP till recently. When all six units of Tala Hydropower project were commissioned by early 2007, the export receipts were believed to have risen to 60 percent of the government revenues. India had provided 60 percent grant and 40 percent loan for the capital costs of Chukka (336 MW), Kurichu (60 MW), and Tala (1,020 MW) hydropower projects during 1974 to 2006 and has been purchasing all the surplus power at prices negotiated between the parties (currently 4.07 cents/kWh for Kurichu and 4.65 cents per kWh for Chukka). The price for Tala power is still being negotiated.[61]

Out of the total hydropower potential of Bhutan, 23,760 MW is considered techno-economically feasible. Only about 1,490 MW had been developed. India has signed an umbrella agreement with Bhutan under which the former provides project investigation, design and engineering services, as well as construction supervision services for hydropower projects, apart from providing highly concessional finance. In return, it would be entitled to import all the surplus power, after Bhutan's needs are met. Under the umbrella agreement, the Indian authorities have prepared detailed project reports for four major projects: Punatsangchu I (1,095 MW), Wangchu (900 MW), Bunakha (180 MW), and Sankosh multipurpose project (4,060 MW). Detailed project reports are under preparation for two more projects: Punatsangchu II (1,000 MW) and Mangdechu (360/600 MW). A prefeasibility report has been prepared for one multipurpose project, Manas (2,800 MW)[62]

In 2004, Bhutan updated its Power System Master Plan (2003–2023) with technical assistance from Norway. This examined 76 sites in all three river basins with a total capacity of 23,760 MW and prioritized six projects with a total capacity of 4,484 MW and total energy output of 21,085 GWh at an average capital cost of $835/kW for construction through 2024. Using a discount rate of 12 percent, the average economic unit cost of generation was computed as 2.87 cents/kWh in 2002 prices.[63] Overall generation investment needs work out to $200 million a year to add 244 MW a year during the period 2007–2024. All are run-of-river projects with little adverse environmental consequence, but about 70 to 76 percent of the annual power output would be seasonal.

Bhutan power is delivered in the eastern region of India, which will not be able to absorb it both from the price point of view and from the point of view of system needs. Thus, simultaneous with the commissioning of Tala project, the transfer capacity from the eastern region to northern region is being raised (see Chapter 2). Recent studies (assuming that the sale price of Tala power at the generation station would be the same as in the case of Chukka, 4.65 cents/kWh) indicate that the cost of Tala power when transmitted to Delhi will be

[61] A price of Rs 1.8/kWh (or 4.5 cents) is reported to have been agreed for FY 2007 only (see *Power in Asia*, Issue #459 August 17, 2006).

[62] "Inter-Country Cooperation in Development of Hydropower," a presentation by the Central Electricity Authority of India in the BIMSTEC Workshop on Sharing Experience in Developing Hydropower Projects in New Delhi, held during October 30–31, 2006, available at www.powermin.nic.in.

[63] These economic calculations are based on preliminary desk studies averaged over a range of project sizes. Financial analysis of the completed Tala Hydropower project (assuming an export price of 4.5 cents/kWh) seems to show financial internal rates of returns of 7 to 8 percent. Which would not be attractive to private investors.

comparable to the price of power from coal-fired units in the northern region, but will be lower than the LNG-based thermal power there. The northern region has severe shortages of both capacity and energy in all seasons and would be able to absorb Tala power despite its seasonality of supply and its price.

The rapid expansion of the interregional transfer capacity in India (see Chapter 2), the development of real-time balancing using availability-based tariffs, and UI charges in the national grid should greatly improve the chances of the Bhutan power being absorbed in any part of the national grid, whose requirement matches the supply pattern from Bhutan.

Given the cost and the seasonal output structure of the Bhutan hydro projects, a recent study concludes that large hydropower projects such as Tala would not be attractive to the private sector and that therefore they are best pursued as before based on bilateral cooperation with India or as joint ventures with Indian public-sector entities. Medium hydropower projects (25 MW to 300 MW) could be pursued on the basis of public–private partnership basis with the involvement of international financial institutions (IFIs) and small hydropower projects (below 25 MW) could be pursued with bilateral and multilateral donors.[64] However, in the context of the gradual liberalization of the Indian power sector with third-party access to the national and regional grid, and with the availability of a number of licensed power-trading companies, it should be possible for some of large entrepreneurs in India to be interested in the generation investments in Bhutan.

A significant problem that would adversely impact on the growth of electricity exports from Bhutan is the very high level of subsidy provided to the domestic consumers and the incentive schemes it operates for attracting power intensive industries. Such distorted price signals would lead to serious misallocation of resources and cut into the surplus available for export. Development of power projects exclusively for export should be considered to mitigate this risk. In the medium to long term, the level of subsidy should be phased out substantially.

## Nepal–India Bilateral Electricity Trade

Although discussions about the Nepal–India electricity trade have been going on for more than five decades, and many of the major Nepal hydropower sites and related project proposals have been studied by wide range of consultants over that period, electricity trade/exchange between the two countries remains insignificant, with Nepal being the net importer (see Chapter 2). Nepal's hydroelectric potential is estimated at 83,000 MW, of which 43,000 MW is considered techno-economically feasible. Only 627 MW have actually been developed. Bilateral assistance from India helped in the construction and financing of Pokhra (1 MW), Trisuli (21 MW), western Gandaki (15 MW) and Devi Ghat (14.1 MW) during 1968-1983, mainly for meeting local demand. Other major projects under discussion between the two governments at various levels include: Karnali-Chisapani multipupose storage hydropower project (10,800 MW), Sapta Kosi High Dam multipurpose project (3,300 MW) along with Sun Kosi storage/diversion project, Pancheshwar multipurpose project (5,600 MW), Burhi Gandaki (600 MW), Upper Karnali (300 MW).

Nepal's peak demand is forecast to grow from 580 MW in FY 2005 at the rate of 7.6 percent per year to 1,750 MW by FY 2020. During the same period, energy needs are forecast to grow from about 2.8 TWh to 8 TWh. This calls for an addition of 220 MW by 2010 and another 1,000 MW by 2020, raising the total capacity in the country to about 1,900 MW. Demand growth of this size would not be able to accommodate large-sized, cost-effective hydropower stations unless the domestic demand is supplemented by substantial export demand. Construction of medium- and small-sized hydropower stations with a high cost per KW installed has resulted in the provision of a very high-cost-power

[64] Parts of this section are drawn from the Pricewaterhouse Coopers' recent draft report, *Bhutan Hydropower Sector Study: Opportunities and Strategic Options* (June 2006).

supply system in Nepal. It is also a system with very little thermal power capacity (less than 8.5 percent). It is thus in the economic interests of Nepal to promote the construction of relatively large-sized, cost-effective hydropower projects in Nepal mainly meant for export to India and import from India thermal power to meet its dry-season power needs. Given the relative sizes of the north Indian power system and that of Nepal, this should not present any major problem, despite the capacity and energy deficits in the Indian system.

Unfortunately, the transmission capacity of the existing 132 kV and 33 kV lines between the two countries limits the exchanges to about a third of the agreed level of 150 MW. The IPPs of Nepal complain that on account of this they are forced to spill water. There is thus an urgent need to increase the transfer capacity to the Indian northern and eastern regional grids. Both sides should pursue proposals to construct four 220 kV single- or double-circuit links—Butwal-to-Ghorakpur, Dhalkebar-to-Muzafferpur, Duhabi-to-Purnima, and Anarmani-to-Siliguri.[65] The distances involved are all small and cost levels should present no major problems. Even more importantly the Nepalese parliament needs to ratify the Power Trade Agreement between the two countries. The recent formation of a joint technical committee consisting of the Power Trading Corporation of India, NEA and the Nepal government for preparing the term sheets and for scheduling the exchanges should greatly help Nepal in marketing its power and receiving its imports without having to deal with the various electricity boards of India.

Recent restoration of democracy in Nepal, ending of the armed conflicts and domestic turbulence, the agreement of Maoists to work as a part of the parliamentary democracy, and the announcement by the Maoist leader that his party welcomes foreign investment in power facilities has created a political climate conducive to attract investors. The liberalization of the Indian power sector at the level of the national and regional grids and the emergence of major private sector investors and traders in the power sector has created fresh opportunities for power export projects in Nepal. The serious power cuts that Nepal faced in the last year and the more liberal approach of the new government appear to have resulted in a strategy of attracting Indian private sector for investing in Nepal hydropower projects.

In the *Power Summit* organized by the Independent Power Producers of Nepal (IPPAN) and PTC of India in September 2006, a wide range of Indian private-sector companies and investors participated and expressed serious interest in pursuing the opportunities. Subsequently, in November 2006 the U.S. Embassy in Nepal, USAID, Nepal U.S. Chamber of Commerce, and American Chamber of Commerce in India organized a seminar, "Powering Nepal—Connecting Markets." It was attended by leading prospective investors, business leaders, and officials. The investing community displayed a great deal of enthusiasm over power export projects.

The government of Nepal has prioritized three project sites for private-sector investment—namely, Upper Karnali (300 MW), Burhi Gandaki (600 MW), and Arun III (402 MW). It has issued a request for proposals for them from the prospective investors recently with a closing date in the last week of December 2006. Bids are expected or have already been received from several reputed Indian firms (Reliance, GMR Group, Jaypee, Larson &Toubro, Avantika, KSK Energy Ventures, and NHPC), one investor from Singapore (SN power), and one from Turkey (Nepal Energy), either by themselves or in the form of consortia.

Overall, the Nepal strategy seems to be to: (1) focus on run-of-the-river projects (with a daily peaking pond), (2) implement the projects on the basis of public–private partnerships, (3) gain experience in the new realities of the Indian power market and, (4) based on such

[65] USAID financed consultants International Resource Group have analyzed these options and consider the first two lines to be a priority. They will have transfer capacities up to 800 MW and would cost about $55.6 million and $52.4 million respectively.

experience and familiarity, scale up the project sizes and operations.[66]

It is also worth noting that Snowy Mountain Engineering Corporation of Australia received a license way back in 1994 to develop West Seti storage hydropower project (750 MW; 3,300 GWh). Ten percent of its output was to be provided to NEA free of cost (as royalty), and the remaining 90 percent was destined for export to India. The cost was estimated in 1997 at $1,098 million. A *power sales agreement* was reported to have been executed with PTC of India in 2003 at a price of 4.95 cents/kWh. The project will include a double-circuit 400 kV transmission line from the project site to Bareilley in India (190 km). The license was renewed annually, and it was announced in May 2005 that SMEC had secured financing from Chinese Export-Import Bank and Asian Development Bank and that construction would commence in September 2005. However, the ADB loan to enable the government to hold equity in the company is expected for approval in 2007, and financial closure is expected soon thereafter, with equity participation from investors of Australia, China, Nepal, and India, and debt mainly from China. A Chinese company had already been awarded the EPC contract for the project.

Hydropower projects in Nepal tend to be expensive because of the geological and seismic problems of the Himalayan region, remote and inaccessible terrain, unfavorable hydrology, and unusually high sediment loads. Power from such projects (especially from the run-of-projects) is not necessarily very competitive in the Indian market. Careful and intelligent marketing is necessary to find the niche in the Indian grid that could absorb it. It may not be marketable in Bhutan and Bangladesh at all. Projects therefore have to be selected to have a large size and economy of scale, resulting in competitive prices. The West Seti project represents one such case.

[66] This section draws from the information found at Web sites of IPPAN—namely www.ippan.org—and of the Department of Electricity Development www.nepal-doed.org on the two conferences. Also useful were www.siliconindia.com/shownews/34218, www.nepalnews.com/contents/2006/englishweekly/spotlight/nov/nov10/economy.php, www.nepalnews.com/contents/2006/englishmonthly/businessage/nov/cover.php, www.peoplesdaily.com.

## Myanmar–India Bilateral Electricity Trade

Myanmar has a total hydropower potential of 39,720 MW, of which 747 MW (2 percent) had been developed. Another 10,398 MW is reported to be under various stages of preparation or construction. By FY 2009, nine projects with a total capacity of about 916 MW are expected to be commissioned. Another four projects with a total capacity of 1,172 MW are expected for completion by FY 2010. The rest would be commissioned by FY 2021. Most of this capacity is being developed as joint venture projects with EGAT and MDX Group of Thailand, and YMEC of China for export to Thailand. Indian government organizations have cooperated in the Sedawyagi and Yeywa hydropower projects. The Central Electricity Authority of India prepared in 2005 the prefeasibility study for the Myanmar government for developing the Tamanti multipurpose project with a hydropower component of 1,200 MW in the first stage. It is located in the northern portions of Myanmar, fairly close to the Indian border and will have substantial irrigation, navigation, and flood control benefits for Myanmar. Power is mainly for export to India. The second and third stages of the project will have a 400 MW and 700 MW power stations downstream. A transmission line has to be constructed to the Indian border as a part of the project. The power will be fed into the NE region of India that is synchronized with eastern and northern regions. Given Myanmar's approach favoring joint venture mechanisms for power development mainly destined for export, it is likely that this cooperation will materialize and Myanmar–India electricity trade will commence with the commissioning of this project around 2014. BIMSTEC-related initiatives would help in this regard.

## Bangladesh–India Bilateral Electricity Trade

Bangladesh has been experiencing an annual power demand growth of about 9 percent during the last decade and is expected to have a similar growth rate (8 to 9 percent) through FY 2020.

Financial resource constraints (arising mostly from poor operational efficiency) slow down the pace of capacity additions in generation, transmission, and distribution, resulting in a perpetual shortage situation.

Import of power from the eastern and northeastern regional grids of India had often been considered an option to meet the shortages in Bangladesh. Bilateral discussions between the two countries during the last 15 years focused on interconnections from Jessore, Rangpur, and Sylhet, but did not result in any action. In March 1999, Power Grid Corporation of India made a feasibility study for enabling an exchange of power between India and Bangladesh of the order of 150 MW, proposing transmission links between Farakka (India) and Ishurdi (Bangladesh), and Kurnarghat (India) and Shahjibazar (Bangladesh).

Subsequently, the focus shifted somewhat toward the possibility of exporting gas-based power to India, while augmenting supplies in Bangladesh. A prefeasibility study prepared for the government of Bangladesh under the USAID SARI-E program in 2000 demonstrated that a gas-fired combined-cycle power plant of 500 MW to 1,000 MW capacity located at Bheramara or Sirajganj and exporting a minimum of 400 MW to the eastern grid of India would be competitive in the Indian power market, with a delivered power cost of about 4.4 to 4.7 cents/kWh and supporting a well head price for gas of $1.5 to $1.85 per million Btu. Similar power plants located at Sylhet or Fenchuganj exporting power to the northeastern grid of India would also be economic and competitive.

Since then, several proposals have been made to the government for similar power plants in Bangladesh that will be primarily for export to India and partly for meeting local demand. In 2000, NTPC of India proposed to build a 1,000 MW thermal power plant at Bheramara. The most recent and spectacular example is the proposal of the Tata Group of India, discussed earlier. However, the Bangladesh authorities have not been able to respond positively to any of these proposals. Natural gas is the only energy resource (apart from the recently developed coal resources) available to meet domestic energy demands, and the government did not want to make any export commitment until it is sure of the true size of the recoverable reserves of gas in the country. Discovery of significant coal resources and its recent development for a coal-fired power plant might have a (favorable) bearing on such decisions.

Increasing the use of coal for power generation, and importing hydropower from Nepal and Bhutan, might release gas or gas-fired power for export. Electrical interconnections and trading agreements are, however, essential prerequisites for exploiting such opportunities.

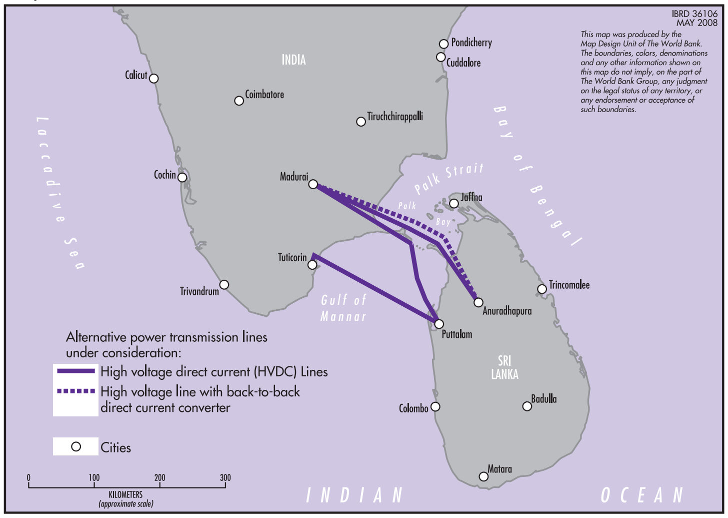
## India–Sri Lanka Bilateral Electricity Trade

Sri Lanka has already exploited most of the economic hydropower potential and has to depend on imported fuels to create additional thermal power capacity and move the hydroelectric generation to meet the peak demand. Given the relatively short distance between the southeast tip of India and the northern tip of Sri Lanka (about 30 km) one option would be to build a submarine cable to interconnect the CEB power system and the southern regional grid of India, which will be fully synchronized with the other four regional grids of India by FY 2012. Once this is done, CEB could use the imported power from India for base load and the domestic hydropower for meeting the peak demand. It may even be able to sell some peak power to India at a good price. SARI-E program of USAID carried out a prefeasibility study in 2002 covering four alternative technically feasible HVDC interconnection options and demonstrated that benefits would accrue to both sides in terms of least cost dispatch, peak displacement, and reliability (see Figure 5.5).

A Madurai–Anuradhapura 400 kV HVDC bipolar interconnection at a capital cost of $133 million appeared to be the best solution. This transmission link would consist of 200 km of overhead line in India and 150 km of overhead line in Sri Lanka and a 30 km under-sea cable to connect them both. It will have a transfer capacity of 1,000 MW with indicative levelized

**Figure 5.5** Proposed India—Sri Lanka HVDC Interconnection

Proposed India-Sri Lanka HVDC Interconnection




*Source:* USAID SARI-E Program Study carried out by Nexant (February 2002).

transmission charges of 0.6 to 0.9 cents/kWh at loads above 500 MW and a plant load factor of 85 percent. The delivered cost of power in Sri Lanka could be about 6.5 to 8.0 cents/kWh compared to its marginal cost at 7 to 9 cents/kWh.

This proposal seems to be making some progress. The Power Grid Corporation of India has made a fresh feasibility study for an HVDC link between Madurai and Anuradhapura. A specially appointed task force with representation from the Ministry of Power, CEA, and Power Grid Corporation of India, and their counterparts from Sri Lanka will review the feasibility report and advice the steering committee of the two secretaries of power from Indian and Sri Lanka, which hope to have the agreement between the two countries signed as early as possible.[67] For a small system like that of Sri Lanka, this may be a better option than the import of LNG.[68]

[67] http://www.hindustantimes.com/news/181_1860601,0008.htm news item dated December 6, 2006.

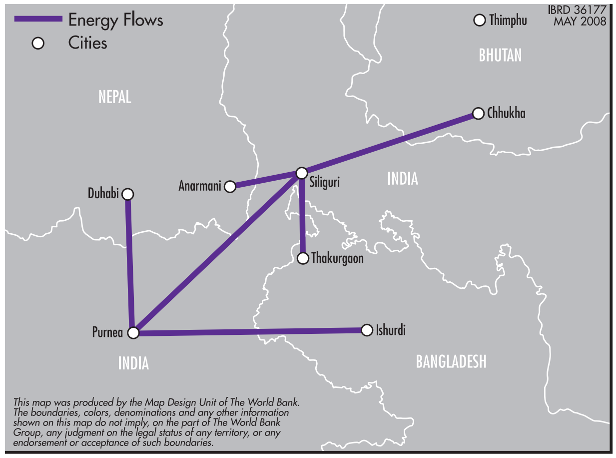
[68] NTPC of India and the government of Sri Lanka signed an agreement in December 2006 for the construction of a 500 MW coal-fired thermal power project in Sri Lanka by a joint venture company to be formed by NTPC and CEB. An agreement for another 300 MW coal-fired power station is believed to have been made with a Chinese company also. The impact of these (on the justification for the India–Sri Lanka power interconnection) needs to be assessed.

## Bangladesh, Bhutan, Nepal, and India Multilateral Electricity Trade

Bangladesh had been desirous of being able to import hydropower from Bhutan and Nepal. Bhutan had been desirous of diversifying its markets. Nepal had been desirous of being able access hydropower from Bhutan and gas-based thermal power from Bangladesh. India is already interconnected to Bhutan and Nepal. The geographic location and the country aspirations, as well as energy resource distribution (hydropower in Nepal and Bhutan, Gas in Bangladesh, and coal in India), are conducive to establishing a power exchange among all four countries in some form of multilateral electricity trade. The borders of Nepal, Bhutan, and Bangladesh converge near Siliguri of the state of Assam in India, and the distances involved are very short.

The SARI-E program of USAID carried out a study "Four Borders Project: Reliability Improvement and Power Transfer in South Asia" (November 2001) that suggested connecting Siliguri (India) to Anarmani (Nepal) and Thakurgaon (Bangladesh) initially by 132 kV lines, capable of being upgraded to 220 kV as the volume of interchange increases. It also suggested the alternative of connecting

**Figure 5.6** Suggested Interconnections among India, Nepal, Bhutan, and Bangladesh




*Source:* USAID SARI-E Program Study carried out by Nexant (February 2002).

Purnea (India) to Duhabi (Nepal)[69] and Ishurdi (Bangladesh). Connections from Chhukha (Bhutan) to Siliguri and then on to Purnea already exist (see Figure 5.6).

System studies confirmed the technical feasibility of the option, that was considered better than the option of constructing 220 kV lines from the beginning or having 132 kV lines all the time. It could support power transfer capacities in the range of 50 MW to 500 MW. Capital costs would range from $9.0 million to $52.0 million. Cost of transmission could fall to 0.2 cents/kWh when interchanges amount to 500 MW. The project is expected to have acceptable rates of return, an easy-to-implement five-year time frame, and no major environmental issues.

Possible problems of synchronous operation of the four systems have to be identified and resolved. The ABT and UI interchange pricing in the Indian regional grid should help in facilitating such exchanges, especially when power-trading companies handle the business. It will be useful to follow up with detailed studies and discussion among the three utilities and the Power Grid Corporation of India. Given the modest cost and the modest scope, this may be a good beginning for the multilateral electricity trade in South Asia.

## Myanmar-India Natural Gas Trade

Myanmar has estimated natural gas reserves of 89.722 tcf, of which 18.012 tcf are considered proven recoverable reserves. It has 3 main large offshore, and 19 onshore oil and gas fields. In the first 11 months of FY 2006 natural gas production and exports amounted to 10.53 bcm and 8.06 bcm, respectively. Gas-related export receipts amounted to $942 million. Investors from Australia, Britain, Canada, China, Indonesia, India, South Korea, Malaysia, and Thailand are engaged in the oil and gas sector of Myanmar. Sun Group of India and Itera of Russia have signed recently a production-sharing contract with Myanmar Oil and Gas enterprise for exploring offshore Block M-8. ONGC and GAIL of India have a 30 percent stake in the partnership with Daewoo of South Korea (60 percent) and South Korean Gas Corporation (10 percent) in the offshore gas exploration of Blocks A-1 and A-3 off the western Rakhine coast. These blocks hold a recoverable reserve of 5.7 to 10 tcf of gas. GAIL (30 percent) in partnership with Silver Wave (70 percent) signed a deal with Myanmar to drill in the A-7 block.[70]

To transport this gas to the state of West Bengal in India, negotiations were held with Bangladesh government to provide transit facilities. In January 2005, Bangladesh agreed to allow the 559 mile pipeline to pass through its territory.

[69] Duhabi-Purnea 220 kV line is also required to enable higher volumes of exchange between Nepal and India.

[70] See news item dated December 14,2006 at www.business-standard.com/general/printpage.php?autono=267844

Bangladesh Gas Transmission Company will have the responsibility of managing the 180-mile pipeline in its territory and will receive an annual transit fee of $125 million. Such acceptance by the Bangladesh government, however, was subject to several conditions, such as grant of several trade concessions including removal of tariff, nontariff, and administrative barriers to Bangladesh exports to India, provision of access to hydroelectricity from Nepal and Bhutan, and an establishment of free-trade corridor to these countries. As Bangladesh continues to press for these wide-ranging trade concessions, Myanmar and Indian companies have begun considering alternative options such as (1) overland route to India bypassing Bangladesh[71] (2) under-sea pipeline to India, and (3) LNG shipments. As negotiations with Bangladesh government continue the prospects for a pipeline through Bangladesh appear uncertain.

Meanwhile, GAIL of India has finalized a feasibility study for a 1,573 km overland pipeline bypassing Bangladesh, from Myanmar to Gaya in India through Mizoram, Assam, and West Bengal, with an initial capacity of 18 million cubic meters /day. This could be increased to 28 million cubic meters /day by adding more compressors. The project was expected to cost about $3.0 billion.

If Bangladesh and India could find their way to approve the much shorter pipeline passing through Bangladesh, it could possibly pave the way for the multilateral gas trade among the eastern nations of the South Asia.

However latest news reports from India indicate that the Myanmar government is reviewing the possibility of exporting this gas as LNG or of selling it as piped gas to China. A decision in this regard is likely after the independent audit of the reserves of the A-3 block.[72]

[71] In June 2006 GAIL completed a feasibility study for a 1,573 km pipeline that will bypass Bangladesh and pass through the northeastern territories and Assam of India terminate in Gaya of Bihar state. Its initial capacity would be 18 million cubic meters per day, which can be increased to 28 million cubic meters per day by the installation of additional compressors. The capital cost is estimated at $3.0 billion.

[72] See http://www.hinduonnet.com/thehindu/thscrip/print.pl?file=2007032203941500.htm&date=2007, http://www.saag.org/%5Cpapers23%5Cpaper2210.html, http://www.zeenews.com/articles.asp?rep=2&aid=361252&ssid=51&sid=BUS.

## Bangladesh–India Bilateral Gas Trade

Bangladesh has substantial gas reserves. However, estimates of reserve from different sources vary. *Oil and Gas Journal* indicated a proved reserve level of 10.6 tcf as of January 2005, but had revised it downward to 5 tcf as of January 2006. The reasons for this are not clear. In mid-2004, Petrobangla estimated the proved reserves at 15.3 tcf. In the same year, the Ministry of Finance estimated a total reserve of 28.4 tcf, of which 20.5 tcf were considered recoverable. In June 2001, the U.S. Geological Survey estimated that Bangladesh contained 32.1 tcf of additional undiscovered reserves. At the current levels of production, this should last for over 100 years.

A recent report, *Gas Strategy for Bangladesh* (January 2006), prepared for Petrobangla by Wood Mackenzie Ltd., assumes a proved level of 9.2 tcf, proven plus probable reserve of 14.4 tcf, and a proven plus probable plus possible reserve of 22.2 tcf. This appears to be the most conservative estimate. The government has been reluctant to make any commitment for the export of gas or gas-based electricity on account of the uncertainty of its reserves position and the fear that the country may run out of its only major energy resource sooner than expected. It is claimed that if coal mining and coal-based power development takes root, and if the country has access to the hydropower of Nepal, Bhutan, and Myanmar, it might adopt a little more liberal approach to gas exports or the exports of gas-based power or of fertilizers and steel products made using gas as fuel.

## Summary of the Prospects in the SAR Eastern Energy Market

A summary of the prospects for energy trade as perceived in the eastern energy market is given in Table 5.5 and the main cross boundary energy flows are indicated in the Map in Appendix 5.

**Table 5.5** Summary of the Trade Prospects in the Eastern Energy Market

| Importing Countries | Exporting Countries: India | Bhutan | Nepal | Bangladesh | Sir Lanka | Myanmar |
|---|---|---|---|---|---|---|
| **India** | x | Significant quantities of hydropower (H) | Significant hydropower export possible | Significant amounts of gas or power possible. Some resource uncertainty | Some peak power support possible | Significant gas and power supply possible. |
| **Bhutan** | Dry season support | x | Unlikely; similiarity of resources and seasonal shortages | Small amounts of thermal power and gas; connection via India (L) | No scope | Unlikely (far off; too small market) |
| **Nepal** | Thermal power support, dry season support | Unlikely; similarity of resources and seasonal shortages | x | Small amounts of thermal power and gas; connection via India (L) | No scope | Unlikely |
| **Bangladesh** | Sharing reserves; electricity swaps | Some hydropower; connection via India (L) | Some hydropower; connection via India (L) | x | No scope | Unlikely (although some potential in hydropower) |
| **Sri Lanka** | Dry season and thermal power support | Unlikely (far off) | Unlikely (far off) | Unlikely (far off) | x | Unlikely (far off) |
| **Myanmar** | No scope | Uncompetitive | Uncompetitive | Uncompetitive | No scope | x |

*Note:* Dark gray color denotes that trade prospects are significant and are either being exploited or can be brought to fruition in the short-to-medium term. Medium purple color denotes that prospects of the trade are good and may materialize in the medium term. Light gray color denotes that prospects for the trade are more limited and may materialize in the medium-to-long term, and light purple color denotes that the prospects for the trade are weak.

*Source:* Krishnaswamy et al. (2006).

# 6 Government Actions and Initiatives for Promoting Energy Trade

The previous chapter outlined the various potential opportunities for trade in electricity and natural gas both in the eastern and western energy markets. Studies and preparation for most of the related projects have either already been completed or are under way at different stages. Based on the status of preparation, it would appear that the regional trade projects for priority consideration and action would include: (1) Central Asia–South Asia 1,000 MW electricity trade project; (2) West Seti hydropower project in Nepal; (3) Iran–Pakistan–India gas pipeline project (4) strengthening transmission interconnections between Nepal and India (the 220 kV transmission line projects)[73]; and (5) the four-borders project to link the power systems of Bangladesh, Bhutan, India, and Nepal. Further analytical work may help to identify specific priority projects on the basis of quantification of economic and environmental benefits (see Appendix 4 for some initial impressions of possible benefits).

Regional trade in electricity and gas should be an important element of a solution to address the mismatch between demand growth and energy resource endowments in South Asia and its neighbors. The trade deals and cross-border projects could be arranged even under the current circumstances and under different levels of development or sophistication of the sector policies, structure, commercial conditions, and regulatory arrangements. Trade is essentially a function of the opportunities of arbitrage when lower cost surplus energy is available in one country for sale to another with significant supply deficits and with higher marginal economic costs of alternative supply. Poor commercial performance of the buying entities in the importing country could be mitigated, for instance, through sovereign guarantees, as is being done in the cases of IPPs. Lack of financial and technical resources in the export country can be handled through partnerships with the international private sector and measures to attract such investors. Absence of or imperfections in regulatory arrangements could be managed through appropriate contractual instruments (*regulation by contract*). Similarly, other risks can be handled through project-specific arrangements, rather than waiting for development of a general trading framework.

Trade that commenced with a single bilateral contract or agreement could, in the course of time, evolve into an increasingly integrated regional market through a series of bilateral and multilateral contracts, based on the experience and confidence level gained under each of the transactions, and as the sector reforms advance and capacity for sustainable trade grows. Such a bottom-up approach, starting from individual bilateral (or multilateral) projects, would allow for better risk mitigation through learning and experience and lead to a more integrated, increasingly commercial regional market, to the benefits of all participants. The governments therefore should focus early on the factors that encourage the emergence of the simpler forms of trade (such as bilateral trade), and later, on the factors that would help to sustain and expand such trade and to enable its evolution into multilateral, market-oriented, and more complex forms of competitive trade.

[73] The first line will connect Butwal (Nepal) and Ghorakpur (India), and the second will connect Dhalkebar (Nepal) to Muzafferpur (India).

## Facilitating Emergence of Trade

Although the energy projects listed in the previous section, and possibly some others, could be implemented under the current circumstances, to facilitate a more vigorous pursuit of regional trade opportunities, the governments may have to focus in the near term on a number of measures, as described next. These measures would signal to the investors the clear political commitments of the governments and would contribute significantly to the mitigation of key risks for investors in such trade projects.

### Energy Trade to Be Perceived as Enhancing Energy Security

National energy policies should analyze and demonstrate how cross-border energy trade would actually enhance energy security, by diversifying the forms of energy (fuels) and the sources of supply, apart from augmenting supplies *in the time frames needed* and in a least cost and environmentally sound manner.

The Integrated Energy Policy Report of the Expert Committee of the Planning Commission of India published in August 2006 after a detailed public review process, for example, advocates clearly (1) import of coal not only whenever there are shortfalls domestic supply, but also whenever imports are cost effective; (2) imports of LNG from different sources (3) reduction of supply risks by policy coordination among importing and exporting countries by importing gas through pipelines or getting hydropower from neighboring countries. It views gas pipelines as providing greater security of supply, as the supplying country that usually builds the pipeline has vital stakes in maintaining the supply because pipelines, unlike the LNG tankers, can not be diverted to other consumers. To find alternate buyers along the route would be normally difficult.

Pakistan's energy documents, likewise, clearly consider electricity imports from Central Asia as an important, cost-effective, and timely component of its supply options to meet forecast demand. They also seem to advocate import of piped gas from Central Asia, Iran, and Qatar, as well as LNG imports to meet anticipated decline in domestic production of gas.

Bangladesh, by contrast, is somewhat ambivalent about its gas or electricity export ambitions.

Nepal and Bhutan policy documents prominently consider hydropower export as an important source of income for their economies and a major driver of their economic growth, though Nepal is trying to operationalize the concept for long without much success.

Sri Lanka has looked upon electricity interconnection to the Indian grid as enhancing its energy security, though as a relatively last stage option. Afghanistan has clearly recognized electricity import as a key strategy for consolidating its war damaged economy.

Myanmar has been pursuing the policy of building hydropower projects for electricity export to Thailand and export of gas to Thailand for several years now. It is also looking at export of hydropower and gas to India.

The governments may yet need to widely publicize their policy choices and rationale and build a base of popular support for the trade policy and the sector reforms such a policy choice implies. The evolution of such a political consensus within the country and a political commitment to trade greatly helps to conclude successful trade deals. This seems to be rather important in Nepal and Bangladesh.

### Encourage the Private Sector to Play a Greater Role in Cross-Border Investments and Trade

The countries with export potential (such as Nepal, Bhutan, Tajikistan, Kyrgyzstan, and Myanmar) do not have the public financial resources to make the capital investments in the export projects and may have to rely on foreign investors for the construction and operation of the export facilities. Since the countries themselves do not have much access to the world capital markets and do not enjoy investment grade credit rating, they may need special assistance from the IFIs by way of guarantees and other mechanisms of credit enhancement to access the capital markets. Especially with respect to hydropower projects and dedicated export transmission lines, a public–private partnership type approach may work best. It would be advantageous for any government to select such private partners on the basis of open competitive bidding using criteria such as their ability to provide investment funds, managerial know-how, successful experience in similar transactions, and credibility of the proposals in terms of construction, operation, export marketing, and export prices. It may also be advantageous to associate IFIs in identifying and formulating projects and preparing the bid documents for the issue of RFPs and the evaluation of the received proposals, as environmental aspects (including climate change concerns), resettlement issues, and benefit sharing issues will have to be dealt with adequately in these stages. Governments could also consider proposals initiated directly by entrepreneurs, provided such proposals address adequately all the concerns already mentioned. Governments need to create a liberal policy environment conducive to attracting and retaining such foreign investment. There should be clarity and consistency on royalties on water use, taxation of electricity sales, corporate tax on profits, and remittance of posttax profits.

Similarly, with respect to transmission lines dedicated for exports, such as in the case of the CASA 1000 project, public–private partnerships should make it more practical to ensure a neutral transmission operation.

## Seek Accession to Energy Charter Treaty

In order to attract private investments in the energy sector for export production and transmission, as well as to provide a level of comfort and confidence for the trade partners, it will be useful for the countries in the region to accede to the Energy Charter Treaty.

International trade is carried out under the framework of the treaty, rules, and regulations of the World Trade Organization, which supplement and influence the national rules. In order to accede to WTO, each country has to harmonize its laws, rules, and regulations with the WTO framework.

A similar organization to provide the multilateral framework specifically for the energy sector cross-border trade and investment was formed in 1991, through the Energy Charter Declaration. The Energy Charter Treaty provides a broad multilateral framework of rules governing energy cooperation. The fundamental aim of the Energy Charter Treaty is to strengthen the rule of law on energy issues. By creating a level playing field of rules to be observed by all participating governments, the treaty aims to minimize the risks associated with energy-related investments and trade.

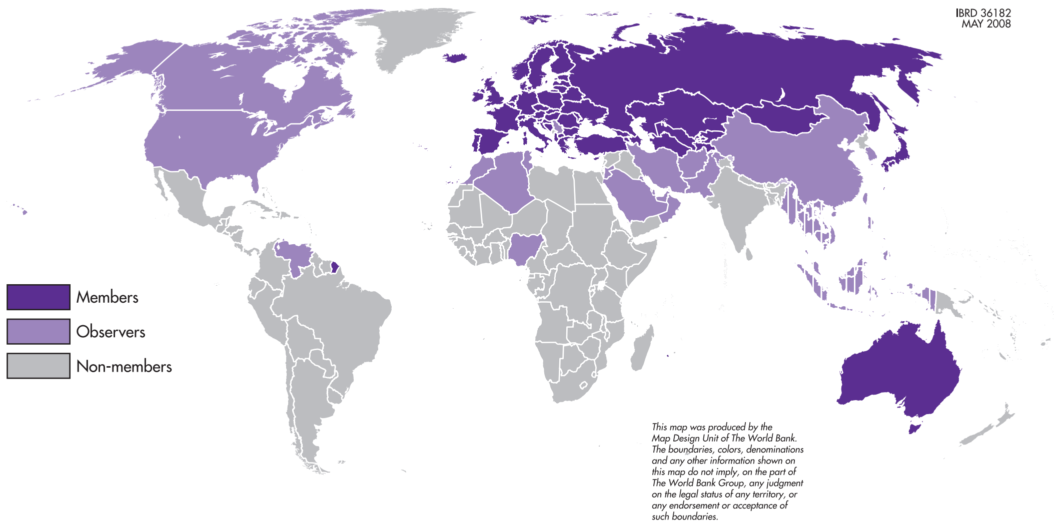
The treaty's provisions focus on five broad areas: (1) the protection and promotion of foreign energy investments, based on the extension of national treatment, or most-favored nation treatment (whichever is more favorable); (2) free trade in energy materials, products, and energy-related equipment, based on WTO rules; (3) freedom of energy transit through pipelines and grids; (4) reducing the negative environmental impact of the energy cycle through improving energy efficiency; and (5) mechanisms for the resolution of state-to-state or investor-to-state disputes.

The Energy Charter Treaty and the Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects were signed in December 1994 and entered into legal force in April 1998. To date, the treaty has been signed or acceded to by 51 states, plus the European Communities (the total number of its Signatories is therefore 52). The treaty was developed on the basis of the Energy Charter Declaration of 1991. Whereas the latter document was drawn up as a declaration of political intent to promote energy cooperation, the Energy Charter Treaty is a legally binding multilateral instrument, the only one of its kind dealing specifically with intergovernmental cooperation in the energy sector.[74]

The treaty is open for accession by any country that wishes to participate, that is ready

[74] For further details, see www.encharter.org.

**Figure 6.1** Participation in the Energy Charter Treaty




*Source:* www.encharter.org

to take on the obligations in the treaty, and whose application is accepted by the Energy Charter Conference (see Figure 6.1). In order to join the Energy Charter Treaty, a country has to take the first step of signing the 1991 Energy Charter Declaration, thus committing itself to the principles of the charter. It then becomes an observer to the Energy Charter with access to all its meetings and documents. The next step is the actual accession for which the country and the Energy Charter secretariat must assess the compatibility of its domestic legislation with the provisions of the treaty. Once the Energy Charter Conference finds the assessment reports satisfactory, the country is invited to accede to the treaty and become a full member.

The Central Asian Republics are already members, but Afghanistan, Iran, Pakistan, and China are observers.[75] India is believed to have initiated action to become an observer. Bangladesh, Bhutan, Nepal, and Sri Lanka are not yet associated with this treaty. Since they have substantial potential for energy trade and the need for cross-border investments and for attracting capital for such investments to enable and sustain trade, it will be advantageous for them to become members of the Energy Charter Treaty. In particular, the membership of the regional countries in the treaty would greatly facilitate the private investors in the region making investments at home and abroad to create regional energy import or export opportunities.

## Pay Attention to Integrity of the Transit Countries

When energy trade takes place between two countries separated by a third country— referred to here as a *transit country*—it is necessary to ensure the integrity of that country and its facilities to enable and sustain trade. By virtue of its location, Afghanistan is a key transit country for the Central Asia–South Asia energy trade, and it is in the interests of all the potential participants to ensure the integrity of that country and the viability and operational stability of its energy systems, by providing maximum possible cooperation, assistance, and funding. The sooner the Afghanistan situation

[75] Pakistan has recently been made a member of the Energy Charter Treaty.

becomes peaceful and its energy systems are restored, the less will be the risk to the energy trade across that country. Pakistan itself will be a transit country when India imports gas by pipeline from Iran or Turkmenistan. Similarly, Myanmar has the potential to be the energy bridge between South Asia and ASEAN energy systems. In the context of interregional trade development, it might need special attention from all participants.

## Prepare for the Commercial Approach to Trade

The existing electricity trade of Afghanistan with Central Asia and of India with Bhutan and Nepal are based more on *ad hoc* intergovernmental agreements than on commercial contracts. In the case of the former, negotiations for the volume and price of supply still appear to be annual event. Enforcement mechanisms for payment defaults and consequences of failure to supply or receive the agreed volume of energy do not appear to have been spelt out. The transactions between India and its neighbors also appear somewhat informal. Prices are renegotiated periodically without reference to any formal PPA and a set of agreed parameters for price escalation. There is some uncertainty regarding the volume of supply. Bhutan appears to have the freedom to consume whatever it needs and has the obligation to supply only whatever turns out to be the surplus. Transactions with Nepal are under an umbrella agreement, allowing power exchange up to 150 MW, and settlement is on the basis of whatever is actually exchanged. Sustainable large volumes of electricity trade would be possible only on the basis of a formal and commercial footing, involving an explicit contract between the buyer and seller. The contract needs to spell out the volume and pattern of supply, metering and billing arrangements, and price details, as well as parameters and formula for price revisions. It also needs to specify the obligations of the buyer and seller relating to such aspects as payment defaults, failure to supply or receive the agreed volumes of power. It should also contain provisions for dispute resolution and arbitration. Experts should help develop contracts that can be adopted for trade-related transactions.

With the entrustment of the trade with Nepal and Bhutan to PTC Limited, India appears to have initiated the process of commercializing its electricity trade transactions with these countries. It is necessary that the relevant organizations in the governments of the region develop the capacity to prepare, negotiate, implement, monitor, and enforce such commercially oriented electricity and gas trade contracts. This type of capacity building would be important for all countries in the region and for the relevant countries in Central Asia, but especially so in smaller economies such as Afghanistan, Bangladesh, Kyrgyzstan, Nepal, and Tajikistan that have notable export potential. It is worth noting that Pakistan has developed this capacity in relation to the IPP transactions based on its range of experience.

## Keep the Price Expectations Realistic

Many of the past attempts for cross-border investments or electricity trade could not come to fruition on account of the wide and unrealistic divergence between the price expectations of the buyer and seller. When Pakistan desired to export surplus power to India, the offered price was 7.2 cents/kWh and the counteroffer was 2.5 cents/kWh. With respect to power export to India, Nepal had very high price expectations based on the avoided peak power costs in India, while India was considering a price based on reasonable return on investments relating to the generation project. In the absence of reliable economic price signals from the power markets, which had several layers of subsidies masking true costs, negotiations perhaps could not be meaningful.

With respect to India, there is now a range of recent cost data relating private hydropower projects, thermal power projects based on coal, gas, and diesel. On top of this, spot and contract market in the national/regional grids send reasonably representative price signals at the grid level. The UI rate range, contract prices for interstate trading, and regulated prices of centrally owned large generation utilities do provide a valuable database from which one can judge the price appropriate for different area segments of the Indian electricity market. Similar build-up of price data and cost signals in each country would be helpful but are probably not easy to obtain under the current market conditions. With respect to Pakistan, the price paid to the IPPs used to be considered a good indicator of the marginal cost, but they may have become outdated. With the improved competitive bidding and contract procedures, fresh bids for IPP supply could perhaps be lower than the prices agreed to earlier.

Trade materializes and is sustained when both sides perceive gain by the transaction. It is therefore more practical to review all price related information with expert help and keep the divergence between the offer and the counteroffer as narrow as possible.

### Political Commitment to Drive the Prioritized Trade Transactions

Good sector policies and supportive environment are necessary for energy trade initiatives, but they are not sufficient. Continued and consistent political commitment to enable actual investments in energy trade-related assets and their sound operation over their economic lives is an essential ingredient. Each government has to agree on the prioritization among the available trade opportunities and pursue the priorities with the establishment of empowered joint ministerial level committee of the relevant governments. Such a joint ministerial committee needs to be underpinned by a joint working group of specialists dealing with the details of technical, commercial, financial, and legal issues and work toward a timetable for concluding the overarching intergovernmental agreement under which the actual transaction between the public sector or private sector entities can take place and result in cross-border investment and trade. Between the signing of the intergovernmental agreement and the actual trade flow, myriads of problems and risk perception will be encountered, and their resolution would primarily depend on the continued and consistent political commitment to realize trade and perhaps the continued use of the joint ministerial level committee and the joint working groups.

## Enabling the Evolution of Competitive Regional Energy Markets

In order to sustain and expand energy trade on a sound footing and to minimize trade risks in the medium to long term, as well as to promote the evolution of bilateral trade into multilateral trade involving market oriented competitive elements, the sector reform efforts of the governments have to focus on creating more appropriate sector structures with financially sustainable entities and predictable and neutral regulatory environment. The key elements to be pursued in this regard would include the following.

### Create Technical and Commercial Coordination for Regional Trade

In the regional energy trade there is always a need to coordinate the technical conditions and interconnected operation of two or more systems and the associated transit issues (see Box 6.1).

The Union for the Coordination of Transmission of Electricity is a well-known example of an arrangement for coordination of the operation of a number of power systems in Europe. Fifty years of joint activities laid the basis for a leading position in the world that the UCTE holds in terms of the quality of synchronous operation of interconnected power systems. Through the networks of the UCTE, about 450 million people of Europe are supplied with electric energy; annual electricity consumption totals approximately 2,300 TWh. It is an association of transmission system operators (TSO) in continental Europe, providing a reliable market base for electricity trade by efficient and secure electric *power highways*. Each TSO is individually committed: (1) to a common set of rules for the operation of the interconnection, its

### Box 6.1 Interconnection Options for Electricity Trade

Bilateral electricity trade between two adjoining countries is the least complicated option from the technical point of view. If a relatively small part of one country has power shortage and needs import, that part of the grid is disconnected from the main country grid and connected in the "island mode" to the grid of the exporting country. The frequency of the interconnected grid is then regulated by the exporting country grid. This is referred to as the *synchronous island mode operation*. Trading here would be governed by bilateral trade contracts.

When the grids of the two adjoining countries are compatible and fulfill certain technical criteria (such as principles of voltage and frequency regulation, level of reserve capacities, quality standards of supply to customers, communication, and protection systems) they can be fully synchronized and operate on the same frequency and submit themselves to the unified common rules of system operation and control. This is referred to as fully synchronized operation, which maximizes the benefits of interconnection. Trading here would be governed by contracts and the bilateral agreement on grid operation and discipline.

Interconnection of two nonadjacent countries through a transit country or interconnection among more than two countries would call for synchronizing all the connected grids with all the discipline going with such synchronous operation and would thus become more complicated as common criteria for system operation and control will have to be agreed among several parties and observed continuously. Trading here would be governed by contracts and multilateral agreements on grid operation and discipline.

When the systems to be interconnected are electrically incompatible, then they could be interconnected by direct current (DC) transmission. Converters in the exporting country convert the alternating current (AC) into DC, and it is then transmitted through the DC line. In the receiving country, converters convert DC back to AC for normal supply. Such DC options used to be expensive, but in the recent years costs are falling due to cost-effective technology upgrades. Nonetheless, the DC interconnection options are more expensive and would require a much larger volume of electricity transmission to become economic than in the case of AC interconnection.

*Source:* Krishnaswamy (2006).

development and reliability standards; and (2) to support the principles of the common electricity market. There is no supraregional UCTE control center governing the whole system. Rather, the integrated, synchronously connected grids are operated in a decentralized way, with adherence to strict technical and organizational rules and standards by all UCTE members (For more details, see www.ucte.org; see also Figure 6.2).

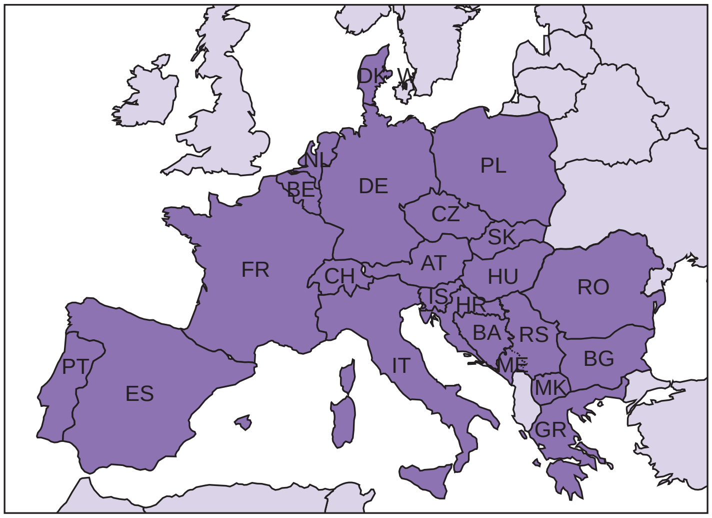
The volume of electricity exported and imported in relation to domestic generation with respect to a few select European countries is given in Table 6.1.

The EU is currently considering whether there should be a regulatory oversight of the operation of the interconnected system at the EU level in light of some of the problems recently emerging. UCTE is not the only model available for this purpose. Other models include the reliability councils models followed in North America, NORDEL model followed in Nordic countries, Greater Mekong Power Trade Organization model in East Asia, South African Power Pool model enabling multilateral trading, and the West Africa Power Pool model enabling the optimal use of hydro- and thermal-generating facilities.

## Strengthen the Role of Regional Cooperation Organizations

SAARC had been functioning since 1985. It has constituted a working group on energy to focus on regional energy cooperation. Among other things, it has decided to give priority to the creation of an interconnected regional power grid. It may be the most appropriate organization for promoting and facilitating regional trade in energy. It has set up a SAARC Energy Center (SEC) in Islamabad as the regional institution

**Figure 6.2** UCTE Area of Operation in Europe




*Source:* www.ucte.org

**Table 6.1** Imports/Exports (TWh) in Selected European Countries in 2005

| Country | Net Generation | Imports | Exports | Net Exchange as Percentage of Avail. Energy |
|---|---|---|---|---|
| **Austria** | 63.9 | 20.4 | 17.4 | 4.5% |
| **Belgium** | 82.3 | 14.3 | 8.0 | 7.1% |
| **Czech Rep.** | 76.2 | 12.4 | 24.9 | -19.6% |
| **Denmark** | 34.3 | 12.9 | 11.6 | 3.7% |
| **Finland** | 67.7 | 17.9 | 0.9 | 20.1% |
| **France** | 547.8 | 7.2 | 67.6 | -12.4% |
| **Germany** | 533.7 | 53.4 | 61.8 | -1.6% |
| **Hungary** | 32.3 | 15.0 | 8.8 | 16.1% |
| **Italy** | 300.2 | 49.8 | 1.0 | 14.0% |
| **Netherlands** | 96.0 | 23.7 | 5.4 | 16.0% |
| **Switzerland** | 57.9 | 43.9 | 39.4 | 7.2% |

*Source:* Krishnaswamy (2006).

for the initiation, coordination, and facilitation of SAARC programs in the energy sector.

It is already working on the concept of energy ring covering the SAARC countries. Such a ring is perceived by SAARC ministers as a key to promote regional energy trade. It could draw on the technical talents in each country and set up a group of officials who could work with consultants and experts provided under funding by the IFIs to harmonize grid codes and evolve common codes and binding technical procedures for the operation of interconnected grids, perhaps, somewhat on the lines of UCTE. Alternatively, the energy center group could study the various models of technical and commercial coordination among interconnected grids mentioned in the earlier section and determine which of the models would fit the South Asian situation best and explore the possibility of evolving such common operational conditions and codes of behavior of the interconnected systems, to facilitate the evolution of regional electricity markets.

This group could also gather the regulators from the member countries and set up a regulators forum to harmonize the regulatory practices among them and also pave the way for creation at the SAARC level a regional regulatory body to regulate the regional electricity and gas trade to the extent such regulation becomes necessary.[76] It may also be productive to arrange for cooperation of this SAARC group with the UCTE secretariat to enable a transfer of knowledge, experiences and best practices in this area. This group should further coordinate its activities with BIMSTEC secretariat and ASEAN energy group to ensure that the interconnection of the Myanmar grid with those of India and Bangladesh is compatible with ASEAN practices. The governments need to make the best use of the existing regional cooperation organizations for the purpose of developing the common rules and operational procedures and codes that should underpin and foster regional energy trade on orderly lines.

## Strengthen Transmission Links and Complete the Ongoing Sector Restructuring Process

In large importing countries, the backbone transmission system should be strengthened and expanded to enable imported power to flow to the load centers, with demand characteristics appropriate to absorb the imported power. The tariff for transmission service should be fair and transparent.

Going forward, separation of the generation, transmission, distribution, and supply functions, providing open access to the transmission and distribution wire services, is generally believed to enable widespread competitive trade within and across the interconnected power systems.[77] Liberalizing the sector by allowing at least the large industrial consumers (who are forced to pay very high prices for a low quality of supply and thus subsidize agricultural consumers and households in most of the region) the freedom to contract for their supplies with electricity traders or the generating companies is an important step to promote trade.

India is moving rapidly in this direction by creating a new class of licensed electricity traders, increasing the interregional power transfer capacity, enabling third-party access in the national and regional grids, and creating a power-trading market using the ABT and frequency-dependent UI charges, as well as transparent transmission charges for national and regional grid services. This needs to be followed up by similar reforms by the state electricity boards within each of the five regions and by the state regulatory commissions for maximizing the impact.

The Indian Electricity Act of 2003 obliges the state regulatory commissions to provide transmission and distribution open access within five years to all consumers with a maximum consumption exceeding 1 MW and in a phased manner for other consumers. It also provides for a cross-subsidy surcharge (to be added to the wheeling charges), to be phased out in line with the phased removal of cross-subsidies. These steps, designed essentially to promote trade within the country, actually reduce risks for the exporters to India and would accelerate investment in the neighboring countries for exporting power to India. Exporters to India in the next few years should be able to strategically select the area to which they want to sell on the basis of a match between their generation pattern and the demand pattern of the area. They should then be in a position to secure attractive prices.

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[76] South Asia Forum of Infrastructure Regulators founded in May 1999 with World Bank assistance to serve as a forum for the regulators of infrastructure in the region to exchange views and experience and to provide training and capacity building programs may have a useful role to play in this regard. See its Web site at www.safirasia.org.

[77] The term *supply* is used to denote the retail sales function as distinct from the physical distribution network-related functions (construction, operation, and maintenance). When the distribution network functions and supply functions are separated and third-party access to transmission and distribution networks are ensured, retail consumers could choose their suppliers.

Power from Bhutan that cannot be absorbed in the adjoining eastern region of India is being sold a few thousand miles away in the northern and in the western regions.

Similar reforms in Bangladesh and Pakistan would be appropriate and desirable. They need to evolve their own methods based on the structures they have chosen to enable the distribution utilities and large consumers to buy from the generators, traders, and importers on the basis of long-, medium- and short-term contracts. Also, Bangladesh needs to ensure the autonomous and independent operation of the Power Grid Company and separate fully the distribution function from BPDB. The desirability of separating generation function also from BPDB and allowing it to function purely as a market operator should be reviewed. Open access to the transmission grid in Nepal would be needed to enable existing privately owned hydropower projects in Nepal to export their surplus power to India.

## Step up the Operational and Commercial Efficiency of Utilities

Distribution utilities are the major ultimate bulk buyers of the imported power, and unless they become financially viable and capable of adhering to the payment discipline, it will be difficult to sustain energy imports in the medium to long term, despite the use of transmission companies and power traders as intermediaries. The governments desirous of resorting to sustainable energy trade need to focus on the operational and commercial efficiency of the distribution utilities. Metering, billing, and collection efficiencies of the South Asian utilities are far below the industry standards, eroding their financial soundness and creditworthiness for trade and investment.

India is trying to tackle this at two different levels. At the central government level, the generating companies, the national and regional grid, and dispatch operate at industry standards of efficiency. Payment discipline by the state electricity boards to the centrally owned generation, grid services, and fuel-supply companies has been significantly raised by the one-time restructuring of past debts, through bond issue and system of recourse to the state funds in the Reserve Bank for payment defaults (see Chapter 4). At the state level, reforms are sought to be achieved through reorienting the Accelerated Power Development and Reform Program (APDRP) to tackle comprehensively the consumer and system metering using smart meters and billing and collection problems through the introduction of better technology and incentives (see Chapter 4 for details). The base line data generated by these efforts can also be used to design meaningfully privatization models for distribution companies to achieve viability more speedily. These efforts need to be pursued with determination and with the full cooperation of the state governments in a federal polity. The privatization of the distribution system in the Delhi state seems to have resulted in a significant reduction of overall ATC losses and improvement of the sector in the state.

Recent attempts by the Ministry of Power and the Power Finance Corporation of India to use outside bodies such as the Indian credit rating agencies CRISIL and ICRA to measure annually efficiency improvements and financial viability of all the electricity boards and rank them on the basis of over a hundred criteria seem to have had a salutary effect, instilling a sense of competition among the electricity boards to do better. Generation of such reliable evaluative data comparable over time and across the utilities would greatly aid the task of improving their performance and should be continued.

Pakistan has privatized KESC. The performance of the new owners in terms of governance and operational improvements needs to be closely monitored. The nine new distribution companies created in the rest of Pakistan have yet to emerge as entities responsible for their performance. Their finances are wholly in the hands of WAPDA, which receives all their revenues and pays most of their bills. Some of the senior managers are still on WAPDA's payroll rather than the payroll of the distribution companies. At current tariffs, at least four of the distribution companies will not be viable, and the rest will be marginally viable. Although these companies were created as far back as 1998, the sector still operates largely as vertically integrated.

Though financial restructuring had been done through debt-to-equity swaps, to enable them to have a reasonable balance sheet to start with, the tariff framework, subsidy framework, and revised tariffs have not been finalized. The thorny question of whether the retail tariff will be uniform all over the country or whether it will vary as a function of the cost of supply faced by each company has not yet been fully resolved. These matters need to be resolved to make these entities capable of operating in a sustainable manner. Meaningful privatization would be possible only thereafter. NEPRA should have full authority and support to promote efficiency upgrades of the distribution companies through devices such as performance benchmarking. A measure of financial solvency and payment discipline on the part of the distribution entities must be achieved for sustainable and expanding trade.

In Bangladesh, the distribution operations of BPDB and DESA are still far below industry standards, and the institutions are not financially viable. Bhutan's BPC gets a very low price from the generating companies, and yet is not financially sound. In all these cases, governance improvement is necessary to reduce losses and improve collection. The arrears of the government agencies and public-sector entities must be settled and continued payment discipline must be ensured.

Programs focusing on the use of GPS mapping, smart meters capable of remote reading (and with ability to disconnect supply to the defaulters through remote controls) and the use of computerized metering, billing, and collection system are likely to be productive when combined with effective laws against electricity theft providing for speedy trials and stern punishments. Governance focusing on operational and commercial improvement of the distribution segment appears to be most urgently needed in most of the countries in the region.

## Adopt Sustainable Tariff and Social Protection Framework

It is conducive to the financial viability of the parties to the transaction for electricity tariffs to broadly reflect the true economic cost of supply in both electricity exporting and importing countries, and therefore it is also conducive to sustainable and expanded electricity trade. Practically all the countries in the region and its neighbors in Central Asia have levels of tariff well below costs of supply, and the structures of tariff are skewed heavily in favor of households and agriculture. In the case of exporting countries, there is a tendency to keep the overall level of domestic tariff substantially lower than the export tariff. In Bhutan, for example, the supply tariff for BPC is only 15 percent of the export price to India. Such a distorted tariff base will not promote efficient consumption and would soon seriously erode the surplus available for export. In Bhutan, things are made even worse by the adoption of a policy of attracting power-intensive industries with a low electricity tariff to make up for labor costs and a lack of raw materials. The sustainability and wisdom of this type of industrialization is open to question. These approaches are somewhat similar to those followed in the hydropower rich countries such as Tajikistan and Kyrgyz Republic.

In the countries such as India, Pakistan, and Bangladesh (potential importers), tariffs below cost of supply and extensive subsidies seriously cut into the financial soundness of the sector, thereby reducing the attractiveness of the market and eroding the sustainability of trade. Programs to raise the tariffs (in a phased manner over a reasonable time frame) to cover the cost of supply and to minimize the cross subsidies by carefully tailoring the lifeline block and the lifeline tariff and making it available only to the consumers in the lowest block and not to all consumers need to be carefully considered for adoption. Further, subsidies to any particular class of consumers should come directly from the state budget without distorting the price structure. To ensure credible energy accountability, all consumers—whether subsidized or not (or even if they receive free power)—should be metered. Among other things, this is necessary for effective governance of the utility and the sector.

Introduction of time-of-day metering and differentiated peak and off-peak electricity prices—at least for larger consumers in all the countries—would be helpful, not only as a load management tool, but also to trade intelligently for peak or off-peak energy and capacity. These considerations are equally important for importing and exporting countries. The use of smart/intelligent meters providing the remote meter-reading capability should be of great help in this regard.

Similarly, there is a clear need to reform the pricing of gas in India and Pakistan. In India, a very complicated administered pricing mechanism is adopted for the use of domestically produced gas, and a relatively market-oriented approach is taken for the imported LNG. In the context of private investors entering the business with substantial quantities of their own production and in the context of the anticipated large increases in LNG imports and gas imports by pipeline, the pricing approach has to be made more market oriented. Current postage-stamp methodology for gas transmission tariffs is not conducive to transmission system expansion or for industries to locate themselves closer to the sources of supply. For the domestic gas, re-gasified gas from an LNG terminal and the imported gas by pipeline, a cost-plus regulation should be considered. Transmission tariffs should be reoriented to take into account the distance and congestion aspects. More importantly, GAIL being the owner of the transport network and the largest marketer of gas is not conducive to competition and nondiscriminatory third-party access to the pipelines. Questions regarding third-party access need to be sorted out, and separation of transmission operation and sale of gas should be carried out to derive the full benefits from gas trade. Further, a medium-term strategy needs to be worked out to phase out the massive gas price subsidies enjoyed by the fertilizer and power industries.

In Pakistan, gas supply for power at around \$4 per million Btu does not appear to be unduly subsidized, while the households and the fertilizer industry are heavily subsidized. Until mid-2006, the tariff on the lowest block of gas consumption for households did not even fully cover the commodity price of gas. The lowest block then accounted for 85 percent of the total consumption by households. Corrective action for these appears to have been initiated in the tariff revision of June 2006 when the number of blocks for households was increased from four to five and the new lowest block was defined with an upper consumption limit of 50 cubic meters per month, compared to the previous limit of 100 cubic meters. The rate for the new lowest block has been increased by 5 percent, while all other rates have been increased by 10 percent. However, in the most recent price revision of March 2007, the prices for all categories appeared to have marginally declined, while the structure was retained. Further reforms toward cost-reflective tariffs should be pursued.

## Improve the Credibility, Competence, and Accountability of Regulation

Fair, independent, and neutral regulatory bodies functioning on the basis of principles incorporated in energy law can be of great help in promoting the health of the domestic energy sector, as well as the energy trade. They could ensure the separation of generation, transmission, and distribution businesses and the functioning of these separated entities on the basis of arms-length and contract-based relationship. They could provide transparent tariffs for transmission and distribution wires services. Apart from the obvious role they play in tariff setting, they could use regulatory incentives and penalties to improve the sector operational efficiency, especially in the distribution segment, and help sustainable trade. They have a key role in fostering competition and regulating the power market, which, among other things, can buy from and sell to the adjoining country power systems. They can regulate the orderly functioning of electricity traders. They can ensure the adherence to the grid code and technical standards by all market participants. Sound and efficient regulatory arrangements promote expanded trade in a sustainable manner.

The central electricity regulatory commission and the state electricity regulatory commissions (in 27 out of 29 states) have been operating in India during the last several years. The central commission and many of the state regulatory commissions are maturing rapidly, and the Electricity Act of 2003 has provided the basic content for their role in promoting trade and competition and, more importantly, for their improved accountability by creating the Appellate Tribunal for Electricity (ATE) to hear appeals against the orders of the central and state regulatory commissions.[78] The existence of such a tribunal is widely perceived as improving the accountability of the regulatory bodies.

Many of the state regulatory commissions still need significant capacity upgrades in terms of modern approaches to promote competition, sector efficiency, and trade, as well as in areas relating to finance, accounting, and economics. The capacity-building task in the regulatory commissions should be the focus of the central government, perhaps with technical assistance from the aid community or through cooperative arrangements with the regulatory bodies in select developed countries.

Gas-sector regulation in India still appears to be in the nascent stage and needs to be built on a sound basis.

The electricity regulatory organization in Pakistan would still need substantial improvement in its capacity, and the scope of its functions needs to be expanded to include monitoring of the sector performance. Another major area for reform relates to the fact that tariff decisions by the regulatory body are not binding without government approval and notification, although the government may not notify tariffs]without receiving the regulator's decisions. Pakistan had succeeded in getting the formal structural reform right. It now needs to put substance in the reform effort and make all the new entities function in the manner they are expected to function, if it is to reap the full benefits of the reform. Bangladesh's regulatory body has been dormant since its creation and needs to be made fully operational as soon as possible.

Nepal's regulatory body has only a limited role of fixing the retail tariff of NEA and is not widely perceived to be doing a credible job. In the context of the existing IPPs and the future IPPs wanting to trade directly with export markets, transmission access and transmission tariff questions will gain significance and the regulatory body needs to be involved in providing the answers to them. Also, there is a good case for Nepal to have licensed electricity traders. A thorough review of the regulatory system with a view to enhancing the scope of regulation and upgrading the capacity and independence of the regulatory body needs to be undertaken, and the findings of the review need to be followed up by the government.

The newly created regulatory body in Bhutan from the ministry needs to be made operational soon. The *four-borders project* that seeks to link the systems of Bhutan, Nepal, and Bangladesh to the Indian system will make sense in the context of the four countries having autonomous and competent regulation. The autonomy and competence of the regulatory bodies in Tajikistan and Kyrgyz Republic must also to be improved to enable investments needed to increase their export supplies.

Sri Lanka needs to make up its mind on regulatory reform and implement it before the interconnection project to India materializes. This will enable Sri Lanka to conduct meaningful trade in base-load, intermediate-load, and peak-load power with India and derive optimal benefits from such interconnection.

For regional trade to expand, there should be effective electricity market regulation throughout South Asia and its neighbors. For India, the basis of such market regulation, including cross-border electricity trading, is provided by the Electricity Act of 2003. Similar legislation may

[78] The ATE has a chairman with the rank of a judge of the Supreme Court and three members with the rank of a judge of the high court. Two of these are to be from the judiciary and the remaining two are to be persons with a distinguished technical background. Each bench constituted to hear appeals must have at least one judicial and one technical member. Since July 2005, when it started functioning, it has decided on 108 of the 249 appeals filed. See the website of ATE www.aptel.gov.in for more information.

be needed in the other countries of the region, broadly compatible with the Indian Electricity Act 2003 and the general principles on which it is based.[79] Such compatibility of regulatory frameworks, trading rules, and grid codes across the countries is important to foster trade.

## Make the Best Efforts to Reach International River Basin Agreements and Improve Water Management Capacity and Practice

The most urgent need of the importing countries of the region is for peaking and load-following capacity, to cope with both daily and seasonal variations in load demand. This need could, in part, be met by the import of power from storage hydroelectric projects. Though the region has significant storage hydropower potential, little progress has been made with any of them.[80] The focus has shifted heavily toward run-of-the-river projects. Run-of-river schemes are needed and have a number of important advantages (generally lower environmental and social impact; simpler to develop, implement, and operate; lower safety risks; etc.). However, a disproportionate shift away from storage projects may result in the potentially suboptimal utilization of water resources, decreased flexibility in managing hydropower production, and more costly balancing of the electricity supply and demand. Hydropower storage projects offer multiple uses and benefits, such as irrigation, flood control, sediment management, drinking and industrial water supply, tourism, fisheries, and so on, which often have a higher priority over power generation. They also help manage hydrological variability, the feature that is likely to assume even greater importance over time, as the variability could increase as a result of climate change.

Storage projects, by contrast, may also have potentially significant adverse environmental, social, and economic impact, especially in the reservoir area and downstream. These effects need to be mitigated, and that make the planning, design, and operation of such projects a very sensitive matter. The allocation of costs and benefits among the various uses and beneficiaries, and compensating those that are adversely affected can be—and usually is—very contentious. Although in the 1970s policies were adopted to compensate people and communities impacted by such projects (the so-called safeguard policies that mandate that development should "do no harm"), there is an increasing recognition that policies based on the principle "do no harm" are not good enough, and that communities should unambiguously benefit from the exploitation of their territory for hydropower generation. Worldwide examples with various benefits-sharing mechanisms range from "one-off" payments and construction of community assets, to streams of payments such as royalties, to equity sharing. The concept of benefits sharing can be extended spatially to include regional development or river-basin-wide development.

Clearly, individual reservoir projects on the same river basin cannot be considered in isolation of each other—not when the river basin is within the same country, and even less so when the river basin crosses international boundaries. Problems relating to reaching agreements on water sharing and benefit sharing, river basin planning, selection of reservoir location and size, reservoir operation and water release regimes, and other issues related to exploitation of international rivers have to be tackled with determination and a spirit of cooperation, to make any progress in building storage hydropower projects.[81] It should be recognized that, in order to maximize economic and social returns of such a key resource, comprehensive river basin agreements

[79] See "Indian Electricity Act, 2003- Implications for Regional Electricity Trade" (September 2004) prepared for USAID SARI-E program available at the program's Web site, http://www.sari-energy.org/, for a further discussion of these aspects.

[80] A notable exception would be the West Seti Storage Hydropower Project in Nepal, which is expected to reach financial closure in the next few months after 12 years of preparation by the sponsors.

[81] See World Bank, "Water and Energy Nexus in Central Asia," February 2004, for a discussion of these concepts in relation to Central Asia.

among all relevant riparian governments is necessary for much broader set of concerns than power generation alone, whether for domestic use or for export.

The Indus River Basin Treaty between India and Pakistan—with the World Bank in a mediatory role—has proven a good example over a period of several decades. It will be advantageous for the governments of the region to undertake similar river basin and reservoir agreements in the areas where the potential storage project sites exist. These agreements should be environmentally and socially responsible and fully recognize the links with global issues (clean energy agenda, climate change, changes in precipitation patters, the shrinking of Himalayan glaciers with disastrous consequences to the people in the hills and plains). They should also create a framework for meaningful benefit sharing among all water users and riparian states/provinces with respect to projects built for domestic use or for export of energy and water services. They should further be consistent with regional strategy for the integrated river basin management.

An important issue is building sufficient expertise and institutional capacity to tackle these problems, at both the national and regional levels. Pricing of hydropower, especially for peaking and firm supply, is another key issue that needs to be properly addressed in order to induce optimal use of water potential for power generation, at the national as well as regional level. The resources that can meet peak demand should command a higher price, as they have higher value. Similarly, storage projects that could offer some firm power should also be properly compensated, taking into account higher value of such power in comparison with run-of-river generation, whose availability is completely driven by hydrology and is, thus, subject to a greater degree of uncertainty.

# 7 The Role of International Financial Institutions and Bilateral Donors

## Identifying Trade Opportunities and Facilitating Intercountry Agreements

International financial institutions (IFIs) such as the World Bank Group and the Asian Development Bank—as well as bilateral development assistance programs of the United States, the United Kingdom, Canada, Japan, and Germany—have been involved in the energy-sector programs of South Asian countries for several decades and are well placed to undertake sector analysis in each country and identify electricity trade opportunities that, on the surface, would be attractive to the concerned governments, and persuade the relevant countries to pursue these opportunities further. The IFIs are uniquely placed to play the part of honest broker and to facilitate the parties to reach the initial intercountry agreements articulating the specific interest of the parties, constituting high-level decision-making bodies and working groups to carry out and review further detailed analytical and technical work to arrive at key decisions.

In 2004, the World Bank carried out an analysis of the power sector of Central Asian Republics, identified their export potential, reviewed the power sector in potential markets, and demonstrated how the Central Asia–South Asia electricity trade could be a win-win situation for both. This has led to the intercountry agreements and further action towards the realization of the CASA 1000 project. The Asian Development Bank had similarly been active in promoting the Turkmenistan–Afghanistan–Pakistan pipeline project and the trade between Central Asia and Afghanistan. The USAID SARI-E Program in South Asia has carried out a large number of studies to identify and analyze various electricity and gas trade opportunities and trade-related issues in South Asia.

## Structuring Project Investments

IFIs have a major role in appropriately structuring the bilateral and multilateral trade projects based on their experience relating to similar projects in other parts of the world. In South Asia and Central Asia, most of the countries with hydropower export potential do not have the public resources for investment in the generation and transmission facilities of the export project. They have little access to commercial sources and capital markets. Even their ability to borrow from the IFIs is limited by country allocations of scarce IFI funds and prudent lending limits adopted by these institutions. Under these circumstances, investment projects may have to be structured as a public–private partnership (PPP) involving foreign private sector (especially from within the region if available and willing), local private sector, the IFIs with equity and debt positions, and the government. Some degree of the government's joint ownership is desirable, especially with respect to hydropower projects and transmission lines, as they involve interaction with various aspects, such as land acquisition, right of ways, rural development issues, flood control and irrigation—in all of which the government is deeply involved. In addition, some amount of equity by the government in the company would enable it to get dividend income from the exploitation of its major natural resource, in addition to royalties on the use of water, tax on electricity exports, and corporate tax on profits. Soft fund windows of the IFIs could be used to lend to such governments for investment as equity in the PPP project dedicated for export.[82] The private partners should have management and operational control and the percentage of shareholding necessary for this purpose. The presence of the IFIs with some equity and debt would make it easier for the private owners to raise debt from the commercial market and on more favorable terms. It also provides comfort to both the importer and the exporter. The structure of the Theun-Hinboun project and Nam Theun 2 project in Laos illustrates the type of structure considered appropriate for such export projects (see Appendix 1). The Sangtuda I hydropower project will export about 670MW and is intended to be structured on similar lines, with the majority shareholding being with RAO UES, and remaining shares being distributed among the government and the IFIs, when they formally decide to participate.

## Structuring Transmission and Trading Facilities

If a dedicated transmission corridor has to serve multiple exporting countries (and possibly multiple exporters from some of those countries) and multiple importing countries (and possibly multiple buyers in some of them), then its ownership structure and operating arrangements have to ensure independence from and neutrality toward all participants in the trade. Decision making on whether to allow new buyers and sellers and whether to expand the capacity of the corridor and how to pay for it have to be taken also in a manner fair to all. For this, structuring of the transmission corridor ownership and operation and the arrangements for trade regulation have to be designed with a neutral party suitably embedded in the decision-making structures. The IFIs (through their participation) may have a role in helping to structure these arrangements and to ensure their fair working.

In order to develop a multilateral electricity-trading market functioning on the basis of synchronized operation of all participating systems, a great deal of work has to be done by way of harmonizing grid codes, regulatory regimes, and evolution of common system operation and control rules. In Chapter 6, we suggested SAARC Energy Center as the locus of this work, as well as cooperation with UCTE. The IFIs and bilateral aid programs need to support such initiatives with technical assistance programs and also enable cooperation with UCTE. Similarly, the IFIs may have a useful role in helping the countries that wish to accede to the Energy Charter Treaty, with the associated review process, and helping the countries in the task of making appropriate changes/reforms to their laws and policies to conform to the Charter principles.

## Promoting Strategic Sector Reforms in Participating Countries

IFIs and bilateral programs have a major role in promoting strategic sector reforms to enable and foster trade in the participating countries, through technical assistance, sector studies, and provision of adjustment loans or investment loans for related investments. Such strategic reforms include separation of transmission function and its independent operation, third-party access to wires services, adoption of transparent pricing policies for transmission services and wheeling services, tariff reforms to minimize cross-subsidies and

[82] In the South Asia Region all the countries with export potential are small low-income countries eligible to borrow from the soft funds window. In appropriate cases soft loans blended with regular loans could be considered.

remove the subsidy burden from the utilities to the state budget, introduction of time of day tariffs, operational efficiency improvements in metering, billing and collection, and improving the content, competence, and accountability of sector regulation. Financing of export project(s) may be linked to advancing the domestic sector reform agenda.

## Evolution of Export/Import Contracts and Dispute Resolution Mechanisms

The IFIs have an important role in building the capacity of the governments in public- and private-sector energy entities in the smaller economies such as Nepal, Bangladesh, Sri Lanka, Tajikistan, and Kyrgyzstan to negotiate, monitor, and enforce export trade contracts. The IFIs and other donors may also play an important role in more or less standardizing the template for export/import contracts or supply/purchase contracts with a fair and proper allocation of risks among the parties and with fair dispute-resolution mechanisms, and a similar contract template for transmission services in trade projects.

## Supporting Transmission and Distribution Expansion

Increasing the power-transfer capacity even within the country is a major need before a country embarks on external trade involving large take or pay contracts. Such projects enhancing power-transfer capacity enables the optimal use of the existing generating capacity and the transfer of the imported power to any part of the country. Financing or co-financing such major expansions of transfer capacity should have priority in the IFI lending plans. A similar focus on the distribution capacity expansion to reduce losses and facilitate the efficient absorption of the imported power would be of equal importance.

## Risk Mitigation

IFI lending and guarantees and insurance arrangements with MIGA would reduce a range of risks to the project, its sponsors, and the trade participants. Involvement of IFIs in a electricity trade project would discourage the transit countries from disrupting supply on political grounds. MIGA insurance, suitably tailored to the project, could provide a cover for most cases of transit country and supply disruption risks. IFI presence in the project with equity and debt would discourage nonadherence to contracts, thereby reducing risks all around.[83] World Bank's guarantee mechanism, when properly designed, can mitigate a range of risks. Examples will include the Brazil–Bolivia gas Pipeline project and the Mozambique–South Africa gas pipeline project. The full set of instruments at the disposal of the World Bank could be used for risk-mitigation purposes in complex electricity trade projects. The instrument of Adjustable Program Lending can be used effectively to support the evolution of the regional market stage by stage, as is sought to be done in the Energy Community of the South Eastern Europe. It is a flexible instrument that had been used for power market/power pool–related lending operations (West African Power Pool, South African Power Pool, and Greater Mekong Subregional Power Trade).

## Priority in the Country Assistance Strategies

The IFI country assistance strategies and country lending and nonlending programs could be reoriented to give high priority for regional energy trade integration programs, especially in the South Asia region, where regional integration is negligible. Regional trade strategy

[83] It is interesting to note that the Integrated Energy Policy Report of the expert Committee of the Planning Commission of India (August 2006) suggests that for pipeline projects for import of gas, pone should get equity and debt from multilateral agencies for risk mitigation.

and financing preferences should be suitably incorporated in the country strategies.

## Coordination among IFIs and Bilateral Donors

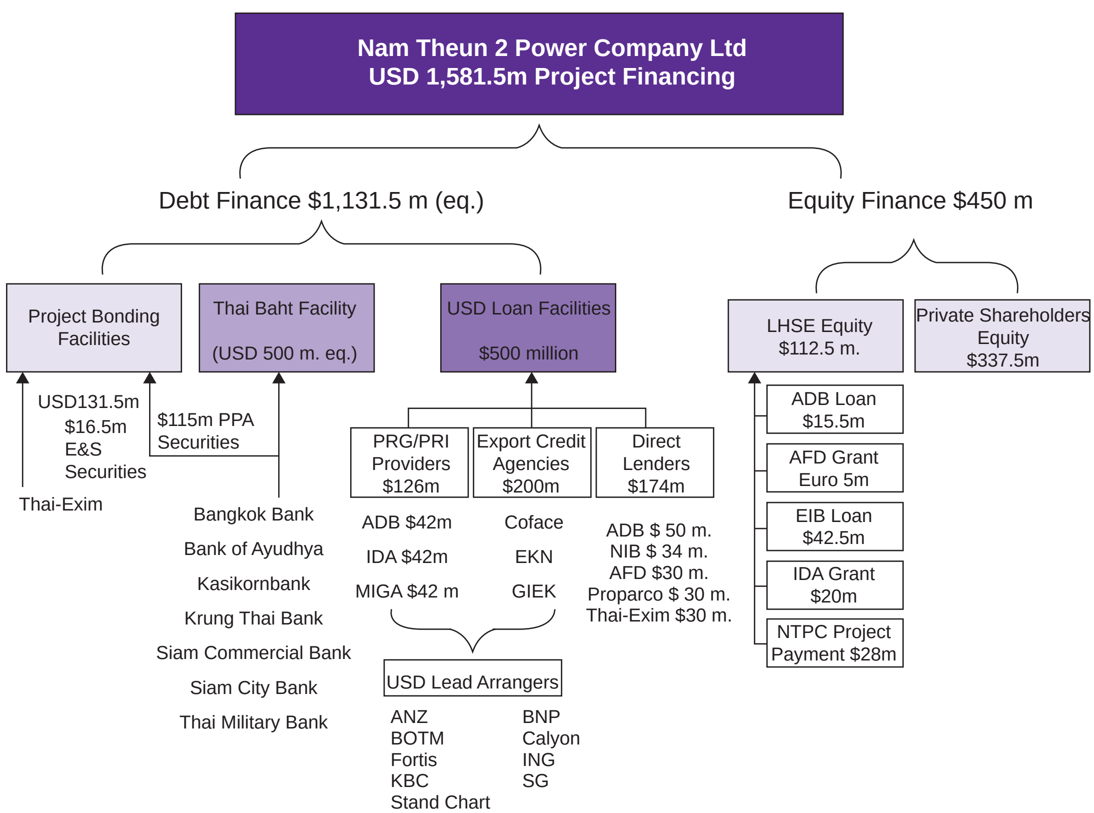
Given the nature of the countries in which export projects would be located, it will be essential for all relevant IFIs and bilateral donors to participate in a well-coordinated manner. Such a coordinated approach would not only enable these large projects to proceed by overcoming allocation limitations and by spreading the risk of large investment among many parties, but would also create a tremendous synergy that will benefit all the participants and the project.

# Appendix 1 Examples of Structuring of Energy Trade Projects

*Nam Theun 2 project* is a storage hydropower project in Laos with a capacity of 1,080 MW and an annual energy of 5,936 GWh that will export 95 percent of its generation to Thailand and sell the remaining 5 percent to EDL, the power company of Laos. The Thai grid and Laotian grid do not operate in synchronism. In order to handle this situation, the project will have a separate penstock and two generating units of 43 MW each with their own switch yard and 115 kV line to supply Laotian grid, while the other penstocks and larger generating units will have a separate and larger switch yard with a double-circuit 500 kV line to feed the Thai grid.

The total financing required for the project was $1,581.5 million. The project was structured as a PPP project on a BOT basis. The equity holding in Nam Theun 2 Power Company consisted of Electricite du France International (EDF) (35 percent), Thai Electricity Generation Public Company (EGCO) (25 percent), Government of Laos through Lao Holding State Enterprise (LHSE) (25 percent), and Ital-Thai Development

**Figure A1.1** Nam Theun 2 Power Company Financing Structure



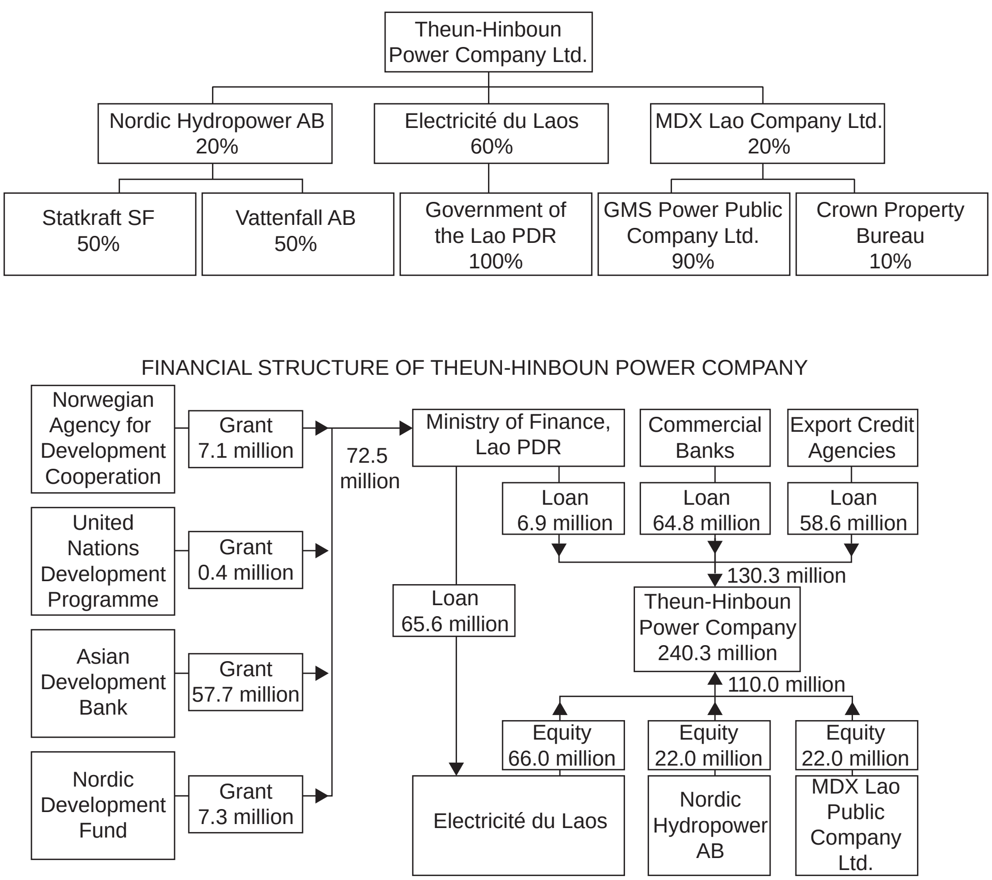

*Source:* World Bank.

Company (ITD) (15 percent). In order to enable the Laotian government to invest $112.5 million as equity, grants, or soft funds, to the government were provided by IDA ($15 million grant), ADB ($15.5million soft loan), AFD (Euro 5 million grant) and EIB ($42.5 million loan). The remaining $28 million came from Nam Theun 2 Power Company's payment for the preparatory expenses and facilities provided.

Debt financing came from 5 multilateral agencies, 4 export credit agencies, 2 bilateral agencies, and 16 international and Thai commercial banks. The average tenor for U.S. dollar loans was 16.5 years, and that for Thai Baht loans was 15 years. Nam Theun 2 Power Company holds the concession for 25 years. The tariff is approximately 50 percent in Thai Baht and 50 percent in U.S. dollars (or indexed to U.S. dollars) to match the financing currency structure. Long-term PPAs were concluded with EGAT of Thailand and EDL of Laos. Royalty will be charged at 5.2 percent during 2009–2024, 15 percent during 2025–2029 and at 30 percent thereafter. Corporate tax will be payable by NTPC at 0 percent during 2009 to 2014, 5 percent during 2015 to 2021, 15 percent during 2022 to 2027, and at 30 percent thereafter. These graduated rates are used because of the need for the project to repay debt in 15 years, while the concession will last for 25 years.

*Theun-Hinboun hydropower project* (210 MW, 1,645 GWh) of Laos was constructed in the early 1990s as a PPP project with BOT arrangements mainly for export of 95 percent of the output to Thailand. The total project cost was $240 million (46 percent equity and 54 percent debt). 60 percent of the equity in the Theun-Hinboun Power Company was held by Laos government through EDL. The remaining 40 percent was held by Nordic and Thai

**Figure A1.2** Thein-Hinboun Power Company: Ownership and Financial Structure




*Source:* Asian Development Bank.

investors. Laos government was enabled to invest $66m in equity by loans and grants from ADB, UNDP, and Nordic agencies. Debt financing came from several commercial banks and export credit agencies.

*Manantali hydropower project (*200 MW, 800 GWh)—along with 1,500 km of 220kV transmission line—was built jointly by the governments of Mali, Mauritania, and Senegal. The power station is located on the Senegal River in Mali, and the power generated was to be sold to all three countries. Total project cost was $445 million, and financing was provided by IDA, AfDF, KfW, CIDA, and IsDB. This was structured as a joint public-sector project. The three governments set up a high-level policy-making body OMVS that organized a corporate entity SOGEM jointly owned by all three governments to construct and own the project. An independent private operator, ESCOM of South Africa, was selected through ICB to operate and maintain the project facilities. The World Bank provided three loans to the three governments simultaneously to finance a part of the project costs.

It is interesting to note that OMVS was established in 1972, the related dams were built in 1986 to 1988, hydropower units and transmission lines were funded in 1998, and that the project was completed in 2003.

*Mozambique Transmission Company* (MOTRACO) was established to build, own, and operate two 300-km-long 400 kV overhead lines and associated transmission facilities to supply 860 MW of power from South Africa to an aluminum smelter in Mozambique as well as 175 MW each to the grid of the transit country Swaziland and the southern portion of the grid of Mozambique. It buys power from the South African utility and sells to the aluminum smelter in Mozambique. It also wheels power from South African utility to the utilities of Swaziland and Mozambique. The total capacity of the transmission facilities of MOTRACO is 1,348 MW. Since its commissioning in 2001, its network availability had been well in excess of 99 percent of the time. It has concession contracts and licenses to carry on transmission business from the three countries. It has a 25-year PPA with the South African utility and a 25-year sales contract with the aluminum smelter and also a 25-year wheeling agreements with the three utilities.

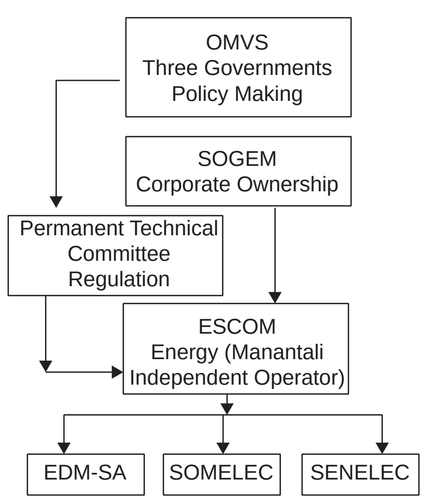
The three national power utilities have equal shares in the company, which is managed by a board with two representatives for each country. It adopts an aggressive policy of outsourcing its work and has only a total manpower of 7 full time employees.

The total cost of the project facilities was $112 million, which was financed by about $30 million of equity and $82 million of debt from EIB and JBIC and Standard Bank of South Africa. ESKOM Holding of South Africa guarantees the debts to MOTRACO to the extent of $75 million, via a special arrangement with MIGA of the World Bank Group mitigating a range of political and other risks. The company has been operating profitably from year 2 of its operations.

*South African Power Pool* covers the grids of 12 member countries. The general details of these grids are given in Table A1.1.

Trading had been going on for 30 years on the basis of bilateral contracts, though the formal inauguration of the pool was in 1995 through the SADC treaty. It was at that time that the southern network (mainly thermal) of Namibia, South Africa, and Mozambique and the northern network (mainly hydro) of Congo, Zambia, and Zimbabwe were interconnected by a 400 kV link. Such contracts cover 95 percent

**Figure A1.3** Structure of MOTRACO Transaction




*Source:* Multilateral Investment Guarantee Agency.

**Table A1.1** General Information on the Member Grids of the South African Power Pool (April 2005 to March 2006)

| Country | Utility | Installed Capacity MW | Maximum Demand MW | MD Growth % | Sales GWH | Sales Growth % | Generation Sent Out GWh | Net Imports GWh | Net Exports GWh | Transmission System Losses % |
|---|---|---|---|---|---|---|---|---|---|---|
| **Angola** | ENE | 745 | 397 | 9 | 1,843 | 12.7 | 2,649 | 0 | 0 | 25 |
| **Botswana** | BPC | 132 | 434 | 7.96 | 2,583.7 | 7.5 | 977 | 2,006.50 | 0 | 10.96 |
| **DRC** | SNEL | 2,442 | 1012 | 2.53 | 4,656 | 13 | 6,904 | 0 | 1,800.00 | 6.3 |
| **Lesotho** | LEC | 72 | 90 | 0 | 354 | 12 | 446 | 8 | 11 | 20 |
| **Malawi** | ESCOM | 285 | 242 | 6.5 | 970 | 4 | 1,177 | 0 | 0 | 19 |
| **Mozambique** | EDM | 233 | 285 | 7.1 | 1,308 | 11.8 | 147.418 | 1,501 | 1,496 | 5 |
| **Namibia** | NamPower | 393 | 491 | 6.51 | 2,976 | 6.5 | 1,660 | 1,703.0 | 0 | 8 |
| **South Africa** | ESKOM | 42,011 | 33,461 | -2.2 | 207,921 | 0.8 | 221,985 | 8,730 | 13,107 | 8.9 |
| **Swaziland** | SEB | 51 | 172 | 1 | 852.8 | 2.5 | 103.5 | 916.8 | 0 | 16 |
| **Tanzania** | TANESCO | 839 | 531 | 4.3 | 2,549 | 10.3 | 3,674 | 43 | 0 | 24 |
| **Zambia** | ZESCO | 1,732 | 1,330 | 2.8 | 8,457 | 3.1 | 8,884 | 0 | 69 | 3.6 |
| **Zimbabwe** | ZESA | 1,975 | 2,066 | -0.1 | 10,480 | 3.5 | 9,391 | 2,666 | 255.5 | 12.6 |

*Source:* www.sapp.co.zw

of the volume of traded power; have durations in the range of one to five years, and have a price in the range 0.85 to 2.95 cents/kWh. Since 2001, there is short-term energy market covering about 5 percent of the volume traded by way of monthly, weekly, daily, and hourly contracts. These relate mostly to off-peak with prices in the range of 0.40 to 1.75 cents/kWh. The SAPP is governed by an intergovernmental agreement (establishment of SAPP), an interutility MOU (which establishes management and operating principles), agreements between operating members (specific rules of operation and pricing) and operational guidelines (standards and operating guidelines).

It has been functioning as a cooperative pool. In the context of the member grids being restructured, it is trying to evolve gradually into a competitive pool. The short-term energy market will then become a spot market. For this improvement of telecommunication facilities and transmission, reinforcements to relieve congestion are needed.

# Appendix 2 Examples of World Bank Group Support for Regional Energy Trade

| Region/Project | Countries | Details |
|---|---|---|
| **Europe / Caucasus** | | |
| Energy Community of southeast Europe | Seven countries in southeast Europe | • $1 billion from World Bank |
| Baku–Tbilisi–Ceyhan Oil Pipeline | Caucasus: Azerbaijan, Georgia, Turkey + private sector | • $125 million IFC loan<br>• $125 million IFC-syndicated loans<br>• IBRD TA loan to Turkey (pipeline feasibility study)<br>• IDA TA loan to Georgia (capacity building |
| **South America** | | |
| Bolivia–Brazil Gas Pipeline | Bolivia, Brazil + private sector | • $130 million investment loan<br>• Partial credit guarantee for $180 million |
| **South Asia** | | |
| Indus Waters Treaty (1960) | India, Pakistan | • World Bank-arranged development fund (raised $893.5 million)<br>• World Bank responsible for dispute resolution and a court of arbitration |
| **Southeast Asia** | | |
| Greater Mekong Sub-region Program (including. Nam Theun 2) | Cambodia, China, Lao PDR, Malaysia, Myanmar, Thailand, Vietnam | • World Bank-financed initial study<br>• A GEF grant |
| **Africa** | | |
| Southern Africa Power Pool | Angola, Botswana, Congo (Dem Rep), Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, Zimbabwe | • $440 million in investment support: planned (some loans already active) |
| West Africa Power Pool | Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo | • West Africa Power Market Development Project (two loans approved, more planned) |

| | | |
|---|---|---|
| West African Gas Pipeline | Benin, Ghana, Nigeria, Togo + private sector | • IDA credit and IDA partial risk guarantee planned<br>• MIGA breach of contract insurance; Global Gas Flaring Reduction Initiative grant |
| Chad–Cameroon Petroleum Pipeline | Chad, Cameroon + private sector | • IDA Credits to Chad and Cameroon IFC: $100 million A and $100 million B loan)<br>• Funding for capacity-building of over $40 million |
| Nile Basin Initiative (cooperative water resources management, including power generation among other aspects) | Burundi, Congo (Dem Rep of), Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, Uganda | • IDF grant for capacity and institutional building<br>• ESMAP scoping study<br>• IDA $35 million for Ethiopia–Sudan transmission interconnection Project |

# Appendix 3 Electricity Tariffs in South Asia

The latest available tariff information for each country of the South Asian region has been collected and reviewed, and the key elements are presented here. Most of them have lifeline rates and increasing block tariffs for households. Most countries charge the industrial consumers and commercial consumers a tariff generally higher than that for households even when such consumers draw power at medium and high voltages. Finally, in a majority of cases the average revenue collected per kWh is significantly lower than what one might expect from the rates notified for various categories of consumers on account of theft of power and inefficient metering, billing, and collection practices.

## Afghanistan

Tariffs in Afghanistan are location specific, depending on the relative costs of imports or local supply. They are highest in areas served by local diesel-fired small generating units and lower in areas that receive domestically generated hydropower. In the areas that depend mainly on imported power, they are in between. In the areas served by hydropower, the households are divided into three blocks. Households in the first block consume less than 300 kWh per the billing cycle of two months. In the second block, the consumption is between 301 and 700 kWh. Households of the third block consume 701 kWh or more. In FY 2005, it was

**Table A3.1** Tariffs in Afghanistan Effective January 31, 2006 (cents/kWh)

| Provinces | Households | | | Industries | Others |
|---|---|---|---|---|---|
| | Block 1 | Block 2 | Block 3 | | |
| With hydropower supply (10 provinces such as Kabul, Kandahar, Helmand) | 3.00 | 8.00 | 12.00 | 12.0 | 20.0 |
| With imports from Uzbekistan (Balkh province) | 6.00 | 6.00 | 6.0 | 12.0 | 16.0 |
| With imports from other countries (7 provinces such as Heart, Nimroz, Kunduz) | 4.0 | 4.0 | 4.0 | 12.0 | 12.0 |
| With supply from local diesel-fueled generators. Tariffs among provinces vary as a function of diesel cost and size (12 provinces such as Ghazni, Khost, Uruzgan) | 36.0 to 62.0 | 36.0 to 62.0 | 36.0 to 62.0 | 36.0 to 62.0 | 36.0 to 62.0 |

*Source:* DABM records. Note: Exchange rate U.S. 1 = 50 Afghani.

**Table A3.2** Tariffs for Select Category of Consumers in Bangladesh

| Consumer Category | Subcategory | Tariff in cents/kWh |
|---|---|---|
| Households | Monthly consumption below 100 kWh | 4.16 |
| Households | Monthly consumption 100 to 400 kWh | 5.00 |
| Households | Monthly consumption above 400 kWh | 8.33 |
| Irrigation | | 3.06 |
| Commercial consumers | | 8.40 |
| Small industrial consumers | Low voltage | 6.38 |
| Industries and others | Medium voltage 11 kV | 6.03 |
| Industries and others | Medium voltage 33 kV | 5.68 |
| Industries, others, and for DESA | High voltage 132 kV | 3.53 |
| Supply to rural electric cooperatives | Medium voltage 33 kV | 3.41 |
| Supply to DESCO | Medium voltage 33 kV | 3.62 |

*Source:* Tariff schedule available at www.bpdb.org.bd Exchange rate: $1= TK60.

**Table A3.3** Retail Electricity Tariffs in Bhutan

| Consumer Category | Demand Charge ($/kW/month) | Energy Charge (cents/kWh) |
|---|---|---|
| Households with a monthly consumption up to 80 kWh | - | 1.52 |
| Households with a monthly consumption of 81–200 kWh | - | 2.61 |
| Households with a monthly consumption exceeding 200 kWh | - | 3.15 |
| For supply at 6.6 kV/11 kV/ 33 kV | 1.17 | 2.71 |
| For supply at 66 kV and above | 1.17 | 2.61 |

*Source:* www.bpc.com.bt Exchange rate: $1= Nu 45.98 (as of July 1, 2006).

estimated that the average tariff covered less than 50 percent of the cost of supply.

## Bangladesh

The overall weighted average tariff/kWh covering the retail sales of BPDB, DESA, and DESCO has gone up from Tk 2.8 in FY 2000 to Tk 3.4 by FY 2006. However the tariff has fallen in terms of dollar equivalent during the same period from 5.4 cents to 5.2 cents.[84] The last notable tariff revision was in September 2003. Since then, fuel costs and other costs have increased and BPDB and DESA are making significant losses. Households have three blocks, and industrial tariffs are by voltage of supply (see Table A3.2).

Peak and off-peak rates are available for large consumers. Peak rates are 40 to 80 percent higher than the regular tariffs, while the off-peak rates are about 15 to 20 percent lower.

## Bhutan

Electricity tariffs were revised last on July 1, 2006. Bhutan exports power to India at 4.65 cents/kWh, while the same generating plants sell power to Bhutan Power Corporation at 0.78 cents. The retail tariffs of BPC are summarized in Table A3.3.

[84] Final Report of June 2006 by Nexant produced under 1TA No.4379-BAN: Power Sector Development Program II of the Asian development Bank, Manila available at www.adb.org.

**Table A3.4** Retail Electricity Tariffs in Nepal

| Consumer Category | Demand Charge ($/kW/month) | Energy Charge (cents/kWh) |
|---|---|---|
| Households with a monthly consumption up to 20 kWh | | 5.4 |
| Households with a monthly consumption of 21–250 kWh | | 9.9 |
| Households with a monthly consumption exceeding 250 kWh | | 13.4 |
| Industries at low voltage | 1.22 | 8.9 |
| Industries at medium voltage | 2.57 | 8.0 |
| Industries at high voltage | 2.37 | 6.2 |
| Commercial at low voltage | 3.01 | 10.4 |
| Commercial at 11 kV | 2.89 | 10.3 |
| Commercial at 33 kV | 2.89 | 10.0 |

*Source:* www.nea.org.np Exchange rate: $1= NRs 74.84.

## Nepal

The average revenue /kWh realized by NEA in Nepal for FY 2006 was 8.79 cents. Even at this tariff, NEA was losing $33.5 million for the year. Tariffs for select retail consumers are summarized in Table A3.4.

For the larger consumers, peak and off-peak tariffs are available. The peak tariff is about 14 percent to 15 percent higher and off-peak tariff is about 30 lower than the regular tariff. Notably lower tariffs are provided for irrigation, water supply, and transport. Furthermore, a 10 percent discount is given to those in the government-approved industrial districts and a 25 percent discount is given to hospitals and health centers.

## India

India has a large number of states and union territories, each of which has a regulatory body and its own schedule of electricity tariffs. The Central Electricity Authority (CEA) has computed that in FY 2004, the overall average revenue per kWh realized in the country was about 4.4 cents, compared to the overall average cost of supply of 5.2 cents at the exchange rate of Rs 45.98 to a dollar. For each of the states and union territories, the CEA has also computed the cost per kWh for a range of consumers, taking into account the tariff parameters such as capacity charge, energy charge, electricity tax, and other applicable taxes, as well as load profiles. Information for select consumers in five states of India is given in Table A3.5. They relate to the tariffs prevailing in FY 2006.

Tamilnadu, Punjab, and Pondicherry provide free power for all agricultural pump sets. The structure of tariff does not reflect the structure of costs for supply at different voltages. The overall average revenue per kWh is very low on account of high level of theft and inefficient metering, billing, and collection.

## Pakistan

According to the power wing statistics of WAPDA for FY 2006, average sale price/kWh was 3.99 Rs/kWh (6.65 USc/kWh) for WAPDA and 4.59 Rs/kWh (7.65 USc/kWh) for KESC.[85] In February 2007, NEPRA determined new tariffs for the eight WAPDA distribution companies, with end-user tariffs being different across the companies. The government, however, notified different end user tariffs that are the same for all eight companies and generally lower (or

[85] At the exchange rate of PRs 57.57 to a dollar prevailing in FY 2006.

**Table A3.5** Tariffs (cents/kWh) for Select Consumers in Select States of India

| Typical Consumer Categories with Monthly Consumption of Electricity in kWh | Cost to the Consumer/kWh in Cents | | | | |
|---|---|---|---|---|---|
| | Delhi | Tamil Nadu | Gujarat | West Bengal | Andhra Pradesh |
| Household, 100 kWh/month | 6.03 | 2.61 | 8.52 | 4.75 | 5.19 |
| Household, 400 kWh/month | 7.54 | 4.70 | 11.23 | 6.51 | 8.63 |
| Household, 1,000 kWh/month | 9.45 | 5.86 | 12.80 | 8.02 | 10.71 |
| Commercial consumer, 300 kWh/month | 10.04 | 13.09 | 12.81 | 7.89 | 13.03 |
| Commercial consumer, 1,500 kWh/month | 11.42 | 13.21 | 13.62 | 11.44 | 13.59 |
| Commercial consumer, 7,500 kWh/month | 11.42 | 13.24 | 13.76 | 13.01 | 13.7 |
| Agricultural pump sets (5 HP), 1,000 kWh/month | NA | 0.00 (free) | 1.26 | 4.15 | 0.52 |
| Industry, 7,500 kWh/month | 12.18 | 10.58 | 10.13 | 10.91 | 9.91 |
| Industry, 4.38 GWh/month | 12.19 | 10.06 | 12.12 | 9.62 | 9.10 |
| Industry, 8.76 GWh/month | 11.90 | 9.83 | 12.11 | 9.62 | 8.87 |
| Railway traction, 25 GWh/month | 11.25 | 11.45 | 11.94 | 9.87 | 9.14 |

*Source:* www.cea.nic.in

**Table A3.6** Electricity Tariffs in Pakistan

| Category of Consumer | Fixed Charge ($/kW/month) | Energy Charge (cents/kWh) |
|---|---|---|
| Households, 0 to 50 kWh/month | | 2.33 |
| Households, 0 to 100 kWh/month | | 4.42 |
| Households, 101–300 kWh/month | | 6.06 |
| Households, 301 to 1000 kWh/month | | 10.25 |
| Households, above 1000 kWh/ month | | 12.35 |
| Commercial, peak loads up to 20 kW | | 12.47 to 12.68 |
| Commercial, peak loads exceeding 20 kW | $4.45 | 7.65 |
| Industrial low voltage | | 9.37 |
| Industrial medium and high voltage | $5.67 to $5.87 | 5.25 to 8.35 |
| Agricultural tube wells in Punjab and Sindh | $1.46 | 5.47 |
| Railway traction | | 9.48 |

*Source:* www.pepco.gov.pk and World Bank documents.

the same for some companies and consumer categories) than NEPRA-determined tariffs. The difference between the two sets of tariffs —those determined by NEPRA and those notified by the government (which the companies are allowed to charge to consumers)—will be paid by the government budget to the power companies as subsidies to consumers. Table A3.6 shows tariffs notified by the government (the table is not exhaustive, as there are some additional consumer categories not included for simplicity).

Peak and off-peak tariffs are available for large industrial consumers and bulk supply. Assuming consumer mix as in FY 2006 and projected sales for FY 2007, average end-user tariff notified by the government is estimated to be 4.26 Rs/kWh (7.1 Usc/kWh), while average

**Table A3.7** Electricity Tariffs in Sri Lanka

| Consumer Category | Fixed Charge ($/month) | Demand Charge ($/kVA/ month) | Energy Charge (cents/ kWh) |
|---|---|---|---|
| Households, 0–30 kWh/month | 0.58 | - | 2.89 |
| Households, 31–60 kWh/month | 0.87 | - | 4.52 |
| Households, 61–90 kWh/month | 1.16 | - | 4.91 |
| Households, 91–180 kWh/month | 1.74 | - | 11.64 |
| Households, above 180 kWh/month | 2.32 | - | 16.64 |
| Industrial low voltage contract, demand up to 42 kVA | 2.32 to 4.81 | - | 8.18 |
| Industrial/hotel low voltage contract, demand above 42 kVA | 28.86 | 3.85 | 7.79 |
| Industrial/hotel, at 11kV/33kV/132kV | 28.86 | 3.66 | 7.70 |

*Source:* www.ceb.lk Exchange rate: $1= LkRs 103.9623 (average rate for 2006).

NEPRA-determined tariff is estimated at 5.12 Rs/kWh (8.53 USc/kWh) and ranges from 4.66 Rs/kWh (7.77 USc/kWh) for Islamabad distribution company to 7 Rs/kWh (11.7 USc.kWh) for Hyderabad distribution company (serving Sindh province, except Karachi).

## Sri Lanka

The average revenue/kWh (excluding value-added tax) for Sri Lanka was reported at 7.57 cents for 2004.[86] Despite this, Ceylon Electricity Board (CEB had a negative 4.86 percent rate of return on its average net fixed assets in operation and a negative debt service ratio. Salient details of the tariffs in effect from September 1, 2006, are summarized in Table A3.7 using the average exchange rate for 2006 indicated in the Web site of the Sri Lankan Central Bank.

All rates are subject to a fuel adjustment charge of 20 percent, except in the case of households and religious institutions consuming less than 90 kWh per month. Religious consumers pay a rate lower than households.

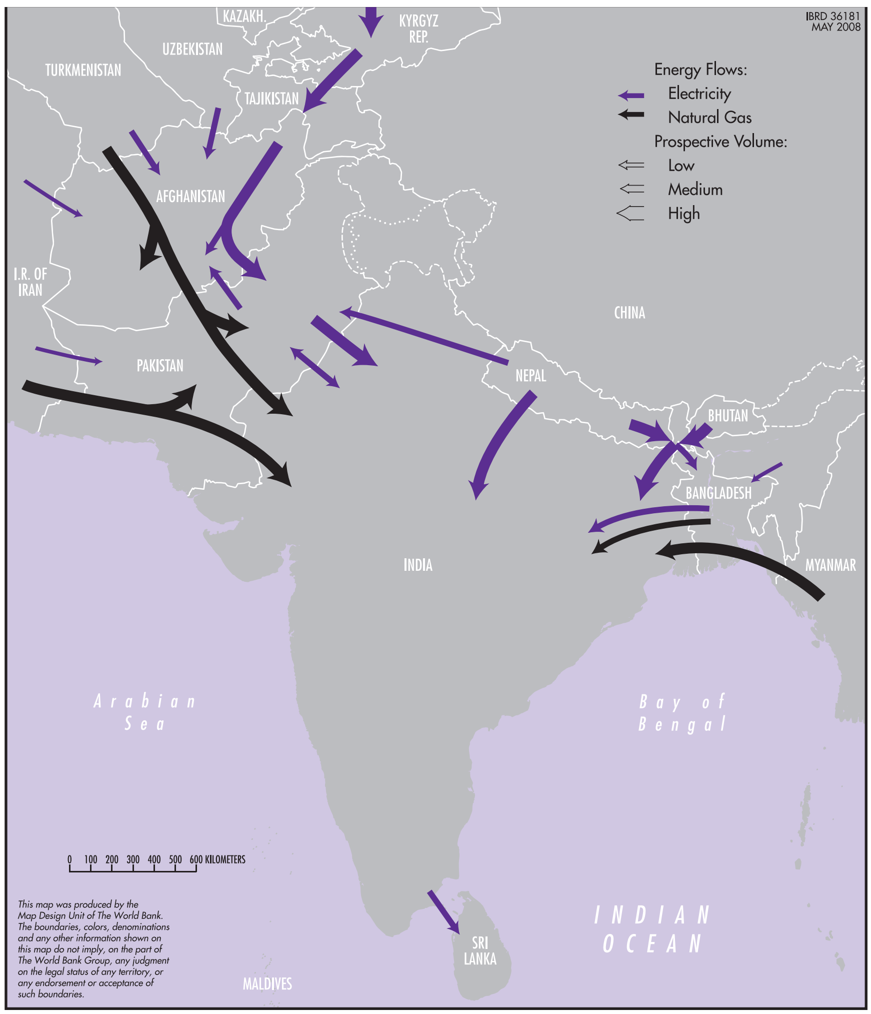
[86] At the exchange rate of LkRs.101.1884 to a dollar, the average rate for 2004 as reported at www.cbsl.lk.

# Appendix 4 Benefits of Electricity Trade at a Glance—Some Illustrative Numbers

| Country | Details |
|---|---|
| Afghanistan | Imported 430.12 GWh of electricity, or 27 percent of total supply in FY 2006. Marginal cost of electricity was 22 cents, while the average import cost was 2 cents. Savings to economy amounted to $86.02 m (or 1.2 percent of GDP in 2005 of $7.3 billion). |
| Bangladesh | Bangladesh sheds loads at around 694 MW in FY 2004. The unserved energy amounted to 3,900 GWh valued at $171 million on the basis of the system AIC of 4.38 cents/kWh and substantially more when valued at the system marginal costs.<br>Bangladesh marginal price during the peak period is estimated at Tk2.03/KWh (2.8 cents) in the east zone and Tk 11.642(16 cents) in the west zone. By linking west zone with the eastern regional grid of India, which has an energy surplus, Bangladesh can hope to lower the marginal cost in the west zone substantially. Conversely, gas supply to the west zone could be stepped up across the Jamuna River to set up large plants (1,000 MW) in the west zone partly to meet the demand in the west zone (600 MW) and to lower the marginal cost there (from 16 cents to about 4 to 5 cents, or even lower), and to export power to India (400 MW, or 2,453 GWh at 4.7 cents/kWh) and earn $115.3 million annually. |
| Bhutan | Exports in FY 2007 amounted to 5664 GWh at 4.65 cents/kWh. Export receipts at $263.4 million would be equal to 24 to 25 percent of GDP. Tala capital cost was $1082 million, or a little over 100 percent of the country's GDP. |
| India | The energy shortage in FY 2007 was 54,916GWh, valued at the marginal cost of Rs 9.3 or (22 cents), equal to $12.082 billion (valuation by CERC). If it gets imported electricity at 6 to 7 cents and imported gas-based electricity at 8 to 9 cents, the saving would be on the order of $7.7 billion. On the basis of recently received bids in the ICB for ultramega projects, the levelized cost of power from the new 3,500 to 3,800 MW power stations using domestic coal from captive coal mines would be 2.85 cents/kWh and the cost of power from a similar-sized power station based on imported coal would be 5.45 cents per kWh. Cost of power from most large hydro projects recently constructed or under construction is around 3.5 to 6 cents/kWh. Gas-based generation using gas at $7/mmBtu will cost 9.25 cents/kWh. These figures give a flavor of the attractiveness of the Indian market for exporters and the likely volume of benefits to India from trade. |
| Nepal | West Seti HPP: Capital cost $1,098 million, exports to India 2970 GWH (90 percent of production) at 4.95 cents/kWh are valued at $147 million (or 2 percent of GDP).<br>Upper Karnauli, Buri Gandaki, and Arun 3 HPPs with a total capacity of 1,302 MW could possibly export 4,562 GWh (at 40 percent PLF) at 6 cents/kWh. Value is $274 million, or 4 percent GDP. All four projects will yield export earnings of 6 percent of GDP.<br>West Seti HPP cost alone amounts to 15 percent of GDP of the country. This would be a significant investment benefit. |

| | |
|---|---|
| Pakistan | Unserved energy in FY 2007 amounted to 17,704 GWh and may rise to over 27,000 GWh by FY 2010 and to 35,000 GWh by FY 2011 if no capacity is added. When valued at the assumed Pakistan system average incremental cost of about 7cents/kWh, the costs of these shortages are of the order of $1.9 billion for FY 2010, rising to $2.5 billion for FY 2011. Power and gas imports could help reduce these shortages significantly. In general, new IPP projects are expected to have a levelized tariff of 5.9 cents to 13.8 cents/kWh, based on the fuel they use. Use of domestic gas results in the lowest levelized tariff and the use of high-speed diese lresults in the highest levelized tariffs. The gas price to IPPs in 2007 is $4.23/mmBtu. As it rises to match import parity prices of around $6.8 to $7/mmBtu, the levelized power tariffs would be higher. |

# Appendix 5 Map Showing the Potential for Regional Energy Trade in South Asia



# List of Formal Reports

| Region/Country | Activity/Report Title | Date | Number |
|---|---|---|---|
| | **SUB-SAHARAN AFRICA (AFR)** | | |
| Africa Regional | Anglophone Africa Household Energy Workshop (English) | 07/88 | 085/88 |
| | Regional Power Seminar on Reducing Electric Power System Losses in Africa (English) | 08/88 | 087/88 |
| | Institutional Evaluation of EGL (English) | 02/89 | 098/89 |
| | Biomass Mapping Regional Workshops (English) | 05/89 | — |
| | Francophone Household Energy Workshop (French) | 08/89 | — |
| | Interafrican Electrical Engineering College: Proposals for Short- and Long-Term Development (English) | 03/90 | 112/90 |
| | Biomass Assessment and Mapping (English) | 03/90 | — |
| | Symposium on Power Sector Reform and Efficiency Improvement in Sub-Saharan Africa (English) | 06/96 | 182/96 |
| | Commercialization of Marginal Gas Fields (English) | 12/97 | 201/97 |
| | Commercializing Natural Gas: Lessons from the Seminar in Nairobi for Sub-Saharan Africa and Beyond | 01/00 | 225/00 |
| | Africa Gas Initiative—Main Report: Volume I | 02/01 | 240/01 |
| | First World Bank Workshop on the Petroleum Products Sector in Sub-Saharan Africa | 09/01 | 245/01 |
| | Ministerial Workshop on Women in Energy | 10/01 | 250/01 |
| | and Poverty Reduction: Proceedings from a Multi-Sector and Multi-Stakeholder Workshop Addis Ababa, Ethiopia, October 23–25, 2002 | 03/03 | 266/03 |
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| Benin | Energy Assessment (English and French) | 06/85 | 5222-BEN |
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| | Household Energy Strategy Study (English) | 02/90 | 110/90 |
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| Chad | Elements of Strategy for Urban Household Energy The Case of N'djamena (French) | 12/93 | 160/94 |
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| | In Search of Better Ways to Develop Solar Markets: The Case of Comoros | 05/00 | 230/00 |

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| | Charcoal Utilization Pre-feasibility Study (English) | 06/90 | 119/90 |
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**Potential and Prospects for Regional Energy Trade in the South Asia Region**

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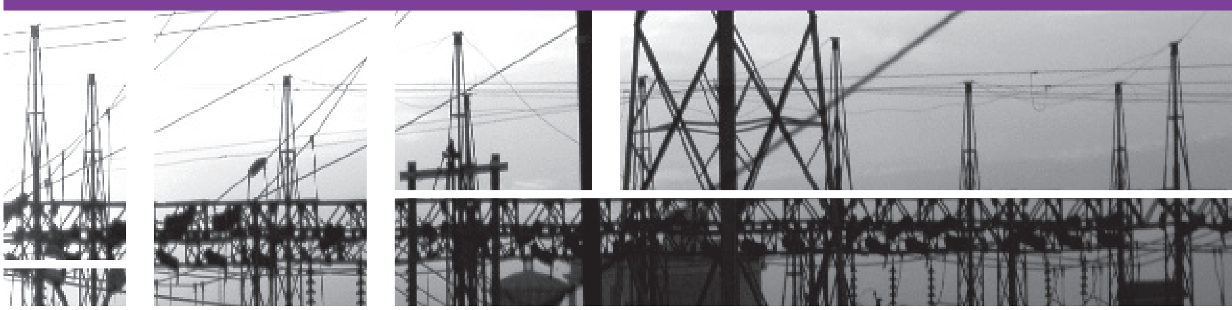

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