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An Overview of Energy Cooperation in South Asia

Priyantha Wijayatunga and P. N. Fernando

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Priyantha Wijayatunga is Unit Head, Portfolio Management at the Nepal Resident Mission.

P.N. Fernando is Senior Advisor, SAARC Regional Power Exchange Study, ADB.

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Asian Development Bank
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1550 Metro Manila, Philippines
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ABSTRACT

There is a wide variation in commercial energy resource endowments and commercial energy demand among the South Asian Countries (SAC). While India, Pakistan and Bangladesh account for the major natural gas and coal resources, Bhutan and Nepal have large hydropower resources. All the countries have vast renewable energy potential and the sharing of these resources naturally leads to more optimal energy supply solutions for the entire region. SAC need enhanced regional energy transfer to leverage economies of scale through a more vibrant intra and inter regional energy trade structure. Key issues faced in energy sector cooperation are centered on the need to develop: (i) a regional power market; (ii) energy supply availability; (iii) energy trade infrastructure; and (iv) harmonized legal and regulatory frameworks.

Energy cooperation is a main focus of the South Asia Subregional Economic Cooperation (SASEC) program. The existing intraregional energy trade among the SASEC countries is limited to electricity trade between India-Bhutan and India-Nepal, (in 2011, within the framework of SASEC cooperation, it was around 5,600 gigawatt hour (GWh) and 700 GWh respectively) and trade in petroleum products between India and Nepal, Bhutan, Bangladesh and Sri Lanka. The enhanced electricity trade will be based on the expansion of power transfer links between Bhutan and India, and India and Nepal. The establishment of ongoing and proposed new power transfer links between Bangladesh and India, India and Sri Lanka and between India and Pakistan would further strengthen the regional power trade.

Apart from petroleum products, coal, liquefied natural gas (LNG), and the limited electricity trade, no interregional energy trade is seen between South Asia and outside the region. However, feasibility studies for some specific high-capacity inter-regional power and natural gas transmission systems, (identified as the Central Asia-South Asia (CASA 1000) power link, Iran-Pakistan-India (IPI) natural gas pipeline and the Turkmenistan-Afghanistan-Pakistan-India (TAPI) natural gas pipeline) have been undertaken. The TAPI project has progressed to the stage to being a Gas Pipeline Framework Agreement, initialed in 2008, followed by an intergovernmental agreement signed in 2010.

To increase energy cooperation, some of the important steps which need to be taken are: (i) develop a structure for a regional power exchange after reviewing the power system structures in individual countries, along with their operational procedures and regulatory and commercial requirements for cross-border trade, (ii) improve investment environment for the private sector for both electricity generation and transmission, particularly in Nepal and Bhutan by streamlining the approval processes and establishing independent regulatory environments, (iii) identify the technically and economically feasible cross-border interconnections based on a scenario analysis and possible financing options, and (iv) harmonize legal and regulatory frameworks dealing with cross-border trade along with an Energy Charter Treaty for greater security for cross-border energy transfer related investments and transactions.

ABBREVIATIONS

AEMC	–	Australian Energy Market Commission
ADB	–	Asian Development Bank
BCF/d	–	billion cubic feet per day
CAGR	–	Compound Annual Growth Rate
CASA	–	Central Asia-South Asia
CDM	–	Clean Development Mechanism
ECT	–	Energy Charter Treaty
GW	–	Gigawatt
GWh	–	Gigawatt hour
HVAC	–	High Voltage Alternating Current
HVDC	–	High Voltage Direct Current
IPI	–	Iran-Pakistan-India
kV	–	kilovolt
kW	–	kilowatt
kWh	–	kilowatt hour
LNG	–	Liquefied Natural Gas
MWh	–	megawatt hour
MTOE	–	million tons of oil equivalent
NLDC	–	National Load Dispatch Center
PGCIL	–	Power Grid Corporation of India Ltd.
SAC	–	South Asian Countries
SEC	–	SAARC Energy Center
SASEC	–	South Asia Subregional Economic Cooperation
TAPI	–	Turkmenistan-Afghanistan-Pakistan-India

I. INTRODUCTION

1. There is a wide variation in commercial energy resource endowments and commercial energy demand among the South Asian Countries (SAC). India, Pakistan and Bangladesh account for the major share of natural gas and coal resources in the region. However, these countries are also large in terms of area as well as population and thus, the higher resource base does not necessarily indicate sufficiency to meet energy needs. Bhutan and Nepal, on the other hand, have hydropower potential in excess of their demand for electricity over the foreseeable future and offer the best prospects for intra-regional electricity export. Neighboring regions, particularly Central Asia and Western Asia, have inter- regional energy export capability to South Asia.

2. The domestic resource development pace in the SAC, together with existing regional bilateral energy trade arrangements, cannot match the growing commercial energy supply required in the region. It is evident that the SAC need to enhance regional energy transfer, increase their access to energy resources (from outside the region) and leverage economies of scale in energy procurement through a more vibrant intra and inter regional energy trade structure. Intra and inter regional energy cooperation therefore, offers viable options to South Asia for augmenting its energy supply. Enhanced interconnection of hydropower generation in Bhutan and Nepal with India, would also bring in power system reliability benefits for India, as well as other interconnected countries. From an overall perspective, the key issues faced in energy sector cooperation to enhance regional energy trade generically emerge from the need for adequate energy supply and a supporting regional market structure particularly for electricity, and are centered on the need to develop: (i) a regional power market; (ii) energy supply availability; (iii) energy trade infrastructure; and (iv) a harmonized legal and regulatory frameworks.

3. However, there are constraints that emerge in the process of exercising the commercial energy trade options. This chapter will focus on the developments, issues and challenges and policy recommendations associated with such energy cooperation.

II. INSTITUTIONAL MECHANISMS FOR ENERGY COOPERATION

4. There are three established institutional mechanisms dealing with regional energy cooperation in all or some of the South Asian countries. They are: (i) South Asia Association for Regional Cooperation (SAARC), (ii) South Asia Subregional Economic Cooperation (SASEC), and (iii) Bangladesh-India-Myanmar-Sri Lanka-Thailand–Economic Co-operation (BIMSTEC).

5. SAARC was created in 1985 with the founding members Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka, with Afghanistan joining subsequently. It is the prime institution dealing with regional cooperation in South Asia on a multilateral level. Subsequent to the Dhaka Declaration in 2004, SAARC established its own energy centre (SEC) in 2006 in Islamabad, Pakistan to enhance energy cooperation among the SAC. Since then, it has been involved in undertaking many activities relating to energy cooperation. Since 2006 ADB has been providing capacity development support to SEC. With the coordination under the SAARC Secretariat and close involvement of SEC, ADB conducted the South Asia Regional Energy Trade Study (SRETS) which was finally endorsed by the 4th meeting of the SAARC Energy Ministers in 2011.

6. Under an ADB initiative, SASEC was initiated in 2001 with four member countries, Bangladesh, India, Bhutan and Nepal. ADB serves as the Secretariat for SASEC which focuses on regional cooperation in the areas of energy, transport and trade facilitation (and tourism in the initial years). Considering the important initiatives in energy cooperation involving Sri Lanka, it was invited to join the SAEC energy working group in 2011. ADB has since been providing both technical and investment assistance under the SASEC framework for capacity building and cross border investment in roads and transmission interconnections.

7. BIMSTEC was initially known as the Bay of Bengal Initiative for Multi Sectoral Technical and Economic Cooperation but later renamed as the Bangladesh-India-Myanmar-Sri Lanka-Thailand Economic Co-operation and was established in 1997 for cooperation in the areas of (i) trade & investment; (ii) technology; (iii) transport & communication; (iv) energy; (v) tourism; and (vi) fisheries. Later, Nepal and Bhutan also joined the forum. The First BIMSTEC Summit held in 2004 agreed to promote sustainable and optimal energy utilization through development of new hydro-carbon and hydro-gas, the inter-connection of electricity and natural gas grids and renewable energy technologies. The First BIMSTEC Energy Ministers Conference, held in 2005, agreed to set up a BIMSTEC Energy Centre in India for sharing experiences in reforms, restructuring, regulation and best practices in the energy sector.

III. REGIONAL COMMERCIAL ENERGY SUPPLY

8. Figure 1 shows the commercial energy supply mix for the SAC in 2010 together with the specific details in Table 1. It is important to note that commercial energy demand in a major part of the South Asia region (Afghanistan, Bangladesh, India, Nepal and Pakistan), during the latter part of the last decade was supply-constrained, and that constraint continues. Hence, the figures reported are best estimates based on actual limits in some cases, and supply limits, in other cases. They range from as low as 0.3 million tons of oil equivalent (mtoe) for the Maldives to as high as 554 mtoe for India.

9. It is evident that while India and Pakistan have certain levels of diversity in their energy supply sources, Bangladesh is heavily reliant on natural gas and Sri Lanka to a large extent, on petroleum sources. Also, while Bhutan and Nepal are largely self-reliant on their existing hydro-electricity, Afghanistan's energy supply is dominated by electricity imports from Central and Western Asia (captured under hydro-electricity in the Figure 1 and Table 1). Such restricted energy supply dependence not only limits the options to meet energy demand but also increases energy security concerns. The three larger SAC countries (India, Pakistan and Bangladesh) accounted for more than 98% of the total SAC energy supply of 649 mtoe in 2010.

10. Nevertheless, power generating capacity additions in India, although significant, have been falling behind planned activities. The planned capacity addition for the Eleventh Five Year Plan (2007-2012) was set at 21 GW but less than half of that was achieved at the start of 2011. Part of the issue has been an overreliance of the system on coal. The 2012 installed coal based power generating capacity of 104 GW, requires a massive 355 million tons of coal per year and the impending coal shortage is a major challenge to the system. The Indian power system was both energy and peak deficient, with the figures for end 2010 standing at 8.2% for energy and 11% for peak, with an installed power-generating capacity of 182GW. The Pakistan and Bangladesh power systems have also experienced power shortages due mainly to over reliance on natural gas-based power generation. Pakistan, with an installed power generating capacity of 20 GW had a 25% peak shortage in 2010, while Bangladesh, with an installed power generating capacity of 7 GW had around a 20% power shortage.

Figure 1: Commercial Energy Supply Mix of SAC in 2010
(numbers in parenthesis are total mtoe supplied)

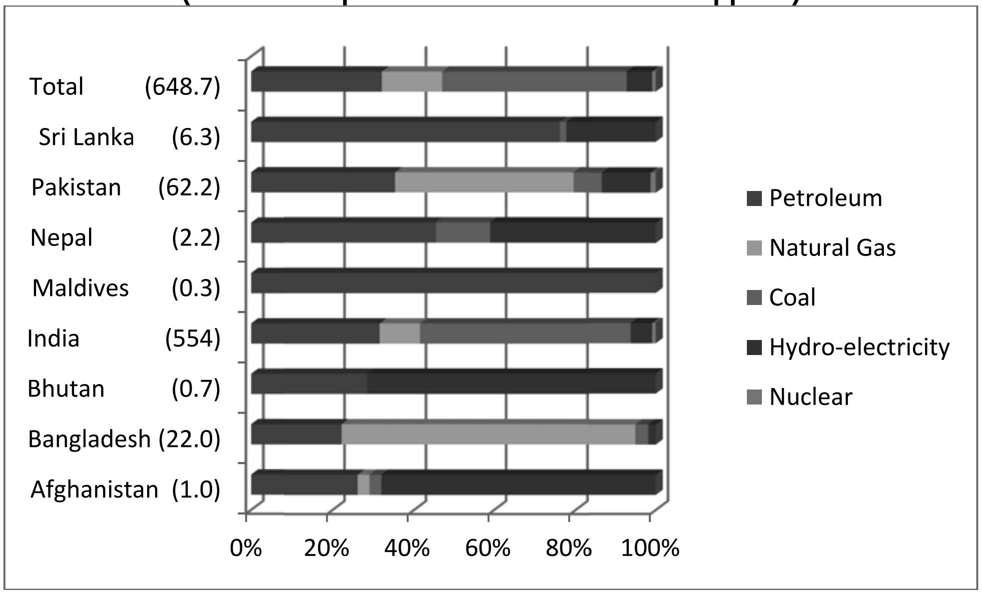


Table 1: Commercial Energy Supply of the SAC in 2010 (mtoe)

	Petroleum	Natural Gas	Coal	Hydro-electricity	Nuclear	Total
Afghanistan	0.27	0.03	0.03	0.7[1]	0	1.0
Bangladesh	4.9	16	0.7	0.4	0	22.0
Bhutan	0.2	0	0	0.5	0	0.7
India	175	55	290	29	7	554
Maldives	0.3	0	0	0	0	0.3
Nepal	1	0	0.3	0.9[2]	0	2.2
Pakistan	22	27.5	4.5	7.4	0.8	62.2
Sri Lanka	4.8	0	0.1	1.4	0	6.3
Total	208.5	98.5	295.6	40.3	5.8	648.7

[1] Imports from neighboring countries
[2] Includes net electricity imports from India

IV. PROJECTED COMMERCIAL ENERGY SUPPLY

11. Key challenges in the region, existing in the form of increasing energy deficits, lack of balance in the energy supply mix, rising oil import dependence and inadequate energy sector infrastructure, need to be addressed in order to meet regional energy demand growth. Provision of enhanced access to diverse forms of commercial energy with the development of a more vibrant intra and inter regional energy trade structure in parallel, would significantly facilitate this process.

12. In the medium to long term (2010-2020), fossil based commercial energy supply in the region in terms of petroleum, coal and natural gas is expected to grow from 603 mtoe to 1006 mtoe at a Compound Annual Growth Rate (CAGR) of 5.3%, with natural gas and petroleum expected to register a growth rate of 5.5%, followed by coal at 5%. Table 2 shows the projected fossil based commercial energy supply. Hydropower and nuclear- based energy supplies are estimated to increase from 36 mtoe to 79 mtoe and 7 mtoe to 43 mtoe, respectively. [India Energy Handbook (2011), Pakistan Integrated Energy Model (2010- ADB TA 4982-PAK),

Bangladesh Power System Master Plan (2010), and Sri Lanka Generation Expansion Plan (2011), SEC Integrated Energy Potential of South Asia: Vision 2020 (2011)].

Table 2: Projected Fossil-based Commercial Energy Supply (mtoe)

	Petroleum			Coal			Natural Gas		
Year/ Countries	2010	2020	CAGR	2010	2020	CAGR	2010	2020	CAGR
Afghanistan	0.3	0.8	10%	0	0	0	0	0.8	-
Bangladesh	4.9	8.0	5%	0.7	6.5	25%	16.0	29.0	6%
Bhutan	0.2	0.5	10%	0	0	0	0	0	0
India	175	300	5.5%	290	450	4.5%	55	90	5%
Maldives	0.3	0.6	7%	0	0	0	0	0	0
Nepal	1.0	2.0	7%	0.3	0.4	3%	0	0	0
Pakistan	22	37.5	5%	4.5	19.9	16%	27.5	49.3	6%
Sri Lanka	4.3	7,8	5%	0	2.9	-	0	0	0
Total	208	357	5.5%	296	480	5%	99	169	5.5%

Source: SAARC Regional Energy Trade Study, 2010

13. Figure 2, Figure 3 and Figure 4, show the projected energy supply composition for India, Pakistan and Bangladesh respectively, over the medium to long term. It is relevant to note that reducing the role of natural gas (gas) in Pakistan and Bangladesh lies mainly in reducing domestic supply that would be offset only to a limited extent by the Liquefied Natural Gas (LNG) and pipeline natural gas imports anticipated.

Figure 2: Projected Energy Supply in India (mtoe)

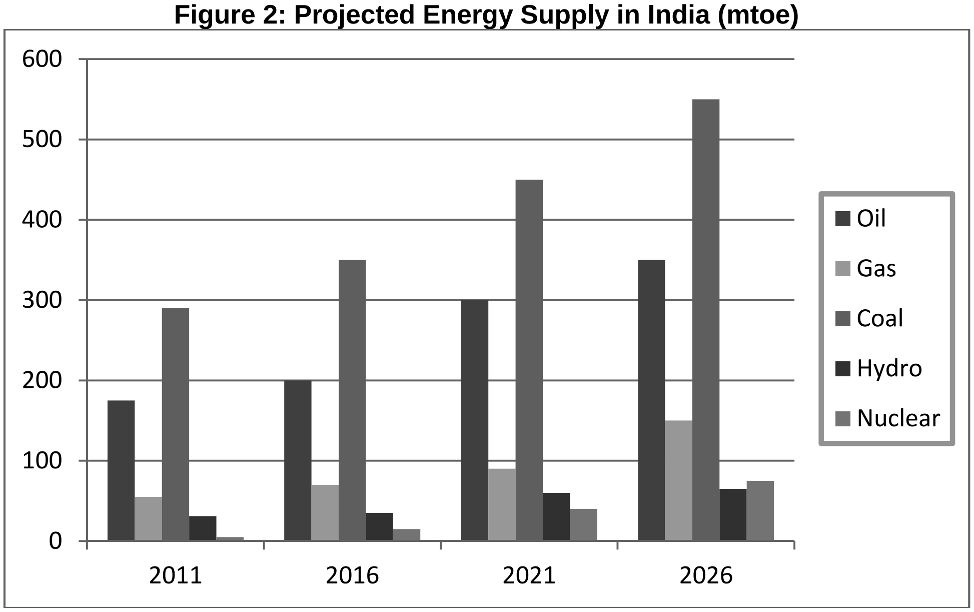


Figure 3: Projected Energy Supply in Pakistan (mtoe)

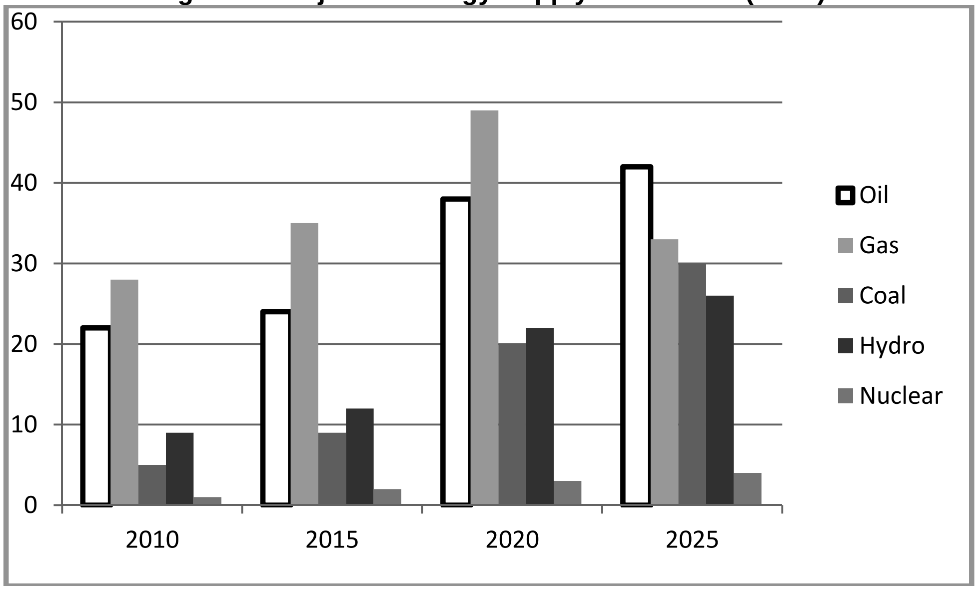
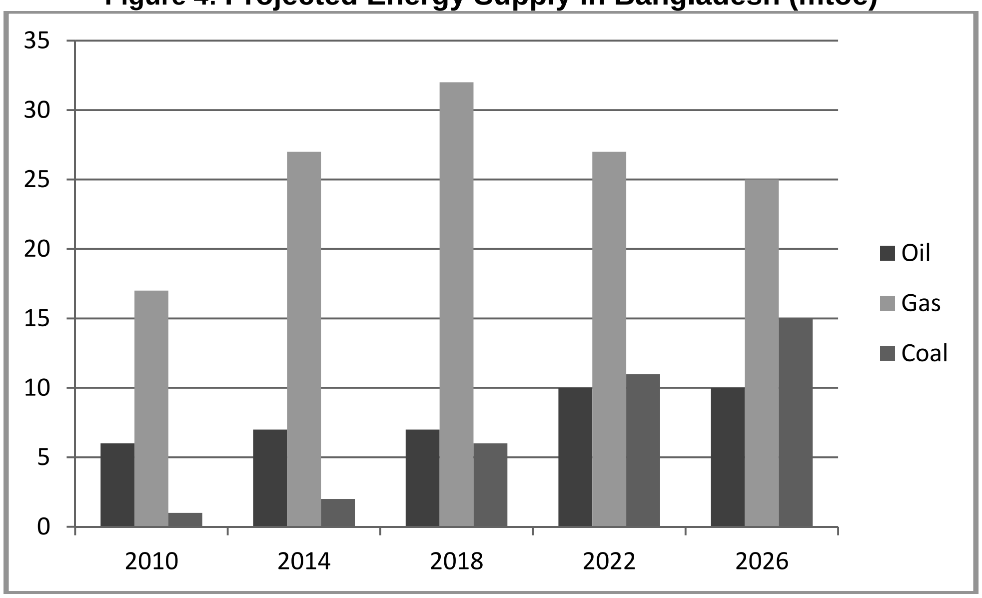


Figure 4: Projected Energy Supply in Bangladesh (mtoe)



14. Table 3 shows the projected electricity generation demand in the SAC for 2020. Electricity demand is expected to have a CAGR of approximately 7%. Although hydropower and nuclear power would continue to make substantial contributions to meet this electricity demand in India and Pakistan, the bulk of that electricity demand would be supplied from coal, oil and natural gas based electricity generation.

Table 3: Projected Electricity Demand

	Demand (GWh)		**CAGR**
	Year 2010	**Year 2020**	
Afghanistan	2600	6750	10%
Bangladesh	28470	67400	9%

	Demand (GWh)		CAGR
	Year 2010	**Year 2020**	
Bhutan	1749	3430	7%
India	938000	1845000	7%
Maldives	800	1300	5%
Nepal	3200	6910	8%
Pakistan	95000	246000	10%
Sri Lanka	10718	21040	7%
Total (mtoe)	1080537 (267)	2197830 (544)	7.4%

15. The hydroelectricity contribution in India is estimated to grow from 128 billion kWh (29.0 mtoe) to 255 billion kWh (58 mtoe) over the period 2010 to 2020, while nuclear electricity contribution is also estimated to grow from 29 billion kWh (7 mtoe) to 158 billion kWh (38 mtoe) during the same period. In Pakistan, the contribution from hydroelectricity is estimated to grow from 33 billion kWh (7.5 mtoe) to 97 billion kWh (22 mtoe) over the period 2010 to 2020, while the corresponding contributions from nuclear electricity are 3.3 billion kWh (0.8 mtoe) and 10 billion kWh (2.4 mtoe). Sri Lanka has also been a significant hydropower producer and its hydroelectricity contribution is estimated to grow from 4.7 billion kWh (1.1 mtoe) to 6.5 billion kWh (1.5 mtoe) over the period from 2010 to 2020. The hydroelectricity supply growth estimate over that period for Bhutan, which has a firm hydropower development plan, is from 7.1 billion kWh (1.6 mtoe) to 58 billion kWh (13 mtoe).

16. The fossil-based commercial energy resources including hydropower resources in the SAC as depicted in Table 4 are equivalent to an annual supply of 803 mtoe of crude oil, 73004 mtoe of coal, 2280 mtoe of natural gas, and 223 mtoe of hydropower (at 50% plant factor). India dominates in these resources with coal accounting for 60,357 mtoe equivalent, but India itself is importing coal to supplement its domestic coal production capability mainly due to quality and logistical issues associated with domestic coal supply. Such coal imports were about 67 million tons (45 mtoe) in 2010.

Table 4: Commercial Energy Resources of the SAC

	Commercial Energy Resources[1]			
Countries	Coal	Oil	Natural Gas	Hydro
	million tons	million barrels	trillion cubic feet	MW
Afghanistan	440 (294.8)	NA	15 (360)	25000 (18.9)
Bhutan	2 (1.5)	0	0	30000 (22.7)
Bangladesh	884 (592.3)	12 (1.6)	8 (192)	330 (0.3)
India	90085 (60356.9)	5700 (775.2)	39 (936)	150000 (113.7)
Maldives	0	0	0	0
Nepal	NA	0	0	42000 (31.8)
Pakistan	17550 (11758.5)	324 (44.1)	33 (792)	45000 (34.1)
Sri Lanka	NA	150 (20.4)	0	2000 (1.5)
Total	108961(73003.8)	5906 (803.3)	95 (2280)	294330 (223.0)

[1] mtoe equivalents of annual energy are in parentheses. In the case of hydropower, a 50% annual plant factor and 38% efficiency in thermal equivalence, are assumed.

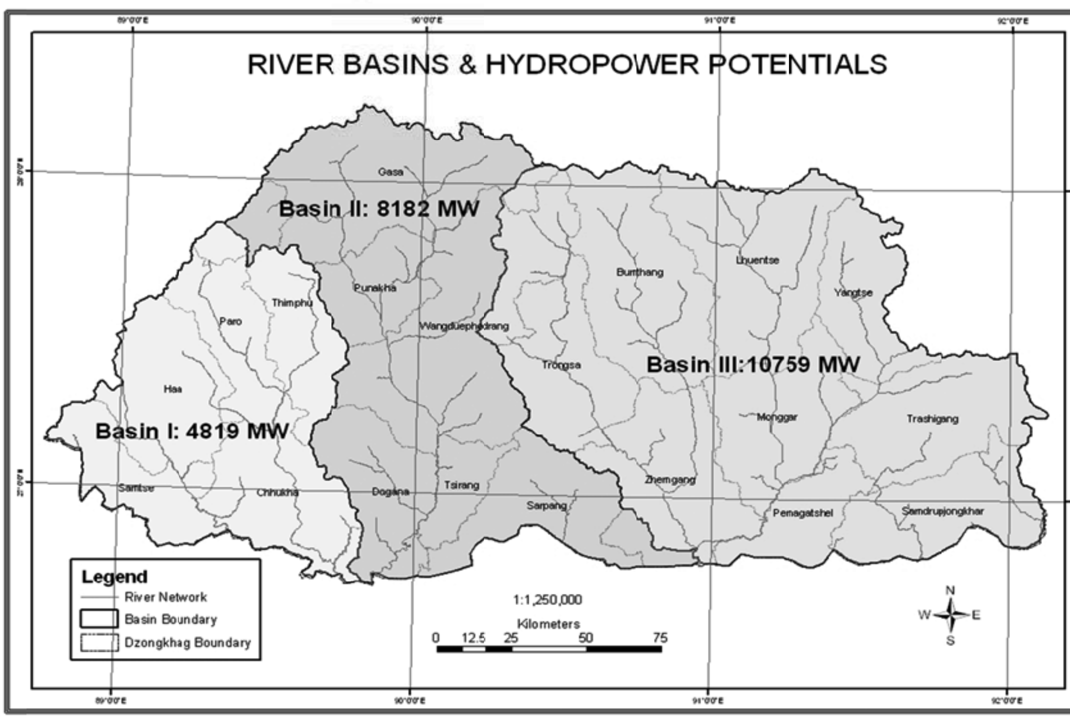
Source: SAARC Regional Energy Trade Study, 2010

17. Table 4 shows that the region's crude oil and natural gas resources are modest in comparison with projected needs, keeping in view also the limited pace at which the remaining resources can be developed. The natural gas resources are mainly in Bangladesh, India and Pakistan. India is already importing natural gas (as LNG) to supplement domestic natural gas production and Pakistan is also planning to import LNG. Bangladesh, with its local gas production being limited, is also moving towards importing LNG. India imported about 9 million tons of LNG in 2010 (equivalent to 10.2 mtoe). This demonstrates the dependence on increasing inter regional trade in natural gas (in the form of LNG now and piped gas later) that is developing apart from that on coal. It is estimated that India would import about 30% of its coal and natural gas requirements by 2020.

V. EXPORT ORIENTED HYDROPOWER DEVELOPMENT IN BHUTAN AND NEPAL

18. The attractive, large scale hydropower development opportunities in Bhutan and Nepal are being actively pursued by the public sector as well as the private sector. Figure 5 to Figure 7 and Table 5 to Table 7 show the scope for such development.

Figure 5: River Basins in Bhutan



Source: Bhutan Presentation at SASEC Transmission Utility Forum 2012, Kandy, Sri Lanka

Table 5: Hydropower Development Potential on Bhutan

River-Basins	Area (km2)	Schemes	Potential (MW)	Energy (GWh)
Amochhu (Basin 1)	2400	6	2060	9656
Wangchhu (Basin 1)	4689	10	2740	11139
Punatsangchhu (Basin II)	10355	19	8099	25495
Mangdechhu/Manas-West (Basin III)	7392	17	3889	18322
Drangmechhu/Manas-East (Basin III)	9207	20	6692	33422
Jaldhaka, Mau, Nyeraamari, Dhansiri	2750	4	280	1213
Others	1601			
Total	**38394**	**76**	**23760**	**99247**

Source: Bhutan Presentation at SASEC Transmission Utility Forum 2012, Kandy, Sri Lanka

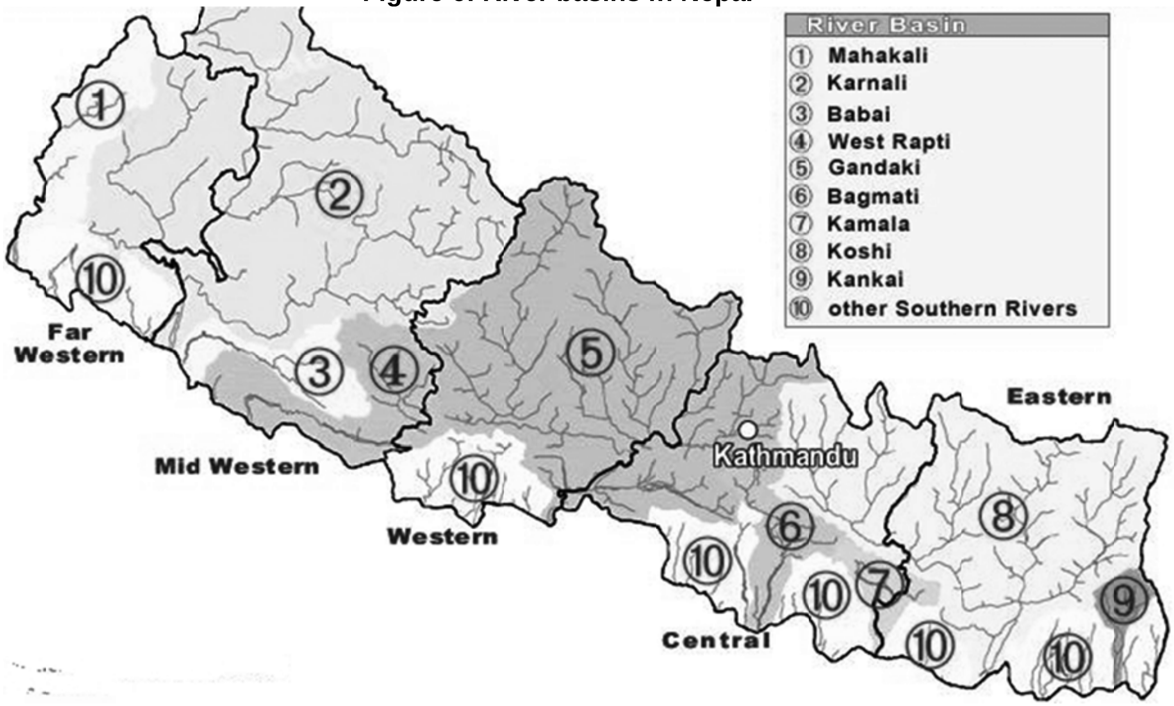
Table 6: Hydropower Projects for Commissioning by 2020 in Bhutan

10 Hydro projects for 10,000MW by 2020

Sl No.	Name of the Project	Capacity
1.	Sunkosh Reservior	4,000 MW
2.	Kuri Gangri	1,800 MW *
3.	Chamkharchu	1,670 MW
4.	Punatsangchu 1	1,200 MW *
5.	Punatsangchu 2	1,000 MW *
6.	Wangchu Reservoir	900 MW
7.	Mangdechu	720 MW *
8.	Amochu Reservior	620 MW
9.	Kholong Chu	486 MW *
10.	Bunakha Reservior	180 MW
	Total * Already Started;	11,576 MW

Source: Bhutan Presentation at SASEC Transmission Utility Forum 2012, Kandy, Sri Lanka

Figure 6: River basins in Nepal



Source: Nepal Presentation at SASEC Transmission Utility Forum 2012, Kandy, Sri Lanka

Table 7: Hydropower Development Potential in Nepal

Hydropower Prospects..
Theoretical Hydropower Potential
(in MW)

River Basin	Major River Courses with catchment area above 1000 sq. km	Small River Courses with small catchment area	Total (MW)
Kosi	18,750	3,600	22,350
Gandaki	17,950	2,700	20,650
Karnali & Mahakali	32,680	3,500	36,180
Southern Rivers	3,070	1,040	4,110
Total	72,450	10,840	83,290

Source: Nepal Presentation at SASEC Transmission Utility Forum 2012, Kandy, Sri Lanka

Table 8: Planned Hydropower Development in Nepal

Hydropower Projects Planned under NEA Initiative

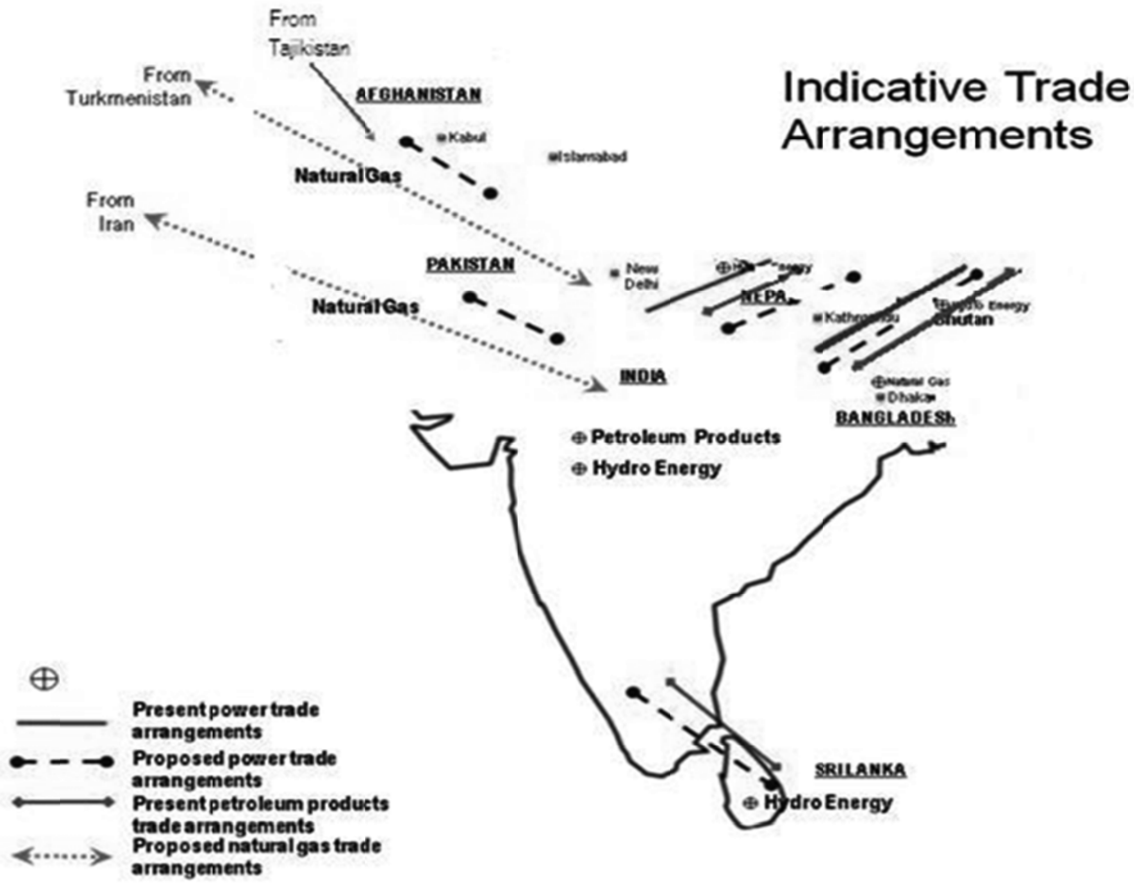
	Projects	Capacity (MW)	GWh	Cost (million $)	Earliest commissioning Year
1	Upper Modi A	42	282.73	85	2017
2	Upper Seti (S)	127	476	328	2017
3	Budhi Gandaki (S)	600	2495	774	2018
4	Nalsyagugad (S)	400	1151	539	2019
5	Andhikhola (S)	180	693	374	2019
6	Dudh Kosi -1 (S)	300	1806	690	2020
7	Kankai (S)	90	247	142.7	2020
8	Kali Gandaki (S)	650	3470	772	2020
	Total	2389			

Source: Nepal Presentation at SASEC Transmission Utility Forum 2012, Kandy, Sri Lanka

19. Given the limited domestic demand for electricity in Bhutan and Nepal, large scale hydropower development in those countries needs a large-target regional electricity market to enable them to offer a substantial contribution to the region's growing energy supply needs. Figure 7 shows from a wider perspective, the energy trade arrangements envisaged to meet those supply needs, along with imported crude oil and oil products, coal and natural gas (as LNG), and domestic energy production in the SAC.

20. Those trade arrangements, (discussed later in this chapter), would require the establishment of both hard infrastructure in terms of physical energy transmission facilities and soft infrastructure in terms of enabling regulatory frameworks and public private partnership facilitation mechanisms. They would, however, bring in technical, economic and environmental benefits by more optimal utilization of resources, capturing comparative advantage and economy of scale, to improve regional energy security and reliability, an increase in economic efficiency in system operation, and enhanced foreign exchange earnings for energy exporting countries.

Figure 7: Energy Trade Arrangements Envisaged



Source: Asian Development Bank

VI. CURRENT AND PROPOSED INTRA REGIONAL ENERGY TRADE IN SASEC

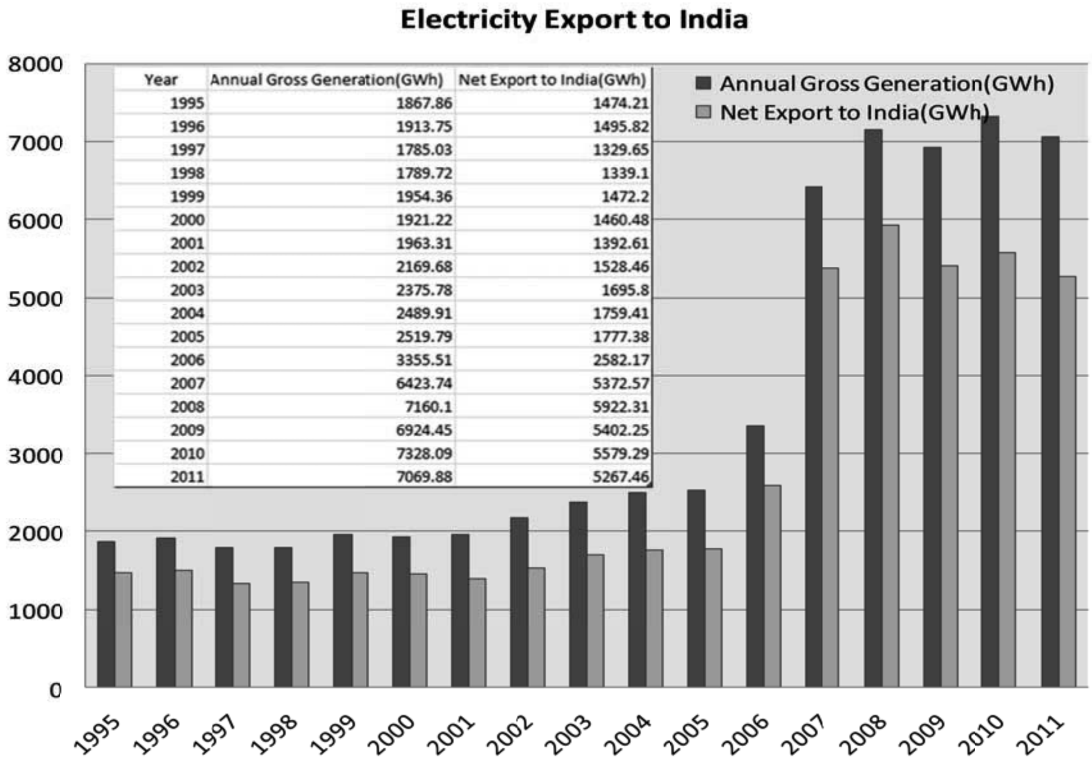
21. While the electricity traded in the region is based on indigenous hydropower resources, the petroleum trade is essentially based on India importing crude oil in excess of its own refining requirement to satisfy the petroleum product demand of Bhutan and Nepal, and partly that of Sri Lanka, using the excess refining capacity available in India. Indian Oil Corporation even has a stake in the Sri Lankan petroleum import and retail industry. The governments of India and Nepal have agreed to proceed with the construction of a 40 km (approximate) long pipeline to transport petroleum products from India to Nepal (about 20,000 barrels a day are sent at present by tanker).

22. Based on several feasibility studies undertaken in the last decade, the realization of a proposed intraregional energy trade, primarily the electricity trade, would lift the magnitude of such trade to a new level. The enhanced electricity trade that would emerge is based on the expansion of power transfer links between Bhutan and India, and India and Nepal. The establishment of new power transfer links between Bangladesh and India, India and Sri Lanka and between India and Pakistan, would also further strengthen the new environment.

A. India-Bhutan Electricity Trade

23. The most significant regional energy trade development has been the export of hydro electricity from Bhutan to India. Figure 8 shows net annual electricity transfers from Bhutan to India since 1995, constituting approximately 75% of Bhutan's electricity generation.

Figure 8: Net Electricity Export from Bhutan to India



Year	Annual Gross Generation(GWh)	Net Export to India(GWh)
1995	1867.86	1474.21
1996	1913.75	1495.82
1997	1785.03	1329.65
1998	1789.72	1339.1
1999	1954.36	1472.2
2000	1921.22	1460.48
2001	1963.31	1392.61
2002	2169.68	1528.46
2003	2375.78	1695.8
2004	2489.91	1759.41
2005	2519.79	1777.38
2006	3355.51	2582.17
2007	6423.74	5372.57
2008	7160.1	5922.31
2009	6924.45	5402.25
2010	7328.09	5579.29
2011	7069.88	5267.46

Source: Bhutan Presentation at SASEC Transmission Utility Forum 2012, Kandy, Sri Lanka

24. For example, in 2010, electricity exports from Bhutan to India amounted to 5,579 million kWh, which earned Nu 10,145 million ($223 million) at an export price of $0.04 per kWh. To ensure an increasing magnitude of such exports, The Government of India (GOI) and the Royal Government of Bhutan (RGOB) signed an agreement in 2006 to further facilitate the development and construction of hydropower projects in Bhutan and associated transmission systems through public as well as and private sector participation. GOI has agreed to a minimum import of 10,000 MW 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.

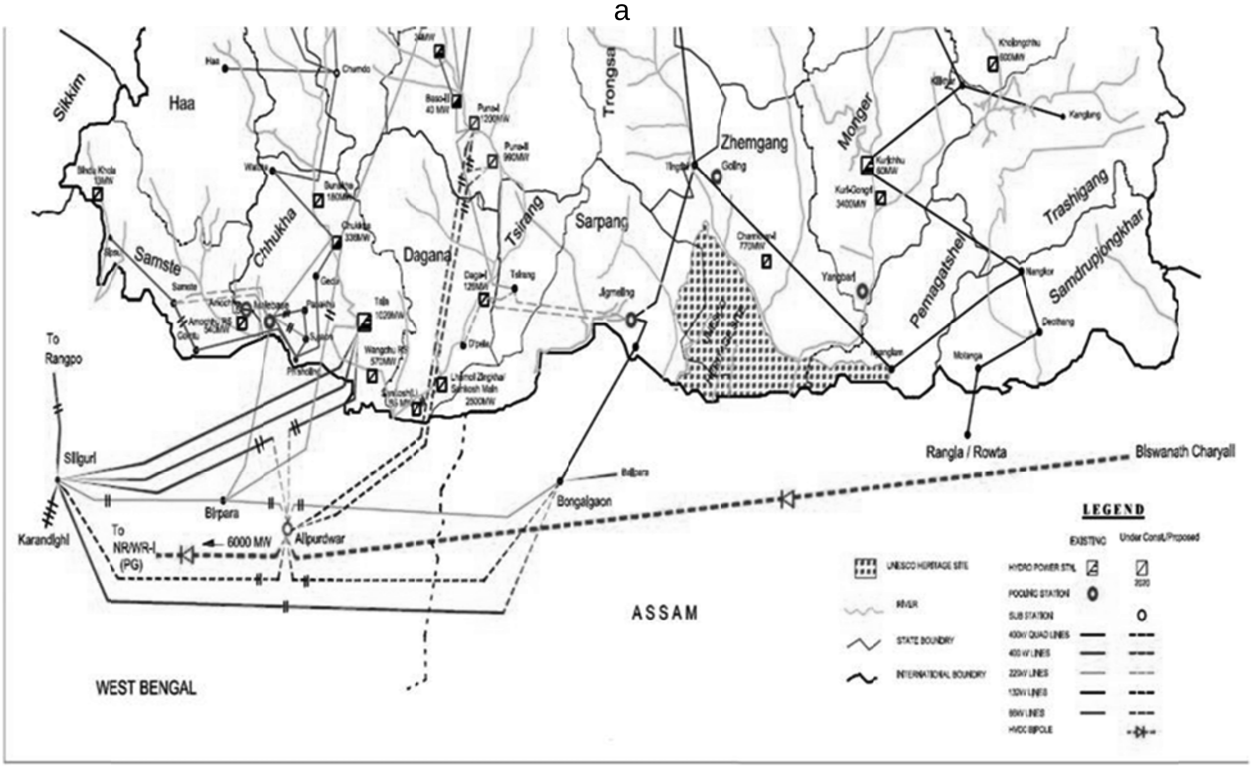
25. The present hydropower development of nearly 1,500 MW of hydropower development in Bhutan with Indian assistance is centered on three major hydro projects (Chukha (336MW), Kurichu (60 MW) and Tala (1020 MW). They are anchored by long term power purchase agreements between the Indian and Bhutanese governments. India, however, provides electricity during the winter season to Bhutan when hydropower availability in the country is inadequate to supply its own needs. The Power Trading Corporation (PTC) in India acts as the

nodal agency to oversee the commercial arrangements of power transfer. The transmission infrastructure to facilitate the evacuation of power from the hydropower projects in Bhutan has also been developed with assistance from India and includes two 220 kV lines for the 336 MW Chukha Project and double circuit 400 kV lines for the 1020 MW Tala Project connecting Bhutan with West Bengal, providing a power transfer capacity of about 2500 MW between the two countries.

26. There is approximately 3,000 MW of additional hydropower development including Punatsangchu (Stage I of 1,200 MW and Stage II of 990 MW) and Mangdechhu, (720 MW) projects that are expected to be completed by 2015/16. Since Bhutan's peak load is expected to remain under 500 MW by then, the bulk of that power would be transferred to India. By 2020, an additional 4,000 MW of hydro project on the Sunkosh River is expected to be completed. A dedicated high voltage direct current (HVDC) transmission line of 800 kV, 6000 MW from Sankosh HEP to a suitable de-pooling point preferably in North/West in India, along with 6000 MW converter modules at the Sankosh hydro generation station and at the de-pooling point, are being planned. There are also other hydropower projects at Kuri-Gongri (1,800 MW), Chamkarchhu (672 MW), Amochhu (620 MW) that are planned to be developed between 2015 and 2020. The total installed power generating capacity in Bhutan by 2020 is expected to be in excess of 11,000 MW. Figure 9 shows the associated power transmission developments proposed.

Figure 9: Power Transmission Developments Proposed for Bhutan

a



Source: Bhutan Presentation at SASEC Transmission Utility Forum 2012, Kandy, Sri Lanka

B. India-Nepal Electricity Trade

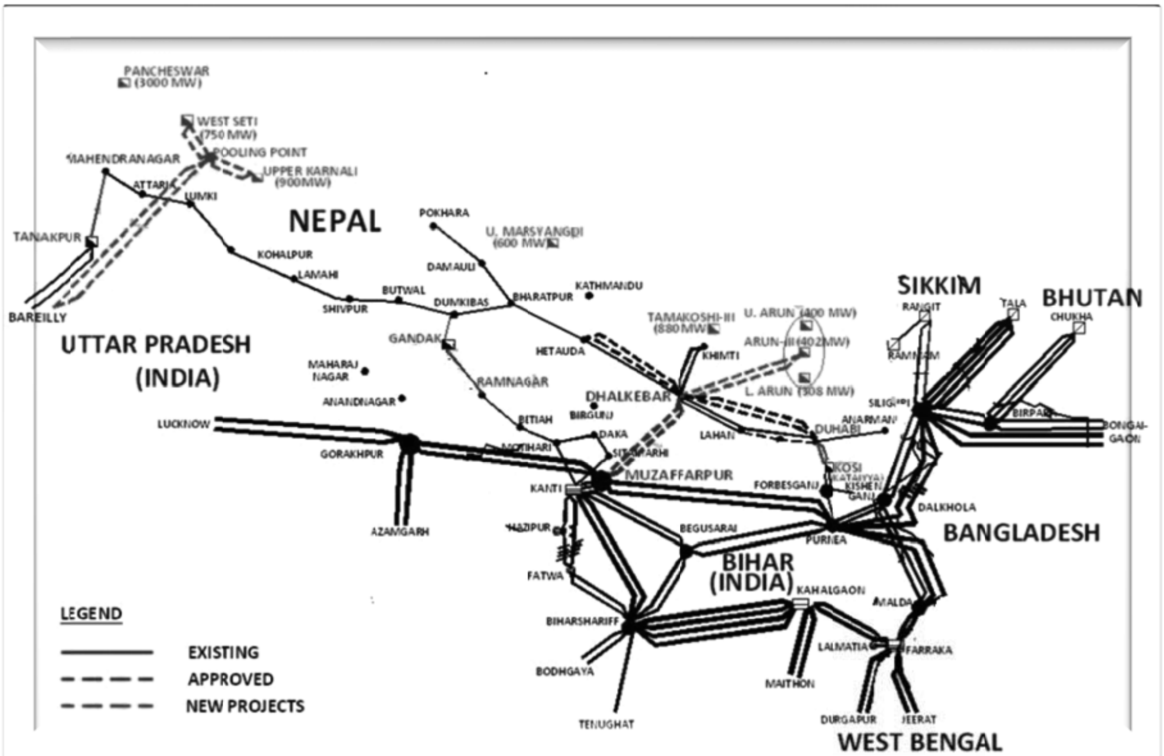
27. India and Nepal also share a long history of electricity exchange, but unlike the India-Bhutan electricity transfers that have been enhanced significantly over the years; the exchanges

between India and Nepal have not grown, mainly due to the lack of commercial initiatives. Lack of hydropower development in Nepal has left the country desperately short of power to meet its own demand with current generation capacity meeting only about half of the peak demand (950 MW in 2011) during the winter season. There is also a significant level of shortage(s) during off-peak hours which shows the system is acutely energy deficient. Only limited electricity exchange takes place currently based on bilateral agreements between Nepal Electricity Authority (NEA) and three utilities on the Indian side namely Bihar State Electricity Board (BSEB), Uttar Pradesh Power Corporation Limited (UPPCL) and Uttaranchal Power Corporation Ltd. (UPCL) India. These are supported by three 132 kV and a number of 33/11 kV cross-border links between the two countries.

28. Given the urgent need for a major expansion of power transfer capacity between Nepal and India, primarily to solve the severe electricity supply crisis in Nepal, and secondarily to evacuate any summer hydropower generation excess in Nepal to India, the work of a 400 kV 126 km (40 km in Nepal and 86 km in India) transmission link between Dhalkebar (Nepal) and Muzaffarpur (India) has been initiated. It will cost around $63 million and provide an additional 1000 MW of power transfer capability between the two countries by 2014/15. Cross Border Power Transmission Company Ltd (CPTC), a joint venture company, will construct the Indian section while Power Transmission Corporation Nepal (PTCN), another joint venture company, will construct the Nepali section. However, significant power transmission upgrades within Nepal estimated to cost $123 million, are also required to support the cross border power trade associated with the 400 kV link. Once completed, that link is expected to provide a major boost to the India-Nepal power trade. This cross-border transmission link is expected to be followed by other similar links such as the West Seti-Bareli, Hetauda-Gorakhpur and Duhabi-Purnea, designed to support export oriented hydropower development in Nepal. See Figure 10 for the Nepal major transmission links including cross-border lines.

29. The development of export-oriented hydropower projects in Nepal, principally for consumption by India with some generation share provided to supply the local demand, is a major area for cooperation. In this regard, the Government of Nepal is pursuing with private sector developers, export oriented hydropower projects like West Seti (750 MW), Budhi Gandaki (600 MW), Upper Karnali (400 MW), Kali Gandaki (660 MW), Arun III (800 MW) and Tamakoshi (880 MW). However, the necessary project development framework and off-take market assurance has not reached the level of maturity seen in the Bhutan-India case. Therefore it is difficult to establish specific electricity export targets.

Figure 10: Locations of Major Power Transmission



Source: India Presentation at SASEC Transmission Utility Forum 2012, Kandy, Sri Lanka

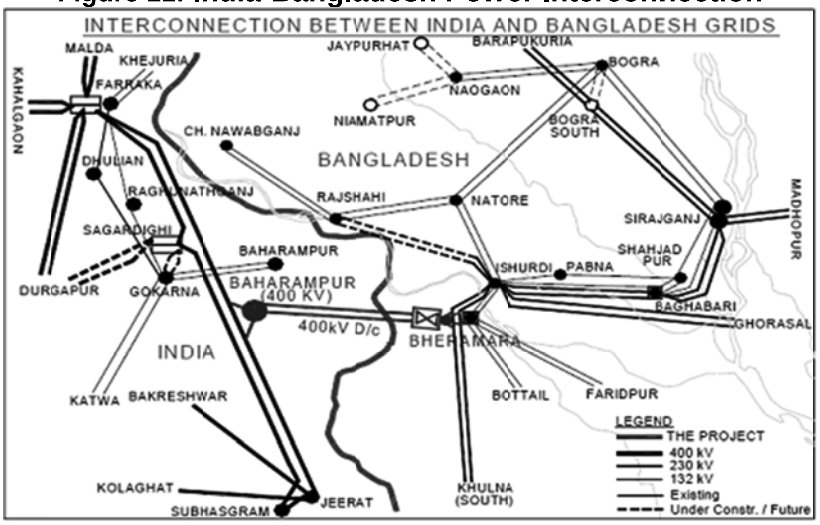
C. India-Bangladesh Electricity Trade

30. Bangladesh has been facing major power shortages over the past decade due mainly to power generating capacity and fuel shortages. In 2010, the maximum demand served was 4,606 MW against an estimated peak of 6,454 MW. Subsidized (natural) gas at $1.1 per gigajoule (economic cost $3 per gigajoule) fuels nearly 90% of total electricity generation, but of 5,800 MW of installed power generating capacity in 2011, only about 20% was in the form of high efficiency combined cycle plant. Low efficiency steam and gas turbine power plant operating on gas and to a lesser extent fuel oil dominate the generation mix.

31. Given the continuing shortage of gas in Bangladesh, power generation costs would likely continue to increase due to the utilization of gas-fired base load power plants (with fuel costs of $20 per MWh or less) supplemented in a large-scale by mid-merit/peaking power plants operating on liquid fuel (with fuel cost of $200 per MWh or more). Power import from India is therefore a real option for Bangladesh in the short to medium term in order to overcome to some extent, capacity as well as gas shortages, at reasonable costs. This option will remain significant until the commencement of the planned commissioning of two 600 MW of (imported) coal based power generating plants in 2015 (to be followed by other similar units to take the installed capacity to about 19,000 MW by 2018) and the provision of increased access to gas though more correct pricing. Both power import and export opportunities would exist between India and Bangladesh in the longer term, depending on the state of demand-supply in the two countries.

32. The first Bangladesh-India power interconnection in the form of a 500 MW HVDC transmission link between Baharampur in Eastern India and Bheramara in Western Bangladesh is under construction. It is scheduled to be commissioned in 2013. The asynchronous connection between the two power systems will minimize their operational interaction and enable their independent operation containing any stability issues. Figure 11 shows the interconnection arrangement.

Figure 11: India-Bangladesh Power Interconnection



Source: India Presentation at SASEC Transmission Utility Forum 2012, Kandy, Sri Lanka

33. The Indian portion, with 85 km worth of 400 kV double circuit power transmission line costing $36.06 million, is being executed by PGCIL (Power Grid Corporation of India Ltd.) with local funding, while the Bangladesh portion with 30 km of 400 kV double circuit power transmission and the 500 MW back-to-back HVDC convertor station, costing $156.44 million, is being executed by PGCB (Power Grid Company of Bangladesh Ltd.) with ADB funding. Power purchase by Bangladesh is covered by two PPAs. The first for 250 MW will have the electricity (kWh) price indexed to specific power plant generating costs in India (2.40 INR per kWh in 2011) and the second for the balance 250 MW is to be linked the Indian power market. A cross-border electricity interconnection in the north-eastern Bangladesh is also under consideration.

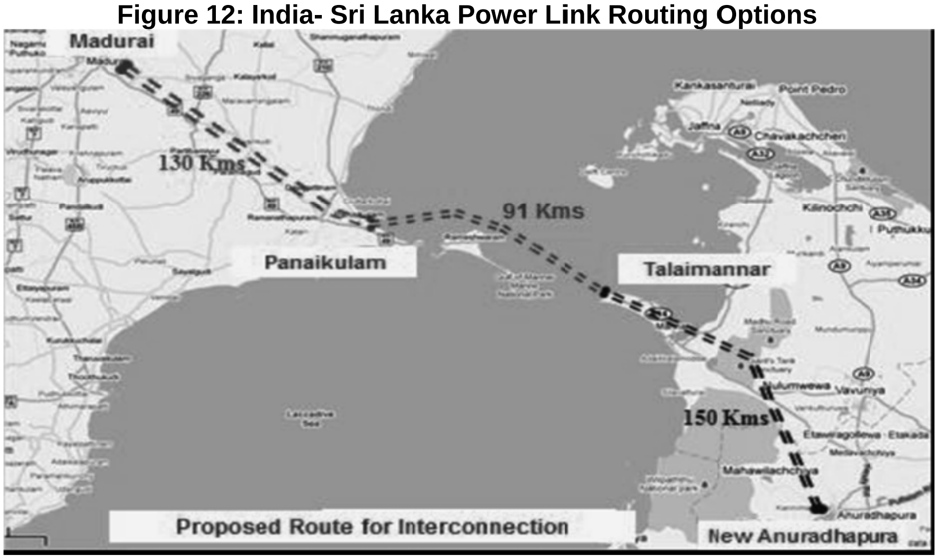
D. India-Sri Lanka Electricity Trade Proposed

34. The Sri Lanka power system, with a maximum power demand of 2163 MW and an installed power generating capacity of 3100 MW in 2011, was dominated by hydropower up to the late 1990s. However, load growth over the past decade fuelled by economic growth required the addition of comparable thermal power generating capacity mostly in the form of expensive fuel- oil based power plants. The addition of the 315 MW first stage of the Puttalam coal-fired power station in early 2011, however, marked an important milestone for the country. Peak shortage would be an issue over the coming years, especially if part of the new capacity addition including the additional two 315 MW stages of Puttalam does not eventuate in 2014, as planned.

35. Interconnection with India would serve Sri Lanka by providing a long term solution to meeting peak load, improving system reliability and enabling better utilisation of its hydropower system, including economic export opportunities during off-peak load hours. The pre-feasibility of establishing a power transmission system of 1,000 MW capacity using a combination of

overhead lines and undersea cabling from Madurai in India up to New Anuradhapura in Sri Lanka was examined by PGCIL in 2006, consisting of: a 400kV HVDC 185 km overhead line from Madurai to the Indian Sea Coast (near Rameshwaram); a 400kV HVDC 50 km cable from the Indian Sea Coast to the Sri Lanka Sea Coast; a 400kV HVDC 150 km overhead line from the Sri Lanka Sea Coast to New Anuradhapura; and two 400kV bipole HVDC terminals of 1000 MW capacity each at Madurai and New Anuradhapura.

Figure 12: India- Sri Lanka Power Link Routing Options



Source: Sri Lanka Presentation at SASEC Transmission Utility Forum 2012, Kandy, Sri Lanka

36. The tentative cost of the link with a 1,000 MW bipole arrangement was estimated at $430 million in 2006. However, it was estimated that initial construction as a 500 MW monopole arrangement would reduce the cost of the project to $339 million. Given the technical and economic benefit of the link as seen by the prefeasibility study, India and Sri Lanka proceeded to carry out a full-fledged feasibility study. That study is now in progress and the results obtained so far have stressed the importance of shortening the long submarine cable route to maintain economic viability of the link (see Figure 12).

VII. OTHER PLANNED INTER REGIONAL ENERGY TRADE IN SOUTH ASIA

37. Current inter regional energy trade between South Asia and the rest of the world covers petroleum, coal, LNG, and limited electricity trade. No inter or intra regional natural gas transmission infrastructure is in place to facilitate natural gas imports, except for the LNG terminals in India satisfying domestic requirements. Inter-regional electricity trade is limited to Afghanistan importing about 200 MW of power from the Central Asian Republics (CARs) and Pakistan importing about 40 MW of power from Iran. The volume of this trade however, is insignificant in comparison to its potential, and is constrained by the infrastructure available. Feasibility studies for some specific high capacity inter-regional power and natural gas transmission systems identified as the Central Asia-South Asia (CASA 1000) power link, Iran-Pakistan-India (IPI) natural gas pipeline and Turkmenistan-Afghanistan-Pakistan-India (TAPI) natural gas pipeline have been undertaken (see below).

A. India-Pakistan Electricity Trade Proposed

38. Based on official data, Pakistan's power demand-supply gap has been escalating rapidly over the last 7 years as shown in Table 9. The current peak shortage is touching 6,000 MW or over 30% of the peak demand. Considering the hydro-thermal power generating capacity content of Pakistan's power system, there is a need to add around 9,000 MW over the next 3-4 years to bring the power system reliability to an acceptable level.

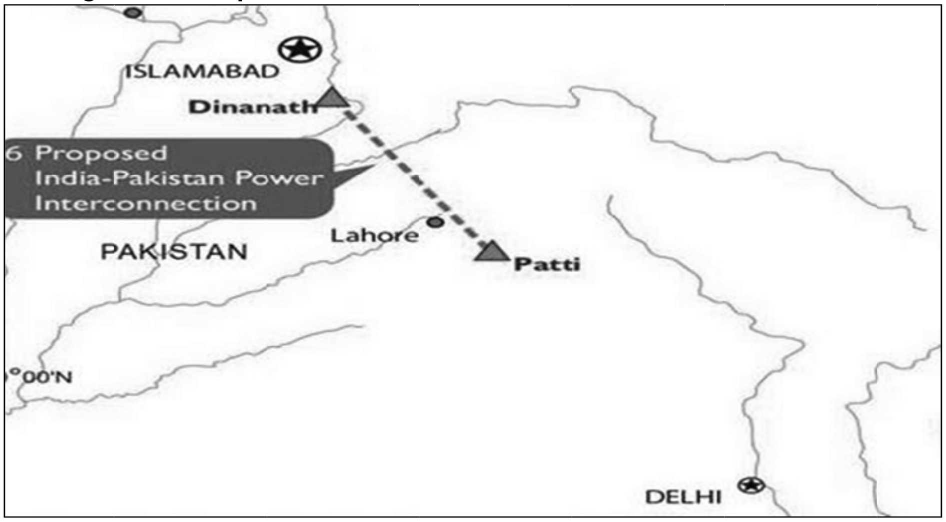
Table 9: Demand-supply Gap in Pakistan

Fiscal Year	Computed Peak Demand	Corresponding Peak Supply	Shortfall
2005/06	13847	12600	1247
2006/07	15838	13282	2556
2007/08	17398	12442	4956
2008/09	17852	13637	4215
2009/10	18583	13413	5170
2010/11	20058	14078	5980

39. There is currently no transmission link between India and Pakistan although the possibility of Pakistan providing its surplus power to India had been discussed in the past. Since the Indian and Pakistani power systems are in close proximity, especially on the northwestern border of Indian Punjab, a power link between Patti (Indian Punjab) and Dinanath (part of the Lahore ring in Pakistan) was considered in 1998/99 to directly link the Pakistani grid with some of the Indian loads. Given the severe power shortages in Pakistan at present and the open access power transmission possibilities in India, there is now renewed interest to pursue mutually beneficial cross border power transfer between the two countries.

40. Although there has been a lack of initiatives over the past 10 years and a dearth of technical/economic studies and data, interconnection between India and Pakistan has recently been discussed between the two governments. On 14 April 2012, the Federal Minister for Water and Power in Pakistan announced Pakistan's decision to import electricity from India to meet its energy requirements. In that context, Pakistan could initially import up to 500 MW through a new 45 km, 220 kV power transmission line. A higher capacity power link through an HVDC link for operational separation between the two power systems could follow, as shown in Figure 13.

Figure 13: Proposed India- Pakistan HVDC Power Interconnection



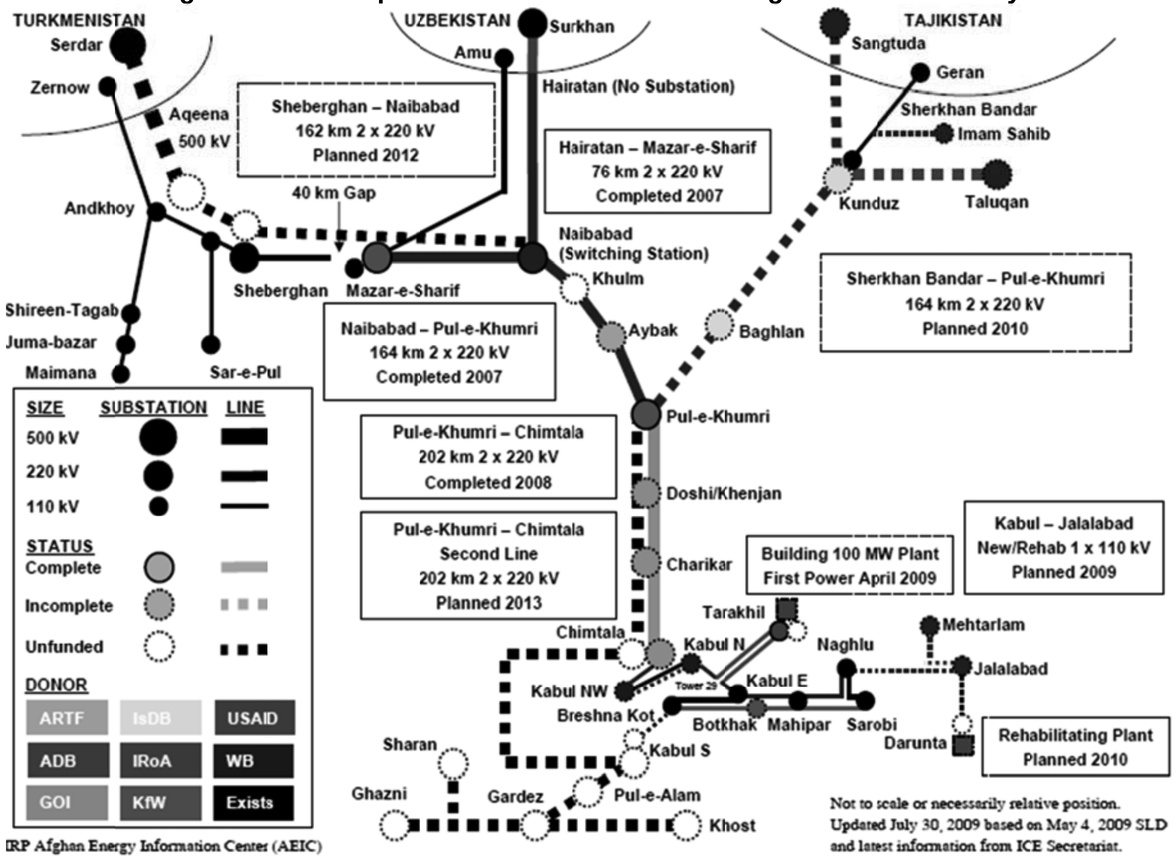
Source: Asian Development Bank

B. Central Asia- Afghanistan Power Transfer

41. Afghanistan has a highly supply-constrained power supply scenario. Its installed power generating capacity is now about 270 MW (140 MW in winter). A number of development partners have been providing assistance to Afghanistan since 2005 to rebuild, expand and integrate its power sector which has been operating as five independent systems. Figure 14 captures the planning for that purpose in 2009, and shows the expansion and integration process for these islanded power systems in the northern areas which are now supplied with power by Turkmenistan, Uzbekistan and Tajikistan. The islanded power system in the west is supplied by Iran. Electricity imports from these countries in 2010 amounted to about 500 GWh. Completion of the ADB financed 300 MW 220 kV Sangtuda (Tajikistan)- Kunduz (Afghanistan) cross border link (extended to Pul-e-Khumri) in 2011 (planned for 2010), was a major step forward towards gaining greater access to electricity for Afghanistan. Completion of the ADB financed links between Mazar-e-Sharif and Pul-e- Khumri and between Naibabad and Hairatan earlier in 2007 accomplished an important part of the power system integration process in Afghanistan.

42. However, it is imperative that Afghanistan gains access to larger external power supplies in the medium term pending further development of its own hydropower generation and fossil based power generation. The proposed Central Asia-South Asia (CASA) 1000 Project, discussed below, has undergone a feasibility study. It is designed to transfer excess electricity generation available in Tajikistan and Kyrgyz Republic to Pakistan through Afghanistan, and in addition, large scale power transfer capability to Afghanistan.

Figure 14: Development Plan for the Northern Afghanistan Power Systems

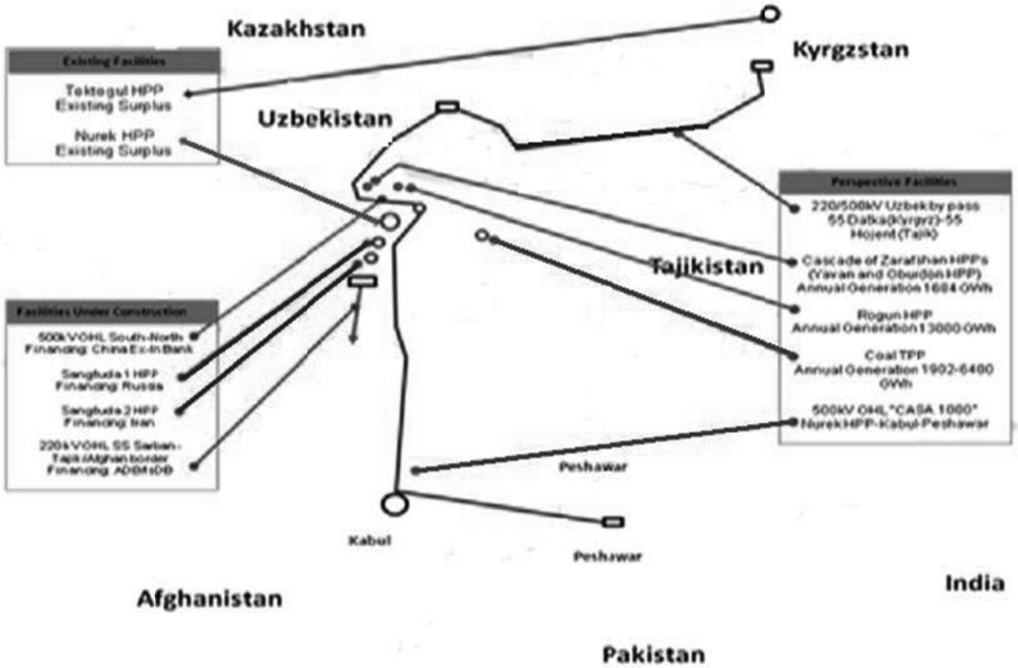


Source: Afghanistan Energy Information Centre

C. Central Asia-South Asia 1000 (CASA 1000) Project

43. The CASA 1000 project is a comprehensive initiative to interconnect Tajikistan, the Kyrgyz Republic, Afghanistan and Pakistan to form a Central Asia–South Asia (CASA) Regional Electricity Market. The core elements of the project include: a 500 kV, 750 km HVDC power interconnection with DC/AC conversion capacities of 1300 MW at Sangtuda (Tajikistan), 300 MW at Kabul (Afghanistan) and 1300 MW at Peshawar (Pakistan); and a 500 kV, 477 km high voltage alternating current (HVAC) power Interconnection between Kyrgyz Republic (Datka substation) and Tajikistan (Khoujand substation). See Figure 15 and Figure 16 The HVDC converter capacity in Pakistan (Peshawar) is equal to that in Tajikistan (Sangtuda). This provides flexibility for Pakistan to absorb up to 1300 MW, should Afghanistan not need to import its entire share. The present project cost estimate is $873 million (SNC Lavalin, February 2011).

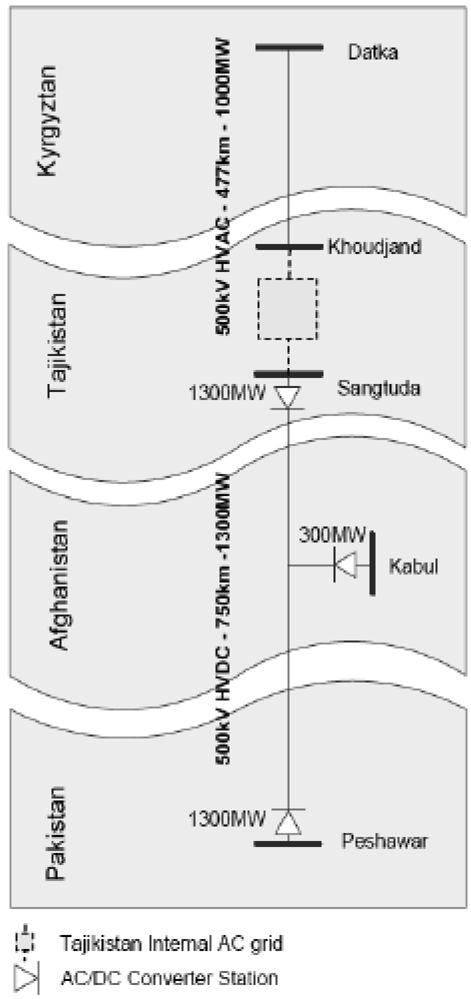
Figure 15: Structure of the CASA 1000 Project



44. The project was motivated by the surplus hydropower potential in Tajikistan and Kyrgyz Republic that may be usefully deployed to support power demand in Afghanistan and Pakistan, which both face severe power shortages. Tajik/Kyrgyz hydropower generation has around 6,000 GWh of surplus power at present during summer months, which would prove extremely beneficial to meet Afghan and Pakistan summer peak power demands.

45. Setting aside the potential benefit of reduction in unserved energy, the economics of power exchange is also encouraging. Hydroelectricity cost in Tajikistan is estimated to be $15 per MWh, in comparison to $132 per MWh that thermal independent power producers (IPPs) in Pakistan require for firm energy. Therefore, the transfer would be quite attractive as long as there exists the prospect for surplus hydroelectricity to be evacuated from Tajikistan. Afghanistan's electricity costs are also significantly higher when compared to Tajik and Kyrgyz hydro electricity supply costs.

Figure 16: CASA 1000 Power Transmission Arrangement



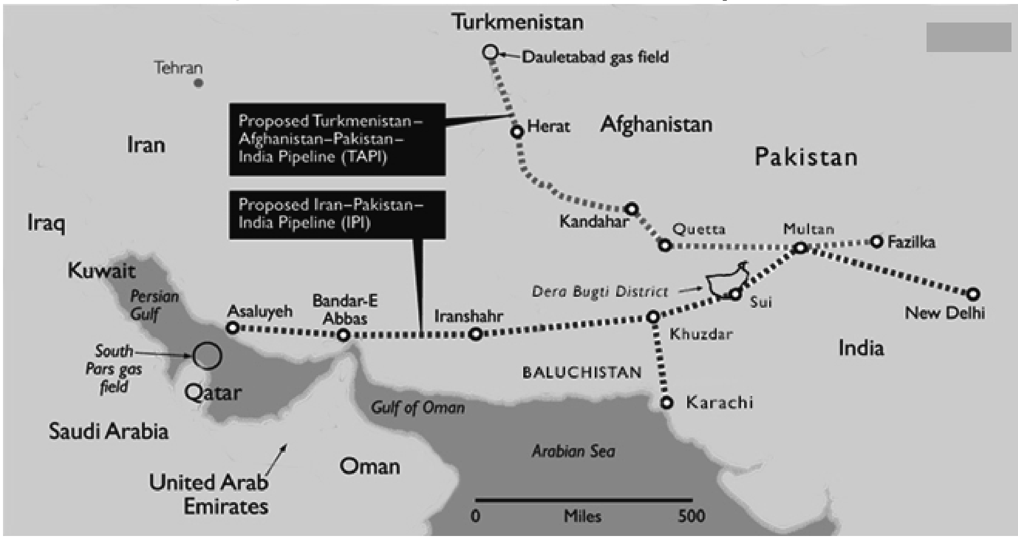
46. The CASA 1000 Project is well supported by the World Bank and ADB. ADB is however, pursuing the possibility of modifying the project design to bring in further integration of the still-islanded Afghanistan power systems and also avoid the less proven three terminal HVDC system (with terminals at Sangtuda, Kabul and Peshawar) by having two HVDC links and an AC system in between, for Afghanistan.

D. Iran-Pakistan-India (IPI) Gas Pipeline Project

47. The IPI Project (Figure 17) was originally proposed to supply 55 billion cubic meters per year (BCM/y), equivalent to 47 mtoe/y of (natural) gas, yielding 5.2 billion cubic feet per day (BCF/d), for use by both Pakistan and India. The estimated project cost was of the order of $7 billion in 2005. However, the gas volume to be supplied has now been revised down to 21 BCM/y (2.0 BCF/d), equivalent to about 18 mtoe/y, to be shared equally between Pakistan and India in a first phase of the project. Iran has constructed the required natural gas transmission facilities from Asalouveh to the Iran-Pakistan border including a 1172 km pipeline. Pakistan is planning to lay a 42 inch diameter, 700 km long pipeline to transport only the Pakistan volume of

up to 1.0 BCF/d from the Iranian border to Nawabshah in Pakistan, while another section of the same size can be added later as and when India decides to join the project.

Figure 17: IPI and TAPI Natural Gas Pipelines



48. Iran signed a natural gas export contract with Pakistan on 13 June 2010 to export 1.0 BCF/d of natural gas to Pakistan from 2014 on the basis that Pakistan would have its section of pipeline commissioned by then. The model proposed for funding the pipeline section in Pakistan was based on an integrated project structure with the Government of Pakistan or a strategic investor taking a lead role in implementing the project. The natural gas transit charge cash flow was expected to come from the major gas purchasers such as Pakistan State Oil, OGDC, Pakistan Petroleum, Sui Northern Gas Pipelines, and Sui Southern Gas Company. However, on 13 March 2012, Pakistan announced that private investors were showing diminished interest and that the government might have to impose a tax on consumers, or seek government-to-government arrangements with Iran, and other countries to build the pipeline.

E. Turkmenistan – Afghanistan – Pakistan – India (TAPI) Gas Pipeline Project

49. The TAPI Project (Figure 17) has been proposed to bring natural gas from the Dauletabad and adjacent gas fields in Turkmenistan to Afghanistan, Pakistan and India. An ADB funded feasibility study envisaged a 1735 km, 3.2 BCF/d (29 mtoe/y), 56-inch diameter pipeline from Turkmenistan through Afghanistan and Pakistan to the Pakistan-India border. The capital cost of the project was estimated at $7.6 billion in 2008. The project will take between 4 to 5 years to complete after signing of all contracts. The TAPI parties have agreed in-principle to initially share 2.2 BCF/d of natural gas, equivalent to about 20 mtoe/y, equally between Pakistan and India (about 1.0 BCF/d each) with Afghanistan taking about 0.2 BCF/d.

50. A Gas Pipeline Framework Agreement (GPFA) was initialed in April 2008 by the respective ministers and an intergovernmental agreement on the pipeline was signed on 11 December 2010. In April 2012, India and Afghanistan failed to agree on a transit fee for gas passing through Afghan territory. Consequently, Pakistan and India could not agree on the transit fee for the segment of the pipeline passing through Pakistan. However, on 16 May 2012, Afghanistan approved the agreement on a gas pipeline and subsequently the state run Gas Authority of India signed the Gas Sale and Purchase Agreement (GSPA) with TurkmenGaz,

Turkmenistan's national oil company. Afghanistan is expected to earn about $350 million per year in natural gas transit fees when the TAPI project starts operations.

51. The TAPI route is in extremely challenging terrain and will also have 830 km of the pipeline in Afghanistan, which poses possible operational constraints. Consequently, the financing risk would be higher than in the case of the IPI pipeline although the market and payment risk would be similar to those for that pipeline. Continued commitment of the gas by Turkmenistan could be an issue given other lucrative markets particularly in Europe.

VIII. ENERGY TRADE ISSUES AND POLICY RECOMMENDATIONS

52. Regional energy trade would typically: (i) help overcome the mismatch between energy demand and energy resource endowments among the countries in the region, especially among neighboring countries; (ii) enhance energy security through prudent reliance on trade to meet part of the demand by diversifying the forms of energy access and supply sources with possible lowering of the average cost of supply; (iii) enable smaller countries with large natural resources (such as hydropower) to develop that resource exploiting economies of scale; (iv) help postpone, reduce, or avoid large and lumpy capital investments in new production facilities and thereby overcome temporal cash flow problems; (v) promote public-private partnership arrangements and thereby enhancing private sector participation in the energy sector; and (vi) capture environmental benefits by enabling the substitution of planned higher per electricity unit pollutant emission projects in one power grid with lower per electricity unit pollutant emission projects in an interconnected power grid.

53. However, it is evident from the degree of maturity of the intra and inter regional energy trade initiatives discussed above that the extent of supplementary energy that can be accessed by the SAC through those initiatives in the medium term would not adequately supplement the country-based energy expansion options available to the SAC to meet their incremental energy supply requirements. The SRETS (SAARC Regional Energy Trade Study), therefore recommends pursuing further energy trade options in the form of an enhanced regional power market, regional LNG terminals for bulk LNG import, large scale regional power plants based on LNG or imported coal, and regional bulk crude oil refining.

54. The key issues faced in energy sector cooperation to enhance regional energy trade generically emerge from the need for adequate energy supply and a supporting regional market structure particularly for electricity, and are centered on the need to develop: (i) a regional power market; (ii) energy supply availability; (iii) energy trade infrastructure; and (iv) harmonized legal and regulatory frameworks

A. Regional Power Market

1. Issue

55. Given the high opportunity cost of electricity shortages in the region, any effort to reduce those shortages would have significant economic benefits. An option available for the region to reduce electricity shortages is to promote enhanced electricity trade in any surpluses that the SAC may have either over the course of the day or seasonally. In this context, it is important to note that Bhutan has agreed to export around 10,000 MW of hydropower to India by 2020, Sri Lanka is in the process of implementing nearly 2,000 MW of coal-fired power plants and considering a 500 MW HVDC power transmission link with India, while India itself is progressing

with the implementation of its 2,000 MW–4,000 MW power plants with coal or LNG firing. On the other hand, predominantly natural gas dependent Bangladesh, and hydropower dependent Nepal, are looking towards early completion of their 500 MW and 1000 MW power interconnections with India, respectively, in order to ease their present power shortages. Pakistan is also seeking power trade opportunities to ease its present power shortages. The present regional trade, which is now bilateral in nature and taking place between India and Bhutan and India and Nepal, to a limited extent, can be enhanced to cover much larger power volumes.

56. Such enhanced electricity trade can be facilitated by a regional power exchange that would provide centralized control to increase opportunities for cross-border multilateral electricity trade among the SAC, which are already interconnected or likely to have interconnections. Bilateral trade arrangements can graduate to multilateral trade arrangements within a regional framework. India already has two working national level electricity exchanges, the India Energy Exchange and Power Exchange India Limited, through which bilateral as well as competitive electricity trade is taking place. Interested power producers and buyers in the SAC that are already connected or to be connected to the Indian electricity grid can consider participating in enhanced regional electricity trade through a regional power exchange linked to these Indian electricity exchanges. The SAC could then as a first step participate in the Indian power market through bilateral contracts facilitated by this regional power exchange, and then proceed to transfer power to third parties where feasible.

57. India has an important role to play in building a regional electricity market because of its size and its central location. All trade, except that between Afghanistan and Pakistan, would involve India as the conduit for electricity transmission. The Indian experience of linking various regional grids to the move to a national grid, may be emulated for building the proposed regional power market. India has five regional transmission grids: Northern, Western, Southern, Eastern, and North Eastern. At present, four regions, the Northern, Western, Eastern, and North Eastern, are synchronously interconnected through high capacity 400 kV AC lines. HVDC interconnections are also available between the Eastern and Northern regions and between the Western and Northern regions. These supplement the AC synchronous links. The Southern region, now connected with the remaining all-India power grid through asynchronous HVDC and radial AC links, is to be synchronously connected to the other regions by 2013–2014.

58. The Indian power exchanges, India Energy Exchange and Power Exchange India Limited, are day-ahead markets. In the process of carrying out market operations, they make a first estimate of the marginal clearing price and the marginal clearing volume of power, based on the bids received from sellers and buyers for each hour over the next day. The exchanges then check the required transmission capacity with the National Load Dispatch Center (NLDC) and regional load dispatch centers, and do a recalculation of the marginal clearing price and marginal clearing volume, considering any transmission constraints. Thereafter, the exchanges issue day-ahead power generation and dispatch schedules for implementation the next day and follow with the issuance of financial statements for the settlement of payments, after the actual power transactions take place.

59. Most of the facilitation offered by the two power exchanges at this stage is for bilaterally traded power between generators and major consumers. However, given the continuing power shortages, there is strong interest in further development of merchant power plants in India. These typically tie up about 70% of their generating capacity through long-term bilateral contracts with major consumers, trading only the balance on a competitive basis. Given this

background, there is scope for elevating cross-border bilateral electricity trade facilitated by a regional power exchange to be partly market based.

60. In the case of contract-based bilateral power exchanges between SAC, a country NLDC can evaluate the net feasible power exchange (based on data from generators, traders, or aggregators) along with the points of power export or import for each scheduling period from that country's perspective and communicate this to the designated regional power exchange for implementation. In the case of market-based power transactions, the power available for export in excess of bilateral commitments can also be marketed through the regional power exchange, given proposed hourly power injection quantities and the points of injection and price, for subsequent finalization and implementation to the extent accepted by the sellers and buyers of power. Harmonized regulatory provisions, including grid codes to ensure reliable interconnected operation together with control and communication mechanisms among the NLDCs of the participating countries to coordinate the regional power exchange, are a prerequisite for both modes of power exchange.

2. Policy Recommendations

61. The following actions are recommended to make an enhanced regional power market, facilitated by a regional power exchange and linked to the existing Indian power exchanges, a reality:

1. A study of power system structures in the SAC, including the legal and regulatory aspects, and the power transmission system security and stability standards in the participating countries and their compatibility from a regional power trading perspective.

2. A review of power generation scheduling and dispatch procedures, energy accounting systems, and financial settlement systems for electricity transactions in the individual countries; detailing of measures for their harmonization to allow feasible cross-border power trade; and analysis of the institutional, regulatory, and commercial requirements for cross-border power trade.

3. The development of a structure for a regional power exchange that can link with the existing Indian power exchanges, with operational modifications necessary, and centrally facilitate the extension of the Indian power market to cater to regional power trade.

B. Energy Supply Availability

1. Issue

62. Expanding and broad-basing the regional energy trade clearly requires further development of the major hydropower resources in Bhutan and in Nepal together with bulk, regionally competitive imported coal and/or LNG based power generation within the region. Parallel development of the power transfer infrastructure required to connect India to Bangladesh, Pakistan, and Sri Lanka to an economically viable extent, and the expansion of the present power transfer infrastructure between Bhutan and India and between Nepal and India, is also required.

63. Bhutan, with an economically viable hydropower generation capability of about 24,000 MW, has an installed capacity of nearly 1500 MW, primarily for electricity export to India and a

firm agreement for the export of 10,000 MW to India by 2020. Nepal, on the other hand, with 43,000 MW of economically viable generation capability, still has no firm agreement with India for any time-bound electricity exports from specific large scale export oriented hydropower projects. This is primarily due to the lack of a strong enabling framework including power purchase arrangements for external participation in the development of those hydropower projects and necessary transmission for power evacuation to an external power market.

64. Nepal is, however, acting to improve that framework while also negotiating project development with specific project sponsors taking a public-private financing approach accessing multilateral bank lending and guarantee instruments. In this context, it is relevant to also note some of the key success factors in Bhutan such as close attention to detailed project feasibility, availability of an Umbrella Agreement with India for both public and private sector cooperation in hydropower development, power export/trading valid for 60 years (extendable with mutual consent), energy based escalating project tariffs so far ranging from $0.04 per kWh for the 1020 MW Tala HP to $0.053 per kWh for the 126 MW Dagachchu HP, and GHG reduction in India by hydropower export from Bhutan enabling Bhutan to earn CDM revenue using the Indian emission baseline.

65. With an installed power generating capacity of 170 GW in 2010, India has dominated the total regional installed power-generating capacity. However, India itself experienced peak power supply deficits of around 15% in that year, mainly due to the need to de-rate the power generating capacity for various reasons, including fuel supply shortages. In this context, India has taken definite steps to rapidly expand its power generating capacity to about 300 GW by 2017 by including LNG based and imported coal based mega power generating plants, in addition to power plants based on domestic natural gas and domestic coal. It is estimated that India would import about 30% of its coal and natural gas requirements by 2020.

66. Imported coal-based, mega power plants generating up to 4000 MW are being developed in India on the basis of best practices. These plants yield operational as well as coal procurement economies of scale. One or more such plants could be considered for overall regional benefit. Importing electricity from a regional power plant by SAC would however be dictated by the competitiveness of the cost of electricity imported, including electricity transmission costs, when compared with the cost of in- country electricity generation. 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, an LNG based bulk power generating plant becomes competitive with an imported coal based power generating plant.

67. India has placed emphasis on new LNG-based mega power plants, considering also the need to minimize the adverse environmental impact brought about by power generation expansion. This emphasis is clear from the 40 million tons a year of LNG imports that India is seeking by 2017 to provide an incremental supply of 5100 million cubic feet per day of natural gas. About 40% of that supply is targeted for bulk power generation in the form of about 20 GW of combined cycle power plant. Part of that LNG based power generation could be in the form of bulk regional power plants in which interested SAC, with adequate power interconnection capacities, could invest in. Such interested SAC can benefit from the economies of scale in power plant operations and in natural gas procurement, preferably through a regional LNG plant.

68. Given that India is already an LNG importing country, and that Pakistan and Bangladesh are also considering LNG imports, the region could benefit from embarking on a bulk regional

LNG terminal project to capture the benefits of economies of scale from terminal size and bulk LNG procurement. The ownership and financing of the LNG terminal can be structured as a joint venture of the participating SAC with each participating SAC holding an equity stake in the terminal and procuring the latest technology. The supply of natural gas can be based on price and/or quantity bids. Development of the incremental natural gas distribution infrastructure needed would be a parallel requirement. Transfer of the natural gas energy through wires in the form of electricity is also a strong option. Such a regional LNG terminal would provide wider and more flexible opportunities for sourcing natural gas with a high level of certainty through both long term and spot contracts, and can be pursued in parallel with the IPI and TAPI projects for power generating and other uses of natural gas.

69. Given their domestic natural gas supply constraints, the IPI and TAPI natural gas supply pipelines have been viewed by Pakistan and India for many years as possible modes of bringing in additional bulk natural gas supplies for their use. Bangladesh has also recently shown interest in a TAPI extension to that country. However, it is evident that a degree of uncertainty does exist with respect to the availability of natural gas quantity, as well as project financing and implementation with respect to these pipeline projects. The success of those projects would depend on: (i) ensuring the availability of adequate natural gas reserves and the commitment and authority of the producer to feed the pipeline capacity for 15–20 years (reserve and production risk); (ii) firming up construction costs and schedule and ensuring ability of the pipeline operator to keep the pipeline functioning for a 15–20 year period (construction and operation risk); (iii) a commitment by the market or buyers to take all the natural gas over this period and pay for it in currencies matching the gas supply costs (market and payment risk); and (iv) the ability to obtain timely financial closure for the project (financing risk). Apart from the need to minimize these commercial risks, there would be a need to mitigate the effects of any political unrest in pipeline transiting countries. Similar commercial risks are associated with the CASA1000 power transmission project which may also require some design modification for the project to be more useful for Afghanistan and also use more proven technology.

2. Policy Recommendations

70. The following policy initiatives are recommended to enhance access to energy supply in the South Asia region:

1. Expand the scope in Bhutan for further private sector participation in hydropower development and associated power transmission;

2. Provide further targeted assistance to Nepal to strengthen its hydropower development framework in terms of detailed feasibility studies, financing mechanisms, and formulation of public private project implementation arrangements;

3. Carry out further quantitative analysis to determine the attractiveness of SAC power purchase from large-scale high-efficiency centralized regional power plant(s), based on imported coal as well as imported natural gas from a LNG terminal;

4. Review the more significant commercial risks associated with TAPI and IPI, particularly related to project cost, implementation, and payment mechanisms for delivered natural gas, and compare with commercial risks and costs associated with imported natural gas based on LNG.

C. Energy Trade Infrastructure

1. Issue

71. Lagging cross border energy trade investment in South Asia has largely been due to inadequate export oriented energy development and also unrealistic energy price expectations on the part of prospective energy receiving countries. Energy tariffs are in fact, often subsidized and held below economic costs. Delays in negotiating the necessary energy transit agreements have also at times impeded the provision of cross border energy transfer infrastructure. However, cross border energy transfer investment infrastructure is now growing with increasing efforts underway to expand the supporting energy supply, develop more realistic expectations of energy cost, improved analytical techniques being deployed to assess interconnection viability, and implement more coherent legal and regulatory frameworks.

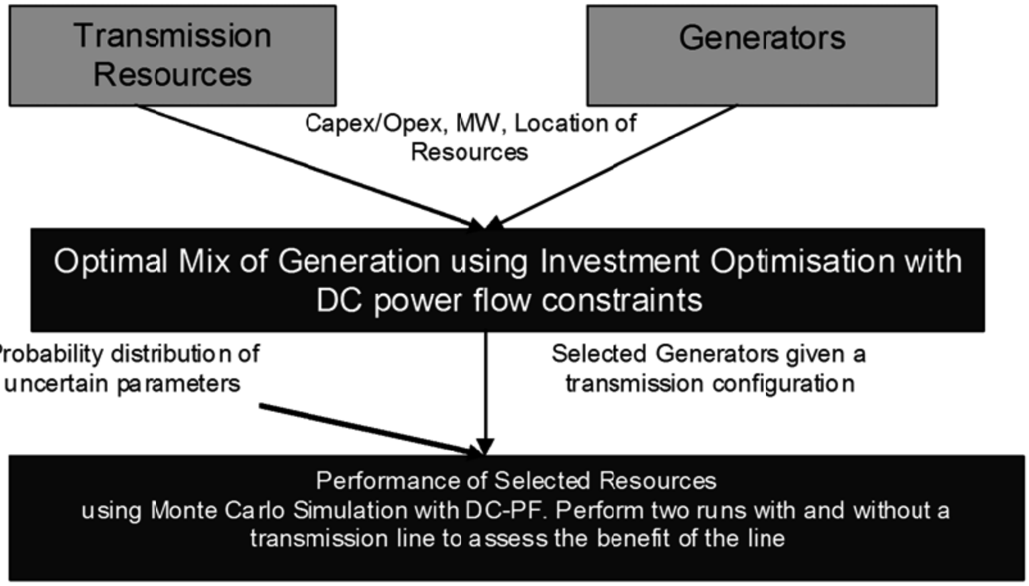
72. In current power system planning practice, the technical and economic viability of cross border power interconnections are typically analyzed on the basis of realistic generation and transmission planning studies with and without integration of the country power systems considered for integration, so that the technical and economic benefits of a particular interconnection can be assessed. Figure 18 illustrates this methodology as being carried out under an ongoing ADB technical assistance[1] for evaluating power system interconnection options.

73. A reliable database is required to carry out these studies in a meaningful manner. Such a database would typically include detailed information for the countries considered on power demand projections, existing systems and operating details, possible power supply expansion options together with their capital costs and financing mechanisms, in-country power transfer options, cross border power transfer options, and integrated and non-integrated power system operating procedures.

74. In this context, it is important to recognize that high HVAC interconnection of two or more power systems calls for synchronizing all the connected grids with the discipline that needs to be associated with such synchronous operation and common criteria for system operation and control will have to be agreed among several parties and observed continuously. HVDC power system interconnection may have to adopted where such synchronous operation is considered to be impractical, even though at a comparatively higher cost, and where the power transfer volume and distance is particularly high for the order of interconnection voltage considered. It is clear that these aspects have also to be factored into the cross border transfer option selection process.

[1] ADB Technical Assistance TA 7529. *Study on South Asia Regional Power Exchange*. Manila. 2010

Figure 18: Power System Interconnection Evaluation Methodology



75. Strong stakeholder commitment and political backing are important factors that help in carrying out the necessary analysis with meaningful data and moving towards implementation. Technical and financial support from external stakeholders such as multilateral financial institutions can be crucial in getting initial project development underway and develop legally enforceable agreements. Private sector participation, where relevant and practical, can speed up the financing process and improve the confidence of commercial lenders. In that context, the creditworthiness of the main buyer of electricity in the case of a power interconnector, for example, is very important to enable completion of project financing arrangements (financial close).

76. It is relevant to note here the broad features and financing mechanisms of two relatively recent ADB financed dedicated power transfer projects. The first is the double circuit 220 kV power interconnection financed by ADB loans in 2006 and 2010 (supplementary) to bring in 300 MW of power from Tajikistan to Afghanistan at a total project cost of $121.9 million with $67.9 million in Afghanistan and $54.0 million in Tajikistan. ADB financing towards meeting the respective costs was $47.0 million for Afghanistan and $21.5 million for Tajikistan. Other major external financiers included the OPEC Fund, Islamic Development Bank and the Afghanistan Reconstruction Trust Fund.

77. The second is the power transfer link constructed by Powerlinks Transmission Ltd. (PTL) a pioneering PPP joint venture power transmission company set up in India between Tata Power Company (51%) and PGCIL (49%) to provide about 3000 MW of capacity with a 1166 km double circuit 400 kV power transmission line between Siliguri in West Bengal and Manduala in Uttar Pradesh (near Delhi) mainly to transmit power generated in Bhutan and brought to Siliguri. The project, brought into commercial operation in September 2006, cost $265.0 million ($79.5 million in equity and $185.5 million in debt) and was financed IFC ($75.0 million), ADB ($66.3 million) and domestic financing institutions ($44.2 million). The entire power transmission capacity has been assigned to PGCIL under a transmission service agreement for regulated transmission fee.

2. Policy Recommendations

78. The following policy initiatives are recommended to develop cross border electricity trade infrastructure in the South Asia region given its predominance in regional energy trade:

1. Identification of possible cross-border power transmission interconnection scenarios for the South Asia region and development of a regional database required to carry out power system studies capturing economic prices to the extent possible.

2. Detailed examination of the interconnection modality, whether HVAC or HVDC, and its size, timing and operational feasibility.

3. Assessment of technical and economic viability of candidate interconnections looking at the power system performance from a ‘with and without’ interconnection perspective.

4. Formulation of interconnector financing options considering the extent to which public sector financing can be deployed and the level and modality of multilateral financing required to catalyze private sector investment.

D. Harmonized Legal and Regulatory Frameworks

1. Issue

79. In terms of institutional improvements, it is relevant to note that energy markets in the individual South Asian countries are governed by individual legal, regulatory and policy frameworks. The legal and regulatory risks multiply if cross border energy transactions, which often have to recover high cost, state of the art technology investments, need to deal with multiple energy sector legal and regulatory frameworks. Immaturity of those frameworks in the individual countries and lack of harmony among the rules and procedures that are needed to facilitate cross border energy trade and simplify transaction mechanisms is a constraint to energy trade. Therefore, the SAC need to work together to harmonize their legal and regulatory frameworks with respect to at least regional electricity trade, as a first step.

80. The institutional structure already exists in most SAC in terms of the relevant energy ministries and energy sub-sector institutions. This facilitates harmonization of the relevant energy sector frameworks within the region. The majority of SAC have energy sector regulators. While Pakistan and India have separate energy sub-sector regulators, Bangladesh has one regulator for the whole energy sector. Sri Lanka has a Public Utilities Commission which is not restricted to just the energy sector. Such divergence in the mandate of regulators across the region can create coordination issues, but would not be a major impediment to the legal and regulatory framework harmonization process.

81. Following are the key aspects that need attention for the purpose of harmonizing the legal and regulatory frameworks in the SAC to promote at least regional electricity trade on a multilateral basis:

(1) Trading License: Recognition and licensing for trading of electricity including provision for cross-border trade to enable development of a cross-border market. The generation licensees, bulk suppliers (if already licensed) as well as distribution licensees can be recognised as deemed trading licensees. A participating member country may initially limit the right to cross-border trade to one of the recognised government entities. That should however be later relaxed to permit greater market participation and competition.

(2) Open Access of Transmission Network: Non-discriminatory open access of the transmission to facilitate development of a competition targeted regional power market. The respective regulations/rules for grant of open access should be coordinated by the respective country nodal agencies.

(3) Coordinated System Operation and Treatment of System Imbalances: Coherence of the Grid Code being followed by the respective system operator in each participating country to facilitate cross-border trade. A mechanism for treatment of system imbalances at the regional level needs to be established (essential for countries inter-connected in a synchronous manner with AC links).

(4) Transmission Planning: Coordinated power transmission planning across transmission licensees in the region to develop cross border linkages with adequate margin to allow for regional trade through power exchange.

(5) Policy for Regional Electricity Trade: Promotion of regional electricity trade and development of a regional power market to be a part of the national energy/ electricity policy in the respective countries.

(6) Export Taxes and Import Duties: Provision to exempt electricity traded through power exchange from any export tax or import duties to be a part of appropriate tax laws of the respective countries. Any uncertainty with respect to the liability of export tax / import duties on market cleared electricity sales quantities would impede country participation in power exchanges.

(7) Dispute Resolution: Provide for joint resolution of any cross-border power trade related dispute through a regional mechanism evolved with regional level agreement. A coordination committee of the participating countries could be empowered to adjudicate between the parties involved in cross-border electricity trade.

82. Private sector financing of large hydropower projects face inherent complexities in the form of complex hydrological, environmental, and social issues compared to large thermal power projects which are essentially fuel conversion projects carried out to provide specified electricity outputs with adherence to stipulated environmental norms. Given acceptable attention to these issues, catalytic funds (both equity and loans) and guarantee instruments to facilitate the financing of hydropower development are available from the private sector windows of multilateral financing institutions such as ADB. However, it is important for that purpose to have in place the enabling framework to facilitate private sector participation including internationally accepted measures to ensure the security of energy sector infrastructure provided and agreements related to the provision of returns on those investments. The same concerns of course prevail for thermal power projects. On the other hand, public sector funds for dedicated cross border power transmission can normally be accessed by the concerned countries form the World Bank or ADB, given their technical, economic, financial, environmental and social acceptance.

83. Harmonization of the legal and regulatory frameworks for regional electricity trade would be a strong incentive for both public and private sector investment in cross border power transmission facilities and both hydro and thermal power generating facilities to provide additional power exploiting economies of scale for regional use. The various investment agreements, trade agreements, and power purchase agreements involved could also benefit from the concerned countries being members of the Energy Charter Treaty (ECT). Such membership would provide greater security for cross border energy transfer related investments and agreements as well as any dispute resolutions.

84. The objective of the 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 to minimize risks associated with energy related regional investments and trade. Box 1 shows the ECT provisions and benefits. In this context, it would be beneficial for the SAC to develop a regional energy trade and cooperation agreement and adopt a regional trade treaty similar to the Energy Charter Treaty or join that treaty.

Box 1: The Energy Charter Treaty

The Energy Charter Treaty's (ECT) provisions focus on five broad areas:

1. Protection and promotion of foreign investments in energy receiving an extension of national treatment or most favored nation treatment whichever is more favorable.
2. Free Trading in energy related materials and products and energy related equipment based on WTO rules.
3. Freedom of energy transit through pipelines and grids.
4. Reducing negative environmental impact of the energy cycle through improving energy efficiency
5. 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 favorable to flow of investments and technologies. The Treaty acts as a forum for experience sharing and encourages co-operative efforts aimed at promoting market oriented reforms in the energy sector.

The 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.

1) The producer member countries benefit from the treaty through investor confidence which results in a constant flow of foreign direct investment into the countries.
2) For the transit country, the treaty creates a secure transit framework, which is an advantage to the purchasers and consumer countries. The treaty also tries to secure a certain income from transit for the transit countries so that these countries can at least cover certain risks associated with transit.
3) For the consumer country, the treaty provides a basis for security of supply of the energy resource. It can also provide security to the investments made by the consumer country.

2. Policy Recommendations

85. The following policy initiatives are recommended to facilitate harmonization of the legal and regulatory framework to develop cross border electricity trade in the South Asia region given its predominance in regional energy trade:

1. Harmonization of the legal and regulatory frameworks would be a strong incentive for both public and private sector investment for cross border power trade and such harmonization should primarily address: electricity trading licensing, open access power transmission, coordinated power system operation, transmission planning across interconnected power systems, inclusion of regional electricity trading in country energy policy, and regionally supported mechanisms for dispute resolution.

2. Promoting SAC to be members of the ECT in order to provide greater security for cross border energy transfer related investments and agreements, as well as security of supply through such agreements to energy consumer countries.

3. Inclusion of internationally accepted measures in the enabling framework to promote private sector participation in cross border power transmission and in hydro and thermal power generating facility development.

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An Overview of Energy Cooperation in South Asia

The South Asia Department of the Asian Development Bank has been providing technical assistance for capacity building activities relating to regional energy cooperation under the frameworks of the South Asia Subregional Economic Cooperation and the South Asia Association for Regional Cooperation (SAARC). This includes studies such as SAARC Regional Energy Trade Study and South Asia Regional Power Exchange Study. The paper provides an overview of both intra-regional and inter-regional energy cooperation in South Asia emanating from these studies covering ongoing and planned activities, barriers to increased cooperation, and recommendations to overcome them.

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