



SAARC Regional Energy Trade Study (SRETS)

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Preface

At the Twelfth SAARC Summit (Islamabad, 4-6 January 2004), the SAARC Heads of States emphasized that for accelerated and balanced economic growth, it is essential to strengthen energy cooperation in the region. The Summit directed that a study on creating a South Asian Energy Cooperation in the energy sector should be undertaken. In follow-up, the First Meeting of the Energy Ministers decided to conduct a study on the options, benefits and constraints of energy trade in the region.

The SAARC Regional Energy Trade Study (SRETS) has consequently been carried out with the assistance of the Asian Development Bank. The study has identified measures that would enhance regional energy cooperation among the Member States of SAARC and promote both intra-regional and inter-regional energy trade. The SRETS promises to be an important source of reference material, containing information on regional energy trade and its relevance to socio-economic development in South Asia.

I commend the National and Regional consultants for their strenuous efforts in preparing the ground work, collecting data and providing input for preparing the initial draft. I would also like to put on record my appreciations to the energy Experts of the SAARC Member States, who provided input and invaluable comments, and to the Lead Consultant for playing a vital role in preparing this study. The efforts of the ADB experts, who carried out peer review of the study and provided very useful comments to make it acceptable to all Member States, are laudable.

I also wish to express appreciation to the Asian Development Bank (ADB) for providing technical and financial assistance to conduct the Study.

Dr. Sheel Kant Sharma
Secretary General of SAARC
March 2010

Acknowledgment

The SAARC Regional Energy Trade Study (SRETS) report has been prepared by a team of experts from South Asia headed by Dr. Leena Srivatava. It has been synthesized from the eight country reports prepared by the National Consultants from Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. The names of the authors of country reports are given below:

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- Prof. Priyantha Wijayatunga, Sri Lanka

Dr. P. N. Fernando and Mr. Durga Raina provided extensive inputs and valuable comments while reviewing the country reports, the regional report, and incorporating responses to the comments of the SAARC Member States while finalizing the SRETS Report. Ms. Ruchika Chawla and Ms. Garima Jain extended assistance to Dr. Srivastava in drafting the regional report.

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List of Abbreviations

ADB	Asian Development Bank
AEPC	Alternative Energy Promotion Centre
AFRA	Average Freight Rate Assessment
AFREC	Africa Energy Commission
AISA	Afghanistan Investment Support Agency
ANDS	Afghanistan National Development Strategy
ANSA	Afghan National Standardization Authority
APP	Asia Pacific Partnership
APM	Administered Pricing Mechanism
APPA	Africa Petroleum Producers Association
AU	Africa Union
BCM	Billion Cubic Meter
BERC	Bangladesh Energy Regulatory Commission
BEA	Bhutan Electricity Authority
BGFCL	Bangladesh Gas Fields Company Limited
BOGMC	Bangladesh Oil, Gas and Mineral Corporation
BPC	Bhutan Power Corporation Limited
BPDB	Bangladesh Power Development Board
CAGR	Compounded Annual Growth Rate
CATS	Customers Access Terminal System
CDM	Clean Development Mechanism
CEA	Central Electricity Authority
CEB	Ceylon Electricity Board
CERC	Central Electricity Regulatory Commission
CIL	Coal India Ltd
CNG	Compressed Natural Gas
CPC	Ceylon Petroleum Corporation
CPGS	Central Power Generating Stations
DAE	Department of Atomic Energy
DGH	Directorate General of Hydrocarbon
DGPC	Druk Green Power Corporation Limited
DHI	Druk Holdings and Investments Limited
DOED	Department of Electricity Development
DRC	Democratic Republic of Congo
DRED	Department of Renewable Energy Development
EAC	Energy Advisory Committee
ECA	Economic Commission of Africa
ECT	Energy Charter Treaty
EI	Energy Intensity

EMRD	Energy & Mineral Resources Division
EPF	Electric Power Forum
E&P	Exploration and Production
F.O.B	Free On Board
GoI	Government of India
GoN	Government of Nepal
GDP	Gross Domestic Product
GMS	Greater Mekong Sub-Region
GTCL	Gas Transmission Company Limited
GWh	Giga Watt Hour
HCU	Hydrocarbon Unit
HDI	Human Development Index
HSD	High Speed Diesel
ICE	Inter-Ministerial Commission for Energy
IDCOL	Infrastructure Development Company Limited
IOCs	International Oil Companies
IEA	International Energy Agency
IEX	India Energy Exchange
IGA	Inter Governmental Agreement
IPI Pipeline	Iran-Pakistan- India Pipeline
IPP	Independent Power Producers
IREDA	Indian Renewable Energy Development Agency
ITC	Independent Transmission Companies
KESC	Karachi Electric Supply Corporation
LDC	Load Dispatch Centre
LECO	Lanka Electricity Company
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MEA	Maldives Energy Authority
MEW	Ministry of Energy and Water
MMSCFD	Standard Million Cubic Feet Per Day
MMPA	Million Tonnes Per Annum
MoEST	Ministry of Environment, Science and Technology
MoICS	Ministry of Industry, Commerce and Supplies
MoP	Ministry of Power
MoPEMR	The Ministry of Power, Energy and Mineral Resources
MoP&NR	Ministry of Petroleum & Natural Resources
MoF	Ministry of Finance
MoFA	Ministry of Foreign Affairs
MoFT	Ministry of Finance and Treasury
MoPNG	Ministry of Petroleum & Natural Gas
MoU	Memorandum of Understanding
MoWR	Ministry of Water and Resources
MoW&P	Ministry of Water & Power

MMT	Million tonnes
MNRE	Ministry of New and Renewable Energy
MTOE	Million tonnes of oil equivalent
MW	Megawatt
MWh	Megawatt Hour
NCL	Nepal Coal Limited
NEA	Nepal Electricity Authority
NEP	National Energy Policy
NELP	New Exploration Licensing Policy
NEEPCO	North Eastern Electric Power Corporation
NLDCs	National Load Dispatch Centres
NOC	Nepal Oil Corporation
NGO	Non-Governmental Organization
NHPC	National Hydro Electric Power Corporation
NPCIL	Nuclear Power Corporation of India Limited
NSP	National Solidarity Program
NTDC	National Transmission and Dispatch Company
NTPC	National Thermal Power Corporation
OGDCL	Oil and Gas Development Company Limited
OGRA	Oil and Gas Regulatory Authority
PAEC	Pakistan Atomic Energy Commission
PEEREA	Protocol on Energy Efficiency and Related Environmental Aspects
PEPCO	Pakistan Electric Power Company
PEPP	Petroleum Exploration Promotion Project
PNGRB	Petroleum and Natural Gas Regulatory Board
PGCIL	Power Grid Corporation of India Limited
POL	Petroleum and Oil Product
PFC	Power Finance Corporation
PSUs	Public Sector Undertaking
PTC	Power Trading Corporation Ltd.
PPIB	Private Power Infrastructure Board
PPP	Purchasing Power Parity
PRR	Priority Reform and Reconstruction Program
PSCs	Production Sharing Contracts
PSO	Pakistan State Oil
PUCSL	Public Utilities Commission of Sri Lanka
R/P ratio	Reserves-to-Production Ratio
REC	Rural Electrification Corporation
RECs	Regional Economic Communities
RERA	Regional Electricity Regulatory Association
RETA	Regional Technical Assistance
RETs	Renewable Energy Technologies
RGoB	Royal Government of Bhutan

RIPA	Regional Integrated Programme of Action
RPTCC	Regional Power Trading Coordination Committee
SAARC	South Asian Association for Regional Cooperation
SADC	Southern African Development Community
SADF	South Asian Development Fund
SAPP	Southern African Power Pool
SC	Single Circuit
SDF	SAARC Development Fund
SEBs	State Electricity Boards
SEC	SAARC Energy Centre
SERCs	State Electricity Regulatory Commissions
SFRPS	SAARC Fund for Regional Projects
SGFL	Sylhet Gas Fields Limited
SHS	Solar Home Systems
SMS	SAARC Member States
SRETF	SAARC Renewable Energy Task Force
SRETS	SAARC Regional Energy Trade Study
SRF	SAARC Regional Fund
SCA	Sindh Coal Authority
SNGPL	Sui Northern Gas Pipe Line Company Limited
SSGCL	Sui Southern Gas Company Limited
STEM	Short Term Energy Market
STELCO	State Electric Company Ltd
STO	State Trading Organization
T&D	Transmission and Distribution
TAPI Pipeline	Turkmenistan-Afghanistan-Pakistan-India Pipeline
TCF	Trillion Cubic Feet
TERI	The Energy and Resources Institute
ToR	Terms of Reference
TSO	Transmission System Operator
UNDP	United Nations Development Programme
UMPP	Ultra Mega Power Projects
USA	United States of America
USD	United States Dollars
WEC	World Energy Council
WTO	World Trade Organization

Energy Conversion Factors

Basic Energy Units

1 joule (J) = 0.2388 cal

1 calorie (cal) = 4.1868 J

(1 British thermal unit [Btu] = 1.055 kJ = 0.252 kcal)

WEC Standard Energy Units

1 tonne of oil equivalent (toe) = 42 GJ (net calorific value) = 10 034 Mcal

1 tonne of coal equivalent (tce) = 29.3 GJ (net calorific value) = 7 000 Mcal

Note: the tonne of oil equivalent currently employed by the International Energy Agency and the United Nations Statistics Division is defined as 107 kilocalories, net calorific value (equivalent to 41.868 GJ).

Volumetric Equivalents

1 barrel = 42 US gallons = approximately 159 litres

1 cubic metre = 35.315 cubic feet = 6.2898 barrels

Electricity

1 kWh of electricity output = 3.6 MJ = approx. 860 kcal

Representative Average Conversion Factors

1 tonne of crude oil = approx. 7.3 barrels

1 tonne of natural gas liquids = 45 GJ (net calorific value)

1 000 standard cubic metres of natural gas = 36 GJ (net calorific value)

1 tonne of uranium (light-water reactors, open cycle) = 10 000–16 000 toe

1 tonne of peat = 0.2275 toe

1 tonne of fuel wood = 0.3215 toe

1 kWh (primary energy equivalent) = 9.36 MJ = approx. 2 236 Mcal

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Executive Summary

The South Asian Association for Regional Cooperation (SAARC) region is home to 23% of total world population. The region has been witnessing an impressive average annual GDP growth rate of 5.6% (1995-2005). Countries such as Bangladesh, India, Pakistan and Sri Lanka have had a GDP growth rate of 6 to 9% in the recent years. Since there is a direct co-relationship between rising economic growth and increasing energy demand, the accelerating economic growth in the region is expected to boost the energy demand. Moreover, even to sustain the robust economic growth, it is necessary that the energy demand of the region be sufficiently met by a continuous supply of energy in various forms. Despite these impressive economic growth levels, the region is home to a large proportion of population that is living below the poverty line. It is, therefore, important to explore all possible options to ensure and enhance regular supply of energy to support the economic growth and to help alleviate poverty in the region.

ES 1. SAARC Energy Sector Overview

There is a wide variation in the energy resource endowments among the SAARC Member States (SMS). India and Pakistan account for the major share of natural gas and coal. However, these Member States are large in terms of area as well as population and thus, the higher resource base need not necessarily be sufficient to meet their energy needs. Being home to the Himalayas, South Asia has a large hydropower potential, with Bhutan and Nepal having hydropower potential in excess of their electric power demand in the foreseeable future. Along with variation in resource endowments, there is disparity in energy consumption pattern across the Member States, due to various reasons.

Annual energy consumption among the Member States ranges from as low as 0.17 million tonnes of oil equivalent (mtoe) for Maldives to 423.2 mtoe for India¹. In per capita consumption terms too, there exist significant variations, albeit in different compositions, with Maldives registering the highest per capita energy consumption and Afghanistan and Nepal the lowest.

In terms of energy consumption pattern, most of the SMS, except for India and Pakistan rely primarily on one predominant form of commercial energy. Afghanistan is dependent on imported energy. The Maldives is heavily dependent on oil. Bhutan, Nepal and Sri Lanka meet a large part of their commercial energy needs, especially electricity from hydropower, but are heavily dependent on imported petroleum products to meet the energy needs in other sectors of the economy. Bangladesh is heavily reliant on natural gas. Such a heavy dependence on a single energy form not only limits the options of meeting diverse energy demands but also increases energy security concerns.

From the regional cooperation and energy trade perspective, an important characteristic of the region is the variation in the energy demand and supply situation. While Bangladesh, India and Pakistan are facing significant levels of power shortages; Bhutan, at its current level of generation capacity, exports relatively a large volume of power to India in addition to meeting its own demand. A similar situation would arise in Nepal with the realization of large scale hydropower under development. Such an environment creates

¹ Country reports

opportunities for trade among the deficit and the surplus Member States given the unique characteristic of electricity – once produced it has to be consumed immediately. The SAARC region is well endowed in renewable energy sources – biomass, wind and solar. While biomass meets the large portion of household energy demand across the region, the full potential of wind and solar energy has not been realised due to lack of requisite technological capacities, high capital cost of equipment and higher energy prices from these resources.

As far as crude oil/ petroleum products are concerned, all the Member States are dependent on either crude oil or petroleum product imports to different extents to meet their domestic demand. This intensifies the energy security concerns of the entire region.

Looking at the sector-wise energy demand in the region, it is observed that two sectors – household and industry – are the key consumers of energy in the SAARC region. The household sector is also the major consumer of the traditional fuel (biomass). Since, SMS are aiming for higher GDP growth rates, energy demand from industry would increase. Moreover, with increasing household income, it is expected that the household sector would shift from traditional energy sources to commercial energy sources, thereby increasing the demand for the commercial energy supplies.

In the medium to long term future (2010-2020) energy demand in the region is expected to grow exponentially. Total regional energy demand is expected to grow at a compounded annual growth rate (CAGR) of 5% with natural gas expected to register a growth rate of 6.34% followed by crude oil and coal. Among all the commercial energy sources, electricity is expected to register the fastest annual growth in demand at around 9%.

Based on the current and the future energy demand supply situation, the following key challenges exist and, these need to be addressed by the region collectively at the earliest:

- (i) Increasing energy deficits
- (ii) Dominance of single fuel in energy mix
- (iii) Limited exploitation of the renewable energy resources
- (iv) High dependence on traditional fuels
- (v) Rising import dependence
- (vi) Lack of requisite energy infrastructure

Cooperation among the SMS would be the most cost effective and efficient mechanism to meet these challenges. Augmenting energy supply and diversifying the fuel basket, would call for both inter and intra-regional energy trade. Resource constraints are limiting the options for intra-regional energy trade. SMS would immensely benefit by collaborating in securing energy supplies through inter-regional trade with the neighbouring energy resource rich regions/countries. It would, therefore, be useful to give equal emphasis to identification of inter-regional trade opportunities. A few inter-regional trade proposals are already under discussion. The SAARC Regional Energy Trade Study (SRETS) examines these and other energy trade options to strengthen energy security in the region through regional energy trade. In this context, SRETS has identified four multilateral trade and cooperation options. These four multilateral trade and cooperation options can, over time, include all countries of the region. In the selection of these options care has been taken to ensure that interests of all concerned stakeholders are addressed and that these options can

be practically implemented. A brief over view of these options is given in subsequent paragraphs.

ES 2. Current Energy Trade between SAARC Member States

The existing regional energy trade among the SMS is limited to electricity trade between Bhutan-India and India-Nepal which is of the order of 5,620GWh and 329GWh respectively and trade in petroleum products between India, Nepal, Bhutan, Bangladesh and Sri Lanka. While the electricity traded is based on indigenous resources, the petroleum trade is essentially India importing crude oil in excess of its requirement to satisfy the petroleum demand in Bhutan, Nepal and partly that of Sri Lanka. As a result of excess refining capacity and availability of surplus of certain petroleum products, India has started exporting diesel to Bangladesh. With the Indian Oil Corporation taking stake in the Sri Lankan petroleum industry, it is helping in partially meeting the petroleum product demand in Sri Lanka. Bangladesh imports about 3-4 million tons of coal from the SAARC region and beyond. The amount of imports may increase significantly in coming years and the Government of Bangladesh is actively considering some coal based power plants for the country.

The inter-regional energy trade between South Asia and the rest of the world covers petroleum, coal, and limited electricity trade. No inter or intra-regional gas transmission infrastructure is in place to facilitate gas imports, except for the LNG terminals in India satisfying domestic requirements. The inter-regional electricity trade is limited to Afghanistan importing power from Central Asian Republics (CAR) and Pakistan from Iran. But the volume of this trade is insignificant in comparison to its potential, the exploitation of which would require building of the essential infrastructure to support this trade.

ES 3. Energy Infrastructure Projects on the Horizon

Recently two pre-feasibility studies, one to interconnect the Indian power grid with that of Bangladesh and the other to interconnect the Indian power grid with that of Sri Lanka have been carried out. Similarly pre-feasibility studies for some specific inter-regional power and gas transmission systems i.e. Iran-Pakistan-India (IPI) gas pipeline, Central Asia-South Asia (CASA) 1000 power link and Turkmenistan-Afghanistan-Pakistan-India (TAPI) gas pipeline have also been undertaken. Related studies have prima facie established financial, economic and technical viability of these projects.

Additional power transmission interconnection options between India and Nepal too have been studied by private developers. With the interest of the IPPs in Nepal and power purchasers in India, it is expected that these projects will be implemented in the foreseeable future. Bhutan-India interconnections are built as part of the power evacuation system for each generation project established in Bhutan.

One pre-feasibility study that needs to be undertaken with earnestness is the power transmission interconnection between India and Pakistan. The nearest substations that can be interconnected are Dinnath near Lahore with Patti in the Indian state of Punjab. The estimated length of this link is about just 50 km. Given the ease with which it can be built and the benefit to both the countries, this needs to be carried out as a priority project.

With the establishment of India-Pakistan, India-Bangladesh and India-Sri Lanka electricity interconnections, six of the eight SAARC Member States will get interconnected and can reap the benefits of regional electricity trade.

ES 4. Financing of Projects

The investment requirement for the energy projects in each Member State is very large, in certain cases, well beyond their manageable limits. It is estimated that India alone needs about US\$ 220 billion over the next 5 years for creating the domestic energy infrastructure, leave alone the inter-regional energy projects. Inter-regional and intra-regional energy investments will raise these requirements well above these figures. The global financial markets melt down would certainly slow down certain investment decisions/projects or result in increased cost of capital to finance these projects.

But one redeeming feature is that, though not isolated from the global economy, South Asian economies are expected to continue to grow at a healthy rate as a result of their own market dynamics. Since the rest of the world is not expected to grow at those rates, South Asia will prove to be an attractive investment destination for global financial players.

Governments from the region will have to be the prime project sponsors and/or supporters for the interregional energy projects, to give a reasonable level of comfort to the investors and lenders to these projects. With government backing these projects, it is expected that financing of these projects may not pose any major challenges.

Moreover the oil and gas majors across the world have stakes in the major oil and gas reserves in CARs and in Myanmar, the two energy rich regions in the vicinity of South Asia. They have the financial wherewithal as well as the willingness to monetize their investments by exporting the energy supplies to South Asia. They themselves, or in association with other investors can finance the interregional energy trade projects between South Asia and its neighbouring regions.

ES 5. Technical Issues in Project Implementation

As far as the in-country projects are concerned, most of the countries in the region have acquired technical expertise to implement energy projects. The inter regional projects are expected to pose some challenges requiring large overseas investments including that from the Multilateral Financial Institutions. Projects availing their financial assistance have to be necessarily awarded through international competitive bidding. The first criterion under this mechanism is the technical capability of the bidder; this ensures that technically competent project developers get selected for the execution of such projects. The regional energy projects on the horizon are similar to those successfully implemented in other parts of world. As such technical issues will not be un-surmountable.

ES 6. Likely Gains from Energy Trade Projects

Energy trade can bring immense benefits to the participating Member States. Earlier studies on the likely gains from power trade have demonstrated that the social and economic benefits from energy trade among the SAARC Member States would in certain

cases even surpass the direct financial benefits from specific energy projects. The benefits can broadly be categorized as technical, operational, environmental, financial, economic and social sector benefits. Some of the main benefits from energy projects and energy trade are given below.

(i) System Operational Benefits from:

- Optimal utilization of natural resources to meet growing energy demand
- Concentration of various types of energy resources in different countries
- Economy of scale
- Improved energy security and reliability
- Optimized transmission network
- Increased economic efficiency in system operation
- Reduced adverse environmental impact
- Reduced spinning reserves in the case of electricity generation

(ii) Economic and Financial Benefits from:

- Enhanced industrial productivity
- Increased revenues from trade and industrial activities
- Faster GDP growth rate
- Increased foreign exchange earnings for exporting countries

ES 7. Proposed Trade Option 1: Regional/Sub-regional Power Market

In addition to the projects mentioned in section ES-3, additional project opportunities are discussed below.

A common link cutting across all SMS is the growing demand for electricity to meet energy needs. However, it is expected that individual Member States themselves would continue to be in a situation of shortages for quite some time to come. Given that the opportunity cost of electricity shortages is very high any effort within the region to reduce such energy shortages would have significant economic benefits. An option the region can pursue is to develop a regional electricity market that would allow trade in any surpluses that a country may have either over time of day or over seasons. Such trade would exploit the unique characteristic of electricity which once generated has to be consumed immediately. India has an important role to play in building a regional electricity market because of its location.

Establishment of a regional power market for the SAARC countries can offer manifold technical and economic benefits including optimal exploitation of energy resources, reduction in generation reserve requirements, reduction in overall cost of supply from competition in generation, improved system reliability, enhanced energy security, better energy access, lesser environmental impacts of power generation, added incentives to resource rich countries to accelerate power development with resultant benefits to the country's economic growth.

An Inter Governmental Agreement (IGA) to facilitate multi-lateral power exchanges/ trade is the pre-requisite for establishing the regional power market. This requires carrying out

of power system studies for different scenarios in the short, medium and long term. These studies will identify the possible quanta of power exchanges and transmission system requirements including the associated costs and benefits. Mode of cross border grid interconnections (synchronous or asynchronous) will also emerge from these studies.

Different options may be considered for implementing the power exchanges between regions. These include (a) for each country, the respective National Load Dispatch Centre (NLDC) to schedule the net feasible power exchange and communicate the same to the designated nodal/regional Load Dispatch Centre (LDC), and (b) a common power exchange (with optional participation) to deal with all power other than bilateral trade also and directly communicate with the designated nodal/regional LDC.

For building the regional and sub regional power market the region would need to adopt a phased approach. Interconnections would need to be established between various Member States, which could then graduate to support a regional/sub regional power market. The cost of electricity transfer through these interconnections depends upon a number of factors such as power transfer capacity, length of the line, energy flow and hours of supply. These costs could be levied as wheeling charges on the base tariff charged for electricity. Alternatively, as a method for financing these interconnections the central governments of the Member States could consider building these interconnections as a public good so as to reap larger benefits in the long term from increased regional electricity trade.

ES 8. Proposed Energy Trade Option 2: Regional/Sub-regional Refinery

All the SAARC member states except India import diesel to meet a substantial part of their petroleum product requirements. India also imports 75% of its total crude oil requirement. Given the high dependence of the entire region on imported petroleum products/crude, the region may consider setting up a Regional/Sub-regional refinery to meet the petroleum products demand of the region. Considering the current dominance of diesel in the energy consumption mix of the region, the refinery could be configured to maximize diesel production. The refinery would result in a two fold benefit for the region – (a) Net saving in foreign exchange due to decrease in import of petroleum products (b) additional revenue stream to the participating Member States in terms of profit sharing from the refinery.

The Regional/Sub-Regional refinery can be set up as a Special Purpose Vehicle (SPV) owned by interested Member States, and regulated as per agreed terms, with the specific objective of setting up additional state-of-art refining capacity that would be available to more than one country. The refinery will be expected to operate on commercial principles (import parity pricing at refinery gate). The SPV can operate under two models:

- (i) Grass Roots Refinery
- (ii) Additional refining capacity in the planned capacity additions of an existing refinery

Both approaches mentioned above would have a long gestation period. It takes about three to four years for commissioning a new refinery and two to three years in expanding an existing one. For the interim period either of the following arrangements may be adopted:

- (i) Procurement of petroleum products from existing Indian refineries (closer to respective borders) on commercial terms.
- (ii) Common crude procurement by SAARC Member States and refining the same at an existing refinery.

However, if we consider the setting up of a regional refinery, the total investment is expected to be around USD 8.21 billion for 23 MMTPA refineries². If the refinery configuration is such that 65% of its product is diesel, then the diesel production from the refinery would be about 14.95 mtoe. At USD 100/bbl (US dollars per barrel) of crude oil, HSD free on board (f.o.b.) price is expected to be USD 135/bbl. Assuming that the diesel produced by the refinery is sufficient to meet the entire diesel import requirement of the region (excluding India), the region would save around USD 14.80 billion on account of foreign exchange saved by avoiding diesel import. But foreign exchange would however be incurred on refinery feedstock import in the form of crude oil. Further, assuming a production profile with 3% LPG production, 10% naphtha, 15% petrol and 5% petroleum coke along with 65% production of diesel³, the refinery is expected to earn a net revenue of USD 2.75 billion (at a crude oil price of USD100/bbl). The expected pay back period for the refinery would be about 3 years. Detailed spreadsheets for the above mentioned analysis are given in **Annexure 1**.

ES 9. Proposed Energy Trade Option 3: Regional/Sub-regional LNG Terminal

In the context of energy security concerns and the need to use cleaner forms of energy, there has been an increased focus on the use of natural gas. Majority of SAARC Member States are largely dependent on one primary energy source and may consider natural gas to be an attractive option to diversify their current fuel mix. Natural gas is an economically attractive substitute for diesel based power generation. Moreover, if environmental costs are internalized, imported natural gas based power generation may be competitive to imported coal based power generation.

For this purpose, each country can either set up its own infrastructure or cooperate to set up a common infrastructure to enjoy the benefit of economies of scale. It is proposed that the region may consider developing a Regional/Sub regional LNG terminal that could cater to the needs of participating SAARC Member States. The additional factor in the establishment of such a terminal would be the gas transportation infrastructure within the region that may require agreements on right of way as also investments on supporting pipeline infrastructure.

Some of the main advantages from the Regional/Sub-regional LNG terminal are:

- (i) It would provide an opportunity for the smaller Member States; Bhutan, the Maldives, Nepal and Sri Lanka who up-till now do not use natural gas in their energy mix to procure natural gas supplies to diversify their fuel mix.

² Assumption: Investment requirement for 1 MMTPA refinery is USD 357 million

³ The production profile is based on discussions with refining experts

- (ii) Given their relatively small requirement for natural gas, setting up of separate LNG terminals to only meet their individual demand would not be justified. But clubbing their demand with other countries would make it economical for them to procure this clean fuel.
- (iii) Due to the economies of scale, they will be able to procure natural gas at competitive rates to justify imports and help in fuel substitution and/or utilization of natural gas for power generation and other applications.

One of the following options can be adopted for the ownership and financing structure of the terminal:

- (i) The LNG terminal can be structured as a joint venture of the participating Member States with each participating member state holding an equity stake, (based on its LNG requirement) in the terminal and procuring the latest technology for setting up the terminal.
- (ii) Involving the private sector in building the LNG terminal and using the storage facility on a common carrier principle basis.
- (iii) Merchant LNG terminal similar to Hazira LNG terminal operating on the Indian western coast. It procures LNG on spot contracts and short to medium term contracts on the supply side.

One of the following options for LNG pricing can be adopted, based on the ownership model and market maturity:

- (i) LNG operator may charge customers a fixed price for the gas supplies.
- (ii) LNG operator may charge a price as determined by a common regulator.
- (iii) Supply of LNG based on price and/or quantity bids.

The key parameters that would require due consideration while building the terminal are the location of the LNG terminal which will be determined by relative transport economics, availability of LNG and the price at which the LNG shall be available. The establishment of a backbone pipeline network is a pre-requisite to exploring this option. Alternatively, instead of transport of gas through pipelines, transfer of gas through wires in the form of electricity may be considered.

Based on the cost estimates for setting up of the Kochi LNG terminal in Kerala, the cost of setting up of an LNG terminal with 2.5 MMTA nominal capacity which is equivalent to about 8 MMCMD of natural gas, with provision of expansion up to 5 MMTA, would be approximately INRs. 20,000 million (US\$ 445 million at the exchange rate of INRs. 45 to 1 US\$). This will include storage and re-gasification facilities, unloading arms, two tanks of 110,000 cubic metre capacity each, vaporization system and utilities and off-site facilities. To begin with SAARC Member States could initiate this process by setting up of a similar LNG terminal and gain experience and confidence to increase the capacity and or number of such LNG facilities in the region to meet the regional gas demand.

ES 10. Proposed Energy Trade Option 4: Regional/Sub-regional Power Plant

Several of the Member States in the region are facing substantial power shortages and require significant additions to their power generating capacity to meet the current demand as well as to ensure universal access to electricity. Member States such as Afghanistan and Bangladesh have a power deficit of more than 20%. Pakistan has a power deficit of around 16% and India and Nepal have deficits to the tune of 10%. Therefore, it is suggested that the region may consider setting up of a Regional/Sub-regional power plant.

The size, location and fuel type (coal, natural gas, hydro) for the power plant are to some extent inter-linked aspects. Size would depend upon the power needs of the participating countries and how much power each country would like to avail from a regional/sub-regional plant keeping in view its own energy security concerns. The type and availability of fuel resource at a particular location would help decide the size and fuel source for the plant. One option available to the region for development of the regional/sub-regional power plant is basing it on natural gas that can be supplied from the proposed regional/sub-regional LNG terminal through appropriate joint ventures where applicable.

An LNG based power plant may not be as competitive as an imported coal based power plant on the financial costs alone, but if the environmental costs, especially those related to emissions of carbon-dioxide, are internalized, the LNG based power plant may be competitive to an imported coal based power plant. Developing a regional power plant based on the hydro-power resources within the region may be explored. Other options, such as the setting up of this regional power generating capacity either on imported coal or imported LNG – both of which are more attractive than the significant current dependence on imported diesel based power generation, may also be explored.

Ownership options include joint ownership of participating governments⁴, full private sector ownership or a joint venture involving private sector and the governments of participating countries. The public-private participation model is preferred as it could provide some involvement of the governments in the project management and also at the same time provide comfort to the private developer.

The process adopted for selection of the developer needs to be transparent giving due weight to his qualification, experience and credibility.

Whosoever be the developer, a Special Purpose Vehicle (SPV) for project facilitation may be created. Such a SPV model has been successfully adopted in India for the Ultra Mega Power Plant (UMPP) projects. The plant can also be set up as a merchant power plant where there is no PPA and the developer takes the entire risk of selling his power. The associated power transmission system would also have to be built along with the power plant. The evaluated levelized tariffs discovered through competitive bidding process for the various thermal generation projects in India are in the range of 1.2 – 3.0 INRs/kWh for long term power purchase agreements. However, the sale of electricity through short-term/power exchange contract in India is as high as 4-14 INRs/kWh especially in peak

⁴ This equity holding could be based on the share of electricity for each country from the power plant.

hours. With the electricity market and power exchanges already in vogue in India and potential of its extension across SAARC region, a regional or a sub-regional power plant can be beneficial for all the participating Member States.

Member States could constitute a Technical Committee of experts to deliberate upon the sharing of the coal based power, as well as, hydropower resources within the region. The committee should submit a detailed report, including methodology and transfer of technology for sharing of these resources among the SMS.

Table: ES-1 provides a snapshot of the above options along with their quantifiable and intangible benefits and expected time frames and suggested next steps.

Table ES-1: Summary of suggested trade options

S.No	Trade option	Expected Time Frame	Quantifiable benefits	Non quantifiable benefits	Techno – commercial and Financing Options	Approach to take forward trade option
1	Electricity Market	Short to long term	<ul style="list-style-type: none"> Reduction in generation reserve requirements Increase in economic value added to the economy through provision of electricity. <ul style="list-style-type: none"> One unit of electricity consumed adds around USD 2 to the Indian GDP. 	<ul style="list-style-type: none"> Optimal exploitation of energy resources Reduction in cost of supply Improved system reliability Improved energy access Lesser environmental impacts of fossil based power generation Incentives to resource rich countries to accelerate power development for increased economic growth 	<p>Techno – commercial options for interconnection</p> <ul style="list-style-type: none"> Single HVDC back to back or HVAC interconnection, where operationally feasible, to be preferred over a number of small AC links <p>Financing Options</p> <ul style="list-style-type: none"> Cost of the interconnect charged through the wheeling charges; or Participating governments may invest as required in building the interconnects treating them as public good 	<ul style="list-style-type: none"> Preparation and signing of inter governmental agreement on pursuing regional trade and giving it priority Build domestic and regional infrastructure – interconnection leading to regional grid Adopt building block approach/ phased approach for building power market Harmonize legal and regulatory frameworks
2	Regional/ Sub regional Refinery	Medium term	<ul style="list-style-type: none"> With a 23 MMTPA refinery the region would save around USD 14.80 billion on account of foreign exchange saved by avoiding diesel import. But foreign exchange would however be incurred on refinery feedstock in the form of crude oil. Net revenue of USD 2.75 billion accruing to all investing Member States based on relative demand for petroleum products 	<ul style="list-style-type: none"> Technology transfer for building state of the art refinery Economies of scale 	<ul style="list-style-type: none"> Techno commercial options <ul style="list-style-type: none"> Grass Root refinery; or Refining capacity added as additional refining capacity in already planned capacity additions of existing refineries Interm arrangement – procurement from existing refineries in the region or joint procurement of crude by participating Member States, which is processed in an already existing refinery with spare capacity Financing Option <ul style="list-style-type: none"> Petroleum product pricing to 	<ul style="list-style-type: none"> Location of the refinery ensuring favourable economics Refinery may adopt a swap arrangement to supply of petroleum products across existing refineries Member States to finalize a framework for pricing petroleum products with the refinery aiming for minimum pricing of products Finalize the specifications of the product to be produced. This would also impact refinery configuration.

3	Regional/ Sub regional LNG Terminal	Medium term	<ul style="list-style-type: none"> • Pay back period – about 3 years • Region natural gas deficit increasing to 139 mtoe by 2020 equivalent to 105 GW of additional power 	<ul style="list-style-type: none"> • Diversification of current fuel basket • Benefits of LNG terminal vis-à-vis natural gas pipeline <ul style="list-style-type: none"> ▪ More supply options available to LNG importer ▪ Option to receive both long term and spot supplies ▪ Decreasing cost of technology • Cleaner fuel for power generation as compared to coal 	<p>be done on international import parity</p> <ul style="list-style-type: none"> • Techno commercial options <ul style="list-style-type: none"> • Joint holding terminal with equity holding of the participating Member States; or • Private sector to be awarded the contract as the LNG terminal operator and using the storage facility on a common carrier principle; or • Merchant LNG terminal • LNG pricing options <ul style="list-style-type: none"> • Fixed charge; or • Regulated price determined by a common regulator; or • Selling of quantities through bidding process 	<ul style="list-style-type: none"> • Location of the LNG terminal would have implications on its relative transport economics. • Availability of requisite port facilities to be an important determinant • LNG terminal to have forward linkages and can be dedicated to meet power demand and fertilizer demand (if feasible) for the region
4	Regional/ Sub regional Power Plant	Medium term	<ul style="list-style-type: none"> • LNG based power generation is more economical as compared to diesel based generation – Sri Lanka and Maldives are heavily dependent on the latter. 	<ul style="list-style-type: none"> • Increase bargaining power of the region for fuel procurement. • Economies of scale 	<ul style="list-style-type: none"> • Techno commercial options <ul style="list-style-type: none"> • Power plant to be either based on imported coal or imported LNG • SPV model (India experience UMPP) may be adopted for selection of the power plant operator • Pricing <ul style="list-style-type: none"> • Regulatory principles for price determination to be established 	<ul style="list-style-type: none"> • Size, location and technology to be decided based on a detailed feasibility report • Joint team of engineers to carry out study on required transmission requirement and propose an optimal transmission expansion plan acceptable to all participating countries.

Source: Author's compilation

ES 11. Suggested Action Plan

There is need to undertake detailed techno-economic feasibility for each of the proposed trade options, based on which, a final decision on their implementation can be taken.

The SAARC structure provides the framework for taking these proposed regional trade options forward. Based on the consensus between the Member States, SAARC may set up Technical Committees under the Working Group of Energy, formed during the Twelfth SAARC Summit to take the proposed trade options forward.

ES 12. Conclusions and Recommendations

Following interventions are needed to create an enabling environment to promote regional energy trade and to ensure that the energy trade options suggested are taken forward:

- (i) Develop a SAARC Regional Energy Trade and Cooperation Agreement
- (ii) Harmonize the Legal and Regulatory Frameworks
- (iii) Build a comprehensive/reliable energy database
- (iv) Promote alternative financing mechanisms for developing regional energy trade and cooperation initiatives
- (v) Develop a regional trade treaty similar to the Energy Charter Treaty.

The major benefits of regional energy trade that would accrue to SAARC highlighted in the preceding paragraphs will help the Member States to overcome the barriers and their apprehensions. It is expected that they will initiate the process of carrying out necessary studies, reaching agreements and collaborate for the development of various options for energy cooperation.

The cross border energy projects that have been suggested above or those that are either under discussion or where some progress has been made, have been categorized below along with the implementation time horizons:

Short Term Initiatives (less than 5 years):

These initiatives listed below can be achieved within a time span of five years:

- India-Nepal oil products pipeline
- Feasibility Study to explore/ identify possible Pakistan-India power transmission interconnection
- Dhalkebar (Nepal)–Muzaffarpur (India) power transmission interconnection
- Feasibility studies for joint development of regional hydropower, gas and coal based power plants

- Development of wind power projects to augment energy supplies for remote areas
- Feasibility study for possibility of connecting the Maldives with other SAARC countries through submarine cable
- Feasibility study for setting up of joint LNG terminal(s)
- Strengthening of in-country gas truck transmissions systems to facilitate transmission of additional gas supplies as and when they become available as a result of implementation of the inter-regional gas pipelines/LNG projects
- Preparation of a “Least Cost Energy Sector Master Plan for SAARC Region”
- India-Bangladesh Power Transmission Interconnection:
 - ◆ Baharampur, India to Bheramara, Bangladesh

Medium Term Initiatives (5-15 years):

- India - Sri Lanka power transmission interconnection
- Pakistan - India power transmission interconnection
- Additional India-Nepal Power Transmission interconnection
- CASA 1000 Project for Central Asia–Afghanistan–Pakistan power transmission interconnection
- Phase-II of CASA project that could bring electricity from Central Asian Republics up to the Indian power grid
- Iran-Pakistan-India gas pipeline
- Additional power grid interconnections between India-Bangladesh
- Eastern Gas Pipeline Infrastructure
- Additional power transmission interconnections between Bhutan and India
- Implementation of joint LNG Terminal(s) for procurement of LNG for the region
- Turkmenistan-Afghanistan-Pakistan-India pipeline
- Regional/Sub-regional Power Market
- Regional/Sub-regional Refinery
- Regional/Sub-regional LNG terminal and gas transmission expansion
- Regional/Sub- regional Power plant

Long Term Initiatives (greater than 15 years):

- Qatar-Iran-Pakistan-India gas pipeline
- SAARC Oil Pipeline grid

The above named projects are an indicative list. There would be many other projects that can be conceived and implemented within the time horizon of 15-20 years, to make the SAARC Energy Ring a reality. SAARC Member States will have to continue to identify and explore other intra and inter-regional energy infrastructure projects that will facilitate energy trade to meet the regional energy demand. The preparation of the “Least Cost Energy Sector Master Plan for SAARC Region” will help in prioritizing investments and reap benefits in the most economic manner.

Chapter 1: Introduction

1.1 Context

South Asian Association for Regional Cooperation (SAARC) region comprises of Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka.

The region has a population of about 1.5 billion, which is nearly 23% of the total world population, living on 5% of the world's land mass. The total Gross Domestic Product (GDP) of the region amounted to US Dollars (USD) 996 billion (2005), and was even less than 3% of the world's total GDP. On the other hand, it is one of the fastest growing regions in the world. It experienced an average annual GDP growth rate of 5.6% between 1995 and 2005.⁵ Countries such as Bangladesh, India, Pakistan, and Sri Lanka have expanded at an even higher GDP growth rate of 6 to 9% in the recent past. This economic growth is expected to facilitate the alleviation of widespread poverty existing in the region.

One of the key inputs for sustaining and accelerating the economic growth of the region is the increasing availability of energy, as there is a strong direct co-relationship between economic growth and increase in energy demand. Upward social mobility associated with faster economic growth, further accentuates the demand for energy. This puts pressure on all SMS to ensure a continuous and reliable supply of energy in its various forms. Though the region as a whole is well endowed with diverse energy resources, including renewable energy, a large part of these resources remains to be tapped due to various reasons. Limited availability of indigenous energy supplies coupled with the large population base, makes the region significantly import dependent.

The SAARC region is surrounded by countries that are rich in energy resources. **Table 1.1** provides a snapshot of the energy resource endowment of these countries. This diversity of resource endowment between South Asia and neighbouring energy resource rich regions provides opportunities for inter-regional energy trade to reap the optimum benefits from available resources. Several of these opportunities have been identified in earlier studies. However, the terrain and competing market conditions make energy trade with them a challenging proposition.

Table 1.1 highlights the resource potential of the neighbouring countries such as Myanmar, Kazakhstan, Turkmenistan, and Uzbekistan and Iran. These countries have fossil fuel reserves (coal, oil and gas) while Central Asian Republics such as Tajikistan and Kyrgyz Republic have substantial hydropower export potential.

⁵ World Development Indicators 2007, World Bank
<http://devdata.worldbank.org/external/CPPProfile.asp?PTYPE=CP&CCODE=SAS> accessed on 21st August 2007

Table 1.1: Resource Endowments of Neighbours of SAARC countries

Country	Oil	Natural Gas	Coal	Hydro Power
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: 2000 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. 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: 1700 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: 4000 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: 3000 MW
Iran	Reserves: 132.5 billion bbl Production: 4.2million bbl	Reserves: 971 tcf Production: 3.5 tcf/year	Reserves: 461million tons Production: 1.1 million ton	Potential: 42,000 MW Developed: 2000 MW
Myanmar	Reserves: 3.2 billion bbl Production: 7.3 million bbl (During 11 months of 2005-2006)	Reserves: 18 tcf Probable: 89.7 tcf Production: 362 bcf (10.53 bcm) Exports: 0.28 tcf (8.06 bcm) (During 11 months of 2005-2006)	Reserves: Modest Production: Modest	Potential: 39,720 MW Developed: 747 MW

Source: Potential and Prospects for Regional Energy Trade in the South Asia Region, World Bank

A brief discussion about the prevailing energy scenario and the prospects of inter-regional energy trade in between SMS with the Central Asian Republics, Iran and Myanmar, the energy resource rich regions/countries in the proximity of South Asia is given in Chapter 4.

1.2 Terms of Reference

Recognizing the importance of energy trade in the region and at the request of the SMS, the Asian Development Bank (ADB) approved a Regional Technical Assistance (RETA) in December 2006 to promote energy cooperation in the SAARC region and to strengthen the SAARC Energy Centre (SEC).⁶ The major component of the RETA is to undertake a SAARC Regional Energy Trade Study (SRETS).

⁶ ADB RETA 6368: Preparing the Energy Sector Dialogue and SAARC Energy Center Capacity Development Project (December 2006)

Following are the Terms of Reference (TOR) as finalized by the Third Meeting of the Working Group on Energy (SAARC Secretariat, 23-24 January 2007) and as communicated to ADB for the SRETS study:

- (i) A sector-wise and fuel-wise study be carried out on the options, benefits and constraints of energy trade in the region, covering the demand and supply - both current and projected for optimal utilization, and development, of energy resources for the benefit of SAARC Member States.
- (ii) The Study would cover the prevailing trade regimes, the regulatory and legal frameworks of the Member States.
- (iii) It would examine the international and regional best practices and their relevance as well as applicability to the region.
- (iv) It would analyse the various technological, financial and commercial options for promoting trade and related projects.
- (v) It would examine the viability and modalities for development of trans-national energy lines (electricity, gas and oil) keeping in view the broader concept of the Energy Ring.

1.3 Objectives of the Study

The SRETS supported by the ADB - RETA is an effort to augment the efforts of the SMS to find the most appropriate and economic solution to help meet the energy needs of the Member States, to the extent possible, through national resources and through regional energy trade. The study is aimed at identifying specific opportunities for energy trade among SAARC Member States and with neighbouring regions. The SRETS report is based on the data provided in the eight country reports prepared by the national country experts (national consultants) and on review of earlier studies done by national and international organisations on various aspects related to regional energy trade, and discussions held with the concerned stakeholders across the region.

1.4 Structure of Report

The SRETS report is organised in 8 chapters addressing the Terms of Reference. Chapter 2 discusses the energy scenario in SAARC region (current and future). Discussing the energy resources available in the region in detail the chapter brings out the key energy issues faced by the region, the benefits and the need for regional energy trade to address these challenges. Chapter 3 discusses the institutional, legal and regulatory framework of the energy sector in SAARC Member States. Chapter 4 presents an overview of the situation in energy rich regions/countries in the neighbourhood of South Asia i.e. the CARS, Iran and Myanmar to appreciate the potential and prospects of energy trade in between South Asia and these regions/countries.

Chapter 5 presents an overview of the international best practices with regard to regional energy trade. It discusses the proposed power interconnections in the Greater Mekong Sub-region (GMS), power pools set up among the Nordic countries and the Southern African countries, the Liquefied Natural Gas (LNG) terminal at Baja California, Mexico and the proposed common refinery in Africa.

Chapter 6 discusses the existing and the proposed intra regional energy trade initiatives among the SAARC Member States, while Chapter 7 assesses the inter regional energy trade opportunities that are on the horizon for implementation in the foreseeable future as well as other initiatives that these Member States can take for their mutual benefit. These include a regional/sub regional power market, a regional/sub regional refinery, a regional/sub regional LNG terminal, and a regional/sub regional power plant. Chapter 8 is the concluding chapter summarizing the various initiatives and activities that the SAARC Member States need to undertake to meet the energy demand of the region to help them sustain and accelerate their economic growth and therewith the push for poverty alleviation.

Chapter 2: SAARC Region Energy Scenario: Key Issues and Need for Regional Energy Trade

2.1 Social and Economic Indicators

This section presents the socio economic profile of the region and its energy demand-supply situation. The socio-economic profile for the region is summarized in **Table 2.1**.

Table 2.1: Key socio-economic indicators for the SAARC region

Member States	Population (2006)	Urban population (2005)	Density of Population (2006)	HDI Ranking (2006)	HDI Index (2006)	Per capita commercial energy consumption (2005/06)	GDP per capita (2007)
Unit	Million (mid year population)	%	Person/ km ²			toe/capita	PPP \$
Afghanistan	24.10	22	38	NA	NA	0.03	733
Bangladesh	140.60	25	964	137	0.530	0.13	1311
Bhutan	0.65	31	14	135	0.538	0.09	4862
India	1118.00	29	340	126	0.611	0.36	2563
Maldives	0.30	30	997	98	0.739	0.58	4603
Nepal	24.00	15	176	138	0.527	0.04	1078
Pakistan	159.00	34	197	134	0.539	0.35	2594
Sri Lanka	19.88	22	314	93	0.755	0.18	4265

Sources: Various Country Reports, *Human Development Index (HDI) Report 2006*, United Nations Development Programme (UNDP); *ADB Basic Statistics 2007*, Asian Development Bank; *ADB Key Indicators 2007*, Asian Development Bank; World Economic Outlook Database, IMF, October 2008

There is a wide variation in the societal and economic profile of the Member States. For instance, the population in Maldives is only a third of a million while that in India is more than a billion. Given the difference in land areas of the countries, a more relevant social indicator is the density of population i.e. number of person per square kilometre of land. The density of population varies from a low of 14 persons per square kilometre in Bhutan to as high as 997 persons per square kilometre in Maldives. Increased population density highlights the increasing pressure on land and national resources of the concerned Member State. The per capita GDP of the Member States (on a PPP basis) also varies significantly and ranges from USD 733 in Afghanistan to over USD 4862 in Bhutan. The Human Development Index (HDI) of the SMS is somewhat similar, except for Maldives and Sri Lanka, which are higher in ranking than the rest of the Member States. Regional energy trade opportunities that can result in a win-win situation in terms of enhancing this ranking need to be pursued aggressively.

2.2 Energy Reserves in the SAARC Region

Table 2.2 given below, indicates the potential total energy reserves of various energy forms in the region. As is the case with other natural resources, the energy resources of South Asia are not uniformly spread over the region. From **Table 2.2**, one can observe that Member States, such as, India and Pakistan account for the major share of energy reserves - coal and natural gas. However, these Member States are also large in terms of

area and population and thus, the higher reserves need not necessarily be sufficient to meet respective country's energy need. The region is rich in hydro potential with Member States, such as, Bhutan and Nepal having a large share of this resource in relation to their size and energy needs in the foreseeable future.

Table 2.2: Energy Reserves of SAARC Member States

Countries	Coal	Oil	Natural Gas	Hydro	Biomass
	Million Tonnes	Million Barrels	tcf	MW	Million tonnes
Afghanistan	440	NA	15	25000	18 - 27
Bhutan	2	0	0	30000	26.60
Bangladesh	884	12	8	330	0.08
India	90085	5700	39	150000	139
Maldives	0	0	0	0	0.06
Nepal	NA	0	0	42000	27.04
Pakistan	17550	324	33	45000	NA
Sri Lanka	NA	150	0	2000	12
Total	108961	5906	95	294330	223

Source: Various Country Reports, Country Report of Bangladesh 'Solar and Wind Energy Resource Assessment', Ministry of New and Renewable Energy, Government of India. Figures are rounded off.

Table 2.3 indicates the Reserves to Production (R/P) ratio of the hydrocarbon fuels for some of the SAARC Member States. The R/P ratio shows the time period for which the reserves will last at the current production rate. As such, it represents the expected longevity of the reserves of a country in relation to its current level of production, but it does not capture in any way, the import dependence of a country.

Table 2.3: Reserves to Production Ratio (2007)

Country	Coal	Oil	Natural Gas
Bangladesh	NA	NA	16
India	45	24	35
Pakistan	NA	NA	21

(Figure indicates the number of years, which have been rounded off to nearest integer)
Source: calculated based on data from Various Country Reports

The R/P ratio is necessarily a dynamic ratio that varies with changes in the estimation of reserves, resulting either from increased investments or improved technologies and or with changes in production pattern. With robust economic growth of the region, there is increased demand for energy that could result in the energy reserves being exploited at a faster rate. The R/P ratio of energy reserves in the region has been falling over the years. For instance, in 1981 Bangladesh had an R/P ratio for natural gas of 300 years. By 2007, the ratio dropped down to 15.5 years.⁷

The R/P ratio of energy in India indicates that its energy reserves will last only for the next couple of decades, unless significant new discoveries are made (34 years for natural gas and 24 years for crude oil). Due to a relatively recent recognition of the differences between proven reserves and extractable reserves for coal, the R/P ratio for this energy

⁷ Bangladesh Country Report

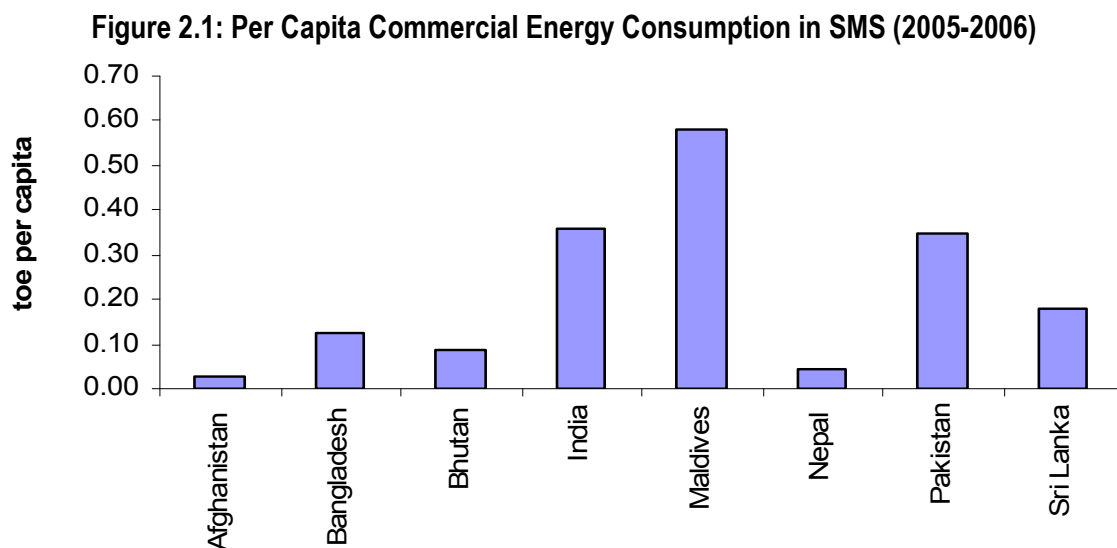
form has been corrected from ~ 200 years to 45 years. This estimate also internalises a future production increase of 5% per annum.

To place in context the picture of reserve endowments of the SAARC region, it is relevant to note that the R/P ratios of some of the Western and Central Asian countries are in the range of 60-90 years for oil and gas. In coal, Kazakhstan has an R/P ratio higher than 300 years and Uzbekistan has more than 142 years.⁸

The limitation of hydrocarbon reserves in the SAARC region, can to a certain extent, be overcome by promoting renewable energy resources such as solar, wind and biomass. The SMS are rich in renewable resources and have a good potential for their utilisation. The region has a total of 223 million tonnes of biomass, with Member States such as India having a larger share of it. This available biomass has huge potential for electricity generation, which is as high as 148756 giga-watt-hours (GWh)⁹. Regional cooperation in the field of technology development and sharing of technical expertise to develop these energy forms can have a direct and large impact on the poorer segments of society, thereby having the potential to provide a huge fillip to social and economic development of the region.

2.3 Current Energy Scenario in SAARC Region

As in the case of energy resource endowments, there is a wide disparity in energy demand and its consumption pattern among the SMS. Total energy consumption in absolute terms, among the Member States ranges from as low as 0.17 million tonnes of oil equivalent (mtoe) in Maldives to 423.2 mtoe in India¹⁰. In per capita terms too significant variations exist, albeit in different forms, as brought out in **Figure 2.1**.



Source: Calculated from data available in various Country Reports

⁸ 'Potential and Prospects for Regional Energy Trade In the South Asia Region' Sustainable Development Department, World Bank, June 2007

⁹ As explained in Annexure 2

¹⁰ Country reports

Figure 2.2 highlights the relative share of various energy forms in the total energy consumption mix in the SAARC region. Most countries, with the exception of India and Pakistan, have a predominant dependence on a single commercial energy form. That is: oil for Afghanistan (77%), Maldives (100%), Nepal (78%) and Sri Lanka (82%); hydropower for Bhutan (78%) and natural gas for Bangladesh (74%).

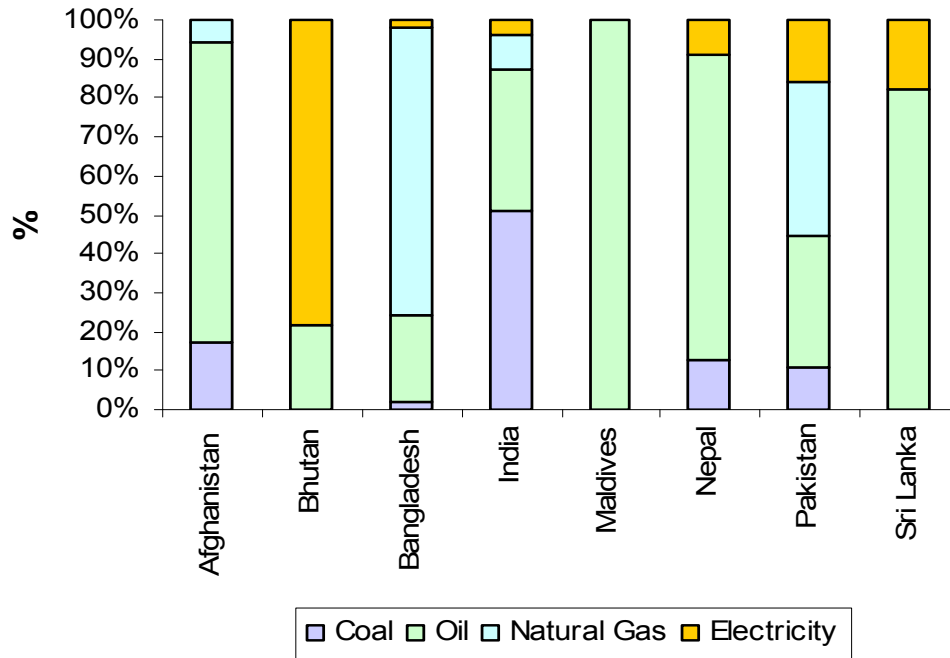


Figure 2.2: Relative Sources of Energy Consumed in SAARC Countries

Source: Various Country Reports

Such a large dependence on a single energy form not only limits the options of meeting diverse energy needs but also increases energy security concerns. The situation worsens with increasing dependence on imported fuels, by all the countries in the region,

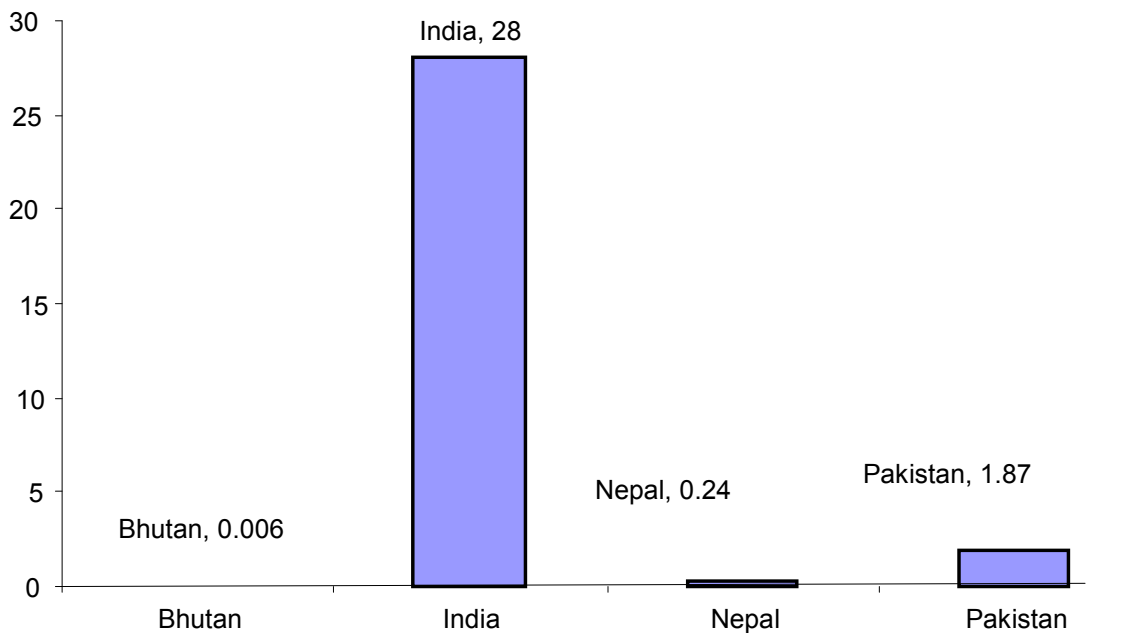
Despite substantial coal resources available in the region, the Member States are importing coal to meet their requirement (see **Figure 2.3**). This is due to the characteristics of coal seams, the poor quality of coal and in part due to technical capabilities, thereby creating the need for Member States to work towards improving their technical/mining capabilities to harness the resource better.

One of the important forms of energy, especially from the transport sector perspective is petroleum and its products. As highlighted in foregoing paragraphs, in several Member States, oil is the dominant fuel. But all the Member States are dependent on oil imports, irrespective of the share of the local production. The region has many energy security concerns associated with oil imports.

- (i) The entire region is dependent on oil imports. In 2005, the total petroleum product demand of the region was around 132 mtoe, out of which only 52 mtoe was

supplied through domestic production. The rest was met through imports, implying an import dependence of around 60%. Member States such as Bangladesh, Bhutan, Maldives, Nepal and Sri Lanka are 100% dependent on imported petroleum and products.

- (ii) SMS have limited refining capacity, with the exception of India, as very little capacity expansion or up-gradation has taken place in the recent years. Bangladesh has a refining capacity of 1.5 million tonnes per annum (MMTPA), Pakistan 12.85 MMTPA and Sri Lanka 2.5 MMTPA. Both Bangladesh and Sri Lanka have one refinery each, and Pakistan 7 refineries. The technology of most of these refineries is out dated and there is limited capacity addition planned in these Member States. Country wise refining capacity of the region is summarized in **Table 2.4**. India is planning substantial refinery capacity addition. However, with a stagnant domestic crude production of 33-34 MMT, dependence on imported crude oil is expected to rise. According to TERI estimates, India's import dependence on crude oil would be above 90% by 2031.¹¹



- (iii) Out of the total product wise consumption across the region, diesel constitutes the largest component. The share of diesel in the total product profile ranges from 37% (India) to 95% (Maldives). In Maldives, most of power generation is based on petroleum products.

Figure 2.3: Coal Imports by SAARC Countries (2006 MMt)

Source: Various Country Report, Coal Import by other SAARC countries is either nil or negligible.

¹¹ PSA/2006/3, "National Energy Map for India, Technology Vision 2030", Study by TERI for Office of the Principal Adviser to the Government of India.

Table 2.4: Current refining capacity and petroleum product consumption of the SAARC Member States (2005)

Country	Refining capacity	Petroleum Product consumption
Afghanistan	0	1.10
Bhutan	0	0.08
Bangladesh	1.50	3.77
India	149	111.92
Maldives	0	0.18
Nepal	0	0.72
Pakistan	12.85	14.87
Sri Lanka	2.50	2.94
Total	165.85	132.40

Source: Various country reports

Energy security concerns increase with the increase of imported petroleum products rather than imported crude. This is for a variety of reasons, including the near saturated utilisation of refinery capacity in the world, affording little flexibility to respond to demand fluctuations, resulting in larger price volatility as compared to crude oil (**Figure 2.4**). More, the diversity in sourcing of crude oil, greater the flexibility in matching product profile to demands.

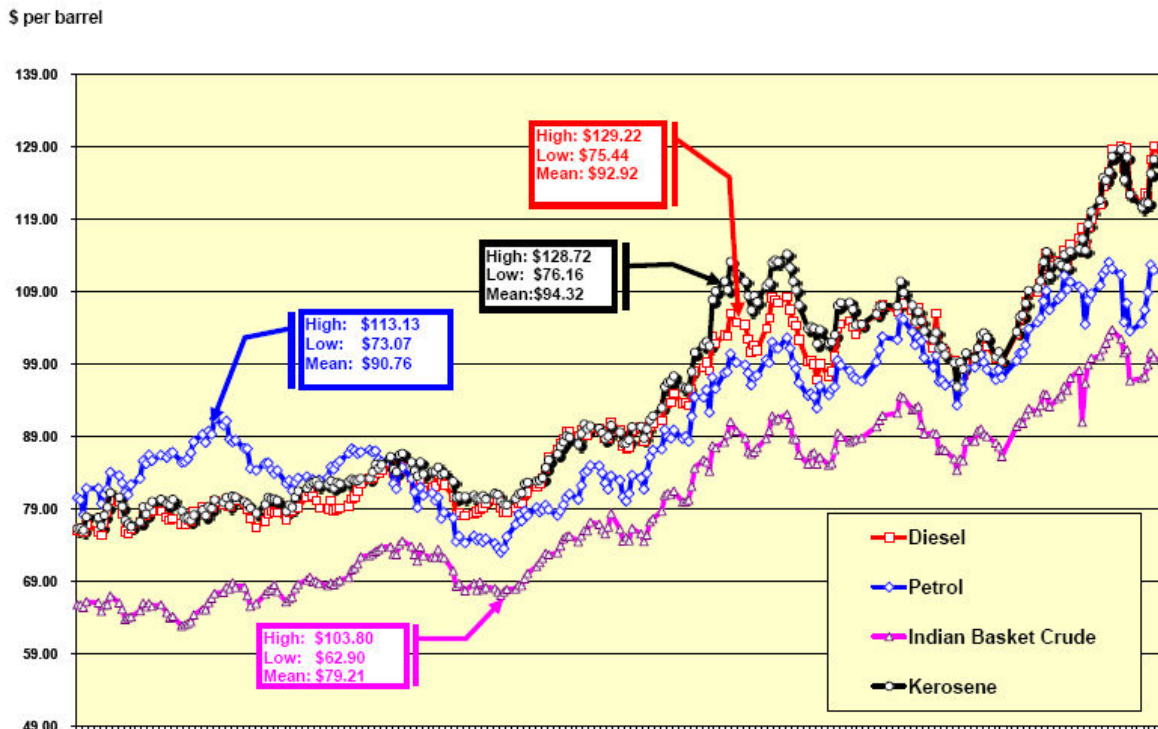


Figure 2.4: Price volatility of crude oil and petroleum products (2007-08)

Source: Petroleum Planning and Analysis Cell, Ministry of Petroleum and Natural Gas, Government of India

An alternative fuel that is being used by the region is natural gas. However, its availability and consumption across the region is skewed. While Bhutan, Maldives, Nepal

and Sri Lanka do not use natural gas at all; Bangladesh and India face supply deficit.¹² The excess of supply over demand in 2006 shown in **Table 2.5** for Pakistan has now turned negative and intensive efforts are being made to accelerate production and also acquire additional supply of natural gas from outside the region through pipelines and in the form of LNG. In the long term (15 years) the region is expected to experience a natural gas shortage of around 99 mtoe/year.¹³

Table 2.5: Current Natural Gas Demand Supply Position in SAARC Region (2006) (mtoe)

Country	Demand	Supply	Deficit/ Surplus
Bhutan	0	0	0
Bangladesh	13.70	12.78	-0.92
India	35.80	28.60	-7.20
Maldives	0	0	0
Nepal	0	0	0
Pakistan	13.33	29.19	15.86
Sri Lanka	0	0	0
Total	62.83	70.57	7.47

Source: Various Country Reports including 2008 Pakistan Energy Year Book.

Data was not available for Afghanistan

The major consumer for natural gas is the power sector. In Bangladesh 82% of the total electricity generation capacity is natural gas based, while in Pakistan it is around 64%. Afghanistan is expected to have substantial gas reserves. However, infrastructure is the main hindrance in development of natural gas markets in the country. This is highlighted by the fact that natural gas production in Afghanistan which was 285 million cubic meters/year in 2006 is declining annually; also about 13 % of the gas produced is lost during transmission. India has natural gas infrastructure, with major trunk natural gas pipelines, called Hazira-Bijaipur-Jagdishpur, Dahej-Vijaipur, Dahej-Uran and East-West pipeline connecting domestic and imported supply. At present, the total trunk natural gas pipeline network is more than 9,000 km and the country is going to add another 9,000 km to the network in the next 5 years.

The demand for electricity is steadily rising with the improvements in economic development of the region. However, Member States have not been able to augment the electricity supply to keep pace with increasing demand. Thus, the demand for power surpasses its supply, resulting in electricity shortages in most of the Member States. **Figure 2.5** shows the level of electricity shortages in the region. These range from about 9% in Nepal to as high as 28% in Bangladesh.

The electricity shortages have been calculated based on the data provided in the country reports, either on the basis of the quantum of electricity imported or on the basis of load shedding experienced in the country. Access to electricity across the various Member States is still low and a cause for concern (**Table 2.6**).

¹² Natural gas is the most important fuel for Pakistan and Bangladesh.

¹³ Based on various country reports

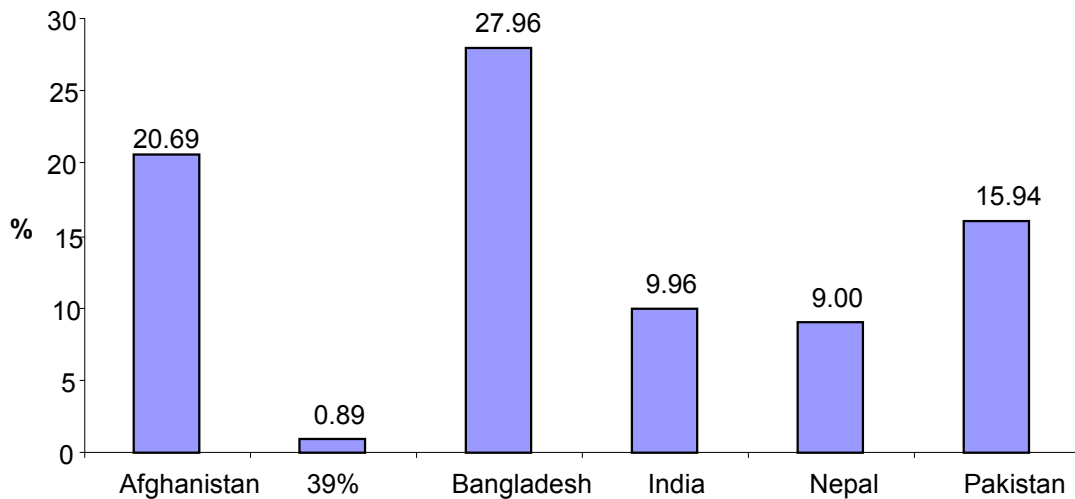


Figure 2.5: Electricity Shortage in SAARC Countries

Source: Various Country Reports.

Above data is for 2006/07, except for Bhutan for which data is for 2004/05. Data not available for Maldives

Table 2.6: Percentage of population with access to electricity

Country	% of population with electricity access
Afghanistan	20%
Bangladesh	42%
Bhutan	40%
India	56%
Maldives	100%
Nepal	25%
Pakistan	70%
Sri Lanka	78%

Sources: Various country reports, Census of India 2001, ADB website, Srivastava L, Misra N ‘Promoting Regional Energy Co-operation in South Asia’ Energy Policy 35, pg 3360-3368, 2007

Demand for electricity will increase with the efforts of Member States to provide electricity to un-served segments of society. India’s mission of ‘Power for All by 2012’ has led the Government of India to plan a capacity addition of around 100,000 MW by that year.

On the supply side, the electricity generation mix in the region also varies widely across nations. About 65% of the total installed capacity of India is based on thermal resources, whereas Bhutan and Nepal are largely hydro based. Although, according to **Figure 2.5**, there are minimal electricity shortages in Bhutan the country experiences a substantial drop in electricity supply in the winter months, which is met through imports from India.

An important characteristic of the SAARC Member States is the heavy dependence on traditional fuels (fuel wood, agricultural residues and animal dung). **Figure 2.6** indicates

the level of usage of traditional fuels in final energy consumption in SAARC countries.

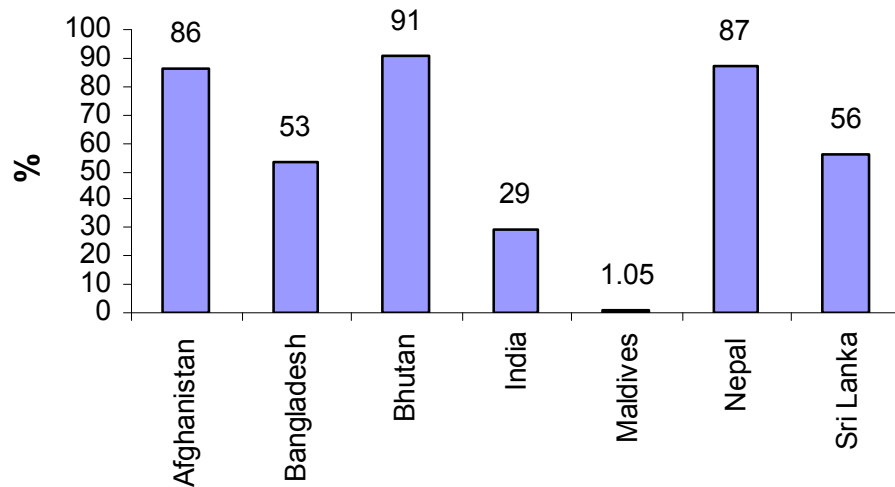


Figure 2.6: Dependence for Traditional Fuels in SAARC Countries

Sources: Various Country Reports, Bhutan Data Directory 2005. Data for Pakistan is not available

Only Maldives has a dependence on traditional fuels lower than the world average of 21.7%.¹⁴ In India around 90% of the cooking energy needs in the rural areas are met through traditional sources of energy.¹⁵ In Bhutan and Nepal, more than 85% of the domestic energy needs are met through traditional fuels. These fuels are primarily used to meet the domestic cooking, lighting and heating requirement, causing great drudgery and adverse health impacts. According to World Health Organization (2002) indoor air pollution, primarily caused by burning of these fuels, is the world's 4th largest health risk, causing perhaps 2.5 million premature deaths a year.¹⁶ However, as the SMS progress, it is expected that their dependence on traditional fuels will decrease and consumption of commercial fuels will increase. This implies increased pressure on the already constrained commercial fuels. SMS should collectively explore and adopt more efficient technologies for use of the traditional fuels. The options for regional cooperation are discussed in greater detail in subsequent chapters.

2.4 Future Energy Scenario in SAARC Region

With faster economic growth, the energy demand of the Member States' is expected to escalate. **Table 2.7** indicates the demand of various energy sources in future, as indicated in various country reports.

¹⁴ *Human Development Index Report 2006*, United Nations Development Programme (UNDP)

¹⁵ Misra N, Chawla R, Srivastava L, Pachauri RK 'Petroleum Pricing in India: balancing efficiency and equity' The Energy and Resources Institute, November 2005

¹⁶ *Household Energy Use in Developing Countries: A Multi-country Study*; UNDP/World Bank Energy Sector Management Assistance Programme, October 2003

Table 2.7: Future Energy Demand in SAARC Region

Year/ Countries	Crude Oil/ Petroleum Products			Coal			Natural Gas		
	2010	2020	CAGR	2010	2020	CAGR	2010	2020	CAGR
Afghanistan	NA	NA	NA	0	0	0	NA	NA	NA
Bangladesh	NA	NA	NA	0.37	6.58	33.35%	16.79	33.95	7.29%
Bhutan	0.09	0.18	7.18%	0.17	0.17	0%	0	0	0
India	147	267	6.15%	426.94	599.95	3.46%	43.95	81.68	6.39%
Maldives	0.50	0.83	5.20%	0	0	0	0	0	0
Nepal	0.85	1.23	3.74%	0.27	0.32	1.94%	0	0	0
Pakistan	20.60	30.70	4.07%	5.80	15.10	10.04%	35.60	62.50	5.79%
Sri Lanka	5.19	6.34	2.01%	0	7.30	0	0	0	0
Total	174.23	306.28	5.80%	433.55	629.42	3.80%	96.34	178.13	6.34%

Sources: Various Country Reports, Energy master plan for Bhutan; TERI Report; TERI 2008, (All figures in mtoe)

From the above table, one can observe that at a regional level, total energy demand is expected to grow at a CAGR of 5% with natural gas expected to register the fastest growth rate of 6.34% followed by crude oil and then coal. At an individual level, demand for crude oil/petroleum products is rising with growth rate of as high as 7% annually in Bhutan. Growth in demand for coal ranges from about 2% in Nepal to as high as about 33% in Bangladesh. Demand for natural gas is also consistently rising in Bangladesh, India and Pakistan.

Looking at the prospective demand of electricity, it is observed that the demand for electricity in the region is rising rapidly. In fact, among all commercial energy forms, electricity is expected to register fastest growth in demand of around 9%. **Table 2.8** indicates the future electricity demand in SAARC region.

Table 2.8: Future Electricity Demand in SAARC Region (GWh)

Country	2010	2020	CAGR
Afghanistan	NA	NA	NA
Bangladesh	33716	71990	7.88%
Bhutan	2260	3703	5.06%
India	1077000	2550000	9.00%
Maldives	1,923	2,447	2.44%
Nepal	3731	8990	9.91%
Pakistan	144711	261523	6.10%
Sri Lanka	10327	22040	7.88%
Total	1273668	2920693	8.65%

Sources: Various Country Reports

Although the electricity demand figures are not available for Afghanistan, the member state has ambitious plan to enhance electricity access from current 20% to 65% by 2010.¹⁷

¹⁷ Afghanistan National Development Strategy (2008-2013) – A strategy of Security, Governance, Economic Growth and Poverty Reduction

Summarising the above discussion, it is concluded that the energy demand in the SAARC region is expected to grow at a rapid pace. SMS would need to make concerted efforts to meet this demand. It would entail substantial investment for building the requisite energy infrastructure, given the present lack of infrastructure.¹⁸ According to an estimate, Bangladesh requires an investment in the range of US\$5–6 billion over the next 10 years for power sector development. The proposed projects under Bhutan's power system master plan will require an investment of \$3.36 billion over the 20-year period from 2003 to 2022. According to the International Energy Agency (IEA), the investment for meeting the projected increase in generating capacity, transmission and distribution in India is estimated at around \$680 billion from now on to 2030. Nepal's combined investment need for generation and transmission for the next 10 years is estimated at US\$1.22 billion.¹⁹ These are substantial investments that are required by each of the Member States, and one of the biggest challenges for them would be to create an enabling environment to attract such large investments.

The subsequent sections discuss sector-wise energy consumption in the SAARC Member States followed by a discussion on the key challenges faced by the region and the role of regional energy trade in addressing these challenges.

2.5 Sector-wise Demand Analysis

In order to have a better appreciation of the extent of import dependence and the vulnerability to energy shortages, the sector-wise energy demand on a country basis needs to be examined. A detailed discussion on this is available in the country reports prepared by the national consultants. A snapshot of the findings thereof is given below.

2.5.1 Afghanistan

Figure 2.7 indicates the sector-wise energy consumption in Afghanistan's estimated total energy consumption of 4.8 mtoe in 2006. The transport sector accounts for the maximum share of the commercial energy consumption. Due to low level of industrial activity, only 10% of energy was consumed in the industrial sector in 2006. Energy consumption by the agriculture sector is negligible and is not reported sufficiently.

¹⁸ http://www.southasianmedia.net/conference/Regional_Cooperation/energy.htm accessed on 23rd August 2007

¹⁹ Srivastava L and Misra N 'Promoting regional energy co-operation in South Asia'; Energy Policy; Volume 35, Issue 6, June 2007, Pages 3360-3368

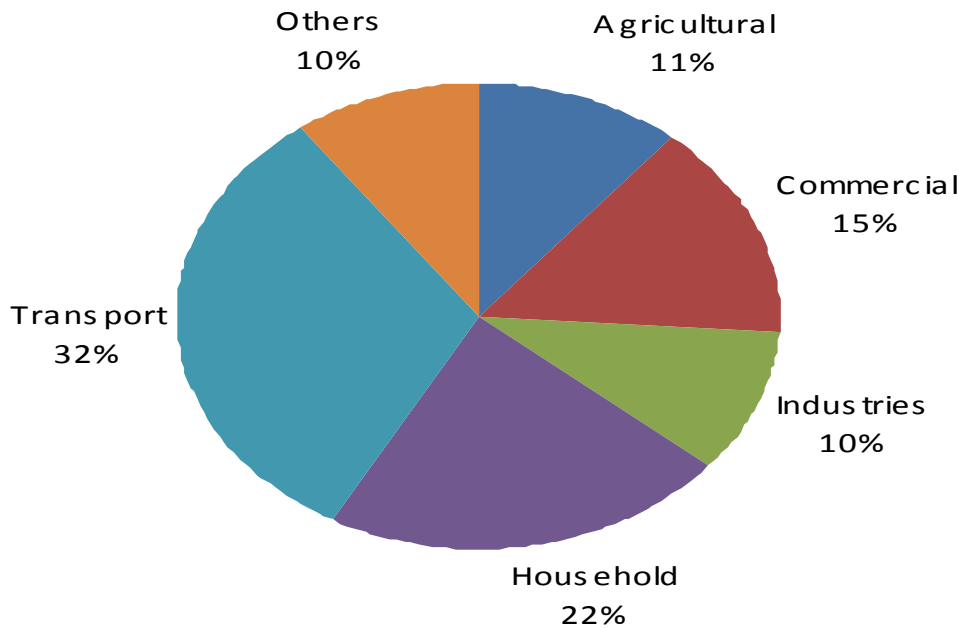


Figure 2.7: Sector-wise energy consumption in Afghanistan in 2006

Source: Afghanistan Country Report

2.5.2 Bangladesh

Natural gas is the main source of commercial energy in Bangladesh. Power and fertilizer sectors are the major consumers of natural gas in Bangladesh. In 2006/07, power, fertilizer, industry, domestic and captive power sectors consumed 41%, 17%, 15%, 12% and 12% of natural gas respectively. **Figure 2.8** indicates the sector-wise usage of natural gas over a decade in million toe.

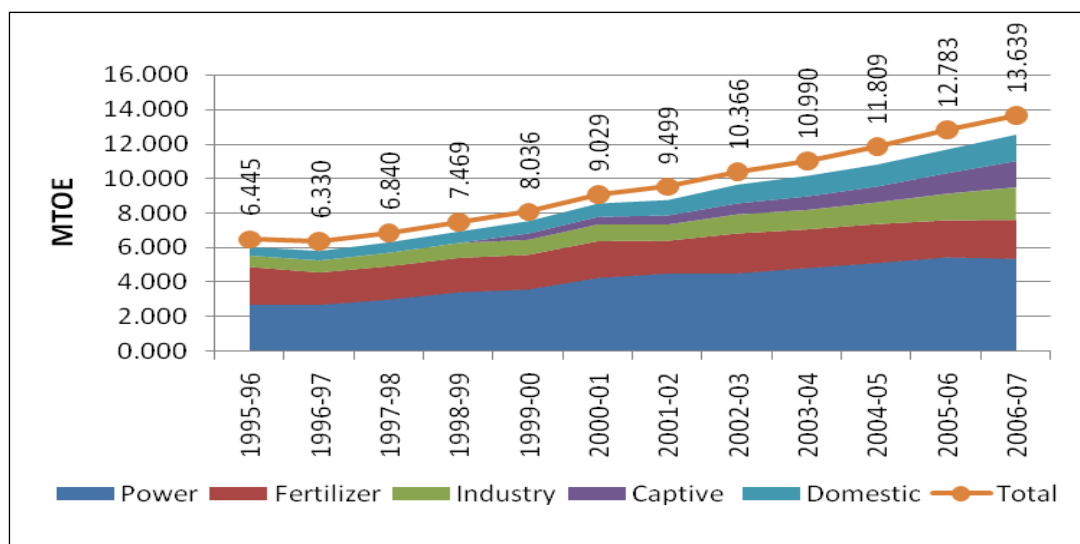


Figure 2.8: Sector-wise Consumption of Natural Gas in Bangladesh

Source: Bangladesh Country Report

Figure 2.8 indicates that although power sector has been the major consumer of natural gas; gas demand is significantly increasing in industrial, captive power and domestic

sectors. Since the power sector consumes a major chunk of the gas, it is important to analyze the sector-wise consumption of power in Bangladesh. Industry and household sectors are the major consumers, accounting for 44% and 42% of power consumed in Bangladesh respectively (2006). **Figure 2.9** indicates the sector-wise usage of power over a decade.

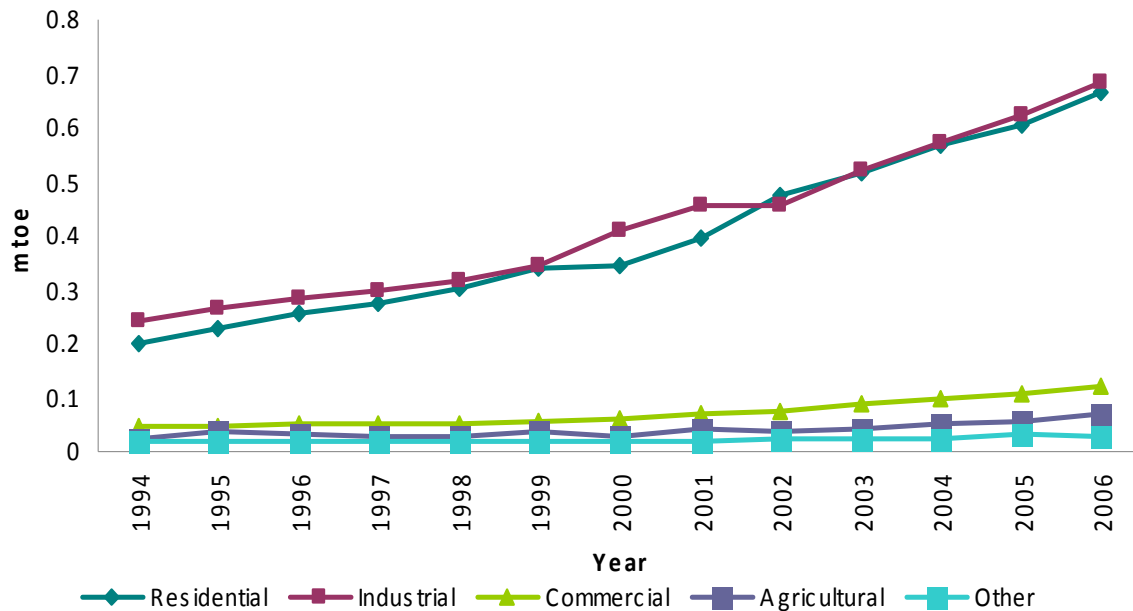


Figure 2.9: Sector-wise Consumption of Power in Bangladesh

Source: Bangladesh Country Report

2.5.3 Bhutan

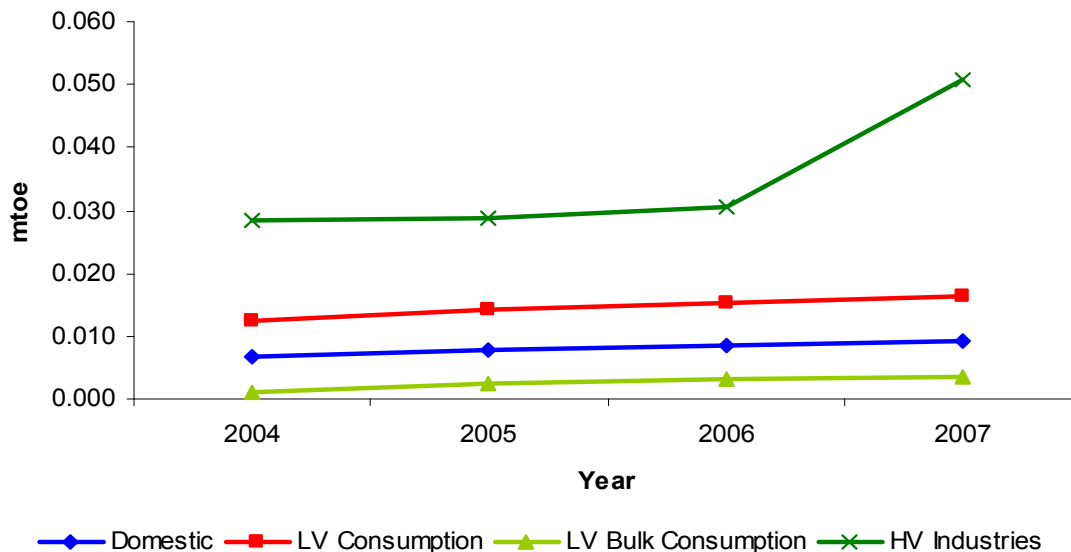


Figure 2.10: Sector-wise Demand of Electricity in Bhutan

Source: Bhutan Country Report

Commercial energy is largely consumed in the form of electricity in Bhutan. Industrial sector accounts for about 75-85% of electricity consumption in Bhutan. **Figure 2.10** indicates the growth pattern of sector-wise demand of electricity in Bhutan. It is expected that the electricity sector will witness an average growth rate of about 8% during 2008-2020 and industrial sector will continue to be the major electricity consumer.

2.5.4 India

In the case of India, industrial, transport and household sectors account for the major share of the energy consumption. **Figure 2.11** indicates the break up of fuel wise commercial energy consumption.

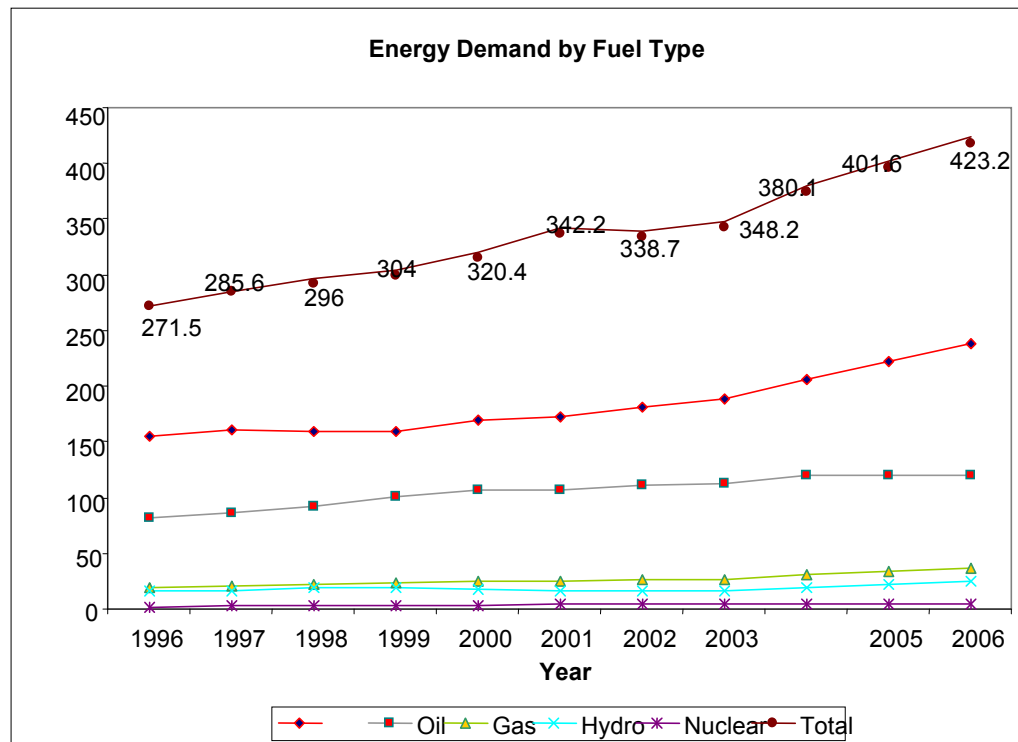


Figure 2.11: Sector-wise Commercial Energy Consumption in India

Source: India Country Report

Traditional sources meet the largest part of the domestic energy demand in the rural areas, where fuel wood and biomass are used extensively; LPG and electricity are used predominantly in urban areas.

2.5.5 Maldives

Energy is mainly consumed in the form of diesel, biomass, LPG and kerosene in Maldives. Looking at the sector-wise break down of the total energy consumed in

Maldives, it is observed that household sector alone accounts for more than 50% of

total energy demand. **Figure 2.12** indicates the growth of share of various sectors in energy demand in Maldives from 2003 to 2005. The figure highlights the dominance of the household sector in energy consumption in the country. The other sectors such as manufacturing and public usage have been increasing steadily over the years; however, energy demand from government buildings has been declining.

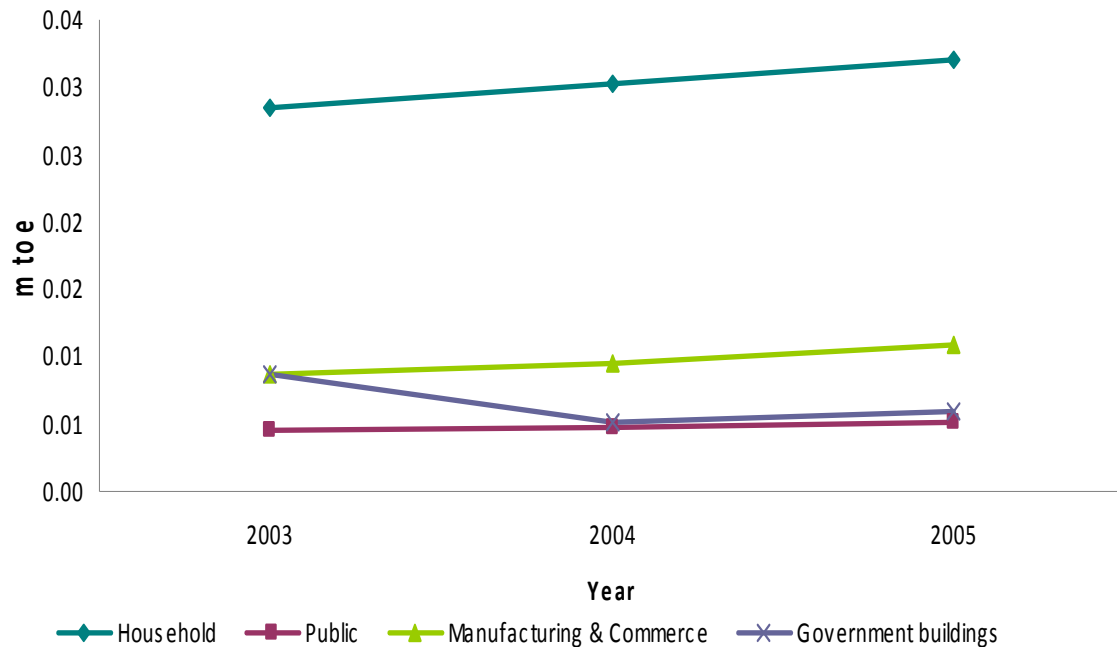


Figure 2.12: Sector-wise Demand for Energy in Maldives

Source: Maldives Country Report

Diesel is the main source of energy in Maldives, accounting for about 78% of commercial energy consumption during the period 2003 to 2005. In 2005, household and manufacturing sectors accounted for about 50% and 28% of the total diesel demand.

2.5.6 Nepal

Traditional fuels dominate the overall energy consumption in Nepal, representing about 87% of the total energy consumption by fuel type in 2006. Household sector accounts for the major share in total energy consumption, however, the share of domestic sector has decreased from 91.7% in 1996 to 89.2% in 2006. Industrial, commercial, transport, agriculture and others accounted for 4.5%, 1.5%, 3.7%, 0.8% and 0.2% of energy consumption respectively in 2006. **Figure 2.13** indicates the growth of energy consumption (in million toe) in different sectors over the decade, 1996-2006.

SAARC Regional Energy Trade Study (SRETS)

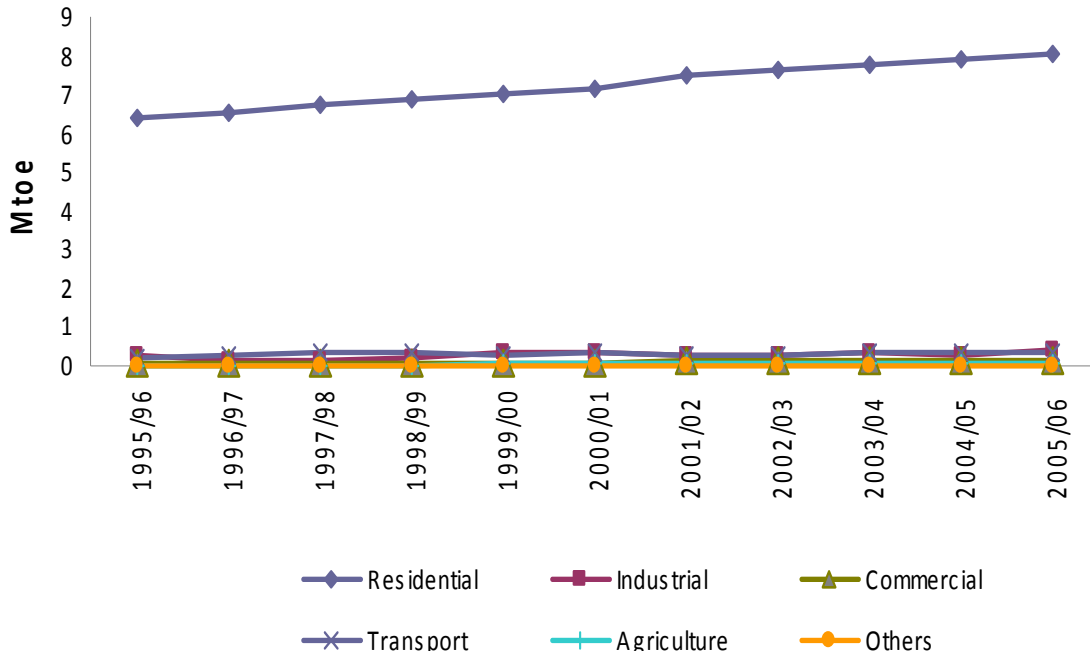


Figure 2.13: Sector-wise Energy Consumption in Nepal

Source: Nepal Country Report

2.5.7 Pakistan

Natural gas is the main commercial fuel consumed in Pakistan. Sector-wise consumption of natural gas is governed by the Federal government allocation. The order of priority is: domestic sector, fertilizer sector, power sector and general industry. Power sector was the largest user of gas in 2006 with a consumption of 9.98 mtoe, followed by industry 6.16 mtoe, domestic (household) with 4.00 mtoe and fertilizer (as feed stock) 3.03 mtoe. The other users include transport (CNG) 0.91 mtoe, fertilizer (as fuel) 0.84 mtoe, commercial 0.69 mtoe, steel 0.36 mtoe and cement sector 0.36 mtoe. **Figure 2.14** indicates the sector-wise consumption of natural gas in 2006 in Pakistan.

Since power sector is the major consumer of natural gas, it is essential to analyse sector-wise consumption of power. It is observed here that the domestic sector was the largest user of electricity with a consumption of 2.5 mtoe, followed by industry with 1.61 mtoe in 2006. **Figure 2.15** indicates the sector-wise consumption of power in Pakistan in 2006.

SAARC Regional Energy Trade Study (SRETS)

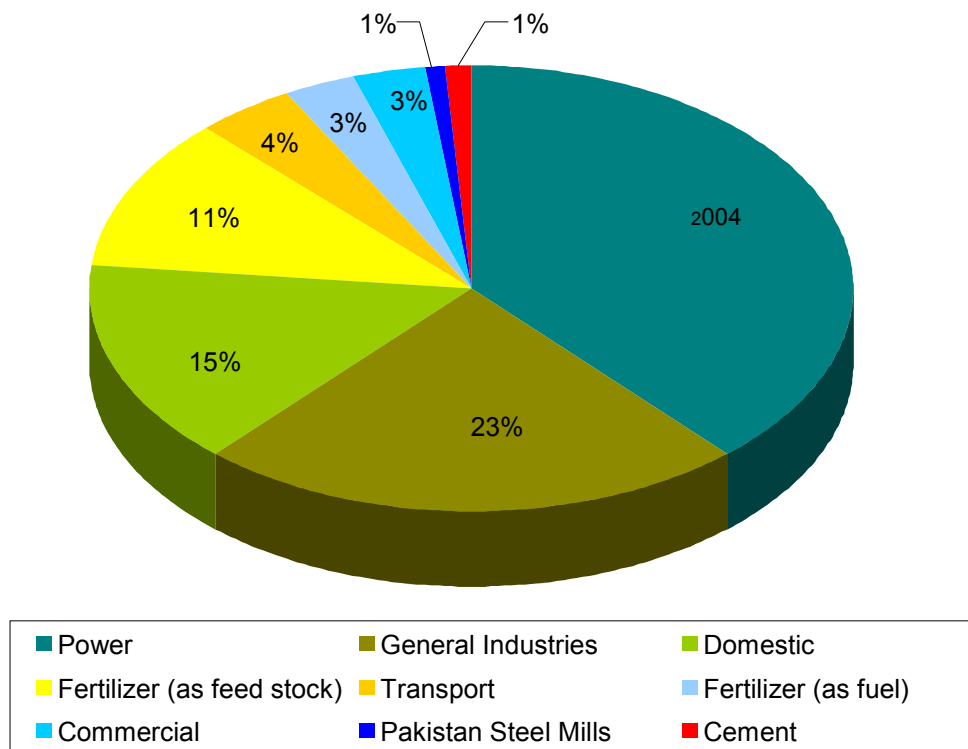


Figure 2.14: Sector-wise Consumption of Natural Gas in Pakistan in 2006

Source: Pakistan Country Report

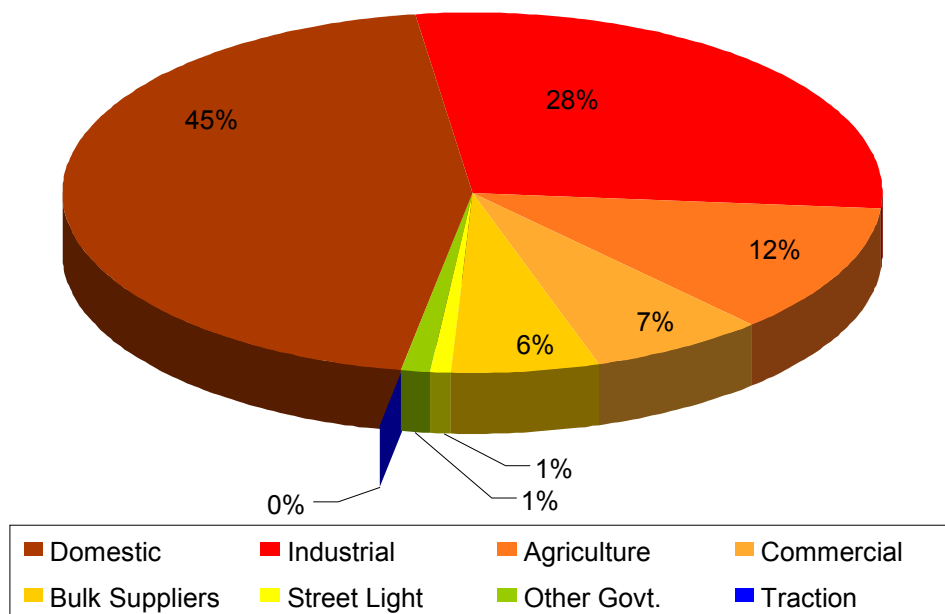


Figure 2.15: Sector-wise Consumption of Power in Pakistan in 2006

Source: Pakistan Country Report

2.5.8 Sri Lanka

The end-use energy demand in Sri Lanka mainly consists of the three sources, electricity, petroleum (including LPG) and biomass. Out of the total energy consumption, the sector comprising household, commercial and others accounted for the major share. In 2005, this sector accounted for about 48% of total energy consumption, followed by equal share of 26% each by the transport and industry sectors. The **Figure 2.16** indicates the growth of the energy consumption (in million toe) over the decade in these three sectors.

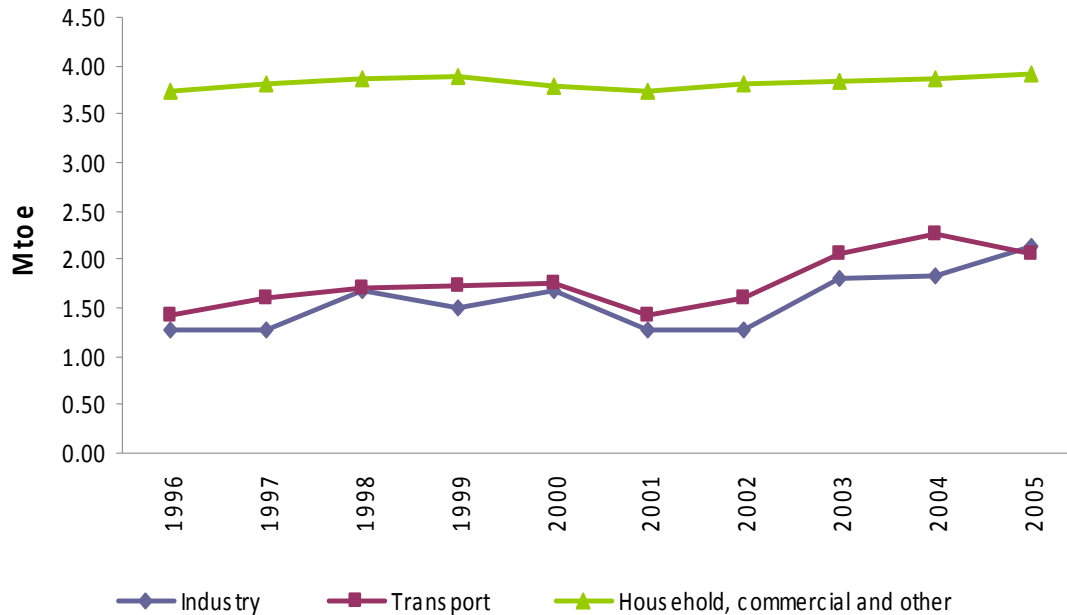


Figure 2.16: Sector-wise Energy Consumption in Sri Lanka

Source: Sri Lanka Country Report

Biomass alone accounts for about 50% of energy demand in Sri Lanka. More than 70% of biomass is consumed in the sector comprising of household, commercial and others. Out of 11.84 million tonnes of biomass consumption in 2005, about 8.3 million tonnes were consumed in this sector and the rest was consumed in industrial sector. Out of the petroleum products consumed, diesel is mainly used in the transport sector and furnace oil is mainly used for electricity generation.

Summary of Sector-wise Energy Consumption

The three sectors which are the main consumers of energy in the SAARC region are household, industry and transport. Household sector is also the major consumer of the traditional fuels (biomass). Since industry is the driver for economic growth, as SAARC Member States aim at higher GDP growth rates, energy demand from industry will increase. So would be the case with the transport sector. In the case of the household sector, as mentioned earlier, with increasing income, it is expected that the household sector would shift from traditional sources to commercial sources of energy. This

would lead to increased pressure on the Member States to source more commercial energy supplies. Transport sector being totally dependant on petroleum products, most of which are imported, would also have a significant impact on energy imports. Another aspect that emerges from the sector-wise analysis is that these sectors are most vulnerable to any energy supply disruptions.

2.6 Key Challenges and Issues Faced by the Energy Sector in SAARC Region

Among the pre-requisites for energy trade, are the availability of energy resources, potential for their economical exploitation, competitive cost advantages, adequate infrastructure, harmonious and enabling policies, lack of trade barriers, a climate of mutual trust and strong political will to cooperate for gaining mutual benefits. The major energy sector challenges in the SAARC region are given below:

2.6.1 Increasing Energy Deficit

The first and foremost energy challenge faced by the region is persistent energy deficit. All Member States of the SAARC region face electricity supply shortages, ranging from about 9% in Nepal to 28% in Bangladesh. The entire region faces either crude oil or petroleum product supply deficit. Member States currently using natural gas also face shortfall. Bangladesh and India are currently natural gas deficient. Although at present Pakistan does not have a natural gas shortage, in the future it is expected that the country would be facing such shortfall. Shortages of energy have an adverse impact on industrial and economic output as well as on social development. The same is elucidated by the fact that both industry and household sector are among the key energy consumers in the region, and a disruption in energy supply would have far reaching implications in these sectors.

The social impacts of energy provision are very well documented. A number of studies have been done to establish benefits that accrue to society at large with availability of commercial energy. Based on a study done in Chitral District, North-West Frontier Province, Pakistan, through the efforts of a Non-Governmental Organization (NGO), community micro hydro power plants were installed in a remote region. With access to electricity, households in the area got better and safer illumination than obtained with pinewood sticks or kerosene. Children got more opportunity to study at night thus improving the quality of their education. This is expected to have long-term benefits for the community with better educated people expected to have better livelihoods in the future. Even in the short term, the livelihood of women in the area has improved.²⁰

2.6.2 Dominance of Single Fuel for Electricity Generation

Most of the Member States in the region are dependent on a single fuel for electricity generation. In India 65% of the total generation capacity is thermal based, Bhutan and Nepal are almost completely dependent upon hydro to meet their electricity requirements,

²⁰

<http://www.ashdenawards.org/files/reports/Aga%20Khan%20Pakistan%202004%20Technical%20report.pdf> accessed on 15th September 2008

Maldives produces all its electricity from diesel and natural gas dominates the generation mix in Bangladesh and Pakistan. Excessive dependence on one energy resource raises concerns related to energy security. The concerns are aggravated with limited domestic supply of these fuels in respective Member States. For instance, India has already started to experience a shortage of non-coking coal. This is highlighted by the steady increase in the amount of coal imports to meet the demand. Within a decade non-coking coal imports have shot up from nearly a negligible level to ~25 million tonnes in 2007-08. Bangladesh dependent on natural gas, has started to face shortage of natural gas, which is expected to increase in the coming years. The cases of India and Bangladesh highlight long-term energy shortages, but certain Member States also experience short term shortages. For instance, Bhutan faces short-term shortage of electricity in winter months, when generation from its hydro resources goes down substantially. It imports electricity from India in winter, thus emphasizing the benefit of cross border energy trade.

2.6.3 Limited Utilization of the Renewable Energy Potential

In the wake of depleting scarce non-renewable energy resources, it becomes imperative that all energy resources are harnessed optimally. Thus, development of renewable energy resources, including wind, solar and biomass assume great importance. The SAARC region has significant potential for the utilisation of these renewable resources. The region has a total of 223 million tonnes of biomass potential, which can be harnessed to generate electricity or to replace diesel usage in industries.

SMS are making increasing efforts to enhance share of renewable energy in total electricity generation. However, despite large resource endowments, they are currently not used to their full potential due to lack of technology, infrastructure and financial resources. Another concern that is creating a hindrance in development of the renewable energy sources is timely availability of wind power equipment and the high cost of solar energy equipment and its availability. While solar and wind mapping has been done for Afghanistan, Maldives, Pakistan and Sri Lanka under the South Asia Regional Energy Programme funded by USAID, this exercise is yet to be undertaken in respect of Bhutan, Bangladesh and Nepal. Completing this exercise for the entire region will help identify the full potential from these renewable resources for the entire region. SAARC/SEC may consider undertaking the wind and solar mapping of the latter countries to assess renewable energy potential. Member States can then collectively prepare an action plan for harnessing of energy from these resources optimally.

2.6.4 High Dependence on Traditional Fuels

It is observed that the region is excessively dependent on traditional energy resource for meeting energy requirements. For instance, in Member States such as Afghanistan, Bhutan and Nepal traditional fuels are used to meet 85% of the total energy requirements. The main traditional energy resource is biomass, which under its current usage pattern is utilized inefficiently. This inefficient utilization of biomass and fuel wood has an impact on the health of household members as burning of these fuel impacts indoor air quality in households. Dependence on traditional sources of energy also has gender related issues attached with it, as responsibility of collection of the fire wood primarily falls on the

female members of the family; for which young girls are forced to drop out of schools.²¹ To address these issues the region can adopt a two pronged approach - first is to encourage technology trade for promotion of efficient technologies such as smokeless efficient chullahs, and second to steadily shift households from traditional sources of energy to commercial and cleaner sources.

2.6.5 Rising Import Dependence

SMS are excessively dependent on import of fuels to meet their energy requirements. Bangladesh, Bhutan, Maldives, Nepal and Sri Lanka are totally dependent on imports to meet petroleum products demand. India having sufficient refining capacity, imports 75% of its total crude requirement. In effect the entire region is in energy deficit and thus imports a large quantum of crude oil/petroleum products to meet its demand. Such import dependence raises energy security concerns as it increases vulnerability of a nation both in terms of availability of the energy supply as well as its prices. Moreover, import of fuels in large quantities also has financial implications on the country's economy. For instance, in the case of Bhutan, in 2007, the entire electricity exports earnings of the country were spent on procuring petroleum products. In the current situation of volatile international crude oil markets, such high dependence on imported fuel can have an inflationary impact on the economy. A related concern in the case of petroleum products is that the current refining capacity of the Member States, excluding India, is insufficient to meet their respective demand and also that the technology employed in these refineries is not state-of-the-art. The region may hence, consider enhancing its aggregate refining capacity by setting up a state-of-the-art refinery to meet the region's petroleum product demand. Under such an arrangement the region would also be able to reap benefits of joint fuel procurement.

2.6.6 Lack of Energy Infrastructure

A prerequisite for energy availability is existence of requisite infrastructure to facilitate transmission/transportation of energy supplies. Energy infrastructure includes electricity transmission lines, natural gas pipelines, crude oil and petroleum product pipelines etc. Energy infrastructure is not only crucial for regional trade to take place but also essential to ensure flow of energy within a country. However, the SAARC region lacks this supporting infrastructure. Lack of infrastructure has had an adverse impact on exploitation of resources and also in accessing the available resources. For instance, in Afghanistan, access to electricity service is limited due to the damaged infrastructure during the war and a large backlog of repair and maintenance work which dates back to 25 years. About 40% of power lines in Afghanistan were destroyed during the war. In Bhutan due to the difficult terrain there has been limited development of an integrated country wide electricity transmission network.

Matching energy infrastructure is also important for countries importing energy. At present, in the entire region only India has LNG terminals and the country is developing

²¹ Cecelski E 'Enabling Equitable Access To Rural Electrification: Current Thinking On Energy, Poverty And Gender' Briefing Paper Asia Alternative Energy Policy and Project Development Support: Emphasis on Poverty Alleviation and Women, Asia Alternative Energy Unit, The World Bank, Washington, DC (January 2000, Revised July 2002)

its natural gas pipeline network to connect all demand and supply centres. Building cross border energy infrastructure may also reduce the need for building dedicated in-country transmission corridors. To resolve the lack of infrastructure bottlenecks, substantial financial investments are required (as mentioned earlier in the chapter), which in turn call for cooperation among the member nations so as to optimise investments for infrastructure development.

2.6.7 Lack of Infrastructure for Developing Remotely Located Hydro Projects

Most of the hydropower projects are located in the remote and mountainous areas, where infrastructure, such as, accessible roads and high-voltage transmission lines do not exist. This necessitates the development of this infrastructure for each and every project with the associated cost being added to the overall cost of the project. This ultimately leads to higher costs for the hydropower project and adversely affects their competitiveness. The study titled “ Financing Hydropower Projects During 9th and 10th Plan periods” carried out in India in 1998 recommended that the entire cost of the infrastructure development of the hydropower projects should not be exclusively loaded to these projects. Because such infrastructure meets the social and economic development needs of the entire region in addition to the needs of the project. SMS could examine the possibility of allocating the infrastructure development cost of hydropower projects between the project and state infrastructure development. This in turn would expedite the development of these projects and result in lower tariff, to make energy from these projects more competitive.

2.6.8 Lack of Funds to Undertake Capital Intensive Projects

Energy infrastructure including power projects and transmission inter-connections require large capital outlay. SMS do not have adequate financial resources for the development of these projects, and have to seek support from international donors and multilateral funding agencies. But, given the focus of these agencies on the soft sectors, their support would be limited. However, in recent times, the private sector has become increasingly active in energy infrastructure. Nevertheless, inadequate internal financial resources and lack of developed capital markets in most of the SMS act as a major barrier.

2.6.9 Absence of Competitive Power Market

India is the only country in South Asia to have permitted electricity trade as a commodity and has also recently put in place two electricity exchanges (India Energy Exchange and Power Exchange India Limited) for electricity trading. Such options are not available to the buyers and sellers of electricity in other countries of the region. Although it is not a precondition for regional trade in energy, a vibrant power market with competitive segments offers better opportunities for electricity trade.

2.6.10 Lack of Harmonious Energy Policy and Related Framework

Existence of well-defined, coherent/harmonious energy policies, enabling legal and regulatory framework are an essential criterion for cross-border trade and investments. As such, there is an urgent need to put in place related mechanisms that would not only facilitate but also encourage energy trade among the SMS.

2.7 Likely Gains from Energy Trade Arrangements

Energy trade can bring immense benefits to the participating Member States. Earlier studies on the subject have demonstrated that the social and economic benefits from these initiatives would in certain cases even surpass their direct financial benefits. The benefits can broadly be categorized as technical, operational, environmental, financial, economic and social sector benefit. Some of the benefits from the energy projects that would accrue to the SMS are given below.

2.7.1 System Operational Benefits

Optimal Utilization of Natural Resources to Meet Growing Power Demand

The area-wise demand/supply mismatch of power creates opportunities for effective exchange of power between two regions or countries to meet the growing demand. For this, the advantages of peak diversity as well as time diversity in inter-connected areas/countries can be exploited. In any power system, the generation capacity is created to meet the peak power demand and so, during off-peak hours, surplus power is available for transfer to some other area. If there is a time diversity of the peak power demand between two power systems, the surplus power available in one system during its off-peak hours can be supplied to the other region during its peak hours. This results in optimized utilization of generation capacity to meet peak load in both power systems. Further, for optimal hydro-thermal mix, power exchange from various resources is the best option. Moreover, electricity can be traded through transmission networks with relative ease as compared to other sources of energy.

Concentration of various types of energy resources in different countries

The concentration of various types of energy sources viz. coal, gas, hydro etc. varies in different SMS. Given the poor road/rail connectivity and absence of gas transmission interconnections among the SMS, large scale trading of coal or natural gas is fraught with serious limitations in their handling and transportation. Transmission of power is the best solution for energy exchange to begin with. Once transmission interconnections are established, coal and gas generating stations can be used to meet the base load of interconnected countries and hydro generating plants can be used to meet the peak load. Thus, better load factor of thermal power plant can be obtained. This results in optimal and economic utilization of resources.

Economy of Scale

Economy of scale can be achieved by setting up large sized generating plants to meet local demand as well as demand of the interconnected regions.

Improved energy security and reliability

Increased interconnectivity of power systems increase their reliability and the expectation with which the demand can be met through continuity in supply under contingencies.

Optimized transmission network

Sometimes the geography of two countries is such that the loads of one country are in proximity with generation facilities of the other country as compared to its own generation facilities. It would then be easier and more economical to meet such loads from neighbouring countries. Such arrangements result in reduced line length, reduced losses and less capital cost.

Increased economic efficiency in system operation

With cross-border exchange, the generation of each of the interconnected countries has access to a larger market. This would result in improved merit order operation and extend opportunity to promote operation of more efficient power plants as far as possible, to achieve overall economic efficiency in system operation.

Reduced environmental damage

Apart from economic benefits, sharing of energy resources through cross border interconnections help reduce adverse energy sector impact on the environment. As in such a scenario, renewable or "clean" energy like hydro power can be used more than other polluting energy sources. By setting up more export oriented hydro power projects, Nepal and Bhutan can further help the region in reducing its dependence on fossil fuel and consequent reduction in GHG emissions.

Increased natural gas use through natural gas interconnections would also result in cleaner production in the power and industrial sectors with reduced adverse environmental impact. There are also likely environment gains from regional energy trade opportunities in the field of renewable energy. Energy sector cooperation among the SMS to enhance energy use efficiency both on the supply side as well as the demand side would also lead to reduced adverse environmental impact.

2.7.2 Economic and Financial Gains

Industrial Productivity Gains

Economic Impact of Poor Power Quality on Industry: Nepal, conducted by Nexant in October 2003 indicated an annual industrial sector loss of US\$ 24.7 million annually due to poor power quality. This translated into 4.43% of the industrial sector Gross Domestic Product (GDP) or 0.47% of the national GDP. The study findings indicate that in the industrial sector loss impact attributable to unplanned power interruptions averaged 0.49 US\$/kWh, while those from planned outages were 0.14 US\$/kWh. Availability of additional supply of electricity/energy through regional energy trade can not only reduce such losses but also help in enhancing industrial productivity.

Revenue Gains

This can be illustrated by the fact that Bhutan exported 1472 GWh of surplus electricity to India from the 336 MW Chukha Hydropower Project during 2002-03 and the revenue generated was US\$ 52 million. With commissioning of the 1020 MW Tala Hydropower Project in 2008, Bhutan's revenue from power exports reached US\$ 214 million annually. Nepal could have earned similarly through power exports from the 750 MW West Seti Hydropower Project had the project been implemented.

GDP Gains

The case of Bhutan illustrates this aspect also. A very large percentage of Bhutan's revenue has been from sale of electricity to India and the revenue so generated has helped it to take its economy on a higher growth trajectory. More than 45% of the national domestic revenue of Bhutan (> Nu 5000 Million) comes from sale of electricity. Electricity sector's contribution to GDP was 22% in 2006 and helped Bhutan's per capita GDP to reach US \$ 1414 per annum (2006). The revenue so generated helped the country in meeting financial resources for social development, education, health care, development of physical infrastructure like roads, industrialization and other nation building activities.

2.8 Need for Regional Trade/Cooperation

The summary of key issues faced by the SMS point towards the likely areas of competition amongst them as well as the shared opportunities that exist for energy trade/cooperation.

Energy trade options could be both inter and intra-regional. Intra-regional energy trade would have limited opportunities due to the fact that the countries of the region are themselves resource constrained and operate in a competitive spirit. Inter-regional trade would be a more attractive option given the fact that the neighbouring regions of SAARC have abundance of energy resource.

Geographically, South Asia is ideally located to reap the benefits of inter-regional energy trade with countries in the West as well as the East; since it is flanked in the West by energy rich West Asia, Central Asian Republics (CARs), and Iran and on the East by Myanmar which also has abundant hydropower as well as hydrocarbon reserves. A brief discussion about the prevailing energy situation in the CARs, Iran and Myanmar and the perspectives and prospects of energy trade between these regions/countries and South Asia are given in Chapter 4.

Before embarking upon these trade initiatives; there is a need to know the prevailing legal and regulatory frameworks that have been put in place in the SMS and how these mechanisms facilitate and/or impede inter and intra-regional energy trade. Chapter 3 focuses on the SAARC member state institutional, legal, and regulatory frameworks.

Chapter 3: Institutional, Legal and Regulatory Framework of Energy Sector in SAARC Member States

This chapter discusses in detail the institutional, legal and regulatory frameworks currently existing in the energy sector of the SAARC Member States.

3.1 Afghanistan

3.1.1 Institutional Framework of the Energy Sector

The Inter-Ministerial Commission for Energy (ICE) established in December 2006 provides overall supervision for the energy sector policy and infrastructure investments. The Commission includes the Ministry of Energy and Water, Ministry of Finance, and Ministry of Mines as core members and the Ministries of Commerce and Industry, Foreign Affairs, Urban Development and Rural Rehabilitation and Development as ad-hoc members. The objective of ICE is to help the Government to understand, support, design and monitor development of energy resources, based on commercial principles. The Commission supervises energy sector policy, infrastructure, and investments and coordinates support and assistance from different development partners. It brings together a wide range of government and donor agencies to assure coordinated actions and practical planning. The Commission develops sound policies in line with fiscal and policy priorities and international standards. The energy sub sectors are directly supervised by the respective ministries as detailed below.

Power Sector

Ministry of Energy and Water (MEW) provides the regulatory and policy framework for the power sector with an aim to provide sustainable power supply, at affordable prices, in an environmentally sound manner, for economic growth to improve living standards and to support multi-purpose irrigation dams and water resource management. The Department of Power under MEW is responsible for overall generation, transmission and distribution of power. The Department of Renewable Energy Development (DRED) works for the promotion of Renewable Energy Technologies (RET). It promotes programmes related to biogas, solar, improved water mills and micro-hydro etc. The Department of Policy and Strategy and the Department of Planning deal with policy and strategy formulation for the power sector and energy supply.

Hydrocarbon Sector

The Ministry of Commerce and Industries is responsible for developing the policies and regulatory framework for demand, supply and purchase of crude oil and petroleum, including technologies, as well as to represent the government for entering in to crude oil, petroleum products, gas and related agreements. It is also responsible for small scale energy technology imports, fuel and gas supply and import facilitation and regulations.

The Ministry aims to integrate Afghanistan markets into the regional and global economy to ensure competitiveness of domestic industries and to improve attractiveness of Afghanistan for investors. The Ministry is responsible for all types of international and regional agreements pertaining to petroleum and natural gas at the government level. The Department of Petroleum in the Ministry is responsible for supply and quality control including licensing to national and international fuel companies.

The Ministry of Mines and Industry manages the underground natural resources and mines including exploration of gas, coal, petroleum and other fossil fuels. It is responsible for development of policies and regulatory framework for explorations and trade of minerals, chemicals and petroleum at the national level including technologies, national level government negotiations, marketing and related agreements.

All these ministries work in close cooperation with the Ministry of Foreign Affairs (MoFA), Ministry of Finance (MoF) and ICE. MoF has jurisdiction over policy formulation of energy sector and provides appropriate funding to the ministries and institutions in accordance with the developed policy, operational and development budget. MoFA facilitates foreign relations and regional cooperation in all sectors including energy, and power transmission agreements.

In addition to the above established institutions, the following advisory positions and national programs are involved in the energy sector development in Afghanistan:

- Advisor on Mines and Energy to the Office of the President
- Afghanistan Investment Support Agency (AISA)
- Afghanistan National Development Strategy (ANDS)
- Afghan National Standardization Authority (ANSA)
- MRRD's National Solidarity Program (NSP)
- Priority Reform and Reconstruction Program (PRR)

3.1.2 Legal and Regulatory Framework of the Energy Sector

Legal framework for the energy sector in Afghanistan is currently at a nascent stage. The existing energy laws being rudimentary do not address energy issues in an integrated fashion. There are three key energy laws in the country:

- Power Consumption Law, 1982
- Oil and Gas/ Hydrocarbons Law, 2005
- Coal/ Minerals Law, 2005

With an aim to alleviate poverty and to create employment opportunities, Ministry of Mines and Natural Resource makes policies and regulations for the development of the mining sector. These include the Mineral Law 2005 and Hydrocarbons (petroleum) Law 2005. Hydrocarbons Regulation, Minerals Regulation and Natural Gas Distribution Law are in the process of being finalized. Specific strategies are being formulated for the identification, exploration and exploitation of crude oil and natural gas resources.

Along with the above mentioned legal framework specific to the energy sector, Afghanistan government has also developed an interim energy strategy called Afghanistan National Development Strategy (ANDS). The strategy aims to promote growth, generate wealth and reduce poverty and vulnerability. It provides the framework for development of government policies and acts as a guide for allocation of resources and programs towards these goals. The Energy Strategy indicates that the optimisation in respect of energy sector will be achieved when the varied sources of energy reaches at least 60% of population. To achieve this optimisation, goals are set for the overall energy sector with the aim to:

- Restructure energy sector governance and promote cost-recoverable operations
- Rehabilitate and expand the public power grid
- Provide adequate incentives to attract private investment in the energy sector
- Improve rural energy access
- Develop indigenous resources for power and energy use

In order to achieve the above mentioned goals following have been identified as the action points:

- Attract funds from international donors and private players to develop transmission networks.
- Undertake intensive capacity building programme for the local staff to operate and maintain the system.
- Increase exploration activities and develop already known reserves.
- Attract private investment in operation of gas pump stations and fuel trucks to improve quality of products and to introduce competitive pricing.
- Develop renewable energy in Afghanistan, as currently, only a number of small renewable projects are undertaken in the country. Promote usage of solar water heating and lighting, water pumping and micro-hydro through private sector participation.

The Ministries in each energy sub-sector lay special emphasis on promotion of inter and intra regional energy trade. MoFA facilitates regional cooperation in energy. Upgrading electricity transmission ties with CARs and exploring options for transport of electricity and natural gas through Afghanistan for regional supply are regarded as important areas for regional cooperation.

Although there is clear distinction of role of ministries in each of the energy sub sector, these form part of the IEC. This has been done to integrate individual energy strategies of each energy sub-sector with others. A major challenge faced by the Afghanistan energy sector in developing an energy sector policy is the lack of reliable energy sector data and a resource repository.

3.2 Bangladesh

3.2.1 Institutional Framework of the Energy Sector

The Ministry of Power, Energy and Mineral Resources (MoPEMR) has the responsibility for the overall planning, development and management of different types of commercial energy resources and power. The two divisions under the Ministry, namely, the Energy & Mineral Resources Division (EMRD) and the Power Division manage the gas and power sector utilities respectively. The two main state corporations are Bangladesh Oil, Gas and Mineral Corporation (BOGMC), commonly referred as Petrobangla and the Bangladesh Power Development Board (BPDB). Institutional framework of each of the energy sub-sectors is discussed below.

Power Sector

Power Division of MoPEMR manages the power sector in Bangladesh. There are four generation utilities apart from the small and independent power producers, one transmission utility and five distribution utilities. Private sector participation is encouraged in generation of power. Power Cell provides assistance to Power Division in implementation of reform measures taken by the Government along with the review of tariff and performance monitoring of the utilities.

Hydrocarbon and Coal Sector

EMRD of MoPEMR is the administrative authority of all energy and mineral resources (oil, gas, coal and other minerals) of Bangladesh. Petrobangla on behalf of EMRD holds the shares of the companies dealing in oil, gas, minerals exploration and development. It is at present in the business of hydrocarbon exploration, development, transmission, distribution and Compressed Natural Gas (CNG) conversion and development and marketing of minerals. It is regarded as an upstream regulator and thus, it administers Production Sharing Contracts (PSCs) with the International Oil Companies (IOCs) on behalf of the government. The Hydrocarbon Unit (HCU) serves as a support wing of the EMRD.

The gas sector of the country is divided into four segments. The utilities involved in various segments of the gas business are as follows:

- **Exploration:** One national company namely, Bangladesh Petroleum Exploration & Production Company Ltd., (BAPEX) and four IOCs are engaged in gas exploration and production activities.
- **Production:** National companies namely, Bangladesh Gas Fields Company Limited (BGFCL) and Sylhet Gas Fields Limited (SGFL) are involved in the gas production business.
- **Transmission:** National Company namely, Gas Transmission Company Limited (GTCL) is engaged in the gas transmission business.

- **Distribution:** Four gas distribution and marketing companies (TGTDCCL, BGSL, JGTDSL and PGCL) and one CNG conversion company (RPGCL) are engaged in gas distribution activities.

3.2.2 Legal and regulatory framework of energy sector

Article 143 of the Constitution of Bangladesh provides that all mineral resources underlying any land of Bangladesh or under land within the territorial waters or continental shelf shall vest in the Republic.

Petroleum Act, 1974 defines the basic legal framework in the petroleum sector. It provides that the Government may enter into a petroleum agreement with any person for any petroleum operation, and that no person shall undertake any petroleum operation except under a petroleum agreement. Petrobangla, the national holding corporation, is authorized to enter into such agreement(s) on behalf of the Government.

The Bangladesh Energy Regulatory Commission (BERC), formed in 2003 and effective from April 2004, is an independent commission with a mandate to regulate energy sector (gas, electricity and petroleum products) in Bangladesh.

The major functions of the Commission are as follows:

- (i) to determine efficiency and standard of the machinery and appliances of the institutions using energy and to ensure through energy audit the verification, monitoring, analysis of economic energy use, and enhancement of energy use efficiency;
- (ii) to ensure efficient use, quality of services, tariff determination and safety enhancement of electricity generation and transmission, marketing, supply, storage and distribution of energy;
- (iii) to issue, cancel, amend and determine conditions of licences, exemption of licences and to determine the conditions to be followed by such exempted persons;
- (iv) to collect, review, maintain and publish statistics of energy;
- (v) to frame codes and standards and enforce those compulsory to ensure quality of service;
- (vi) to develop uniform methods of accounting for all licensees;
- (vii) to create a congenial atmosphere to promote competition amongst the licensees;
- (viii) to extend co-operation and advice to the Government, if necessary, regarding electricity generation, transmission, marketing, supply, distribution and storage of energy;

- (ix) to resolve disputes between the licensees, and between licensees and consumers, and refer those to arbitration if considered necessary; and
- (x) to ensure control of environmental standards for energy use under existing laws.

BERC plays a significant role in attracting private investment in electricity generation and transmission, and transportation and marketing of gas resources and petroleum products. The Commission ensures transparency in management, operation and tariff determination in the energy sector and promotes creation of a competitive market. It is independent of the Government, but is responsive to government policies, which determines the policy and overall planning in the energy sector. BERC is also regarded as a downstream regulator with responsibility for gas transmission, distribution and supply. It grants licenses to entities involved in the transmission, distribution and supply of gas. It is empowered to set tariffs in the future for gas transmission and supply in consultation with the Government, based on published policy guidelines and methodology.

National Energy Policy

The National Energy Policy (NEP) was first issued in 1996 and provides guidelines for the overall energy sector. It is presently under a process of revision. NEP deals with country specific energy sector issues. The objectives of the revised draft National Energy Policy (NEP 2004) are:

- To provide energy for sustainable economic growth so that the economic development activities of different sectors are not constrained due to shortage of energy.
- To meet energy needs of different zones of the country and socio-economic groups.
- To ensure optimum development of all indigenous energy sources.
- To ensure sustainable operation of the energy utilities.
- To ensure rational use of total energy source.
- To ensure environmentally sound sustainable energy development programs causing minimum damage to environment.
- To encourage public and private sector participation in the development and management of the energy sector.
- To bring entire country under electrification by the year 2020.
- To ensure reliable supply of energy to the people at reasonable and affordable price.
- To develop a regional energy market for rational exchange of commercial energy to ensure energy security.
- To provide and secure energy resources for all.

To achieve these strategic objectives, the energy policy focuses on:

- Providing a sustainable and balanced energy supply
- Promoting rational use of energy
- Improving sector management and performance

- Increasing private sector participation and investment
- Reducing inter regional disparity (disparity between east zone and west zone)
- Creating regional energy markets

The policy framework in Bangladesh indicates possibility of regional cooperation on energy trade. With regard to electricity trade, NEP emphasizes examination of possibility of cross border electricity trade among neighbouring countries and establishment of linkages of local utilities with those in other countries for provision of a basis for exchange of experience in power development and training of human resources. It also emphasises the possibility of cooperation and linkage of utilities across the region for promoting experience sharing and capacity development.

3.3 Bhutan

3.3.1 Institutional framework of the energy sector

The energy sector in Bhutan is primarily governed by the Ministry of Economic Affairs (MEA, erstwhile Ministry of Trade & Industry). It has the following five technical departments:

- Department of Trade
- Department of Industry
- Department of Geology & Mines
- Department of Tourism
- Department of Energy

The institutional framework specific to each of the energy sub sectors is discussed below.

Power Sector

The electricity sector falls under the Department of Energy of MEA which looks after all the national planning aspects in the energy sector. Its functions include master plan developments, resource mobilization, coordination with donor agencies, monitoring power projects including generation, transmission and rural electrification and implementation of guidelines related to the energy sector.

Bhutan Electricity Authority (BEA) is the regulatory body for the Power sector as per Electricity Act 2001. Bhutan Power Corporation Limited (BPC) is a public owned utility responsible for transmission, distribution and supply of electricity in Bhutan. There are three hydro-generating companies, namely Chhukha; Basochhu and Kurichhu. In January 2008, the corporations holding the above-mentioned hydropower generating stations were amalgamated under Druk Holdings and Investments Limited (DHI) to form the Druk Green Power Corporation Limited (DGPC), which is responsible for managing all hydropower plants fully owned by the Royal Government of Bhutan. DGPC has the mandate to develop projects on its own or through joint ventures on behalf of the Royal Government.

Hydrocarbon Sector and Coal Sector

The petroleum sector is controlled by the Department of Trade under MEA. The Department looks after the import of petroleum products and their distribution. The Internal Trade Division of the Department deals with the retail and wholesale business within Bhutan (including licensing and regulatory issues) and the Foreign Trade Division of the department deals with bilateral and multilateral trade activities.

The coal and mining sectors are controlled by the Department of Geology & Mines under MEA. This Department functions through two divisions.

Legal and Regulatory Framework of Energy Sector

As mentioned earlier, BEA is the electricity regulator in the country responsible for power sector. Operations such as generation, transmission and distribution are carried out by the respective licensees within the framework of the Electricity Act, 2001. The following aspects are included under the purview of the BEA – electricity pricing, ensuring licensees meet their functional obligations and responsibilities to their customers and other stakeholders, ensuring inter-operational discipline and dispute resolution etc. It also provides various codes and regulations such as grid code, distribution code, grievance redressal mechanism etc. and policy preparation.

The Government aims to attract private investment for hydropower development in the country through independent power producers. Although the specific regulations in this regard are yet to be finalized (Hydropower Policy on Foreign Direct Investment – FDI and formulation of IPPs is at draft stage), these regulations are expected to provide sufficient incentives for investments in hydropower projects of Bhutan and to ensure sale of electricity outside the country by IPPs thereby promoting regional trade.

3.4 India

3.4.1 Institutional Framework of the Energy Sector

Government of India manages the energy sector through five key ministries for the energy sub sectors - power, coal, oil and gas, renewable energy and atomic energy. A brief description of the institutional framework of each energy sub sector is discussed below.

Power Sector

The Ministry of Power

The Ministry of Power (MoP) is primarily responsible for development of the electricity sector in India. It deals with perspective planning, policy formulation, processing of projects of PSUs for investment decision, monitoring of the implementation of power projects, training and manpower development and the administration and enactment of legislation in regard to thermal, hydro power generation, transmission and distribution.

Electricity is a concurrent subject under the Constitution of India and therefore, both central and state governments have the jurisdiction over the sector. MoP coordinates with the State Electricity Boards (SEBs), power departments and the private sector. It is responsible for administration of the Electricity Act, 2003; the Energy Conservation Act, 2001 and to suggest amendments to these Acts, as may be necessary from time to time, in conformity with the Government's policy objectives. MoP is also responsible for formulating National Electricity Policy.

The Central Electricity Regulatory Commission (CERC) is the regulator at Central level for inter-state power matters. Its responsibilities include licensing/regulating and promoting power market, determining generation tariffs of central utilities and projects that supply power to more than one state, regulating inter-state transmission and tariffs, inter-state trading of power, bringing efficiency in the sector and safeguarding the interest of the consumers. State Electricity Regulatory Commissions (SERCs) have the above mentioned responsibilities at the state level. Regulatory issues related to regional energy trade would fall under the purview of the CERC.

Central Electricity Authority (CEA) assists the MoP in all technical and economic matters. It is responsible for the technical coordination and supervision of programmes and is also entrusted with a number of statutory functions. It is also responsible for preparation of National Electricity Plan in accordance with the National Electricity Policy and notifies such plan once in five years.

The construction and operation of generation and transmission projects in the Central Sector are entrusted to Central Sector Power Corporations, such as the National Thermal Power Corporation (NTPC), the National Hydro Electric Power Corporation (NHPC), the North Eastern Electric Power Corporation (NEEPCO) and the Power Grid Corporation of India Limited (POWERGRID). POWERGRID has the mandate to establish and operate regional and national power grids to facilitate transfer of electricity within and across the regions.

Power Finance Corporation (PFC) and Rural Electrification Corporation (REC) provide support for financing power projects and rural electrification respectively.

Hydrocarbon Sector

The Ministry of Petroleum & Natural Gas (MoPNG) has the responsibility for exploration and production of oil and natural gas. Transportation, refining of petroleum, distribution, marketing, import, export, and conservation of petroleum products also falls within the ambit of its responsibilities. It also deals with development and implementation of pricing policy and with the supervision, production and marketing of bio-fuels.

Directorate General of Hydrocarbon (DGH) has been established to look after the interests of GoI as it is the owner of all hydrocarbon resources of the country and the operators are only leaseholders. DGH also maintains the repository of data pertaining to the oil fields and promotes participation of oil companies in the rounds of bidding and supervises award of concessions after ensuring proper evaluation of the bids received. It

supervises activities of operators and approves the budgets and establishment of reserves of hydrocarbons.

With the enactment of the Petroleum and Natural Gas Regulatory Board (PNGRB) Act in 2006, the regulator for the oil and gas downstream sector was established. The objective of PNGRB is to regulate the refining, processing, storage, transportation, distribution, marketing and sale of petroleum, petroleum products and natural gas so as to protect the interests of the consumers and entities engaged in specified activities, to ensure uninterrupted and adequate supply of petroleum products and natural gas in all parts of the country, and to promote competitive markets. It supervises the work of the operator and approves the budgets and the establishment of reserves of hydrocarbons.

Coal Sector

The Ministry of Coal is responsible for development of the coal industry in the country by formulating plans and policies for exploration and development of coal and lignite reserves and attracting investment in the sector. The Ministry works through Coal India Ltd (CIL), Neyveli Lignite Corporation Ltd. (subsidiary of CIL), and Singareni Collieries Company Limited (a joint venture between CIL and Government of Andhra Pradesh)

Renewable Energy Sector

The Ministry of New and Renewable Energy (MNRE) is the nodal agency of GoI for all matters relating to new and renewable energy resources. The Ministry aims to develop and deploy these energy sources to augment energy supply for the country and for carrying out a national programme to increase wind, small hydro, solar and biomass based power generation capacity. Indian Renewable Energy Development Agency (IREDA) is a public sector enterprise under MNRE to promote, develop and extend financial assistance for renewable energy and energy efficiency/conservation projects.

Atomic Energy Sector

The Department of Atomic Energy (DAE), set up in 1954, is directly under the charge of the Prime Minister of India and it administers India's nuclear programme. Nuclear Power Corporation of India Limited (NPCIL), a public enterprise under DAE, undertakes the designing, construction, operation and maintenance of the atomic power stations for generation of electricity in the country.

3.4.2 Legal and Regulatory framework of the energy sector

Power Sector

The Electricity Act 2003 provides the overarching legal framework for the Indian electricity sector. It consolidates the laws relating to generation, transmission, distribution, trading and use of electricity. It aims to promote competition, protect the interest of the consumers and rationalize electricity tariffs. The Act facilitates flow of investment into the sector by creating a competitive environment and reforming the distribution segment of the power industry. The Act also removed and reduced many entry barriers by de-licensing generation for setting up captive generation facilities,

recognizing trading of power as independent activity; allowing multiple licenses in distribution of electricity; establishing Regulatory Commissions for developing the sector in a transparent and competitive manner by rational fixation and management of tariff. National Electricity Policy, 2005 and National Tariff Policy, 2006 aim to improve access to reliable electricity supply and to make the power sector commercially viable through cost-reflective tariffs.

The Government of India also issued guidelines for tariff based competitive bidding in 2006 for promoting competitive procurement of electricity by distribution licensees, facilitating transparency and fairness in procurement processes, protecting consumer interests by facilitating competitive conditions in procurement of electricity, etc.

Private participation in the transmission segment is encouraged through joint ventures. Development of Ultra Mega Power Projects (UMPP) is another major investment initiative to encourage private participation through international competitive tariff based bidding. State Electricity Regulatory Commissions (SERCs) have initiated actions on open access in the distribution segment.

Foreign Investment Promotion Board grants approval for foreign investment in the coal sector on a case-to-case basis and up to a maximum of 50% of equity. So far, Coal India Ltd plays a dominant role in the sector and not much private investments have been made in the coal sector.

Hydrocarbon Sector

Reforms in the oil sector began in the early 1990s with private and foreign firms allowed to participate in onshore exploration and production through PSCs regime. In 1997, the government announced the New Exploration Licensing Policy (NELP) to provide a more attractive framework for private domestic and foreign investment in oil and gas exploration.

The government officially abolished the Administered Pricing Mechanism (APM) in 2002 for all petroleum products except kerosene and Liquefied Petroleum Gas (LPG). Oil Marketing Companies were allowed to fix price of petroleum products for a while but as international oil prices rose, the government continued its control on diesel and petrol prices. These controls, along with subsidies on kerosene and LPG have imposed heavy financial burden on the downstream oil companies. Private sector participation in building oil-product pipelines through joint ventures has been allowed since 2002. Private sector is also free to invest in gas-pipeline infrastructure. Foreign direct investment in the gas sector is allowed in exploration and production and in liquefied natural gas terminals (LNG).

In 2007, the Petroleum & Natural Gas Regulatory Board (PNGRB) was set up. It is an independent regulator for midstream and downstream activities with an aim to promote competition in the oil and gas sector and the development of natural gas pipelines and city or local gas distribution networks in the country. The role of PNGRB in promotion of regional energy trade is primarily related to giving approvals for laying cross-border pipelines within the Indian Territory.

3.5 Maldives

3.5.1 Institutional Framework of the Energy Sector

The Ministry of Environment, Energy and Water (MEEW), established in July 2005, oversees energy, environment and water sectors in Maldives, and was later renamed as Ministry of Housing, Transport and Environment (MHTE). It replaced the multiple ministries that existed in the energy sector prior to it being set up. It aims to encourage energy efficiency and alternative energy use in Maldives. The following sections discuss the institutional framework of each energy sub sector.

Power Sector

Maldives Energy Authority (MEA) regulates the energy sector of the Maldives. Although it has a broad mandate to regulate the energy sector, set standards and conduct awareness programs, its activities are restricted to technical activities in the electricity sub-sector, such as setting technical standards for improving the quality of electricity supply and resolving conflicts between electricity providers and consumers. In the Maldives, electricity service is provided by the state owned companies and private parties. State Electric Company is the biggest company which provides electricity to the inhabited islands of the North Central province which includes the capital Malé. Electricity provision at the rest of the six provinces is done by the respective regional utility companies and private parties.

In the renewable energy sector, the Ministry of Housing, Transport and Environment has the mandate to develop and promote renewable energy technologies (RETs), which include RE resources assessments, energy policy formulation, capacity development, and awareness and to provide the financial and technical support in order to promote and develop RETs in the country.

Hydrocarbon Sector

The State Trading Organization (STO) under MoFT plays an important role in fossil fuel imports to the country such as import of diesel, gasoline, LPG, kerosene and aviation fuel. It is also licensed to re-export the products.

3.6 Nepal

3.6.1 Institutional Framework of the Energy Sector

The various institutions involved in the energy sector of Nepal are discussed below.

Power Sector

The power sector in Nepal is under the jurisdiction of Ministry of Water and Resources (MoWR). Department of Electricity Development (DOED) was formed in 1992 under

MoWR as the electricity development centre. It has three working divisions; Project Study Division (responsible for survey and feasibility study of hydropower projects), Privatization Division (responsible for proposal evaluation, project licensing and promotion) and Inspection Division (responsible for project inspections). Nepal Electricity Authority (NEA) is a government undertaking, responsible for the generation, transmission and distribution of electricity in Nepal. It undertakes system planning studies including demand forecast and generation planning. It is in the process of unbundling its vertically integrated structure to improve operational efficiency.

The Water and Energy Commission (WEC), established to develop water and energy resources in an integrated and accelerated manner, primarily assists Government of Nepal, MoWR and other related agencies in the formulation of policies and planning of projects in the water resources and energy sectors.

Petroleum Sector

The Ministry of Industry, Commerce and Supplies (MoICS) is the legislative body for the exploration and development of fossil fuel resources, as well as for the marketing and distribution of their products. Petroleum Exploration Promotion Project (PEPP) is an independent unit under the Department of Mines and Geology, to promote petroleum exploration activities. PEPP acts as the facilitator in negotiations and grants petroleum agreement to private investors in conformity with the procedural arrangement as defined in the Petroleum Act and Regulations. The Nepal Oil Corporation (NOC) is the public enterprise under the Ministry. It primarily arranges import of petroleum and oil (POL) products and storage and distribution of POL products throughout Nepal.

Coal Sector

Till 1992, Nepal Coal Limited (NCL), a public corporation had the exclusive right for import of coal from India. However NCL was dissolved to encourage private participation. Currently the private sector is engaged in import and distribution of coal throughout the country.

Renewable Energy Sector

The Ministry of Environment, Science and Technology (MoEST) and Alternative Energy Promotion Centre (AEPC) under MoEST are the main entities for promotion and development of RETs. AEPC provides the financial and technical support to local organizations for promoting and developing decentralized rural energy through technology transfer, and research and development activities.

3.6.2 Legal and Regulatory Framework of the Energy Sector

The Government of Nepal (GoN) is responsible for developing the statutory, legal and policy framework for the energy sector. Various acts and regulations constitute the statutory framework, under which public and private energy supply activities take place. With regard to energy trade, GoN lays special emphasis on development of hydropower projects in Nepal as export oriented projects, as reflected in the Hydropower Development Policy in 2001. One of the major objectives of the Policy is to develop

hydropower as an exportable commodity, pursue a strategy of bilateral and regional cooperation. To achieve this objective the government intends to pursue investment friendly and transparent procedures to promote private sector participation in the development of hydropower, taking into consideration internal consumption and export possibility of hydropower. It aims to attract investment from both private sector and governmental sector, as necessary, and through joint ventures. In the process of reforming the power sector, Nepal is bringing new legislation, namely the new Electricity Act and Nepal Electricity Regulatory Commission Act, which are currently tabled in the Parliament.

3.7 Pakistan

3.7.1 Institutional Framework of the Energy Sector

Pakistan has a well defined institutional structure for the energy sector. The country has established regulators for the electricity sector and the oil and gas sector. A brief outline of the institutional structure and role of each entity involved in the energy sector of Pakistan are discussed below.

Power Sector

The Ministry of Water & Power (MoW&P) is primarily responsible for the power sector in Pakistan. National Electric Power Regulating Authority (NEPRA) is the overall regulator of the power sector and provides regulations for power generation, transmission and distribution activities in Pakistan.

Water and Power Development Authority (WAPDA) was responsible for supplying electricity across the entire country, except for the greater metropolis of Karachi, which was the responsibility of the Karachi Electric Supply Corporation (KESC). In 1992, unbundling of the WAPDA power wing began and it was unbundled into four thermal power generation companies, one National Transmission and Dispatch company (NTDC), and nine electricity distribution companies. At present, apart from these entities there are about 28 Independent Power Producers (IPPs) in Pakistan. Pakistan Electric Power Company (PEPCO) manages power sector reforms in the country including restructuring of the power wing of WAPDA.

The first power sector public entity KESC has been handed over to private sector with license for Generation, Transmission and Distribution to the biggest metropolis of the country, Karachi, for involvement of private sector to improve the power sector performance since last three years.

Private Power Infrastructure Board (PPIB) has the mandate to promote private sector investment in Pakistan through a “Single One-Window” facility to investors. PPIB formulates reviews and updates policies and procedures relating to private sector investments in power generation and allied infrastructure. Provincial Private Power (PPP) Cells have been formed in each of the four provinces of Pakistan to promote private investment in the power sector, especially hydro electric plants.

Hydrocarbon Sector

Ministry of Petroleum & Natural Resources (MoP&NR) is responsible for the overall activities of the oil and gas sector. Oil and Gas Regulatory Authority (OGRA), the regulator for the sector, aims to foster competition, increase private investment and ownership in the midstream and downstream petroleum industry, protect the public interest and provide effective and efficient regulations.

Oil and Gas Development Company Limited (OGDCL) is the largest hydrocarbon exploration and production (E&P) company in Pakistan oil and gas sector. Pakistan State Oil (PSO) is the oil market leader in Pakistan and is engaged in importing, storage, distribution and marketing of various POL products, including gasoline, diesel, fuel oil, jet fuel, kerosene, LPG, CNG and petrochemicals. Sui Southern Gas Company Limited (SSGCL) and Sui Northern Gas Pipe Line Company Limited (SNGPL) are the two main companies engaged in gas distribution and transmission.

Coal Sector

Coal is a provincial subject therefore provincial governments are responsible for development of the coal industry in their respective provinces by formulating plans for exploration, development and mining of coal and attracting investment in the sector. For exploitation of the huge coal resources in Thar Coalfield in Sindh on fast track, the Government of Sindh has established Thar Coal and Energy Board (TCEB) chaired by the Chief Minister to act as a one stop organization on behalf of Federal and Provincial Government organizations and departments in the matters relating to development, mining, leasing and attracting investment in the Thar Coalfield.

Renewable Energy Sector

Alternate Energy Development Board (AEDB) looks after alternate sources of power especially wind power. Solar, biomass and other technologies are also promoted through private sector participation.

3.7.2 Legal and Regulatory Framework of Energy Sector

Pakistan has separate regulatory authorities for power and the oil & gas sectors, respectively.

NEPRA aims to develop and pursue a regulatory framework, which ensures provision of safe, reliable, efficient and affordable electric power to consumers, facilitate building of competitive markets in the power sector in an efficiency oriented and market driven environment and maintain a balance between the interests of the consumers, service providers and economic and social policy objectives of the Government of Pakistan.

For the oil and gas sector, OGRA is the regulator. Functions of the regulator include regulating refineries, oil storage, oil pipe lines, oil marketing companies, compressed natural gas (CNG) and liquefied petroleum gas (LPG) supply, natural gas transmission, distribution and sale, including determination of gas tariffs of the companies. Since its

inception OGRA has laid down performance and service standards as part of licence conditions to improve the quality of service to the consumers. A number of regulatory measures have been introduced to ensure the provision of safe, efficient and satisfactory service to the CNG and LPG consumers.

A total of 28 private power projects have materialized with a net capacity of 6707 MW while an additional capacity of about 1800 MW was scheduled in 2008 for induction to the national grid. Apart from this, KESC with power generation capacity of 1948 MW is also being operated by the private sector. Thus 40 % of the country's total power generation is through the private sector.

Pakistan also has a policy to promote renewable energy based power generation in the country by providing various types of incentives to developers. It permits an investor to generate electricity based on renewable energy resources at one location and receive an equivalent amount of electricity for own use elsewhere on the grid at the investor's own cost of generation plus transmission charges (wheeling). It facilitates projects to obtain carbon credits for avoided greenhouse gas emission, helping to improve financial returns and reducing per unit costs for the purchaser.

3.8 Sri Lanka

3.8.1 Institutional Framework of the Energy Sector

The following section discusses the broad institutional framework of the Sri Lankan energy sector. The Ministry of Power and Energy (MPE) and the Ministry of Petroleum and Petroleum Resources Development (MPPRD) are responsible for implementing energy sector policies.

Power Sector

In the power sector, the Ceylon Electricity Board (CEB), under MPE, is the owner and operator of the national electricity grid. It owns all large hydropower stations and about 50% of the thermal power generation capacity in Sri Lanka. Rest of the thermal based power generation is owned by private players. CEB is the main agency dealing with its counterparts in India in any technical collaboration required for the proposed India-Sri Lanka electricity grid interconnection.

On the distribution side, CEB caters to about 85% of the consumers connected to the national grid and Lanka Electricity Company (LECO), under MPE, supplies electricity to about 15% of the consumers mainly in urban and sub-urban areas.

Private sector involvement in thermal power generation has been steadily increasing since the mid 1990s when the first independent power producer entered the supply industry.

Hydrocarbon Sector

State owned Ceylon Petroleum Corporation (CPC), under MPPRD, is the only player in the petroleum refining business. All crude oil imports in the country are handled by it. For the import of finished petroleum products, CPC competes with the privately owned Lanka IOC (a subsidiary of Indian Oil Corporation). Import and distribution of Liquefied Petroleum Gas (LPG) is completely owned by the private sector, with CPC contributing about 15% of the total LPG supply through its own refinery output.

Renewable Energy

Sri Lanka has recently established Sustainable Energy Authority to coordinate the development of the renewable energy sector and take forward initiatives on energy efficiency. Government is providing financial incentives to small scale (less than 10MW) electricity generation facilities using renewable energy sources such as small-hydropower, wind and biomass. There are many professional non-governmental organisations promoting renewable energy use, such as the Sri Lanka Energy Managers Association (SLEMA), Energy Forum and Bio-energy Association.

3.8.2 Regulatory and Policy Framework of Energy Sector

The government has developed a ten year development framework for the period 2006-2016 in line with the broad policy of the government. One of the features of the development framework is the diversification of fuel in such a manner that 90% of electricity generation is from the non oil resources. The overall strategy to address this issue is to build coal-fired power plants, and large/medium hydroelectric power plants with involvement of the private sector. Also, the target of 10% of grid energy to be supplied from renewable energy sources by 2015 is being set. The development framework also provides for the increase in investment in transmission and distribution network expansion to ensure the stipulated quality and reliability of electricity supply. Other relevant provisions of the Energy Policy include:

- (i) Ensuring energy security through diversification of fuel in electricity generation and transport sector and promotion of regional cooperation in the energy sector by establishing cross-border energy transfer links with neighbouring countries.
- (ii) Provision of basic electricity requirements of people through grid-extension or off-grid systems at competitive prices.
- (iii) Appropriate pricing policy adoption by the regulatory agency. Cost reflective pricing policy for all commercial energy products including a reasonable rate of return on equity.
- (iv) Provision of necessary incentives for increased usage of non conventional renewable energy sources.
- (v) Encouraging supply side and end-use energy efficiency through financial and other incentives/disincentives.

- (vi) Enhancing energy sector management capacity through appropriate training, empowerment and delegation of authority to develop integrated long term energy plans and conduct policy analyses in the energy sector.
- (vii) Reforming and restructuring of energy industry to accommodate public private partnership in the development process.

A multi-sector regulatory body, Public Utilities Commission of Sri Lanka (PUCSL) has been established as an independent regulator for the electricity and downstream petroleum industries. Regulations for the electricity and the petroleum sector are in the process of being finalized.

3.9 Conclusions

There is a wide diversity in the institutional, legal and regulatory frameworks across the SAARC Member States. On one hand Afghanistan is still at a nascent stage of developing these frameworks and would require hand holding from the Member States to develop relevant frameworks, on the other, India and Pakistan have well developed frameworks.

There is a difference in the institutional structure across member states. In select member states energy falls under the purview of a single ministry, alternatively there are multiple ministries handling energy related and energy sub-sector-wise issues. These differences add complexity to regional energy trade as it is difficult to draw one to one relationships across ministries and across member states.

Differences also exist in structure and mandate of the regulators. Their roles range from multi sector regulation, overall energy sector regulation, to energy sub-sector-wise regulation. Another difference is in terms of pace of reforms in respective Member States for instance in unbundling of energy utilities. This is an important aspect as unbundling of utilities creates an enabling environment for promoting regional energy trade. **Table 3.1** summarizes briefly the key aspects of the legal and regulatory frameworks that in the region.

Table 3.1: Summary of Legal Regulatory Frameworks in SAARC Member States

Country	Unbundling of utilities	Energy Regulator	Private sector participation in energy sector	Provisions for promoting regional energy trade
Afghanistan	No	No	No policy promoting Private sector participation, but has been included in the energy strategy	Regional energy trade has been recognized as an option for increasing energy availability.
Bangladesh	Yes	Yes – one common energy regulator for downstream oil and gas sector and electricity sector- Bangladesh Energy Regulatory Commission (BERC). Oil & Gas Upstream Regulator – Energy and Mineral Resources Division (EMRD), Ministry of Power, Energy and Mineral Resources.	Policy in place. Private sector participation already there in upstream oil and gas sector and electricity sector	Regional energy trade recognized as an option for increasing energy availability
Bhutan	Yes. Partially unbundled.	Yes. Bhutan Electricity Authority (BEA) is responsible for electricity and the petroleum sector is regulated by the Department of Trade.	PSP encouraged in the energy sector especially in hydro power generation	No particular mention to regional energy trade in the policy, however, regulations in place for promoting open access
India	Yes	Yes – Energy sub-sector-wise regulator <ul style="list-style-type: none"> ▪ Electricity regulator – Central and State regulator ▪ Oil and gas – Central regulator 	Private sector present in most sections of the energy value chain	No particular provision in the Indian legislative framework, however, regulations for open access and third party access in place
Maldives	Yes	Yes – Maldives Energy Authority	Limited private sector participation in the energy sector	No particular mention of regional energy trade in the legislations and regulations
Nepal	Yes, after the new Legislations come into effect.	In the process of establishing NERC.	Private sector participation in electricity generation.	Hydro Policy 2001 recognizes scope of regional energy trade (bilateral and multilateral) to harness the hydro potential in the country
Pakistan	Yes	Yes – Energy Sub-sector-wise regulator <ul style="list-style-type: none"> ▪ Electricity sector – NEPRA ▪ Oil and gas sector – OGRA 	Private sector participation allowed in the electricity sector	The Government of Pakistan recognizes scope of regional energy trade and is actively engaged with Iran and CARs for cross border electricity trade.
Sri Lanka	No	Yes, but a non-energy, multi sector regulator- PUSCL	Private sector participation already exists in petroleum distribution and in electricity generation	Regional energy trade recognized as a measure for enhancing energy security

Notwithstanding the differences that exist in these frameworks across the member states, all Member States are making efforts at increasing private sector participation in the energy sector. This is especially relevant in wake of the huge investment requirements highlighted in the previous chapter. This creates an opportunity for the region to work together and create an enabling environment for promoting regional energy trade. The pace of reforms may differ across the region; however, efforts need to be made to harmonize these differing legal and regulatory frameworks. Harmonization of these frameworks is essential as is discussed in the international best practices.

Given that regional energy trade is a long term commitment, SAARC Member States may consider in the long term setting up an independent regulator for promoting regional energy trade only. The mandate of the regulator to ensure smooth functioning of contracts, developing short term/spot energy markets, grid (electricity, oil and gas) operations, price setting (wheeling charges) etc. Setting up of an independent regulator would be possible once regional energy trade reaches a critical mass. While regulations and policies for the independent regulator need to be made, care would have to be taken that its mandate does not clash with the mandate of the member state specific regulator.

Chapter 4: Prospects of Energy Imports from Central Asian Republics, Iran and Myanmar

The situation of the energy sector development, energy availability and the need for energy imports by the SMS from the neighbouring regions has been discussed in the previous chapters. In order to put in to context, the possibilities of energy imports by SMS from the neighbouring regions/countries, this chapter briefly discusses the situation of the energy sector and energy export potential of Central Asian Republics, Iran and Myanmar, which are in the vicinity of South Asia and the nearest potential energy exporters to South Asia.

4.1 Energy Situation in the CARs

The Central Asian Republics (CARs) viz. Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan are one of the energy resource rich regions of the world with plenty of hydropower potential and hydrocarbon resources. As in any other part of the world, these energy resources are not evenly distributed. While Kazakhstan is very rich in oil, gas and coal; Uzbekistan is rich in gas, coal and has some oil reserves. Turkmenistan is rich in gas and has some oil. Kyrgyzstan and Tajikistan are primarily endowed with plenty of hydropower potential with insignificant gas or oil reserves (see Table 1.1). Despite being energy rich countries, their economic growth rates have been lagging far behind the economic development indicators of the neighbouring regions, such as, South Asia.

The elasticity of demand for electricity consumption has a direct co-relation to GDP growth rate of a nation. For developing economies this ratio is around 1:1.2. That is, for every percentage point increase in the GDP, the demand for electricity increases by 1.2 times. In order to have a long-term perspective about the energy needs of the CAR countries it is essential to know the Gross Domestic Product projections these countries have set for themselves for the foreseeable future. The GDP growth rates prevailing in the year 2004 and for the future, of the four CAR countries are given in **Table 4.1** given below:

Table 4.1: Gross Domestic Product Growth Rates of the Four CARs

Country	Data Source	GDP growth rates (per unit)			
		2004	2005	2006	2007-2025
Kazakhstan	2004-2006:SIMA,IMF 2007-2025:Estimate	0.072	0.07	0.075	0.04
Kyrgyzstan	2004-2006:SIMA,IMF 2007-2025:Estimate	0.041	0.045	0.051	0.03
Tajikistan	2004-2006:SIMA,IMF 2007-2025:Estimate	0.153	0.066	0.067	0.03
Uzbekistan	2004-2006:SIMA,IMF 2007-2025:Estimate	0.04	0.04	0.04	0.025

Source: World Bank study titled “Central Asian Regional Electricity Export Potential”, 2004

During the Soviet Union era of central planning, the natural resources were developed and allocated as

per national requirement. The hydropower resources in the Kyrgyz Republic and Tajikistan were operated primarily in an irrigation mode, with power generation being a secondary objective. As a result energy was exchanged regionally among the various republics. After the break-up of the Soviet Union the energy exchanges turned into energy trade among these countries. Physical and financial resource constraints have limited further exploitation of energy resources on a large scale. Moreover, the individual national interests have now prevented these countries from deploying the resources to meet the regional demand. Instead each country is now focusing on securing its own energy supplies.

Easier transportation of fossil fuels has enabled the fossil fuel resource rich countries to leverage their energy resources into a significant volume of energy exports even to markets outside Central Asia. Kyrgyzstan and Tajikistan the two hydropower rich countries continue to face electricity shortages during the winter and their attempts to export their summer hydropower surpluses are constrained by the access limitations to the markets outside the CARs. Changes in the political climate in Afghanistan and the increasing demand for electricity in Pakistan, India and other neighbouring SMS provide an excellent opportunity for these countries to explore options for export of their hydropower.

4.1.1 Installed Capacity

It may be pertinent to state here that though a part of the CARs power grid till 2003, Turkmenistan is operating independent of CAR power system and is interconnected with the Iranian power grid. As such, the power sector review for the purpose of this study does not cover Turkmenistan. The installed electricity generation capacities and supply/demand balances for the year 2002 of the CAR countries are given in **Table 4.2** below.

Table 4.2: Installed Capacity and Supply/Demand Balances of CARs in 2002

Item	Kyrgyzstan	Tajikistan	Uzbekistan	Kazakhstan	Total
Installed Capacity Hydro(MW)	2,950	4,059	1,710	2,000	10,719
Installed Capacity Thermal(MW)	763	346	9,870	16,240	27,219
Installed Capacity Total(MW)	3,713	4,405	11,580	18,240	37,938
Available Capacity(MW)	About 3,100	3,428	7,800	13,840	25,068
Peak Demand(MW)	2,687	2,901	7,925	9,432	
Generation Hydro(GWh)	10,778	15,086	7,278	8,861	42,003
Generation Thermal (GWh)	1,115	138	42,021	49,317	92,591
Generation Total(GWh)	11,893	15,224	49,299	58,178	134,594
Exports(GWh)	1,216	266	634	595	2,711
Imports(GWh)	430	1,058	609	464	2,561
Gross supply to Domestic Market(GWh)	11,107	16,016	49,274	58,048	134,445
Domestic Billed Consumption Annual(GWh)	6,836	12,988	38,112	40,053	97,989

Source: World Bank study titled "Central Asian Regional Electricity Export Potential", 2004

Given the resource scenario of the four CAR countries, Tajikistan and Kyrgyzstan can export hydropower, while Kazakhstan and Uzbekistan can export power from their thermal power plants. Moreover, there is a large scope for increasing the power generation within CARs through rehabilitation and up-gradation of the existing power plants and completion of the incomplete/languishing projects that have not been completed due to resource constraints after the collapse of the Soviet Union. Equally important would be the rehabilitation, augmentation and construction of new transmission interconnections to wheel the additional generation to the load centres within the CARs and to South Asia.

4.1.2 Demand Forecast

The country wise gross electricity demand projections, in GWh, for the period 2005-2025 of the CAR countries are given in **Tables 4.3** below:

Table 4.3: Gross Electricity Demand Projections, in GWh, 2005-2025

Country	Actual	Demand Forecast (GWh)				Annual Growth rates			
	2003	2010	2015	2020	2025	2003-2010	2003-2015	2003-2020	2003-2025
Kazakhstan	58,944	72,056	84,034	98,367	115,146	2.91%	3.00%	3.06%	3.09%
Kyrgyzstan	12,145	9,222	10,033	11,296	12,719	-3.86%	-1.58%	-0.43%	0.21%
Tajikistan	16,348	11,267	12,410	13,972	15,731	-5.18%	-2.27%	-0.92%	-0.17%
Uzbekistan	48,691	46,597	51,255	56,589	62,479	-0.63%	0.43%	0.89%	1.14%
Total	136,128	139,142	157,731	180,225	206,075	0.31%	1.24%	1.66%	1.90%

Source: World Bank study titled “Central Asian Regional Electricity Export Potential”, 2004

The export potential of the CARs has been worked on the basis of their generation capacity addition programmes, consumption patterns and transmission and distribution losses that the power systems suffer. The surplus electricity available for trade in each of the four CARs is given in **Table 4.4** below:

Table 4.4: Surplus Electricity Available for Trade (GWh)

Country	Season	2005	2010	2015	2020	2025
Kazakhstan	Summer	3198	3623	6876	3745	-234
	Winter	-2504	-2969	-130	-5563	-12318
	Annual	694	654	6746	-1818	-12552
Kyrgyzstan	Summer	4737	6283	6863	6406	5991
	Winter	-2092	1584	1517	5761	4753
	Annual	2645	7866	8381	12167	10744
Tajikistan	Summer	1511	4587	6767	12579	11697
	Winter	96	2841	4287	8308	7431
	Annual	1607	7429	11055	20887	19128
Uzbekistan	Summer	1620	3904	7635	5088	2091
	Winter	2862	5485	9846	7058	3767
	Annual	4482	9389	17481	12147	5858
Total	Summer	11066	18396	28142	27819	19545
	Winter	-1637	6942	15521	15564	3633
	Annual	9429	25338	43663	43383	23178

Source: World Bank study titled “Central Asian Regional Electricity Export Potential”, 2004

4.1.3 Electricity Tariffs

Two important factors that will determine the potential of power exports from CARs to the SMS are: i) the quantum of surplus power available with the CARs for export, and ii) the price at which they can offer the supply. The quantum of surplus power available has been identified in **Table 4.4** above. The actual tariff at the bus-bar to enable the utility to fully recover its cost, plus a reasonable profit margin would normally be the highest price required to be paid by the power importing country. However, the power exporting country would use generation cost from the most expensive generation facility as the price to negotiate the tariff for power exports. A look at the retail tariffs and the actual cost of supply will be a good indicator to get an idea about the possible range of tariff at which CARs could export their surplus power. The electricity tariffs and the actual cost of supply within the CARs in the year 2003 are given in **Table 4.5** below:

Table 4.5: Electricity Tariffs in the CARs in 2003

Item	Kyrgyzstan	Tajikistan	Uzbekistan	Kazakhstan
Average tariff(cents/kWh)	1.4	0.5	2.15	2.64
Cost recovery level of tariff (cents/kWh)	2.3	2.1	3.5	2.8
Current Tariff as% of Cost Recovery Tariff	61%	24%	61%	94%

Source: World Bank study titled “Central Asian Regional Electricity Export Potential”, 2004

To further evaluate the viability of power imports by some of the SMS from the CARs, it would be of interest to have a comparison of marginal cost in the export market with import costs from CARs. This comparison in respect of Afghanistan and Pakistan, the two SMS that have already entered in to a MOU with Kyrgyz Republic and Tajikistan for the inter-regional Central Asia South Asia – 1000 Power Transmission Project; is given in **Table 4.6** below:

Table: 4.6 Comparison of Marginal Cost in the Export Market with 2003 Import Cost from CARs (US Cents/kWh)

Target Market	Marginal generation cost in Target Market	Generation options in CARs	Cost of Supply from CARs
Afghanistan	>10	Sangtuda-I, Rogun-I, Talimardjan I & II	2.26 to 3.43
Pakistan	5.6	Sangtuda-I, Rogun-I, Talimardjan I & II and Kambarata II	2.26 to 3.75

Source: World Bank study titled “Central Asian Regional Electricity Export Potential”, 2004

The marginal cost of generation in the target SMS markets is likely to be higher than the landed cost of supply from CARs. As such, SMS would benefit from power trade with the CARs. CARs need to expedite completion of their partly complete power projects with export orientation.

4.1.4 Potential of CARs Electricity Exporters to SMS

The two potential power exporters from the CARs to South Asia are Tajikistan and Kyrgyz Republic with hydropower potential of 40,000 MW (developed: 4000 MW) and 26,000 MW (developed: 3000 MW) respectively. The surplus electricity available with these two countries by 2015 with the addition of proposed thermal and hydropower plant would be of the order of 11,055 and 8381 GWh annually, which if imported into South Asia could bridge the demand-supply gap to a large extent. Since these two countries have modest reserves of other forms of energy they could be hydropower exporters to South Asia.

It is pertinent to state here that these two countries have already initiated the process of power export to Afghanistan and Pakistan through the CASA 1000 project. The special purpose vehicle for the implementation of the project has been put in place with its Headquarters in Kabul. The project is being supported by the World Bank.

Uzbekistan's has a hydropower potential of 15,000 MW, out of which only 1710 MW has been developed thus far, but due to its rich hydrocarbon base, it still has a surplus electricity which can be exported to South Asia. But bottlenecks in the grid capacity within Uzbekistan, which limit interregional power transfers within the country, shall have to be removed by strengthening the national grid, before any progress can be made in this direction.

4.1.5 Opportunities for Hydrocarbon/Gas Export from CARs to South Asia

Kazakhstan has oil reserves of 29 billion bbl (production: 1.3 million bbl/day), gas reserves of 65 to 70 tcf (production: 0.570 tcf/yr); coal reserves of 37.5 billion tons (production: 95 million tons) and hydropower potential of 20,000 MW (developed: 2000 MW). With such a large resource base, Kazakhstan can export energy in various forms to the SMS.

Uzbekistan with oil reserves of 594 million bbl (production of 150,000 bbl/day), gas reserves of 66.2 tcf (production: 2.07 tcf/year) and coal reserves of 4 billion tons (production: 2.8 million tons/year) can export gas and coal to SMS.

Turkmenistan with oil reserves of 546 million bbl (production: 260,000 bbl/day) and gas reserves: 71 tcf (production: 2.1 tcf/year) has the potential to export only gas, as its resource base with regard to other forms of energy is relatively modest.

As stated above, Kyrgyzstan and Tajikistan having modest hydrocarbon reserves, can be potential exporters of only hydropower.

The only initiative on hydrocarbon exports from CARs to SMS so far has been the Turkmenistan-Afghanistan-Pakistan-India (TAPI) gas pipeline. Since inter-regional gas pipeline projects entail very large investments, such projects are undertaken only after full scrutiny of the reserve and production data. The re-certification of the gas reserves now renews the hope for the establishment of this gas pipeline project. A brief synopsis of this pipeline project is given at Annexure-5 to this report.

4.2 Opportunities for Oil, Gas and Electricity Imports by SMS from Iran

From the energy perspective Iran is one of the richest countries, having very large reserves of oil, gas and hydropower potential. With oil reserves: 132.5 billion bbl (production: 4.2 million bbl/day); gas reserves: 971 tcf (production: 3.5 tcf/year) and hydropower potential: 42,000 MW (developed: 2000 MW). Iran has the potential of being the largest energy export partner for the SMS. The added advantage is that the terrain between Iran and South Asia is much smoother than that between the CARs and South Asia. In the case of CARs the terrain is extremely rugged and mountainous. Building of energy infrastructure between Iran and South Asia will be much cheaper and faster than that required for the CARs-South Asia energy linkages.

The tripartite discussions between Iran, Pakistan and India for construction of the Iran-Pakistan-India gas pipeline have made considerable progress. There is also good potential for importing oil from Iran through an oil pipeline.. Power transmission interconnection from Iran to South Asian neighbours is another major opportunity for enhancing energy trade between Iran and SMS.

Afghanistan and Pakistan are the two SMS that have energy linkages with Iran. Afghanistan is importing a small quantity of power from Iran to meet the demand in the bordering towns. Pakistan is importing 39 MW of electricity from Iran to meet the demand in its Western province of Balochistan. It intends to increase the quantum of power imports from Iran to 1100 MW to meet the demand of the port city Gwadar and other parts of Balochistan province by connecting with the national grid.

Iran with its large hydropower and gas reserves has the option of not only exporting natural gas and oil to the SMS, but it can also establish large gas based power plants near the gas fields and also develop hydropower projects for dedicated power export to the SMS. The Iranian power grid operates synchronously with the power grid of Turkmenistan. This also provides the opportunity for Turkmenistan to export power through the Iranian grid to the SMS. These two countries could jointly help in meeting the natural gas as well electricity demand of the SMS.

4.3 Opportunities for Oil, Gas and Electricity Imports by SMS from Myanmar

With oil reserves of 3.2 billion bbl (production: about 8 million bbl /year), confirmed gas reserves: 18 tcf and probable gas reserves: 89.7 tcf (production: about 400 bcf /year) and hydropower potential of 39,720 MW (developed: 747 MW), Myanmar is another energy resource rich country in the vicinity of South Asia. Hydropower projects with an installed capacity 10,398 MW are reported to be under construction. Out of these, nine projects with an installed capacity of 916 MW are complete and four projects with an installed capacity of 1,172 MW are expected to be completed by 2010, and the rest are expected to be commissioned by 2021. This provides an opportunity for the SMS to import both, electricity as well as gas from Myanmar. However, one of the limiting factors for electricity imports may be that several of the hydropower projects are being developed as

joint venture projects and the foreign partners might want to wheel the electricity from such projects to their own countries.

India is also developing the Tamanti multipurpose project, close to the India-Myanmar border with an installed capacity of 1200 MW in the first stage and 400 MW and 700 MW in the second and third stage. Most of the electricity generated from this project is meant for export to India.

Myanmar has invited substantial foreign direct investment for the exploration and development of oil and gas fields. Indian energy companies from both, public as well as private sector have taken equity stakes for the development of gas and oil fields of Myanmar. Sun group of companies with a Russian consortium has taken stake for the development of B-8 block. ONGC Videsh Limited and Gas Authority of India Limited (GAIL) have nearly 30% equity stake in the A-1 and A-3 blocks with reserves of the order of 5.43 tcf of gas, off the coast of Myanmar.

In 2007, India was planning to bring its equity gas from the A-1/A-3 blocks through a pipeline passing through Bangladesh. The pipeline section within Bangladesh would have been 180 miles. Furthering this project needs a mutually beneficial agreement on the use of the right of way within Bangladesh. The gas transit fee alone could be in the range of US\$125 million per year. However, Myanmar Government has taken a decision to export gas to China from blocks A-1/A-3.

4.4 Diversification of the Energy Basket of SMS

The SMS have to recognize that their energy needs are not going to be met exclusively from indigenous resources. They will have to adopt a multi-pronged strategy, of developing their in-country as well as the regional resources and import energy from neighbouring regions to ensure and enhance energy security. As discussed in the earlier chapters the reliance on a single fuel for electricity generation in several of the SMS makes them vulnerable both from supply and availability perspective as well as from the pricing aspect. Diversification of their energy baskets has to be a priority of almost all the SMS, if they want to enhance their energy security, given the adverse impacts of non-availability of energy on economic growth.

Before one embarks on to suggest specific intra and inter-regional energy trade and energy cooperation initiatives with the neighbouring countries, SMS may want to learn from experiences in other parts of the world that have successfully demonstrated the benefits of energy cooperation. An overview of international experience and best practices in the area of energy cooperation is given in Chapter 5.

Chapter-5: Review of International Experience and Best Practices

Regional energy trade is being pursued by a number of regions across the world, wherein the constituent countries collaborate and cooperate to take advantage of each other's strength and meet their energy requirements in a sustainable manner. This chapter discusses in detail, some of the best practices in regional trade across the globe, so as to draw lessons for the SAARC region. The best practices discussed include:

- (i) **Greater Mekong Sub-Region (GMS)** – This region has been selected, as it is similar to the SAARC region. GMS has been studied from the point of view to understand the institutional set up required with which the region has progressed with power system interconnection to ensure involvement of all countries.
- (ii) **Nordic pool:** The Nordic pool is a good example to study to understand the policy/ regulatory interventions planned to develop an integrated electricity market in the region.
- (iii) **South African Power Pool (SAPP)** – While discussing the experience of development of electricity pool markets across the world, this chapter also discusses the experience of the South African Power Pool (SAPP).

Along with the above- mentioned best practices in regional cooperation, the chapter also discusses some of the recent developments/initiatives that are being undertaken across the globe to promote regional trade. These initiatives are a) development of a joint LNG terminal in Baja California, Mexico b) proposal for setting up joint strategic refineries in the African region.

5.1 Building Institutional Framework for Promoting Regional Energy Trade: Case of Greater Mekong Sub-region

In 1992, an important development that took place in South Asia, was the establishment of the hexagonal growth area comprising six countries along side the Mekong River namely, Thailand, Myanmar, Cambodia, Laos, Vietnam and the southern Chinese province of Yunnan. This region is better known as Greater Mekong Sub region (GMS).

One of the drivers for formation of GMS was the similarities that existed across these six countries. Following are the similarities, which fostered cooperation among the countries:

- All of the GMS countries, except Thailand, were in transition from highly centralised, planned economies to more market-oriented, open economies.
- These countries are resource-rich countries, and there exists a high degree of complementarity between their resource endowments.

- Even prior to the GMS initiative there was bilateral trade among the countries in the sub-region, for example there was trade between China and Thailand, Vietnam and Thailand, and Myanmar and Thailand. However, this trade was limited due to the poor state of infrastructure.
- The sub-region suffered from a severe lack of investible capital which had to come, in a significant part, from outside sources. Private investors were expected to invest in the sub-region if all countries coordinated their efforts to improve the returns on investment.
- There was common cultural heritage among the countries of GMS. For example, Thailand has a long historical relationship with Laos and shares some common language roots with the ethnic groups of Yunnan Province.

Along with these similarities, individual countries had specific reasons for coming together. These individual drivers helped the region to work together. **Table 5.1** lists these individual reasons for the countries to join hands.

Table 5.1: Individual Drivers for Each Country to Join GMS

<u>Country</u>	<u>Reason</u>
Cambodia	<ul style="list-style-type: none"> • Willingness to improve linkages with countries for development of infrastructure and human resources
Chinese Province of Yunann	<ul style="list-style-type: none"> • Aim to expand trade by opening up route to Thailand • Aim to get connected to Malaysia, Singapore through Thailand
Loas	<ul style="list-style-type: none"> • Aim to improve relationship with Thailand
Myanmar	<ul style="list-style-type: none"> • Keen to access benefits of cooperation
Thailand	<ul style="list-style-type: none"> • Opportunity to expand trade and investment • Aim to acquire production inputs and to remove artificial barriers through policy adjustments
Vietnam	<ul style="list-style-type: none"> • Liberalize foreign trade and foreign investment promotion

Source: Author's Compilation

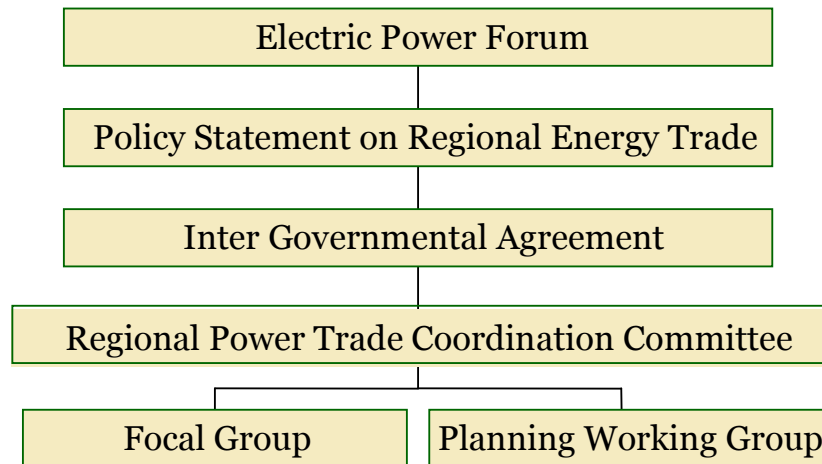
Ever since the formation of the region, the countries of GMS have embarked upon a programme of economic cooperation, called the GMS Programme. The objective of the programme is to promote development within the region through closer economic linkages. The GMS Programme aimed at implementation of projects in high priority sectors such as transport, energy, telecommunications, environment, human resource development, tourism, trade, private sector investment, and agriculture.

The GMS programme stressed on power interconnections among the countries to improve reliable power supply, enhance consumer access to power and reduce operational cost and investments in power reserves to meet peak demand. The rest of the section on GMS discusses the institutional mechanism that was adopted in the region to promote interconnections and power trade.

5.1.1 Institutional Framework

Understanding the institutional structure and thus drawing lessons are important for the SAARC region in promoting regional trade. **Figure 5.1** describes the institutional framework adopted by the GMS for initiating power trade in the region.

Figure 5.1: Institutional Framework of Power Interconnection among GMS



The GMS Economic Cooperation Programme was initiated under which, the Electric Power Forum (EPF) was set up to serve as an advisory body on sub-regional power projects and issues. The EPF reported to the Ministerial Conference and the respective governments on treaties or protocols²². EPF had the following objectives:

- Act as a cooperative link among government agencies and institutions such as power utilities that are directly involved in power supply and power system development.
- Act as a promotional and advisory organization for the development of efficient electric power systems.
- Identify and promote opportunities for mutually beneficial power projects.
- Promote financing of such projects by the governments, power utilities, donor agencies and the private sector.
- Provide and disseminate information to participating countries, and communicate and cooperate with regional and international organizations involved in the energy sector.
- Facilitate training and other human resource development initiatives.

Each GMS country was represented by two persons in the EPF core group; one senior official from the government organization dealing with policy and planning in the power sector and one senior official of a key power utility. EPF prepared a ‘Policy Statement

²² According to the IGA, the Experts’ Group on Power Interconnection and Trade (EGP), which is a group of experts drawn from the utilities and GMS member government and constituted by the EPF in 1998, was to prepare a protocol on regional power trade for adoption by the EPF and endorsement at GMS Ministerial Meeting. The protocol is to reflect foreseen trading environment and it is expected that subsidiary formal bodies may be constituted as trade develops in order to deal with technical and non-technical matters relating to power trade. (Source: Inter Governmental Agreement on Regional Power Trade in the Greater Mekong Region)

for Regional Cooperation in Power Trade' which was signed by member countries in 1999. The key objectives of the policy were to:

- Promote efficient development of the power sector in the GMS.
- Promote opportunities for extension of economic cooperation between Members in the field of energy.
- Facilitate the implementation of priority power projects.
- Address technical, economic, financial and institutional issues relevant to GMS power development.
- Protect and improve the environment through the adoption of appropriate technologies and plans.

The Policy Statement also required the government of each of the member countries to sign an Inter Governmental Agreement (IGA). The IGA provided a framework to implement the Policy Statement. The IGA put forth the principles of electricity trade that enabled the member countries to:²³

- Coordinate and cooperate in the planning and operation of their systems to minimize costs while maintaining satisfactory reliability.
- Fully recover their costs and share equitably in the resulting benefits, including reductions in required generation and transmission capacity, reduction in fuel costs and improved use of low cost electricity sources.
- Provide reliable and economic power services to the customers of each party.

Under the IGA, the Regional Power Trading Coordination Committee (RPTCC) was formed to actively coordinate implementation of regional trade. The mandate of RPTCC included:

- Preparation of a Regional Power Trade Operating Agreement specifying the rules of regional power trade
- Recommending policies for the overall and day to day management of regional power trade
- Establishing short, medium and long term initiatives which need to be pursued on a priority basis in order to achieve the objectives of regional power trade within a specified timetable.
- Identifying necessary steps for implementation of regional trade, including means for financing.

A Memorandum of Understanding (MoU) was signed for implementation of the Regional Power Trading Operating Agreement. Two subgroups were formed - Focal Group and Planning Working Group for implementing the agreement.

Focal Group had a middle level official representative from each country. Each member country was associated with planning and operation of regional power interconnections. The group implemented RPTCC's decision on a day to day basis in each individual country and reported to the RPTCC.

²³ Inter-Governmental Agreement on Regional Power Interconnection and Trade in the GMS or the IGA
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The Planning Working Group has representation from a senior level official from each country's TSO (Transmission System Operator) with a responsibility for national transmission planning. It prepared plans for augmenting the capacity of existing cross border transmission facilities and facilitating cross border power trading. This group also developed performance standards regarding safety, security reliability and quality of services and created and maintained the regional data base on power trading.

Power trade in GMS has been developed according to the Regional Indicative Master Plan on Power Interconnection.

The master plan identifies various projects for development of the power grid. These projects are either bilateral or multi lateral in nature. Following is an indicative list of the projects planned that are currently underway:

- 500 kV power transmission line from Ban Sok (Lao) to Pleiku (Vietnam)
- 115-kV single circuit (SC) line from Thailand to supply isolated load centres in Western Cambodia which are currently supplied by diesel units
- 230-kV SC line to transfer power from Nam Mo hydropower in Lao PDR to Northern Viet Nam
- 230-kV line along Malutang in Yunnan to Soc Son in Viet Nam
- Power Transmission lines between PRC, Lao and Thailand

The member countries of GMS are deeply committed to the cooperation programme. This is highlighted in the Joint Summit Declaration of the Third GMS Summit²⁴ which states:

Quote

In energy, we are in the process of building new power generation and transmission facilities and broadening cooperation to other energy sub-sectors, and have laid down the foundations for future sub-regional power trade and energy market.

Unquote

5.1.2 Learning from the GMS Model

The GMS model is a good case study to look at the institutional mechanism and planning that was adopted to promote power trade. **Box 5.1** discusses some of the key learning for the SAARC region from the GMS experience.

²⁴ Third GMS Summit Vientiane, Lao People's Democratic Republic 30-31 March 2008 titled "Enhancing Competitiveness Through Greater Connectivity"

Box 5.1: Learning from GMS model

Commonalities exist between the structure of GMS and SAARC region. Similar to the GMS, SAARC Member States are reasonably well resource endowed nations with a high degree of complementarity. Second, before regional trade was initiated in the region, there already existed bilateral trade contracts. Third, the SAARC region too needs to mobilize greater private sector participation. And finally, all countries in the region are closely linked to each other culturally. Given these similarities that exist between the two regions, there are a number of lessons that can be drawn from GMS for the SAARC region in terms of development of institutional mechanisms for greater cooperation and trade in electricity. These are listed below:

- *Need for an intergovernmental agreement:* The starting point for regional cooperation in GMS was the IGA, which provided the guideline for developing the frameworks for implementing policy statements for promoting regional trade. The Member States of the SAARC region also need to come together and sign an intergovernmental agreement committing to regional trade.
- *Involvement of technical personnel at all levels:* Under the GMS a number of working groups and forums were established. In each body there was representation of both government and utility. Further, even from the utility there was involvement of both senior level personnel (for planning) and middle level personnel (for implementation). Such an approach is useful in ensuring that the plans made at the policy level are such that they can be implemented. Also, it ensures that the planning is not faulty and is technically sound.
- *Clarity on policy framework to be adopted:* Efforts were made since inception of GMS to develop a clear and transparent policy framework promoting regional electricity trade. This helped the members to understand the concept of regional electricity trade so as to plan their internal policies and reforms that would support regional trade.

5.2 Developing a Power Exchange: Case of Nordic Pool

One of the most often discussed regional energy trade models is the Nordic power exchange. It has been considered as a best practice in sub- regional TSO cooperation.²⁵

It is important to study the Nord Pool, as it is the world's first international electricity commodity exchange, which has been successfully in operation for more than a decade. A power exchange is a market clearing platform, where participants trade any form of contracts for delivery or receipt of power or trade in any instrument derived from an underlying power contract. The Nordic power exchange or the Nord Pool was established in 1996 for the exchange of electricity among the four Scandinavian countries i.e. Finland, Sweden, Norway and Denmark. Nord Pool organizes trade in two separate markets –a physical market called Elspot and a financial contracts market called Etermin.

²⁵ Building Regional Power Pools: A Toolkit, World Bank
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5.2.1 Formation of the Nordic Pool

The Nord Pool reached its current structure in a phased manner. There were a number of factors that contributed and created incentives for the four Scandinavian countries to come together:



- Even before development of the regional market, informal trading arrangements existed among these countries. This laid the foundation for development of the Nord Pool. Also, it ensured that some amount of transmission inter-linkages pre existed before initiation of power trade. For instance transmission lines from Northern Finland-Northern Sweden (1959), Sweden – Norway (1964), Sweden – Denmark (1965) were already in operation before setting up of the Nord Pool.
- A driver for the power pool was the significantly different power generation mix each country had. Norway had completely hydro based power generation, whereas Denmark had all thermal based power generation. Sweden and Finland had a mix of hydro, nuclear and thermal based power generation. **Table 5.2** indicates the mix of power generation in Nordic Countries. The countries thus decided to cooperate among themselves to realize benefits of difference in generation mix and improve security of energy supply.

Table 5.2: Power Generation Mix in Nordic Countries (2003)

Countries	Power Generation Mix
Norway 26,631 MW	100.00% - Hydro
Sweden 32,461 MW	40.50% - Hydro 49.50%- Nuclear 10.00%- Thermal
Finland 16,569 MW	11.25% - Hydro 61.25 %- Thermal 27.50% - Nuclear
Denmark 13,335 MW	86.36%- Thermal 13.64% - Wind

Source: Carlsson L ‘International Power Trade— the Nordic Power Pool

As mentioned earlier, development of the Nord Pool happened in a phased manner. **Table 5.3** summarizes events that instigated countries to come together to form a Nord Pool.

Table 5.3: Events Leading to Formation of the Nord Pool

Year	Activities
1990	<ul style="list-style-type: none"> Norway Electricity Act was passed *
1993	<ul style="list-style-type: none"> Norwegian power exchange Statnett Market AS was formed
1995	<ul style="list-style-type: none"> Louisiana declaration by Nordic Council of Ministers regarding development of a free and open market with efficient trade with neighbouring markets Finland Electricity Market Act was passed*
1996	<ul style="list-style-type: none"> Sweden Electricity Act was passed* Nord Pool is established as the first international power exchange by amalgamation of Norway and Swedish power markets. The Swedish grid company – Svenska Kraftnät – acquired 50% of the Statnett Power Market, which was then renamed Nord Pool.
1998	<ul style="list-style-type: none"> Finland joined the Nord Pool Denmark Electricity Act was passed*
1999	<ul style="list-style-type: none"> West Denmark joined the Nord pool First Agreement on System Operation was signed by Transmission System Operators in all countries
2000	<ul style="list-style-type: none"> East Denmark joined the Nord Pool

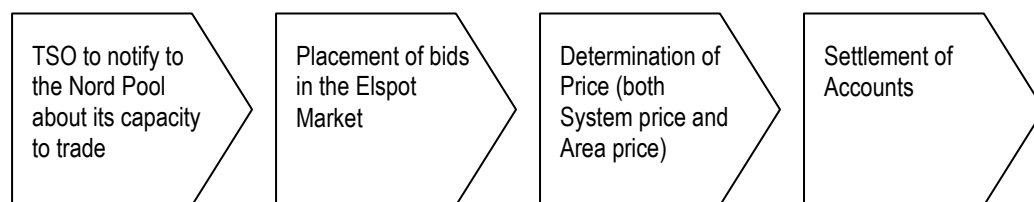
* Separation of generation and transmission activities

Source: Author's Compilation

5.2.2 Operation of Nord Pool

Nord Pool operates a spot market called Elspot, which is a day-ahead market, where power contracts of a minimum of one-hour duration are traded for physical delivery the following day. **Figure 5.2** describes the operation of Nord Pool Spot Market in brief.

Figure 5.2: Operation of Nord Pool



Source: Author's Compilation

For maintaining the grid discipline across the regions there was one TSO operating in each country. These were Energinet, Denmark; Fingrid, Finland; Statnett SF, Norway and Svenska Kraftnät, Sweden.

To begin operations, the TSO operating in each Nordic country notified to the Nord Spot Market (also called the Nord Pool Spot AS) capacities allocated by them to Elspot contracts by 10.00 a.m. for the following day trade.

For undertaking bidding, the entire Nordic Exchange area is geographically divided into bidding areas, which are consistent with the geographical area of each of the TSO.

Power flow between the bidding areas is determined according to the bids submitted by the participants. Bids made by participants fall in the bidding area where their production or consumption lies.

A bid is a sequence of price/volume pairs for each specified hour with volumes being stated in Megawatt hour (MWh). In a bid form, purchases are designated as positive numbers whereas sales as negative numbers. Participants submit their bids (to make or take delivery) on bidding forms covering all 24- delivery hours through an internet application for submitting bids to Elspot's trading system, or fax their bid forms to the marketplace by noon for the following day delivery.

All bids received from the market participants are summed to form a curve for purchase (demand) and a curve for sale (supply). The intersection point of the two curves determines the System Price for that hour. In all, 24 price calculations are made, one for each delivery hour of the following day. If the contracted power flow between the bidding areas is same as the capacity allocated to the areas by the TSOs , then only **System Price** prevails in the entire market, otherwise separate **Area Prices**²⁶ are determined. This method of setting the different bidding area prices is called the **market splitting mechanism**. This mechanism is regarded as a congestion management tool at the Nordic power exchange . The market splitting system ensures that all available capacity will be utilized from the area which has a sales surplus (lower price) to the area which has a sales deficit (higher price).

In case the contractual power flow demand across bidding areas exceeds the capacity allocated to it, then the price of power is increased in power deficit area to stimulate higher generation (supply) and lower consumption (demand) and price is reduced in power surplus area to stimulate lower generation (supply) and higher consumption (demand). Area prices are adjusted until the contract may have different Area prices instead of one single System Price. Area price in effect introduces an extra charge on those causing an imbalance in the system. Through area prices the Pool can earn some revenue as the System Price is usually a break even price.²⁷

For settlement of accounts between participants, net amounts to be debited /credited to each participant are calculated at the end of the day when the bids are submitted by the participants.

Invoices/credit notes are issued to the participants the same day. Nord Pool receives payment from buyers the following day and it subsequently makes payment to seller on the next day, on which it receives payment.

There is a payment security mechanism in-built in the Nord Pool system. In a typical exchange transaction the Pool is exposed to settlement risk.²⁸ Players in the Nord Pool need to have a security deposit with the Pool before initiating transactions. Further this

²⁶ Area prices are prices that are applicable to each TSO bidding area. In case the contractual flow between bidding areas is equal to the capacity allocated then the system price is equal to area price.

²⁷ Kristiansena T 'The Nordic approach to market-based provision of ancillary services'; Energy Policy; Volume 35, Issue 7, July 2007, Pages 3681-3700

²⁸ Settlement risk can be defines as the risk faced by the exchange that the participant may pay to settle accounts.

security is posted as an on-demand guarantee or as a cash deposit in a pledged bank account or a combination of both.

5.2.3 Institutional Framework

The TSO in each Nordic country plays an important role in operation of Nord Pool. The core duty of the TSOs is the system responsibility, which includes:

- Ensuring the operational security of the power system so that the power reaches to the end consumers
- Maintaining balance between supply and demand
- Ensuring stability of the transmission system by keeping frequency at 50Hz.
- Responsibility for the efficient functioning of the electricity market

The System Operating Agreement signed between Nordic countries for the operation of the Nord Pool and the Nordic Grid Code governs the coordinated operation of the Nord Pool.

The first System Operation Agreement between two Nordic TSOs i. e. Statnett and Svenska Kraftnat was made in 1996. This agreement was followed by bilateral system operation agreements between all TSOs and thus the system operation agreement reached between all Nordic TSOs by October 1999.

The Agreement entails effective operational collaboration and co-ordination taking place between the system operators, which provided the technical prerequisites for trading in power on an open electricity market. The Agreement specifies in detail the commitments that the Parties undertake to honour during their operational collaboration.

The formulation of a common code for the Nordic grid (the Nordic Grid Code) was a step towards the harmonisation of the rules that govern the various national grid companies. The purpose of the Nordic Grid Code is to achieve coherent and coordinated operation and planning between the TSOs, in order to establish the best possible conditions for development of a functioning and effectively integrated Nordic power market.

An objective is to develop a shared basis for satisfactory operational reliability and quality of delivery in the coherent Nordic electric power system. The Nordic Grid Code must, however, be subordinate to the national rules in the various Nordic countries, such as the provisions of legislation, decrees and the conditions imposed by official bodies.

5.2.4 Learning from Nord Pool

The Nord Pool lays down the path for developing a power exchange. The key learning for the SAARC region from the Nord Pool experience are summarized in **Box 5.2**

Box 5.2: Learning from Nord Pool

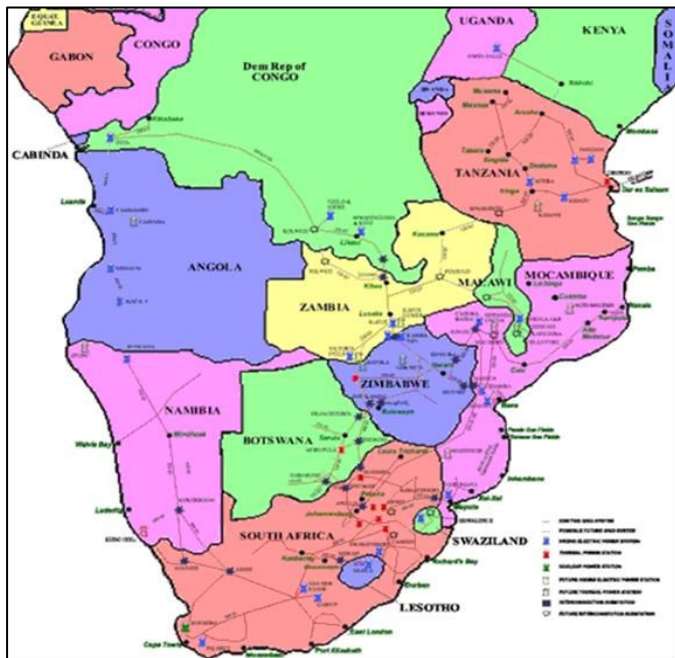
The Nord Pool is one of the most developed power exchanges in the world. It clearly lays the path that a regional power exchange can adopt. Following are some of the key lessons that are derived from the Nord pool experience:

- One of the drivers for initiation of the Nord pool was the ***difference in the generation mix*** of each of the country. Hence, Norway would be able to have an access to thermal generation in Denmark during winters and in summers Denmark would have access to cheap hydro electricity of Norway.
- ***Harmonization of legal and regulatory structures***: Prior to a new country becoming a part of the Nord pool, the country passed a legislation suggesting unbundling of the electricity markets. This facilitated formation of a TSO in each of the countries
- ***Clearly defined roles and responsibilities***: The Nord pool clearly defines the roles and responsibilities of all concerned players in the market. Along with that, the pricing mechanism and the price discovery process are also clearly defined. This is essential to ensure good participation from all players and for smooth functioning of the Power Pool.

5.3 Building a Power Pool: Experience of the Southern African Power Pool

The South African Power Pool (SAPP) consists of interconnections among the power utilities of 12 countries: Angola, Botswana, Congo, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe. It was set up in 1995, with an objective to provide reliable and economical electricity supply to the consumers of each of the SAPP members, consistent with the reasonable utilisation of natural resources and the effect on the environment.²⁹

The starting point for the power pool was already existing bilateral trade and interconnections between the South African companies. The interconnections and bilateral power trading existed among South African countries since 1950s. There were interconnections between Democratic Republic of Congo (DRC) and Zambia in 1950s. In 1960s interconnections were developed between Zambia and Zimbabwe with construction of Kariba Dam. In 1975, South Africa was connected to Mozambique via a transmission line from Cahora Bassa to Apollo. Consequently, due to the gradual extension of interconnections among the South African countries, two broad networks were developed namely:



²⁹ <http://www.sapp.co.zw/> accessed on 15th August 2008

- Southern Network, dominated primarily by thermal based power generation and included interconnections among Namibia, South Africa and Mozambique
- Northern network which was primarily hydro based power generation and included DRC, Zambia, Mozambique’s Cahora Bassa and Zimbabwe.

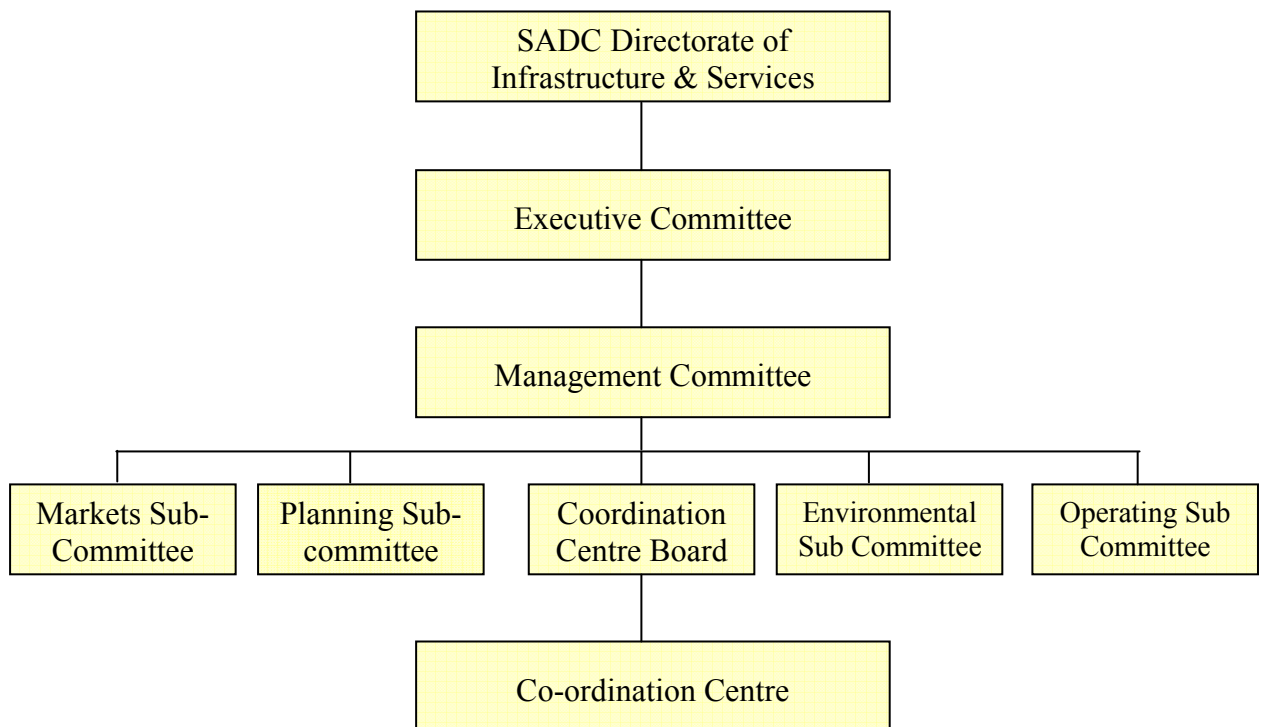
This complementarity of resource endowments that existed between the two networks was one of the key factors that led to creation of the SAPP. The two networks got linked to each other in 1995 with commissioning of a 400 KV line. This interconnection between northern and southern network laid the platform for development of regional trade and cooperation and thereby leading to creation of SAPP.

5.3.1 Institutional mechanism

SAPP is an association of 12 member countries represented by the respective electricity utilities organized via Southern African Development Community (SADC).

The SAPP has a well defined institutional structure involving all the relevant stakeholders at various stages. **Figure 5.3** summarizes the SAPP structure.

Figure 5.3: Hierarchical Structure of SAPP



Source: SAPP Annual Report 2007

The Executive Committee consisting of the heads of the participating utilities acts like the board of directors of the power pool. The Management Committee, consisting of the senior managers of the transmission utilities and energy trading departments of each utility, is responsible for collating information from the five sub committees – planning, operating, markets, environmental and Coordination Centre Board³⁰ - preparing proposals for the Executive Committee and presenting biannually the report to the Executive Committee. These sub committees work under the guidance of the Management Committee. The Coordination Centre works under the Operating Sub Committee and is responsible for the working of the pool and monitoring activities.

There are a number of guiding documents that have been agreed to by all the participating nations so as to ensure smooth working of the pool. Broadly, SAPP is guided by the following four agreements:

- **Inter Governmental Memorandum of Understanding** signed among member governments of SADC for the formation of South African Power Pool. This is the guiding agreement based on which the Pool was established. The pool was inaugurated by this agreement.³¹ It grants permission for the utilities to participate in SAPP and enter into contracts, and guarantees the financial and technical performance of the power utilities.
- **Inter Utility Memorandum of Understanding** among the utilities establishes the basic management and operating principles for SAPP. The MoU defines ownership of assets and other rights, for example, provision for change in status from participating to operating member. In 2007, a revised inter-utility Memorandum of Understanding was signed following which a new committee Market Sub Committee was formed. The revised MoU enables other players within the SADC region such as Independent Power Producers (IPP) and Independent Transmission Companies (ITC) to join the SAPP and to participate in all activities of the SAPP.
- **Agreement between Operating Members** determines the interaction between the utilities with respect to operating responsibilities under normal and emergency conditions.
- **Operating Guidelines** provides the standards and the operating guidelines. It also defines the sharing of costs and functional responsibilities for plant operation and maintenance, including safety rules.

5.3.2 Operating Mechanism

Currently there are two mechanisms through which the market operates – bilateral market and Short Term Energy Market (STEM).

³⁰ The Coordination Centre Board and the Markets Sub Committee has been formed recently in 2007, with signing of the revised Inter Utility Memorandum of Understanding.

³¹ Donal T O’Leary, Jean-Pierre Charpentier and Diane Minogue ‘Promoting Regional Power Trade – The Southern African Power Pool’ Public Policy for the private Sector, Note number 145, June 1998

Bilateral Contracts

Bilateral contracts under the pool are inter utility long term power purchase arrangements. Long term could be from one year to five year time span. This trade accounts for around 90% of the total trade under the pool, and is primarily meant for meeting the peak demand in the region .

Prices for these transactions are determined on a bilateral basis and are governed by the bilateral contract between the trading parties. For settlement of these transactions the Coordination Centre plays an important role, under its function to monitor operation of the members of the pool. The four documents governing the functioning of the SAPP also lay the guideline for implementing the bilateral trade arrangements.

Short Term Energy Market (STEM)

SAPP is operated through STEM. STEM participants include any party of SAPP or any other participant approved by the SAPP Executive Committee. The STEM operates as follows:

- Each participant of the STEM submits the trading form to the Coordination Centre. The participants may bid for Monthly, Weekly and Daily Contracts. The bid form must provide the details such as participant name, volumes of energy to be traded and peak in MW, type of contract, trading period, prices required and applicable currency etc. The bids may be submitted either through facsimile, internet, electronic mail, or an agent.
- Each participant network must fall under any host control area such as Eskom control area; ZESA control area, or ZESCO control area. Host control area is aware of the network constraints and transfer limits; and scheduled bilateral energy trade arrangements.
- The Coordination Centre matches the bids and offers using an optimization process taking into consideration the bilateral agreements (as they are given the first priority), latest system constraints and wheeling charges etc.
- The Co-ordination Centre publishes the volume and price results to all the successful participants as well as unallocated offers and unmatched bids. The Coordination Centre follows the following basic rules for allocation of offers to successful bidders:
 - ◆ Rule 1: The cheapest power sells first, unless such sales would compromise system integrity.
 - ◆ Rule 2: Equal sharing of cheaper power to all the qualified bidders.
- The centre publishes all the offer power and the corresponding offer price without any inclusion of the wheeling charges. The buyers are responsible for payments of all wheeling charges.

- The bids are qualified by the centre on the following basis:
 - ◆ When a seller advertises P MW of power at the selling price of Cs cents/kWh and the bidder is ready to buy power at the bidding price of Cb cents/kWh, then for the bidder to qualify for the advertised power it is necessary that the Cs [1 + Wheeling charge as a percentage] should be less than Cb.
- All Participants to STEM notifies on the 1st working day following the delivery of the contracted energy to the Co-ordination Centre, of all information pertaining to forced outages or other events that may impact final payments.
- There could be two types of imbalances that may occur in the STEM. These may include Inter Control Area Imbalance which is dealt in accordance with SAPP operating guidelines or the Intra Control Area Imbalance which is dealt with according to the host control area procedures.

Payment Security Mechanism

Electricity is traded in increments of 1 MW (one megawatt) at United States cents per kWh or South African cents per kWh.

The security required for each electricity contract shall be the value of the contract from the date of optimisation of bids and offers until the date of payment of the settlement amount. The security could either be in form of cash collateral or a bank guarantee with the Coordination Centre. All forms of security shall be held at Stanbic Bank, Gaborone, Botswana.

The coordination centre maintains the security account and authorizes liquidations and transfers from this account. Any interest accruing from the security account is credited to the Participant. Payment of settlement amounts is not made from the security account.

The following procedure is followed for the payments:

Day 1: Offers and bids are matched. Confirmation of trading notification issued. Delivery of contracted energy is made for different contracts.

Day 2 - Day 3: Reconciliation of the actual energy traded.

Day 4: Invoice issued.

Day 7: Payment of Invoice into the clearing account by buyers

Day 8: Settlement amounts to be paid through electronic banking system, Customers Access Terminal System (CATS) Special Accounts of sellers. Notice is given to buyers who defaulted in payment of invoices. Co-ordination Centre proceeds to claim the amount outstanding and interest from the security.

Day 9: Late payments to CATS Special Accounts of sellers.

5.3.4 Learning from SAPP development

SAPP is the first power pool to be set up outside North American and Western Europe. Being a power pool of the developing world, there is relevant learning that the SAARC region can draw from its experience (**Box 5.3**).

Box 5.3: Learning from SAPP

The key lessons that can be drawn from the SAPP experience are :

- **Need of political will:** One of the driving forces for development of SAPP was initiatives taken up by South Africa. This highlights the role one country can play in driving other countries in the region to move towards regional energy trade.
- **Synergies in power generation mix:** The SAPP was formed so that the region is able to benefit from the varying electricity mix existing in the region, for instance the southern network was dominated by thermal based generation and the northern network was dominated by hydro. Both regions were able to benefit from this diversity in generation mix, leading to a cleaner supply of electricity, which is more reliable.
- **Laying down the rules before the market begins operation:** Four important documents, laid down the procedures/ processes that need to be adopted for building the power pool. This aids in delineating responsibilities of the various concerned members and thus in smooth operations of the power pool. Further, these four underlying documents/ agreements have been revised recently so as to keep pace with the developments in the electricity market structure across the participating countries.

5.4 Involving Private Sector for Infrastructure Development: Case of Baja California LNG Terminal

The demand for natural gas in Mexico and United States of America (USA) has been growing steadily. Consequently, both these countries are net importers of natural gas despite having significant reserves. Imports by Mexico have increased to about 500 million cubic feet per day (MMSCFD) in 2005 from about 200 MMSCFD in 1995. Gas based power generation is the primary driver raising demand for natural gas. Natural gas demand is expected to nearly double by 2010.

With Mexico and USA both being net importers of natural gas and sharing a common border as well as pipeline infrastructure, setting up of a common LNG terminal seemed natural to enhance security of supply in both countries. Also, setting up of the LNG terminal would help Mexico in diversification of sources of natural gas import, since presently Mexico sources most of its import of natural gas from USA alone.

5.4.1 LNG Project Overview

Sempra Energy Mexico, a subsidiary company of Sempra Energy, has just commissioned an LNG receipt terminal at Energía Costa Azul at Baja California, México. Natural gas for this plant is expected to be imported from Indonesia. The gas received by this terminal will be used for power generation and diverse industries in the region via a new 72 km long gas pipeline, which will be interconnected with gas pipelines already existing in the area. The gas received will first meet the needs of Baja California, Mexico. Only after its needs are met will excess supply move into the Southwest USA. The total investment in setting up the terminal amounted to USD 875 million dollars and it has an output capacity of 1 billion cubic feet per day of natural gas.

5.4.2 Operation of LNG Terminal³²

The storage capacity in the terminal is available on common carrier basis. Energía Costa Azul has a standard terms and conditions for allocation of capacity and supply of natural gas. As per Article 63 of the Regulation of Natural Gas, Energía Costa Azul allows open access, limited to the available capacity, to the interested parties for the storage capacities for LNG terminal.

The storage facilities are provided under the service contract signed by the parties with Energía Costa Azul. These storage facilities could be of two types:

- Storage Facilities at Firm Base (SABF): For stockpiling LNG received at the receipt point of the user. It is an uninterruptible storage facility except in conditions as provided in the general terms and conditions and the service contract.
- Service Storage base Interruptible Supply: The availability of this storage facility is subject to capacity available after meeting the orders for SABF. This service has the higher probability of being interrupted.

In order to qualify for the hire capacity, the party requesting for it, must submit a written service application specifying the requirements. On receipt of such application, Energía Costa Azul evaluates them. Capacity available is allocated to the request having the greatest economic value as determined by Energía Costa Azul. It notifies within 30 days of receipt of application whether it can provide the service requested or not. On acceptance of request by Energía Costa Azul, the applicant meets the financial guarantees within next 30 days.

Once the contract is signed, the user for LNG must withdraw or otherwise dispose of all the quantity of LNG as contracted by him before the termination of service contract. In the event of any failure to withdraw all natural gas prior to termination of service, Energía Costa Azul reserves the right to retain the available amount without appropriate claims by the users.

Bills for the charges applicable for usage of storage service for the prior month are issued by Energía Costa Azul not later than the tenth day of each month. The user is required to make due payment within 10 days of receipt of the bill.

Energía Costa Azul may render the services of storage facilities by setting aside the necessary capacity to deliver natural gas up to a capacity equivalent to volumes needed to fulfil commitments made by signing contracts. However in case of failure to set aside capacity, Energía Costa Azul allocates the LNG capacity among its prospective users by a process called “Open Season” wherein the users submit their request in order to allocate the available capacity.

³² Details regarding the operation of the LNG Terminal is based on provisions mentioned in ‘General Conditions for the Provision of the Storage Services’ (July 2004)

It publishes notices for open season in one of the largest newspapers at least 30 days prior to start of the open season, which will not last less than 10 days. Energía Costa Azul establishes and discloses the criteria for evaluating bids, as well as the established method for awarding capacity in case of expansion of system. Energía Costa Azul evaluates each valid service application in accordance with terms of service of contract and with the capacity required. The capacity is awarded to the service application with the highest value in terms of net present value based on ability, currency and price, at the date of receipt of the request for service.

5.4.3 Learning from Energía Costa Azul LNG Terminal

Though the project has just been commissioned in May 2008, there are a few lessons that can be drawn from the terminal. These are summarized in **Box 5.4**.

Box 5.4: Learning from Energía Costa Azul LNG Terminal

The Energía Costa Azul LNG terminal is the first LNG terminal to be built on the East coast of Mexico. There are some specific lessons the SAARC region can draw from the experience. These are:-

- **Promotion to Natural Gas:** One of the drivers for building the LNG terminal was to increase natural gas supply in the region. Natural gas is a cleaner fuel as compared to other fossil fuels such as oil and coal, given increasing concerns with respect to environment.
- **Benefit of involving private sector:** The total investment in the LNG terminal was around USD 1 billion. Energía Costa Azul managed its funds and made the requisite investments. This strengthens the case for encouraging private sector participation in building the infrastructure.
- **Building integrated projects:** The LNG project is not a project done in isolation. Energía Costa Azul has also made investments in building the related infrastructure such as spur pipelines etc. Therefore, such projects should not be looked in isolation and require investments in basic as well as auxiliary investment.

5.5 Joint Procurement of Crude Oil and Sharing of Infrastructure for Optimal Utilization: Case of African Oil Sector

5.5.1 Refining Sector in Africa – Drivers for Change

The African continent is richly endowed with natural resources. It has 168.60 billion tonnes of oil reserves, accounting for 9.5% of the total world reserves. The R/P ratio, although a lot of this production is exported, is 32 years.³³ However, to meet its domestic requirement of petroleum products the continent imports petroleum products and crude oil.

The African continent has 45 refineries, with an average refinery size of 3.7 Million tonnes per annum (MMTPA).³⁴ These refineries are currently being under utilized. Further, most of these refineries are only topping refineries³⁵ that produce primarily fuel

³³ BP Statistical Review of World Energy, June 2008

³⁴ Overview of the Africa's Hydrocarbon Situation the Need for Coherent Strategies and Directions; First African Union Conference of Ministers responsible for Hydrocarbons (11-15 December 2006 Cairo, Egypt)

³⁵ Refineries with only a distillation unit

oil and other lower distillates, which are exported for further refining so as to produce diesel and other lighter distillates.³⁶ These non-complex refineries produce products that are high in sulphur content and there are no standards laid for product specification. Further most of these refineries are old -- built in early 60's and 70's and are very low in efficiency. There have been a number of proposals to upgrade these refineries, but due to their poor financial performance they do not have the requisite funds to upgrade. The financial performance of the refineries is impacted by the petroleum pricing regimes in the countries. In most countries the ex-refinery price formula is based on Platt's quotations plus Average Freight Rate Assessment (AFRA) freight from Europe or the AG. However the formula is applied inconsistently by the government, which puts a dent on the profitability of these refineries.³⁷

5.5.2 Collaboration in the Refining Sector – The proposal³⁸

Recognizing the shortcomings of the existing African refinery sector, the Africa Energy Commission (AFREC), in 2006, proposed standardization of the refining sector at the regional or the sub-regional level. The reason for this suggestion was that it was felt that from the economic point of view it was uneconomical for each country to build a small refinery to meet its domestic demand. It was also felt that the existing refining industry is not as effective as those built outside the region. Under the proposal it was planned to make strategic investments to rehabilitate, modernize and expand select refineries at sub-regional and regional levels so as to optimize Africa's refining capacity and obtain economies of scales. Further, it was expected that this would improve negotiating powers of the member countries in crude oil procurement.

The proposal also suggested that if such a regional/sub-regional refinery is set up that with a common strategy designed to concentrate its refining capacity in two or three large units, an area such as West Africa could save 0.5 USD/ bbl in the cost price of oil for its importing countries.

Based on the above, in the First African Union Conference of Ministers Responsible for Hydrocarbons (11-15 December 2006, Cairo, Egypt), a comprehensive proposal to develop the African refining sector through regional cooperation was presented. Following are the key points of the proposal:

- (i) Encourage policies aimed at pooling of refineries, under which a group of countries may share the construction and operation of refinery/refineries which serve them as a group.

³⁶ Sorbara M.J. 'Refining Africa's Future' Business Africa online, March 2007

³⁷ Overview of the Africa's Hydrocarbon Situation the Need for Coherent Strategies and Directions; First African Union Conference of Ministers responsible for Hydrocarbons (11-15 December 2006 Cairo, Egypt)

³⁸ This section is based on the proposal presented in the First African Union Conference of Ministers Responsible for Hydrocarbons (Oil and Gas); 11-15 December 2006; Cairo, Egypt. Details available at http://www.africa-union.org/root/au/index/archive_December_2006.htm accessed on 15th June 2008

- (ii) Promote plans for attracting big African oil companies to build, own and operate refineries in strategic locations around Africa – each to serve a group of countries.
- (iii) Support Regional Economic Communities’ (RECs’) policies for oil products procurement from refineries within their geographic regions.
- (iv) Encourage bi-lateral or multi-lateral construction of refineries and attract African and international financial institutions for funding support.
- (v) Promote policies aimed at harmonization of fuel specifications and standards throughout Africa in order to get benefits from.
 - a) Economies of scale of oil refining;
 - b) Economies of scale for petroleum product importing countries;
 - c) Reduced health hazards associated with cleaner fuels;
 - d) Alleviation of dumping of poor quality fuels and motor vehicles from outside Africa; and
 - e) Inability of newer vehicles to operate on inferior fuels.
- (vi) The possibilities of improving the terms and conditions under which oil products are supplied to the land-locked African countries from nearby refineries should be carefully considered. The astronomical prices currently paid by these countries for their supply underscore the relevancy of a joint sub-regional financial effort to improve and build refining and transportation infrastructures (refineries, storage depots, railways, waterways, and oil and gas pipelines) combined with a common oil products purchasing policy.

Recognizing the magnitude of the project, a number of agencies involved in regional cooperation in Africa have been entrusted with the responsibility of promoting large scale regional integration projects. The agencies include:

- (i) Africa Union (AU)
- (ii) African Development Bank (AfDB)
- (iii) Economic Commission of Africa (ECA)
- (iv) Regional Economic Communities (RECs)
- (v) Africa Petroleum Producers Association (APPA)
- (vi) Africa Energy Commission (AFREC)

5.5.3 Learning from African Experience

Though the idea of building a joint infrastructure is currently at a formative stage, there are lessons that can be drawn from the experience. **Box 5.5** summarizes the key lessons relevant to the SAARC region.

Box 5.5: Learning from Africa Oil Sector

There are a number of similarities that can be drawn between the African and the SAARC refining sector. Drawing from these similarities, there are lessons that the SAARC region can learn from the African experience.

- **Limited domestic availability:** In both regions the domestic refining capacity is insufficient to meet the domestic demand for petroleum products and therefore, the countries are dependent on imports to meet their domestic demand. In the SAARC region there are Member States such as Bhutan, Nepal and Maldives which are 100% dependent on imported petroleum products. Further, Member States such as Bangladesh, Sri Lanka and Pakistan do not have sufficient refining capacity and import a large part of the petroleum products required to meet the domestic demand.
- The driver for joint procurement of crude as well as building common refinery is that the region would be able to reap benefits attached to economies of scale. The average size of a refinery in Africa region is small (3.7MMTPA), and at present most of these refineries require up-gradation to meet the growing energy demand. A bigger refinery is expected to lower costs of operation as compared to building a number of small refineries across the region.
- Move towards common pricing regime: The regional/ sub-regional refinery is expected to promote trade among the participating countries. Further, it is also expected to favourably impact financial performance of the utilities involved.

5.6 Conclusions

In essence, the above international experiences are extremely useful in understanding the frameworks required for enhancing regional trade. There are lessons that can be drawn from each of the international experiences, which need to be borne in mind while developing the regional trade framework in the SAARC Region.

5.6.1 Existing Bilateral Trade Creates an Enabling Environment for Graduating to Regional Trade: The Building Block Approach

In the cases of GMS and Nord Pool, interconnections did exist before initiation of regional trade. This implies that countries adopt a building block approach i.e. developing bilateral trade arrangements into multilateral trade arrangements. In the case of SAPP, bilateral and spot trade coexist. In the case of SAARC, bilateral trade arrangements, though limited to a few Member States, already exist. Applying the same approach in the region, the Member States may consider graduating these bilateral trade arrangements to multilateral trade arrangements. For instance, in case of electricity, interconnections already exist between India –Bhutan and India- Nepal. Further, India already has two working level electricity exchanges namely India Energy Exchange (IEX) and Power Exchange India Limited (PEXIL). Various power producers and buyers in all the Member States within SAARC may consider participating in these exchanges for promoting regional electricity trade.

5.6.2 Harmonization of Legal, Policy and Regulatory Regimes

In the case of both GMS and Nord Pool the countries involved harmonized in a phased manner their legal and policy regimes. The Nord Pool countries adopted similar market

structures by unbundling the power sector and appointing TSOs in each country.

Under the SAPP, a common regulator Regional Electricity Regulatory Association (RERA) was created in June 2001. The key objectives of RERA are:³⁹

- Capacity building, information sharing and experience sharing among regulators;
- Coordination of regional policy/strategy/legislation, with a view to harmonizing regulatory frameworks that will enhance regional electricity trade and facilitate regional ESI systems integration; and
- Regulatory cooperation on issues affecting the economic efficiency of regional electricity trade with a view to deliberating and making recommendations to the SADC Energy Ministers on issues outside the scope of jurisdiction of national regulators, and to undertake such duties as may be conferred on it through the Energy Protocol.

However, it does not undermine the role that has to be played by the national regulators in promoting regional trade, and strives to work in coordination with the respective regulators.

In the SAARC region, in most of the Member States regulators have been appointed; however, they are presently not completely functional. Further, in certain Member States there are energy regulators and in some sector specific regulators. In the case of Sri Lanka instead of sector/energy regulators, there exists a Public Utilities Regulator. In terms of market structure, in most Member States – Nepal, Bhutan, Sri Lanka, bundled entities operate in the energy sector. For promoting trading, there may be a need to harmonize these structures so as to promote regional energy trade. The region may take a step wise approach here, starting with strengthening capacities of individual regulators and creating a national level enabling framework for regional trade followed by creation of a common regulator as and when the energy markets develop. The SAARC Secretariat would have an important role to play in this.

5.6.3 Clearly Defined Roles and Responsibilities of Market Players

In both GMS and Nord Pool, there is clear demarcation of roles and responsibilities of each of the players/ stakeholders involved. This brings in clarity in the functioning of the regional trade arrangement. This needs to be borne in mind while developing any trade option in the SAARC region. Further, clarity needs to be provided in the price determination mechanisms and the safeguards need to be spelt out to ensure payment security. This is clearly visible from the detailed pricing methodology that has been adopted in the day-ahead market in the Nord pool (discussed in the Nord pool section in detail). In case of SAPP also the pricing discovery method is clearly defined and in case of bilateral trade, it is mentioned that the price is based on negotiations.

³⁹ Assessment of power pooling arrangements in Africa, Sustainable Development Division, Economic Commission of Africa, October 2004

5.6.4 Building Integrated Projects

The African region is planning to build joint refineries at strategically located places. However, this is not being planned in isolation. The region plans to invest in big regional integrating projects, where along with building the refinery, there are plans to link these refineries across the region. This is particularly relevant to the SAARC context, as at present the member countries are not connected through an oil pipeline grid. Hence, while planning such a refinery, planning could be inclusive of the pipelines that need to be laid. An advantage SAARC region has vis-à-vis the African region, is that India has a number of refineries located near to its borders with other SAARC member nations. Therefore, one possible solution that the region could consider is to build a refinery in one of the Member States, which could then swap its refined products with those refineries nearer to the border of distant Member States.⁴⁰

A similar example of building integrated projects is seen in case of the joint LNG terminal. There again the LNG terminal is not being built in isolation, but also investments were made in related infrastructure such as pipelines.

5.6.5 Efforts to Reap Benefits of Economies of Scale

Infrastructure projects have high capital costs and long gestation periods. Therefore, while planning an infrastructure project it is important to have a well defined revenue stream, big enough to ensure break even followed return on the project. While planning such investments it is beneficial to aggregate smaller demands and to build a bigger infrastructure project to meet energy demands of many. In Africa a driver for common procurement and joint refinery is that the refinery would be able to enjoy economies of scale. This aids in cutting down incremental capital cost per unit of refinery added. Further, joint projects are also expected to enhance negotiating powers of the refiners/ crude procurement agency.

5.6.6 Benefit of Commercial Transactions

The ECA LNG terminal has been built on completely commercial terms and conditions. The payment terms and conditions remain same irrespective of the consumer of natural gas. This ensures payment security for the LNG supplier. Further, during the construction phase of the terminal the company made efforts to ensure transparency in its working. Information is available with respect to the various clearances required by the terminal and the status of the same.

5.6.7 Building Database for Information Sharing

The SAPP experience highlights the importance of information exchange so as to maximise both economic benefits and reliability of the trading system. Development of databanks also facilitates in building system autonomy, as it gets in built in the institutional frameworks required for promoting regional trade. Thus one of the initial steps or for that matter the first step is to build a regional database. This is expected to

⁴⁰ This arrangement is explained in detail in the subsequent chapter.

encourage and enhance regional energy trade as it would provide the building blocks for estimating benefits of various proposed trade options.

5.6.8 Long Term Commitment from Participating Countries

All the regional projects discussed above have had a long gestation period before they were commissioned as full fledged regional energy projects. For instance, the GMS was initiated in 1992 and the first 500 kV power transmission project between Thailand and the Lao PDR associated with the 1080 MW Nam Theun 2 Hydropower Project is now under commission, implying a total gestation period of nearly two decades. Even in the case of Nord Pool, it took over a decade for step by step harmonization of legal and regulatory frameworks and setting up the fully functional Nord Pool. These experiences highlight the need for long term commitment from each of the participating member states for establishing good regional energy trade relations. As the SAARC region makes efforts to build regional energy trade these timelines need to be considered and all member states need to have firm commitment to commission the projects involved.

Chapter-6: Intra-Regional Energy Trade - Perspective and Prospects

While the intra-regional energy trade initiatives are covered in the next chapter, this chapter discusses the past initiatives and prospects of intra-regional energy trade among the SMS.

6.0 Intra-Regional Energy Trade and Cooperation Opportunities

Hydropower

Intra-regional energy trade and investment would offer enormous economic, social and environment benefit to SMS. The region though deficient in hydrocarbon reserves has been endowed by nature with a very large hydropower potential of over 266,020 MW of which 145,720 MW is economically exploitable. If exploited fully, the same could meet the electricity demand of the region for the foreseeable future and may even enable it to export some of it in the near-term. Bhutan and Nepal are endowed with huge hydro potential of about 23,000 MW and 42,000 MW respectively, in excess of their domestic requirements that can be economically exploited. While Bhutan has developed about 5% of its hydroelectric potential, Nepal has developed only about 1.5% of its hydroelectric potential.

If the region is able to develop even 50% of the total hydropower potential, it would account for over 50% of the existing installed electricity generation capacity of the entire region, which would be a major breakthrough for meeting the electricity needs of the region.

Oil and Natural Gas

None of the countries in the region have adequate oil and gas reserves to meet domestic demand. The four countries that have proven gas reserves and use natural gas in their energy mix are Afghanistan, Bangladesh, India and Pakistan. Due to financial and other reasons, exploration and building of the gas infrastructure is taking longer time than required.

On the oil front none of the countries is able even to meet a notable part of their demand for the petroleum products from their own resources. Opportunities of any major oil finds in the near future too do not seem to be promising as per the existing seismological and geological data related to oil exploration. The region would therefore, primarily depend on external resources to meet the oil and gas requirement.

Renewable Energy Resources

South Asia has enormous biomass, solar and wind energy potential. While biomass is meeting a large part of the household energy demand throughout the region, solar and wind energy resources have not been exploited in a big way. Though India during the past one decade has made considerable progress in exploiting its wind energy potential and is today the fourth largest wind power producer in the world; no other country in the region has made comparable progress in this direction. Since India has not only the technology, but is also a manufacturer of high quality wind turbines and associated equipment required for harnessing the wind power potential, other countries in the region could seek its collaboration to help them exploit this vital source of energy. Solar energy is being used on a very small scale for solar lighting and heating systems in the remote areas. Given the solar energy potential, South Asia needs to adopt and evolve technologies that can help its countries reap the benefits of this largest energy resource in a cost effective manner. On the biomass side as well they need to adopt and/or develop technologies for the efficient use of the biomass. Bio-fuel provides another important window for collaboration between the Member States.

Coal

Coal is an important hydrocarbon resource being extensively used for power generation in India. Bangladesh has recently set up its first coal based power plant. Pakistan initiated steps for utilization of coal to meet its energy demand a decade back, but has not progressed to the stage of actual utilization. Though India and Pakistan have very large coal reserves, the quality of coal is poor with about 35% ash content, compelling India to import as a supplementary energy source, high quality coal for power generation and other applications. However, Bangladeshi coal is assessed to be of very high quality⁴¹. Afghanistan too has some coal reserves. SMS can collaborate for exploration and exploitation of more coal reserves to meet their energy demand.

Regional Trade

Currently less than 0.5% of regional trade comes from within the region and total intra regional trade in energy is less than 5% of the total trade taking place between SMS. Formulating policies that promote and at least that do not impede energy trade is a challenge that is facing the SMS.

SMS are looking to diversify their energy supply and promote regional energy trade and investment. They are increasingly recognizing that there is a need to promote sustainable use and supply of energy by strengthening regional cooperation and that there is need to address cross border transmission and energy import issues. Several initiatives have been under way to sensitize SMS about the benefits of regional energy trade and cooperation in the energy sector.

Discussions are underway to develop electricity transmission interconnections within the region and with neighbouring regions. Some of the prominent regional projects being

⁴¹ As assessed by the expert deputed under the SARI/energy programme to identify the quality of coal in Bangladesh

discussed at the moment are the additional power transmission interconnections from Bhutan and Nepal to India and those between Sri Lanka –India and Bangladesh-India.

These cross border energy trade initiatives would no doubt help relieve the overall supply shortage through energy trade. Diversity of national endowment and use of energy resources within the region present a unique opportunity for energy trade for the common benefit and towards meeting the demand and for better energy security of the region.

Despite large opportunities for energy trade within the region, the progress has been sub-optimal thus far. The successful example of electricity trade between Bhutan-India and the resultant benefits to both economies are well appreciated and could be emulated by other countries in the region. A brief discussion about the existing and past energy trade initiatives within South Asia are given below.

6.1 Existing Trade Arrangements - Petroleum Products

India meets the entire demand of petroleum products in Nepal and Bhutan. The governments of India and Nepal have recently agreed to proceed with construction of about a 40 km long pipeline to transport petroleum products from India to Nepal (about 20,000 bbl/d are sent at present by bowser). With the increased refining capacity of crude oil, India also exports petroleum products to Bangladesh. Moreover, Lanka IOC, Indian Oil's subsidiary in Sri Lanka, is the only private oil company other than the state-owned Ceylon Petroleum Corporation (CPC) that operates retail petrol/diesel stations in Sri Lanka. It has been incorporated to carry out retail marketing of petroleum products, bulk supply to industrial consumers, building and operating storage facilities at the Trincomalee Tank Farm, thereby not only providing energy security and supply stability for Sri Lanka but also upgrading the overall standards of service, particularly in petroleum retailing in the nation.

6.2 Existing Electricity Trade between India-Bhutan and Future Prospects

6.2.1 Historical overview

One of the most important areas of cooperation and assistance extended by India has been for the development of hydro power resources of Bhutan. Cooperation in the hydro power sector between India and Bhutan dates back to 1961 when the first Indo-Bhutan Agreement was signed for implementation of the Jaldhaka Hydroelectric Project located at the boundary of the Indian State of West Bengal. The project supplied electricity to the adjoining border towns of Bhutan. Even today the supply to some part of the bordering area of Bhutan continues. Since 1967, Government of India (GOI) has been providing assistance to Bhutan for development of mini hydropower projects and electricity infrastructure.

At the bilateral level, India and Bhutan have enjoyed free trade ever since the two countries signed the treaty of friendship in 1949. A formal agreement on trade and commerce was signed in 1972, and further extended till 2005 and beyond.

6.2.2 Collaboration on Large Hydro Projects and Power Trade

India and Bhutan maintain friendly relations. Their key companies have been collaborating for decades in the power sector development, resulting in setting up of a number of hydro electric projects in Bhutan. Both countries recognize the benefits of these initiatives, their contribution to the economic growth and in addressing the energy security concerns. Power trade between the two countries is an outcome of successful completion of these projects and a shining example of the regional cooperation among SMS. Bhutan after catering to its domestic demand sells the surplus power to India, the largest energy market in the region.

6.2.3 Development of 336 MW Chukha Hydroelectric Project

The first major initiative in this direction was the bilateral agreement signed in the year 1974 for the construction of Chukha Hydroelectric Project (336 MW installed capacity) as a joint venture. GOI agreed to finance the total cost of the project with 60% grant and 40% loan. The first 84 MW Unit was commissioned in the year 1986 and by the year 1988 all the remaining three units were commissioned.

The Royal Government of Bhutan agreed to sell the surplus power generated by the project to India after meeting its internal requirement. The project not only provided electricity for meeting the internal demand of Western Bhutan and large revenue earnings from its export, but also set an example of an excellent economic cooperation. Power is evacuated to India through three 220 kV transmission lines – one S/C 220 kV Chukha (Bhutan) – Birpara (India) and one D/C 220 kV Chukha – Birpara line.

PTC of India has signed a 15 year PPA with the Department of Energy (DOE), RGOB for the purchase of surplus power from the Chukha and Kurichhu Projects. These agreements became operational from 1st October 2002. The surplus power from these projects is being supplied to the Indian power utilities of the Eastern Region. The typical annual generation of these projects is about 1860 Million Units (MU) and out of this about 1300–1400 MUs (70-80%) is exported to India while the rest is consumed within the country.

The successful completion of the Chukha HEP coupled with its sustained performance after commissioning has given added confidence to the Governments of India and Bhutan to construct similar large hydroelectric projects as joint ventures. This led to the construction of 60 MW Kurichhu HEP and 1020 MW Tala HEP.

6.2.4 Development of Tala Hydroelectric Project (1020 MW)

An agreement for implementation of the Tala HEP with an installed capacity of 1020 MW was signed between the GOI and RGOB in 1996. The project was conceived as a joint venture with funding provided by GOI: 60% grant and 40% loan. The Tala HEP is an environment friendly run-of-the-river scheme downstream of the Chukha HEP. The underground power house has six generation units of 170 MW capacity each. The project was commissioned on 30th March 2007. Two 400 kV D/C transmission lines evacuate power from Tala the HEP at two different locations at the India-Bhutan border. The transmission system in India carries power from the border to a pooling point at Siliguri

(West Bengal) and beyond to the Eastern and Northern Grid. Electricity generation as of 30th November 2007 was 4568 MUs and a revenue worth NU 6723.92 million (1 Nu =1 INR) was generated. The project will generate 4865 million units (Gwh) of energy in an average year and also provide 1122 MW of peaking power (3-4 hrs) throughout the year. PTC signed a 35 year PPA with RGOB in the year 2006. **Table 6.1** indicates the year wise energy trade between India and Bhutan.

Table 6.1: Energy Trade to India from Bhutan (MU)

Year	Tala	Chukha	Kurichu	Total
FY 03	0	333	81	414
FY 04	0	1494	256	1751
FY 05	0	1447	288	1735
FY 06	0	1466	296	1762
FY 07	821	1851	291	2963
FY 08	3001	1696	195	4893
FY 09*	3900	1470	250	5620
FY 10*	3900	1470	250	5620
FY 11*	3900	1470	250	5620
FY 12*	3900	1470	250	5620

* Projected

Source: India Country Report

6.2.5 Prospects of Future Hydro Project Development and Energy Trade

Bhutan situated in Eastern Himalayas is blessed with four major river systems namely Amochu (Torsa), Wangchu (known as Raidak in India), Phochu-Mochu (Sankosh) and Dangmechu (Manas). All these rivers having snow fed perennial flow afford attractive possibilities of hydro electric development.

The total hydro potential exploited in the country by 2008 was 1500 MW which is less than 5% of the total potential. The 2007 power demand of 130 MW in Bhutan is expected to rise to 350 MW in 2010 . The higher rate of growth in demand is primarily on account of energy intensive industries and increased economic and commercial activities besides life style changes. The long term demand growth for electricity in Bhutan is expected to be moderate.

GOI and RGOB signed an agreement in 2006 for cooperation in the field of hydro electric power. The two sides agreed to facilitate, encourage and promote the development and construction of hydro power projects and associated transmission systems as well as trade in electricity between the two countries, both through public and private sector participation. The Government of India has agreed to a minimum import of 10,000 MW electricity from Bhutan by the year 2020. One of the important features of the agreement is that the two countries would be cooperating to develop projects under the Clean Development Mechanism (CDM) of the Kyoto Protocol, using India's carbon emission baseline.

As per the assessment made in the Bhutan Power System Master Plan, the potential of easily accessible sites is roughly 10,000 MW at 60% plant load factor. A large hydro potential, therefore, exists which could be developed at an economical cost for export of power to other SMS, keeping in view the region's huge demand for power and prevailing shortages.

The present power transfer capacity between the two countries through transmission interconnection is about 2500 MW. As new projects are undertaken in the coming years, an additional 10000 MW capacity is targeted by 2020. The transmission interconnection capacity would have to be suitably augmented or new capacity created. Techno-economic feasibility is being examined for AC transmission interconnection at 765 kV or asynchronous HVDC transmission depending on the long term plan and the schemes that are to be finalized by CEA.

6.2.6 Hydro projects that could be developed in Bhutan for bilateral and regional cooperation

GOI and RGOB signed an agreement in 2007 to implement the Punatsangchhu-I hydroelectric project (1095 MW) in Bhutan. Besides these, the two sides have agreed to cooperate on Punatsangchhu-II (1000 MW) and Mangdechhu (720 MW). The Detailed Project Reports (DPRs) for these projects are being prepared. In addition, investigations and DPRs of two hydroelectric projects, namely Bunakha (180 MW) and Wangchu (900 MW), have been completed.

Although due to environmental concerns and need for sustainable development, the hydro projects developed in Bhutan so far have been run-of-river schemes, there could be possibility of development of two major storage based hydroelectric projects -- . Sankosh Dam (4000 +60 MW) and Manas Dam (1000+1800 MW). These projects have the potential to make major contributions to meet the energy demand in the region. Since the investment requirements for these projects would be quite large, the prospective beneficiary Member States could consider participating in the promotion/development of these projects.

6.2.7 Prospects of India-Bhutan Transmission Interconnections and Hydro Project Development in Bhutan

The transmission system between India and Bhutan along with the future development of hydro projects in Bhutan are being planned and developed considering optimization of investment in transmission and optimization of right-of-way in the chicken-neck area on a long-term basis along with requirement of transmission system for evacuation of power from future projects in Sikkim and North-Eastern region of India. Presently, it is envisaged that the connectivity with generation projects could be at high capacity 400kV lines upto pooling point(s) and onward transmission from suitable pooling points would be through hybrid system of HVDC and 400kV/765kV transmission lines.

6.3 Existing Electricity Trade between Nepal-India and Future Prospects

The history of Indo-Nepal cooperation on power dates back to the 1950s with the commissioning of Kataiya Powerhouse on the Koshi Canal. Subsequently, Trisuli, Devighat and Phewa hydro projects were built in Nepal in the 1970s and 1980s with India's assistance. Indo-Nepal Power Exchange began in 1971 with the exchange of about 5 MW of power and by 2001-02 the exchange of power grew to about 150 MW to meet the requirement of remote adjoining areas. **Figure 6.1** gives the details of power exchange between the two countries.

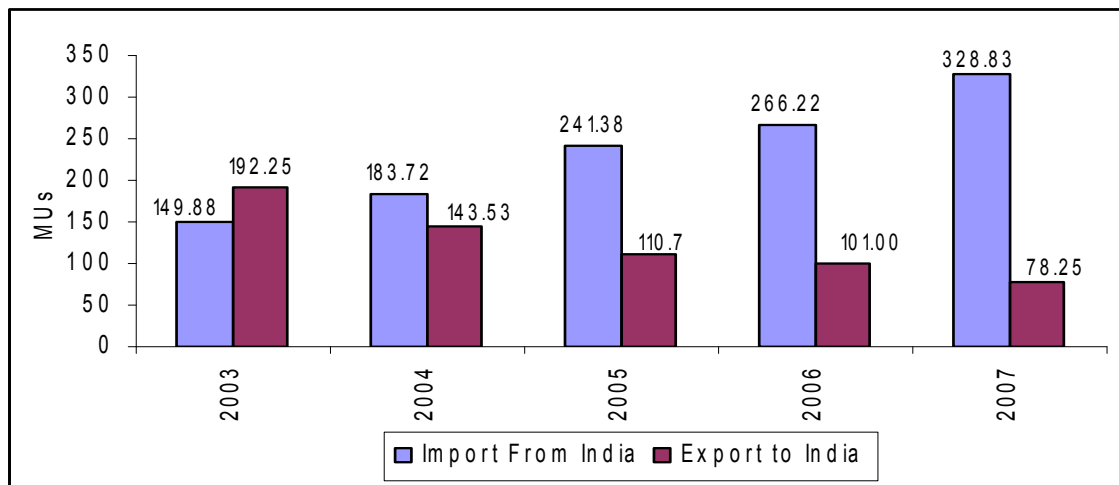


Figure 6.1: Nepal-India Electricity Trade

Source: India Country Report.

The present exchange is taking place through 21 interconnections through 11kV, 33kV, 132kV transmission lines which are not adequate to accommodate the transfer of summer surplus capacity from Nepal to India. The power exchange takes place between Nepal Electricity Authority and utilities on the Indian side namely Bihar State Electricity Board, Uttar Pradesh Power Corporation Limited and Uttarakhand. India also supplies free power from Tanakpur HEP to Nepal.

Nepal has a hydro-dominated power system whereas India is primarily a thermal system. Nepal's generation comprises mainly of the run-of-river schemes. With reduced demand during wet season (April-October) these hydro projects have to reduce generation and spill energy. This spill energy could potentially be exported as electricity to India, which faces shortage during this period. During the dry season (October to March) Nepal faces shortage of power. Presently, bilateral power exchange between India and Nepal up to 50 MW net import by Nepal is taking place. The intra-State power system in the Indian side especially in Bihar, which is supplying power to Nepal, is being augmented to enable Nepal to draw power from India in excess of 50 MW. For power transfer beyond 50 MW, Nepal needs to arrange power from Indian power market/producers on a commercial basis. Additional transmission inter-connections between India and Nepal may be planned and implemented along with the proposed medium sized and large storage hydro projects in Nepal.

Several of the prospective hydropower sites in Nepal are located near the Northern region of India, which faces the most severe power shortages, especially during the summer when Nepal's rivers overflow with water. Development of export oriented hydro power projects in Nepal, principally for consumption by India, is potentially the biggest area for cooperation. The 750 MW SMEC West Seti storage HEP exemplifies a project being developed under this model. It is already under process of development by an IPP in Nepal and a PPA has been initialled. The Government of Nepal has also either awarded or is in an advanced stage of awarding to developers some hydro projects like Budhi Gandaki storage type project of 600 MW installed capacity, Upper Karnali (900 MW), Arun III (402 MW) and Lower Arun (300MW).

6.3.1 Proposed Transmission Interconnection (220 kV / 400 kV)

Recently MoUs have been signed between Indian and Nepalese public/private sector companies for construction of a transmission line to enhance the power transfer capacity between the two countries. Initially, the following four 400/220 kV transmission lines to interconnect the Indian and Nepalese grids for import/export of power between the two countries were considered:

- Butwal – Gorakhpur
- Duhabi-Purnea
- Dhalkebar – Muzaffarpur
- Anarmani-Siliguri

Out of the above proposed four alternatives, the Anarmani-Siliguri link is not feasible as it passes through the chicken-neck area in the Indian territory, which is being used for evacuation of power from power generation projects in North-Eastern region of India and in Bhutan.

The Dhalkebar-Muzaffarpur, Butwal-Gorakhpur and Duhabi-Purnea lines were studied as alternate transmission proposals between India and Nepal, and the Dhalkebar-Muzaffarpur line was selected as it was found to be the most viable alternative both for initial transfer of power to Nepal and later for importing power from hydro projects being developed in Eastern Nepal. The Dhalkebar-Muzaffarpur link would be constructed as a 400kV D/C line initially charged at 220kV.

PTC India Ltd is presently acting as nodal agency for trade of power from/to Indian Utilities to Bhutan and Nepal. After construction of the 400kV Dhalkebar-Muzaffarpur D/C line, NEA will import power through PTC from India. At a later date, this line will be utilized for import of power from Nepal when hydro potential in Nepal will be increasingly harnessed. The Dhalkebar-Muzaffarpur line is being taken up through joint venture companies for implementation. Nepal needs to sign a Transmission Service Agreement with the transmission providers so as to enable financial closure and subsequent implementation of the project.

The present Nepal peak demand is of the order of 800 MW and is estimated to increase to about 1300 MW by 2014 and 2000 MW by 2020. Against this background, the proposal of four power transmission lines to interconnect with India, which would have a total

transmission capacity of the order of 4000-5000 MW, for implementation within five years will be excessive and in any case cannot be justified on techno-economic analysis in the short term.

6.3.2 Institutional Models for Project Development

There are mainly three models for institutional involvement for project development:

- Government to Government as in the existing arrangement between India and Nepal (BSEB / UPPCL and NEA are exporting/importing power),
- Government and Private (Public Private Partnership) as in the proposed interconnection transmission line project (IL&FS and NEA will be executing the project), and
- Private to Private as in the West Seti Project (Project developer and PTC)

There is a need to develop projects on a commercial basis at either the government level or private sector level. There is also the possibility of developing a project in partnership with a national or foreign private developer to supply power to India and other SMS.

6.4 Energy Trade Initiatives between India - Bangladesh and Prospects

6.4.1 Current Status

Bangladesh is facing a grim power situation with both capacity and energy shortages. The present peak shortage is expected to be about 750 MW (about 17%). The western grid of Bangladesh which is nearer to Eastern Region of India is mainly facing power deficit. Bangladesh has predominantly gas based electricity generation while India has substantial amounts of coal and hydro based electricity generation. There is daily and seasonal diversity in electricity demand of the two countries. The difference in weekly and festival holidays and 30 minute time diversity can also provide opportunities for exchanging power.

Bangladesh and India may decide on the modalities for mutually beneficial mechanisms to share the benefits from their respective generation assets. This would also be important from the energy security point of view for both countries. Annexure 3 discusses the proposed power interconnection option between the two countries.

There could be another possibility of cooperation between the two countries i.e. exploring and development of coal in Bangladesh and setting up thermal power projects based on coal. With its experience in coal exploration, production and related technologies as well as setting up thermal power projects based on coal, India can assist Bangladesh in development of coal resources and development of coal-based thermal power projects. This also will open up possibilities of strengthening the bilateral relationship.

6.5 Power Trade Initiative between India and Pakistan

Pakistan's informal offer to India in 1998 for selling surplus power that was available from the IPP units was primarily based on two very compulsive domestic realities. Firstly, Pakistan was under obligation to buy power being produced by the IPPs, which it could not sell in its own market, as the projected industrialization and economic growth did not materialize to absorb the electricity generated. The availability was to further increase due to the Ghazi Barotha and Chashma Hydel projects coming on stream. Surplus power production was causing Pakistan great economic loss, because WAPDA was bound to make the capacity payments to IPPs even if it did not need the power. The option left for an efficient and gainful disposal of power was to export the same to India⁴². And secondly, the international financial institutions which had either extended loans or guarantees to the power sector investors in Pakistan wanted to have an uninterrupted repayment of debts which was possible only through power sale to a stable market like that of India. But, tariff came up as a major stumbling block in the entire negotiation process that was conducted during 1998/1999. WAPDA offered a price of US 7.2 cents/KWh while the Indian side was not ready to go beyond US 2.25 cents/KWh, the rate at which the Indian power utilities were supplying power to the national grid. It was not possible for the Indian power utilities to absorb power at that high tariff.

6.5.1 India-Pakistan Power Transmission Interconnections

There is a complete network of transmission lines and grids on the Pakistani side along the north-western border of Indian Punjab. The nearest grid on the Indian side of Punjab is Patti, located very near to Lahore Ring. In 1998-99, the Dinanath (in Pakistan) – Patti (in India) link between Pakistan-India was considered to transfer surplus power available in Pakistan at that time, on radial basis, by synchronously connecting some part of the Indian load with the Pakistan grid. It may be noted that the Pakistan grid is at 500kV AC whereas the voltage adopted in the Indian grid is 400kV and 765kV AC. Therefore, a direct AC link between the two countries may not be technically feasible. For interconnecting India and Pakistan, an asynchronous link with HVDC back-to-back module(s) of suitable capacity would be needed along with a 400kV / 500kV AC interconnecting transmission line. The option of having 220 kV transmission interconnection(s) between India-Pakistan to be operated on radial mode, can also be considered/explored as an initial step. A suitable point in Pakistan (whether Dinanath or any other point) and a suitable point in Indian side (whether Patti or any other point) along with corresponding system strengthening on both sides and possible power/energy transfer potentials are required to be studied.

6.6 Power Trade Initiatives between India - Sri Lanka and Prospects

The island nation of Sri Lanka has also faced power sector capacity and energy shortages in the recent past. The country's heavy dependence on oil import accentuated the

⁴² As a reaction to power purchase proposals, the then Water and Power Minister Raja Nadir Pervaiz said, "GOP is considering a proposal to allow the IPP to export 200 MW of surplus power to India. Pakistan has got a study conducted and found it viable that surplus power could be exported to India through multi-nationals. MNCs would be asked to lay transmission lines and export electricity to India." The IPPs including Japan Power, Fauji Kabairwala Power and Liberty Power had completed their plants and were in a position to sell power to India through MNCs.

situation. Most hydropower resources of the country have been exploited and there is limited scope for further exploitation. The average cost of electricity is as high as 15 US cent/ kWh whereas the average selling price is about 10 US cent/ kWh. Thus the electricity sector in Sri Lanka is under a deep financial crisis and is seriously looking for diversification of fuel resources to address its energy security risks and also to address the rising energy demand in the island. Accordingly Government of Sri Lanka (Ceylon Electricity Board) has entered into a Memorandum of Understanding with NTPC of India for setting up of a 2 x 500 MW thermal power station in Sri Lanka based on coal in addition to the 900 MW of such generation now under construction with assistance from the Peoples Republic of China.

Another possibility that is being seriously evaluated between Sri Lanka and India is a power transmission interconnection between the two countries through a 50 km long HVDC submarine cable link and HVDC overhead transmission. To take care of reliability in transfer of power in the event of outage of one circuit, an HVDC bi-pole arrangement needs to be constructed with two overhead circuits as well as two submarine cables. The HVDC connection needs strong buses at both ends to have sufficient short circuit level at them. Accordingly, Madurai substation on the Indian side and New Anuradhapura substation on the Sri Lankan side have been identified as strong substations for this purpose. The length of the HVDC line is about 385km. The details are as followed:

Asynchronous Interconnection for 1000MW Transmission (initial 500 MW):

- 400kV HVDC overhead line from Madurai to Indian Sea Coast (near Rameshwaram) (185 km)
- 400kV HVDC cable from Indian Sea Coast to Sri Lankan Sea Coast (50 km)
- 400kV HVDC overhead line from Sri Lankan Sea Coast to New Anuradhapura (150 km) Substation
- 400kV HVDC terminal of 1000MW capacity one each at Madurai and New Anuradhapura

The proposed link could initially provide for 500 MW of power transfer with the possibility to enhance the capacity to 1000 MW in future. Summarized technical details and the cost involved are given in Annexure 4. The investment requirement for setting up the initial 500 MW of transmission is estimated at US\$ 339 with a transmission line cost of US \$248 Million and a substation cost US \$91million.

Sri Lanka energy sector officials are also in discussion with NTPC for a 2 x 500 MW coastal power station in Sri Lanka based on imported coal for supply of power to Sri Lanka. It is expected that power will mostly be exported from India to Sri Lanka over the above mentioned HVDC link, but due to seasonal variation and demand diversity, it would be possible in certain periods of time to export power from Sri Lanka with increase in coal fired power generation. This will help in optimal utilization of resources.

Sri Lanka would also like to have access to energy sources other than those in India. Nepal and Bhutan have large hydro power potential. Since the Indian load centres are in the Northern, Western and Southern parts of the country, high capacity

EHVAC/UHVAC/HVDC interconnections from Nepal and Bhutan to these regions of India could be built. Sri Lanka may avail supply of power from regional/sub-regional projects in Nepal/Bhutan through wheeling/transmission of power through the Indian national grid system and cross-country transmission links by paying the applicable open access/wheeling/transmission charges. These options would have to be evaluated techno-economically for their feasibility. To facilitate such international transactions of supply of power, enabling regulatory, commercial and legal framework would be needed.

India is also setting up LNG terminals on its West coast and there are proposals for LNG terminals on the East coast as well. Again depending on techno-economic feasibility, there could be a power plant based on natural gas for supply of power to Sri Lanka. Sri Lanka can share some of the cost of the LNG terminal depending on its natural gas share in the LNG terminal. Setting up of an LNG terminal in Sri Lanka may not be economical at present, as Sri Lanka's demand for natural gas has yet to reach an inflexion point where it can support such a terminal.

6.7 Potential Areas for Cooperation in Regional Energy Trade

The energy challenges facing SAARC countries need a coherent energy policy for tackling common problems. Such a policy is essential to deliver sustainable, competitive and secure energy supplies. SAARC member countries can cooperate on formulating such policy which would also reflect their commitment to common solutions to shared problems. The countries would also need to ensure effective exchange of information particularly of their energy market, policies, legal, regulatory and other matters and work towards a harmonious policy that supports regional energy trade. This will result in effective exchange of information and also a real coordination of approach.

The member countries must cooperate to improve regional cross border exchange and accelerate the development of regional energy cooperation while facilitating integration of their local energy markets with regional energy markets notably through adequate interconnections, such as, electricity interconnections and/or gas interconnections.

The SMS should agree on a priority interconnection plan with in a specified time frame by identifying measures to be taken by each member country involved in the interconnection. The countries could also collaborate to fix a target level of electricity interconnections, in line with the European Community, whose member countries agreed to establish electricity interconnection equivalent to 10% of their installed generation capacity. To begin with the SMS (other than Maldives) may fix a target of dedicating 10% of their electricity installed capacity for regional energy exchanges/trade. Bhutan, is already exporting a major part of its generation.

SMS would have to agree sooner or later to make their transmission interconnections operate like a single integrated grid from the end users point of view by completing the conformity of technical rules and procedures for grid connectivity required for cross border trade in energy, access to networks and suitable congestion management in the electricity market.

Transparent open access to transmission infrastructure and agreeing to common protocol

and harmonious legal, regulatory and economic rules would be essential and member countries must work towards them.

SMS also need to develop energy infrastructure. They can review and improve their medium to long term investment plans and coordinate investment with regard to cross border power interconnections, gas infrastructure and LNG facilities as well as electricity generation capacity and ensure a business climate more conducive to long term investment through increased transparency and exchange of information based on member countries' own planning.

The SMS can also cooperate to further promote, in a cost effective manner, a renewable energy development roadmap for a long-term horizon. One target could be raising the share of renewable energy to more than say 10% by 2020. Setting up such targets shall not be limited to meeting the target from within the country's RE resources but could be through regional RE trade based on cost effectiveness of such arrangements.

The SMS could also collaborate for promoting use of biomass and also agree to energy efficiency targets that would further strengthen cooperation among them. . They can bring out necessary legislative changes and put in place administrative framework arrangements to promote renewable energy and facilitate its access to the grid, wherever possible, by ensuring transparency, effectiveness and certainty of support policies.

It would be important for the SMS to provide non discriminatory, transparent and third party access to export through gas pipeline infrastructure and power transmission infrastructure. The countries may also jointly promote a strategic reserve stock of energy (particularly crude oil and petroleum products) and encourage joint stock holdings with partner countries where appropriate.

6.8 Collaboration for Clean Development Mechanism (CDM) Projects

SMS can also cooperate among themselves in developing projects under the clean development mechanism (CDM) which has tremendous potential. CDM is a mechanism created under Kyoto Protocol for projects, which reduce green house gas (GHG) emission in developing countries. India acceded to the Kyoto Protocol in 2002 and the Government is becoming more active in Global Climate Change negotiations. Although it does not have GHG mitigation obligations, it has taken active steps to address global climate change issues, notably by encouraging projects under CDM, which play an important role in curbing global emissions.

India is one of the leading CDM destinations today hosting about 1/3rd of the all registered CDM projects (2007). CDM activity in India is second only to China. These projects focus mainly on RE, energy efficiency and fuel switching. Most of the projects are being developed by Indian companies.

India's carbon base line is such that many of the RE projects in the neighbouring countries can become viable by supplying power to India to replace some of its thermal base generation and help in GHG mitigation. For example, India and Bhutan are already

cooperating on the Dagachhu Hydroelectric Project in Bhutan to develop it as a CDM project by utilizing the Indian carbon base line. As a run-of-river hydro power project, it will have an installed capacity of 114 MW with an approximate annual energy generation of 500 GWh. The overall purpose of the project is the generation of electricity based on renewable energy sources for export to India. Preliminary estimates suggest that hydropower projects in Bhutan developed to supply electricity to India could generate Certified Emission Reduction (CERs) of up to 500,000 tonne of CO₂ equivalent per annum. Thus, the sale of CERs will contribute not only to the socio-economic development in Bhutan and its financial sustainability but also help reduce CO₂ emissions in India. Demonstrable success of the Dagachhu HE Project could lead to a large number of CDM projects that could be undertaken bilaterally between India and Bhutan.

6.9 India Energy Exchange Ltd.

Indian Energy Exchange Limited (IEX) has been set up to provide a national level online electricity trading platform. It will enable the market forces of demand and supply to determine electricity prices in a transparent manner for electricity traded outside bilateral agreements. IEX is India's and South Asia's first ever power exchange. A second power exchange: Power Exchange India Limited (PXIL) was also set up subsequently. The power exchange provides a spot market (mainly day ahead for electricity) by matching demand and supply for each hour, by providing/publishing a price index. It can be viewed as a competitive whole sale spot trading arrangement that facilitates selling and buying of electricity. The power exchange is a voluntary market providing an alternative to the classical bilateral market.

Competition in the power exchange would occur through generators, distributors, traders and large consumers submitting bids for buying and selling electricity. Each sale bid would specify the quantity and its minimum price at which sellers are willing to supply energy. Conversely each buy bid would specify the desired quantity and maximum price at which the buyers are willing to buy energy. The power exchange would match supply and demand along with publishing a market clearing price.

At this stage IEX is envisaged to be a national electricity exchange, with participation limited to national players. But as the exchange evolves and necessary transmission interconnections between the SMS get established and/or strengthened, it would be possible for neighbouring countries also to trade power through this exchange. There are many successful examples of regional energy trade taking place such as the South African Power Pool (SAPP), NORD POOL, and the North American Interconnection. ASEAN countries are also planning to cooperate for regional power exchange by setting up interconnection projects. Indian integrated energy policy also recommends easy access to neighbouring countries to the Indian Power Market. This can open up huge opportunities for cooperation between the SMS.

6.10 Diversification of Energy Supplies

Energy security can be increased not only by import of a particular energy source but also by diversifying the energy mix by using different types of fuel. An economy that uses coal, oil, gas, nuclear, hydro and renewable energy of various kinds is naturally less

dependent on one particular fuel and hence less vulnerable to supply disruptions or price fluctuations of either domestic or imported energy sources. Some additional initiatives that are currently under way, especially in India and can be adopted by other countries in the region to diversify the energy mix, are given below.

6.10.1 Coal Bed Methane

It is estimated that India's resource base of Coal Bed Methane (CBM) is between 1400 BCM (1260 mtoe) and 2500 BCM (2340 mtoe). To give impetus to exploration and production, the government has formulated a CBM policy. Since Pakistan and Bangladesh are having substantial coal reserves, possibilities of CBM exist in these countries as well. India is engaged in developing/adopting appropriate technologies for the utilization of this relative new energy source in South Asia. It could share its experiences with other countries to help them harness the benefits of this energy source.

6.10.2 Coal Gasification

In-situ coal gasification can significantly increase the extractable energy from India's vast in-place coal reserves to tap energy that cannot be extracted economically with the available open cast/underground extraction technologies. Trials are in progress to establish the feasibility and economics of this technology for Indian coal and lignite in collaboration with Russia and Australia. In-situ gasification has many environmental advantages. The potential for domestic energy supply based on in-situ coal gasification can be large but it has not yet been assessed.

6.10.3 Gas Hydrates

South Asia has a very large coast line stretching from the Myanmar-India border in the East to the Iran-Pakistan border in the West. The entire coast line is rich in gas hydrates in the form of methane hydrate. Technology to harness this vast energy resource, said to be enough to meet the entire energy needs of South Asia, needs to be developed through joint research programmes sponsored by the SMS. ADB or World Bank may be approached to develop and realize the potential of gas hydrates. Success in developing this technology would reduce or might eliminate the need for oil imports.

6.10.4 Cooperation in Wind and Solar Energy Development

This is another possibility for regional energy cooperation/trade among the SMS. Wind and solar mapping for Afghanistan, Maldives, Pakistan and Sri Lanka has been done under the SARI/E program through National Renewable Energy Laboratory (NREL), USA. High resolution wind and solar maps developed for these countries provide critical information on location and extent of renewable energy resources that these countries can tap to meet their energy demand. These maps together with easy to use geo-spatial tool kits assist planners and developers in identifying the most cost effective sites for renewable energy development.

Based on these resources, it is possible to develop wind energy and solar projects in those countries. Sri Lanka wind maps have led to the award of an initial 34 MW wind power

project and offers for an additional 150 MW of wind power. Other countries can emulate the Indian and Sri Lankan experience to tap these potential sources of energy.

India is one of the leading countries in wind power development, with the fourth largest wind power installed capacity in the world. It has acquired equipment manufacturing as well as project development capability. The Indian companies engaged in the development of wind power projects are helping India to develop this renewable energy resource and also have a large presence in China and in markets in the developed world including USA, Europe and other parts of world. They can undertake development of wind power projects in all the SMS.

With the state of art satellite imaging capabilities, India could do the solar and wind mapping of the remaining three countries viz., Bhutan, Nepal and Bangladesh to help them harness the benefits from wind and solar energy.

Most of the countries in the region have been harnessing solar energy, though at a minuscule scale for lighting purposes and solar water heating systems. South Asia being one of the regions which receive large annual solar radiation has the potential to exploit and diversify the use of solar energy. Member States can share their experiences to widen the user base for such applications.

6.11 Areas for Sharing of Experiences and Best Practices

For regional energy trade to take place it is important that regulatory and trading practices are harmonious. Unless they evolve in a manner that encourages standardization of rules and procedures and simplify transaction mechanisms and reduce costs associated therewith, it will be difficult to reach the stage where markets can develop and trade can take place. Some of the SMS have put in place the regulatory mechanisms and regulators are discharging their responsibilities effectively. Others have either yet to have regulatory mechanisms in place or where the policies have been formulated and regulators put in place, they have yet to effectively discharge their functions. SMS need to learn from each other's experiences so that fair and transparent rules and procedures govern energy trade transactions under a proper regulatory oversight. Apprehensions of these governments need to be overcome through proper sharing of information. South Asia Forum for Infrastructure Regulators (SAFIR) is already a functioning body, where these regulators meet on a regular basis. SAARC Secretariat could involve SAFIR to address the concerns of governments that still have reservations in allowing deeper regulatory mechanisms to function in their countries.

6.12 Cooperation in the Areas of Capacity Development, Research and Development

There are several institutions of excellence in the region dedicated to development of the energy sector. Such institutions are spread across the region. While larger countries like India have several such institutions, others have a limited number of them. SMS could utilize the services of such institutions for capacity development of their professionals.

In order to meet the long term energy needs, it is essential to carry out Research and

Development (R&D). As the demand for energy is growing at a rate faster than the growth in the world's fossil fuel supply, it becomes essential to use fuel efficiently by using high efficiency technologies. Energy R & D would play a critical role in this aspect. There are some scientific research bodies under CSIR in India that could support related efforts of the energy sector. SMS could collaborate to offer the services of their institutions of excellence for carrying out research in various areas of energy sector development.

6.13 Cooperation in the Area of Energy Efficiency and Fuel Diversification

SMS can agree to realistic action plans on energy efficiency keeping in view that energy intensity in SMS is high and there are ample opportunities for reducing the same. This will require improvement in energy efficiency in participating countries, implementing necessary legislation on energy intensity norms and end use efficiency as well as agreement to increasing efficiency of power stations and promoting use of combined heat and power. There is also enormous scope for the applicability of energy efficiency at the consumer end through efforts among SMS to evolve standards and labelling of electric appliances. India already has evolved a Building Energy Code and Pakistan is in the process of evolving one. Other countries could evolve similar codes with the help of India and attain a reasonable level of energy efficiency in this area.

6.14 Conclusions

In essence the above discussion boils down to the following conclusions:

- Hydropower is the largest indigenous energy resource of the region and can meet a large part of the energy requirement of the SMS. They need to adopt a collaborative approach for the exploitation of this resource and possible CDM opportunities from a regional than from a national perspective alone.
- Coal, another abundant indigenous energy resource of the region, is not exploited to its full potential. Member States – Afghanistan, Bangladesh and Pakistan who have proven coal reserves, need to utilize the long experience of India in the development of coal mines/infrastructure and its utilization for power generation and meeting other energy needs in the region.
- Member States need to expedite exploration of oil and natural gas resources, the two commodities in their energy imports basket, which are impacting their economies adversely. Sharing of technical expertise and information and data on seismology can help the Member States in expediting the finds and reduce dependence of costly services they have to hire from outside the region. Where ever opportunities exist, monetizing the resource by sharing it with neighbouring countries will be beneficial in the long run.

- Diversification of the energy basket of the Member States through the development of energy resources additional to conventional energy and renewable energy (including wind, solar and biomass) provides another important opportunity to meet their energy demand. The areas that could be covered under this initiative are coal bed methane, in-situ coal gasification, and gas hydrates.
- Other important areas of collaboration would be in energy efficiency, availing the benefits under the CDM, sharing best practices, and joint research programmes.

Chapter-7: Inter Regional Energy Trade and Related Options

7.0 Joint Procurement of Energy Supplies

The current inter-regional energy trade arrangements between South Asia and other parts of the world primarily cover import of petroleum and its products, and coal and limited electricity imports by Afghanistan and Pakistan from the CARs and Iran respectively. A number of energy supply options are being explored by the SMS for joint procurement of energy supplies from outside the region. These include opportunities, such as, establishing inter-regional gas pipelines and power transmission interconnections. Some of the prominent projects on the horizon being discussed are:

- Iran-Pakistan- India gas pipeline (IPI)
- Eastern Gas Pipeline Infrastructure
- Central Asia, South Asia (CASA) Power Transmission Project (CASA1000)
- Turkmenistan-Afghanistan-Pakistan-India gas pipeline (TAPI)

A brief overview of these projects is given below.

7.1 Iran-Pakistan-India Gas Pipeline

This project has remained under discussion for the past couple of decades. However, the recent round of negotiations started in 2004, and after protracted discussions, the counterparties i.e. Inter State Gas Systems (ISGS) from Pakistan and National Iranian Oil Company (NIOC) from Iran, finally initialled the Gas Sale and Purchase Agreement (GSPA) on 24th May 2009. The Presidents of both countries signed the Inter Governmental Framework Declaration also on the same date. The Federal Cabinet of Pakistan in its meeting dated 3rd June 2009 approved the GSPA as initialled on 24th May 2009 and the GSPA was signed bilaterally on 5th June 2009 at Istanbul in Turkey.

The signed GSPA leaves room for India to join the project also at a later stage.

7.1.1 Financing of the Project

The original investment requirement for the project was of the order of US\$ 7 billion. As per the latest project negotiations, the respective sections of the gas pipeline falling within the territory of each country are to be built and operated by the concerned country. The gas volume has been revised from the original proposal of 55 BCMA to 21 BCMA to be shared equally between Pakistan and India in the first phase of the project.

It is understood that Iran has completed its pipeline up-to Iran Shehr, which is about 200 KM away from Iran-Pakistan border.

Pakistan is currently planning to lay a 42 inch pipeline in the first stage to transport only the Pakistan volume of upto 1.0 BCFD, while another section of the same size can be added later as and when India decides to join the project. The pipeline cost based on

current steel prices is estimated at US\$ 1.3 billion to supply the Pakistan volume up to Nawabshah, which is about 800 KM from the Iran-Pakistan border.

Funding for these pipelines would be based on project finance principles, with the transit charge cash flow coming from gas purchasers possessing high credit ratings and strong balance sheets i.e. those which will provide credible power purchase contracts. These project participants could be big companies such as Pakistan State Oil, OGDC, Pakistan Petroleum, Sui Northern Gas Pipelines, Sui Southern Gas Company, some international companies, and major power generation and industrial companies.

The model proposed for funding the project is fundamentally based on an integrated project structure with the Government of Pakistan or a strategic investor taking a lead role in implementing the project, and participating in the midstream activities.

Member States as Project Developers/Owners

Pakistan has sought the requisite approval and designed a financial mechanism to finance the project through equity participation by the Government owned entities. Since the funding required to complete the Pakistan segment has reduced significantly compared to the overall project financing estimated originally, it is expected that arrangements for project funding will not be a major issue.

7.1.2 Technical Aspects

This 800 KM long pipeline to transport an estimated 21 BCMA will be passing mostly through normal terrain conditions, and will not pose any major technical issues and challenges, except for pipeline security measures. This may entail higher costs than the building of normal pipeline infrastructure projects. All the countries have extensive experience of establishing gas pipelines of somewhat similar magnitude. Most of the material for the pipeline is indigenously available within the region. The only item that these countries may need to import would be the high pressure pumps for the compressor stations. Moreover, local companies are well versed in undertaking such projects.

7.2 Eastern Gas Pipeline Infrastructure

The first project of this nature that came up for discussions was the Myanmar-Bangladesh-India pipeline project. But the right of way has not been resolved so far.

It would be advantageous for Bangladesh, India and some of the other SAARC Member States to have gas infrastructure that could help them access the gas reserves in Myanmar and possibly in other neighbouring countries to the East of the SAARC region. Even if the concerned SMS as a group intend to bring in natural gas in the form of LNG, they would still require the pipeline infrastructure to evacuate the gas to the load centres from the LNG re-gasification terminals.

7.2.1 Financing of - Eastern Pipeline Infrastructure

As and when the concerned SMS decide to build the joint pipeline infrastructure referred to above, its financing may not be a major challenge, since the infrastructure would be sponsored and / or supported by several countries in the region. Their active participation would make the infrastructure project bankable and the MFIs and private sector would get interested to serve the larger market segment that would be the ultimate beneficiary of the gas supplies from this pipeline infrastructure.

7.3 Central Asia, South Asia (CASA 1000) Power Transmission Project

Kyrgyzstan and Tajikistan, the two hydropower resource rich countries of Central Asia and the potential hydropower exporters, have entered into project agreements with Afghanistan and Pakistan, the two power importing countries, for construction of the CASA 1000 transmission project. The project company has already been formed with its headquarters in Kabul, Afghanistan with representation from all four countries. The pre-feasibility studies and economic analysis studies for the project were sponsored by the Asian Development Bank and the World Bank respectively. The same have been completed. The project overview and the latest status of the developments taking place are given in Annexure 6.

7.3.1 Financing of the Project

The project is supported by the World Bank to demonstrate the potential of inter-regional energy projects for regional cooperation and economic development. As is evident from the project overview the aim of the facilitation process is to attract a private project developer for this project.

The major issue right now in view of the global economic melt down is that project developers might find it difficult to finance the project. Even if a financial close is reached in the current situation of financial crisis, the financing costs that the developer will have to bear would be in excess of project financing costs identified earlier. That might perhaps delay reaching a financial close, as per the projected time schedule.

7.3.2 Technical Issues

The project may pose some major technical challenges, as the transmission line has to pass through very rough and rugged terrain over snow clad mountains and soft sub-soil conditions. But the challenges are not un-surmountable, as the Power Grid Corporation of India has already built a 220 kV transmission system over the same mountain range under the India-Afghanistan bi-lateral aid agreement to help Afghanistan evacuate power from the CARs. One thing to note will be that given the terrain and harsh winter weather conditions the project will entail higher cost than for a similar project in normal terrain conditions. During the Donor Conference in July 2005, Power Grid Corporation of India in their presentation at the conference were able to convince the participants, especially the technical experts that the design parameters that they had envisaged for building the 220 kV system were strong enough to withstand all the hostile weather conditions that might prevail in the region.

7.4 Turkmenistan-Afghanistan-Pakistan-India Gas Pipeline

This project like the Iran-Pakistan-India gas pipeline project has been discussed over the past two decades. But the gas availability, geo-political situation in the CARs and Afghanistan, and India-Pakistan relations were the main reasons for holding back progress on this project. An overview of the project is placed at Annexure 5.

As gas pipeline projects entail huge investments, one of the preconditions for laying such pipelines is the long-term availability of the gas supplies to ensure the economic and financial viability. Now that the gas certification has been done, the governments involved have started moving towards the project preparation activities and signing of the relevant agreements.

The design capacity of the pipeline is 33 BCMA (3.2 BCFD). The route proposed for the 56-inch diameter pipeline is through Herat, Kandhar across Pakistan border near Chaman, Zhob, DG Khan, Multan and onwards to Fazilka near Pak-India border. The length of the pipeline up to Pakistan-India border is 1,680km. The cost of the project was originally estimated at US\$ 3.3 billion, which has since been revised to US\$ 7.6 billion based upon current steel and construction costs.

7.4.1 Financing of the Project

The financing options discussed above in respect of the I-P-I gas pipeline would hold good for this project as well. ADB's association as a main supporter and a good quality feasibility study would certainly add credibility to the project and help attract financing for the project.

Still the governments involved in the project will have to lend support to either their own entities to raise resources, if they choose to take the public sector route for project development or provide credible support mechanisms in place if the project is to be developed through either PPP or exclusively through the private sector.

Another option that could be explored would be the major energy consuming industries in the energy recipient countries taking equity stakes in the project, as they would be some of the main beneficiaries of the additional energy supplies. Energy intensive industries and major energy utilities might not be averse to contributing equity and/or debt for the project against assured energy supply. Giving tax breaks and other incentives to equity participants would be another option to raise resources expeditiously.

7.4.2 Technical Aspects

Unlike the Iran-Pakistan-India gas pipeline the TAPI project will have to traverse through a rugged and mountainous terrain. But gas from CARs and Balkans is being exported to markets as far as Europe. Those pipeline projects too traverse through similar terrain. So there would be no additional challenges in building this project.

7.5 Additional Options

A number of studies have been undertaken over time looking at the economic feasibility of the above mentioned trade options and the possibility of a Qatar-Pakistan-India natural gas pipeline ⁴³. These studies have been reviewed while developing the following trade options.

Four multilateral trade and cooperation options that can, over time, include almost all countries of the region have been identified here. In the selection of these options care has been taken to ensure that interests of all concerned stakeholders are addressed and that these options can be practically implemented. The subsequent sections discuss these four options in some detail and broadly estimate the economic benefits that would accrue to the Member States, if adopted. These regional energy trade/cooperation options have taken into account, the future energy demand supply position and limited resource endowments of the region and have focussed primarily on cooperation on infrastructure development within the region which could facilitate trade at a regional level.

It is also important to stress here that a long term integrated view of energy cooperation needs to be taken beyond looking at the attractiveness of each project in isolation.

7.5.1 Proposed Trade Option 1: Regional/Sub-regional Power Market

A common link cutting across all SAARC Member States is the growing demand for electricity to meet energy needs. In the near future (2010-2020), the region's electricity demand is expected to grow faster than that for any other commercial energy source, with a CAGR of around 9%.⁴⁴ However, it is expected that many of the individual Member States themselves would continue to be in a situation of shortages for quite some time to come. It is well recognised that the opportunity cost of electricity shortages can be very high. According to a TERI study done on economic value created by electricity consumption, one kWh of electricity consumed in the Indian economy raises output by Rs.39.41.⁴⁵ The corresponding value at 2006-07 prices is Rs.81.22.⁴⁶ Hence, any potential that might be exploited within the region to reduce electricity shortages would have significant economic benefits. An option the region can pursue is to develop a regional electricity market that would allow trade in any surpluses that a country may have either over the time span of a day or over a seasons. Such trade would exploit the unique characteristic of electricity – which once generated has to be consumed immediately.

⁴³ The Qatar-Pakistan-India Pipeline through the UAE and Karachi has also been considered for a long time, but its chances of materializing are dependant on whether Qatar can commit the 2.6 bcf/d of natural gas to be supplied by the pipeline given its LNG commitments

⁴⁴ Calculations based on the data provided in the various Country reports. This number understates the growth in electricity demand, as projections for electricity demand of Afghanistan and Maldives are not available.

⁴⁵ TERI study titled 'Valuation of the Socio-Economic and Environmental Costs and Benefits of Hydro Power Projects in India: Case Study of Two Selected Projects'; TERI 2005 (2005SF32)

⁴⁶ The wholesale price index number for Indian Economy was considered for inflating the coefficients at 2006-07 prices. At 1993-94 prices the coefficients was found to be 39.41. The wholesale price index number for all commodities stood at 206.1 with weight-base 100 for the year 1993-94. Therefore, the change in electricity consumption in the economy by one kWh contributes to 39.41*(206.1/100) at constant 2005-06 prices. Source: <http://www.rbi.org.in/scripts/PublicationsView.aspx?id=9545> accessed on 6th September 2008

India has an important role to play in building a regional electricity market because of its location. All trade except that between Afghanistan and Pakistan would involve India as the conduit for electricity transmission. This highlights the need for adopting a planned approach to build adequate capacities for developing electricity markets.

Establishment of a regional power market for the SAARC countries can offer manifold technical and economic benefits. These include optimal exploitation of energy resources, reduction in generation reserve requirements, reduction in overall cost of supply through competition in generation, improved system reliability, enhanced energy security, better energy access, lesser environmental impacts of power generation, and added incentives to resource rich countries to accelerate power development with resultant benefits to the country's economic growth.

Looking at international experience, it emerges that a regional power market can be set up by adopting a building block approach. Regional electricity markets need to evolve over time for a variety of reasons – technical, regulatory and policy related. The evolutionary path for this market would depend on the pace at which the regional resource potential is exploited, the demand-supply balance in the foreseeable future, structure of the power supply industry — including the network characteristics, legal and regulatory framework, government policies and, not in the least, the surpluses that these countries can identify over seasons and over time of day. A roadmap with definite time lines is, therefore, difficult at this stage. But a beginning could definitely be made. It would, therefore, be desirable to develop a framework and to identify the actions needed and conditions to be satisfied in achieving this long-term objective.

At present the electricity trade taking place in the SAARC region is limited to India-Bhutan and India-Nepal, which is primarily bilateral in nature. There are a number of interconnects that have been proposed over the years, for which detailed feasibility has also been undertaken.

The first and foremost requirement for moving towards a regional power market would be a broad agreement at the governmental level, between participating Member States to facilitate bilateral power exchanges followed by multi-lateral power exchanges. This has been an initiating point for a number of power pools currently operating across the world, for instance GMS and SAPP discussed in Chapter 5. Once this is decided, in principle, then, power system studies for different scenarios in the short, medium and long term may be taken up. These studies would help identify the possible quanta of power exchanges and transmission system requirements including the associated costs and benefits. A joint task force of participating countries could carry out the studies.

An important decision while interconnecting a number of power systems would be the mode of interconnection (synchronous or asynchronous) and a scheme for grid level protection. The radial (asynchronous) AC Link is normally used for small blocks of power exchange (up to 150 MW). Synchronous AC links could be used if it were technically possible to operate the two grids in synchronous mode, which is determined on the basis of relevant technical studies. HVDC back-to-back links could be used for interconnecting two adjacent grids for regulated power transfer or for those, which need to be operated in asynchronous manner due to operational reasons. HVDC bipole lines

are used for transferring large blocks of power over longer distances. All investments need to be justified considering economic and technical analysis.

The Indian experience of linking various regional grids to move to a national grid may be emulated for building the proposed regional/sub-regional power market and a SAARC grid/ring. India has five regional transmission grids viz. Northern, Western, Southern, Eastern and North Eastern. In India, as in case of SAARC, resources are unevenly distributed with select regions such as Bihar/Jharkhand, Orissa and West Bengal in the East having abundant coal and north and North-east India having abundant hydro resources. The demand centres in the North, West and South do not have adequate natural resources for setting up power plants to meet their requirements. Therefore, the regions were inter-linked for optimal utilization of generating resources for sustainable development. At present four regions viz. Northern, Western, Eastern and North Eastern regions are synchronously interconnected through high capacity 400kV AC lines. ER-NR and WR-NR also have HVDC back-to-back interconnections, which are operated to supplement the AC synchronous links. The Southern Region now connected with the remaining all-India grid through asynchronous HVDC/radial AC links, is expected to be synchronously connected to the other Regions by 2013-14. In India, the current scenario is to inter-connect the regional grids through more and more synchronous inter-regional links with the aim of developing a strong National Grid for optimum resource utilization and enhanced grid stability.

Along with setting up interconnections, it is necessary to review the regulatory provisions including the grid codes to ensure that the interconnected operation would not endanger grid reliability. Another important technical requirement would be well equipped and adequately manned National Load Dispatch Centres (NLDCs) in all the participating countries and a mechanism for close coordination between them. Studies are also required to be taken up on (a) augmentation of the communication and dispatch facilities, (b) joint formulation and incorporation in respective national grid codes a section which defines procedures for operational planning, dispatch and control, and liaison between dispatch centres at the regional level, (c) joint formulation of market operation rules (corresponding to the stage of market evolution), (d) identification of a nodal Load Dispatch Centre (LDC) ideally suited for overall coordination, and (e) the stage at which a separate regional level dispatch centre has to be established. There should also be agreement on commercial aspects such as (a) pricing of traded power⁴⁷, (b) transmission pricing including the wheeling charges and compensation for transmission losses, and (c) payment security mechanisms. On the policy front, incentives would have to be created for attracting investments in both generation and transmission facilities.

Different options may be considered for implementing the power exchanges between SMS. These include (a) for each country, the respective NLDC scheduling the net feasible power exchange (based on data from generators, traders or aggregators) along with the points of power export/ import for each scheduling period from that country's perspective and communicating the same to the designated nodal/ regional LDC, and (b) a common power exchange (with optional participation) dealing with all power other than bilateral ones and directly communicating with the designated nodal/ regional LDC. In

⁴⁷ As the regional market develops, price discovery would be on commercial basis, driven by demand supply balance. This is unlike the current system of price determination through negotiations.

turn the designated nodal/ regional LDC would put together the schedules and communicate the proposed net power exchanges including the injection points and price (for the part not covered under contracts) with all NLDCs for them to examine the same from the point of view of grid security and their power needs. Based on the response from the NLDCs, the nodal/ regional LDC could finalize the exchange schedule and communicate the same to all for implementation. Open access of transmission grid, transparent functioning of the nodal/ regional LDC and proper confidentiality agreements between partner countries would be prerequisites in this context.

A possible evolutionary trajectory for the market could be to start with short-term trading on a multi lateral basis. A prerequisite for moving towards multilateral trading is existence of interconnections between Member States. An important aspect while setting up these interconnect points shall be the cost of inter country transmission of power. Once short term trading works satisfactorily, the region could move to a day-ahead market and depending on the techno-commercial preparedness gradually to a spot market. It would be advisable to follow ‘a feel the shore and swim policy’ while opening up the market. It would also be desirable to keep track of how the essential pre-conditions that are required for any region to operate in a fully competitive market are satisfied. These include (a) adequate redundancy in generation and transmission, (b) electricity sales price reaching its economic value, (c) level playing field for all participants, and (d) a mechanism for market surveillance to guard against abuse of market power. Moving into a market mode of operation may also require legislative changes. If so, the time required for these changes to come into effect would significantly affect the time lines for opening up of the market.

Phasing of the Regional/Sub-regional Power Market

For building the regional and sub regional power market the region would need to adopt a phased approach. Interconnections initially established between various Member States, could then be graduated to support a regional/ sub regional market.

The cost of these interconnections depends upon a number of factors such as – power transfer capacity, length of the line, energy flow, and hours of supply. The costs of transmission interconnections could be either recovered separately from the beneficiaries of the transmission systems or could be levied as part of the tariff for energy. Alternatively, as a method for financing these interconnections the central governments of the Member States could consider providing funds to build these interconnections as a public good so as to reap larger benefits in the long term as a result of increased regional electricity trade. To identify these interconnect points it is imperative that the region collectively undertakes a detailed study to zero-in on them and also work out the investments required for the interconnections. A detailed study or a Master Plan can be prepared in line with the Regional Indicative Master Plan on Power Interconnection developed by GMS so as to identify the road map for building a regional power market. The power transmission interconnections that are on the horizon for implementation have been given in Chapter 6 of this report.

7.5.2 Proposed Trade Option 2: Regional/Sub-regional Refinery

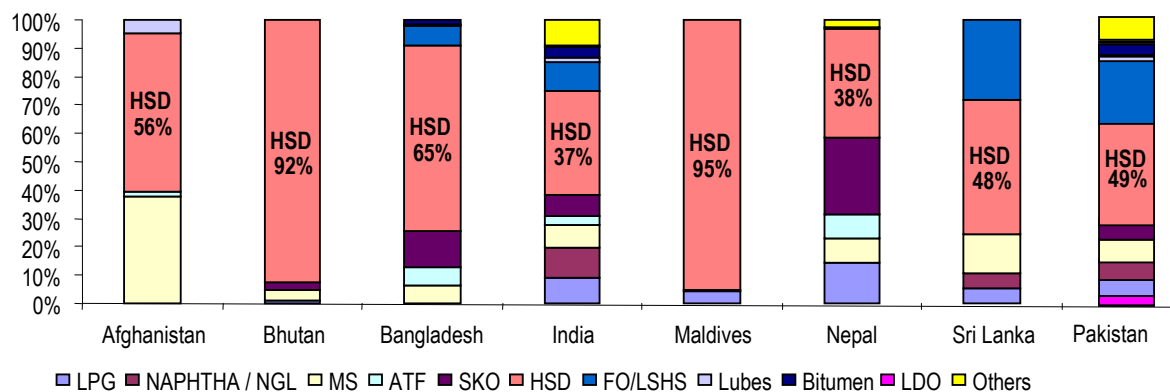
From the foregoing chapters, it is evident that the region is very heavily import dependent to meet its crude oil and petroleum product demand, and import of petroleum products has a higher energy security concern linked to it as compared to import of crude oil.

Member States such as Bhutan, Maldives, Nepal and Afghanistan are nearly 100% import dependent while Sri Lanka is about 50% dependent on imports for its petroleum product demand. Bangladesh and Sri Lanka have limited refining capacity and therefore are dependent on import of petroleum products to meet their energy demand. Current refining capacity in Pakistan meets about 68% of its demand., but Pakistan is actively pursuing three new refinery projects namely; Khalifa Coastal Refinery, New Boticor Refinery and Trans-Asia Refinery, which are expected to commence by 2012 and add around 20 mtpa. Consequently, Pakistan's diesel and furnace oil deficit would reduce considerably. Although India, on an aggregate basis, has a surplus refining capacity it is still not able to meet the demand for all its petroleum products and therefore imports some quantity of select petroleum products such as LPG.

In a five year time frame (2005-2010)⁴⁸, the demand for petroleum products in the region is expected to grow at a CAGR of 3.08% from 132 mtoe to 153 mtoe, with Maldives registering the highest growth rate of around 22.17%, followed by Sri Lanka at 12.09% and Pakistan at 11.96%.⁴⁹ Although there would be an increase in the demand for petroleum products, plans for refinery capacity expansion are limited and thus the import dependence on petroleum products is expected to increase in the future.

An analysis of the current petroleum product consumption pattern of the Member States reveals that High Speed Diesel (HSD) constitutes the major share of the total petroleum product consumption (see **Figure 7.1**). In select Member States such as Bhutan and Maldives, HSD accounts for more than 90% of the petroleum product consumption.

Figure 7.1: Petroleum Product Consumption Profile of Selected SAARC Member States



Sources: Various country report and Petroleum Planning and Analysis Cell, Ministry of PNG, GOI

⁴⁸ The lack of long term demand projections for petroleum by-products, has proved to be a constraining factor in this analysis.

⁴⁹ It needs to be highlighted that these projections do not include projections of petroleum product demand of Afghanistan and Bangladesh as none are available. Source for projections: various country reports

Another point that needs to be highlighted here is that all Member States, except India, import diesel to meet their requirements. In effect the entire region is importing diesel to meet its energy needs. India also has had some diesel imports in 2008. The current refining technology employed in most of the refineries across the region is old and there is a need to infuse state of the art technology in the refining sector.

Also, the entire region is experiencing rapidly increasing demand for electricity and would require an adequate quantum of furnace oil based power projects. Therefore, any proposed refining capacity should also have the configuration to address this need.

Given the above points, the region could consider cooperating in *setting up a Regional/Sub-regional refinery* to meet the petroleum products demand of the region. The refinery would be aimed at enhancing energy security of the region by decreasing its dependence on imports of petroleum products and configuring it so as to maximise HSD production. Based on projections given in the respective country reports and assuming that the current dominance of HSD is expected to continue, it is expected that a 23 MMTPA refinery would suffice to meet the HSD demand of the region (2010 scenario). The total investment is expected to be around USD 8.1 billion⁵⁰. If the refinery configuration is such that 65% of its product is diesel, then the diesel production from the refinery would be about 14 mtoe. At USD 100/bbl (US dollars per barrel) of crude oil, HSD free on board (f.o.b.) price is expected to be USD 135/bbl. Assuming that the diesel produced by the refinery is sufficient to meet the entire diesel import requirement of the region (excluding India), the region would save around USD 14.80 billion on account of foreign exchange saved by avoiding diesel import. Foreign exchange would however be incurred on feedstock in the form of crude oil for the refinery. Further, assuming a production profile with 3% LPG production, 10% naphtha, 15% petrol and 5% petroleum coke along with 65% production of diesel⁵¹, the refinery is expected to earn a net annual revenue of USD 2.75 billion at a crude oil price of USD100/bbl (reducing to USD 2.07 billion at a crude oil price of USD75/bbl). The expected pay back period for the refinery could be about 3 years. Detailed spreadsheets for the above mentioned analysis are in Annexure 1. If the 65% of diesel production is changed to 60% diesel and 5% furnace oil (valued at 70% of crude oil price), the refinery can be expected to earn a net annual revenue of USD 2.20 billion.

From the above it clearly emerges that setting up of a regional/sub regional refinery shall be beneficial to the entire region, and this benefit is expected to go up if high crude oil prices prevail.

The Regional/Sub-Regional refinery can be set up as a Special Purpose Vehicle (SPV) owned by interested Member States, and regulated as per agreed terms, with the specific objective of setting up additional state-of-art refining capacity that would be available to more than one country. While it is suggested that this refinery should operate on commercial principles (import parity pricing at refinery gate), by virtue of their ownership share in the refinery, participating Member States would obtain an additional source of income. This SPV can operate under various models:

⁵⁰ Assumption: Investment requirement for 1 MMTPA refinery is USD 357 million

⁵¹ The production profile is based on discussions with refining experts

- (i) **Grass-Roots Refinery:** The SPV can be entrusted with the responsibility of setting up a grass roots refinery to meet the petroleum product needs of participating Member States in an optimal manner. Identifying potential location and sizing, and obtaining operational clearances would all be the responsibility of the SPV.
- (ii) **Additional refining capacity in planned capacity additions:** There are a number of refinery capacity expansion projects that are planned in the region, especially in India. The SPV can be tasked with the responsibility of negotiating incremental capacities in such projects for meeting the needs of other member-states – individually or severally. The interest of participating countries in such incremental capacities may differ by the specific locations where such incremental capacity is being sought. This could be a less expensive and accelerated method of accessing capacity than setting up a grassroots refinery.

Both methods mentioned above could have a long gestation period. It takes about three to four years for commissioning a new refinery and two to three years for expanding an existing one. In the meanwhile, either of the following interim arrangements can be adopted by the region as short term options with the first option being less cumbersome:

- (i) **Interim arrangement with existing Indian refineries:** The SAARC region can benefit from the currently existing refining capacity by tying up commercial agreements with existing Indian refineries closer to their respective borders to supply the required petroleum products. Locational advantages may allow these countries to source imports at a lower cost as compared to importing the products from longer distances.
- (ii) **Common crude procurement and refining at an existing refinery:** Participating SAARC Member States can jointly procure the required crude, possibly through the above defined SPV, tie up with an existing refinery with spare capacity to process the crude and supply the products to participating Member States (fee-for-service model).

Along with savings on outflow of foreign exchange, following are some of the key benefits that the region would derive by adopting any of the above approaches:

- Most of the existing refineries in the region are old and require upgrading to increase output. The refining capacity in three of the four Member States that have refining capacity has remained nearly constant over the past few years. Pakistan has added only 1MMTPA of additional refining capacity since 2001.⁵² Both Bangladesh and Sri Lanka have one refinery each, with a refining capacity of 1.5 MMTPA and 1.2 MMTPA respectively.⁵³ On the other hand, India has been augmenting its refining capacity on a regular basis.

⁵² Pakistan country report

⁵³ Respective country reports

- It is expected that a regional refinery would be able to supply products within the region at a lower cost as compared to each country building its own refinery due to the benefits of economies of scale. Economies of scale have been one of the driving forces for the African region to consider building strategic refineries in the region. Member States with the requisite technology could provide technical inputs for building the refining.

While developing a detailed feasibility for the refinery project the following need to be considered, to ensure a mutually beneficial and profitable venture:

- Location of the refinery – for either the grass roots refinery or add-on capacity – shall be a crucial factor in ensuring favourable economics for the project. Therefore, the refinery location has to take into account the transportation costs of sourcing crude oil to the refinery and supplying petroleum products to the Member States.
- For transporting refined products, the region could allow swap arrangements for supply of petroleum products across the existing refineries. This could also help in limiting transportation costs for petroleum products. This swap arrangement could be worked out between the regional and domestic refineries. Some of the domestic refineries have an advantage in that they are located in proximity to the border of the adjoining Member States. The regional refinery can have swap arrangements with these refineries under which it could supply to markets of the domestic refineries located closer to it and in turn the domestic refineries can supply to the regional refinery markets closer to them.
- A common framework for pricing petroleum products to be supplied from the refinery would need to be worked out.
- Petroleum product quality would be another factor that would impact the refinery configuration.

7.5.3 Proposed Trade Option 3: Regional/Sub-regional LNG Terminal

Concept and Rationale

A common thread running across the region is that it is a natural gas deficit region. The three Member States Bangladesh, India and Pakistan using natural gas in their energy mix are facing a deficit in natural gas supply. For instance, in Bangladesh out of a 2008 power shortage of about 1000 MW, 600-700 MW was due to non availability of natural gas.⁵⁴ In India, the gas based electricity generating capacity requires about 29 mtoe (89 MMSCMD), however it is being supplied only about 13 mtoe (40 MMSCMD) of the resource.⁵⁵ The deficit position is more worrisome for Member States, such as, Bangladesh and Pakistan where gas is the predominant resource of energy. India and Sri Lanka are making efforts to diversify their energy basket. While India is trying to increase gas supply, Sri Lanka has sought to include natural gas in its energy basket. For Member States such as Bhutan also, diversification from hydro to other sources of energy

⁵⁴ Based on discussions with Bangladesh's energy sector experts

⁵⁵ India Country Report

for electricity generation may be desirable, particularly as in winter months, when electricity demand is at its peak, power generation from hydro resources goes down substantially forcing the country to import electricity. In 2005, Bhutan imported around 18 MW of electricity from India.⁵⁶

In the long term (2020) the region is expected to experience a natural gas shortage of around 99 mtoe.⁵⁷ This is a substantial deficit, and is illustrated by the fact that if the region is able to meet this deficit, it would be able to commission 75 GW of additional power generating capacity. Almost all countries of the region have expressed an interest in accessing larger quantities of natural gas and an interest in expanding the proposed IPI pipeline as well as the proposed TAPI pipeline to serve other countries of the region has been expressed time and again. While flagging this interest, recognising the inflexibilities of sourcing natural gas imports through the pipeline route as well as the current limitations on quantities, it is proposed here to seriously explore the possibility of developing a bulk natural gas import infrastructure based on the LNG technology. Not only would this provide wider and flexible opportunities for sourcing natural gas but could also potentially be faster than the pipeline projects referred to above. The region may, therefore, also plan to build a *regional/ sub regional LNG terminal*.

There are a number of arguments that can be put forward in support of the LNG terminal. First, the regional/ sub regional LNG terminal would provide the importing Member States more supply options for importing LNG (as mentioned earlier). At a single large terminal, cargoes from multiple supply sources could be received.

Second, in an LNG terminal the Member States have options of importing LNG on both long-term as well as through spot contracts to meet temporary increase in natural gas demand.

Third, any cost advantage that a pipeline project may have had would recede in the future as it is expected that the price of natural gas supplied by cross border pipelines would move in line with international LNG prices. This was highlighted when, for the TAPI cross border natural gas pipeline, the gas supplier suggested that the price of natural gas may be linked to that of market prices of natural gas.

Finally, with technology development, the cost gap between establishing pipelines and importing gas through the LNG route is closing fast.

Setting up an LNG terminal, however, is a capital intensive investment and it may not be feasible for each Member State to commission an LNG terminal individually. Also, select Member States such as Sri Lanka would have a marginal demand as compared to other Member States in the region. An advantage the region has for sourcing natural gas (both in LNG and piped natural gas) is that it is surrounded by countries/ regions such as the Caspian region, Algeria, Middle East and Myanmar and hence it may be easier for the region to source the resource. The current international scenario indicates a tight natural gas market, but it is expected that a regional/ sub regional LNG terminal would enhance the negotiating power of the SAARC region.

⁵⁶ Bhutan Energy Data Directory 2005

⁵⁷ Based on various country reports

Following are the benefits that would accrue to the region as a whole with setting up of a joint LNG terminal.

- The region would be able to bridge the substantial natural gas supply deficit it faces in the medium as well as in the long term.
- Diversification of the current energy basket of the Member States, as most of them have a single fuel source predominating their energy resource base
- Clean resource: Natural gas is a cleaner energy resource as compared to coal. Therefore, natural gas usage replacing coal shall have favourable impact on the environment.
- Economies of scale: Instead of each member state building its own LNG terminal, a joint LNG terminal would help the Member States in reaping benefits of economies of scale.

Financial Structuring Options for the LNG Terminal

There are a few options that can be considered for deciding the ownership structure as well as financing options for the regional/ sub-regional LNG terminal.

The first option for the terminal is to structure it as a joint holding of the participating Member States. This could be through equity holding of the participating Member States.

Alternatively, the participating Member States may also consider involving the private sector in building the LNG terminal and using the storage facility on a common carrier principle. This model is similar to the model discussed in Chapter 5 with reference to the Baja California LNG terminal. The storage facility can then be auctioned to the interested consumers on a bid basis so as to tie up the supplies. Supplies could be tied on both long-term basis and short term basis.

The third option that is available for the ownership and financing is to build a Merchant LNG terminal for meeting natural gas demand of the region. This option does have a higher market risk associated with it.. The Hazira LNG terminal in India, located on its western coast functions as a Merchant LNG terminal, wherein, it procures LNG on spot contracts and then on the supply side also has short to medium term contracts. The promoters of the Hazira LNG terminal are Shell Gas B.V, and Total Gaz Electricité Holdings France. A deviation from the usual practice, a merchant LNG terminal offers flexibility in contract duration to match fluctuations in customer demand profile. The Hazira terminal was built to benefit from the number of LNG projects existing across the globe, which Shell wanted to exploit. In this proposed structure, involvement of the private sector is also expected to be beneficial.

In terms of commercial arrangements there are a number of options that are available for pricing the LNG to be supplied from the LNG terminal. From the following options one option can be selected based on expected maturity of the market to accept LNG, price of LNG source, ownership structure, and terms and conditions of functioning of the LNG terminal operator.

- (i) Fixed charge – under this arrangement the developer charges its customers a fixed charge based on the price at which the LNG is procured.
- (ii) Regulated by a common regulator – under this arrangement the price for LNG is decided on the basis of principles as defined by the common regulator in the region using cost plus or performance benchmarked pricing. Setting up of the common regulator would require first and foremost harmonization of the different policy and regulatory regimes and possibly customs and tariff structures existing across the Member States.
- (iii) Selling of quantities through a bidding process – This price setting mechanism is similar to that followed in the Baja California case. The bids invited could either be price or quantity bids. Under the first case, the bidding process shall be used to determine the price for delivery and under the latter case the price may be fixed by the operator, and the consumers are required to bid for quantity of LNG as well as the period of supply. Under this case also, as in case of Baja California, there could be two prices prevailing, one short term price, which is higher than the long term supply price.

The following are the key parameters that would require due consideration while undertaking a detailed feasibility of building a regional/ sub regional terminal:

- (i) A crucial factor for deciding the location of the LNG terminal would be the relative transport economics and availability of requisite port facilities, which are important determinants in deciding the place of setting up the LNG terminal.
- (ii) An LNG terminal dedicated to meet the power and fertilizer demand for the region shall be a good option to pursue.
- (iii) The establishment of a backbone pipeline network would be a pre-requisite to exploring this option unless the transfer of gas takes place through wires in the form of electricity.

Presently the only country in the region to import natural gas in the form of LNG is India, through the company named Petronet LNG Ltd. It set up its first plant in Dahej and is now in the process of setting up an LNG receiving and re-gasification terminal at Kochi in Kerala with 2.5 MMTPA nominal capacity which is equivalent to 8 MMCMD of natural gas, with provision of expansion up to 5 MMTPA. Storage and Re-gasification facilities will include unloading arms, two tanks of 110,000 cubic million capacity each, vaporization system and utilities and off-site facilities. The estimated cost of the project is INRs. 20,000 million (US\$ 445 million)⁵⁸. The other terminal India is putting up is at Dabhol, Maharashtra with 2.5 MMTPA nominal capacity with a provision of expansion up to 5 MMTPA by Ratnagiri Gas and Power Private Limited. To begin with SAARC Member States could initiate this process by setting up a similar facility and gain

⁵⁸ Petronet LNG Website, <http://www.petronetlng.com/kochi-terminal.asp>

experience and confidence to increase the number and the capacity of such LNG facilities in the region to meet the regional energy demand.

As can be interpolated from Table 7.1 below; the cost of electricity generated from LNG, priced at \$ 18/GJ works out to \$ 0.12/kWh as against the diesel based electricity generation cost of \$ 0.21/kWh at the diesel price of \$ 784/MMT (\$18/GJ). Countries which are using diesel to partially meet their electricity demand would benefit immensely by fuel switching to accessible natural gas.

7.5.4 Proposed Trade Option 4: Regional/Sub-regional Power Plant

A major hindrance to development in the SAARC region is that a majority of Member States in the region are facing substantial power shortages and would require considerable addition in the power generating capacity to meet the current demand as well as ensure that electricity access is available to all. Member States such as Afghanistan and Bangladesh had a growing power deficit of more than 20% in 2007. Pakistan had a power deficit of around 16% and India and Nepal had power deficits in the order of 10%.⁵⁹ While Bhutan does not have large annual deficits, it does have seasonal deficits, driven largely by its dependence on a single source of electricity generation. To avoid any further worsening of the electricity situation, the Government of Bhutan has currently put a moratorium for energy intensive industries till additional power generation capacity is added to the system.⁶⁰

Therefore, the region may consider *commissioning a Regional/Sub regional power plant*. A regional/ sub-regional power plant refers to a power plant set up in the geographical territory of one country with the intent of using the power generated from it not only by the home country but others as well. The plant may be set up either jointly by the countries or by a third party. A Regional/sub regional power plant is not a new concept as seen from international experience and also regional experience⁶¹. The rationale for this in the present context lies in the following.

- All Member States are facing energy deficits and their power requirements are increasing at a fast pace;
- Capacity addition within the country to meet the growing demand may not be easy due to constraints of fuel availability, fiscal resources, etc.;
- Unexploited hydropower and the coastal facilities for import of fuels in different countries could be optimally utilized;
- Economies of scale are likely; and
- It would provide an opportunity to those countries which may not have the demand or resources to develop their natural resources and thereby realize significant improvements in their own economy.

⁵⁹ Based on information provided in the Country Reports

⁶⁰ Source: Bhutan Country Report

⁶¹ Regional examples include power projects set up under Indo-Bhutan and Indo-Nepal co-operation. The inter-State power projects in India, like Ultra Mega Power Plants (UMPP) and those set up by NTPC, NHPC, NPC, etc also has this concept at a utility level.

There are various options to be considered in proceeding with this concept like size, location and technology of the plant, cost and benefit sharing mechanism. The pros and cons in case of each of the options need to be carefully assessed and a consensus arrived at.

Size, Location and Technology Options

These are to some extent inter-linked. Size would depend upon the power needs of the participating countries and how much power each country would like to draw from a regional/ sub-regional plant keeping in view its own energy security concerns. The type and availability of fuel resource (that can be techno-economically developed) at a particular location would also have an impact on the size and technology of the plant. For example, the prevailing regional scenario shows prospects of large hydropower plants in Bhutan, India or Nepal. Similarly, a LNG based or imported coal based plant could be conceived in a location which has relatively easy access to the fuel through import (port location). Bangladesh, Pakistan, India and Sri Lanka could be considered for such a plant.

An option available to the region for development of the regional/sub regional power plant is that it could be based on natural gas to be supplied from the proposed regional/sub regional LNG terminal. One advantage LNG offers is that the cost of power generation based on LNG is much lower than that based on liquid fuels such as diesel. This is highlighted by **Table 7.1**. The table summarizes cost of power generation by LNG and diesel based generation at various price levels.

Table 7.1: Cost of Power Generation from Different Fuels

LNG Price	LNG Price	LNG CCGT generation	Diesel price	Diesel price	Diesel based generation
\$/MMBtu	\$/GJ	\$/kWh	\$/MMT	\$/GJ	\$/kWh
8	7.58	0.060	784	18	0.210
10	9.48	0.072	990	23	0.270
12	11.37	0.083	1503	35	0.400
15	14.22	0.100	1605	37	0.430
20	18.96	0.128	1810	42	0.480
25	23.70	0.157	2015	46	0.530
30	28.44	0.185	2527	58	0.660
35	33.18	0.214	3040	70	0.800

Source: Author's analysis

Although the setting up of an LNG based power plant may not be as competitive as an imported coal based power plant based only on financial costs, if the environmental costs, especially those related to emissions of carbon-dioxide, are internalized, the economics move in favour of the LNG based power plant. This environmental benefit of using LNG vis-à-vis coal has been the driving force in commissioning of new LNG terminals (considering the constraints in accessing coal supplies also). The same is exhibited by the ECA LNG terminal, as discussed earlier in Chapter 5. The region may also explore the possibility of generating additional revenues through the Clean Development Mechanism

(CDM) route for an LNG based power plant.

Developing a regional power plant based on the hydro-power resources within the region may also be explored along with other options, such as setting up of this regional power generating capacity either on imported coal or imported LNG – both of which are more attractive than the significant current dependence on imported diesel based power generation.

The environmental and social impacts, transmission facilities that are required to distribute power to the participating countries could also vary from site to site. Thus, the cost economics would depend on the size, location and technology chosen including sourcing of fuel. Ease of access to location, issues related to fuel sourcing, time for preparation of a detailed project report, processes for project clearance and approval by concerned authorities, construction time, and extent of project risks would also merit consideration in making the final decision.

As a first project it appears prudent to select a “low hanging” fruit which has minimum complexities in implementation, demonstrable GHG benefits, and indicative tariffs comparable to the marginal cost of generation in the respective countries in economic terms.

Once the concept is accepted and the size, location and type of the power plant are decided for which a detailed feasibility is required, agreements would be required on the following aspects relating to implementation.

- Ownership of the plant
- Selection of developer
- Arrangement for project facilitation
- Agency or agencies for planning and implementation of associated transmission system
- Principle of cost and benefit sharing including royalty aspects, if any
- Mechanism for monitoring and control of power transfers as well as settlement mechanisms

Ownership options include joint ownership of participating governments⁶², full private sector ownership or a joint venture involving private sector and the governments of participating countries. Government participation could also be through a public sector undertaking. Public-private participation model is preferred as it could provide some involvement of the governments in the project management and also at the same time provide a hand holding comfort to the private developer. The projects could be awarded to the developer on BOO (build, own and operate) basis for say 30-40 years with a provision for handing it over to the concerned governments thereafter or for granting extension on request.

The selection process adopted for selection of the developer needs to be transparent and impartial giving due weight to its qualification, experience and credibility. The process of

⁶² In this equity holding could be based on the share of power for each country from the power plant.

selection should be such as to ensure a level of confidence both among project developers and investors as well as financial lenders. Tariff-based bidding would be ideal as it would help to get the best price⁶³. However, this may not be possible for hydropower projects, especially if well-investigated project reports or details of some of the planning data⁶⁴ are not readily available in public domain. Where it is not possible to adopt a tariff-based bidding, the tariff should be regulated and determined as per a pre-defined methodology preferably by an independent regulator.

Whosoever be the developer a vehicle for project facilitation is highly desired. This will help attract investors and also speed up the implementation process. A Special Purpose Vehicle (SPV) may be created for this purpose, which would facilitate fuel linkage, environmental and local clearances, land acquisition, etc. The SPV could also be entrusted with the responsibility for the tendering process. It would also provide a single point of contact for the developers. This is especially important in the case of a private developer or a public sector undertaking from a different country. Such an SPV model has been adopted in India under the Ultra Mega Power Plant (UMPP) projects. Under this policy initiative of the Ministry of Power, GoI, a SPV has been formed for each of the proposed 4000 MW UMPPs. It is entrusted with the responsibility of undertaking all the preparatory work such as site selection, fuel tie up (in case of pit head power plants only), expediting clearance and preparation of the detailed project report. Post completion of the preliminary work, the SPV invites bids from potential investors through a competitive process on a least cost tariff basis. The SPV is then transferred to the successful bidder along with the assets and liabilities.

In the above cases it is assumed that the developer enters into a long-term power purchase agreement (PPA) with the prospective buyers. Another option would be setting up the plant as a merchant power plant where there is no PPA and the developer takes the entire risk of selling his power. But for a regional/sub-regional power plant, this model does not appear feasible at the present juncture. Nevertheless, it is possible that the developer may decide on a capacity in excess of the committed purchases by the participating countries and look for avenues to sell that excess in the short-term market.

Transmission System

Necessary transmission links need to be established for delivering the power to the participating countries as per their requirements. Planning of the transmission system for evacuation of power for this purpose, especially from a regional/sub-regional plant is a complex exercise. It should take into consideration among other things, the grid development in the respective countries, RoW (right-of-way) issues, operational and reliability aspects, etc. A joint team of engineers from the participating countries could be set up for this purpose, which could carry out the requisite planning studies and propose an optimal transmission expansion plan acceptable to all the participating countries.

⁶³ This has been clear in the biddings in India for the UMPP projects.

⁶⁴ This could be so in case of hydrology data, especially that relating to river basins covering one or more countries. Further, the uncertainties relating to geology, hydrology, R&R (re-habitation and resettlement) needs, etc, generally associated with large hydropower projects may have significant impact on the completed cost.

The objective should be to minimize the cost of the transmission system associated with the project. The obvious choice for this would be to interconnect the plant/ grid of the host country to the nearest grid points in the countries drawing the power, considering of course the availability of ROW and operational and reliability concerns. The voltage level and nature of interconnection would depend on the quantum and distance (which would depend on the relative location of the power plant and the supply points in the different grid systems) of power transmission as well as the RoW constraints. Where power transfers are small, say for example of the order of 50 MW, and the grids are contiguous, simple radial interconnections⁶⁵ would serve the purpose; however, where power transfers are large and power has to be wheeled through the power systems of intermediary countries, the transmission system has to be planned in more detail considering the impact on the intermediary system(s). The interconnection between any two systems may be synchronous through AC (alternating current) lines or asynchronous through DC (line or back-back station⁶⁶). The choice in this regard as well as the need of additional power electronic control systems would depend upon the grid characteristics and operational requirements. All these have cost implications and hence the choice has to be based on detailed studies. It should also be noted in this context that the incremental transmission requirements within a country could vary depending upon the point of interconnection and hence what is more economical from a regional point of view may not be so for a particular country. An agreement on sharing of transmission charges assumes importance in this context⁶⁷.

An agreement on an agency for implementing the transmission system improvements should also be identified. The options available in this regard are (a) implementing by an Independent Power Transmission Company (IPTC) either as a fully private owned one or a joint venture with a public sector transmission company; and (b) implementing through the respective national transmission utilities as per a jointly agreed design and construction plan. Both these models are in operation in the region.

Regulatory Aspects

In establishing any regional/ sub-regional power plant the following regulatory aspects would merit consideration.

- Principles for price regulation (both for the power produced and transmission system).
- Scope of performance regulation
- Agency/ agencies responsible for regulation
- Accounting and settlement procedures
- Validity period for the agreements and provisions for review

⁶⁵ In a radial interconnection, part of the grid of the receiving system is islanded from the rest (load in this part of the grid being equal to the share to be received) and connected to the power system supplying power. The power systems of the two countries are not operating interconnected in this arrangement.

⁶⁶ In a back-back interconnection an AC line links the two power systems; but at the interconnecting point power is converted from AC to DC and then again reconverted to AC.

⁶⁷ The experience of Indo-Bhutan projects and of inter-State generation projects in India could provide some useful lessons.

These should be of interest to the participating countries as well as prospective developers. It would also be necessary to examine ab-initio whether the proposed implementation strategy would necessitate any amendment to the electricity laws in the concerned countries⁶⁸. As far as possible this should be avoided or pragmatically accounted for in deciding the implementation schedule.

7.6 Suggested Action Plan

In each of the proposed trade options, a number of factors that influence the economics and feasibility of the trade option have been identified. There is a need to undertake a detailed techno-economic feasibility for each of the alternatives identified, based on which only the final shape of the trade option would be decided. Further, the current analysis is preliminary in nature and would need further refining to proceed further. Some example economic analyses covering a typical high voltage power transmission link, an onshore natural gas pipeline, and an onshore oil pipeline are given in Annexure 7 to this report to illustrate the broad parameters to be considered.

A suggested approach for taking these proposed trade options forward is to examine the aspects outlined above in the context of a few relevant projects short-listed on the basis of discussions with member countries and if possible with a few interested developers.. Such an examination could form the basis to prepare appropriate pre-feasibility and feasibility reports, which should become launching pads for project implementation. ADB may consider TA for this purpose.

The SAARC structure provides the framework for taking these proposed regional trade option forward. Based on the consensus between the Member States, SAARC may set up technical committees under the Working Group of Energy, formed during the Twelfth SAARC Summit to take the proposed trade options forward.

While developing the various energy trade options, following elements should also be considered:

- Analysis to quantitatively evaluate technological and commercial options and location where applicable, and to determine institutional and financial arrangements and implementation framework.
- Identification of specific opportunities keeping in view regional demand and supply of petroleum products.
- Lessons learnt from and way forward for existing proposals like gas import options available for the region.
- Prioritization of options and projects according to the needs of Member States.

⁶⁸ In the event of a need for significant changes to the laws through a legislative process there will be a high level of uncertainty in the implementation time.

Chapter 8: Conclusions and Recommendations

8.1 Conclusions

The SAARC region is rich in hydropower and renewable energy resources, but it is deficient in hydrocarbon resources. The region has not been able to exploit the indigenous energy resources due to various constraints including lack of: (i) financial resources to undertake capital intensive projects, (ii) cross border energy infrastructure to facilitate regional energy trade, (iii) spirit of cooperation to collectively address energy issues, and (iv) institutional mechanisms that could promote inter and intra regional energy trade. SMS could benefit by sharing their experiences and success stories in addressing energy challenges faced by the individual Member States, but there is no mechanism to facilitate such a process.

The region is flanked by energy resource rich countries/regions, such as West Asia, the Central Asian Region, Iran and Myanmar. There is significant potential for importing energy in its various forms from these regions/countries at competitive rates to meet the growing energy demand of the SAARC region. Tapping this potential is vital for not only sustaining, but also accelerating the economic growth of the SAARC region.

Except in certain cases, initiatives undertaken thus far to promote inter and intra regional energy trade have yet to reach a stage where, actual execution of projects could take place for improving the energy supply situation in the SAARC region.

The SMS recognize the barriers to as well as the benefits of regional energy trade and cooperation. But the initiatives required to overcome the barriers, and create an enabling environment to harness the benefits of energy trade are yet to be undertaken.

8.2 Recommendations

The recommendations emerging from this study have been divided into policy initiatives and project activities that the SMS need to undertake to promote and harness the benefits of regional energy trade and cooperation among the SMS.

The following sub-sections discuss the key policy interventions and frameworks that need to be put in place by the SMS to create an environment conducive to promote regional energy trade and, thereafter, summarize the activities that need to be undertaken to expedite regional energy trade.

8.2.1 Develop SAARC Regional Trade and Cooperation Agreement

The first and foremost step that all Member States have to undertake is to commit to a common agreement to promote energy trade in the region. This agreement, which would also need to be environmentally sensitive, would be similar to the IGA signed by the GMS countries and be the cornerstone for promoting energy trade in the region.

Such an agreement could be called the SAARC Regional Energy Trade and Cooperation Agreement and can be developed by first building the basic framework conditions for developing regional energy trade and then developing an Inter Governmental Agreement (IGA) to promote specific energy trade initiatives in the region. A similar agreement was also the starting point of development of the SAPP in Africa. The Inter Governmental Memorandum of Understanding signed among member governments of SADC at the time of formation SAPP, laid down the agreement conditions for developing the power pool in the region. Further, there were agreements among all expected participants of the power pool – boards of directors of utilities, senior utility managers, and operating members of the pool. Efforts were also made to define important operational aspects of the power pool through the operating guidelines.

For the SAARC region, it is suggested that the Member States may first come together and develop an IGA to promote regional energy trade. This agreement should define the areas where the governments of the Member States shall commit to work towards regional energy trade. Further, it may also prioritize the regional energy trade initiatives so that the relevant stakeholders can then come together and develop detailed feasibility reports for the prioritized trade options.

8.2.2 Harmonize Legal and Regulatory Frameworks

Energy markets in individual Member States are governed by the individual legal, regulatory and policy frameworks. The existing legal and regulatory framework in each of the individual member countries is discussed in Chapter 3. A highlight of the current framework is that the institutional structure already exists in most of the Member States. This creates the first step for harmonizing relevant frameworks. Each member state in the region has the requisite institutional set up, in terms of the relevant ministries. Select Member States such as Pakistan, India and Bangladesh have energy sector regulators also. However Pakistan and India have separate sector-wise regulators and Bangladesh has one energy regulator. In the case of Sri Lanka, it has a Public Utilities Commission which is not restricted to only the energy sector. Such divergence in the mandate of regulators across the region can create a problem in coordination. Therefore, as a first step these regulators need to work together to develop a road map for harmonizing the relevant regulations.

The legal, policy and regulatory risks multiply in the case of a cross border transaction as the trade arrangements need to deal with multiple frameworks. The risks are further increased by the fact that the investments required in such projects are substantial and the investors need to be given an assurance of return on investment. To mitigate these risks the region needs to move towards a common legal and regulatory framework to govern the cross border transactions. This need for harmonization of legal and regulatory

frameworks is also highlighted in the case of the Nordic Pool. Under the pool arrangement, the regulatory reforms in all the member countries were at the same level. All the utilities in the region were unbundled so as to clearly delineate roles of each of the players (generation, transmission and distribution) thereby ensuring a smooth functioning. There was a TSO in each member country to ensure that the national entities maintained grid discipline, as also a regional TSO to ensure grid discipline across countries.

8.2.3 Build Comprehensive and Reliable Energy Database

A comprehensive and reliable energy database for the region would facilitate better estimation of intra and inter regional trade and cooperation benefits. Moreover, sharing of information is a strong confidence building measure that could pave the way for better cooperation and trade within the region. The database would also aid in better planning at the regional and/or sub-regional level. Also, given the renewable potential in the region, it is essential to include the results of energy resource mapping exercises in the database. The review of international experience also shows that developing an energy database would aid in developing regional energy trade ties. For instance, prior to the operation of both power pools referred to earlier (Nord Pool and SAPP) the relevant databases were built with respect to electricity demand and supply patterns of the participating countries, along with the generation profiles and the prevailing tariff regimes. A comprehensive and reliable database would also aid in developing operational guidelines for the selected trade options.

8.2.4 Promote Alternative Financing Mechanisms for Developing Regional Energy Trade and Cooperation Initiatives

Most of the options under regional energy trade are capital intensive. Hence, mobilization of finances for these projects is a crucial aspect in implementing these concepts. Under the SAARC umbrella there are a number of financing options available to the investors:

- (i) ***SAARC Development Fund (SDF)***: SAARC over the years has made a number of efforts to formulate a fund for regional trade activities in the region. Earlier there was a South Asian Development Fund (SADF), which came into existence in 1996. The SADF was formed with the merger of two erstwhile funds - SAARC Fund for Regional Projects (SFRP) and SAARC Regional Fund (SRF). In 2005, it was proposed to reconstitute the SADF and form an umbrella organization- the SDF with:
- *Social Window*, with an initial corpus of USD300 million, which shall be used to fund poverty alleviation programmes and projects.
 - *Infrastructure Window*, wherein funds would be mobilized, from within and beyond the region, to finance infrastructure projects.
 - *Economic Window*, which would fund other non-infrastructure commercial projects.

It was proposed that the fund should be professionally managed and should have a permanent secretariat.⁶⁹ The agreement for the SDF was finalized in November 2007, and signed during the 15th SAARC Summit held in Colombo in August 2008. The agreement clearly lays down the rules for funding, according to which, funds shall be provided to only multilateral regional trade projects (involving all or more than two Member States).⁷⁰

- (ii) ***Private sector participation and public private partnership:*** A very important source of funding in the region are funds flowing through increased private sector participation and public private partnership. At present, most of the energy sector is operated by publicly owned utilities, and these have not had good financial performance for a variety of reasons. As a result the investment capability of these utilities is limited. Therefore, thrust has been given to encourage private sector participation in regional trade either individually or jointly with public utilities. An advantage that private sector participation (national and international private sector firms) has is that these entities are seen as neutral parties driven by commercial principles as compared to state owned utilities. This adds to the credibility of their involvement in the cross border trade. Also, it is perceived that involvement of private sector in regional trade would expedite the process of implementation of projects.

Notwithstanding the above, private sector participation in regional trade has been limited in the SAARC region. This is due to a variety of reasons, one of them being lack of policy and regulatory clarity in cross border dealings.

- (iii) ***Other sources of funding*** such as Member State funds, and pooling of Member States funding. Under these sources, investors could approach singular or multiple Member States for funding a regional trade option.

Thus, there are a number of sources of funding available to those interested in investing in the SAARC region. Increasing emphasis is also being given to multilateral trade involvement rather than bilateral trade arrangements. However, Member State governments need to provide policy, regulatory and contractual clarity so as to increase investments in the region. They need to move towards a more transparent policy and regulatory mechanism and also develop clear contracts with well defined provisions related to matters such as taxation and royalties.

8.2.5 Develop Regional Trade Treaty Similar to the Energy Charter Treaty

SAARC Member States need to either join the Energy Charter Treaty (ECT) or to collectively develop a regional energy trade treaty, which may be structured similar to the ECT. The ECT was signed in December 1994 by 51 countries mostly from Europe and the Former Soviet Union and by European Community and Euratom (which aims at developing the market for nuclear energy). The objective of ECT 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 SAARC regional trade treaty could be structured to

⁶⁹ <http://www.saarc-sec.org/main.php?t=5> accessed on 14th July 2008

⁷⁰ <http://www.meaindia.nic.in/parliament/ls/2008/04/23ls01.htm> accessed on 14th July 2008

minimize risks associated with energy related regional investments and trade focusing on inter-governmental cooperation in the energy sector. **Box 8.1** discusses the ECT in greater detail and its relevance for the SAARC region.

Box 8.1: The Energy Charter Treaty

The Energy Charter Treaty's provisions focus on five broad areas:

- Protection and promotion of foreign energy investments based on the extension of national treatment or most favoured nation treatment whichever is more favourable.
- Free trading in energy materials products and energy related equipments based on the WTO rules.
- The freedom of energy transit through pipelines and grids.
- Reducing the negative environmental impact of the energy cycle through improving energy efficiency
- Mechanisms for resolution of state-to-state or investor-to-state disputes.

The ECT promotes long term energy cooperation through stable and predictable 'rules of the game.' Developed in line with the World Trade Organization (WTO) rules, specifically for the energy sector, the ECT guarantees security of supply through reliable and well defined transit rules. Through its various provisions it creates an investor friendly environment favourable to flow of investments and technologies. A forum for experience sharing, the Treaty encourages co-operative efforts aimed at promoting market oriented reforms in the energy sector.

ECT has been structured in such a way that it benefits all the concerned parties in a cross border trade arrangement – the supplier of energy or producer, the transit entity/ country and the consumer.

- **The Producer Country:** The producer member countries benefit through investor confidence which results in a constant flow of foreign direct investment into the countries. Further, the increased confidence may lead to an increase in the flow of income for producing countries by giving access to markets.
- **The Transit Country:** ECT creates a secure transit framework, which is also an advantage to the purchasers and consumer countries. The treaty also tries to secure certain income from transit for the transit countries such that these countries can at least cover certain risks associated with transit and at the same time provides for incentives to allow transit.
- **The Consumer Country:** For the consumer country the treaty provides a basis for security of supply of the energy resource. It also provides security to the investments made by the consumer country.

Source: Proceedings of the Workshop on The Energy Charter Treaty under the aegis of Ministry of Petroleum and Natural Gas, Government of India and the Energy Charter Secretariat; 6th April, 2005, New Delhi

8.2.6 Role of SAARC Secretariat

In all the interventions suggested above and in the previous chapter, the SAARC Secretariat has an important role to play in promoting regional energy trade. For instance, in the case of developing the inter governmental agreement on regional trade it may facilitate the process of development of such an agreement (model agreement) and then along with other stakeholders provide the requisite push so that agreement is reached at the earliest.

The Secretariat could act as a coordinating body for developing a trade treaty similar to the ECT. For all the trade and cooperation concepts mentioned in earlier chapters, The Secretariat could act as the coordinating agency for taking these concepts forward. The

Secretariat may also help the SAARC Energy Centre (SEC) to undertake capacity building programmes, and transfer of technical, financial and personnel knowledge.

To conclude, benefits of regional energy trade that would accrue to the SAARC region are well known and cannot be disputed. The concerned stakeholders – governments of member states, public and private utilities, policymakers, and various organizations under the SAARC framework-- have an important role to play in ensuring promotion of regional energy trade. However, there is a need for all these stakeholders to coordinate their activities to expedite the process of taking forward the proposed trade options.

8.2.7 Activities to be Undertaken to Expedite Regional Energy Trade

As discussed earlier in the report, the SMS need to expedite the implantation of the various initiatives that would facilitate and promote regional energy trade. The major initiatives that are to be expedited including the policy frameworks, as well as, hard core projects are listed below:

- Develop SAARC Regional Energy Trade and Cooperation Agreement
- Harmonize Legal and Regulatory Frameworks
- Build a comprehensive and reliable energy database
- Promote alternative financing mechanisms for developing regional energy trade and cooperation initiatives
- Develop a regional trade treaty similar to the Energy Charter Treaty

Further, SMS need to have a time bound action plan to implement the energy infrastructure projects. These projects have been categorized below under three categories, i.e. short-term (less than 5 years) medium term (5-15 years) and long-term (greater than 15 years) for implementation to reap the benefits of regional energy trade and energy cooperation:

Short Term Initiatives (less than 5 years)

These initiatives listed below can be achieved within a time span of five years:

- India-Nepal oil products pipeline
- Feasibility Study to explore/ identify possible Pakistan-India power transmission interconnection
- Dhalkebar(Nepal)– Muzaffarpur(India) power transmission interconnection
- Feasibility studies for joint development of regional hydropower, gas and coal based power plants
- Development of wind power projects to augment energy supplies for remote areas
- Feasibility study for possibility of connecting the Maldives with other SAARC countries through submarine cable
- Feasibility study for setting up of joint LNG terminal(s)
- Strengthening of in-country gas truck transmissions systems to facilitate transmission of additional gas supplies as and when they become available as a result of implementation of the inter-regional gas pipelines/LNG projects
- Preparation of a “Least Cost Energy Sector Master Plan for SAARC Region”

- India-Bangladesh Power Transmission Interconnections:
 - ◆ Baharampur, India to Bheramara, Bangladesh

Medium Term Initiatives (5-15 years):

- India - Sri Lanka power transmission interconnection
- Pakistan - India power transmission interconnection
- Additional India-Nepal Power Transmission interconnection
- CASA 1000 Project for Central Asia–Afghanistan–Pakistan power transmission interconnection
- Phase-II of CASA project that could bring electricity from Central Asian Republics up to the Indian power grid
- Iran-Pakistan-India gas pipeline
- Additional power grid interconnections between India-Bangladesh
- Eastern Gas Pipeline Infrastructure
- Additional power transmission interconnections between Bhutan and India
- Implementation of joint LNG Terminal(s) for procurement of LNG for the region
- Turkmenistan-Afghanistan-Pakistan-India pipeline
- Regional/ Sub-regional Power Market
- Regional/ Sub-regional Refinery
- Regional/ Sub-regional LNG terminal and gas transmission expansion
- Regional/ Sub- regional Power plant

Long Term Initiatives (greater than 15 years):

- Qatar-Iran-Pakistan-India gas pipeline
- SAARC Oil Pipeline grid

The above named projects have emerged from previous relevant studies as well as from the discussions in the report.. There would be other projects also that can be conceived and implemented within the time horizon of 15-20 years towards making the SAARC Energy Ring a ground reality.

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Annexure 1 – Example Economic Analysis for Regional/Sub-Regional Refinery

Table A1.1: Net revenue generated from the refinery

Particulars	Amount	Unit
Regional refining	23	MMTPA
Capital investment @ USD 357/MMTPA	8.21	USD billion
Share of diesel	14.95	MMT
Fob price of diesel	990	USD/MT
Expenditure on diesel imports saved	14.80	USD billion
Revenue earned from the refinery	20.61	USD billion
Cost of procurement of crude @ \$100/bbl	16.79	USD billion
Refining cost	1.07	USD billion
Net revenue to region	2.75	USD billion
Payback time period	3.0	Years

Table A1.2: Gross revenue accruing to the refinery

Product	Produce (MMT)	Price (USD/MT)	Revenue (USD million)
LPG	0.69	875	604
Naphtha	2.3	1131	2601
Motor Spirit	2.3	1131	2601
SKO/ ATF	0	0	0
Diesel	14.95	990	14801
Coke	1.15	0	0
Total Revenue			20607

Table A1.3: Calculation of gross refinery margins

Product	Share (%)	Price of petroleum product (international price \$)	Value (\$)
LPG	3%	119.37	3.58
Naphtha	10%	154.30	15.43
Motor Spirit	10%	154.30	15.43
SKO/ ATF	0%	0.00	0
Diesel	65%	135.06	87.79
Coke	5%	0	0
Total Value / bbl			122.23
Crude price / bbl			100
Refinery Margin / bbl			22.23
Refinery Costs / bbl			6.38
Gross Refinery Margin / bbl			15.851

Annexure 2 – Spreadsheet for Biomass Conversion Potential

Table A2.1: Electricity generation potential of biomass

	Biomass Potential (million tonnes)	Electricity Generation potential (GWh)
Afghanistan	27	18000.00
	18	12000.00
Bangladesh	26.60	17732.33
Bhutan	0.08	54.08
India	139	92903.87
Maldives	0.062	41.47
Nepal	27.04	18023.85
Pakistan	NA	NA
Sri Lanka	12	8000.00
Grand Total	223	148755.59

Sources: Various country reports, Country Report on Bangladesh Solar and Wind Energy Resource Assessment TERI, February 2007, Ministry of New and Renewable Energy Resources, Government of India

Table A2.2: Diesel generation potential of biomass

	Biomass Potential (million tonnes)	Diesel substitution (kL)	Diesel substitution (MMT)	Diesel substitution (mtoe)
Afghanistan	27	7714285.71	4.18	4.33
	18	5142857.14	2.79	2.88
Bangladesh	26.60	7599568.35	4.12	4.26
Bhutan	0.08	23176.86	0.01	0.01
India	139	39815942.86	21.58	22.34
Maldives	0.062	17773.83	0.01	0.01
Nepal	27.04	7724505.67	4.19	4.33
Pakistan		0.00	0.00	0.00
Sri Lanka	12	3428571.43	1.86	1.92
Grand Total	223	63752396.13	38.73	40.09

Sources: Various country reports, Country Report on Bangladesh Solar and Wind Energy Resource Assessment TERI, February 2007, Ministry of New and Renewable Energy Resources, Government of India

Table A2.3: Assumptions for the biomass substitution potential

Assumptions				
Biomass based electricity generation	1.5	kg	1	KWh
Heat and electricity generation (industrial use)	3.5	kg	1	litre diesel

Annexure 3: Proposed Transmission Interconnection between India and Bangladesh

The possible routes for exchange of power are:

- between Eastern Region of India and Western Grid of Bangladesh
- between North Eastern Region of India and Eastern Grid of Bangladesh

The detailed analysis so far shows that interconnection between the North Eastern Region of India and the Eastern Grid of Bangladesh would have limited attractiveness for development since any power tradable between India and Bangladesh through this route would ultimately increase flow of power through the critically loaded East-West interconnector of Bangladesh. However, development of the 750MW gas fired power plant at Tripura close to Agartala in India and the recent initiatives taken by the Government of Bangladesh and the Government of India to increase power interconnections between the two countries requires reconsideration of possible cross-border interconnection of the Bangladesh Eastern Grid with the North Eastern Region of India together with possible options to increase the power transfer capacity of the East-West interconnector in Bangladesh. The most attractive, interconnection between Bangladesh and India in the meantime is through the route between the Western Grid of Bangladesh and the Eastern Region of India.

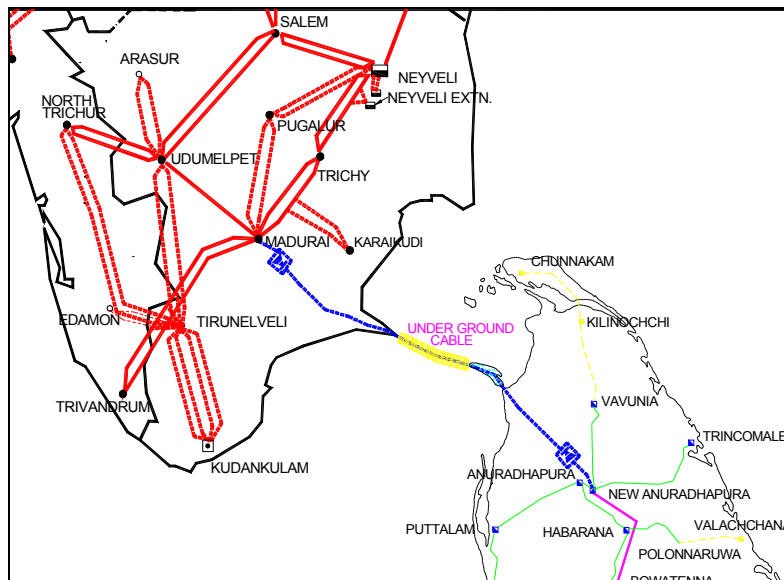
The above-mentioned power interconnections can take place with the help of an asynchronous link like a HVDC back-to-back between the countries. In this case, the load centres and transmission grid of either country would remain unaltered. Power transfer can be controlled in either direction up to the capacity of the HVDC unit depending upon the availability and demand on either side. Further, any fluctuations or disturbances of one grid would not affect the other side. The transfer capacity can be upgraded by adding a new HVDC block provided the AC transmission line is provided for the ultimate capacity planned.

It is proposed at this stage to connect India and Bangladesh (on the Western side) through a HVDC back-to-back link of 500 MW capacity in the short term with provision for upgrading to about 1000 MW in the longer term. For establishment of this asynchronous interconnection between the Eastern Region of India and the Western Grid of Bangladesh, the short circuit MVA of both interconnecting terminal AC substations should be strong enough. In the Bangladesh side, the substation identified for this purpose is Bheramara close to Ishurdi in the Western Grid of Bangladesh. For the interconnection at 400kV with the Eastern Region of India a 400kV/230kV substation needs to be established at Bheramara. On the Indian side, one 400 kV substation is to be created at Baharampur using one circuit of the Farakka-Jeerat 400kV line. The back to back HVDC converter will be located at Bheramara along with Baharampur-Bheramara 400 kV double circuit line.

Annexure 4: Proposed Transmission Interconnection between India and Sri Lanka

Technically, the best option for the proposed India-Sri Lanka power transmission interconnection would be an asynchronous type of interconnection with double circuit HVDC overhead transmission and an interconnecting double circuit HVDC submarine cable. The quantum of power planned for exchange between these countries is 500 MW in the short term and 1000MW in the longer term. In view of the difficulty in laying the transmission line involving submarine cable as well as the cost of the transmission system it is techno economically advantageous, to build the transmission system for the ultimate capacity i.e. 1000MW.

The HVDC connection needs strong AC buses at both ends with sufficient short circuit level. After detail study, Madurai on the Indian side and New Anuradhapura on the Sri Lankan side have been identified as strong substations. The length of the proposed HVDC line between Madurai(India) and New Anuradhapura(Sri Lanka) is about 385km. The proposed interconnection is shown below.



The details of the scope of work are given below:

Asynchronous Interconnection (for the 1000MW capacity)

Transmission Line

- $\pm 400\text{kV}$ HVDC overhead line from Madurai to Indian Sea Coast (near Rameshwaram) (185 km)
- $\pm 400\text{kV}$ HVDC cable from Indian Sea Coast to Sri Lankan Sea Coast (50 km)
- $\pm 400\text{kV}$ HVDC overhead line from Sri Lankan Sea Coast to New Anuradhapura (150 km)

Substation

- ± 400 kV HVDC terminal of 1000MW capacity each at Madurai and New Anuradhapura.

Tentative cost of the scheme:

Transmission line: \$248 Million

Substation Cost: \$182million

Total Cost: \$ 430 million.)

In the short term period, if required, the line could be operated as a mono-polar HVDC line with ground return at the initial stage for transfer of 500MW power. In this case, there would be no saving in the HVDC line portion, however, the HVDC terminal station could be of 500MW capacity instead of 1000MW, which would give a financial relief of about \$90 million. Later on, the above link can be used as HVDC bipole link for transfer of 1000MW power with up-gradation of the HVDC terminals by addition of new blocks of 500MW at each end. The transmission system in this case is given below:

Asynchronous Interconnection (for the 500MW capacity)

Transmission Line

- ± 400 kV HVDC overhead line from Madurai to Indian Sea Coast (near Rameshwaram) (185 km)
- ± 400 kV HVDC cable from Indian Sea Coast to Sri Lankan Sea Coast(50 km)
- ± 400 kV HVDC overhead line from Sri Lankan Sea Coast to New Anuradhapura (150 km)

Substation

- ± 400 kV HVDC terminal of 500MW capacity each at Madurai and New Anuradhapura.

Tentative cost of the scheme:

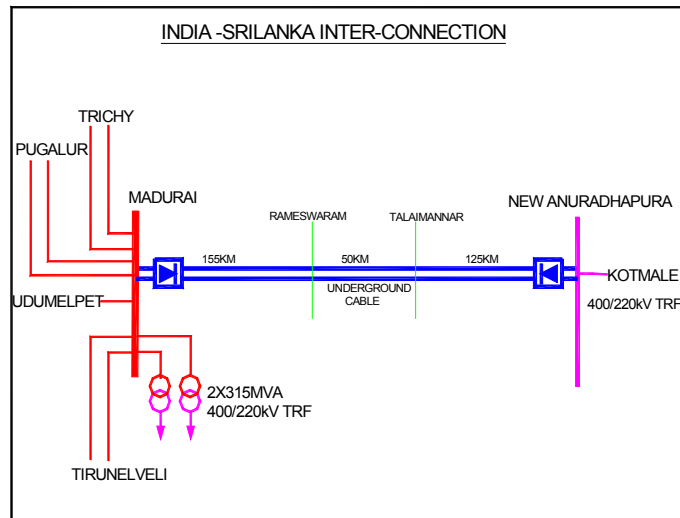
Transmission line: \$248 Million

Substation Cost: \$91million

Total Cost: \$ 339 million.)

SAARC Regional Energy Trade Study (SRETS)

The single line diagram of the proposed scheme is given below:



The annual transmission charges for Stage-I transmission system is about \$47 Million/annum which would correspond to about \$0.022 /unit for an electricity flow of 2190 MU/annum based on 500MW maximum flow and a load factor of 0.5.

The annual transmission charges for Stage-II transmission system (including the charges of Stage-I) is about \$60 Million/annum which would correspond to about \$0.014 /unit for an energy flow of 4380 MU/annum based on 1000MW maximum flow a load factor 0.5.

Annexure 5: Turkmenistan-Afghanistan-Pakistan-India Gas Pipeline Project

1. Project Brief

- (i) Turkmenistan is the second largest producer of natural gas among the Eastern and Central European States, with current estimated production of about 73 billion cubic meters per annum, and standing only behind Russia.
- (ii) As per Turkmen Authorities, after an audit of the newly discovered Osman/South Yolatan Gas Field, the gas reserves are now estimated to range around 14 Trillion Cubic Meter (TCM). This places Turkmenistan as world's fifth largest gas reserves country after Russia, Iran, Qatar and the USA.
- (iii) Most of Turkmenistan gas is being sold to Russia, who transports it to sell it to Europe. Some gas volume is also sold to Iran. China has made major investments in Turkmenistan and is building a pipeline to transport Turkmen gas to China through Central Asian states.
- (iv) Discussions between Pakistan and Turkmenistan have continued since 2002, however little progress has been witnessed during the last one and half year.
- (v) The Turkmenistan–Afghanistan–Pakistan–India (TAPI) gas pipeline project aims to bring natural gas from the Dauletabad and adjacent gas fields in Turkmenistan to Afghanistan, Pakistan and India. **(Route Map-1 below)**.
- (vi) The ADB is acting as the facilitator and coordinator for the project. ADB funded a feasibility study of the project in 2004, which was conducted by a British consulting firm PENSPEN.
- (vii) As per the feasibility study, the design capacity of the pipeline is 3.2 billion cubic feet of natural gas per annum (BCFD). It is proposed to lay a 56-inch diameter 1,680 KM pipeline from Turkmenistan through Heart and Kandahar in Afghanistan, cross the Pakistan border near Chaman to pass near Zhob, DG Khan, Multan, and onwards to Fazilka near Pak-India border.
- (viii) The capital cost of the project was originally estimated at US\$ 3.3 billion, which has since been revised to US \$ 7.6 billion, using the current steel and construction costs. The project will take between 4 to 5 years to complete after signing of all contracts.

2. Current Status

- (i) The project is being supervised by an inter ministerial Steering Committee of the Petroleum Ministers of the participating countries, i.e. Turkmenistan, Afghanistan, Pakistan and India, which has had ten meetings so far. The last meeting was held at Islamabad in April 2008, in which some progress was made on gas price discussion.

- (ii) The Member Countries of TAPI project exchanged the comments on draft Gas Sale Purchase Agreement (GSPA) for its finalization. The next meeting of the Steering Committee is likely to be held in April 2010, where GSPA is expected to be signed by the Member States.

3. Off-take Volumes

- (i) The TAPI parties have agreed in-principle to share the gas volumes (in MMCFD) as under:

Country	Year 1	Year 2	Year 3 & onwards
Afghanistan	175	175	500
Pakistan	960	1,225	1,325
India	960	1,225	1,325
Total	2,095	2,625	3,150

4. Gas Pipeline Framework Agreement (GPFA)

- (i) Originally, a GPFA was signed by the heads of state of three countries (Turkmenistan, Afghanistan and Pakistan) in December 2002.
- (ii) However, to formalize Indian participation in the project, a revised GPFA has been initialed during 10th SC meeting held in April 2008 by the respective Ministers of the concerned parties. Turkmen Party’s internal approval of the GPFA is awaited.

5. Heads of Agreement (HOA)

- (i) The Heads of Agreement is a framework document which outlines the key principles of the Gas Sales and Purchase Agreement (GSPA).
- (ii) The TWG in its 3rd meeting, held in May 2008, successfully completed negotiations on the HOA, and it was initialed and frozen for submission to the relevant authorities for consideration and signing. Turkmen Party’s internal approval of the HOA is awaited.

6. Pipeline Consortium

- (i) In the initialed GPFA, Parties have agreed to the formation of a pipeline consortium with equal shareholding of participating countries lead by an oil & gas major to undertake the financing, construction and operation of the pipeline.

7. Transaction Advisor

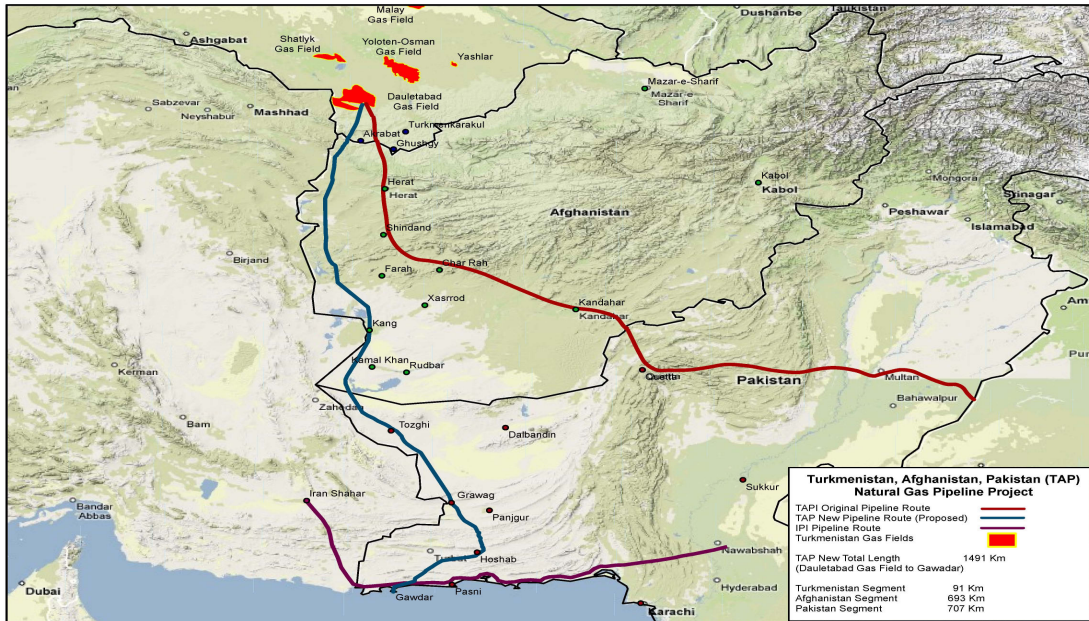
- (i) Parties also agreed to engage services of a Transaction Advisor to update the Feasibility Study, prospecting the lead investor and project developer. The assignment is expected to be completed in 12 to 18 months.

8. Negotiations on Gas Pricing & GSPA

- (i) Considerable progress has been made in negotiations on gas pricing and Gas Sale and Purchase Agreement (GSPA). The parties have achieved consensus on

a number of issues of GSPA, and it is planned that all remaining issues of model GSPA will be resolved in next round of negotiations.

TAPI Gas Pipeline Route Map-1



Annexure 6: CASA 1000 Project

1. Background and Brief Description

Pakistan and Afghanistan, as most of the countries in the South Asia region, need to increase electricity supply to meet the growing demand for electricity. The neighbouring states of the Central Asia region (Tajikistan, Kyrgyz Republic, Uzbekistan, Kazakhstan and Turkmenistan) are well endowed with energy resources, including hydropower and natural gas, and would have electricity surpluses which they would like to export. Afghanistan does not have an integrated national electricity network but some electricity lines interconnect the border areas of Afghanistan with the three neighbouring Central Asian states (Tajikistan, Uzbekistan, and Turkmenistan).

The countries involved have recognized the electricity trade potential and are looking into ways to exploit it. This is particularly the case with Pakistan and Tajikistan, which have been discussing opportunities for electricity trade since early 1990s. These discussions received a renewed impetus during the last few years, as the international financial institutions – especially the World Bank and ADB – as well as the private sector have shown strong interest in supporting regional integration. The Europe and Central Asia region of the World Bank completed a study on electricity export potential in Central Asia, and the South Asia Region, in June 2005 and organized a workshop on electricity trade with the Economic Cooperation Organization (ECO), which encompasses both Central and South Asian countries. At a regional conference on electricity trade, organized by the Government of Pakistan in Islamabad in May 2006, the four countries – Afghanistan, Kyrgyz Republic, Pakistan, and Tajikistan – created a joint Multi-Country Working Group (MCWG) to pursue a project for constructing a transmission line to export about 1000 MW of electricity from Tajikistan and Kyrgyz Republic to Pakistan via Afghanistan (with a possibility to off-load some electricity in Afghanistan). Subsequently, at the second regional conference in Dushanbe in October 2006, the countries signed a Memorandum of Understanding (MoU) for the Central Asia-South Asia (CASA) project development (CASA-1000) and created a Ministerial Committee to oversee the effort. They also formally requested the World Bank and ADB to assist in conducting the necessary analytical work for project preparation.

2. Project Summary

CASA-1000 involves: (i) construction of a high-voltage power transmission line from Tajikistan to Pakistan via Afghanistan and strengthening of transmission infrastructure in the associated countries (including possibly in Kyrgyz Republic as well); and (ii) development of the associated electricity trading arrangements. The analytical work in support of the CASA-1000 project consists of two main tasks: (a) a Technical and Economic Assessment (TEA); and (b) Commercial Assessment (CA) of the project. The TEA study, examined the technical and economic merits of the project and its environmental, social and other safeguard implications, while the CA examined options for implementing the project through public-private partnerships arrangement and the institutional, financial, risk, and legal structures of the project. The two studies, which are interlinked, were conducted in parallel.

At present, there are no electrical (nor other energy) links between the two regions. By demonstrating how a regional electricity project could be structured, financed, implemented, and operated, the project would establish a precedent that could be used to expand electricity (and gas) trade further, paving the way for building up an integrated Central Asia – South Asia Regional Electricity Market (CASAREM), whose potential benefits would extend beyond electricity/energy sector.

Promoting regional cooperation and regional markets is the primary thematic area of the CASA-1000 project. At the same time, such cooperation in the specific context of Central Asia – South Asia electricity trade would contribute to increased energy security of the region, as well as to the increased use of renewable energy resources (hydropower). The trade would open up export markets for hydropower of Tajikistan and Kyrgyz Republic, providing a boost to economic growth in the two countries. The income from the transit fees to Afghanistan and the prospects of closer integration of the country with its neighbours should have direct and indirect benefits to its economy and its ability to broaden electricity access.

3. Project Status

The country delegations and their advisors, the IFIs and the consulting teams and representatives of the US Government met over July 31-August 2, 2008 to discuss the CASA 1000 project and reached the following consensus, which is to be considered as a recommendation to the Inter Governmental Committee for endorsement.

Institutional Structure

The Concession would include the Kyrgyz-Tajik link (a.k.a. AC facilities). The Concession Company would develop, construct and operate the Tajik-Afghan-Pakistan transmission system (a.k.a. the DC facilities) as well as construct the Kyrgyz-Tajik link. A decision on whether to also include the operations and maintenance of the AC facilities in the concession is under consideration.

Trading Arrangements

It was considered in principle that Barki Tajik (Tajikistan) could be the consolidator in the initial phase which would require Kyrgyz GENCO to sell power to Barki Tajik (at the Tajik-Kyrgyz border) on the Kyrgyz-Tajik link (which is part of the CASA 1000 project) and Barki Tajik will then sign a single PPA power purchasers. But this was subject to further discussion.

Energy Flows

Until additional exportable capacities are developed, Kyrgyz Republic and Tajikistan are together expected to commit 5 TWh flow on average per year through the line during the operating period of the concession agreement (25 - 30 years) to be delivered during the summer months (Tajikistan - 3 TWh and Kyrgyz Republic - 2 TWh).

Transmission Tariffs

Different options will be considered for transmission service pricing between sellers and buyers as a basis for (TSA) negotiations. These tariff estimates will be based on total project costs and adjusted once the final EPC is determined during the tendering process.

Project Processing

The Project Engineering Consultant (SNC) will submit the draft bidding documents within one month of the countries having completed negotiations of the commercial term sheets.

The bidding process will begin immediately after the countries' aforementioned commitment to go forward with the Project has been received.

Annexure 7: Illustrative Basic Economic Analyses

1. Power Transmission Project Example

Transmission Project Example With Distribution and Without Distribution (HV Transfer of 1000 GWh/yr only) (all costs and benefits in \$ million)												
Year	Capital Cost High Voltage	Operation & Maintain	HV Purchased Power	Annuitized Distribution Costs	Total Costs	Unserved Electricity UE (GWh)	Loss Reduction LR (GWh)	Total Reven	Net Project Revenue	HV Transfer Charge	Net HV Reven	
2015	40	-	-	-	40	-	-	-	(40)	-	(40)	
2016	60	-	-	-	60	-	-	-	(60)	-	(60)	
2017	60	-	-	-	60	-	-	-	(60)	-	(60)	
2018	40	-	-	-	40	-	-	-	(40)	-	(40)	
2019	-	-	-	-	-	-	-	-	-	-	-	
2020	-	2	60	10	72	1,000	50	101	29	30	28	
2021	-	2	60	10	72	1,000	50	101	29	30	28	
2022	-	2	60	10	72	1,000	50	101	29	30	28	
2023	-	2	60	10	72	1,000	50	101	29	30	28	
2024	-	2	60	10	72	1,000	50	101	29	30	28	
2025	-	2	60	10	72	1,000	50	101	29	30	28	
2026	-	2	60	10	72	1,000	50	101	29	30	28	
2027	-	2	60	10	72	1,000	50	101	29	30	28	
2028	-	2	60	10	72	1,000	50	101	29	30	28	
2029	-	2	60	10	72	1,000	50	101	29	30	28	
2030	-	2	60	10	72	1,000	50	101	29	30	28	
2031	-	2	60	10	72	1,000	50	101	29	30	28	
2032	-	2	60	10	72	1,000	50	101	29	30	28	
2033	-	2	60	10	72	1,000	50	101	29	30	28	
2034	-	2	60	10	72	1,000	50	101	29	30	28	
2035	-	2	60	10	72	1,000	50	101	29	30	28	
2036	-	2	60	10	72	1,000	50	101	29	30	28	
2037	-	2	60	10	72	1,000	50	101	29	30	28	
2038	-	2	60	10	72	1,000	50	101	29	30	28	
2039	-	2	60	10	72	1,000	50	101	29	30	28	
2040	-	2	60	10	72	1,000	50	101	29	30	28	
2041	-	2	60	10	72	1,000	50	101	29	30	28	
2042	-	2	60	10	72	1,000	50	101	29	30	28	
2043	-	2	60	10	72	1,000	50	101	29	30	28	
2044	-	2	60	10	72	1,000	50	101	29	30	28	
NPV	158	11	338	564	564	5,636	282	569	5	169	1	
									EIRR =	10.3%	EIRR =	10.0%

Total Cost Year 1 (pu) Year 2 (pu) Year 3 (pu) Year 4 (pu)
 200 0.20 0.30 0.30 0.20
 UE \$/kwh LR \$/kwh
 0.10 0.02
 High Voltage Purchase \$/kwh
 0.06
 Annuitized Distribution \$/kwh
 0.01
 HV Transfer Charge \$/kwh
 0.03

3. Onshore Oil Pipeline Project Example

ONSHORE OIL TRANSPORT PIPELINE EXAMPLE										
20 inch OD 40 km long pipeline with one pump station										
Year	Sales MMbbl	Tariff \$/bbl	Revenue MM\$	Capital Expenditure Pipeline MM\$	Pumps MM\$	Operating Costs Pipeline MM\$	Pumps MM\$	Net Revenue MM\$		
1	0	0	0.0	1	0	0	0	0	-1.0	
2	0	0	0.0	4	0	0	0	0	-4.0	
3	0	0	0.0	4	1	0	0	0	-5.0	
4	0	0	0.0	1	1	0	0	0	-2.0	
5	10.95		0.2	2.2	0	0.5	0.3	0.3	1.4	
6	10.95		0.2	2.2	0	0.5	0.3	0.3	1.4	
7	10.95		0.2	2.2	0	0.5	0.3	0.3	1.4	
8	14.6		0.2	2.9	0	0.5	0.4	0.4	2.0	
9	14.6		0.2	2.9	0	0.5	0.4	0.4	2.0	
10	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
11	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
12	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
13	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
14	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
15	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
16	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
17	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
18	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
19	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
20	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
21	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
22	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
23	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
24	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
25	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
26	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
27	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
28	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
29	18.25		0.2	3.7	0	0.5	0.5	0.5	2.7	
Total	423.4		84.7	10	2	12.5	11.6	48.6		
15% Discount	NPV		\$10.96	\$7.10	\$1.23	\$1.85	\$1.50	(\$0.72)		
0.2 Tariff	\$/bbl									IRR=
8 Pipe cost	\$ million									13.9%
2 Pump cost	\$ million									