

6th Japan-SAARC Energy Symposium

6 – 7 March
2013, Kathmandu Nepal

*Commercially Viable Energy Networking in the SAARC
Region, with Emphasis on Energy Grid Structure*

Funded By:

Ministry of Foreign Affairs
Government of Japan

Organized By:

Nepal Electricity Authority

Nepal Electricity Authority (NEA)

Introduction

Nepal Electricity Authority (NEA) was created on August 16, 1985 under the Nepal Electricity Authority Act 1984, through the merger of the Department of Electricity of the Ministry of Water Resources, Nepal Electricity Corporation and related Development Boards. To remedy the inherent weakness associated with these fragmented electricity organizations with overlapping and duplication of works, merger of this individual organization became necessary to achieve efficiency and reliable service.

Objectives

The primary objective of NEA is to generate, transmit and distribute adequate, reliable and affordable power by planning, constructing, operating and maintaining all generation, transmission and distribution facilities in Nepal's power system both interconnected and isolated.

Responsibilities

In addition to achieving above primary objective, NEA's major responsibilities are:

- to recommend to the Government of Nepal, long and short- term plans and policies in the power sector.
- to recommend, determine and realize tariff structure for electricity consumption with prior approval of the Government of Nepal.
- to arrange for training and study so as to produce skilled manpower in generation, transmission, distribution and other sectors.

More information on the activities of the Nepal Electricity Authority is available at:

<http://www.nea.org.np>

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Introduction

The **6th Japan-SAARC Energy Symposium** was organized by the Ministry of Foreign Affairs, Government of Japan in partnership with the Nepal Electricity Authority (NEA) on March 6-7, 2013 in the Hotel Soaltee Crowne Plaza, Kathmandu, Nepal. The theme of the symposium was “***Commercially Viable Energy Networking in the SAARC Region, with Emphasis on Energy Grid Structure***”. The symposium was inaugurated by Mr. Leela Mani Paudyal, Chief Secretary of the Government of Nepal and Chairman of NEA. In addition to the participants from Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal and Sri Lanka, the symposium was attended by the SAARC Secretariat, SAARC Energy Centre, Asian Development Bank, USAID, Ambassadors and diplomats from the SAARC Member Countries and other organizations based in Kathmandu. Presentations were made by the experts from the SAARC Member countries, SAARC Energy Centre, the ADB, USAID and SN Power Holdings Singapore Pte. Ltd. during the four sessions held over the period of two days.

The aim of this symposium was to discuss the possible cooperation among SAARC member countries and also between Japan and SAARC member countries, with focus on subjects of common interest of energy and subsequently recommend future activities. Relevant organization in India, Pakistan, Bangladesh and Sri Lanka have hosted previous round of this symposium.

The benefits of regional resource development and grid integration for electricity trade to enhance reliability, security and affordability of supply to the end-users was clearly brought out during the various deliberations in the symposium. The symposium acknowledged the contribution of the Government of Japan and requested them to continue with the Japan-SAARC Energy Symposia initiative for enhanced regional energy cooperation in South Asia. The Ministry of Foreign Affairs of the Government of Japan in consultation with the SAARC Energy Centre may plan and implement the future Japan-SAARC Energy Symposium collaboration with relevant local institution of the member countries.

The symposium was divided into four sessions with different Sub themes including a Plenary session.

Program

Day 1: Wednesday, March 6, 2013

Opening Ceremony

8:00 AM	-	8:30 AM	Registration
8:30 AM	-	8:40 AM	Introduction by Mr. Rameshwar Yadav , MD, NEA
8:40 AM	-	8:45 AM	Inauguration
8:45 AM	-	8:50 AM	Remarks by H.E. Mr. Kunio Takahashi , Ambassador, Japan
8:50 AM	-	8:55 AM	Remarks by H.E. Mr. W. M. Seneviranthna , Ambassador, Sri Lanka
8:55 AM	-	9:00 AM	Remarks by Mr. Jaideep Mazumdar , Charge d'affairs a.i., Indian Embassy
9:00 AM	-	9:05 AM	Remarks by Mr. M. Forhadul Islam , Charge d'affairs a.i., Bangladeshi Embassy
9:05 AM	-	9:10 AM	Remarks by Mr. Ahmar Ismail , Director, SAARC Secretariat
9:10 AM	-	9:15 AM	Remarks on behalf of the GOJ, Mr. Kazumi Endo , MOFA
9:15 AM	-	9:30 AM	Keynote Speech by Mr. Hari Ram Koirala , Secretary Ministry of Energy
9:30 AM	-	9:35 AM	Remarks by Chief Guest, Mr. Leela Mani Paudyal , Chief Secretary, GON & Chairman of NEA
9:35 AM	-	9:55 AM	Group Photo
9:55 AM	-	10:45 AM	Refreshment

Plenary Session

10:45 AM	-	11:05 AM	Issues and Correspondence related to the status of the power supply by Prof. Dr. Shigeru Sudo , Teikyo Heisei University in Tokyo, Japan
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Session 1 : Problem extraction from technical aspect

	Synchronization issues in regional interconnection
11:05 AM - 11:20 AM	by Mr. Dasho Bharat Tamang , Managing Director of Bhutan Power Corporation (BPC) Ltd.
	Power Market in SAARC: in Bangladesh perspectives
11:20 AM - 11:35 AM	by Dr. Aminul Hoque , Professor, Department of Electrical and Electronics Engineering, Bangladesh University of Engineering & Technology (BUET)
	HVDC Transmission Network as Infrastructure for the Smart SAARC Power Grid
11:35 AM - 11:50 AM	by Dr. Netra Prasad Gyawali , Coordinator of MSc in Power System Engineering, Institute of Engineering, Pulchowk Campus
	Opportunities for Cooperation on Technical Aspects for Sri Lanka under the Electricity & Petroleum Sub sectors Development Policy, Sri Lanka 2011-2012
11:50 AM - 12:05 PM	by Prof. K. Kapila C.K. Perera , Professor, Department of Mechanical Engineering, University of Moratuwa, Sri Lanka
	Afghanistan Grid and power Export Opportunities to Pakistan
12:05 PM - 12:20 PM	by Mr. Moshin Amin , Technical Adviser for DABS, Fichtner, Afghanistan
12:20 PM - 12:50 PM	Group Discussion
Session Chair Person	Prof. Dr. Indraman Tamrakar
Commentator	Dr. Zaid Mohamed Prof. Mohd. Nazif Faqiry
Rapporteur	Mr. Anil Kumar Meena
12:50 PM - 1:50 PM	Lunch

Session 2 : Problem extraction from infrastructure aspect

1:50 PM	-	2:05 PM	Creating Power Market in SAARC - Prospects and Challenges by Mr. D. N. Raina , President, Entecsol International, India
2:05 PM	-	2:20 PM	The Need for an Energy Grid in the Maldives by Dr. Zaid Mohamed (Chief Technical Officer) / Mr. Mohammed Latheef (Deputy Managing Director) , STELCO, Maldives
2:20 PM	-	2:35 PM	The Energy Cooperation in South Asia Under SAARC Umbrella by Dr. Muhammad Pervaz , Programme Leader, Technology Transfer SAARC Energy Centre, Islamabad, Pakistan
2:35 PM	-	3:05 PM	Group Discussion
Session Chair Person			Mr. Rameshwor Yadav
Commentator			Dr. Aminul Hoque Mr. Shankar Krishna Khagi
Rapporteur			Mr. Karma Tshewang
3:05 PM	-	3:35 PM	Tea Break
Session 3 : Problem extraction from policy and legal aspect			
3:35 PM	-	3:50 PM	Economics of Regional Energy Cooperation: Nepal Case Study by Dr. Priyantha Wijayatunga , Head of Portfolio Management Unit of ADB, NRM
3:50 PM	-	4:05 PM	Regulatory framework needed for trade by Mr. Sher Singh Bhat , Director, NEA
4:05 PM	-	4:20 PM	Food, Water & Energy security through Hydropower development by Mr. Gyanendra Lal Pradhan , FNCCI, Nepal
4:20 PM	-	4:35 PM	Fundamentals of legal and commercial frameworks and agreements of Nepal-India cross-border interconnections: particular reference to Dhalkebar - Muzaffarpur 400 kV cross-border line

by **Rajan Dhakal**, Deputy Manager, NIETTP, NEA

4:35 PM - 5:05 PM Group Discussion

Session Chair Person Mr. Dasho Bharat Tamang

Commentator Dr. M. Pervaz
Mr. D. N. Raina

Rapporteur Prof. K. Kapila C.K. Perera

Break + Transport

Day 2: Thursday, March 7, 2013

8:00 AM - 8:30 AM Registration

Session 4 : Problem extraction from economic aspect

8:30 AM - 8:45 AM **Cross-Border Electricity Trade between Nepal and India Issues and Challenges**
by **Dr. Sandip Shah**, Vice President & Country Director, SN Power Holding Singapore Pte. Ltd.

8:45 AM - 9:00 AM **Regional Power Planning : Indian Perspectives**
by **Mr. Anil Kumar Meena**, Manager (CTU), Power Grid Corporation of India Ltd.

9:00 AM - 9:15 AM **Appropriate market structure of the regional integration, Pool and Exchange: Nepalese Perspective**
by **Mr. Hitendra Dev Shakya** (Director, NEA) / **Mr. Chandan Kumar Ghosh** (Assistant Manager, NIETTP, NEA)

9:15 AM - 9:30 AM **Regional Power Sector Integration – South Asia Opportunities and Barriers to RPSI, and Modalities from International Experience**
by **Mr. Satish Joshi**, Project Management Specialist, Nepal Investment Board

		USAID's South Asia Regional Initiatives for Energy Integration (SARI/EI) - supporting Cross Border Energy Trade in South Asia
9:30 AM	- 9:45 AM	by Mr. Shankar Krishna Khagi , Country Representative, USAID/SARI, Nepal
9:45 AM	- 10:15 AM	Group Discussion
Session Chair Person	Dr. Govind Nepal	
Commentator	Prof. K. Kapila C. K. Perera Dr. Shigeru Sudo	
Rapporteur	Mr. Sher Singh Bhat	
10:15 AM	- 10:55 AM	Tea Break
10:55 AM	- 12:25 PM	Wrap up presentation
Chair Person	Dr. Govind Nepal Mr. Anil Kumar Meena Mr. Karma Tshewang Prof. K. Kapila C.K. Perera Mr. Sher Singh Bhat	
12:25 PM	- 1:25 PM	Lunch
1:25 PM	- 2:25 PM	Discussion on recommendation (problems which should be tackled by member countries to realize the commercially viable energy network in SAARC region)
Chair Person	Mr. D. N. Raina Mr. Mohsin Amin Dr. Aminul Hoque Mr. Dasho Bharat Tamang Dr. Zaid Mohamed Mr. Sher Singh Bhat Prof. K. Kapila C.K. Perera	
2:25 PM	- 2:45 PM	Vote of thanks by Mr. Hoshino , First Secretary, Embassy of Japan

Introduction Remarks by Chairman of Organizing Committee



Chief Guest, Honorable Ambassadors, distinguished guests from SAARC Countries, high level officials from various organization of the Government of Nepal, Embassies, Universities, WB, ADB, JICA and other dignitaries on and off dias, the media persons, my dear colleagues, Ladies and Gentleman;

On behalf of the Nepal Electricity Authority, I would like to thank the Japanese government and Embassy of Japan in Nepal for believing NEA and giving us this wonderful opportunity to organize this symposium. As an organizer, I would like to extend my honors to all the delegates for accepting our invitation and participating in this event. With this, I would like to welcome you all in this forum.

I see today as a very significant day for initiation of Energy Networking in the SAARC region. This is very timely topic as the primary energy consumption of the world is on rise. This is alarming, since we already faced the scarcity of energy. So new concepts, new modalities must be identified and studied so as to meet energy requirement. Many countries in SAARC region initiated bilateral grid interconnection, but there is absence of uniform and harmonized policies in the countries on electricity trading. This is not so institutionalized, however in viewing the future context; there is a need of a common network in as many possible countries in the SAARC. Talking further, the geographic location and the country aspirations, as well as energy resource distribution like hydropower in Nepal and Bhutan, gas in Bangladesh, and coal in India and many more, are conducive to establishing a power exchange among all member countries in some form of multilateral electricity trade.

Energy is very much vital for development of any country. Despite of being land lock country Nepal, she has vast water resources potential. There is possibilities of development of hydropower for its energy need and the potential being estimated more than of 3000MW depending upon the suitable optimization of the available resource. This capacity in Q₂₅ mode may be increase up to 200,000MW.

At present Nepal has the installed capacity of the power plant in the range of 751 MW. No other resources available except biomass for use of energy, however, wind and solar is also available for extracting the energy which is expensive at present state of development. Hydropower has been dominated in Nepal and we are heading toward the hydro and hydro

only scenario. During the Dry season the flow in the river is reducing and consequence of low generation which resulted shortage of energy in comparison to the demand. Now, we are at present facing heavy load shedding up to 12 hours a day during this period.

River and rivulets flowing in Nepal are more than 6000 with mean annual precipitation of 1500mm and annual runoff 220 Billion cubic meter. At present biggest plant capacity of hydro plant in operation is Kali Gandaki 'A' Project with capacity of 144 MW, and Upper Tamakoshi 456 MW is under construction. At the same time, Nepal has been promoting private developers power system by private developers is 220 MW which is about 29% contribution to Nepal Power Sector.

Present peak demand recorded last year is 1026 MW which is estimated to increase about 9% every year. Forecast peak capacity would be about 1770 MW in 2018 and will be 3000 MW in 2025. This is based on normal growth of forecast. With the introduction of new policy for private developers in power sector, Nepal Electricity Authority has signed 1751 MW capacity of Power purchase Agreement with Private Developer. By this time, if all the project are developed by the time 2018, installed capacity will be 2416 MW. If this will continue, the share of public sector in power sector will reduce from 75% now to 25% in 2018. This has been possible with the introduction of new Electricity Act and further new Act is on table for discussion and approval by Parliament. At the same time NEA/ Government of Nepal is planning to develop big run of river as well as storage project to optimize the system requirement and also to export power to India.

By 2018, more than 3000 MW hydropower is planning to develop from Indian companies which will be another mile stone for the development in this sector. This will create new environment to create power exchange between Nepal and India. The number of hydro projects with capacity more than 5000 MW is waiting for the development or waiting for signing the Power Purchase Agreement.

Therefore, I see there is prospect of great potential of export and import of power between Nepal and India. But we still lack high capacity interconnection with our neighbor country India which may be one reason for slow progress of hydropower development in Nepal. Considering this we have initiated the process for building 400 kV Dhalkebar-Mujaffarpur Nepal India Cross Border interconnection and I am very happy to inform you all that tender has been invited on 4th of March, 2013 for the construction of this line. I believe construction

of this link will be milestone for the development of Hydropower in Nepal and Power trade between Nepal and India.

Energy grid networking could be glimmer of hope for the SAARC region. As evident by the participation of experts from different countries, this symposium will create many opportunities to promote collaborative efforts among SAARC member countries and also other stakeholder organization. We people are the top most people from all SAARC countries, our vision in this forum is also important for all bureaucrats of participating nations and I hope this also create an opportunities to share facing problems among the member countries and share vision for further go ahead.

I already mentioned the upcoming energy crisis in this region demands us to explore further opportunities to work towards constructing a common grid structure. As we know, there are a number of examples of successful development of interconnected regional grids throughout the world. I think, the experience in development and operation of interconnected networks like **The Southern Africa Power Pool (SAPP), The regional power market of South Eastern Europe, The Nord Pool in Scandinavian region of Europe, the United Power System of Central Asia (Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan and Turkmenistan) etc.** may have particular relevance to SAARC. In fact, interconnection of one power system with another provides benefits to both interconnected system even if there are no contractual energy exchanges between these systems, but simply by virtue of availability of mutual assistance in emergency situations. Also, an interconnected regional transmission grid system would enhance reliability of national power system operation, and increase the potential for energy trading and facilitate energy security. This also helps to reducing installed capacity requirements of interconnected Power Systems.

As we know, for the common transmission grid connection, there is a need of the massive capacity building at various levels such as in technical, commercial, financial, regulatory and legal areas. I hope, this symposium concluded and able to handle the upcoming challenges of power trade and development of regional electricity market in the SAARC. The member countries should create appropriate institutional mechanism to focus on cross-border electricity trade. To achieve these goals, it is necessary to foster cross-border dialogue and exchange of ideas and best practices, and to build trust and confidence between countries and partner utilities.

Let us hope this symposium will create an opportunity for us to share experience on issues and initiatives taken in our respective countries. Let us make this an opportunity to create common grounds for common agenda for future common energy grid structure of the SAARC region. I wish you all the success with the symposium!

Mr. Rameshwar Yadav

Managing Director, NEA

Remarks by H.E. Mr. Kunio Takahashi, Ambassador, Japan



It is indeed my great pleasure to be here with you today for this inaugural session of the two-day event, “the 6th Japan – SAARC Energy Symposium – 2013” with the main theme on ‘Commercially Viable Energy Networking in SAARC Region with emphasis on Energy Grid Structure’. The symposium is organized by the Nepal Electricity Authority (NEA) of the Government of Nepal, and funded by the Government of Japan.

Ladies and Gentlemen, we all know that SAARC members are rich in natural resources. The Hindukus Himalayan Region, the Karakorum and the Pamir – water reserve of South-Asia and third pole of the earth – are abundant in water and energy resources for the SAARC member countries’ human development. With respect to the socio-economic advancement of the region in a global context, a new perspective, a new vision, and a new focus have to be sincerely considered. Previously energy trade was only an issue for two countries, and was not so complicated. But, there is now a need for a collective effort to achieve an optimum balance between local, national, regional and global responsibility in harnessing natural resources for socio-economic development of the region.

Energy is a necessity for the development of any nation, and in this regard, as we all know, all the SAARC countries are facing serious energy shortages, which have been one of the biggest obstacles in the way of their development. But when we look into the situation individually, it is different in each country. For example, from the aspect of energy resources, India widely depends on thermal and nuclear energy, while Bangladesh depends on gas, and Nepal and Bhutan on hydro-electricity. In addition, situations of the gap between demand and supply are also different among the SAARC countries. India and Bangladesh need more energy in summer, when air conditioning is required all over the country, while Nepal and Bhutan need more power in winter, when power generation capacity of the hydro electric plants decrease due to the decline in water flow. I think the other SAARC countries may be under different circumstances.

Therefore, I think, if the SAARC countries could establish an efficient regional energy network, they could achieve an optimum diversification of energy sources in the region and could help enable the better management of fluctuating energy generation and demand. Hence, we must come up with innovative solutions and start effective planning for the development of an energy infrastructure considering common problems, interests and

aspirations of the people of the SAARC countries. In this regard, bilateral, tripartite or multi-national corporation may be required for the development of the energy sector.

But, one may wonder why the immense benefits of sustainable energy generation potential through regional co-operation have not yet been sufficiently brought about. The reason for this has to be identified and addressed accordingly for the sake of one fifth of the global population.

With this in mind, I believe that this symposium organized by the NEA targeting the identification of problems in the development of energy generation and the transmission sub-sector is very meaningful. The Symposium is expected to come up with invaluable suggestions in technical, economic, policy and legal, and infrastructural aspects of the main theme.

On this occasion, I would like to express my sincere belief that this Symposium will be instrumental in helping identify the bottle-neck, possible problems and challenges as well as the comparative advantages of commercially viable energy-network in the region.

I also believe that the outcomes and recommendations of this Symposium will be very practical and will surely be invaluable for all those concerned in the energy sector in the region.

Before concluding, let me pass on my best wishes to the distinguished participants and all who strive for sustainable energy development in the region in the future. Finally, I am confident that this Symposium will be a wonderful success.

Thank you.

Keynote Speech by Secretary Ministry of Energy



I would like to extend my warm welcome to all the distinguished participants, the media and all other participants to the 6th Japan-SAARC Energy Symposium being held with the theme of “Commercially Viable Energy Networking with emphasis on Grid Structure”. There is abundance of energy sources in the South Asia and it is not encouraging to express that the shortage in this region is not

diminutive either. We as professionals in the energy sector should now work together to solve the crisis before it gets too late for the next generation to curse us with examples of optimized solutions in the European, the American or even the South East Asia’s successful networking practices.

We have a huge market for energy; else we would not have the crisis and the shortage. In other words it is our business opportunity. The market could grow even larger if it is abundant. The purpose of opening the electricity market is to create competition in as many links of the power supply chain as possible. After the opening of the market with new business opportunities for market participants, there will be competition in electricity generation and retail. At the same time, the functions related to the network infrastructure and transmission services will remain under monopoly. The production of energy is through exploitation of the natural resources. Infrastructures are required to integrate the region for the networking and all of them need to be commercially viable and economically sustainable. It can be! But what are we lacking? And Why?

Let us all ponder upon this issue and through this symposium, let us come to some conclusion regarding the actions to be done by each country so that the energy crisis in this region becomes a history.

Nepal, Bhutan with rich abundance in water resources, Bangladesh with Natural Gas and India with coal reserves, all are willing to set generating stations based on these fuels. Investments are knocking the door for the establishment. But a start of these investments can only happen on the basis of a strong market. Nepal opened its national market for private IPPS to invest in hydropower generation and mitigated their risk of investment through a take-or-pay power purchase agreements (PPA) between the IPP and the Nepal Electricity Authority. The mechanism now will lead a surplus of power by the year 2015-16 and end the

crisis. Similarly, a nice start of the regional networking could be an international bilateral PPA mechanism, which could insure the associated risk of investment in the international scenario. Power Purchase Agreement in Nepalese context is being carried out in a priority basis and progresses of construction of many IPPs are satisfactory as well. And this pressures the need for the infrastructure to transport the energy to the load centers through transmission lines. Nepal now envisages to construct almost 3000 kms of Transmission lines of different Voltage in next 5 to 10 years for the evacuation of the energy from these IPPs as the utilization of these Transmission Lines are guaranteed. Similarly, I would suggest that an international PPA for generating stations would automatically flourish the need for the required infrastructure. We cannot envisage a fully open electricity market at this point, and a market where the price of electricity itself will not be regulated, where the price will be determined in competition between the sale and purchase bids may not be conceivable at this hour. Though there are several advantages of such a exchange, the transparency of electricity market price where market price for electricity will be determined in the intersection of supply and demand per each hour a day before and market participants will continue to have the opportunity to use bilateral contracts to trade electricity are some of the advantages.

Whatever be the mechanism, we have to remember our only god at the moment! Our dearest **consumers**. We have to ensure a rich and abundant availability of energy to our consumers, which is reliable in supply and within the mark of quality. Thus the electricity market must provide the ability to buy electricity for all consumers, be it the countries or the state discos, or a big industry though other consumers may not be far behind. I don't know whether it could be possible under the terms of bilateral agreements or from the power exchange. And whether the eligible consumers themselves go and trade on the exchange or avert the high participation expenses and rather use the services of existing brokers.

It may be a dream for me, but I don't see it too distant, because all of you from so far have come here and we are so near to each other. All we need is to forget all other issues and concentrate on this important issue of the hour. Let's be honest and put our most positive attitude to solve this problem. May not be possible in this session, but I am sure it will show the path that will lead to the future SAARC Energy Market.

Let us decide the leadership to make an effort to integrate the domestic market with other markets in the South Asia. Let us decide on the construction of new international connections, and fulfilling the obligations a leader as the transmission system operator. Let us grasp this important opportunity to open the electricity market which has the ability to use solutions for

offering ample network services like purchases of reserves and regulation. Let us extend the existing mechanisms that are under practice in this region and are quite successful as well. Let us decide if we can extend highly successful mechanisms like ABT in the Indian Market and also not forget the reason behind the recent blackout of nearly half of the India. Is it due to poor regulation only? I think the market could have easily purchased ancillary services from its neighbors and such a day could have been averted. So, it is not only the basic services but the ancillary costs as well which can be optimized through a regional grid and could be mutually beneficial for all.

Thank you.

Hari Ram Koirala

Secretary, Ministry of Energy, GoN

Session 1: Problem extraction from technical aspect

Prof. Dr. Shigeru Sudo

Teikyo Heisei University in Tokyo, Japan

Born in 1950, Tokyo. After graduated from Chuo University with a bachelor of laws in 1973, he joined Petroleum Association of Japan (PAJ) and was mainly engaged in research and analysis of the energy industry. After leaving PAJ in 1999, he worked for Mitsubishi Research Institute (MRI) in 1999-02 and International



Development Center of Japan (IDCJ) in 2003-10 as an energy industry researcher. Now he is a professor of Teikyo Heisei University in Tokyo and teaches energy economics and environmental issues, etc. in the Department of Business Management.

He also teaches energy and environmental issues at another two universities including Tokyo Institute of Technology as a lecturer. He is Co-Author of “Energy Security–Visions from Asia and Europe” Feb. 2008, Palgrave and “Climate change negotiations - Can Asia change the game?” Nov. 2008, Civic Exchange.

Issues and counter-measures related to the status of the power supply in SAARC countries

Prof. Dr. Shigeru Sudo

Power industry in India

I would like to clarify the problems being faced by India having the largest power consumption in South Asia and potential impacts these problems in India have on problems of South Asia at large. Electric power conditions in India may be summarized in the following;

- (1) While power demand has been on the increase, power supply is unable to catch up with it.
- (2) Apart from technical losses in the process of power transmission and distribution, power theft is also a major loss factor.
- (3) Due to its high economic growth rate and high population growth rate, India's primary energy consumption is expected to grow at an annual rate of 3.9% from 0.524 billion tons (coal equivalent) in 2010 to 1.376 billion (coal equivalent) in 2035.
- (4) As of January 2012, 20 nuclear power reactors with a total power capacity of 4.78 million kW are in operation. The Indian Government has been implementing active plans to construct nuclear power stations. It is intending to expand plant capacity by 7.9 times from 4.10 million kW in 2010 to 32.40 million kW in 2030.

Problems being faced by India in promoting its nuclear power plan

An important element in its plan is the targeted capacity of 32.40 million kW to be achieved by 2030. Will it be possible to achieve this targeted capacity? Views of Japanese experts concerned are varied. However, their majority is of the view that two conditions must be met in order for this target to be achieved. These two conditions relate firstly to probability of the eventual application of The Civil Liability for Nuclear Damage Act (2010) and secondly to the issue of how to ensure public acceptance.

Identification of problems and counter-measures to deal with them

The major purpose of the present Symposium is to identify problems being faced in power supplies in South Asia and to discuss possible counter-measures to deal with such problems. Therefore, I would like to discuss possible impacts on the South Asian economy in the event that India's nuclear power generation plan may not proceed as planned.

- (1) Since last year the situation has been continuing where the level of power supply remains below the level of peak-time power demand.
- (2) I hear that efforts on the part of certain States to procure electricity at levels higher than predetermined from other States have aggravated the spread of domino-like adverse effects.
- (3) The lack of sufficient power generation capacity comes from the fact that investment in power plant construction does not catch up with rapidly expanding power demand.

What sort of alternative measures can be possibly taken in order to avert negative impacts that possible major setbacks in the nuclear-power-generation -promotion-scenario in India might have on structurally-India-dependent other South Asian countries.

1. To promote the development of alternative power sources concurrently and in parallel with nuclear power development in India. In this connection, I would like to count upon Indian participants for further detailed comments. However, I myself believe that coal-fired thermal power generation could play the most important role in this respect.
2. To promote intra-regional pooling arrangements

To what extent shall intra-regional pooling arrangements be considered to be possible? According to a macro (country-by-country basis) analysis, rates of reserve in power supplies in each country seem not to be high. However, more detailed studies will be warranted to find what sort of overall picture can be drawn by way of a more detailed region-by-region analysis.

3. Possibility of extra-regional cooperative arrangements

The third point for consideration is to work out extra-regional cooperative arrangements as an exponential measure of intra-regional arrangements.

Relating basic questions:

Question No1: Most important matter in keeping supply and demand balance

Do you think that the most important matter in overcoming power shortages is the expansion of generation capacity? Or do you think that what is the most important is power-pooling arrangements with neighboring countries?

Question No.2: The possibility of regional cooperation

Do you have any concrete plan for promoting power pooling arrangements? More particularly <Do you have any plan for making more effective use of the existing transmission systems within the region?

Question No.3 : Regional cooperation:

Is there any example of regional cooperation in the field of financial cooperation?

I have discussed possible frameworks of policy measures to overcome vulnerability in power supplies in South Asia. Namely, (i) accepting reliance on India as the baseline, and (ii) how to pursue the possibility of intra-regional pooling arrangements within the framework of reliance on India, and (iii) how to work out extra-regional cooperative arrangements as an exponential arrangement for intra-regional arrangements.

Bharat Tamang, MSEE

Managing Director of Bhutan Power Corporation (BPC) Ltd.

Dasho Bharat Tamang Yonzen, born in 1957, in Goshi, Dagana Bhutan is currently serving as the Managing Director of Bhutan Power Corporation (BPC) Ltd, Transmission and Distribution utility of Bhutan and subsidiary company of Druk Holding and Investments (DHI) and its 100% share owned by the Royal Government of Bhutan. He did his schooling in Bhutan and after passing out from Karnataka Regional Engineering College, Mysore University, India with B. Tech (Hons) degree in Electrical Power Engineering, Mr. Tamang started his career as a Assistant Engineer in the Research & Development Division, Department of Power, Ministry of Development, Royal Government of Bhutan in 1984. In 1988 he travelled to United States, America to study in the University of Missouri, Rolla under UN fellowship and obtained his Master of Science (MSEE) in Electrical Engineering degree in 1989. After completing higher studies, he continued to serve in the Department of Power/Energy and was involved in various job positions and responsibilities in the Planning, Design, Construction and Operation of Generation, Transmission and Distribution infrastructures including the preparation of 20 years' Hydro Power System Master Plan, Rural Electrification Master Plan, Integrated Energy Master Plan and Water Resources Management plan for Bhutan. He was serving as Energy Specialist in 2007 in the Ministry of Economic Affairs (earlier Ministry of Trade & Industry), Royal Government of Bhutan when he retired from the Government Service to take over the position of Chief Executive in BPC from 2008. He was awarded the honour of knighthood with title of Dasho with red scarf and sword by his Majesty the Vth King of Bhutan on 17 December 2009, National day of Bhutan for his meritorious service to the Nation. Since then, he has been serving in the Power corporate services sector and in the Board of both the Druk Green Power Corporation (Hydro generation company of Bhutan) and the BPC as a Board Director. His fascination and professional interests are on Energy economics, Sustainable development of Green energy resources, Smartgrid, LENR (Cold Fusion) and other energy innovations.



Synchronization Issues in Regional Interconnection

Bharat Tamang

Basic Issues:

The basic issues related to synchronization i.e. voltage, frequency and vector matching would be the core ones to be addressed for regional interconnection. While all the SAARC regional grids follow 50Hz system and to an extent follow similar voltage levels, it is essential that the technical parameters like allowable tolerances along with the insulation levels adopted are standardized, especially since most of the SAARC countries have their respective standards / codes. It is also necessary that where two grids are likely to be interconnected at more than one voltage level, the vector groups of the corresponding ICTs match.

Inter-grid communication issues:

Another important aspect is to ensure that the interconnected grids properly ‘communicate’ with each other – in the sense that the various communication protocols both for protection and control are standardized and seamless integration is possible.

Internal security mechanisms:

In the context of Bhutan, where the power generation far exceeds the internal demand especially during Monsoon season, the aspects of internal grid security shall duly be considered so that the same are not compromised due to external grid disturbances. This needs proper security mechanisms to be built-in the internal as well as external systems in terms of technical requirements of control, protection, response spectrum of the generator systems, other features like black-starting facility, islanded mode of generation grid etc., in addition to policy mechanisms for maintaining the grid discipline.

Impact of different sets of standards:

It is also necessary to consider the practices in various constituent utilities in terms of the standardized transmission line parameters (tower designs), especially if the trunk lines cut across the international boundaries without any intermediate substations at the boundaries. It is possible that the same transmission line would have (a) different thermal capacity limitations, requiring different mechanisms for maintaining the reliability; (b) different constraints of contingency (like circuit outage versus tower outage for multi-circuit lines); (c) different design parameters in the tower design due to the country-specific standards as well as the geographic data; etc.

Technical vs Policy Issues:

It is necessary that the technical requirements dovetail into the policy mechanisms both in technical and commercial terms. The requirement of metering both for export and import (if the system does not support netting-off), the philosophy of accounting for wheeling (can the system work better with uniform charges of wheeling with / without due consideration to the route length of the wheeled energy?) if not netted; etc. require appropriate technical means for implementing the same. Same will be the case, if the internal systems of one grid need

any additional investments to meet the external requirements (and how this will be related to the resultant tariffs).

Issues of internal and external regulatory mechanisms:

The issues of transparency in operation – to what extent the inter-grid data transfer is necessary and if so, the mechanisms to filter the appropriate data; the internal tariff and technical regulatory mechanism vis-à-vis the inter-grid tariff mechanism and other such issues – need to be taken care of in the technical aspects of the communication / SCADA systems.

Prof. Dr. Aminul Hoque

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Dr. Aminul Hoque received his B.Sc., M.Sc., and Ph.D. degrees from the Department of Electrical and Electronic Engineering (EEE) of Bangladesh University of Engineering and Technology (BUET), Dhaka in 1972, 1980, and 1990, respectively. His Ph.D. dissertation was on wind, photovoltaic and thermal generation system for an isolated area in Bangladesh. He was the recipient of the first Ph.D. degree from the Department of EEE, BUET.

Dr. Hoque did his Postdoctoral research under the supervision of Dr. W. C. Beattie in the Department of EE of Queens University, Belfast, UK during 1992 to 1993. In his postdoctoral research, he worked with the Wave Power Group leaded by Dr. Trevor Whittaker under the European Community Research Project.

Dr. Hoque joined in the Department of EEE, BUET as an Assistant Professor in 1980, became an Associate Professor in 1987, and then Professor in 1997. Later he was the Head of the Department of EEE, BUET during 2008 to 2010. As additional duties, he served as the Director, Center for Energy Studies, BUET during 1993 to 1995 and since Sept. 2010, he had been the Director, Directorate of students' Welfare (DSW), BUET from September 2010 to May 2012.

Dr. Hoque served as the Project Director cum Founder Vice-Chancellor of Maulana Bhashani Science and Technology University, Santosh, Tangail from January 2001 to November 2002. In his early carrier, he joined in the Department of EE, Engineering College Chittagong (now CUET) as an Assistant Professor in 1978 and later he served as the Principal in-charge in 1979.

Prof. Hoque has been extensively involved in advanced research and consultancy. His research interest includes power system engineering, advanced protective relays, switchgear and protection, electrical design and drawings, high voltage engineering and renewable energy. He has supervised/examined about 40 M.Sc. and Ph.D. theses. To his credit, he has published hundreds of intentional/national journal and conference papers and country-leading research projects and edited 4 text books. He has been considered as one of the best electrical system designers of large electrical installations in the country.

He is the Life Fellow of Bangladesh Computer Society (BCS) and the Life Fellow of the Institution of Engineers, Bangladesh (IEB). He is the Life Member of Bangla Academy and the Life Member of Bangladesh Solar Energy Society (BSES).

Power Market in SAARC: in Bangladesh Perspectives

Prof. Dr. Aminul Hoque

Energy and economic development are interlinked and the quality of life achieved in a community or a country can be accessed from the amount of energy (per capita) it consumes. This approach is more appropriate for societies where the production and distribution of energy are secured and widely spread.

Though the integrated power market electricity network is highly complex nature of power system, but some of the benefits of such a modernized integrated power market electricity network are: (i) ability to reduce load shedding/blackout at the consumer side during peak hours, namely demand side management; (ii) to enable grid connection of distributed generation power with all possible alternative power sources; (iii) to incorporate grid energy storage for distributed generation load balancing; and (iv) to eliminate failures, such as widespread power grid cascading failures. (v) To increased efficiency and reliability of the integrated power systems among SAARC member countries [2,3,4].

As per election manifesto of the present government of Bangladesh, electricity generation in the country would be increased from 4000 MW to 7000 MW by the year 2013, 8000 MW by 2015 and 20,000 MW by 2021. In line with the election manifesto, present government has adopted short, medium and long-term expansion plans. At present only 60% of the people in our country have direct access to electricity. Per capita generation is 292 kWh, which is one of the lowest in the region. Every year the demand is increasing at a rate of 12%. Keeping this into consideration, with a vision to achieve 8% projected GDP growth by 2013 and beyond, a massive generation and expansion program has been adopted, which will help maintaining sustained electricity supply facilitating establishment of new industries and SMEs, fulfilling the government's vision: **Electricity for all by 2021 and to build 'Digital Bangladesh'**[5].

In the paper I have discussed on (i) Challenges of a Regional Integrated Power System, (ii) Presentation of Integrated Grid Technologies, (iii) Bangladesh (BD) Power System: Present and Future Projections, (iv) BD Power Sector Development Program, (v) Integrated Power Grid in SAARC Member Countries and its Possibility in BD, (vi) Power Generation Projection, (vii) Generation Cost Per Unit, (viii) Energy Rate and (ix) Power Market Analysis.

Dr. Netra Gyawali

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Dr. Netra Gyawali passed BE (electrical) in 1999 from IOE, Tribhuwan University Nepal. Likewise he got MSc degree (Electrical Engg) and PhD degree (Electrical Power System Engg) both from Kyoto University Japan with the sponsorship of Japanese Government Fellowship (Monbusho). He has started academic career in 2001 as lecture in IOE, Pulchowk Campus; and currently working an Associate professor in IOE (Tribhuwan University). He is also the program coordinator of MSc in Power System Engineering, run by the IOE. He is involved in teaching power system related courses in undergraduate/graduate levels, and has served as a research supervisor for their thesis works. As a power engineer and a researcher, he also provides expert services in many institutions in Nepal and abroad.

Dr. Gyawali is actively engaged in research and innovative activities, and has published many papers in renowned international journals, like IEEE (USA), IET (UK) and IEEJ (Japan). Currently he is active reviewer of the IEEE journal of energy generations and IET journal of renewable power system. His research areas include power electronics, distributed generation, FACTS/ HVDC, energy storage applications.

HVDC Transmission Network as Infrastructure for the Smart SAARC Power Grid

Dr. Netra Gyawali

The rapid increase in electric power demand in the SAARC countries has demanded construction of dedicated transmission network which can exchange power over long distance in effective manner. Through the cross-border transmission ties, power deficit in one country can be balanced by the surplus of power in another country. In the beginning, ac transmission has to transfer relatively low power over long distances. Technical problems, such as voltage control and dynamic stability, did arise, but they could be alleviated by shunt and series compensation. With increase in developmental activities, the power demand grew many folds; resulting several issues in the transmission grid, such as system securities, stability margin and voltage regulation. Furthermore, with rising trend towards deregulation, power market is opening up a power market and giving customers the opportunity to buy energy at a more favorable price. This changing environment decisively influences the optimization of the transmission network since the load flows existing today will be altered considerably. The ancillary functions required for smooth operation of the networks, such as frequency control, load-flow control, reactive-power and voltage stability, are being assumed by the operators. To address these issues, substantial enhancement in the transmission network is needed. These include new installation of FACTS equipment in the system and adopting additional HVDC transmission network wherever appropriate.

The main application area for HVDC is the interconnection between systems which cannot be interconnected by ac because of different operating frequencies or different frequency controls. In this case, it provided an asynchronous tie. This type of interconnection is mainly represented by back-to-back stations or long-distance transmissions when a large amount of power has to be transmitted by overhead line or by submarine cable. Connecting by the asynchronous link provide “firewall” against the propagation of system disturbance, thereby providing better system securities. The HVDC technology reduces transmission costs and losses for transmission bulk power when a certain threshold distance is crossed, as it does not require the burden of transmission reactive power. HVDC also enables integrating large renewable resources, as it provides the dc-link for the PV and wind power generation. In case of deregulated market, an HVDC application is found to be effective for flexible power flow control due to lack of delaying inertia factor.

Development of HVDC transmission in SAARC countries is only limited to the India. Owned by the Power Grid India Limited, India has currently 4448 circuit-km of installed HVDC line and several other are under plan. It has been reported that the HVDC link has significantly combated the propagation of disturbance occurred in July power catastrophe. In other countries, the HVDC link is virtually not existent. Back to back or bipolar HVDC network linking cross border transmission grid is a strong alternative to obtain effective power wheeling among the member countris. Some prospective HVDC link would be *Bheramara (Bangladesh) to Baharampur (India)*, *Anuradhapura (Sri Lanka)-Madhurai (India)*, *Lahor (Pakistan)-Amritsar (India)* and *Mahendra Nagar (Nepal) to Lakhanow (India)*. This HVDC network would provide a substantial infrastructure for future SAARC Smart Grid; proving better resilience, interoperability, assesses management and accommodating large scale renewable power.

K. Kapila C.K. Perera

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Kapila Perera is a Professor in this Department who joined the University staff in 1995, also served as a Lieutenant Commander of the regular force of the Sri Lanka Navy prior to joining the Department. He obtained a Masters Degree from University of California Davis in 1989 in Mechanical Engineering, followed by Ph.D. in Mechanical Engineering in 1993 from the same University.

Prof. Perera's research interests include Turbulent Heat Transfer and Combustion Modeling, Energy Sources, Renewable Energy Technologies and Co-generation.

Opportunities for Cooperation on Technical Aspects for Sri Lanka under the Electricity & Petroleum sub Sectors Development Policy, Sri Lanka 2011-2012

K. Kapila C.K. Perera

Background

Sri Lanka has recognized the fact that creating the necessary framework to provide the basic energy needs of the population as a primary social responsibility of the state. Also the importance of maintaining the adequacy and the continuity of energy supplies at the lowest cost to the economy to satisfy the increasing energy requirement of the population, arising from the country's economic development. Moreover, sustainable development activities based on the two key energy subsectors namely, electricity and petroleum has been acknowledged by the state. Same is justified by the government policy directives such as *“Diversification of energy resources used in the country will be encouraged and the future energy mix will be rationalized to minimize fuel fired power generation. Management and operation of energy supply systems of the country will be made ensuring efficient utilization and conservation of energy”*. [1, pp 48], *“With the long-term objective of reducing 8.7 percent of energy consumption by the year 2020, under the power conservation and management programme, energy conservation activities will be implemented at household as well as industrial and commercial consumer levels”* [1, pp51], *“The system losses will be reduced to 13 percent by 2016 and to 12 percent by 2020”*[1 pp 50]etc. It is encouraging for all stakeholders in energy sector to note the consistency of the government in vigorously pursuing to accomplish the targets and milestones set by the first ever Energy Policy published by a Gazette notification in 2008 . This is evident from the Development Policy Frame of the Government document of the Department of National Planning, Ministry of Finance and Planning, Sri Lanka published in 2010 titled “Sri Lanka the Emerging Wonder of Asia, Mahinda Chinthana - Vision for Future”.

State has been successful in accomplishing most of the key targets and milestones. In particular, electricity and petroleum subsectors. According to the Energy Balance of Sri Lanka 2011 published by the Sustainable Energy Authority (SEA), of Sri Lanka, by the end of year 2011, grid electrification was 91.0% besides, electricity supplied to remote households through off grid community and household installations (which has resulted in the reduction of the share of un electrified households to very low levels in comparison with other countries in the region). Electricity subsector has moved out of the two-energy resource

(hydro and oil) status to multi-energy resource status. The third energy source, coal is in place and will be further pursued. Non Conventional Renewable Energy Source (NCRES) which had been identified in the policy strategy as the fourth energy resource has contributed only 1% (181 GWh out of 11528 GWh in 2011) of the electricity generation [2,pp 3]. Although this is meeting the minimum targets, there is a growth from 2010 to 2011. In 2010, 86 GWh out of the total 10714 GWh was generated from NCRES [2, pp3]. It should also be noted that the NCRES in the Energy Policy includes small hydro which had amounted to 604 GWh (6%) in 2011 where as that is accounted under hydro in the statistical digest of the CEB. However, the regulatory framework on issuing licenses to NCRES based stakeholders is being streamlined so that interest of them will be better facilitated from the consumer point of view as well as business point of view by the Public Utilities Commission of Sri Lanka (PUCSL) [3,pp 7].

Commitment by the state, follow-up and the performance of the targets and milestones with regard to the other policy elements such as promoting energy efficiency & conservation, enhancing energy sector management capacity, pricing, quality of energy service & equity, environmental conservation etc. are excellent thus far. However, the strategies proposed under the policy on the development of the electricity and petroleum subsector for 2011-2020 are new to Sri Lankan energy sector and the estimated cost for proposed to develop the electricity subsector alone is Rs (million) 933,255. Considering the fact such as proposed technologies had not been implemented or tried out in Sri Lanka before, the quantum of investments required, harnessing of such technologies have been proven commercially and environmentally viable in the countries of the SAARC region Sri Lanka should look for opportunities for cooperation on technical aspects with regard to the same.

Probable Opportune Areas for Cooperation on Technical Aspects

Exploration of the Petroleum

Commitment and the perseverance on exploration of petroleum have been vigorously pursued by the Government of Sri Lanka (GOSL). Setting up of Petroleum Resources Development Secretariat (PRDS), the conclusion of three road shows in USA, UK and Malaysia in 2007 to allocate blocks, conclusion of the first round of drilling and commencement of the second round of drilling by Cairns Lanka Ltd, subsidiary of Cairns India Limited, announcement of

the second round of road shows in March 2013 (USA, UK and Singapore) to allocate blocks in both shallow and deep waters of Mannar and Cauvery Basins, calling for Expression of Interests to carry out further 2D/3D seismic surveys, conducting national programs to identify the areas of skills and capacity building etc. are few of the highlights in this regard.

Electricity Sub Sector

Trends in the Electricity sub sector as per the policy document published by the Department of National Planning of the Ministry of Finance and Planning in 2010 and the strategy shown below indicate that by 2020 installed capacity will be increased to 6367 (102.7% increase with respect to the actual value in 2011 which is 3141 MW) and the base demand would be 5306 in 2020. Systems losses will be reduced to 12%. It is envisaged that this will be available as an additional capacity of 620 GWh of electrical energy per annum.

Category	2005	2010	2012	2016	2020
Electrification Coverage (%)	75	88	100	100	100
Base Demand (MW)	1768	2517	2921	3943	5306
Installed Capacity (MW)	2409	2891	3470	4732	6367
System Losses (%)	16.7	14.5	14	13	12

At present, the electricity generation in Sri Lanka is mainly dependent on crude oil and about 60 percent of the electricity requirement is generated using thermal power. Due to this fact, the cost of the electricity generation has risen over the years. Owing to the increase in thermal generation, the national average selling price of an electricity unit increased to 17.06 LKR/kWh in 2011 from 13.03 LKR/kWh, which is a 23.6% increase.[4, pp 101]. Recognizing these price increases, it has been proposed to achieve targets in the electricity generation through the following strategy (an extract from the policy document) [1].

- Setting up of coal fired power plants and hydro power plants to promote low cost electricity.
- Hydro power projects: 35 MW at Broadlands, 120 MW at Uma Oya, 27 MW at Moragolla and 49 MW at Gin Ganga.
- Rehabilitation of the existing hydro power plants to stabilize their capacity of 1115 MW.

- Setting up of pump storage hydro power plants to stand by as a supportive source of electricity, to be utilized during peak hours.
- A high voltage transmission line of 400 MW capacity between India and Sri Lanka is to be erected for the purpose of exchanging electricity.
- The high cost oil fired operation technology in thermal power plants to be replaced with low cost LNG technology.
- New LNG power plants.
- A feasibility study examining the possibility of establishing the nuclear power plants in the country will be carried out.

Besides, by 2020, about 20 percent of electricity supply is expected to be generated by the renewable energy. For this purpose, sufficient investment is to be made on development of renewable energy sector with wind, dendro, solar and mini hydro power plants. Solar power parks, wind poser parks are proposed to under this.

State of the art solar home systems incorporating high efficiency LED light sources with reduced system costs are to be deployed to serve households which are not served through the national grid.

According to the policy document in Reference 1 Sri Lanka's first nuclear power plant is expected to be commissioned in 2020. [1(pp.86)]. The vigor with the government is pursuing this is further consolidated by the following extract of the speech made by the Minister of Power and Energy in Sep. 2010 at the 54th General Conference of the International Atomic Energy Agency (IAEA), Viana.

“In meeting these development priorities and plans, Sri Lanka has therefore taken a decision to look into incorporating Nuclear Power into its energy mix. Recently, the Government of Sri Lanka has approved the Atomic Energy Authority of Sri Lanka to conduct a pre-feasibility study of using nuclear energy as a viable option beyond 2020 for power generation with the technical cooperation of the Agency. Further, a program to enhance human resource development in the field nuclear energy has already been initiated in collaboration with Engineering Universities of Sri Lanka”.

Conclusions

Petroleum exploration, pump storage hydro power plants, LNG power plants, High Voltage 400 MW capacity power line (through India) and nuclear power plants are yet to be implemented by Sri Lankan energy sector although commercial, technical, social and environmental viability in other parts of the world and in the SAARC countries has been proven. Furthermore, they are cost intensive compared with the scales of economical and environmental friendly operations. Therefore the technical, socio-economic and socio-political aspects of developing and implementing these and realizing them in the Sri Lankan context are vital for the energy policy makers, energy professionals, operation & maintenance work force and to the general public. Hence, Sri Lanka could be benefited from the opportunities of cooperation on technical and other relevant key activities with a view to competency building and capacity enhancement in order to keep up with technologies relevant to the petroleum and electricity subsector plans of the government of Sri Lanka through Sustainable Energy Initiative for the SAARC Region.

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Mohsin Amin

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Mohsin Amin holds Bachelor (Honors) degree in Electrical Engineering (1st position holder) from Kabul Polytechnic University, Kabul-2010. He is now working in Fichnter –Dabs (Afghanistan National Power Utility).

He have wide area of expertise in Energy Projects Management (Projects worth USD 570 million), Transmission and Distribution Planning, Bidding Documents Preparation, Bid Evaluation, Contract

Award Contract Negotiation, Project Implementation & Supervision and Power Utility Management (Metering, Billing, Revenue Protection).

Mr. Moshin presented various papers in national and international forum related to regional transmission interconnection and power trade.

Afghanistan Grid and Power Export Opportunities to Pakistan

Moshin Amin

The on hand paper will primarily focus on Afghanistan grid structure and will look for viable opportunities to wheel energy to Pakistan and further to India. Afghanistan is holding important strategic location and can play a key role in Energy Trading in the SAARC region.

Problems to extract:

- How to resolve Synchronization issue in Afghanistan grid with neighboring countries?
- How to enhance and reinforce Afghanistan transmission system for energy trading within SAARC and Central Asia regions?
- What can be recommended for Afghanistan Power system to handle and smoothly operate large scale power transmission with neighboring countries?

1.1 Afghanistan Grid and Background

In the first section of the paper, Afghanistan power system will be discussed, Afghanistan is surrounded by four electrical systems operating asynchronously, and these separate systems except Pakistan network are feeding different islands in Afghanistan grid, the surrounding systems are as following:

- Turkmenistan network and Iran network (operating synchronously)
- Uzbekistan network operating synchronously with CAPS (Central Asia Power System)
- Tajikistan network operating isolated from CAPS
- Pakistan network

Due to the asynchronous operation of the surrounding networks, connection of these along with the Afghan network is not possible. Even local generation in Afghanistan is currently operating without connection to a neighboring network.



Figure 1.1

Power sources in Afghanistan are divided into two types, one is local or home generation and other is import power, local generation is constantly remained in the range of 800 to 1000 GWh, and import power holds the 73% consumption (in 2011). Power is imported from four neighboring countries with the following percentages:

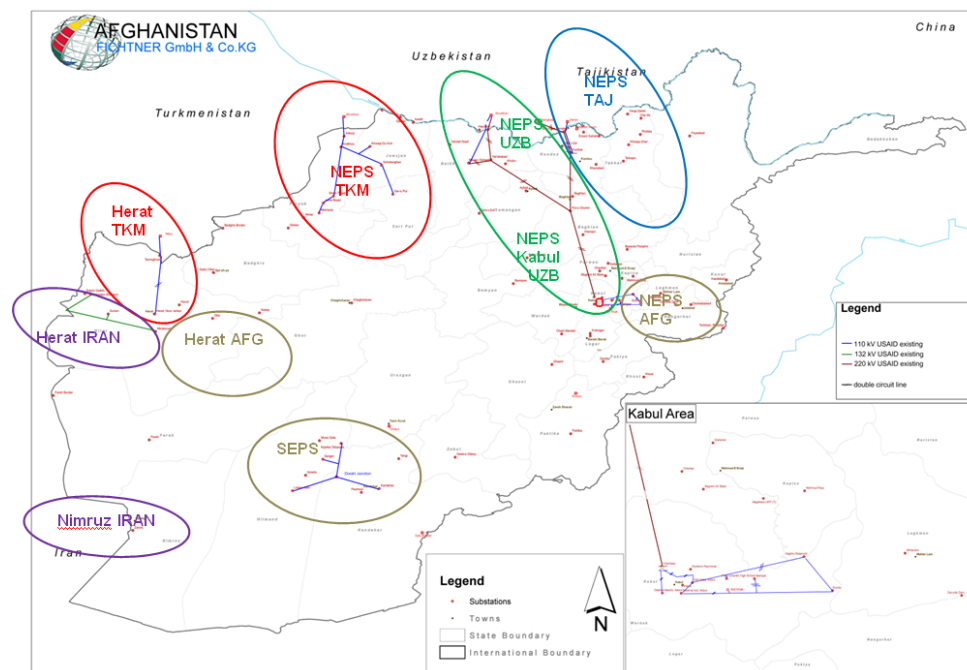


Figure 1.2

- Uzbekistan (57%)
- Tajikistan (4%)
- Turkmenistan (16%)
- Iran (22%)

There are four Major load centers in Afghanistan grid, these four largest consumers areas (Kabul / Herat / Balkh / Kandahar) make up 55% of total Afghan peak demand.

Province	Peak Load 2012 MW	Peak Load by 2020 MW
Kabul	441.4	718.1
Heart	142.8	224.2
Balkh	56.2	100.7
Kandahar	41.7	95.2

Table 1.1

Overall demand forecast is briefly explained in the below figure:

Demand Forecast: Results Total Afghanistan – peak load

- 3,502 MW peak load expected in 2032 in base case scenario
- Increase by factor 5.7
- Average annual growth rate: 8.6%
- Low scenario: 2,607 MW
- High scenario: 4,287 MW

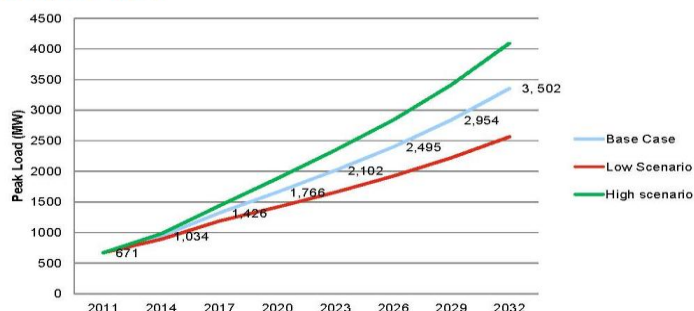


Figure 1.3

1.2 Expansion Planning

The new power master plan, which is yet to be approved by Ministry of Energy and Water and Afghanistan Parliament, proposes the following development stages for Expansion planning:

Short term, development stage A (up to 2015)

- Increase of import line capacity to the currently isolated grids
- Increase on-grid consumers as the import and generation capacity is expanded.
- Local thermal generation with gas fired power plant

Medium term, development stage B (up to 2020)

- A new transmission line between Pul-e-Chomri and Argandi, south of Kabul, at 500 kV will eliminate the power transfer bottleneck to Kabul.
- HVDC back-to-back station at Pul-e-Chomri supplied from the Turkmenistan
- Generation capacity in the Kabul area is synchronized with the existing Afghan power system at the earlier NEPS.
- Transmission network development to increase connection rate
- NEPS to SEPS interconnector will secure the power supply to southern Afghanistan.

Long term, development stage C and D (up to 2032)

- Further development of local generation, hydro and thermal
- More foreign power systems will feed in to the back-to-back hub at Pul-e-Chomri
- Further development of the transmission system to reach high connection rate

1.3 Synchronization is a bottleneck

For Afghanistan to utilize the strategic location importance and play a key role in energy trading between SAARC and central Asian countries, it needs to resolve the synchronization issue with energy exporters and importers, meanwhile Afghanistan transmission expansion must cope with the expansion of generation and must connect the demand centers with the generation sources, and nevertheless to finalize the grid coding process for its power system network.

To overcome the synchronization bottleneck, it has been proposed to create a major HVDC hub in Puli-Khumri area by installing back to back converters. The initial proposal of B2B converters' capacity is as following:

- 1000 MW HVDC B2B Turkmenistan
- 300 MW HVDC B2B Tajikistan
- 300 MW HVDC B2B Uzbekistan

This will allow transmitting large amount of energy to Pakistan through 500kV TL. We can also mention some of the advantages of having in feed from different sources:

- whole year availability of power for export to Pakistan
- Possibility of export from Turkmenistan to Tajikistan without reconnection to CAPS
- More power available for supply of Afghan loads
- Creation of an Afghan national network

The other option to solve the synchronization issue is to connect Afghanistan power system with CAPS (Central Asia Power System), connection with CAPS is not free of challenges, and we can name them as following:

- Necessary adjustment of control, automatic and protection systems within Afghanistan and CAPS
- Possible uncontrolled power surges on the interconnection lines
- Possibility of irregular power oscillations on the interconnection lines (especially in case of weak interconnections)
- Special control of power flow under stability requirements needed

2.1 Huge Demand in Pakistan

The electricity sector of Pakistan is facing high shortage in supply which has led to power outages on a large scale. The electricity demand in Pakistan is growing at a rapid pace due to increase in the population and the power demand increase of all the sectors of economy.

The SNC-Lavalin (Consultant prepared CASA-1000 feasibility study) calculated the following on Pakistan Demand:

Year	Electricity Demand (MW)
2010-11	21755
2011-12	23491
2012-13	25356
2013-14	27488
2014-15	29513
2015-16	31722
2016-17	33204
2017-18	35618
2018-19	38607
2019-20	41832
2020-21	45257
2021-22	48885
2022-23	52777
2023-24	56863
2024-25	61158
2025-26	65700
2026-27	70396
2027-28	75177
2028-29	80203
2029-30	85532

Table 2.1

Furthermore, SNC-Lavalin also worked out to compare the available capacity and demand; the results are shown in the following table:

Year	Installed Generation Capacity (MW)	Available Capacity (MW)	Demand Forecast (MW)	Surplus/Short fall (MW)
2010-11	2269	1815	2175	-
2011-12	2378	1903	2349	-
2012-13	2627	2102	2535	-
2013-14	2940	2352	2748	-
2014-15	3363	2690	2951	-
2015-16	4235	3388	3172	21
2016-17	4533	3627	3320	30
2017-18	5003	4002	3561	44
2018-19	5328	4262	3860	40
2019-20	5886	4709	4183	52
2020-21	6368	5094	4525	56
2021-22	6834	5467	4888	57
2022-23	7001	5601	5277	32
2023-24	7061	5649	5686	-
2024-25	7621	6097	6115	-
2025-26	7901	6321	6570	-
2026-27	8301	6641	7039	-
2027-28	8401	6721	7517	-
2028-29	8833	7066	8020	-
2029-30	N/	N/	8553	N

Table 2.2

The above table indicates that in case all the planned capacity is realized, there would be shortage in the generation capacity during the period 2010-11 to 2014-15 and then during the period 2023-24 to 2028-29.

In view of the huge capital requirements and institutional issues, it might be difficult to build all the generation capacity as planned. In particular, for the large capacity coal-fired and hydro plants a significant investment will be required which will be difficult to obtain. For example, during the financial year 2015-16, the generation plan suggests the commissioning of 8900 MW, which will entail a huge amount of investment. The substantial lead times for the construction of these power plants may also result in delays in acquiring additional capacity as planned. Therefore, the likelihood of delays in commissioning of these projects cannot be ignored. Therefore, in such a scenario, the construction of CASA transmission line would likely contribute in alleviating the shortage of generation capacity in Pakistan.

CASA will deliver 300 MW to Afghanistan power system and 1000 MW to Pakistan system, with flexibility of expanding the export amount.

2.2 Transmission Routes for CASA-1000

The options of routing the HVDC line in the vicinity of Salang Pass are limited. Much of the existing Right of Way has been utilized for the existing 220 kV Line. The more precise planning of the existing space will only be possible after the detailed survey of the area.

Based on load flow studies carried out during the initial assessment of the HVDC interconnection by SNC-Lavalin, the Pakistan network at Peshawar can absorb all the power to be delivered by the CASA DC interconnection project without incurring significant costs in the upgrade of their AC power systems up to an import level of 1,000 MW. If the import level into Pakistan were increased to 2,000 MW, then some additional 500 kV transmission out of the Peshawar area would be required. This could take the form of a 500 kV line from Peshawar to Ghazi Brotha, as examined in the Phase-I report. However, if the import were kept at the 1,000 MW level, the additional 1,000 MW would have to be provided from generation in the south of the country. This would certainly require additional transmission capacity from south to north and would be more expensive than the reinforcement out of Peshawar. Thus any reinforcement of the 500 kV systems out of Peshawar is considered as part of general system reinforcement and is not directly tied to the interconnection project.

3.1 Conclusion

Afghanistan can play an important role in wheeling fair amount of energy to other SAARC countries; this goal can be achieved only when Afghanistan establishes a unified national grid, resolves synchronization issue with neighboring countries, and reinforce the transmission system to enable large scale power transmission between surrounded countries. Afghanistan power system also needs to be equipped with modern protection and automation equipments and mobilize experienced and skillful operation personnel.

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Session 2: Problem extraction from infrastructure aspect

D. N. Raina

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Mr. D. N. Raina holds a Masters Degrees in Management and in Public Administration. Over the past 35 years, he held senior level positions in government, public sector undertakings and multinational organizations. He is the founder President of Entecsol International, a global energy consulting organisation. The positions held earlier include; Director and Senior Energy Advisor, Nexant Inc. USA (an affiliate of Bechtel Corporation), Deputy Chief of Party for “South Asia Regional Initiative on Energy Cooperation and Development” and Additional General Manager, Power Finance Corporation.



Raina is a Member of the World Energy Council and a member of leading think tanks including the South Asia Policy Analysis (SAPANA) and South Asia Free media Association (SAFMA). *He has* close working relationship with South Asia Centre for Policy Studies (SACEPS) and Centre for Policy Dialogue (CPD).

He has been advising the Ministry of Foreign Affairs Governments of Germany and Japan, Asian Development Bank, Energy Charter Treaty (Belgium), German Technical Cooperation Organization (GTZ), Japan Bank for International Cooperation, Sumitomo Mitsui Banking Cooperation (Japan) and the SAARC Energy Centre on energy issues. **He has extensively worked on energy issues across South and Central Asia. Areas of expertise include:**

- Regional cooperation in energy sector including identification of opportunities; carrying out policy studies and supporting policy dialogue; undertaking analytical studies; analyses of the socio-economic benefits of energy projects and energy trade; and various project related studies,
- Strategic planning, institutional development, capacity building, governance, Reform and Restructuring,
- Project financing and financial appraisal of energy projects,
- Negotiation of Power Purchase, Fuel Supply, Transmission Service, Distribution Management and Tolling Agreements,
- International energy trade and technical collaborations

He has authored and/or co-authored several publications including:

- Regional Energy Security for South Asia
- Power Trade in Between Central Asian Republics and with South Asia
- White Paper on the Development of Hydropower Resources of Sikkim
- SAARC Regional Energy Trade study
- The Pre-feasibility studies for interconnecting power grids of India-Nepal-Bhutan-Bangladesh; India-Sri Lankan and India-Sri Lanka Trade Project
- Economic and Social Benefits Analysis of India-Sri Lanka Trade Project, Power Trade in South Asia Growth Quadrangle, and Power Trade Between India and Pakistan
- Power Sector Reform initiatives in India
- Energy Sector Reforms in India
- Policy on “Financing of Hydropower Projects during 9th and 10th Plan Periods” for the Government of India; which lead to the development of the National Hydropower Policy
- Restructuring study for implementing Power Sector Reforms in West Bengal

SAARC Power Market – Prospects and Challenges

D. N. Raina

1. Prospects:

Despite relatively large energy resource endowed comprising of hydropower potential- 294,330 MW; coal reserves - 108,961 million tons; 95 Tcf of natural gas and a large renewable energy resource base; SAARC region is facing acute power shortages; leading to frequent and long outages. The spread of these resources as well as the demand pattern are highly skewed across the region. While the resource base in some countries far exceeds their projected demand, other countries do not enjoy this luxury. This scenario provides a perfect environment for the development of these resources to meet the in-country demand as well as for cross border electricity trade within and with neighboring regions. The status of collaboration efforts in power trade amongst these countries are listed below:

i. Bhutan-India:

Currently India imports about 1100-1200 MW from Bhutan. New generation capacity is under implementation to enhance the power exports to 5000 MW by 2020. Given the progress of the under construction projects, it is felt that the achievement of this target is well within reach.

ii. Nepal-India:

Fourteen transmission interconnections along Nepal-India border help exchange 50 MW between the two countries in a radial mode. They intend to increase it to 150 MW by building additional transmission systems. The 400 kV Muzaffarpur (India)-Dhalkebar (Nepal) transmission system will be the biggest interconnection between the power grids of these two countries.

iii. Bangladesh-India:

In order to initiate power trade between India and Bangladesh a 400 kV HVDC Bangladesh-India transmission interconnection with a capacity to 1000 MW is being build. Initially Bangladesh will import 500 MW from India, to partly address the significant power shortages in Bangladesh. PGCB, Bangladesh and PGCIL, India are building the respective segments of the line within their territories, with a 400 kV HVDC sub-station in Behramara, Bangladesh.

iv. Sri Lanka-India:

The India–Sri Lanka transmission interconnection will link the national power grids of India and Sri Lanka. The project involves the construction of a HVDC interconnection between Madurai (India) and Anuradhapura (Sri Lanka) through the Palk Strait. The link will measure 285 km in length, including 50 km of submarine cables. It will take more than three years to build. The system will have a carrying capacity of 1000 MW. The discussions for the construction of this link are at a very advanced stage.

v. Pakistan-India:

The prefeasibility for interconnecting the power grid of Pakistan and India to help Pakistan import 500 MW from India has been completed recently. Next steps in this connection are in the offing.

These initiatives along with other initiatives under consideration will certainly help these countries to develop a South Asia wide power market. Creation of a Power

Market would help them in attracting large investments required for the exploitation of the energy resources and give a flip to their economic development mediated through the availability of electricity. Though small, the present initiatives will act as the first steps towards the formation of a SAARC power Market as and when the barriers to power trade are removed.

2. Challenges:

The main barriers to establishment of a Power Market in the SAARC region are given below.

i. Electricity Laws and Regulations:

The prevailing laws and regulation of the SAARC Member States have their genesis in the initiation and implementation of power sector reforms across the region since early 1990's; which brought in structural and operational changes in the sector including setting up of Regulatory Commissions, through the enactment of new legislations. While Bhutan and Nepal incorporated specific provisions to govern the cross border electricity trade in their new electricity laws and regulations, other Member States did not do so. As a result whenever there arise opportunities for cross border power trade, or any initiative to create a South Asia wide Power Market, the first hurdle to be crossed is to amend their electricity laws and regulations governing the sector to permit and facilitate electricity trade among these countries.

ii. Open Access to Transmission Systems

Open access to transmission systems is an essential tool to facilitating free flows of electricity within and across grids. Redundancies in the existing transmission systems will help power imports and also facilitate transit of electricity. As they obviate the need for setting up of new transmission lines to wheel additional electricity flows from the source of supply to the load centers in a given country or for the purpose of providing transit to other countries. This is a big incentive for power traders and utilities.

One of the redeeming features in the prevailing electricity laws and regulations of the SMS is that most of the countries in the region (with the exception of Afghanistan and Nepal who have yet to put in place electricity regulators), though not specifically from the perspective of cross border electricity trade, have made necessary provisions for Open Access to transmission systems to facilitate their use by sector participants on payment of requisite charges to be fixed by the regulators. While the provision is in the statute, its actual application on the ground has not been satisfactory. It is, therefore, essential that the SAARC Member States while formulating the regional mechanism to facilitate electricity trade provide for and implement Open Access to transmission systems in a sincere manner.

iii. Implications of Prevailing Laws & Regulations on Cross Border electricity Trade

Various provisions in the prevailing laws and regulations for governance, licensing, investment promotion, regulation and tariff setting have implications on adding new capacities, enhancing availability of supply, and increasing transmission networks within these countries. Though these laws and regulations do not mention that they will be applicable to cross border electricity trade, but the moment imported power lands in a

country, it will be subjected to these laws and regulations, which in turn will have direct impacts on power trade among the member states. Therefore, the laws and regulations prevailing in each country though meant to govern the sector operations within the country will have ramifications on electricity trade and also the decision making for the sector in other countries of the region.

The prevailing regulations relating to tariff setting will dictate the success or failure of the cross border electricity deals. So would be the capacity of the member states to attract investments required for the creation of the cross border electricity infrastructure.

iv. Investment

Large investment requirement for the creation of physical infrastructure, essential to develop a Power Market in South Asia, is another big hurdle. Creation of a power Market in South Asia will change the dynamics of the domestic electricity markets in the region. As it will have implications for generation, transmission and distribution utilities, electricity traders, infrastructure developers and investors including those involved in creation of cross border electricity infrastructure. Cross border electricity trade will create the need for setting up of new transmission systems to handle additional electricity flows within countries, as well as, for providing transit facility for power flows to other countries through their territory. They will also impact the decisions to be made by the power generation and distribution utilities in other countries, as their investment decisions are impacted by the availability of supply and the options to import electricity to meet the demand and export the surplus energy when supply exceeds their demand.

Project developers and investors look forward to cash flows from projects, whether in generation, transmission or distribution. A larger market that permits free flows of electricity within and outside the political boundaries of the host country, gives more options to project proponents to maximize their revenue streams and minimize the adverse impacts of demand-supply fluctuations in the local electricity market. Such mechanisms also facilitate speedier project development and lower cost of capital resulting in lower cost of generation that can be passed on to the end use consumers.

Lenders closely examine the risks and payment security mechanisms on offer, while funding projects. These include the risks associated with the failure of the power purchasers to off-take the contracted quantities of power, a situation that may arise due to their inability to pay in time. Power Market will minimize this risk, thereby making it easy to raise resources at competitive rate for timely completion of projects.

Each power system needs to maintain a spinning reserve to overcome any eventuality of unscheduled shut down of its generation facilities. The need for such a reserve is minimized, if the system operator has the option to import electricity in unforeseen circumstances at short notice; thereby reducing the investment requirement in creating the spinning reserve. This will be one of the biggest advantages of creation of a power market in the region.

v. Other Requirements

There are other issues, though not un-surmountable, that have to be addressed

mutually by the SAARC Member State for the creation for the creation of the South Asia Power Market. These are listed below.

a. Legal Requirements

- Freedom of transit to allow the SMS to wheel electricity through the territory of other member states without any unreasonable delays in granting permissions, putting restrictions or through levy of undue charges;
- Cross border electricity flows to enjoy the same treatment as provided by the host country for its own power flows irrespective of its origin, destination, ownership or pricing;
- Assurance with regard to non-disruption of supply in case of any eventuality, political or otherwise;
- Provision of creating new infrastructure in case the existing one is insufficient to meet the requirement;
- Open access to the power transmission systems of the host country to other countries who need to wheel power through their territory, to the extent that:
 - the transmission systems have surplus capacities available after taking in to cognizance the requirements for wheeling of electricity for the domestic electricity market and for their own imports and exports of electricity,
 - the technical and operational norms of the host country are adhered to by the country that intends to wheeled electricity, through their transmission systems,
- Grant the right of way for setting up of dedicated transmission line(s) through the transit State, to wheel electricity between the electricity buyer and the seller Member States, or by a Member State between its two or more regions.

b. Regulatory Requirements

Regulatory Commissions set up by the six SMS have authority to regulate the electricity sector within the respective country. There is need to put in place an independent regulatory mechanism at the regional level to regulate cross border electricity trade and transit in South Asia. The major objectives that the mechanism should, inter-alia, aim at achieving are:

- Minimize the landed costs of imported electricity supply;
- Mitigate environmental concerns, while creating cross border transmission infrastructure;
- Creation of the SAARC regional electricity market;
- Encourage deployment of innovative technologies to reduce system losses;

- System pricing to be cost reflective and elimination of cross-subsidies;
- Ownership and management of the cross border transmission networks be independent of power generation and supply companies;
- Non-discriminatory access to the grid at prices that reflect the cost of services provided;
- Benefits that generators provide to the system (e.g., voltage and frequency support, grid reliability and stability, reduction in transmission and distribution losses, and reduced requirements for Spinning Reserve) should be fully and fairly reflected in system pricing;
- Generators not to be excessively charged for their system impacts;
- Electricity system, be subjected to market based instruments, for example; emissions trading, energy taxation, and out-put based standards that fully reflect energy conversion efficiencies and internalize environmental costs of energy conversion.

c. Technical Requirements

The following technical issues merit consideration in order to ensure that electricity trade among the SAARC Member States becomes a reality:

- Harmonization of Grid Codes/Standard, Grid Operation Parameter, connectivity Standards for Grid Participants, maintenance schedules and procedures. These will inter-alia include the voltage and frequency level, etc.;
- Decision on the level of energy flows for the transmission systems, based on detailed Load flow studies, Optimal power flow modeling, Short-circuit modeling, Dynamic stability modeling and Transient modeling;
- Protection systems to be put in place for load segregation, in the event of any major fault occurring in one of the interconnected systems;
- Establishment of an Independent System Operator to manage the system operations;
- Setting up of appropriate communication and monitoring systems;
- Establishment of AC instead of HVDC interconnections, to save the investment requirement for setting up the cross border transmission infrastructure;
- Adoption of common metering standards and other relevant arrangements to measure the energy flows.

d. Commercial Requirements:

As regards the commercial issues, in addition to the pricing mechanism etc., SMS will have to agree upon the:

- Currency to be used for settling accounts;
- Payment security and settlement mechanisms;
- Frequency at which the meter readings will be recorded;
- Periodicity for submission of bills and settlement of accounts;
- Mechanism to record deviations from scheduled energy flows and the incentives or penalties to be imposed for deviations; to ensure maintenance of grid discipline;
- Dispute resolution mechanism.
- Standardization of commercial documentation including bidding documents, contracts etc. to reduce time in award of project and to reduce the transaction costs.

3. **Recommendations:**

SAARC Member States shall have to evolve a regional electricity trading mechanism that takes care of the above factors as well as helps in overcoming other crucial issues that have been impeding the development of an electricity market in the region. The following steps may help them overcome the hurdles.

- Creation of a SAARC Electricity Legal Framework to adequately address the legal, regulatory, technical and commercial issues listed above.
- Since electricity demand far exceeds the supply, creation of new generation capacities either individually or through collaboration between two or more countries would make energy supplies available to be traded through the power market.
- While the efforts of the individual countries face limitations of making large investments for the development of electricity sector; permitting and encouraging cross border investments could help in obviating this difficulty.
- In order to avoid multiplicity of authority with regard to regulation of cross border electricity trade and transit amongst the SAARC Member States, it is highly desirable to create a SAARC Electricity Regulatory Commission to regulate cross border electricity trade and transit.

Dr. Zaid Mohamed

Chief Technical Officer, STELCO, Maldives



Dr. Zaid Mohamed has completed Doctor of Philosophy in Electrical and Electronic Engineering at University of Canterbury, Christchurch, New Zealand in June 2005 on the topic “Forecasting Electricity Consumption: A comparison of growth curves, Econometric and ARIMA Models for selected countries and world Regions”.

He has also completed Bachelor of Electrical and Electronic Engineering with first class honors from the University of Adelaide, South Australia in April 2000.

Dr. Zaid Mohamed has gained over 10 years in experience in the power sector of the Maldives. He was the Managing Director of State Electric Company Ltd (STELCO) until January 2013 when he resigned to work on his own and family business.

STELCO is a fully state owned government company responsible for generation, distribution and sale of electricity to the North Central Province of the Republic of Maldives which includes the capital island Male’. He has also been a Board Director of the Company from 2008 to 2013. He has also worked at other senior positions of the Company including Chief Technical Officer and Assistant Managing Director. As a member of the board of directors and senior management, he was responsible for the day to day operation of the Company. He was also involved in providing technical expertise in the areas of generation and distribution, especially in the short, medium and long term planning.

Further, his work on electricity forecasting has been published in international journals and has presented his work in a number of international conferences including Australia and New Zealand.

The Need for an Energy Grid in the Maldives

Dr. Zaid Mohamed (Chief Technical Officer) / **Mr. Mohamed Latheef** (Deputy Managing Director), STELCO, Maldives

Maldives, with a population of only about 300,000, and low laying 1190 islands with 185 inhabited islands, mainly generates power from diesel generators. Except for one or two power stations, each island has got its own power stations and independent grid for power distribution. The presentation will initially focus on the capital island of Maldives, Male' where more than a third of the population of the country currently resides. The current power demand growth pattern in Male' will be presented with a brief overview of challenges in meeting the demand. In 2009, the Government of Maldives announced its intention to become carbon neutral by the year 2020. Our experiences and challenges in implementing the renewable energy projects in the context of Maldives will also be presented. Expansions in terms of conventional methods of power generation or renewable energy technologies are limited in the case of Maldives due to our unique geographical setting. There are many challenges in interconnecting the power grids of the islands by submarines cables. A national grid as well as a grid in the SAARC region will be very beneficial for the Maldives to overcome many of the barriers in terms of generation and transmission.

Dr. Muhammad PERVAZ,

Programme Leader, Technology Transfer, SAARC Energy Centre



Dr. Muhammad Pervaz obtained a Ph. D. degree in natural science from Quaid-I-Azam University, Pakistan in collaboration with the Technical University of Aachen, Germany. He was a visiting scientist on a post-doctoral research project in the field of marine geochemistry at the Federal Institute of Geo-Sciences and Natural Resources (BGR), Hannover, Germany.

In September 2007, Dr. Pervaz joined the newly established SAARC Energy Centre (SEC), Islamabad, Pakistan as a Programme Leader, Technology Transfer. In SEC he is responsible for implementation of energy technologies transfer and sharing of best practices in South Asia. Presently, he is actively involved in the dissemination and promotion of renewable energy technologies and energy policy research in South Asia. Previously he was working in the Hydrocarbon Development Institute of Pakistan (HDIP) since 1988 in various capacities. In HDIP he was responsible for research and Development activities in petroleum geochemistry and environmental monitoring. Since 2000 He is actively involved in technical and policy research in energy and environment nexus, regional and international energy cooperation.

Present and past professional affiliations include, the New York Academy of Sciences, European Association of Organic Geo-chemists (EAOG), Pakistan Association of Petroleum Geoscientists (PAPG) and Fellow, The Chemical Society of Pakistan, Corporate Member Sri Lanka Energy Manager Association (SLEMA), Life Member Society of Asian Civilizations, Islamabad, Fellow of Leadership for Environment and Development (LEAD). He visited many countries and participated in several National and International seminars, conferences, workshops, official meetings including SAARC and UNESCAP Energy Expert Groups and training courses related to the environment, energy, regional and international energy cooperation, etc. He has more than 60 research publications to his credit and several technical institutional reports, including a chapter in the book *Geology, Geo-chemistry and Composition of Oil Shales*, published by Kluwer Academics, Dordrecht, The Netherlands and co-author of paper in published by Geological Society, London, Special Publications (2002), 195, 445-461 on Discovery of the Toba Ash (c.70 ka) in a High-resolution Core Recovering Millennial Monsoonal Variability OFF Pakistan. In: *The Tectonic and Climatic Evolution of the Arabian Sea Region*.

The Energy Cooperation in South Asia Under SAARC Umbrella

Dr. Muhammad Pervaz

ABSTRACT: South Asian countries are under immense social and political compulsions to secure reliable, sustainable and affordable energy supply to meet the fast growing demand for commercial energy to fulfill aspirations of the people and economic growth of the region. In order to address social equity and development objectives, the Governments in the region endeavour to provide electricity to all, but the fact is that the gap between supply and demand is widening. It has been estimated that primary commercial energy demand of South Asia will increase from primary commercial energy supply of 655 million tonnes of oil equivalent in 2011 to more than 2,200 million tonnes of oil equivalent by 2030. The Intra- and Inter-regional energy trade and energy cooperation is one of the key options to fill the huge supply and demand gap.

Much needed energy cooperation in the SAARC region got formal recognition in 2004 through the Islamabad Declaration of the 12th SAARC Summit when our leaders directed to conduct a study by Working Group of Energy on the concept of a South Asian Energy Ring and constituted Ministerial level Energy Forum. The Working Group in its first meeting proposed establishment of a SAARC Energy Centre to realize the concept of the regional energy ring. This proposal was supported by the Energy Ministers in their first meeting in October 2005. The 13th SAARC Summit, held at Dhaka in November 2005, approved the establishment of SAARC Energy Centre to serve as the focal point for increasing energy cooperation. The Centre is not only driving intra-regional energy cooperation within South Asia but also serving as a platform for international and inter-regional energy cooperation with neighboring regional blocks in West Asia, Central Asia, East Asia and South-East Asia.

In order to contribute towards materializing the concept of energy ring the SAARC Energy Centre has developed its Strategic and Operational Plan. The Plan identified five thematic areas of programme activities focusing on: (i) Energy Trade, (ii) Technology Transfer and sharing best practices, (iii) Energy and Environment, (iv) Energy Efficiency and Fuel Substitution, and (v) Rural Energy Accessibility.

The paper describes the concept of energy ring and highlights the regional energy situation, potential of energy trade in South Asia and ongoing efforts and opportunities for intra- and inter-regional energy cooperation under SAARC Umbrella.

1. Some Important Features and Facts of SAARC Region

- Population more than 1.6 billion, (above 1/5th of world population);
- Low per capita income with vast population living in poverty ;
- Low per capita energy consumption (514 kgoe/capita/year). EU (3,536); USA(7,051); Malaysia (2,391); China (1,695); World avg (1,788).
- Low access to electricity and low consumption(517 kwh/capita/year)
- Even at this level region is facing huge energy shortage

- High ratio of traditional biomass: More than 200 Million TOE per annum
- Lack of balance energy mix nationally;
- Energy deficient (except Bhutan) and high oil import dependence, which is on rise due to rise in demand;
- Annual commercial energy consumption 655 Million TOE;
- Commercial energy demand will be more than 2,000 Million TOE by 2030.
- Low cross border energy trade; and
- Resource potentials under-explored

2. How to Meet Growing Energy Demand

- Enhance indigenous resource base and promote R&D
- Diversify of energy mix and energy supply sources
- Sharing resources by promoting energy trade within SAARC countries and beyond
- Enhance regional and international energy cooperation
- Development and deployment of renewable energy resources; solar, wind, micro hydel, biomass etc
- Optimum and Efficient use of resources and conservation of energy
- Exploration and development of non conventional hydrocarbon resources like shale gas and tight gas

3. Primary Commercial Energy Consumption – 2011

		Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka
Commercial Energy Type	Million TOE	24.3	0.29	559.1	0.35	1.15	64.52	5.61
Primary Electricity	%	1.2	48	6.63	0	16.64	13.2	24
Oil	%	20.6	40	29.02	100	47.34	32.0	72
Natural Gas/LPG	%	73.7	2 (LPG)	9.84	0	20.16 (LPG)	48.1 (LPG=0.5%)	3 (LPG)

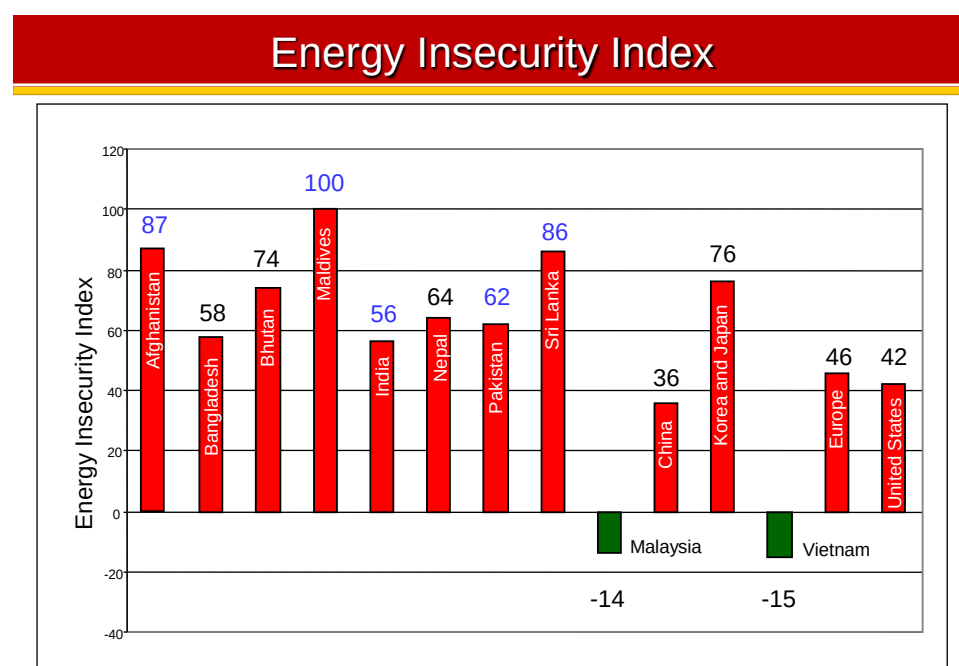
Coal	%	4.1	10	52.87	0	15.85	6.7	1
Renewables (excluding hydro)	In 2011 the share of RE in commercial energy supplies of India was 9.2 Million TOE which is around 1.6% of total commercial energy supplies. For other countries the share of RE is negligible <i>For Bangladesh, India and: Source BP Statistics June 2012. For Bhutan, Maldives, Nepal, Pakistan and Sri Lanka data from official sources.</i>							

4. Energy Insecurity Index

Energy Insecurity Index is based on:

- Share of net imports in total oil consumption (40% weightage)
- Share of oil in total primary commercial energy consumption (35% weightage)
- Share of the Middle East oil in total oil imports (25% weightage)

All South Asian countries suffer from energy insecurity and are projected to remain so in the foreseeable future.



Source: <http://www.eastwestcenter.org/fileadmin/stored/pdfs/asiaenergyfuture10insecurityindex.pdf>

5. SAARC Institutional Mechanism for Energy Cooperation

- Ministerial Level Energy Forum;
- SAARC Working Group on Energy;
- Energy Commodities Expert Groups on:
 - Oil and Gas;

- Electricity;
- Renewable Energy; and
- Technology/ knowledge sharing (including energy efficiency, coal, etc.)
- The SAARC Energy Centre

6. SAARC Energy Centre

- Established in 2006 at Islamabad to initiate, promote and facilitate cooperation in energy sector of SAARC Member States for the benefit of all
- Funded by SAARC Member States and supervised by a Governing Board comprising all Member States
- Professional staff selected on merit from Member States

Session 3: Problem extraction from policy and legal aspect

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Dr Priyantha D C Wijayatunga graduated with First Class Honours from the University of Moratuwa Sri Lanka specializing in Electrical Engineering and holds a PhD in Power Economics from Imperial College, London which awarded him the prestigious Beit Scientific research Fellowship in 1988. He is presently the Head of Portfolio Management Unit of the Nepal Resident Mission of Asian Development Bank and also an Honorary Professor in Electrical Engineering at the General Sir John Kotalawale

Defence University in Sri Lanka.

At the time of joining Asian Development Bank in 2008 he was a Senior Professor of Electrical Engineering at the University of Moratuwa. He led the setting up of the Faculty of Information Technology at the University of Moratuwa and became its first Dean in 2001. He has experience in energy sector policy making, regulatory and Climate Change activities over 20 years and has authored over 75 publications including over 25 refereed international journal publications in the field of energy. He is the lead author of the ADB publication on “Energy Trade in South Asia: Opportunities and Challenges”.

Dr Wijayatunga set up the independent electricity regulatory agency in Sri Lanka, Public Utilities Commission, in 2003 and became its first Director General, a post which he held concurrently along with his substantive position as a Professor, until 2008. He also served as a member of the Ceylon Electricity Board, the main electricity utility in the country. He was the Chairman, South Asia Forum for Infrastructure Regulation in 2006. He is a Chartered Engineer and a Corporate Member of IET, London. Also he is a Senior Member of the IEEE. Before moving to Kathmandu he was involved in processing key energy sector loans in Bangladesh, Nepal, Sri Lanka and Maldives. He has been the ADB focal point for regional energy cooperation in South Asia since 2008.

Economics of Regional Energy Cooperation: Nepal Case Study

Priyantha Wijayatunga

It is widely accepted that regional cooperation in the energy sector provides opportunities for countries to share and optimize the use of energy resources in individual countries. This is even more important in both the local and global context if such shared resources can be clean and renewable. Examples of successful cooperation in the electricity sector can be found in many parts of the world.

In the case of South Asia Region, there are a few large capacity electricity transmission interconnections between Bhutan and India. A 500MW asynchronous electricity interconnection is also under construction between Bangladesh and India while a 400kV 1000MW interconnection is about to start its construction between Dhalkebar(Nepal)-Muzzafarpur (India). The recently concluded SAARC (South Asian Association for Regional Cooperation) Regional Energy Trade Study (SRETS) has suggested several electricity interconnections within the SAARC region for implementation in the next phase in addition to the ongoing efforts of interconnecting electricity networks between (i) Bhutan and India, (ii) Bangladesh and India and (iii) India and Nepal. These new electricity transmission interconnections will be (i) India-Sri Lanka power interconnection from Madurai to Anuradhapura; (ii) India-Nepal power interconnection from Gorakhpur (India) to Butwal (Nepal); (iii) a Central Asia–Afghanistan–Pakistan power transmission interconnection. Also the SRETS suggests the expansion of the regional power market in South Asia and establishment of a bulk power generation for regional consumption which in turn need high capacity cross-border transmission interconnections.

The paper presents the benefits of regional cooperation taking the ongoing efforts of interconnecting the Nepal and India electricity grids through the Dhalkebar-Muzzafarpur transmission line which is expected to come into operation by 2016/17. The analysis was carried out with an investment planning model with a reduced integrated South Asia transmission network of 40 nodes and 166 transmission lines for “with” and “without” project scenarios. The options for generation investments were based on generation plans of the individual countries. The transmission capacity and electricity demand projections were also based on the national plans with extrapolation in certain cases where the plans do not project adequately into the future. Benefit of cross-border transmission is measured in terms of reduced generation costs (both investment and operation) and reduced cost of unserved energy due to increased overall effective generation capacity at the disposal of each of the countries.

Dhalkebar-Muazaffarpur 400 kV transmission line project is estimated to cost \$186 million inclusive of in-country transmission network strengthening to support 1000MW of cross-border power flows. The study analysed two scenarios; (i) Nepal reaching a generation surplus state by 2016/17; and (ii) Nepal remains a deficit state even by then. The model shows that the interconnector is highly beneficial in both scenarios. However the benefits are far higher in the latter because the interconnector’s ability to achieve significant unserved energy reduction in Nepal under such circumstances. In both cases, the annualised cost of the transmission which is around \$ 20 million per year is only a small fraction of the accrued benefits that are in the range of \$ 105-215 million per year. It is concluded that the level of economic benefits provides a strong justification for the proposed transmission line.

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Mr. Bhat has experience of working more than 30 years in the sector. He has worked as Manager of Power Plants, Transmission Grid, Distribution Center as well as Director of System Operation. Currently he is Director of Power Trading Department in Nepal Electricity Authority. He has good exposure of different energy markets.



Regulatory Framework for Trading of Power

Sher Singh Bhat

❑ Why Liberal Markets and Trading?

All developing countries started facing very high demand growth of electricity by the end of 20th Century. Supply needs to be increased to meet increasing demand. To manage this additional supply, asking rate of investment in power sector became more than 25% of annual budget. Since state has many other sectors to invest and hence could not afford to invest more than 25% of annual budget in power sector only. This created an investment gap in power sector and limited public resources and development aid could not close the investment gap. At this juncture, private Sector perceived as vehicle of choice for electricity sector development. But it was not possible in state controlled monopoly market structure and the market structure had to be changed for participation of private sector. Entry of private sector in the market starts trading and trading is inherent activity in all liberal markets after monopoly.

❑ Why Regulatory Framework for Trading?

But financiers of private investors are risk averse and enough upstream ground work is necessary for private involvement in the energy business. Attractive environment for private investors needs to be furnished. This requires a level playing ground for private capital which may be ensured through appropriate Regulatory Framework. That is why Regulatory Framework suitable for private investment is foundation of trading. The regulations should encourage the investors for investment but at the same time should give directions to create an economic consumer.

❑ Economic Growth and Regulatory Framework

Regulatory framework should give directions to create a sustainable economic growth through spiral positive feedback loop result of small and medium scale projects through domestic private investments and a parallel Mega project investment through public or FDI investment to result in quantum growth.

❑ Objectives of Regulatory Framework

1. It should give directions to create spiral positive feedback loop of economic growth through domestic private investment and attain quantum growth through public or FDI investment in Mega projects
2. It should ensure safe, reliable, efficient and affordable electric power to the electricity consumers
3. It should facilitate transition from a protected monopoly service structure to a competitive environment
4. It should strike and maintain balance between flourishing of electricity industry and rights of its consumers

❑ **Coverage of Regulatory Framework**

1. **Related to Expansion :**

Licensing to Generators, transmission providers, distributors and traders as well as Market Development

2. **Related to Operation**

Grid Code, Granting Open access, Procurement of Power and Transmission Service from market, Regulation for performance standards

3. **Related to Tariff**

Regulation including Tariff determination for generation, transmission and distribution; Retail Tariff; Trading Margin; Capex

4. **Related to Consumer rights and Judicial Process**

Adjudication, Judicial Process including Public hearings and Tariff petitions

❑ **Policy Guidelines for Regulatory Framework**

1. Policy Guidelines related to Internal Market Regulation
2. Policy Guidelines related to Cost of Service
3. Policy Guidelines related to Financial Planning and Accounting of Utilities
4. Performance Standards and Benchmarking of Utilities responsible for Natural Monopolies of Transmission and Distribution (T&D).

❑ **Regulatory Framework for Cross border Power Trade**

Cross Border Trading of Power may be at Bilateral or Regional Multilateral level. Regulatory Framework for Cross border Power Trade shall include regulations concerning Infrastructure and assets as well as Markets. Whether for bilateral or multilateral trade, there has to be an Inter- Governmental Framework Agreement as policy document between/among the governments of member countries participating in the trade.

In fact the Regulatory Framework for Cross border trade has two steps. In the first step, the domestic policy documents including Electricity Act and regulation of trading countries must acknowledge electricity as tradable commodity and accept its import and export as normal trade.

In the second step there has to be a bilateral/multilateral government to government umbrella agreement for trading of electricity. Under the cover of this umbrella agreement requisite regulatory framework for bilateral/multilateral trade of electricity are developed. This regulatory framework clarifies issues like planning and implementation of combined grid, regional infrastructure and market etc.

Er. Gyanendra Lal Pradhan
Chairman

SAARC CCI Council on Climate Change, Energy & water Resources

Mr. Gyanendra Lal Pradhan is an electrical engineer and a business entrepreneur and widely known for his contribution on areas like hydroelectricity and clean water. Presently he is executive chairman of Hydro Solutions: *“One stop shop for Hydro Power”*, HSL Capital, HSL Engineering, HSL Constructions, Trishakti Cable Industries and Scenic Developers. He involved in 4 MW to 280 MW capacity in 12 Hydropower projects as promoter.



Currently He is Executive Member Federation of Nepalese Chamber Of Commerce & Industry, FNCCI SAARC chamber of commerce & Industry – Nepal Independent Power Producers Association of Nepal Nepal Russia Chamber Of Commerce & Industry Nepal China Chamber of Commerce & Industry Nepal German Chamber Of Commerce & Industry CACCI, Taiwan and chairman of Energy Committee, FNCCI Water Energy and Environment committee, SAARC CCI & CACCI. He received many national and international awards and prizes.

Food, Water & Energy security through Hydropower development

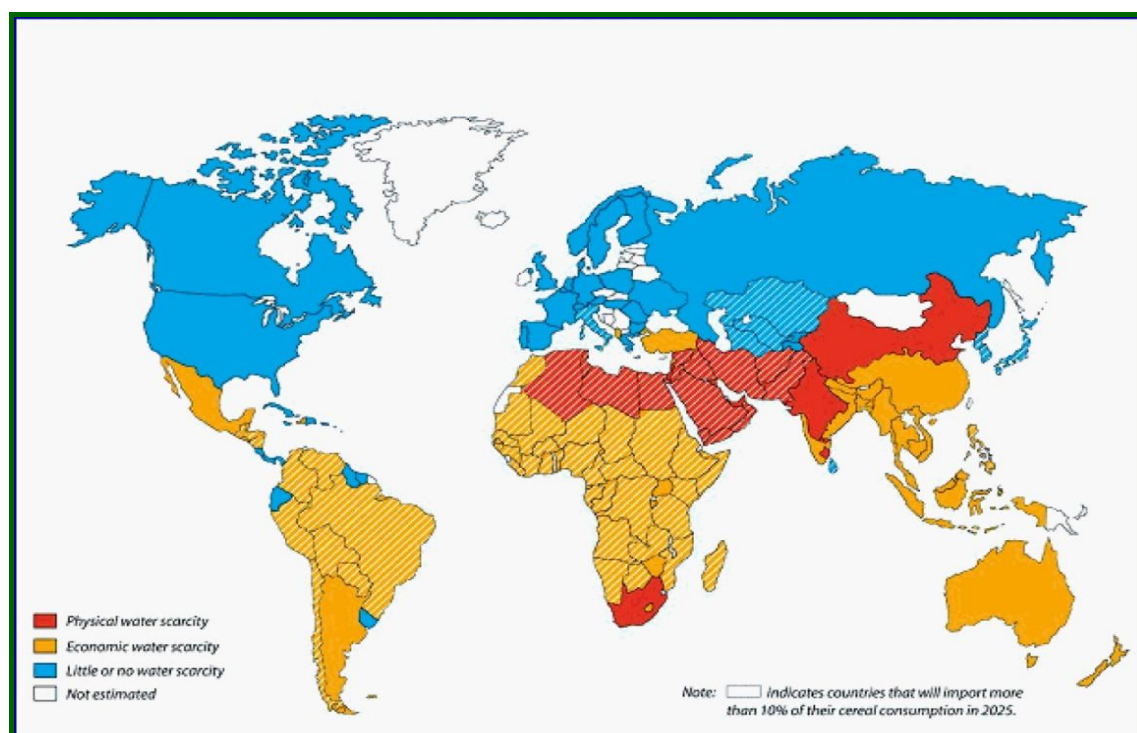
Er. Gyanendra Lal Pradhan

The **South Asian Association for Regional Cooperation (SAARC)** – an economic and political organization of eight countries in Southern Asia – Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka – is home to more than 1.5 billion people and with a grand vibrant economy. Enhancement of trade and investment are inevitable for economic integration among the SAARC member, where enormous potential already exists in areas of trade, investment, natural resources and services for the prosperity in the region. The biological, physical and cultural diversity makes SAARC the most fascinating tourist destination/Zone in the world.



As the climate changes, and in the context of rapid demographic growth in the region, the importance of clean renewable power and clean water in the coming 10-30 years will be immense in the future (both at the domestic and regional front) which would need augmentation of the storage capacity for the available clean water. Clean water has already become a scarce resource in the region. The projected water scarcity by 2025 as indicated below is very daunting and needs a serious thought.

Projected Water Scarcity by 2025



As FAO in 1995 has already prognosed that there is a serious risk of water becoming a casus belli in some of the arid parts of the world as populations expand, economies grow, and the competition for limited water supplies intensifies. SAARC is no different.

South Asia, endowed with the world's greatest water towers and with its resplendent biological diversity, has unimaginable potential for Asia's food and water security if it is effectively mobilized and used. For example, glaciers of the Himalaya Mountain Range are an enormous reservoir of fresh water and their melt water is an important resource for much of SAARC region. Due to global warming the storage capacity of clean water needs to be augmented. Let alone the cumulative potential of the SAARC Countries, Nepal alone has a storage capacity of over 140 bil. m³.

If 'health for all' and 'education for all' are valid approaches to striking at the root causes of poverty so also we need, as SAARC, seek 'electricity for all' and 'sanitation and irrigation for all' as well as 'drinking water for all' by 2020. None of this can be imagined without electricity. **And energy is the underbelly of SAARC progress with lack of water a real threat to regional peace and security.** Energy is a top priority, and no economy can grow to their full strength due to lack of substantial energy resources. The region is immensely rich with this natural gift, with Nepal's clean water and renewable hydropower energy potential alone being adequate to meet the regional water and energy demand.

Hydro Development – Worldwide and in Asia



	WORLD	ASIA
Hydro capacity in operation	807,000 MW	319,219 MW
Annual hydro production	3030 TWh/year	1061 TWh/year
Technically feasible potential	14,388 TWh/year	6800 TWh/year
Hydro capacity under construction	150,600 MW (in 106 countries)	126,044 MW (in 30 countries)
Hydro capacity planned	>340,000 MW (in 152 countries)	>220,000 MW (in ~ 37 countries)

Hydro currently provides 20 % of the world's electricity

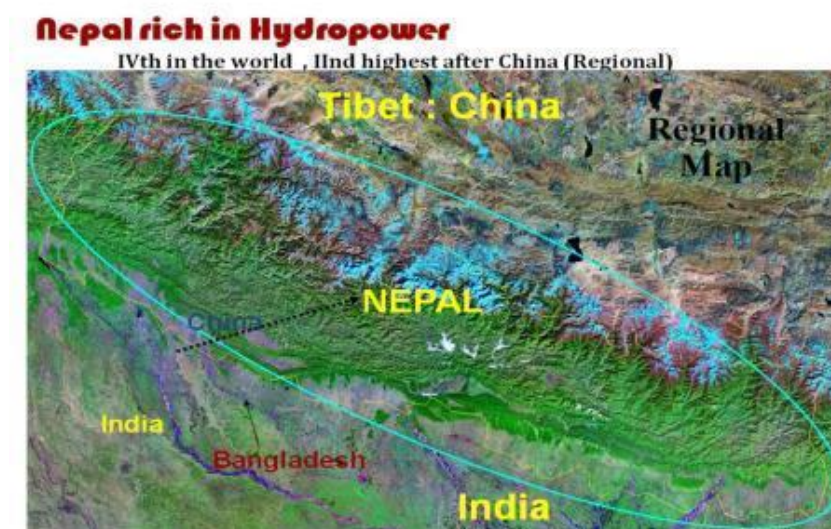
~ 84% of hydro under construction is in Asia

As can be seen above 84% of hydro under construction is in Asia (mainly in China, Vietnam) but this does not lend enough reasons for the SAARC countries to be happy about. Energy per capita is low in the countries where energy is surplus. For a two digit growth economies like India, the energy needs are ever increasing and a substantial hefty amount of national resources is used to buy energy and fuels from the Gulf countries making domestic energy very expensive. Presently, energy crisis has been a major problem faced by the SAARC countries. As per a tentative calculation, 10,000MW of electricity generated can stop ~2.5 billion dollar equivalent of oil import in the country. If we analyses the hydro potential of three countries-Nepal, India and Bhutan, 4 lakh MW of commercially viable energy can be generated. With this generation capacity, every year, 100 billion dollar worth of oil import can be restricted, immensely helping the domestic as well as the regional economy to thrive and grow.

The increased rate of deforestation in the SAARC region is also attributed to no increased use of environment friendly compatible clean sustainable renewable form of energy like hydropower thereby resulting to serious environmental degradation and unsustainable practices.

A substantial amount of water during the flood months in the SAARC Countries goes into the sea, gets polluted and remain unused. If this water is properly stored and used during the dry season when the water level recedes considerably due to low water flow, water can be significantly regulated to increase dry production. This is also associated with other multiple benefits, such as flood control in the country and adjoining states, increased regulated flow facilitating navigation and increased area under irrigation in lean season that open up the possibility of ushering in a new cycle of economic growth in the poverty stricken areas of the neighboring basins. For example, Nepal by using its storage capacity to contain glacial melt water due to Global warming can help in flood control in Bangladesh.

Here Nepal deserves a special mention. In the area of regional clean – water supply and hydropower energy Nepal is the only potent place where the storage capacity of the clean water can be affectively augmented. Nepal is immensely rich in hydropower with annual 224 billion cubic meter of surface run – off and over 20,000 liters of water available to a person per day. As per Hydro Solutions’ estimate, the total hydropower potential of Nepal stands at around 200,000 MW against the popularly assumed figure of 83,000MW. With more than 6000 rivers and rivulets, around one million GW hour of electricity can be generated. This potential is adequate to meet the total domestic and part of the regional energy demands for many years. Nepal- the fourth richest hydroelectric rich country in the world and the second in Asia after China is golden investment gateway to enter the huge energy craving and emerging power market with the highest market price.



The Government of Nepal formally announced that fiscal year 2012-13 would be observed as Nepal Investment Year (NIY). NIY is one of the ambitious programmes of the Government that seeks to encourage domestic investments and double foreign direct investment (FDI) in the country. To successfully realize this, the Government has come up with different affirmative declarations which are welcoming and highly appreciated by all quarters. Nepal plans to use Nepal Investment Year 2012-13 to not only encourage increased investment in the country but also plans to seriously discuss and advocate for issues related to energy security and the imminent agenda for increased use of environment friendly compatible clean sustainable renewable form of energy, now made even important due to the global warming menace.

SAARC should dialogue through participation and should work together to enhance, preserve and protect environmental, energy and water security to all through regional cooperation and integration. It should promote and address South Asia's collective water security interests by adopting a common position in promoting the development of hydropower and environment friendly compatible clean sustainable renewable form of energy in view of the ecological unity of South Asia as one region bound by one civilization facing akin problems.

Mr. Rajan Dhakal

Deputy Manager, Nepal Electricity Authority (NEA), Kathmandu, Nepal



Mr. Rajan Dhakal is currently working as Deputy Manager in Nepal Electricity Authority (NEA); fully government owned and sole responsible organization for generation, transmission and distribution of electricity throughout the nation. Mr. Dhakal has completed his B.E. in Electrical Engineering in 2000 and M. Sc. in Power System Engineering in 2008 from Institute of Engineering, Pulchowk Campus. He also has completed Masters in Business Studies from, Tribhuvan University in 2006.

He has over 10 years of experience in the field of electrical and power system engineering. During his tenure in NEA, he has been involved in different offices and projects such as Distribution and Consumer Services, Community Rural Electrification Project, Loss Reduction Project, Cross-border Transmission Line Project. He has been involved in drafting and negotiating the legal and commercial agreements namely PSA, ITSA and SHAs in connection with Cross-border interconnection between Nepal and India. He is currently working in Nepal-India Electricity Transmission and Trade Project; also he is the Project Manager of Koshi Corridor 220 kV Transmission Line Project.

Fundamentals of commercial and legal frameworks and agreements for cross border interconnection between Nepal and India a particular reference to Dhalkebar- Muzaffarpur 400 kV Cross Border Interconnection

Mr. Rajan Dhakal

Despite the long history of Nepal- India power exchange, bulk power trading in real sense has not been realized due to lack of physical infrastructure and sound commercial modalities. In order to facilitate the commercial power trading between two countries, unlike earlier inter governmental power exchange modalities, the government of Nepal and India decided to realize the cross border projects with new commercial modalities under public private partnership model. As a consequence of which, in Mid 2006 IL&FS, NEA and PTC with support from the MOWR/MOF took initiative towards the development of transmission interconnection between India and Nepal for mutual interest of both countries. Subsequently the JVC-Nepal called Power Transmission Company Limited (PTCN); a joint venture company of NEA and IL&FS was registered in Nepal and similarly JVC- India called Cross Border Power Transmission Company (CPTC) a joint venture company of IL&FS, Power Grid and SJVNL was registered in India in- order to develop, construct, operate and maintain the transmission line in the respective territory. For this purpose, the Dhalkebar (Nepal)-Muzaffarpur (India) 400 kV Transmission line was chosen in the first phase and would be synchronized with Nepalese and Indian grid.

The D-M line will be constructed, owned and operated by the companies PTCN and CPTC in the respective territories of Nepal and India respectively. NEA shall book the whole of the transmission capacity of this line and pay the Transmission Service Charge (TSC) to both the JV companies. NEA can tie up with other users and IPPS in Nepal or India to lease the part of the reserved capacity of the line for the export and import of electric power. The governing agreements in form of separate Implementation and Transmission Service Agreements (ITSA-India and ITSA-Nepal) for both portion of the line has been signed on 13th December 2011 between NEA and two JV companies. Similarly Share Holders Agreement of Both the Companies were signed on 9 July, 2013. Also there is a provision that NEA shall enter in to a Power Sale Agreement (PSA) with PTC India for the purchase of 150 MW of power on the long term basis. This power will help reduce load shedding of Nepal on the short term and will act as base load when sufficient hydro generation would be developed in Nepal. A year long discussion and negotiations the signing of PSA was

concluded on 12th December, 2011. The Scheduled Delivery Date for this power is 42 months from the date of signing the Agreement.

The signing of these fundamental commercial and legal agreements: the ITSA, PSA and SHAs have been a remarkable achievement for the development of D-M line in commercial modality. This type of modality in cross border power trading is being exercised for the first time in this region. With the signing of the above commercial agreements, the door for financial closure of the companies has been opened and it is expected that both the companies achieve their financial closure by the end of March 2013. Project is expected to be commissioned by the end of December 2014.

Session 4: Problem extraction from economic aspect

Dr. Sandip Shah

Vice President & Country Director
SN Power Holding Singapore Pte. Ltd.



Dr. Sandip Shah is an experienced hydropower engineer and independent power producer of Nepal. After completing his Ph.D. in Civil Engineering from Canada in 1992, Dr. Shah has worked as a consultant for the investigation, design and construction of hydropower projects in Nepal, including the Kali Gandaki “A” (144MW), Upper Bhote Koshi (45MW), Khimti (60MW), Middle Marsyangdi (70MW), Likhu-IV (51MW), Trishuli-Devighat Hydropower Upgrading Project (45MW), Indrawa -III (5MW), etc.

Currently he is Vice President and Country Director for SN Power in Nepal, and is working on the development of Tamakoshi-3 (650 MW) HEP as Project Director and expansion of the Khimti Project, termed Kirne Power Project (67 MW). He is also responsible for the 400 kV transmission line for evacuation of power from Tamakoshi Valley to India.

As Chief Engineer - Civil - for SN Power, he is responsible for projects and construction aspects of its greenfield projects globally. He is currently a member of the Board of Directors of Himel Power Ltd., which owns and operates the 60MW Khimti Power Plant. Prior to this assignment, he was General Manager of the Bhote Koshi Power Company, which owns and operates the 45MW Upper Bhote Koshi hydropower plant in Nepal representing Panda Energy International, Inc. of USA. As President of the Independent Power Producers' Association, Nepal (IPPAN) since January 2001 till September 2010, Dr. Shah has contributed considerably to formulation of power sector policies, acts, regulations and has participated in various national and international forums for power sector reforms, introduction of legal and regulatory framework, transmission interconnections, development of electricity markets, optimization of hydropower plants for maximum water resource utilization with minimum environmental impacts, carbon emission trading, etc.. He has been a strong advocate of private investments in the hydropower sector in Nepal and for promotion of project finance and energy markets. He has been instrumental in advocating for establishment of cross-border transmission lines to India and for formalizing a Power Trade Agreement with India for access to the electricity market in India. As IPPAN President, he was key to organizing the Power Summits 2006, 2007, 2008 and Hydropower Convention 2009 and 2011 to attract foreign investment in Nepal's hydropower sector.

Cross-Border Electricity Trade between Nepal and India

Issues and Challenges

Dr. Sandip Shah

Historically, there has been limited amount of electricity exchange between Nepal and India at 14 points along the international border at low capacity. A Power Exchange Agreement was signed between Nepal and India in the 1990s for exchange of upto 150 MW, but this is currently limited to appx. 50MW, and any additional volume is to be supplied on the basis of trade.

Since the 2000s, NEA and the private sector have been exploring various possibilities of trading electricity with India. NEA's attention is more focused on short to medium term imports followed by exports once the projects in pipeline are commissioned. Private sector's efforts, especially after 2006, have been to develop medium to large projects primarily for exports with possibilities of domestic supply as well. Several issues and challenges exist in this process:

1. Political consensus in Nepal on how its hydropower resources are to be developed;
2. Acceptance of electricity as a tradable commodity;
3. Realization that, in the absence of prospects of further value addition to the product, electricity is the product to be traded;
4. Notion of complementarities of demand and supply between the two countries;
5. Move towards deregulated electricity market;
6. Regulatory Approvals and Techno-economic clearances;
7. High capacity cross-border transmission lines;
8. Open Access on transmission lines;
9. Congestion in transmission capacity;
10. Grid synchronization;
11. Peaking benefits of hydropower in a blended-supply market;
12. Affordability of end consumers;
13. Financial health of Electricity Board and Discoms;
14. Electricity treated as restricted commodity in India – tariff and non-tariff barriers;
15. Nodal Agency for trading of power;
16. Project financing – high country risk and market premium;
17. Majority of the transactions are brokerage deals, real trading is minimal but increasing.
18. Power Trade Agreement;
19. Power Trading Agency in Nepal;
20. Geopolitics of the Region.

For power trading to happen for economic development of the countries, these issues need to be addressed urgently.

Chandan Kumar Ghosh, (M.E. Power)*Assistant Manager,**Nepal India Electricity Transmission and Trade Project**Nepal Electricity Authority*

Mr. Chandan career in NEA started in October 2000. He joined as an Electrical Engineer Level-7 and as a Distribution Engineer in Bhaktapur Power Distribution Centre, a company of the Kathmandu Mid Directorate of the NEA Distribution and Consumer Services. In October 2004, he got an opportunity



to work as a Distribution Engineer in Kathmandu North Power Distribution Centre, under the same directorate. From year 2004 to year 2006, He was involved in operation and maintenance of Hydropower plants and transmission lines of the Nepalese Grid.

He had over Nine years experience in Electricity generation, transmission and distribution in various utilities of Nepal, operation and maintenance of Hydropower Plants of the ranges between 20 and 144 MW, operation and maintenance of Transmission Lines, design and construction management of Transmission lines, associated switchgears and substations.

Presently he is working as an Assistant Manager in *Hetuada-Dhalekbar-Duhabi 400 kV Transmission Line Project under the Nepal-India Electricity Transmission & Trade Project* funded by the World Bank.

Appropriate Market Structure of Regional Integration, Pool and Exchange

Chandan Kumar Ghosh, (M.E. Power)

&

Hitendra Dev Shakya, (M.E. Power)

Director,

Nepal Electricity Authority

This paper presents the factors which should be considered by a Hydro-developing Nation such as Nepal, on the basis of which, Nepal can utilize its Natural Resources as well as contribute in the regional exchange of energy. A market totally conducive for thermal or other sources of power may not be equally favorable for Hydro Generation. Thermal Power Plants have a characteristic to provide a solid base load. With a favourable coal linkage, the generation is mostly constant. Hydro Generation however fluctuates as per seasonal discharge in rivers and also as per demand. Thus a system with a mix of such generation is stable and strong and thus market of energy produced from a hydro has an important stake in a Power Market. To tap the huge hydropotential of a hydro-rich country like Nepal, the market should encourage production of a major portion through hydro, whose energy is economical, has an environment friendly characteristic, a flexibility in generation, but also has a high gestation period and an associated market risk.

Nepal and its Hydro characteristics for the Market

Nepal has mostly hydro installations for its power needs. Due to its vast hydro potential, Nepal is considered one of the most gifted nations of the world. However Hydro Stations are highly capital intensive. Hence, Run-of-river type of Hydro power stations are popular among developers. Peaking Run-of-River type of Hydropower stations are the new choice in Nepal due to the load curve of the country. Majority of the hydro-stations are ROR type. New upcoming hydros are based on the ROR scheme with some Peaking Storage as well. There are less Storage type Hydro Power Stations in Nepal.

The demand for energy is soaring high in South Asia. Hence, there is a good chance for Private or Public Sector to enter the market.

Characteristics of a ROR:

There is no Storage in a ROR type of Hydro Station. The drawback henceforth is that such a station cannot exploit the advantage of the demand and pricing of a free market. ROR type of stations need to sell its energy in realtime, or spill it, in case it does not find the market. Hence, it requires a Long term Contract, especially a Take-or-pay Contract or monthly energy contract or a suitable scheme designed for it to enter the market and to hedge its risk for the spill.

Considering the most economical range of investment and to optimize cost, Investment in ROR type with a small pondage for Some Peaking Capacity should be encouraged. The system should also have some Storage type projects for Seasonal deficit balance.

Market Design should provide price signals such that investment in capacity increase is encouraged. One proposed formulation is pricing capacity reserve. This gives signal to developers to go for PROR that ROR.

Characteristic of Nepalese Load Curve is such that the Peak Load is nearly double of the Base Load. The duration of peak load is normally 3 hours in the evening and a few hours in the morning. The curve does not vary much from Winter to Summer. The Demand remains almost the same during Summer and Winter. But the supply changes proportionately with the river discharges. The Market Design is such that it addresses this issue.

Pricing of Energy whether traded in Winter or in Summer across the border should have same pricing mechanism. It can be started by a barter system with additional surcharge for every transaction. The barter system should be based on committed power and not surplus power. The cost of committed power is high in comparison to surplus power. Surplus power could be sold in a spot market as per commercial tariff.

To Maintain reliability and quality of supply on an interconnected transmission system, reserves of real power and reactive power are required. They must be strategically located around the network as well. Peaking ROR ramps up production during sudden surges in Power Demand. This was also proven during the recent blackout in India. In the worst case, during dire emergency of a system shutdown, a self-start (called 'black-start') capability is required. If the market does not have a standby 'reactive market' or a 'black start mechanism', it needs to purchase or outsource and subsequently charge to system users on some equitable basis. Hydropower can be revived quickly.

Ancillary Services 1: Black Start Capability

Ancillary Services such as Black Start should also be priced. If Hydropower has such an advantage, the market should be designed in such a way that it rewards the advantage. The reserve capacity of a hydro station is usable in 1 or 2 mins, whereas for a thermal, it can take a half a day and for Diesel, 15 to 20 minutes at a minimum. Hence the reserve capacity of a Hydro station should be priced higher in comparison to other sources.

Ancillary Services 2 : Reactive Power (Voltage Support)

Voltage Support through reactive Power Generation by power plants can come at the cost of energy generation, ie, cost of fuel. Market should encourage production of reactive power production. UI and ABT based mechanisms instead of SPOT market could be a temporary measure before Market establishment.

Ancillary Service 3 : Standing Reserve

The market should encourage establishment of unsynchronized, fast start-up plant (hydro, gas turbine) whose energy can be made available within 5 min or less. Hydro has a typical characteristics of a start-up time of less than 2 mins and a minute in average. Demand reduction as per operator's instruction can also be used in this category.

Ancillary Service 4 : Replacement Reserve

The market should also encourage establishment of plants that can be brought into service with longer notice in the event of a shortfall in standing reserve. This could be termed hot standby plant or deferred-start plant, designated by System Operator.

Ancillary Service 5 : Spinning Reserve Margin

Market should have provision for a fast-response capability of a partially loaded synchronized generators to check any sudden frequency change due to loss of any generation from a station. The response time should be as less as possible to manage the system surge averting collapses.

Nodal Pricing Mechanisms and costing transmission and distribution access:

There are many cross border points between India and Nepal. Likewise there could be many between India and Bangladesh and so on between other bordering countries. The regional price can be different. For example, the cost of energy in North-East India could be cheaper in comparison to the Eastern of Central Region. The solution to the problem is a Nodal Pricing Mechanism. It takes care of the Transmission Postage Stamps (fixed surcharges).

Likewise, price needs to be increased in congested transmission lines

Contingency Optimization:

If one line of a generating station trips, there should be reserve capacity of generation or transmission. Pricing Signals for reserve capacity and transmission capacity should be considered while designing a market.

Mr. Satish Joshi
Investment Board, Nepal

Mr. Satish Joshi is a Project Finance & Management specialist working at the Investment Board Nepal. He has an undergraduate degree in Finance and Mathematics from the US, and is a FA charter holder. Before joining the Investment Board, he worked in the US for Pattern Energy and Babcock and Brown in the Renewable Energy & Transmission sector principally



focused on utility scale wind power development. His work focused on the structuring of RE energy projects that sought to optimize the efficient use of tax incentives. He led the analysis and optimization of the first leveraged Special Allocation Partnership for a 283 MW wind project in the US and one of the first private bond placement transaction for a 101MW, US\$ 200million project in California in almost 20yrs.

Mr. Joshi has worked for the Investment Board Nepal (IBN) since in inception in December 2011. At the IBN, he is involved in the Board's Hydropower initiatives primarily working on the development and negotiation of Project Development Agreements with the developers of four export oriented HEPs, and is also leading the interactions with CWEI on the West Seti storage project. Given the export component of these projects Mr. Joshi has also been involved in working with the GoN on a pushing forward the Power Trade Agreement agenda with India.

Regional Power Sector Integration – South Asia

Opportunities and Barriers to RPSI, and Modalities from International Experience

Satish N. Joshi

Developing countries are pursuing regional power sector integration (RPSI) as a strategy to help provide reliable, affordable electricity to their citizens. The benefits of RPSI are numerous – increased trade, enhanced energy security, optimal utilization of resources, economies of scale in investments, synergistic sharing of complementary resources, reduced environmental impacts and numerous system operation benefits.

Tremendous opportunities for trade in the region notwithstanding, progress in this sphere has been dismal in the region, but recent signs are encouraging, with bilateral trade between Bhutan and India being a notable exception. So what are the barriers and risk to electricity trade in the region that has held up progress in the region? The regional players will have to understand the risks in Cross Border Trade, Governance of Trade arrangements and Institutional frameworks. Evolution of regional trade arrangements occurs in incremental steps over several decades, but invariably requires political will translated into action and firm commitment from the dominant player in the Region. Given India's location and its dominance in the region from geopolitics to economics, the necessary pre-condition to flourishing cross border trade in the region will be the facilitating role that India can play.

International experience of national and regional trading arrangements provides a helpful guide on charting a road map for Regional Power Sector Integration in South Asia. The transformation of well-developed regional trade has been a result of an evolution over several decades and drawing on international experience and its relevance to the region is germane to how South Asia charts its path towards regional integration. Progress on some bilateral interconnections projects are encouraging signs but much needs to be done and will depend on the catalytic role India plays going forward.

Mr. Shanker Krishna Khagi

Country Coordinator of SARI/Energy – Nepal, USAID



Mr. Shanker Krishna Khagi is Country Coordinator of SARI/Energy USAID. USAID is the lead U.S. government agency providing development and humanitarian assistance to people around the world. The USAID/SARI/Energy program promotes energy security in South Asia through three focus areas: cross border energy trade, energy market formation, and regional clean energy development.

Through these activities SARI/Energy facilitates more efficient regional energy resource utilization, works toward transparent and profitable energy practices, mitigates the environmental impacts of energy production, and increases regional access to energy. SARI/Energy countries include: Afghanistan, Pakistan, India, Nepal, Bhutan, Bangladesh, Sri Lanka and the Maldives.

Mr. Khagi presented various papers in national and international forum and he strongly advocate for the regional transmission interconnection and power trade.

**USAID's South Asia Regional Initiative for Energy Integration (SARI/EI)-
supporting Cross Border Energy Trade in South Asia**

Mr. Shanker Krishna Khagi

Over the last two decades South Asia (SA) has been one of the fastest growing regions in the world, with an average annual growth rate of 6% as measured by GDP per capita. Yet despite this impressive macroeconomic growth, the energy sector in the region has not been able to keep pace, and continues to experience chronic problems of shortage of supply and poor quality of service. In order to meet the rising energy demands South Asian governments have increased their reliance on oil imports, to the effect that all the countries without exception rely on these supplies to meet more than a quarter of their commercial energy needs. The South Asian nations should capitalize on the complementarities of their resource base and energy needs. Despite tremendous benefits to be derived out of regional co-operation, the region has had limited energy cooperate on in the past. Limited cross-border transmission interconnections and cross-border trading transactions are taking place only between India and Bhutan and to a lesser extent between India and Nepal. It lags significantly behind most if not all regions of the world in energy trade and regional integration.

The South Asia Regional Initiative for Energy Integration (SARI/EI) program is a regional energy program of USAID covering eight countries of the region: Afghanistan, Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan, and Sri Lanka. Started in the year 2000, the program has consistently strived for promotion of energy security in the South Asian nations.

The SARI/EI program has entered into its fourth and final phase, in October 2012, for next five years. The project goal is to advance regional energy integration and its project purpose is to increase cross border energy trade through focus on the following three components:

1. Harmonization of Policy, Legal, and Regulatory mechanisms
2. Advancement of Transmission Systems Interconnections
3. Establishment of a South Asia Regional Electricity Market

SARI/EI will form a Project Steering Committee (PSC), to provide overall strategic directions to the program. It will build consensus, ensure buy-in and help coordinate activities and programs of national and regional stakeholders. The PSC comprises of members from the individual SARI/EI countries as well as those from the regional association like SAARC and donors like ADB and World Bank.

It is envisaged that the program would catalyze enabling systemic conditions for regional energy integration through the formation and support to three Task Forces (TFs) focusing on the three aforementioned components, supported by SARI/EI in partnership with its implementing partners and country governments. SARI/EI is implemented through a cooperative grant agreement with Integrated Research and Action for Development (IRADe), a New Delhi based institution.

6th Japan-SAARC Energy Symposium **March 6-7, 2013, Kathmandu, Nepal**

Recommendations:

The 6th Japan-SAARC Energy Symposium was organized by the Ministry of Foreign Affairs, Government of Japan in partnership with the Nepal Electricity Authority (NEA) on March 6-7, 2013 in Kathmandu, Nepal. The theme of the symposium was “Commercially Viable Energy Networking in the SAARC Region, with Emphasis on Energy Grid Structure”. The symposium was inaugurated by Mr. Leela Mani Paudyal, Chief Secretary of the Government of Nepal and Chairman of NEA. In addition to the participants from Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal and Sri Lanka, the symposium was attended by the SAARC Secretariat, SAARC Energy Centre, Asian Development Bank, USAID, Ambassadors and diplomats from the SAARC Member Countries and other organizations based in Kathmandu. Presentations were made by the experts from the SAARC Member countries, SAARC Energy Centre, the ADB, USAID and SN Power Holdings Singapore Pte. Ltd. during the four sessions held over the period of two days.

The benefits of regional resource development and grid integration for electricity trade to enhance reliability, security and affordability of supply to the end-users was clearly brought out during the various deliberations in the symposium.

After the detailed deliberations, a consensus was arrived at submitting the following recommendations to the SAARC Secretariat for the consideration of Member countries.

1. Augmentation of Generation and Transmission Capacities:

The symposium recognized that the generation and transmission capacity additions planned by member countries are aimed at meeting their own electricity requirements. However, Bhutan and Nepal have the interest to export surplus hydroelectric power. It was felt that there is urgent need to make substantial generation capacity additions through the implementation of Regional Power Plants to make energy available for the SAARC Electricity Market (SEM). The required transmission capacity additions to support the wheeling of energy traded through the SEM too need to be laid.

2. Incorporation of necessary Provisions in Electricity Laws and Regulations:

The prevailing electricity laws and regulations of only Bhutan and Nepal provides for cross border electricity trade. Other countries need to make necessary changes in their electricity laws and regulations to permit and facilitate cross border electricity trade.

3. Harmonization of Technical Parameters:

In order to help smooth trading of electricity across the South Asia Region and creation of a commercially viable South Asian Electricity Market, there is a need to harmonize power system technical parameters and operational procedures by the Member States.

4. Commercial Arrangements:

There is need for evolving standard commercial arrangements, including payment security mechanisms for smooth cross border electricity trade.

5. Open Access on Transmission Systems:

The key to the success for electricity trade within the region is to permit open access on transmission systems, both cross-border as well as trunk domestic transmission systems to allow energy flows from one country to the other or to a third country.

6. Transit Facilitation:

Electricity flows in the region will have to transcend the borders of one or more countries to reach the load centers from the generation facilities. The examples could be the power imports by Pakistan and India or any country in South Asia from Central Asia; similarly from Bhutan or Nepal to Afghanistan, Bangladesh, Pakistan or Sri Lanka. The Member States, therefore, need to evolve a mechanism of facilitating transit of energy flows through their respective territories for electricity flows between two or more third countries. This could include permitting the laying of dedicated transmission systems and/or use of any redundancies in the existing transmission systems of a transit country for the purpose of third country electricity trade.

The symposium acknowledged the contribution of the Government of Japan and requested them to continue with the Japan-SAARC Energy Symposia initiative for enhanced regional energy cooperation in South Asia. Ministry of Foreign Affairs, Government of Japan in consultation with the SAARC Energy Centre may plan and implement the future Japan-SAARC Energy Symposia in collaboration with relevant local institution of the member countries.

These recommendations have been adopted unanimously by the participants from the SAARC Member countries and are hereby submitted for the consideration of SAARC Secretariat for appropriate actions.

Organizing Committee

Chairman: Mr. Rameshwar Yadav

Managing Director

Nepal Electricity Authority (NEA)

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Observer

	Name	Designation
1	Mr. Shuich Sakakibara	Deputy Chief of Mission, Embassy of Japan
2	Mr. Hisashi Hoshino	First Secretary, Embassy of Japan
3	Mr. Kailash Man Pradhan	Program Manager, Embassy of Japan
4	Mr. Yoshiyuki Ozaki	Energy Expert, JICA

Note: All the two day activities are found in the website: <http://nea.org.np/neademo/nea.php>

Appendix

Appendix I

Presentations

Issues and counter-measures related to the status of the power supply in SAARC countries

March 6, 2013

Professor Shigeru Sudo
Department of Business Management
Teikyo Heisei University

Three topics in the presentation

- I . The actual state of the power industry in India
- II . The problems being faced by SAARC countries
- III . The counter-measures which must be taken
in SAARC countries.

I . Power industry in India

Electric power conditions in India may be summarized in the following;

(1) While power demand has been on the increase, power supply is unable to catch up with it.

(2) Apart from technical losses in the process of power transmission and distribution, power theft is also a major loss factor.

(3) Due to high economic/population growth rate, India's primary energy consumption is expected to grow by 3.9% annually from 0.524 billion tons (coal equivalent) in 2010 to 1.376 billion (coal equivalent) in 2035.

(4) As of January 2012, 20 nuclear power reactors with a total power capacity of 4.78 million kW are in operation. The Indian Government has been implementing active plans to construct nuclear power stations. It is intending to expand plant capacity by 7.9 times from 4.10 million kW in 2010 to 32.40 million kW in 2030.

Power Generation & Consumption in SAARC countries

		India	Pakistan	Bangladesh	Sri Lanka	Bhutan	Nepal	Afghanistan	Maldives
Net Generation	Billion kWh	904.13	89.6	39.78	10.4	7.23	3.17	0.99	0.3
	Rank	5	32	58	91	102	127	150	173
Net Consumption	Billion kWh	698.82	74.42	38.89	8.92	1.68	2.74	2.49	0.28
	Rank	5	36	54	91	147	130	135	178
Installed Capacity	GW	208.09	22.27	6.67	2.69	1.51	0.72	0.49	0.06
	Rank	5	33	70	88	112	128	137	177

II . Problems being faced by India in promoting its nuclear power plan

1. An important element in its plan is the targeted capacity of 32.40 million kW to be achieved by 2030.
2. Views of Japanese experts concerned are varied. However, their majority is of the view that two conditions must be met in order for this target to be achieved.
3. These two conditions relate firstly to probability of the eventual application of **the Civil Liability for Nuclear Damage Act (2010)** and secondly to the issue of **how to ensure public acceptance**.

III . Identification of problems and counter-measures to deal with them

Possible impacts on the South Asian economy in the event that India's nuclear power generation plan may not proceed as planned.

1. Since last year the situation has been continuing where the level of power supply remains below the level of peak-time power demand.
2. Efforts on the part of certain States to procure electricity at levels higher than predetermined from other States have aggravated the spread of domino-like adverse effects.
3. The lack of sufficient power generation capacity comes from the fact that investment in power plant construction does not catch up with rapidly expanding power demand.

Basic framework of the countermeasures

1. To promote the development of alternative power sources concurrently and in parallel with nuclear power development in India. In this connection, I would like to count upon Indian participants for further detailed comments. However, I myself believe that coal-fired thermal power generation could play the most important role in this respect.

2. To promote intra-regional pooling arrangements

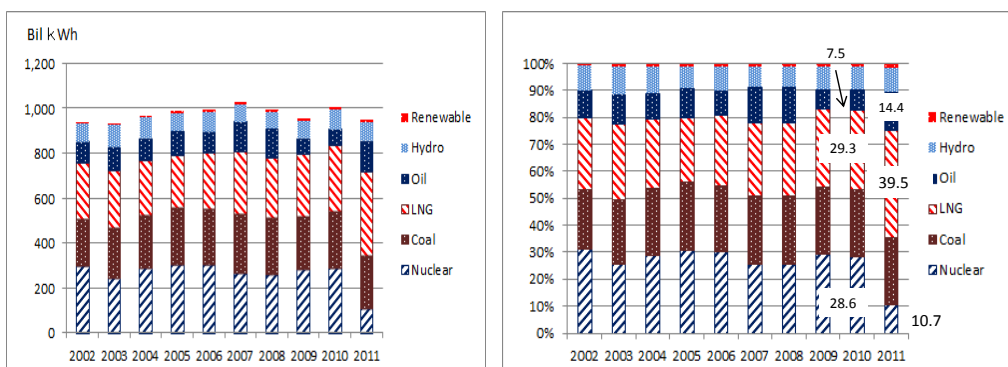
To what extent shall intra-regional pooling arrangements be considered to be possible? According to a macro (country-by-country basis) analysis, rates of reserve in power supplies in each country seem not to be high.

However, more detailed studies will be warranted to find what sort of overall picture can be drawn by way of a more detailed region-by-region analysis.

3. Possibility of extra-regional cooperative arrangements

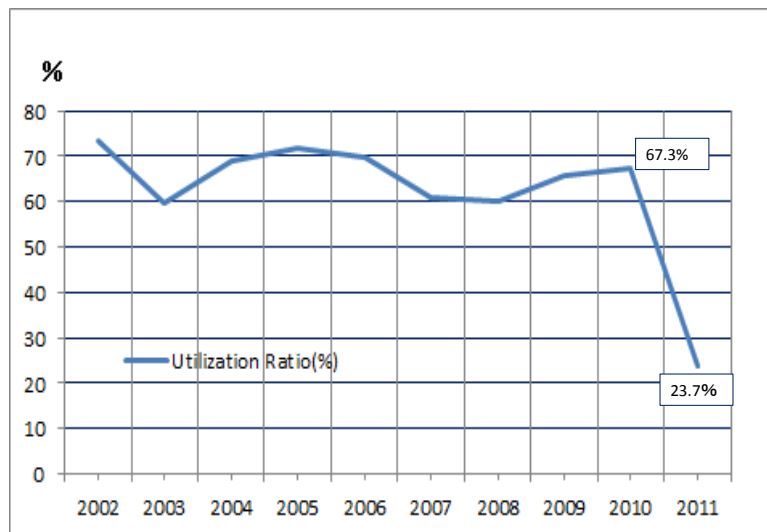
The third point for consideration is to work out extra-regional cooperative arrangements as an exponential measure of intra-regional arrangements.

Electric Power Generation by Energy Source in Japan



Source: "Federation of Electric Power Companies"

Utilization Ratio of Nuclear Power Plant



Source: "Federation of Electric Power Companies"

V. Relating basic questions

Question No1: Most important matter in keeping supply and demand balance

"Do you think that the most important matter in overcoming power shortages is the expansion of generation capacity?" Or "Do you think that what is the most important is power-pooling arrangements with neighboring countries?"

Question No.2: The possibility of regional cooperation

"Do you have any concrete plan for promoting power pooling arrangements?"

"Do you have any plan for making more effective use of the existing transmission systems within the region?"

Question No.3 : Regional cooperation:

"Is there any example of regional cooperation in the field of financial cooperation?"

Proposed objectives of CASA1000

- The objective of the Project is to promote clean hydroelectricity exports from Tajikistan and the Kyrgyz Republic to Afghanistan and Pakistan.
- The project outcome will be measured by the amount of electricity (in Gigawatt-hours) exported via the transmission system to be constructed under the Project.

Source: World Bank "PROJECT INFORMATION DOCUMENT CONCEPT STAGE Report No.70560 "

Preliminary description of CASA1000

The CASA-1000 Project would comprise of:

- (a) around 750 km High Voltage Direct Current (DC) transmission system between Tajikistan and Pakistan via Afghanistan;
- (b) a DC to Alternate Current (AC) converter station in Kabul to supply Kabul area;
- (c) an AC transmission link between the Kyrgyz Republic and Tajikistan to supply the Kyrgyz electricity to South Asia via Tajikistan;
- (d) the concomitant institutional and legal framework to enable such electricity trade.

Tentative financing source: To be determined

Approximately 950 US\$ million

Source: World Bank "PROJECT INFORMATION DOCUMENT CONCEPT STAGE Report No.70560 "

Synchronization issues in Regional Interconnection

Presentation in the
6th Japan-SAARC Energy Symposium

Theme: *Commercially viable Energy Networking in the SAARC Region,
with Emphasis on Energy Grid Structure.*

Outline of the Presentation

- Choice of Inter-connection: Asynchronous (DC) vs Synchronous Interconnection (AC)
- Voltage (regulation & vector group)
- Frequency (variation regulation)
- Thermal Limit of Line (conductor type)
- Stability of Line (V_s , V_r , δ , X)
- Communication (OPGW, SCADA) & Coordination Protocol (language, regulating norms/standards, telemetering)
- Volume and likely direction of power flow
- Interconnecting points, Type of towers/circuits for reliability
- Relay and Protection coordination.

Technical choice of DC vs AC inter-connection

- DC interconnection is preferred if AC system frequency is different between the interconnection points. Sometimes, it is desirable to wholly isolate/insulate from AC induced grid disturbances and other joint control measures even in the common AC 50 Hz system by DC back to back interconnection.
- For under sea (submarine) connection and especially if the volume of power to be transacted is very large and meant for a long distance transfer, definitely DC Economics work out better.
- However, initial capital cost, future O&M cost as well as the institutional capacity to plan, design, operate and maintain the HV DC technology (especially terminal plant and equipment) could be a constraining factor in the final choice between the systems especially if the line distance for large power transfer between two points is less than 400 miles. Final decision should be based on Cost, Benefit and Risks/rewards that we are willing to take.
- This becomes an **issue of matter of choice** especially in a bi-lateral inter-connection when lot of time is often spent on sorting out the differences of opinion among experts (economist vs engineer).

Voltage, regulation & vector group

- SAARC countries have adopted their own AC Voltage standards even though all are 50 Hz power system. For inter-connection, harmonization of voltage standard itself sometimes become an issue (why should I change attitude !)
- System Voltage regulation in general is 5-10% of nominal value and is maintained to avoid system voltage collapse and damage to customer loads. Local country specific requirement and tolerance limit differ !
- Reactive compensators (Capacitors in series and shunts, inductors in shunt) are employed to maintain the voltage within permissible limit of regulation at the sending and receiving ends. While auto-transformers are mostly deployed for voltage regulation, FACTS (Flexible AC Transmission System) are deployed in Large long distant and complicated inter-connections to improve grid stability and voltage regulation.
- If the inter-connection between two grids is at Multiple voltage levels, it will require both the grid interconnections to have identical vector groups for the ICT between these two voltages or additional phase-correction transformers would be necessary.
- **Sometimes voltage regulation becomes an issue, when and which side is not sure who will put up the voltage regulating device and where.** This needs to be planned, designed and incorporated appropriately at the System planning and design stage in the beginning along with appropriate codal norms and prior to inter-connection to avoid operation problem later.

Grid Frequency regulation and Grid Code

- Although 50 Hz is the AC Power frequency adopted by all SAARC countries, each country's Grid Code may be allowing variation as much as upto +/- 3% depending upon the country specific system requirement and tolerance limit of the connected plant, equipment, consumer appliances and the System Grid discipline.
- Each country has its own Grid Code and governing regulation as per Electricity Act and Standard adopted. Electricity industry in each country is regulated by the Electricity Act. Code of Practice difference can thus pose a problem in the smooth operation of inter-connections. Harmonization of Grid code and Electricity Trade practices would be necessary through a Common South Asian Grid code under a SAARC Electricity Charter/ Electricity Trade Treaty, which is envisaged.
- For example, in India they have Availability Based Tariff (ABT) and Unscheduled Interchange (UI) mechanism, where frequency tolerance variation is used to measure the deviation in a 15 minutes block of monitoring; and generators and consumers are made to pay high charges if they deviate in their limit of injection/drawl schedule which affects the grid frequency and system stability; basically aimed at maintaining GRID Discipline !
- This frequency tolerance limit/regulation and Grid code harmonization can become **an issue** in synchronizing inter-connection between countries as **Frequency Control and Grid Code** is necessary to maintain Grid Discipline and Grid stability including the stable and sustainable international connection !

Thermal Limit Constraint of Inter-connection

- Capacity of Lines, Transformers as well as other Electrical Plant and Equipment is determined by Temperatures. Line Conductor ampacity loading varies with temperature (annealing problem, sagging problem)
- Transmission lines using ACSR conductors are now being designed for 85/90 degree centigrade temperature loading (HTLS for even 200 degree Celsius).
- Old lines used to be designed for only 75 degree Celsius maximum loading temperature of conductor.
- Due to global warming, ambient temperature is rising, we all know !
- Operation Issue arises during Monsoon peaking hydel generation & summer loading season as this System constraint issue arises and during line outage contingency condition during the season, where lines get over-loaded if spare capacity (n-1) is also out !
- **Issue arises when one side wants to put on load and other side does not agree because of this system constraint (eg SIL loading) in the inter-connection !**

Stability Limit issue

- Stability limit is determined by the max power flow in the line when the system remains synchronized even if a disturbance occurs. It is determined by the product of sending end V, receiving end V, sin delta divided by line reactance.
- Surge impedance loading (SIL) is a consideration if the inter-connecting line and power transfer is over long distances in A/C synchronous mode of operation.
- Major grid disturbances and Failures are caused by violation of stability limits in the lines. For example, report on 30/31 July 2012 Major Grid Failure in WR-NR-ER-NER of India mentioned "Load encroachment and relay operation on zone 3 protection" and "power swings" being some of the main technical causes of grid failures.
- **This can become a major issue during the interconnected operation of the Grid if such technical aspects on "system stability" are compromised and not properly taken care of during the planning, design stage and system operation stage ! Maintaining grid discipline is difficult task for the Transmission System Operator.**

Loop and Parallel Path flows during fault conditions

- Electron sometimes does not flow as planned and designed as it finds its own "short-circuit" path to complete its journey and accounting of energy becomes complex and difficult in that case, especially during abnormal contingency conditions (line outage and grid disturbance and faults). Power flows start in unwanted paths and disturb PPA/SLA agreement conditions and Independent System Operators(ISO) are blamed by the parties. Sometimes it triggers a major Grid failure as "**power swings**" trip the interconnections! Blame game starts and Social Media can make it an international issue !
- This may become a sensitive issue and understanding of all concerned are required to deal in such a situation through policy as well as dove-tailed Technical Standardization and consistent System Studies (load flow and stability) to make the parties responsible and disciplined.

System Operation & Coordination

- It is necessary to establish operational protocols between various grids. In addition, even the protection & control system communication protocols (SCADA) may also be necessary for seamless communication of grid information.
- Individual grid and interconnected grid operations could have conflicting requirements and this needs to be addressed.
- Protection system requirements need to be addressed, since the line parameters for cross-border lines could be different due to different tower configurations, the ampacity limitations due to different ambient conditions.

System Operation & Coordination

- Metering and Billing systems shall duly consider the policy decisions. In addition, the wheeling principles for cross-border trade need to duly consider operational limitations and possible 'vested interest' in wheeling through maximum revenue generating path. [Should the wheeling be a fixed rate / fixed rate per km per unit, based on energy received by the importer and who will pay for the losses etc.?].
- If the internal systems of one grid need additional investments to meet the external requirements, the same need to be duly considered for cost recovery.

System Operation & Coordination

- The issues of transparency in data exchange need to be considered. What data is required to be sent to the multiple grid operators on-line and accessible across-board.
- Power systems, being mostly under regulatory mechanism, the internal and external regulatory requirements need to be met with and synchronised with Common grid code to be agreed upon.

Summary

The various issues, in summary can be classified as

- Basic Issues (Voltage, frequency, phasor matching)
- Inter-grid communication Issues (both technical and policy protocol requirements)
- Internal Security Mechanisms (Safeguarding the internal systems from external disturbances and the necessity to ensure transient response and protection)
- Impact of non-uniform standards (effect on line parameters, thermal capacity of cross-border transmission lines etc.)
- Technical vs Policy issues (Billing, Metering and Wheeling related issues)
- Internal and External Regulatory Issues

Concluding remarks

- The Hard work and efforts that we , the committed electricity handlers put in for integrated grid development and Power system operation for the benefits of mankind are often challenged and questioned especially during major grid failures. Just one minor fault or small unforeseen error can cause the Grid to collapse and customers only point finger at us and we should be always aware of this, because our stakeholders don't understand the complexity of electricity and its operation! They just want the "electricity service", no matter whether it is sun, rain, snow, wind, typhoon and earthquake or tsunami or any force majeure condition! They just don't care ! That's the reality of life situation, we face!
- We should know that and be always prepared for any eventuality and we should not compromise on costs for acquiring knowledge, skills and experience in system planning, design, construction, operation and including system studies for stability, fault analysis and relay & protection coordination. Power system managers and engineers therefore need to think, plan and work always to be "smart" and adopt **smartgrid** management techniques all the while for this purpose !
- Periodic review of both technical and policy matters need to be taken up through appropriate forums such as TCC, OCC, PCC, SCC etc. for overall enhanced inter-grid operation.
- **This networking is an great opportunity to share the experiences through such dialogue for initiating Transmission Utility Forum.**

End of Presentation

THANK YOU

Possible Trans-boundary Inter-connections : Pools likely





POWER MARKET IN SAARC: IN BANGLADESH PERSPECTIVES

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Organised by:

The Nepal Electricity Authority (NEA), and ADB, Funded by
The Ministry of Foreign Affairs of Japan



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WELCOME TO POWER MARKET IN SAARC

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POWER MARKET IN SAARC: IN BANGLADESH PERSPECTIVES

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Energy and economic development are interlinked and the quality of life achieved in a community or a country can be assessed from the amount of energy (per capita) it consumes. This approach is more appropriate for societies where the production and distribution of energy are secured and widely spread.

Power Market in SAARC member countries deals with the integration of the (possible excess) generating power stations, development of transmission, distribution and load management up to consumers' points. It also needs to upgradation of power generation/distribution and long distance transmission grids in order to reduce the losses, as well as, open up new power markets/trades for all possible power productions.

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Though the integrated regional power grid is a very complex system, but some of the benefits of such a modernized integrated power market electricity network are :

- (i) ability to reduce load shedding/blackout at the consumer side during peak hours, namely demand side management;
- (ii) to enable grid connection of distributed generation power with all possible alternative power sources;
- (iii) to incorporate grid energy storage for distributed generation load balancing;
- (iv) to eliminate failures, such as, widespread power grid cascading failures, and
- (v) to increase efficiency and reliability of the integrated power systems among SAARC member countries [2,3,4].

As per election manifesto of the present GoB, electricity generation would be increased from 4000 MW to 7000 MW by the year 2013 (already increased to 8525 MW, by December 2012), 8000 MW by 2015 and 20,000 MW by 2021.

1. At present only 60% of the people have direct access to electricity. Per capita generation is 292 kWh.
2. Every year the demand is increasing at a rate of 12%.
3. The government's vision: To build 'Digital Bangladesh' Electricity for all by 2021.

In the paper I have discussed on

- I. Bangladesh (BD) Power System: Present and Future Projections
- II. Long Term Generation Plan (2010-2013)
- III. Challenges of Power Sector Development.
- IV. Cost Structure of Electricity, Tariff and Budgetary Support.
- V. Road Map for Coal Power Development (as of 2030).
- VI. Nuclear Power Plant: Inter Government Agreement.
- VII. Power Market in SAARC Member Countries.
- VIII. Challenges of Regional Integrated Power System.
- IX. Goals of Integrated Power System.
- X. Regional Power Exchange: Possibilities.
- XI. Electricity Tariff(Res.& Agr.) in Neighboring Countries.

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Components of a Energy System : The Most Essential Components are shown as

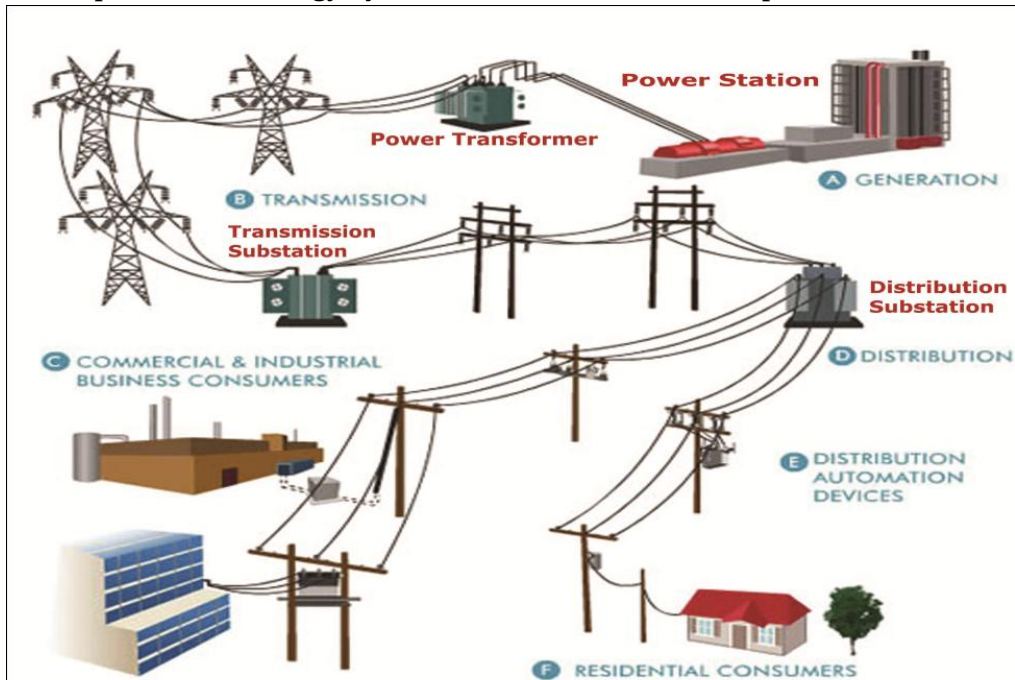


Figure : Components of a "Modern Energy System" Prof. Dr. Aminul Hogue 8
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Bangladesh Power System : Present and Future Projection

Background

BPDB has started its journey with the generation capacity of **200 MW on May 1, 1972**, presently which has reached to **8525 MW**. BPDB has been unbundled into transmission and a part of distribution. The **transmission** function has been vested upon Power Grid Company of Bangladesh (**PGCB**) while the **distribution** has been segregated into a number of entities, such as, Dhaka Power Distribution Company Limited (**DPDC**), Dhaka Electric Supply Company Limited (**DESCO**), West Zone Power Distribution Company Limited (**WZPDC**), Palli Biddyt Samiti (**PBS**) and BPDB itself.

Bangladesh's Ministry of Power, Energy and Mineral Resources (MPEMR) has overall responsibility for the country's energy sector, as shown in Figure 9.

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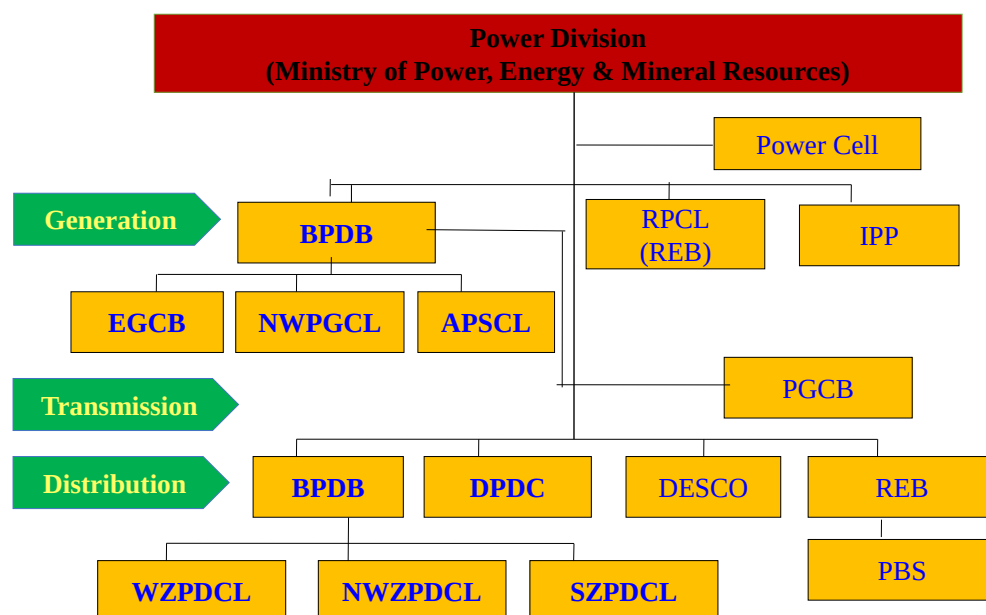


Figure 10 : Current Structure of Bangladesh Power Sector

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Power Sector at a Glance

Installed Capacity (Derated)	8525 MW
Demand(Summer)	7600 MW
Generation Capacity(Summer)	6000-6800 MW
Maximum Generation(August 04,2012)	6350 MW
Transmission Line(230 kV &132 kV)	8949 kM
Distribution Line(33 kV &below)	2,81,123 kM
Number of Consumers	13.5 Million
Access to Electricity(including renewable)	60%
Per Capita Power Generation(including private)	292 kWh

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Bangladesh Power System Perspectives

Present Infrastructure

Communication

- ❑ PGCB owns an optical fiber backbone network covering BPDB and major IPP owned power stations and all 230kV/132 kV/33 kV and 132kV/33 KV grid substations.
- ❑ Last mile fiber connectivity is offered by a number of BTRC approved private link providers.
- ❑ Mobile phone operators have wireless connectivity all over the country.

Metering

- ❑ Meters with AM/RM (automatic/remote metering) facilities have already been installed for a significant number of bulk consumers at 11 kV and 400 volts level.
- ❑ Prepayment meters are installed at selected areas for single phase consumers.

Distributed generation

- ❑ Very small sized (<100 W) PV panels are used in stand-alone mode at the off-grid sites.
- ❑ PV systems with roof top kW sized PV modules in urban sites near the grid are being installed.
- ❑ Directed the new urban consumers to install 3% of the connected load demand by their own PV panels to get grid utility supply connection.
- ❑ Captive generation plants with a total of about 800 MW are operated by some industries near the grid.

Limitations

Despite all the glorious benefits, the present power system also has some drawbacks. Some of the critical drawbacks are listed below-

- Large gap between dependable generation capacity and demand mainly due to inadequate supply of indigenous primary fuel and ageing generation units.
- Poor affordability of consumers to electrical appliances
- Cost reflective and real time pricing of electricity is difficult to be implemented for the majority consumers due to various reasons.
- Load shedding (blackout) possible only by switching off the feeders from the utility side.
- Lack of affordable and maintainable technology and significant quantity of surplus power from captive and urban site PV systems (with rooftop PV modules) for injection at the grid (132 or 230 kV) buses.

Long Term Generation Plan (2010-2030)

* Government has prepared a **Power System Master Plan 2010** (PSMP 2010). * According to the PSMP-2010, the maximum demand in 2015, 2021 and 2030 will be **10,000, 19,000 and 34,000 MW** respectively. * To meet the demand with reliability, installed capacity needs to be increased to **24,000 MW and 39,000 MW** by the year **2021 & 2030** respectively. * Generation capacity from **different primary fuel in the year 2030** would be:

- Domestic and imported coal based ST:19,650 MW
- Nuclear power:4,000 MW
- Gas and LNG:8,850 MW
- **Regional Grid:3,500 MW**
- Liquid fuel, Hydro, Renewable: 2,700 MW
- **Cross Boarder Trade with Neighboring countries.**

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Way Forward to Provide Electricity to All by 2021

Primary Fuel Supply

- Enhanced Gas Exploration, Production
- Domestic Coal development
- Coal and LNG Import and deep sea port for coal handling
- Safe Nuke for Base Load

Project Financing

- Ensuring financing for Public and Private sector projects
- Availability of foreign currency

Establishment of Regional Power Market

- Infrastructure for regional grid inter-connection
- Establishment of regional power market for power trade

Human Resources Development

- Development of skilled manpower: adopt and operate new technology
- Introduction of corporate culture and professionalism in sector entities

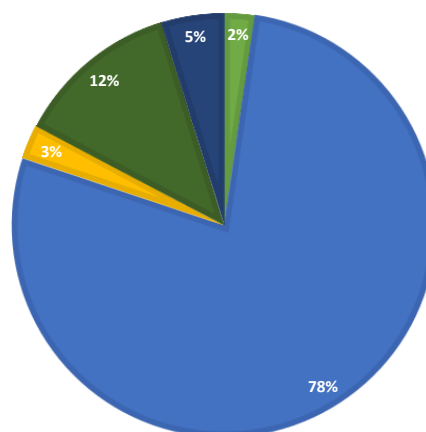
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Primary Fuel Supply Options

- **Gas:** Only 16 tcf proven reserve; No significant gas discovery in recent years; Depleting gas reserve restricts gas based generation expansion
- **Hydro:** Present capacity 230 MW and average energy generation- 800 GWh; No further significant potential
- **Coal:** Total 3.2 billion ton reserve in 5 mines; Near term option; Indigenous or Imported; Base Load
- **Oil:** Volatile market; High price; For peaking duty only
- **LNG:** Necessary to ensure secure and reliable gas supply
- **Nuclear:** Safe technology; No pollution; Future Base Load option
- **Renewable:** Present capacity only 70 MW; still high cost

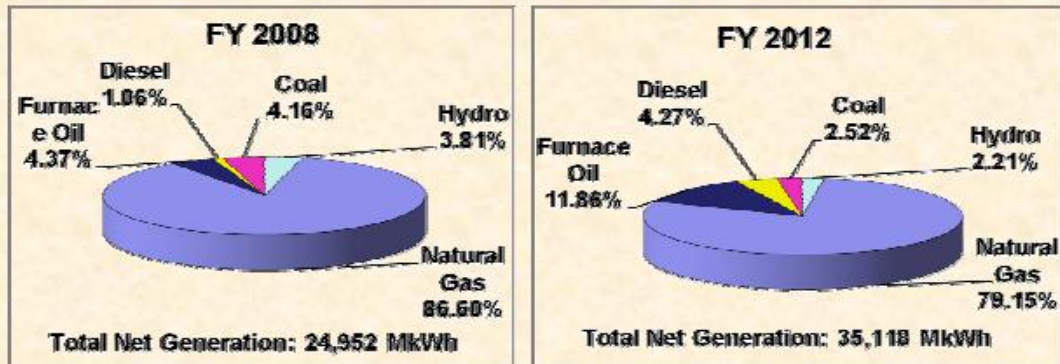
SHARE OF GENERATION

■ Hydro ■ Gas ■ Coal ■ Furnace Oil ■ Diesel



Source: Bangladesh Power Development Board, Generation Cost & Power Purchase Cost For the Year 2011-12 (Actual)

Energy Generation by Fuel Type in FY 2008 and FY 2012



- Energy Growth in 4 years is about 41 %
- High Dependence on Gas

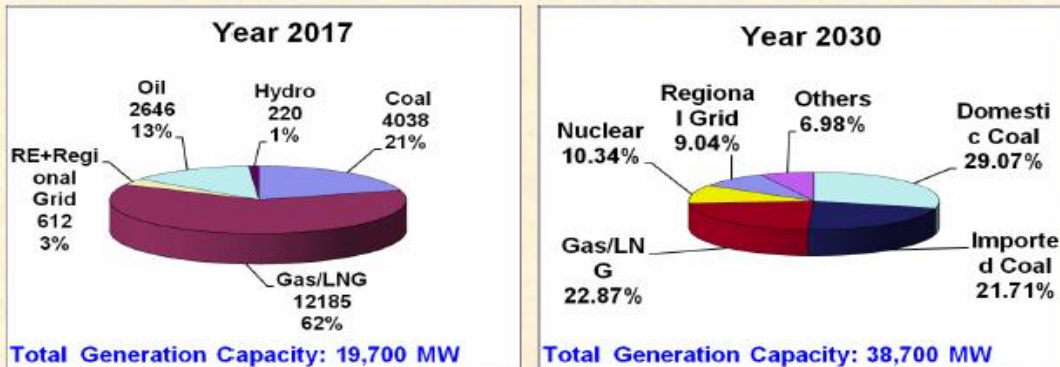
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Fuel Mix up to 2017

CY	Gas + LNG		Hydro		Coal (Dom + Imp)		Power Imp + Renewable		Oil		Total (MW)
	Capacity (MW)	%	Capacity (MW)	%	Capacity (MW)	%	Capacity (MW)	%	Capacity (MW)	%	
2011	5107	67%	220	3%	200	3%	0	0%	2086	27	7,600
2012	5730	67%	220	3%	200	2%	0	0%	2375	28	8,525
2013	6595	64%	220	2%	200	2%	500	5%	2722	27	10,237
2014	7490	64%	220	2%	200	2%	505	4%	3353	28	11,768
2015	9859	68%	220	2%	200	1%	612	4%	3578	25	14,469
2016	11435	68%	220	1%	1538	9%	612	4%	2946	18	16,751
2017	12185	62%	220	1%	4038	21%	612	3%	2646	13	19,701

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Probable Generation Capacity in 2017 & 2030: Fuel Type



Challenges in Power Sector Development

- Increased Cost of Production due to increased oil consumption and high price of imported oil
- Gas supply constraints
- Policy barrier for conducive investment environment (Tax, Vat, Governing Law etc)
- Delay in base load project implementation (coal and gas) and failure to achieve financial close of some large power projects
- Old aged plants and lack of it's proper maintenance
- Tariff adjustment and budgetary support

Cost Structure of Electricity, Tariff and Budgetary Support

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Table: Generation Cost per Unit

Generating Plant under Power Station	Generation Cost per Unit (Tk.)	Generating Plant under Power Station	Generation Cost per Unit (Tk.)
1.Karnafuli Hydro Power Station	0.90	15.Dohazari Peaking Power Plant	13.99
2.Baghabari Power Station	1.60	16.Faridpur Peaking Power Plant	14.45
3.Ghorashal Power Station	1.78	17.Gopalganj Peaking Power Plant	16.76
4.Chittagong Power Station, Rawzan	2.87	18.Daudkandi Peaking Power Plant	14.63
5.Shikalbaha Power Station	3.58	19.Bheramara Power Station	35.83
6.Kumergoan GT Power Station	5.33	20.Barisal GT Power Station	25.66
7.Sylhet 150MG Peaking Power Plant	0.20	21.Barisal Diesel Power Station	398.64
8.Fenchuganj 2*90 MW CCPP	1.46	22.Bhola Diesel Power Station	127.63
9.Shahjibajar Power Station	2.02	23.Sayedpur GT Power Station	24.74
10.Tongi Power Station	1.96	24.Kumudbia Diesel Generator	46.21
11.Chadpur Peaking Power Plant	0.66	25.Sandwip Diesel Generator	32.89
12.Barapukuria Power Station	6.52	26.Hatiya Diesel Generator	24.91
13.Khulna Power Station	23.55	27.Hathazari Peaking Power Plant	14.76
14.Baghabari 50 Peaking Power Plant	12.84	28.Bera Peaking Power Plant	15.11

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Table: Generation Cost per Unit (Continued)

Generating Plant under Power Station	Generation Cost per Unit (Tk.)	Generating Plant under Power Station	Generation Cost per Unit (Tk.)
29.SBU Haripur	2.80	54. Quantum Power Systems Ltd.(Vera.)	19.73
30.Ashugong Power Co. Ltd	1.91	55.R Z Power Ltd.	23.29
31.EGCB	2.24	56.Max Power	9.19
32.Rural Power Co. Ltd	3.32	57.Agreko Int. Projects Ltd. Ashugonj	5.34
33.Meghnaghat Power Ltd.	2.22	58. Aggreko Int. Projects Ltd. Baria	5.47
34.Haripur Power Ltd.	1.51	59. United Ashugonj Power Ltd..	4.69
35.Westmont Power(BD)	3.91	60. Aggreko Int. Projects Ltd. 145 MW	5.17
36.United Power Gen. & Dist. Co.	2.81	61 Summit Narayangonj Power Ltd.	15.56
37.NEPC Consortium Power Ltd.	18.82	62.IEL Consortium & Associates Ltd.	16.61
38.Khulna Power Co. Ltd.	16.13	63.KPCL-II	14.51
39.Doreen Power Gen. & Syst. Ltd, Tan	2.52	64.Khanjahan Ali Power Co.	15.46
40. Doreen Power Gen. & Syst. Ltd, Fen	2.31	65.Power PacMutiar Keranigonj	18.91
41.Regent Power Ltd.	2.38	66.Amnura-Sinha Ltd.	19.05
42.Summit Purbanchal Power Ltd.	2.63	67.Julda Ltd.	18.99
43.Energyprima Ltd., 50MW Kumargaon	3.54	68.Dutch Bangla Ltd.	15.46
44.Energyprima Ltd., 50MW Shahjibazar	3.54	69.Northern Power Ltd.	15.70
45.Desh Cambridge Kumargaon Power	3.03	70. Aggreko Int. Projects, Ghorasal 45MW	13.86
46.Shahjibazar Power Co. Ltd.	2.42	71. Aggreko Int. Projects, Khulna 55MW	21.51
47.GBB Power Ltd.	2.78	72. Aggreko Int. Projects, Ghora. 100MW	14.81
48.Venture Energy Resources Ltd.	5.88	73.Desh Energy Ltd.-100 MW Shiddhir.	20.25
49.Precision Energy Ltd.	3.57	74.DPA Power Gen. Ltd.	20.69
50.Barkatullah Electro Dynamics Ltd.	2.26	75.Agreko Int. Projects, Khulna(40MW)	20.24
51.Energyprima Ltd., 20MW Bogra	2.66	76.Energis Power Corporation	22.57
52.Energyprima Ltd., 50MW Fenchugonj	2.17	77.Total Quick Rental HSD	17.76
53. Quantum Power Systems Ltd. (Nowa.)	17.13	78.Grand Total Private	6.77

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ENERGY RATE (BERC)

Sl. No.	CLASS OF CUSTOMERS	Approved Rate: Taka/kWh
1	2	3
1	CLASS-A: DOMESTIC	
	1 st Step t 00-75 Unit	3.33
	2 nd Step t 76-200 Unit	4.73
	3 rd Step t 201-300 Unit	4.83
	4 th Step t 301-400 Unit	4.93
	5 th Step t 401-600 Unit	7.98
	6 th Step t 601 Unit above	9.38
2	CLASS B: Agriculture Pump	2.51
3	CLASS C: Small Industry	
	(A) FLAT	6.95
	(B) OFF-PEAK HOUR	5.96
	(C) PEAK HOUR	8.47
4	CLASS D: NON DOMESTIC LIGHT & ELECTRICITY	4.53

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	CLASS E: COMMERCIAL & OFFICE	
	(A) FLAT	9.00
	(B) OFF-PEAK HOUR	7.22
	(C) PEAK HOUR	11.85
	CLASS F: MEDIUM VOLTAGE GENERAL USE (11kV)	
	(A) FLAT	6.81
	(B) OFF-PEAK HOUR	5.96
	(C) PEAK HOUR	9.33
	CLASS G-2 :VERY HIGH VOLTAGE GENERAL USE (132kV)	
	(A) FLAT	6.16
	(B) OFF-PEAK PERIOD	5.57
	(C) PEAK HOUR	8.67
	CLASS H : HIGH VOLTAGE GENERAL USE (33kV)	
	(A) FLAT	6.48
	(B) OFF-PEAK HOUR	5.87
	(C) PEAK HOUR	9.14
	CLASS J: STREET LIGHT & WATER PUMP	6.48
Source: Bangladesh Energy Regulatory Commission, GoB, (Valid from 1 st Sept., 2012)		

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Tariff Adjustment

- Average Cost in FY 2012 : 5.35 Tk/kWh
- Average Cost in FY 2012 : 6.07 Tk/kWh
- Average Fuel Cost from Oil Base Plants:
 - 1) HSD – 15/16 Tk/kWh;
 - 2) FO – 13/ 14 Tk/kWh
- Bulk Tariff Increased
 - Av Bulk Tariff in 2009: 2.37 Tk/ kWh
 - Av Bulk Tariff in 2012(since Sep): 4.70 Tk/ kWh

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Cost of Supply at Different Level, Tariff & Gap

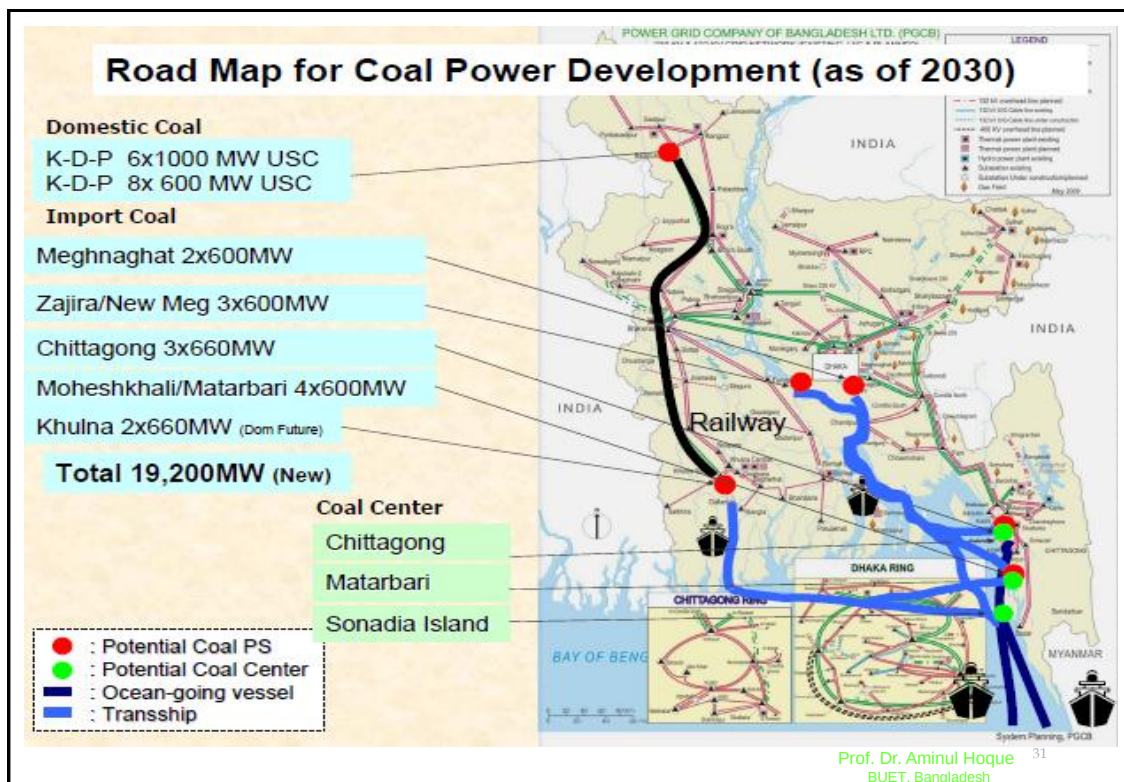
	Voltage Level	Cost of Supply		
		2010 – 2011	2011 – 2012	2012 – 2013 (Expected)
	Cost of Supply for Bulk (Utility)			
A	Generation (Net Gen)	4.057	5.16	5.85
B	Average (Bulk) Supply Cost	4.20	5.35	6.07
C	Bulk Tariff	2.61	4.02	4.70
D	Difference	1.59	1.33	1.37

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Probable Power Generation: Primary Fuel Sources by 2030

Sl. No.	Description	Capacity (MW)	Probable Location (s)
1	Domestic Coal	11,250	North West Region at Mine Mouth
2	Imported Coal	8,400	Chittagong and Khulna
3	Domestic Gas/LNG	8,850	Near Load Centers
4	Nuclear	4,000	Ruppur
5	Regional Grid	3,500	Bahrapur - Bheramara, Agartola - Comilla, Silchar - Fenchuganj, Purnia-Bogra, Myanmar - Chittagong
6	Others (Oil, Hydro and Renewable)	2,700	Near Load Centers
Total		38,700	

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Nuclear Power Plant : Inter Governmental Agreement (IGA)

- Supply, installation, commissioning and operation of the RNPP with 2 units of 1000 MWe VVER (PWR) reactors
- Cooperate to build up infrastructures including Regulatory infrastructures
- Financing
- Supply of fuel for the whole operational life of the reactors
- Take-back of Spent Fuel
- Development of HRD both for operation and regulation of RNPP

Power Market in saarc member Countries

For Power Market analysis, the following information are necessary:

- **Generation capacity** at different Power Stations of each member country.
- **Type** of Power **Generation/Fuel** use to generate power
- **Per-unit cost** of power generation
- **Per-unit rate** of electrical energy
- Possible amount of power/energy **import/export** among member countries
- **Possibility of joint venture** Power Generation. e.g. Nepal-India Electricity Transmission and Trade Project

- Construction of **transmission line** among **member countries**. e.g. Grid International between Bangladesh (Bheramara) and India (Bhaharampur) Project (33 km transmission line + 2 substations) to import 500 MW.
- Development of **distribution** system.
- **Fixation of per unit of cost** of power.
- Determine the **legal matters**, relate to generate, to transmit and to distribute power **among SAARC member countries**

Major Sources of Electrical Power are:

(i) Fossil fuel (coal, oil and gas), (ii) Nuclear fuel, (iii) Hydro power

Unconventional (Renewable) Sources of Energy

(i) Wind, (ii) Solar, (iii) Waves, (iv) Tides, (v) Biomass, (vi) Ocean current, (vii) Geothermal, (viii) Mini hydro etc.

Basic Concept of Cost Analysis

- Capacity cost
- Production cost
- Operating and maintenance cost

Global Cost Analysis

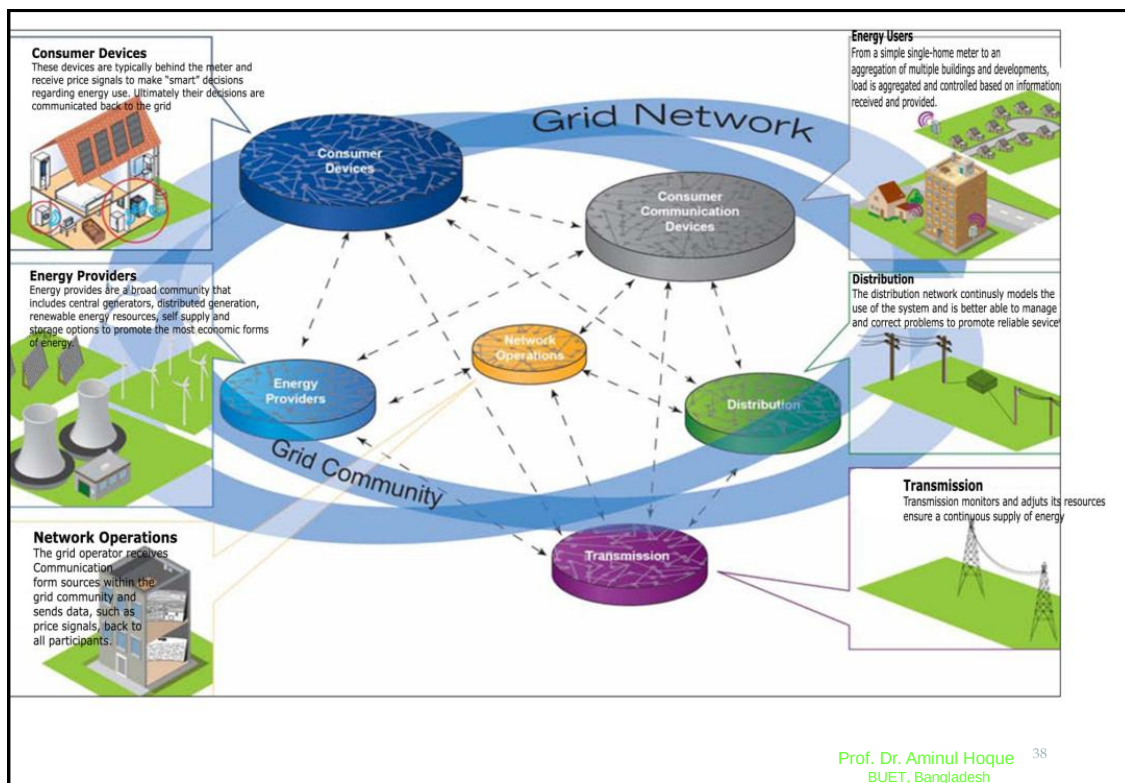
- Service life of a generating unit
- Interest rate
- Depreciation and
- The salvage value of the generating unit

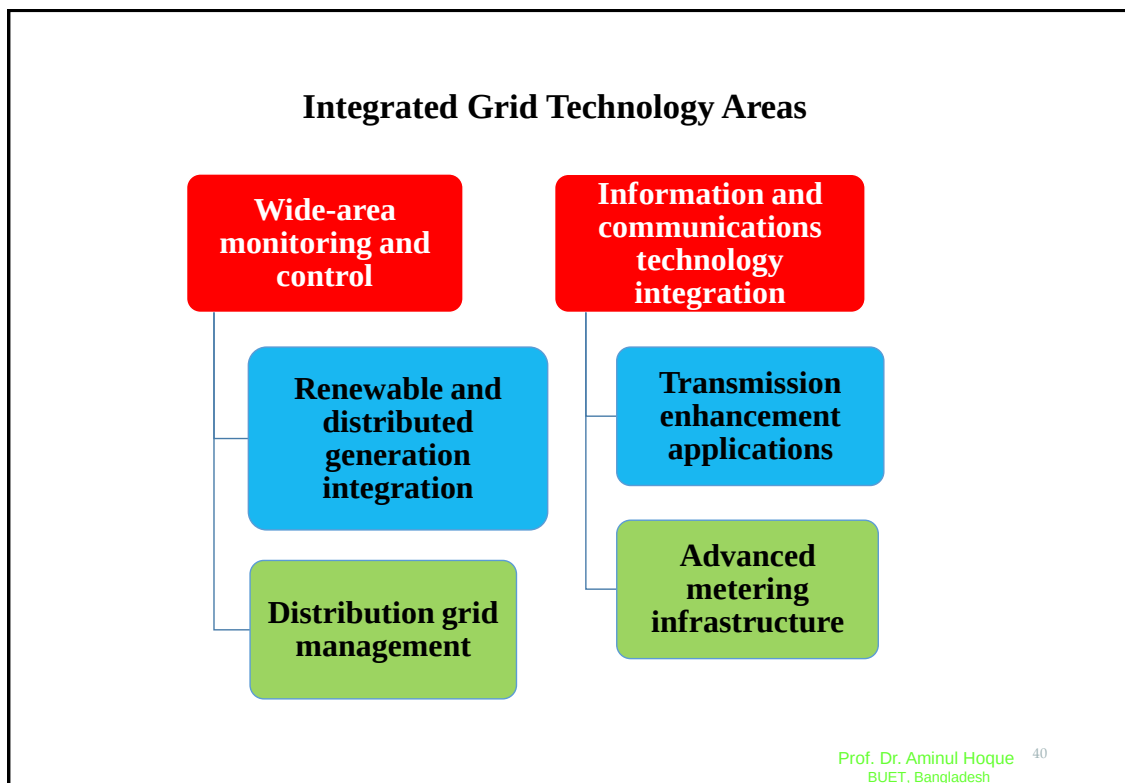
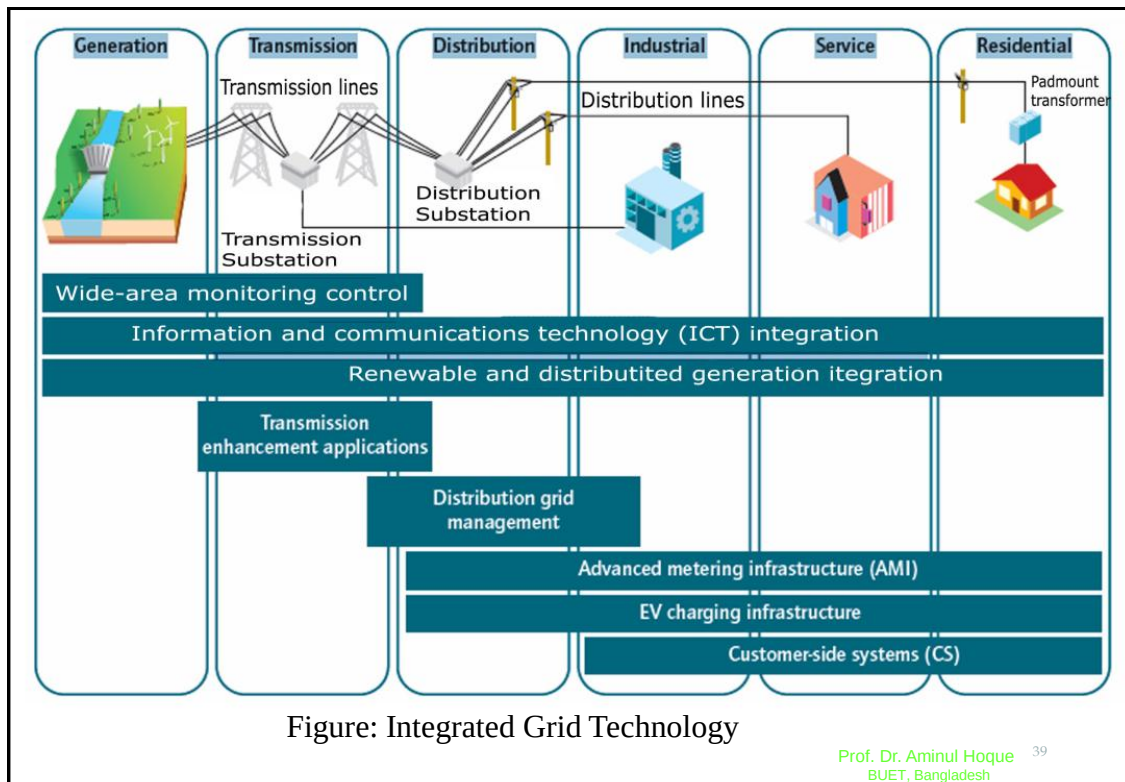
Challenges of a Regional Integrated Power System

- Enable all power production and distribution systems
- Development of effective communication system to millions of parties in a single market.
- If possible extension of the system to SAARC countries and beyond.
- Introduction of intelligent generation and consumption system.
- Enabling all consumers to play an active role in the system operation.
- Exploitation of renewable energy sources e.g. Hydro/Mini hydro, Biomass, Waves etc.
- Development of efficient connections for remote power generation centers.

- **Fast and reliable load management.**
- **Proper energy distribution during peak and off-peak hrs to improve overall efficiency of the system.**
- **Effective operation of a modernized grid community.**
- **Development of efficient electrical appliances to cope with the modern integrated power system.**

For Bangladesh proper application of an effective and **integrated power** system and participation of **neighboring South Asian countries** can open new doors towards glory.





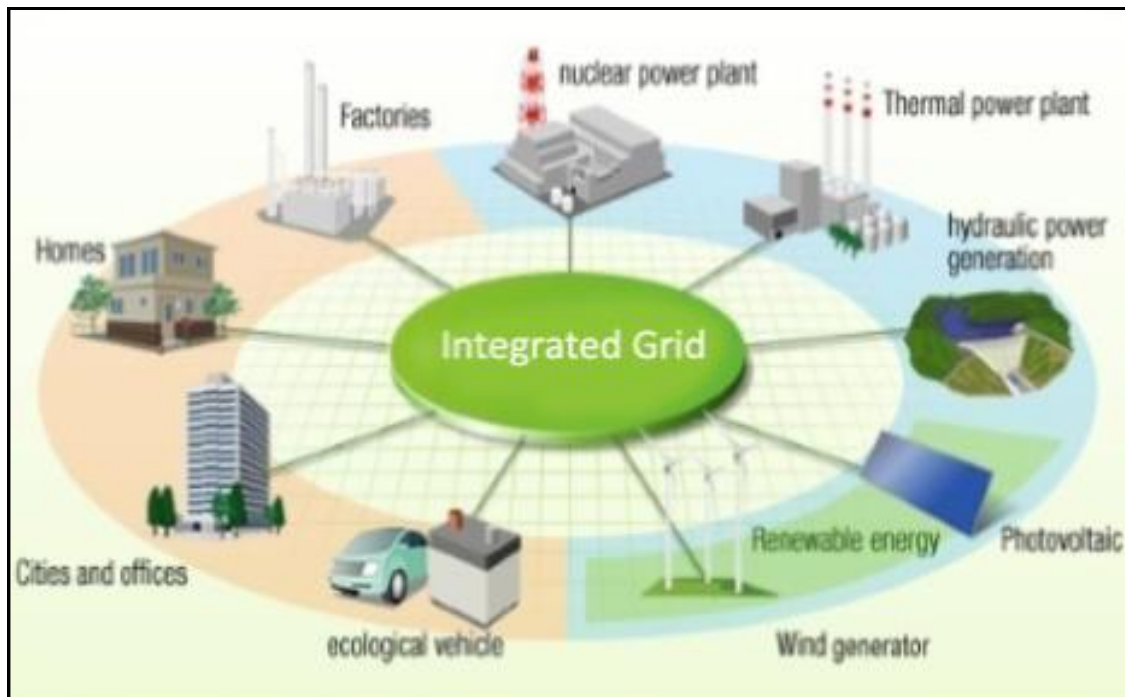


Figure : An integrated Grid System

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Goals of the Integrated Power System : Purposes are to :

**Best usage of
central generation**

- Enhancement of Reliability
- Reduce Peak Demand

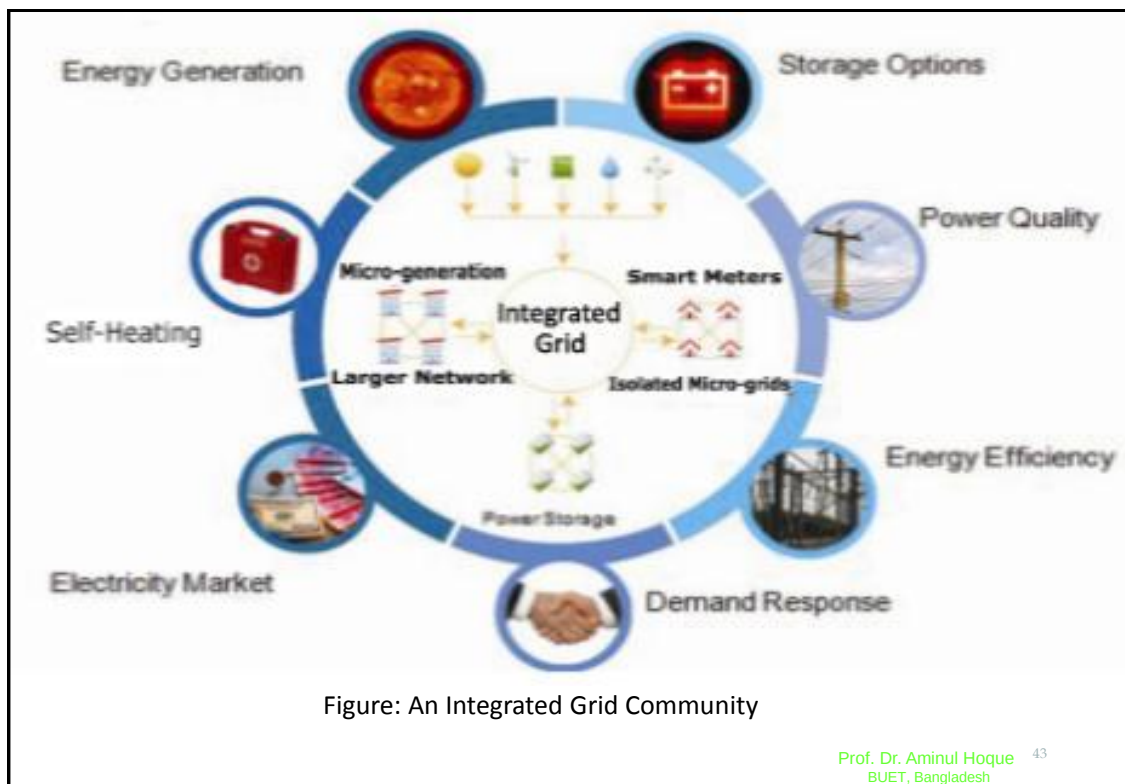
**Environmental
limitations**

- Shift usage to off-peak hours
- Respond to Solar, Wind, and other Renewable Resources

Consumer savings

- Security of Supply and Distribution
- Utilization of Renewable Energy Sources

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Integrated Grid Technologies		
Technology Area	Hardware	Systems and Software
Wide-area monitoring and control	Phasor measurement units (PMU) and other sensor equipments	SCADA , wide-area monitoring systems , wide-area adaptive protection, control and automation , wide area situational awareness
Information and communication technology integration	Communication equipment, routers, relays, switches, computers, internet	resource planning software (ERP), customer information system (CIS)
Renewable and distributed generation integration	Power conditioning equipment for bulk power and grid support, communication and control hardware for generation and enabling storage technology	Energy management system , distribution management system , SCADA, geographic Information system

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Integrated Grid Technologies (Cont'd)

Technology Area	Hardware	Systems and Software
Transmission enhancement	Superconductors , FACTS, HVDC	Network stability analysis, automatic recovery systems
Distribution grid management	Automated re-closers , switches and capacitors , remote controlled distributed generation and storage , transformer sensors , wire and cable sensors	Geographic information system, distribution management system, outage management system, workforce management system
Advanced metering infrastructure	Modern meter , in-home displays , servers , relays	Meter data management system
Customer-side systems	Efficient Electrical appliances , routers , in-home display , building automation systems, thermal accumulators , smart thermostat	Energy dashboards , energy management systems, energy applications for smart phones and tablets

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An Effective Integrated Power System Model

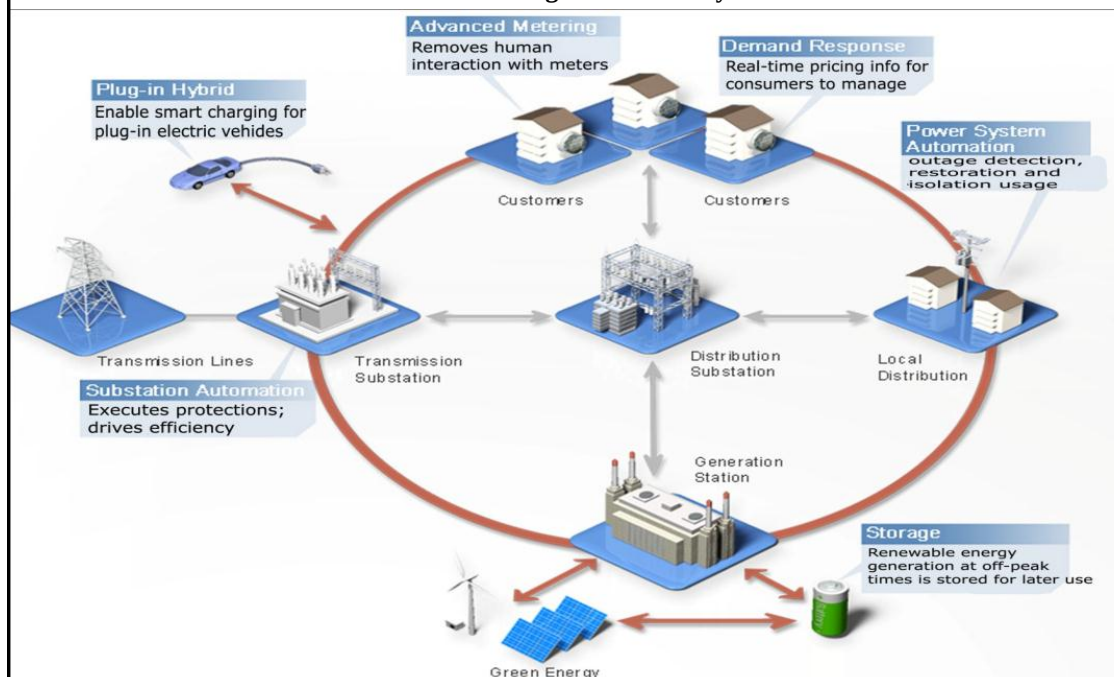
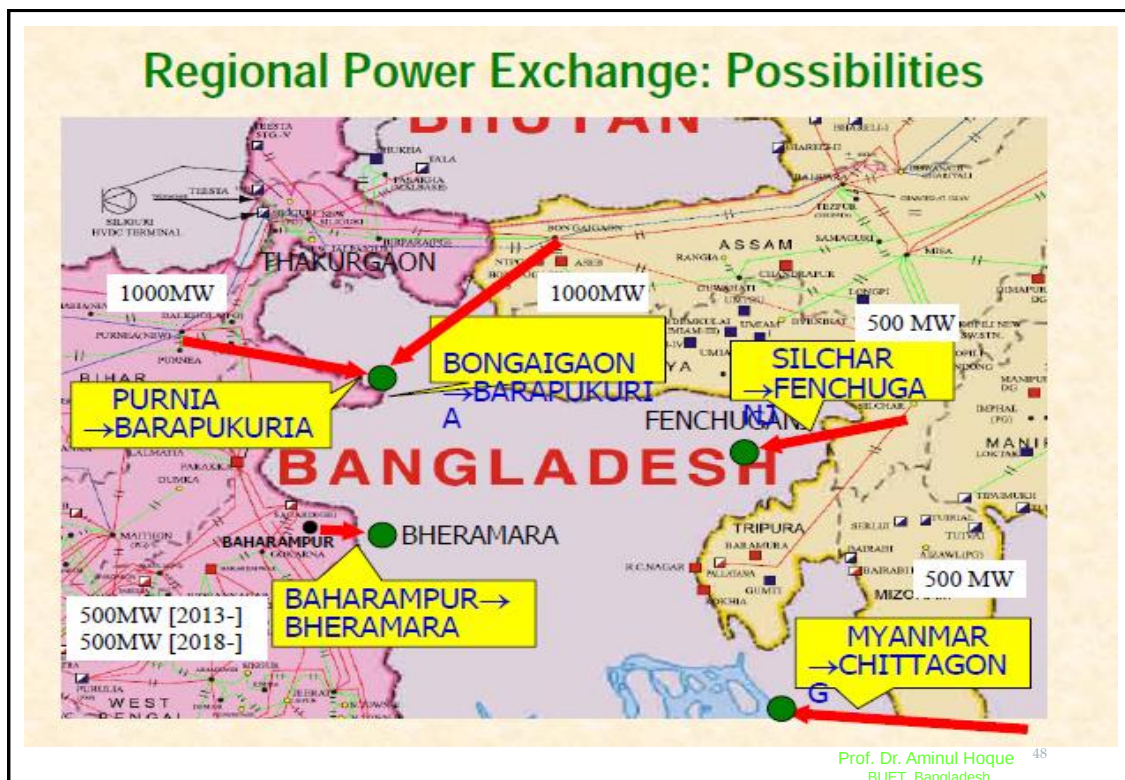
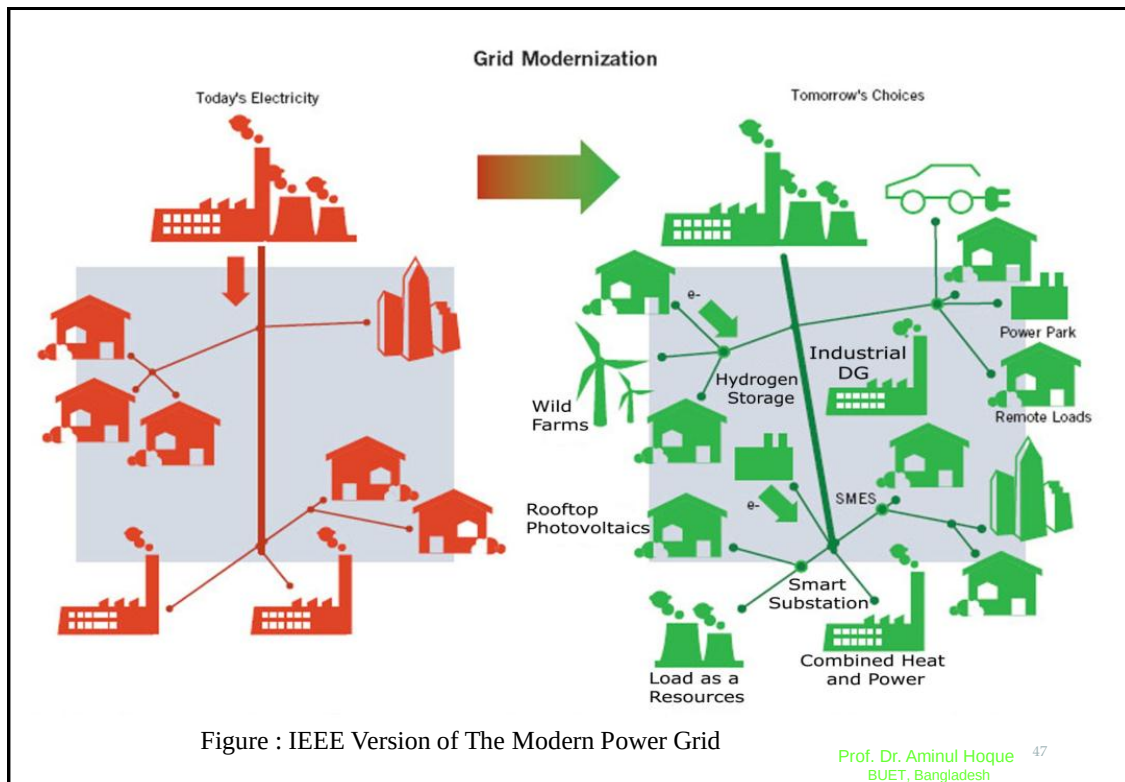


Figure : Fields of an “Integrated Power System”

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Electricity Tariff (Res & Agri) in Neighboring Countries

SI	Countries/Area	0-100 unit Residential (Taka/kWh)	Agriculture (Taka/kWh)
1	Bangladesh	3.68	2.51
2	West Bengal WBSEDCL	3.88 (Rural) 3.90 (Urban)	Off Peak: 2.34 Peak: 9.06
3	CESC (Calcutta)	6.00 (Urban)	
4	KESC, Karachi	5.90	Flat:11.00
5	Nepal	6.79 (>50 Unit: 8.00)	
6	Srilanka	3.88 (>90 Unit: 13.25)	

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Conclusion

- **Nepal** has hydro power generation capacity of about 80,000 MW. At present under **Nepal-India Electricity Transmission** and Trade Project only about **2,000 MW** has been producing.
- Similarly, **Bhutan** has hydro power generation capacity of about 40,000 MW and at present under, **Bhutan-India** Project has been producing only about **1,000 MW**.
- In future under **joint venture** program, **20,000 to 30,000** MW Power may be produced from hydro source of **Nepal** for **Power Market in SAARC** member countries and **neighboring** countries(e.g. Iran, Myanmar).

Conclusion (Cont.)

- **Bangladesh** may have possibility to **import** power from **neighboring country** e.g. Myanmar.
- **Pakistan** has already made an agreement (on March,2013) to **import gas** from **Iran**.
- Such **bi-lateral** or **multi-lateral agreement** will **benefit** the **SAARC member countries and other neighboring countries.**

THANK YOU

HVDC Network as Infrastructure for Smart SAARC Power Grid

Netra Gyawali, PhD
(Associate Professor)
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1

CONTENTS

- Background
- Key Attributes of High Voltage Direct Current (HVDC) Transmission
- HVDC Transmission: Configuration and Modalities
- HVDC Transmission: World Picture
- HVDC Transmission: SAARC Context
- HVDC Network in SAARC: Possibilities
- Conclusions

2

BACKGROUND

Requirement of Modern Transmission GRID

- Effective (Functions as desired)
 - ✓ Speed and accuracy
- Efficient (Low Loss)
- Asset Management (Optimum use the asset)
- Resilience
- Interoperability
- Accommodate Large Scale Renewable Power

3

KEY HVDC ATTRIBUTES

- **No reactive losses**
 - ✓ Provision for high cable length
 - ✓ Lower electrical losses
- **Accommodate Renewable Power**
 - ✓ BTB connection
 - ✓ Better Voltage Ride through Capability
- **The Power Flow on an HVDC link is Fully Controllable** (Fast and Accurate)
 - ✓ The operator or automatic controller determines how much power flows via the link and in which direction
Irrespective of the interconnected AC system conditions

KEY HVDC ATTRIBUTES

- **An HVDC Link is asynchronous**
 - ✓ The ac voltage and frequency in the two ac networks can be controlled independently of each other
 - ✓ No need for common frequency control
- **The HVDC link can be used to improve the dynamic conditions in both of the interconnected ac networks (power system damping)**
 - ✓ Can be controlled independently of AC system variations
- **HVDC links do not increase the Short Circuit Level of the connected systems**
- **Faults and oscillations don't transfer across HVDC interconnected systems**
 - ✓ Firewall against cascading outages

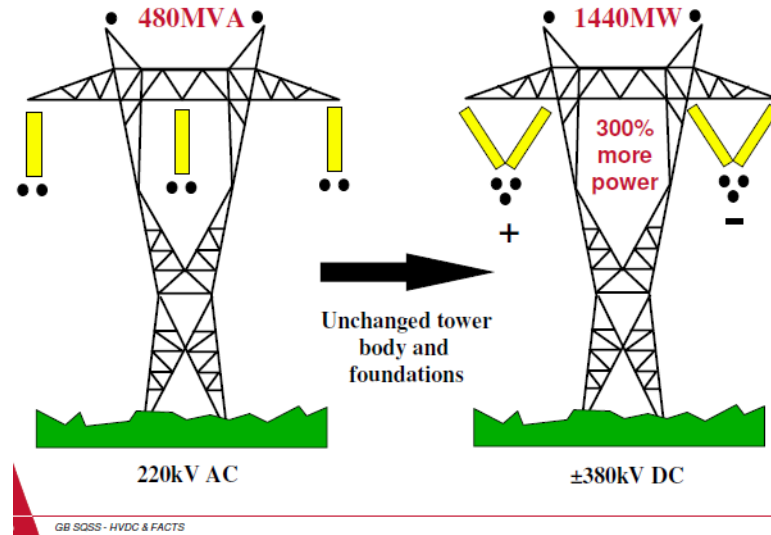
5

KEY HVDC ATTRIBUTES

- **HVDC can transport energy economically and efficiently over longer distances than ac lines or cables**
 - ✓ Increased Transmission Capacity in a fixed corridor
Up to 3 times more power per tower, therefore narrower rights of way

6

KEY HVDC ATTRIBUTES



7

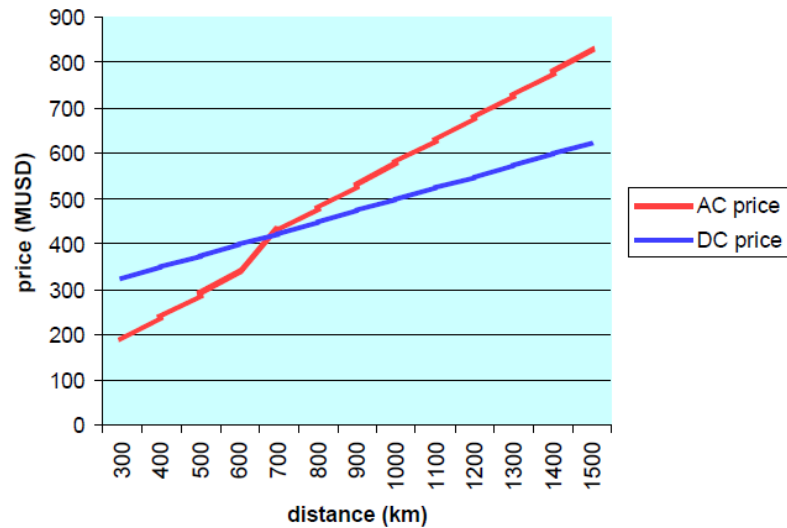
KEY HVDC ATTRIBUTES

Table 1. Comparative costs of HVDC and EHV AC transmission alternatives.

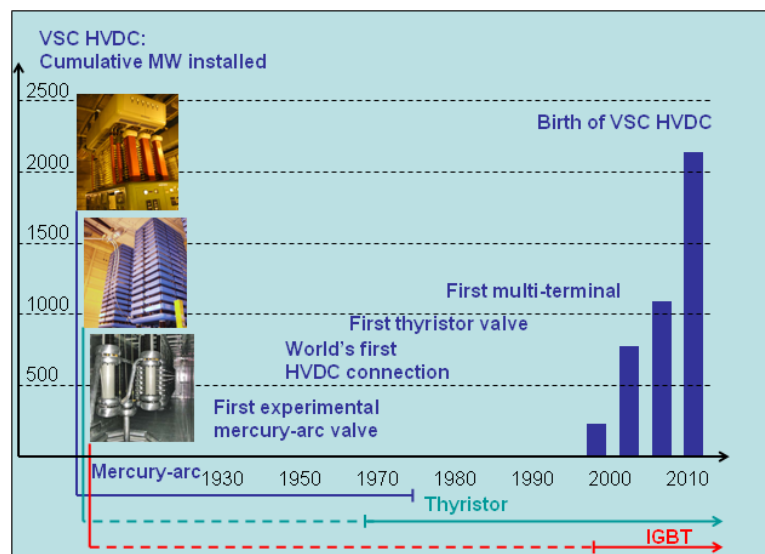
Alternative	DC Alternatives + 500 Kv Bipole	2 x + 500 kv 2 bipoles	+ 600 kv Bipole	+ 800 kv Bipole	AC Alternatives 500 kv 2 Single Ckt	500 kv Double Ckt	765 kv 2 Singl Ckt	Hybrid AC/DC Alternative + 500 kv Bipole	500 kv Single Ckt	Total AC + DC
Capital Cost										
Rated Power (MW)	3000	4000	3000	3000	3000	3000	3000	3000	1500	4500
Station costs including reactive compensation (M\$)	\$420	\$680	\$465	\$510	\$542	\$542	\$630	\$420	\$302	\$722
Transmission line cost (M\$/mile)	\$1.60	\$1.60	\$1.80	\$1.95	\$2.00	\$3.20	\$2.80	\$1.60	\$2.00	
Distance in miles	750	1,500	750	750	1,500	750	1,500	750	750	1,500
Transmission Line Cost (M\$)	\$1,200	\$2,400	\$1,350	\$1,463	\$3,000	\$2,400	\$4,200	\$1,200	\$1,500	\$2,700
Total Cost (M\$)	\$1,620	\$3,080	\$1,815	\$1,973	\$3,542	\$2,942	\$4,830	\$1,620	\$1,802	\$3,422
Annual Payment, 30 years @ 10%	\$172	\$327	\$193	\$209	\$376	\$312	\$512	\$172	\$191	\$363
Cost per kW-Yr	\$57.28	\$81.68	\$64.18	\$69.75	\$125.24	\$104.03	\$170.77	\$57.28	\$127.40	\$80.66
Cost per MWh @ 85% Utilization Factor	\$7.69	\$10.97	\$8.62	\$9.37	\$16.82	\$13.97	\$22.93	\$7.69	\$17.11	\$10.83
Losses @ full load	193	134	148	103	208	208	139	106	48	154
Losses at full load in %	6.44%	3.35%	4.93%	3.43%	6.93%	6.93%	4.62%	5.29%	4.79%	5.12%
Capitalized cost of losses @ \$1500 kW (M\$)	\$246	\$171	\$188	\$131	\$265	\$265	\$177	\$135	\$61	\$196
Parameters:										
Interest rate %	10%									
Capitalized cost of losses \$/kW	\$1,500									
Note:										
AC current assumes 94% pf										
Full load converter station losses = 9.75% per station										
Total substation losses (transformers, reactors) assumed = 0.5% of rated power										

Source: IEEE Magazine 2008

KEY HVDC ATTRIBUTES

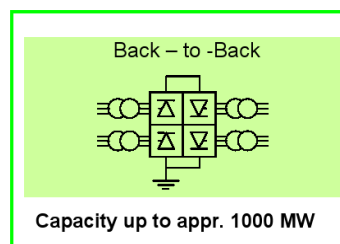
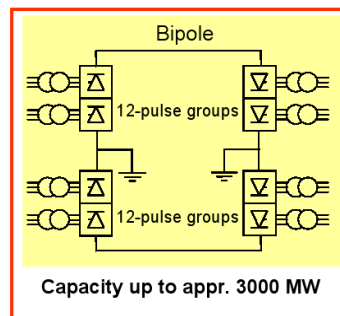
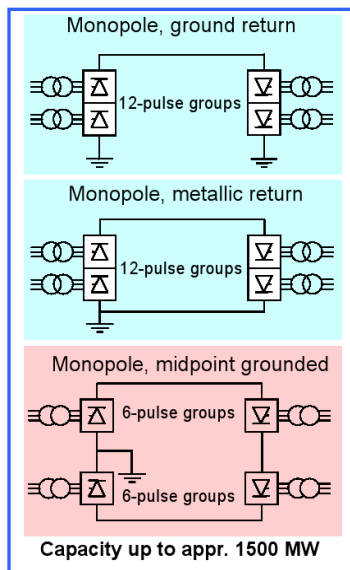


HVDC TRANSMISSION: CONCEPT



Source: IEEE Magazine 2008

HVDC CONFIGURATIONS

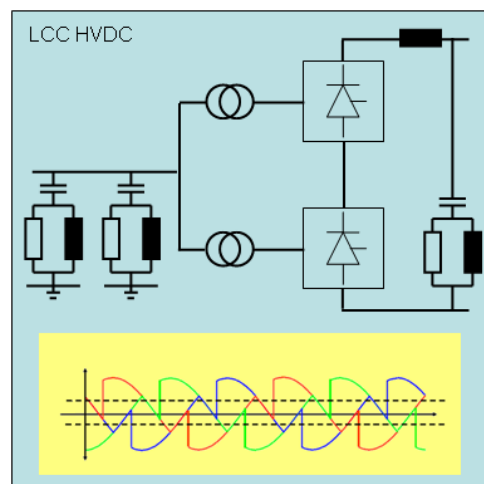


ABB

HVDC TRANSMISSION: CONCEPT

Natural Commutation Based HVDC

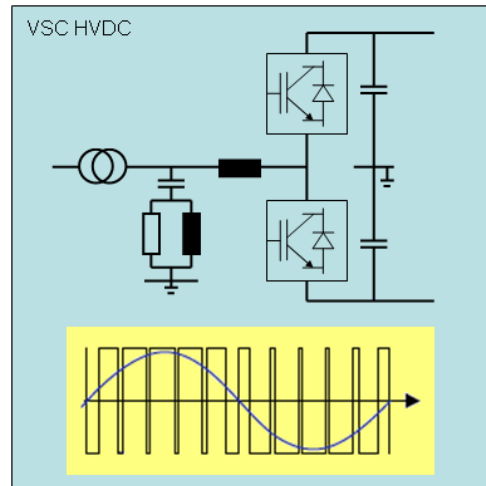
- Thyristor or mercury-arc valves
- Reactive power source needed
- Large harmonic filters needed



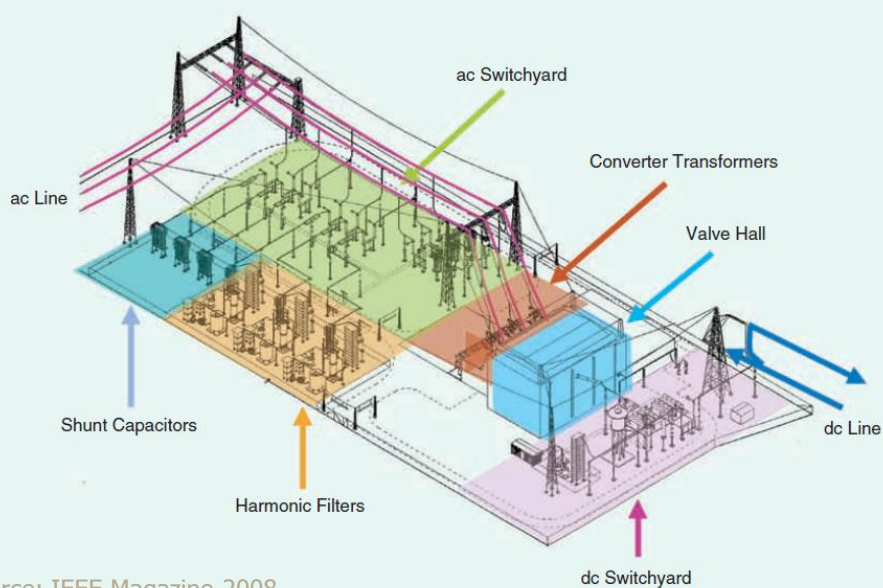
HVDC TRANSMISSION: CONCEPT

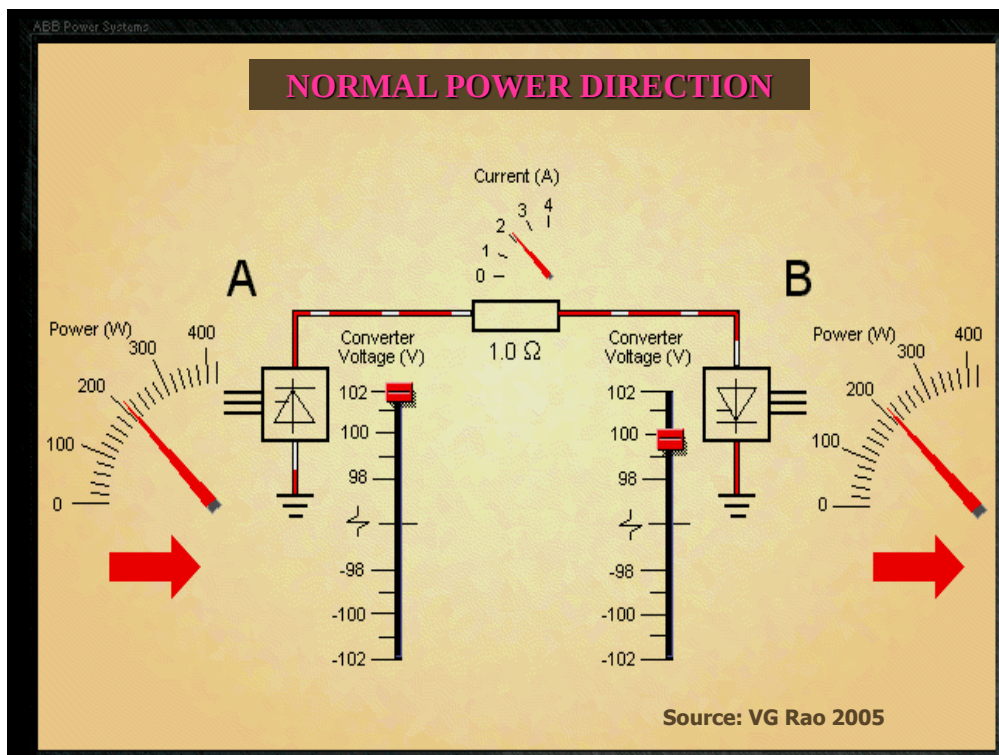
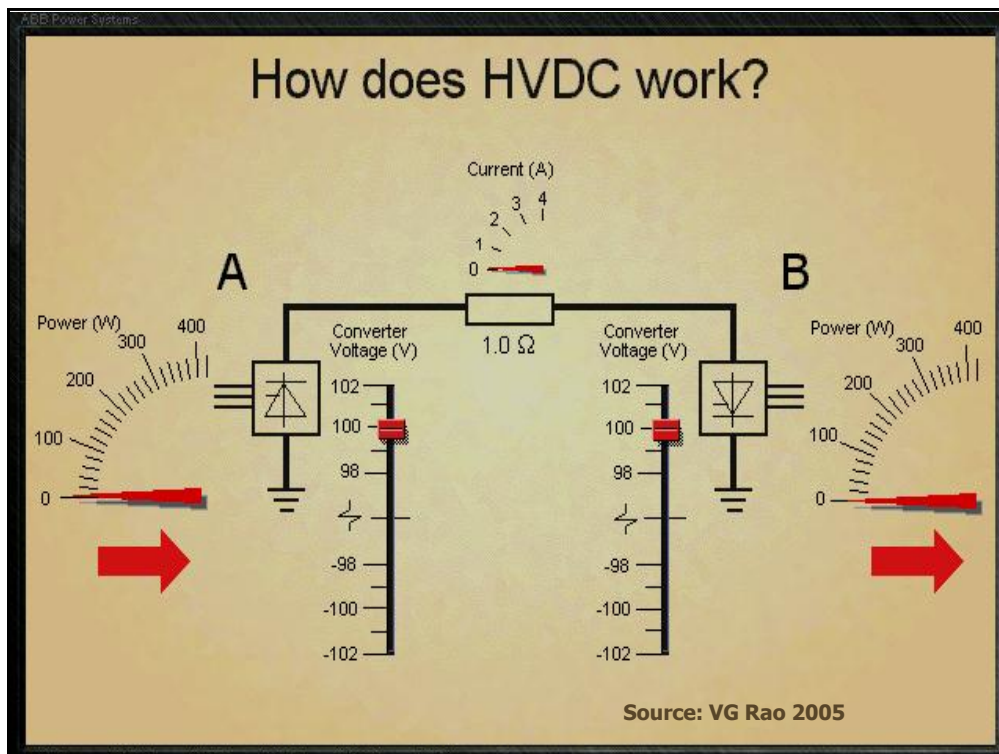
VSC Based HVDC

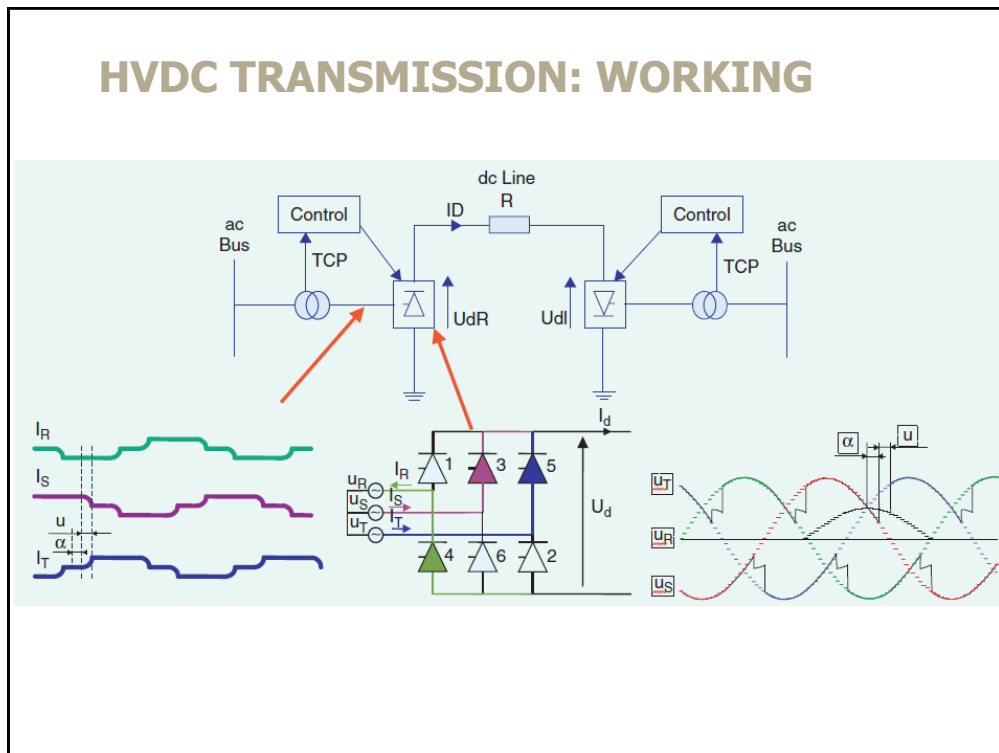
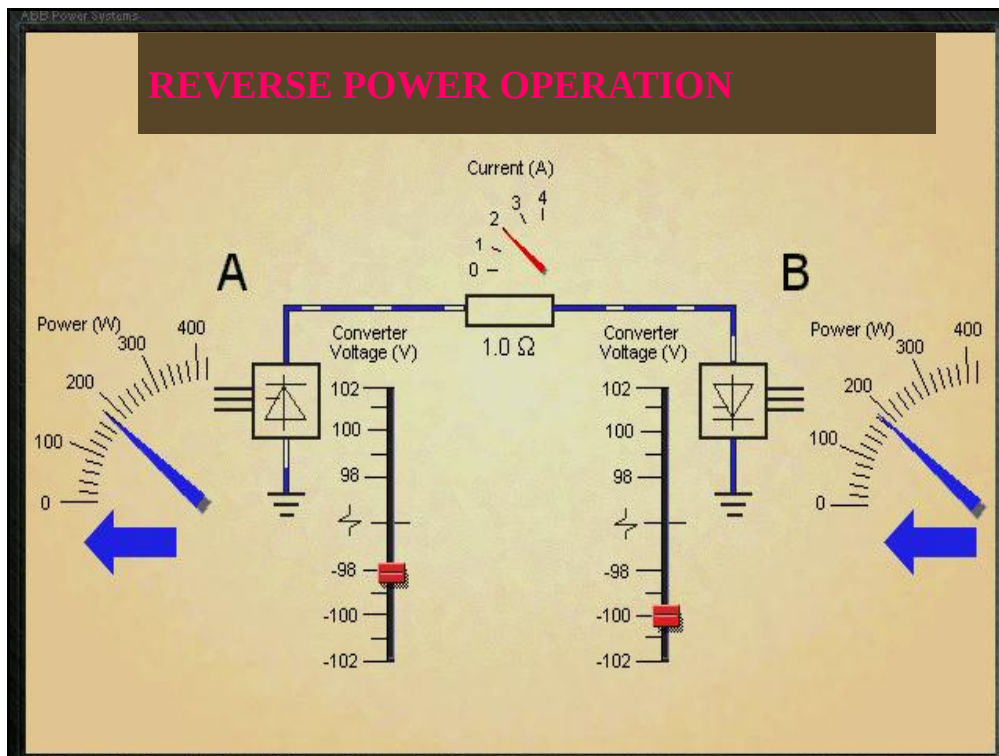
- Natural Commutation Based HVDC
- IGBT valves
- P and Q (or U) control
- Can feed in passive networks
- Smaller footprint
- Less filters needed



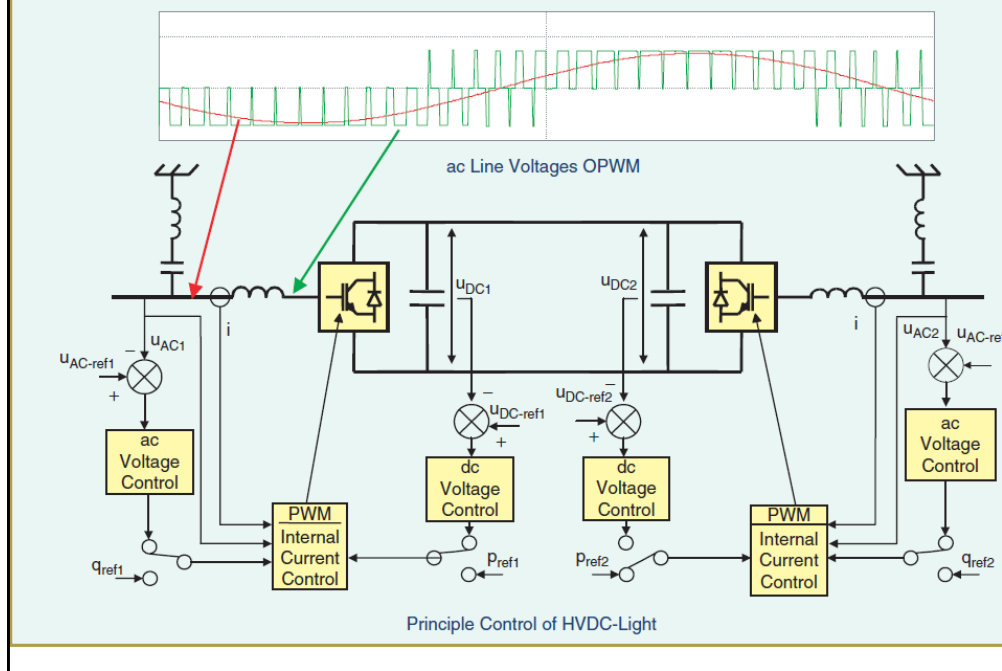
HVDC TRANSMISSION: CONFIGURATION







HVDC TRANSMISSION: WORKING

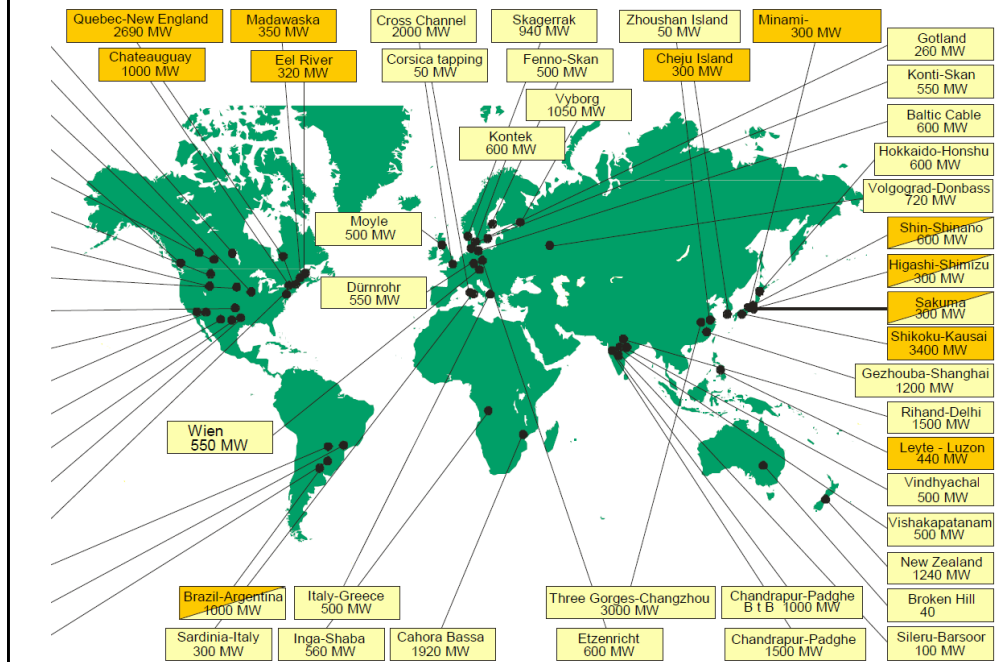


OVERVIEW OF HVDC APPLICATIONS

Overview of HVDC Applications

	Long distance transmission over land	Long distance transmission over sea	Interconnections of asynchronous networks	Windmill connection to network	Feed of small isolated loads
Natural commutated HVDC with OH lines	X		X		
Natural commutated HVDC with sea cables		X	X		
VSC Converters in Back-to-Back			X	X	
VSC Converters with Land or Sea Cables	X	X	X	X	X

HVDC TRANSMISSION: WORLD PICTURE



HVDC TRANSMISSION: SOME EXAMPLES

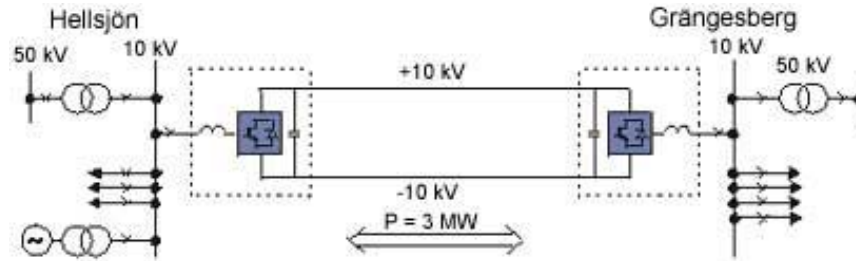
Norway Netherland Line

Type	submarine cable
Type of current	HVDC
Total length	580 km (360 mi)
Power rating	700 MW
AC Voltage	300 kV (Feda), 400 kV (Eemshaven)
DC Voltage	± 450 kV



HVDC TRANSMISSION: SOME EXAMPLES

The first HVDC Light transmission



Commissioning year:	1997 (Sweden)
Power rating:	3 MW
No. of poles:	1
AC voltage:	10 kV (both ends)
DC voltage:	± 10 kV
Length of DC overhead line:	10 km
Main reason for choosing HVDC Light:	Test transmission

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HVDC TRANSMISSION: SOME EXAMPLES

VSC HVDC example: troll (north sea)

Troll A, converters on the platform

The converters are housed in a pre-fabricated module, shipped and lifted onto the platform.



© ABB Power Technologies
Power Systems DC-37-

- Commissioning year: 2005
- Power rating: 2 x 42 MW AC Voltage: 132 kV at Kollsnes, 56 kV at Troll
- DC Voltage: ± 60 kV
- DC Current: 350 A
- Length of DC cable: 4 x 70 km

ABB

Main reason for choosing HVDC Light:

Environment, long submarine cable distance, compactness of converter on platform

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BRAZIL ARGENTINA HVDC LINE



Technical Data:

Commissioning year:	1984-1987
Power rating:	3150+3150 MW
DC voltage:	±600 kV
Length of overhead DC line:	785 km + 805 km
Main reasons for choosing HVDC system:	Long distance, 50/60 Hz conversion

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HVDC TRANSMISSION PHILIPPINES

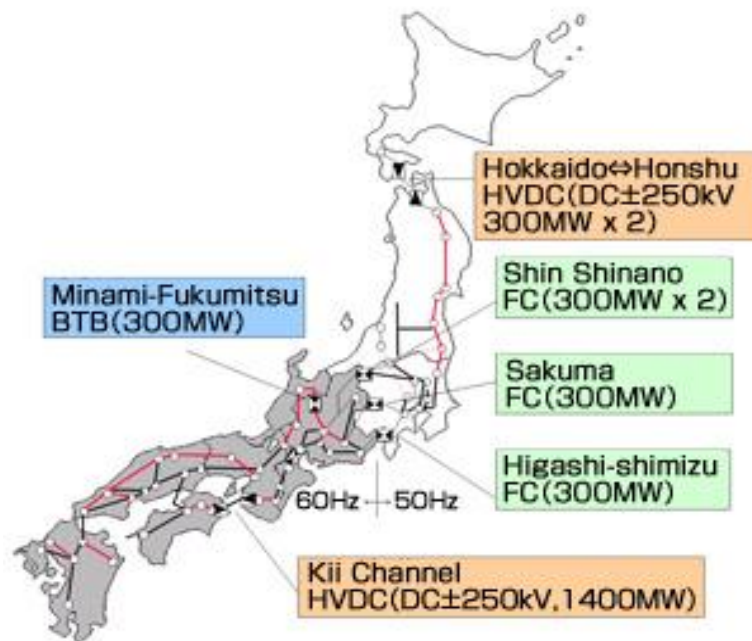


Technical Data:

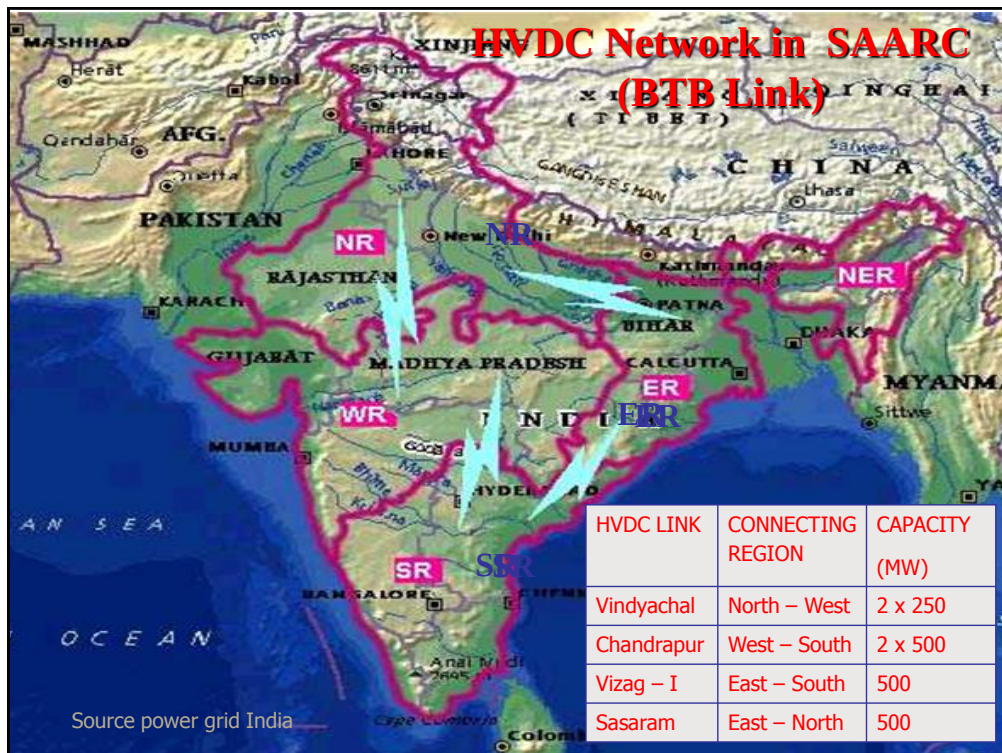
Power Rating:	440 MW
DC Voltage:	350 kV
Length of overhead line:	430 km
Length of submarine cable:	21 km

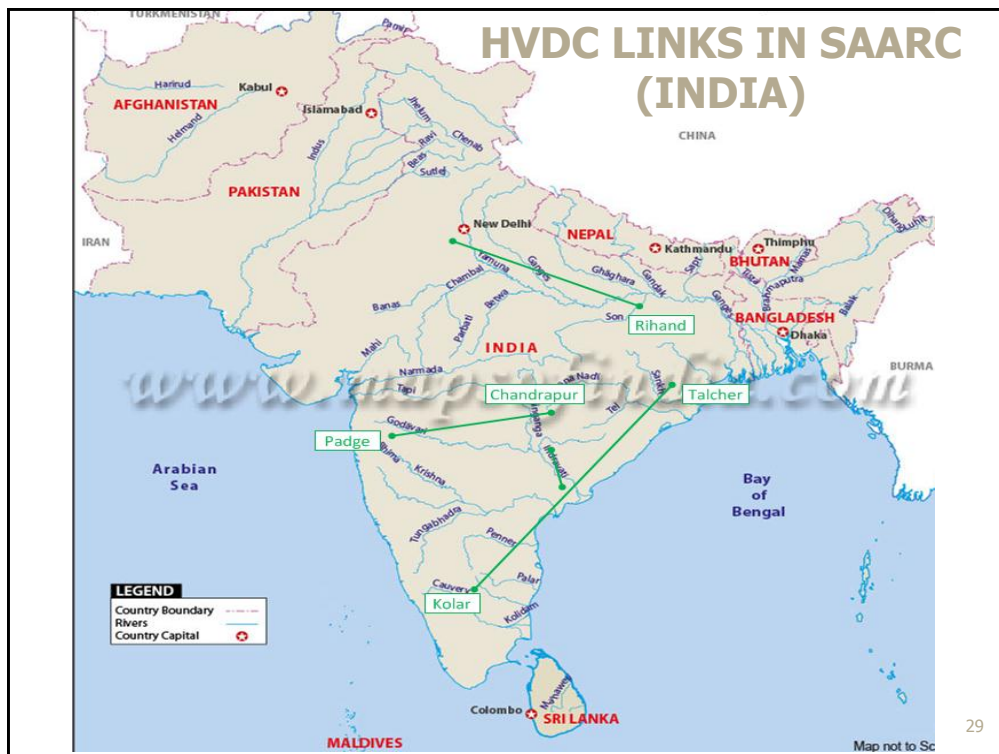
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HVDC TRANSMISSION: SOME EXAMPLES



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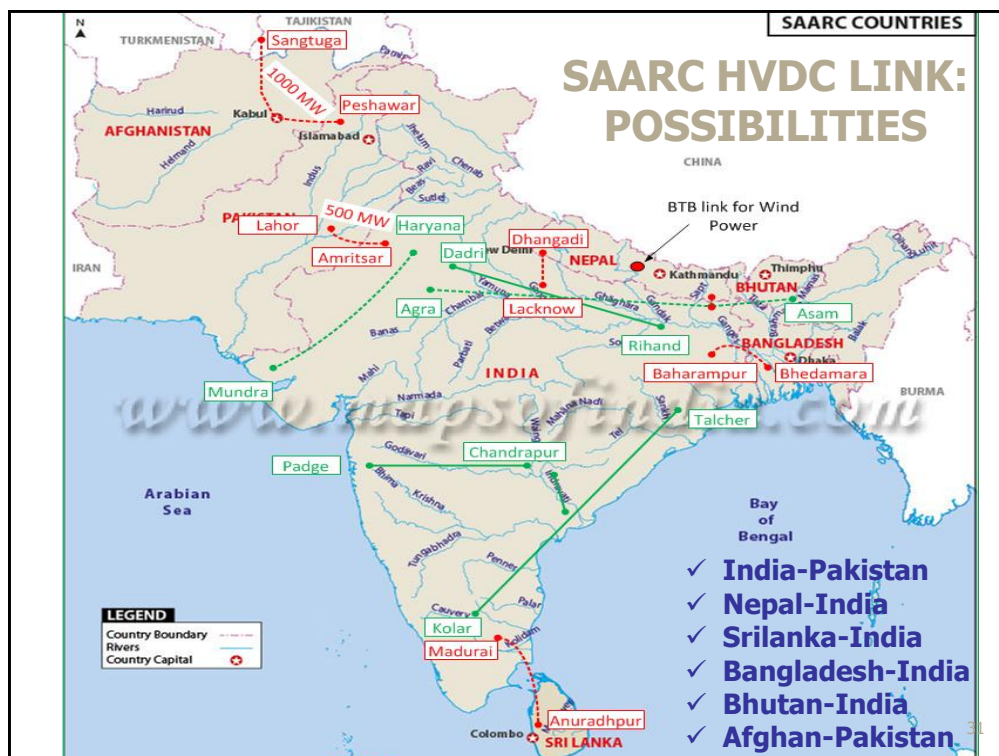




HVDC IN INDIA BIPOLAR

HVDC LINK	CONNECTING REGION	CAPACITY (MW)	LINE LENGTH
Rihand – Dadri	North-North	1500	815
Chandrapur - Padghe	West - West	1500	752
Talcher – Kolar	East – South	2500	1367

Source power grid India



CONCLUSIONS

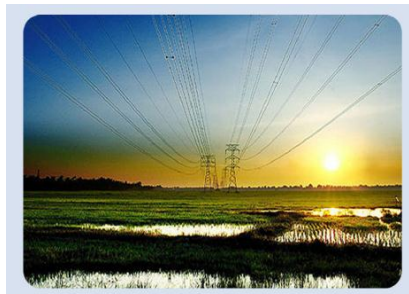
- HVDC transmission has number of benefits for bulk power transmission; namely efficiency, resilience, interoperability etc.
- In short distance, BTB HVDC provides smart link for frequency conversion and renewable power integration.
- In SAARC Country, the development of HVDC is only limited to India. For cross-border transmission link, HVDC is a good candidate.
- Combining with FACTS technology, HVDC provides a infrastructure of the future Smart Transmission Grid for SAARC.

REFERENCES

- Understanding Facts: Concepts and Technology of Flexible AC Transmission Systems, *Narain G. Hingorani, Laszlo Gyugyi*
- Flexible AC transmission systems, *Song & Johns*
- Thyristor-based FACTS controllers for electrical transmission systems, *Mathur Vama*

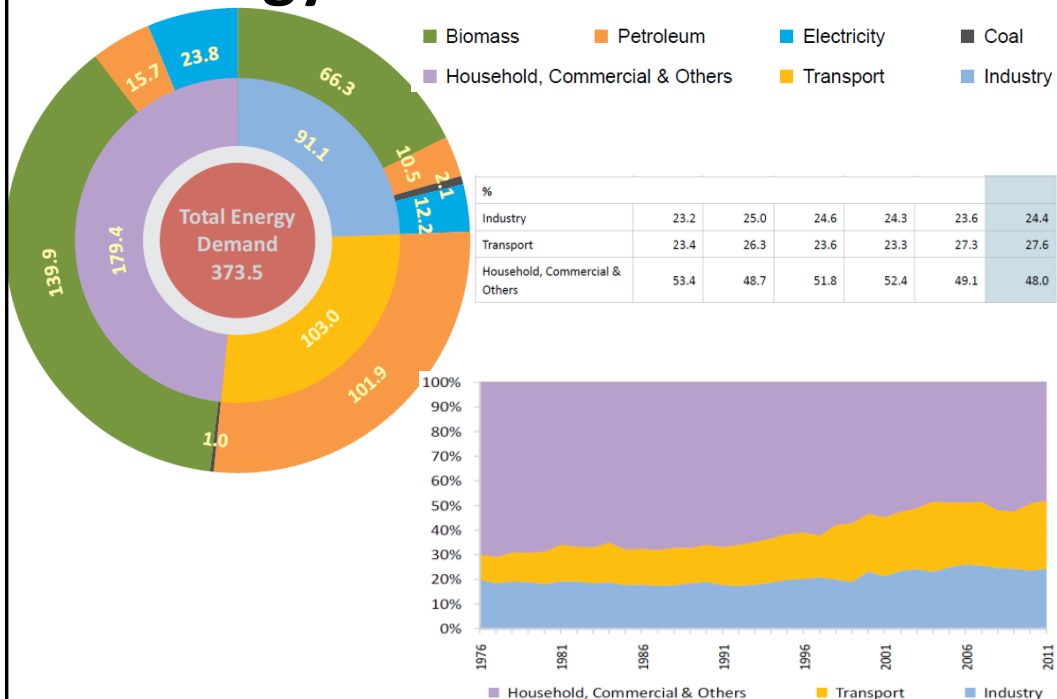
Thank you for your Attention

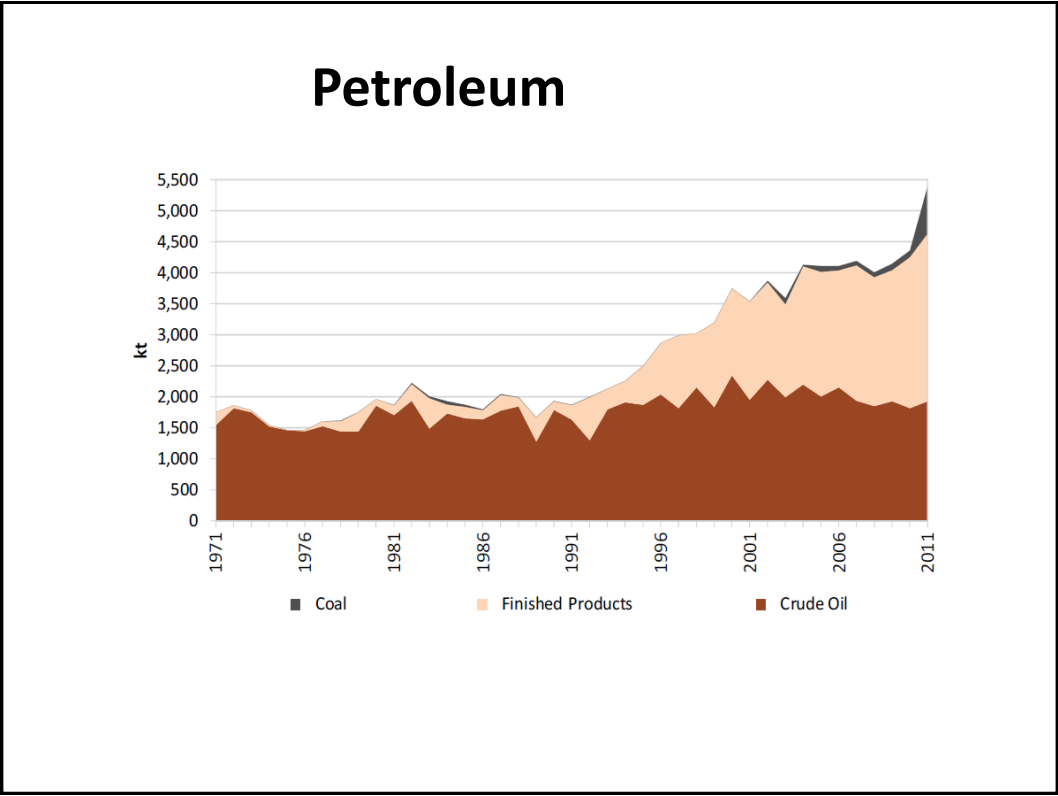
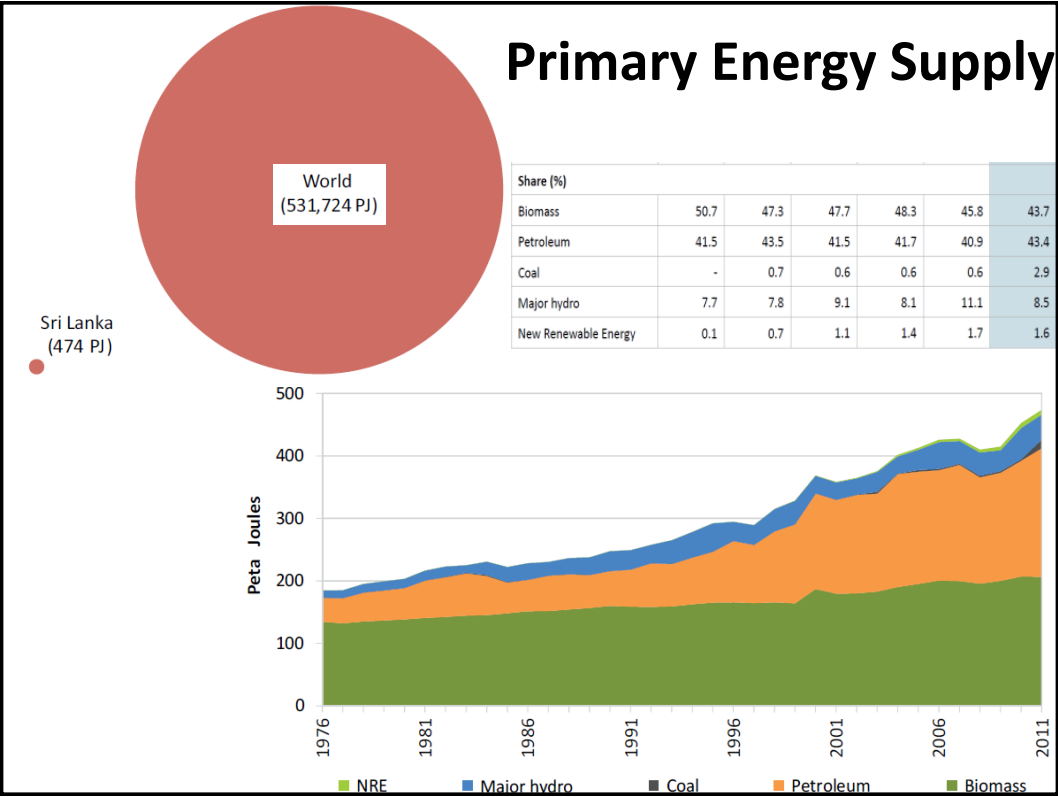
Opportunities for Cooperation on Technical Aspects for Sri Lanka under the Electricity & Petroleum sub Sector Development Policy – Sri Lanka



Prof. K.Kapila C. K. Perera
Department of Mechanical Engineering
University of Moratuwa

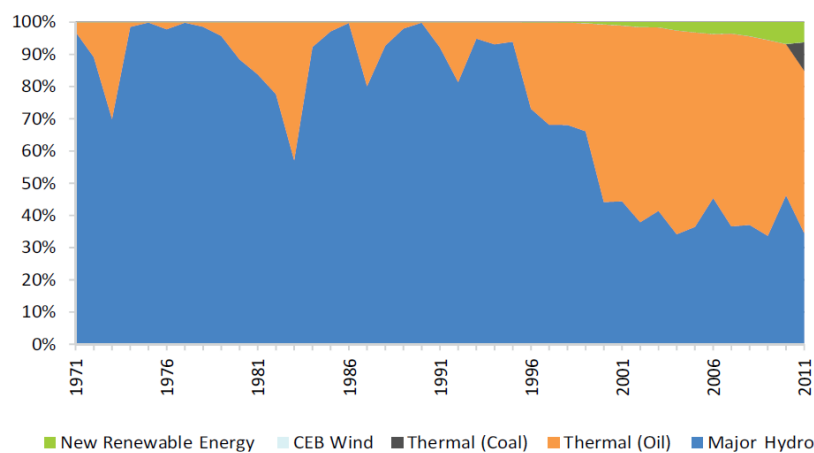
Energy Demand - 2011



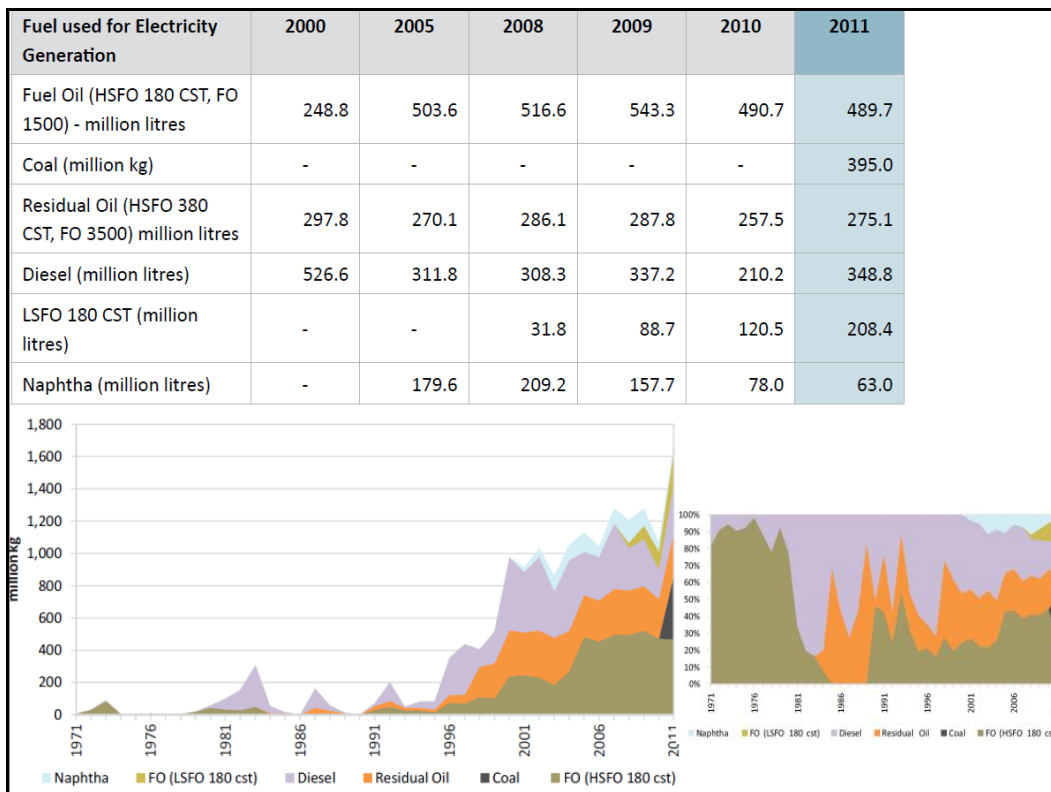
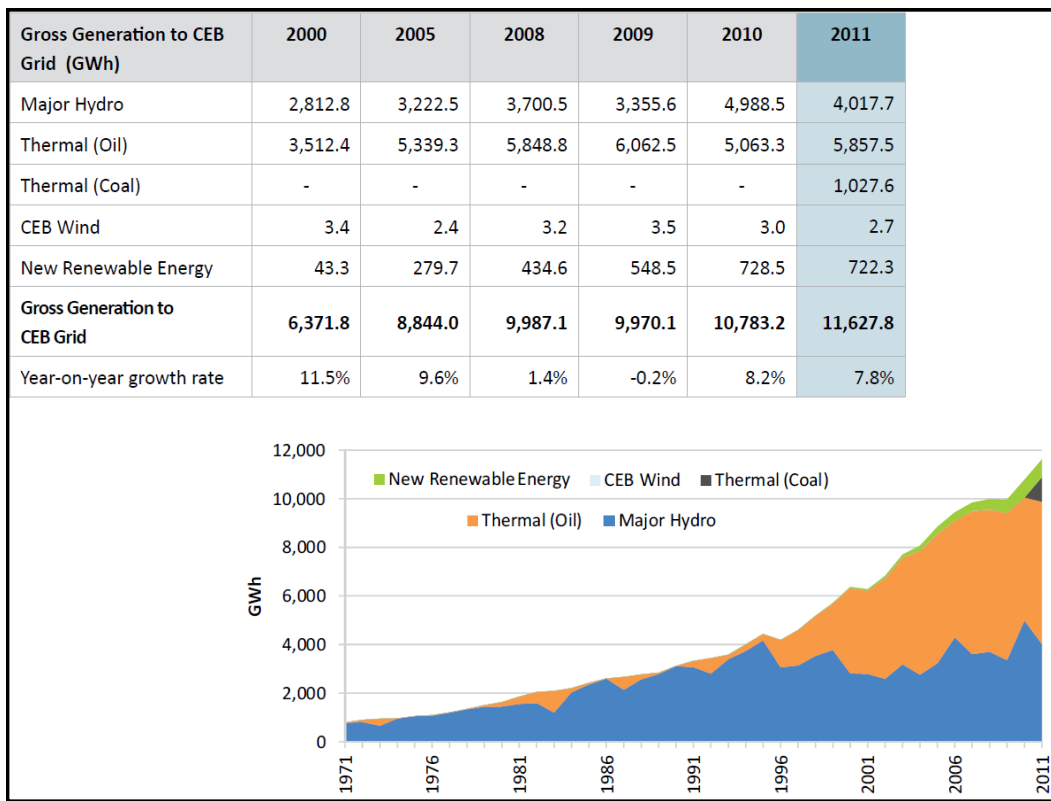


Electricity- Installed Capacity

Total Grid Connected Capacity (MW)	2000	2005	2008	2009	2010	2011
Major Hydro	1,137.5	1,207.5	1,207.5	1,207.5	1,207.5	1,207.5
Thermal Power Producers (CEB+IPP+Hired)	685.0	1,114.5	1,284.5	1,304.5	1,389.5	1,689.5
CEB Wind	3.0	3.0	3.0	3.0	3.0	3.0
New Renewable Energy	12.8	85.8	145.9	182.2	217.6	240.7
Total Installed Capacity	1,838.2	2,410.8	2,640.9	2,697.2	2,817.6	3,140.7
Major Hydro (%)	61.9	50.1	45.7	44.8	42.9	38.4
Thermal Power Producers (CEB+IPP+Hired) (%)	37.3	46.2	48.6	48.4	49.3	53.8
CEB Wind (%)	0.2	0.1	0.1	0.1	0.1	0.1
New Renewable Energy (%)	0.7	3.6	5.5	6.8	7.7	7.7



Type of Power Station	Number of Plants	Total Installed Capacity (MW)	Generation in 2011 (GWh)	Share in Generation (%)
Hydro	92	193.6	600.6	83.2
Biomass	4	12.5	31.6	4.4
Solar	4	1.4	1.1	0.2
Wind	5	33.2	89.0	12.3
Total	105	240.7	722.3	100.0

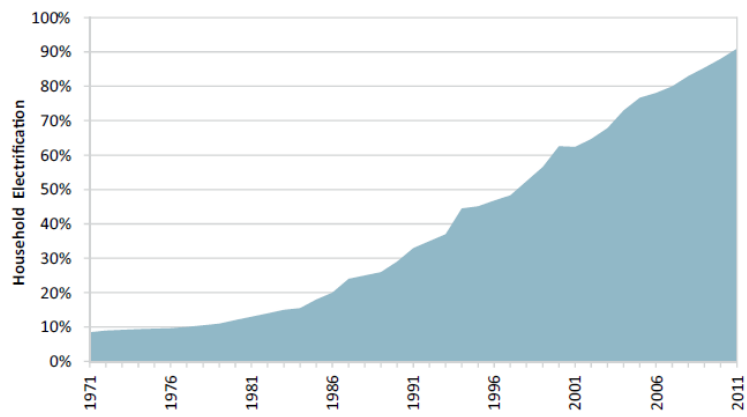


Off Grid Estimates

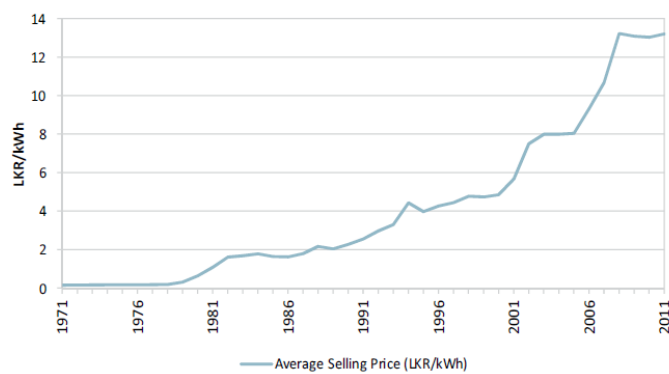
Aggregate Peak Capacity (kW)					
Village Hydro	421.9	1,210.9	1,639.4	1,789.1	1,928.0
Estate Hydro	3,226.2	3,226.2	3,226.2	3,226.2	3,226.2
Solar PV	400.0	4,264.2	5,902.9	6,281.3	6,659.7
Wind Battery Charging	-	8.2	8.2	8.2	8.2
Wind Community	-	1.0	1.0	1.0	1.0
Biomass	-	1.0	13.0	23.0	23.0
Total	4,048.1	8,711.5	10,790.7	11,328.8	11,846.1
Estimated Energy (MWh)					
Village Hydro	702.2	2,015.3	2,728.5	2,977.7	3,208.9
Estate Hydro	7,065.5	7,065.5	7,065.5	7,065.5	7,065.5
Solar PV	432.0	4,605.3	6,375.1	6,783.8	7,192.5
Wind Battery Charging	-	5.7	5.7	5.7	5.7
Wind Community	-	0.7	0.7	0.7	0.7
Biomass	-	1.2	15.6	27.6	27.6
Total	8,199.7	13,691.9	16,174.9	16,832.7	17,472.6

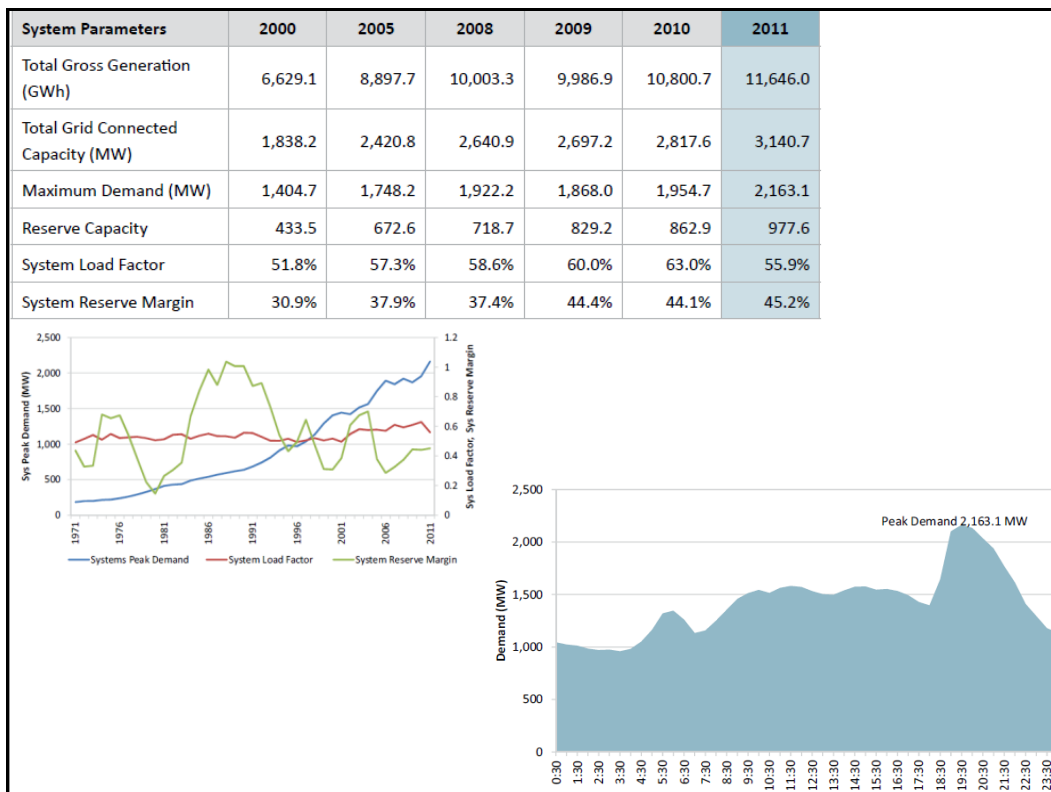
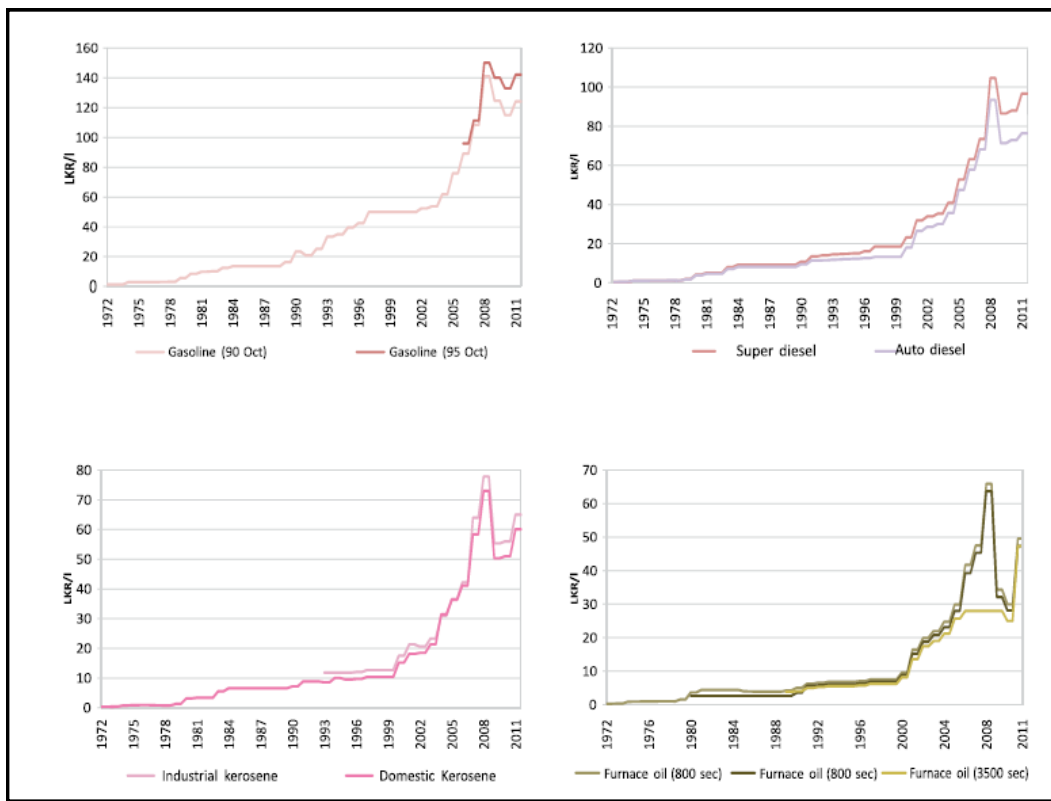
Total Gross Generation (GWh)	2000	2005	2008	2009	2010	2011
Major Hydro Power	2,812.8	3,222.5	3,700.5	3,355.6	4,988.5	4,017.7
Thermal Power	3,512.4	5,339.3	5,848.8	6,062.5	5,063.3	6,885.2
CEB Wind Power	3.4	2.4	3.2	3.5	3.0	2.7
New Renewable Energy	43.3	279.7	434.6	548.5	728.5	722.3
Self generation by customers	166.7	-	-	-	-	-
Off-grid Conventional Power (Hired)	82.4	40.1	-	-	-	-
Off-grid Non-Conventional (Off-grid Renewables)	8.2	13.7	16.2	16.8	17.5	18.3
Gross Generation	6,629.1	8,897.7	10,003.3	9,986.9	10,800.7	11,646.0
Total Gross Generation (%)						
Major Hydro Power	42.4	36.2	37.0	33.6	46.2	34.5
Thermal Power	53.0	60.0	58.5	60.7	46.9	59.1
CEB Wind Power	0.1	0.0	0.0	0.03	0.03	0.02
New Renewable Energy	0.7	3.1	4.3	5.5	6.7	6.2
Self generation by customers	2.5	-	-	-	-	-
Off-grid Conventional Power (Hired)	1.2	0.5	-	-	-	-
Off-grid Non-Conventional (Off-grid Renewables)	0.1	0.2	0.2	0.2	0.2	0.2

Household Electrification Rate

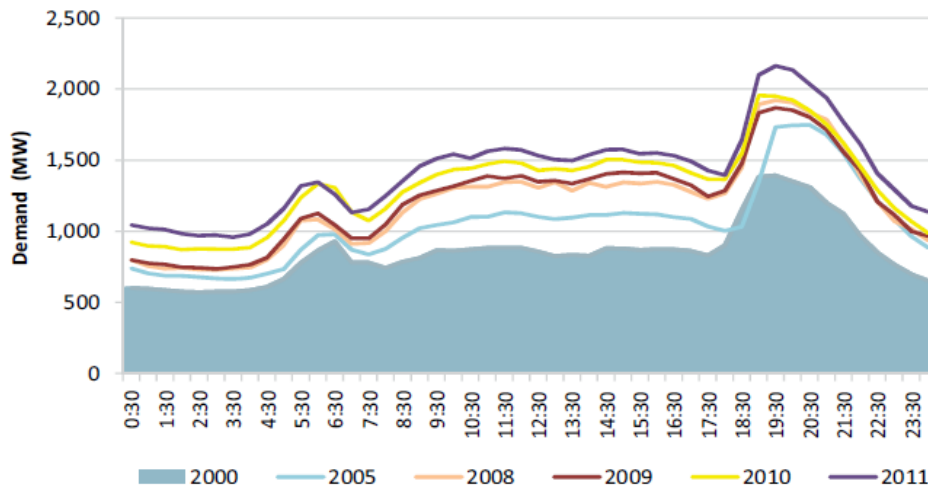


	2000	2005	2008	2009	2010	2011
Average Selling price (LKR/kWh)	4.86	8.04	13.23	13.10	13.03	13.63

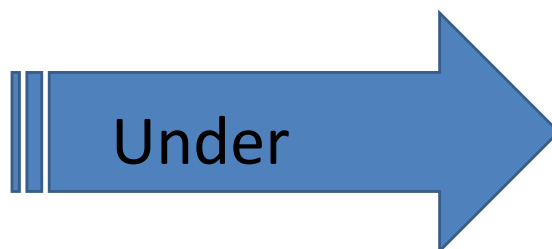




The Growth in System Peak Demand



FUTURE PLANS (ELECTRICAL AND PETROLEUM SUB SECTOR'S



Sri Lanka – The Emerging
Wonder of Asia

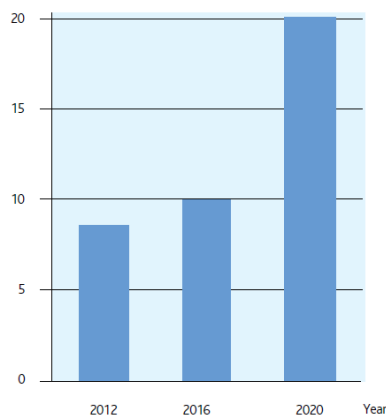
Ministry of Finance and Planning - 2010

Item	Unit	2005	2010 Est.	2016 Proj.
Population	mn	19.7	20.7	21.9
GDP	USD bn	24.4	49.1	98.0
Per Capita Income	US\$	1,241	2,375	4,470
Inflation - GDP Deflator	%	5.7	7.0	4.0
Exports	US\$ bn	6.3	8.0	18.0
International Trade Turnover	US\$ bn	15.2	21.3	44.1
International Services Income (Net)	US\$ bn	0.3	0.6	2.6
Earnings from Tourism	US\$ bn	0.3	0.5	2.5
Remittances	US\$ bn	2.0	3.8	7.0
Access to Electricity	%	75.0	88.0	100.0
Access to Telecommunications	%	23.6	85.0	100.0
Women in Labour Force	%	32.6	34.3	40.0
Unemployment	%	7.2	5.3	3.2
Infant Mortality	Per 1000	11.2	10.9	4.0
Maternal Mortality	Per 1000	0.45 ^a	0.39	0.2
Poverty	%	15.2	7.6	4.2
Primary School Enrolment	%	95.0	98.0	100.0
Literacy Rate - (15 - 24 years)	%	95.0	97.0	98.0
Literacy Rate - Computer	%	9.7	20.3	75.0

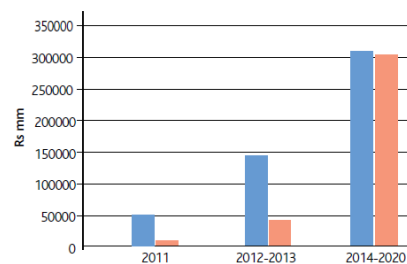
Trends in the Electricity Sector

Category	2005	2010	2012	2016	2020
Electrification Coverage(%)	75	88	100	100	100
Base Demand(MW)	1768	2517	2921	3943	5306
Installed Capacity(MW)	2409	2891	3470	4732	6367
System Losses(%)	16.7	14.5	14	13	12

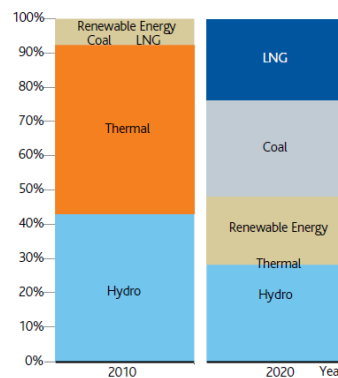
The Share of Renewable Energy on Grid



Investment on Electricity Development



Composition of Future Energy Mix



Category	2011	2012-2013	2014-2020	2011-2020
Generation				
Foreign	40,066	104,690	300,000	444,756
Domestic	7,650	28,099	176,000	211,749
Total	47,716	132,789	476,000	656,505
Transmission				
Foreign	8,020	13,197	22,000	43,217
Domestic	11,213	20,043	72,000	103,256
Total	19,233	33,240	94,000	146,473
Distribution				
Foreign	8,141	17,075	21,397	46,613
Domestic	4,288	7,324	32,000	43,612
Total	12,429	24,399	53,397	90,225
Energy Conservation				
Foreign	1,827	2,952	13,603	18,382
Domestic	456	1,214	20,000	21,670
Total	2,283	4,166	33,603	40,052
Grand Total	81,661	194,594	657,000	933,255

Sector Priorities	Strategy	Indicator	Target 2012	Target 2016	Target 2020
Electricity Generation Development	- Setting up of coal fired power plants and hydro power plants. - The high cost oil fired operation technology in thermal power plants will be replaced with low cost LNG technology. - New LNG power plants to be established. - The existing hydro power plants will be rehabilitated to stabilize their capacity. - A feasibility study examining the possibility of establishing the nuclear power plants will be carried out.	Capacity of the entire system	3470 MW	4732 MW	6367 MW
Electricity Transmission Development	- The new transmission facilities will be established to evacuate the power which will be generated by the new power plants. - Existing transmission lines will be expanded and grid substations will be augmented. - The transmission system will be upgraded to facilitate the absorption of the electricity generated by means of renewable energy sources to the national grid.	Compliance with reliability indices and statutory limits on quality of supply	Essential reliability level will be established	Endeavour to reach international norms of reliability and supply quality	Endeavour to reach international norms of reliability and supply quality
Electricity Distribution Development	- Distribution network will be developed to provide electricity to all by the end of 2012. - The exiting distribution network in urban council areas will be replaced with an underground system. - Medium and low voltage network will be developed.	Access to electricity	100%	100%	100%

Sector Priorities	Strategy	Indicator	Target 2012	Target 2016	Target 2020
Reduction of System Losses	- Electricity network studies will be conducted. - Commercial losses will be reduced by improving metering efficiency with improved management system. - Technical losses will be minimized by identifying sections of the network where losses are high, and improving such cables and transformers and reorganizing supply arrangements.	Total system loss	14% of net generation	13% of net generation	12% of net generation
Renewable Energy Development	Sufficient investment will be made on development of renewable energy sector with wind, dendro, solar and mini hydro power plants.	Share of Renewable energy on grid	8.5%	10%	20%
Energy Conservation	- Use of energy efficient bulbs, labeling electrical appliances and application of energy saving designs in building construction will be encouraged. - All new constructions will be undertaken ensuring the energy efficiency. - A comprehensive mechanism to deliver energy efficiency services will be developed to curtail energy waste in Industrial and commercial sectors. - LED lighting, solar and wind power systems will be introduced in place of the existing street lights.	Energy saving potential to the actual consumption	4.3%	6.4%	8.7%

Opportunities under the Present Vision in the two Sub Sectors (Electricity & Petroleum)

Summery Electrical Energy Vision

- Setting up of coal fired power plants and hydro power plants to promote low cost electricity.
- Hydro power projects: 35 MW at Broadlands, 120 MW at Uma Oya, 27 MW at Moragolla and 49 MW at Gin Ganga.
- Rehabilitation of the existing hydro power plants to stabilize their capacity of 1115 MW.
- Setting up of pump storage hydro power plants to stand by as a supportive source of electricity, to be utilized during peak hours.
- A high voltage transmission line of 400 MW capacity between India and Sri Lanka is to be erected for the purpose of exchanging electricity.
- The high cost oil fired operation technology in thermal power plants to be replaced with low cost LNG technology.
- New LNG power plants.
- A feasibility study examining the possibility of establishing the nuclear power plants in the country will be carried out.

India – Sri Lanka Power Transmission Interconnection Project

Total Estimated Cost:	Rs. 39,334 mn
Funding:	Foreign Rs. 35,161 mn
	Local Rs. 4,173 mn



Current Status:

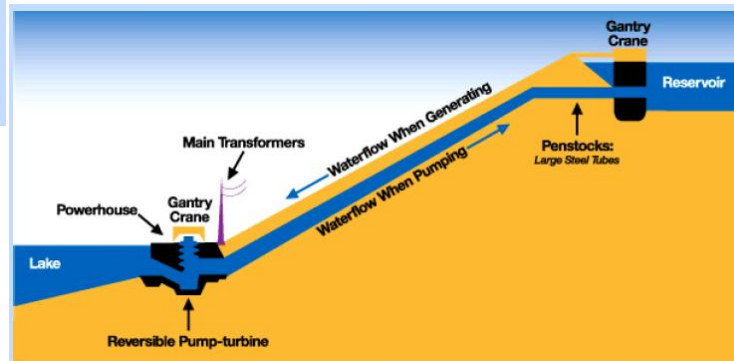
- Pre- feasibility study of the project has already been undertaken.
- India and Sri Lanka will soon sign an MoU to study the feasibility of laying an under sea cable.

Feasibility Study of Pump Storage Hydro Power Option in the Sri Lanka Power System

Total Estimated Cost:	Rs. 773 mn	
Funding:	Foreign	Rs. 690 mn
	Local	Rs. 83 mn

Current Status:

The concept paper of the project has been prepared and submitted for preliminary appraisal.



Petroleum Exploration History in Sri Lanka

1957-1958	Aeromagnetic survey by Hunting Survey Co. Canada
1967-1968	1st seismic survey CGG, France. 500 km seismic
1972-1975	Soviets 4780 km seismic and 3 wells (Pesalai 1, 2 & 3)
1976	Western Geophysical, USA. 3800 km seismic
1976	Marathon Petroleum, U.S.A. wells (Palk Bay 1, Delft 1)
1981	Cities Service Group, U.S.A. 3050 km seismic
1981	Cities Service Group, USA. 2 wells (Pearl 1, Pedro-1)
1982	Cities Service Group, USA. 208 km seismic
1984	Petro-Canada, Canada, 980 km seismic
2001	TGS-NOPEC, Norway, 1050 km seismic
2005	TGS-NOPEC, Norway, 4500 km seismic

Call for Expressions of Interest

From Geophysical Exploration companies to conduct Airborne Gravity/Gravity Gradiometry, Magnetic and Seep Detection surveys over the offshore Mannar and Cauvery basins of Sri Lanka

From Geophysical Exploration companies to perform modern reprocessing and imaging on various vintages of existing 2D seismic data covering the Mannar basin offshore Sri Lanka

*Commercially viable Energy Networking in the SAARC
Region, with Emphasis on Energy Grid Structure*

Afghanistan Grid and Power Export Opportunities to Pakistan

6th Japan-SAARC Energy Symposium-2013
Kathmandu, Nepal

Mohsin Amin

Contents

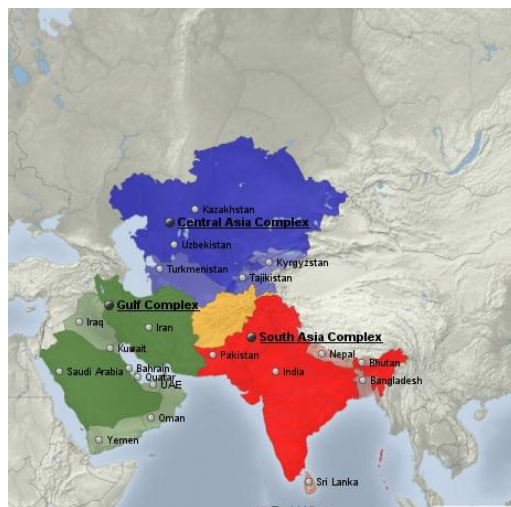
- Problems to extract
- Afghanistan Grid and Background
- Expansion Planning in Afghanistan System
- Synchronization is a bottleneck
- Huge Demand in Pakistan
- Transmission Routes for CASA-1000
- Conclusion

Problems to extract

- How to resolve Synchronization issue in Afghanistan grid with neighboring countries?
- How to enhance and reinforce Afghanistan transmission system for energy trading within SAARC and Central Asia regions?
- What can be recommended for Afghanistan Power system to handle and smoothly operate large scale power transmission with neighboring countries?

Afghanistan Grid and Background

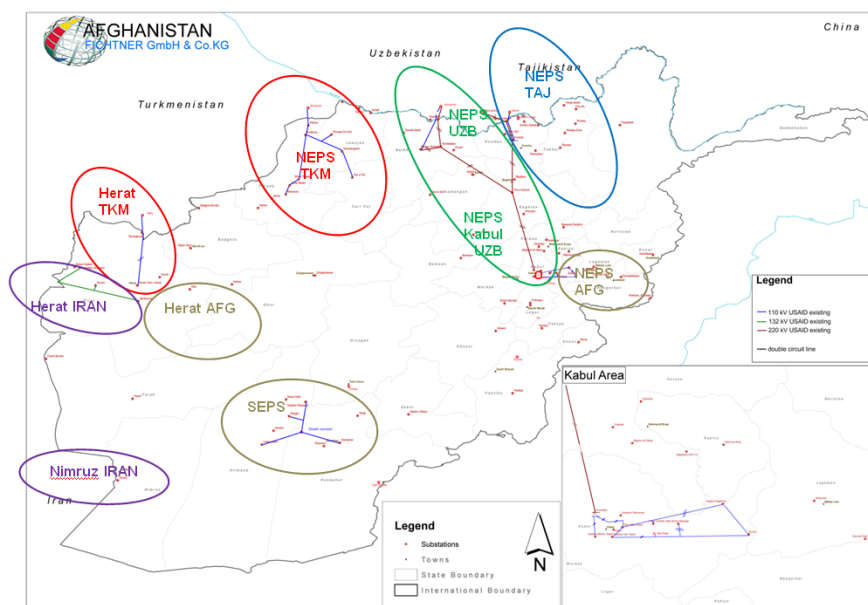
- Afghanistan is holding important strategic location and can play a key role in Energy Trading in the SAARC region



Afghanistan is surrounded by four electrical systems operating asynchronously



Current Situation



Power Generation in Afghanistan

Power generation in Afghanistan is currently based on hydropower

- Most of the hydropower plants were built in the sixties and seventies of the last century
- High seasonal variation of power generated by the hydropower plants
- Installed capacity (total after rehabilitation): 250 MW
- Average annual generated energy (2006 -10): 830 MWh

Name	River	Capacity after rehabilitation [MW]	Date of commissioning / rehabilitation	Annual energy** [GWh]	Estimated costs *** [\$m]
Naghlu	Kabul	100	1967 / Sept. 2012	413	90
Sarobi	Kabul	22	1957 / completed	188	25
Mahipar	Kabul	66	1967 / completed	152	80
Darunta	Kabul	11.5	1964 / 2012	85	14
Assassab.	Kunar	0.7	1983 / *	4	1.2
Charikar	Ghorband	2.4	1973 / *	14	3.6
Jabul Ser.	Salang	2.5	1920 / *	14	3.6
Ghorband	Ghorband	0.3	1975 / *	2	0.6
Kajaki (I & III)	Helmand	33	1975 / completed	272	40
Grishk	Helmand	2.4	1957 / *	14	3.6
Pul-i-Chomri	Pulikhumri	3x1.37=4.12	1950 / 2013-2015	24	6
Pul-i-Chomri II	Pulikhumri	3x2.93=8.79	1962 / 2013-2015	49	13

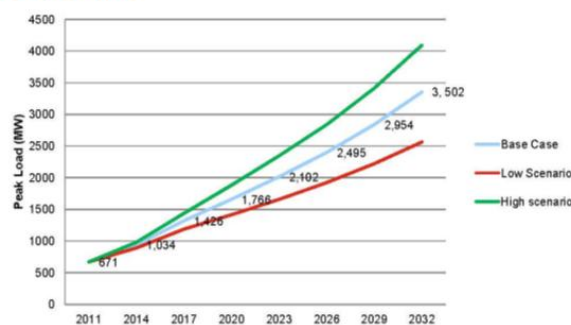
Import Power

- In 2011 Afghanistan imported 2,250 GWh, 73% of its overall electrical energy demand.
- Import by Country wise
 - Uzbekistan (57%)
 - Tajikistan (4%)
 - Turkmenistan (16%)
 - Iran (22%)

Demand in Afghanistan

Demand Forecast: Results Total Afghanistan – peak load

- 3,502 MW peak load expected in 2032 in base case scenario
- Increase by factor 5.7
- Average annual growth rate: 8.6%
- Low scenario: 2,607 MW
- High scenario: 4,287 MW



Expansion Planning in Afghanistan System

Short term, development stage A (up to 2015)

- Increase of import line capacity to the currently isolated grids
- Increase on-grid consumers as the import and generation capacity is expanded.
- Local thermal generation with gas fired power plant

Medium term, development stage B (up to 2020)

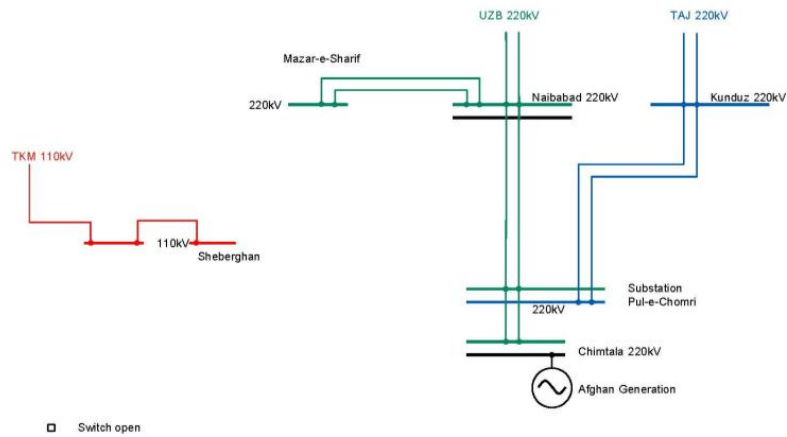
- A new transmission line between Pul-e-Chomri and Argandi, south of Kabul, at 500 kV will eliminate the power transfer bottleneck to Kabul.
- HVDC back-to-back station at Pul-e-Chomri supplied from the Turkmenistan
- Generation capacity in the Kabul area is synchronized with the existing Afghan power system at the earlier NEPS.
- Transmission network development to increase connection rate
- NEPS to SEPS interconnector will secure the power supply to southern Afghanistan.

Long term, development stage C and D (up to 2032)

- Further development of local generation, hydro and thermal
- More foreign power systems will feed in to the back-to-back hub at Pul-e-Chomri
- Further development of the transmission system to reach high connection rate

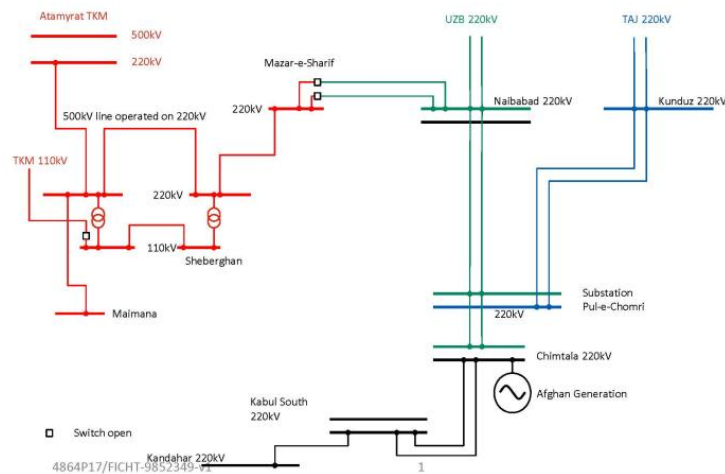
Synchronization is a bottleneck

Major Transmission Project: Existing System



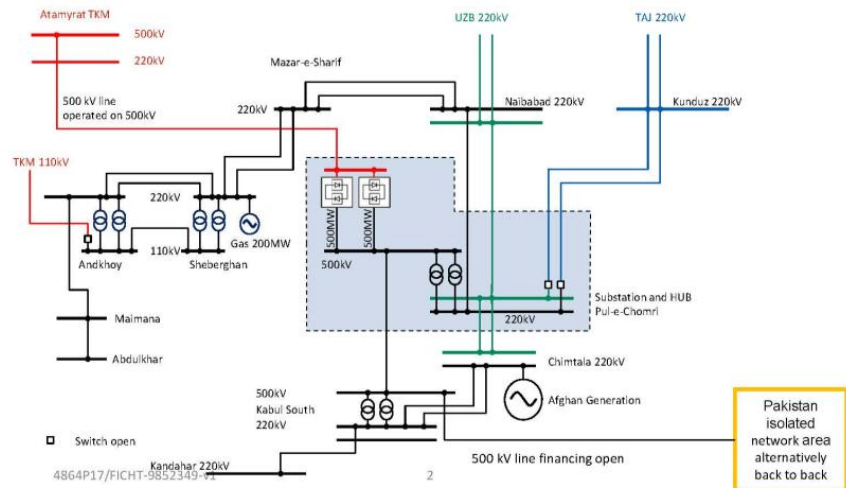
Synchronization is a bottleneck

Major Transmission Project: Stage A



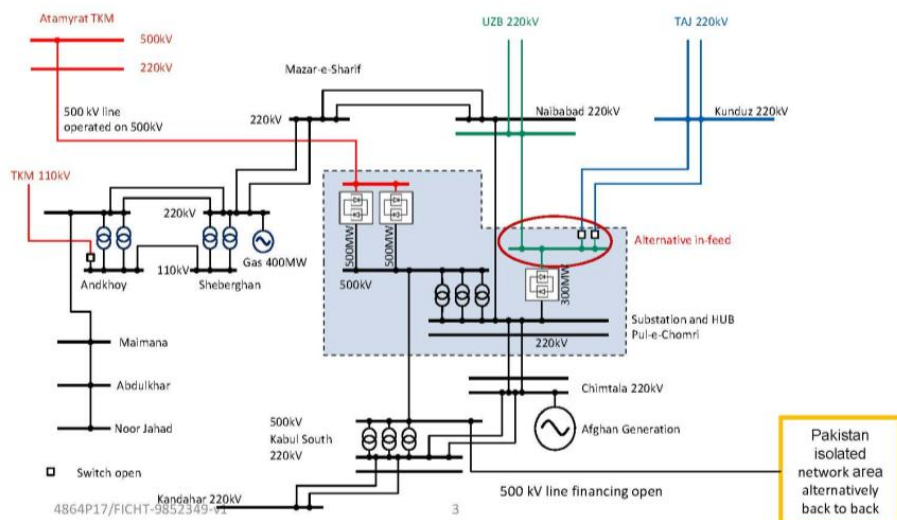
Synchronization is a bottleneck

Major Transmission Project: Stage B



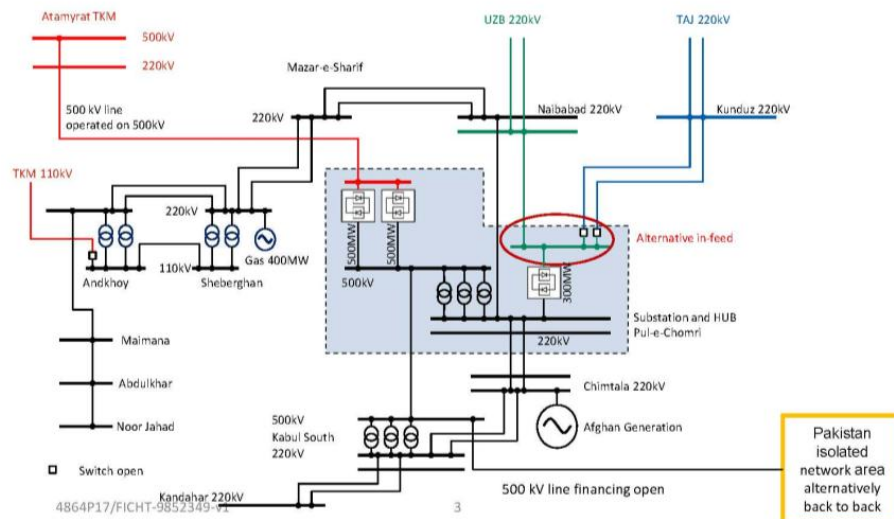
Synchronization is a bottleneck

Major Transmission Project: Stage C



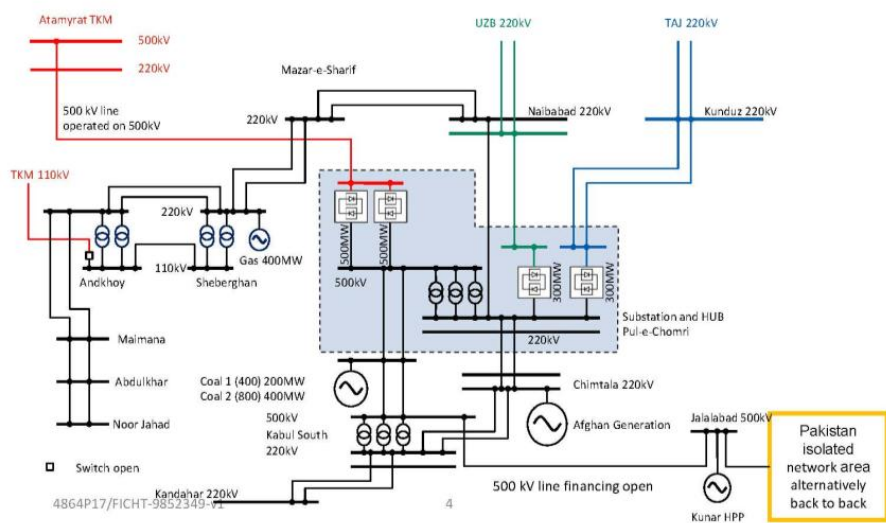
Synchronization is a bottleneck

Major Transmission Project: Stage C



Synchronization is a bottleneck

Major Transmission Project: Stage D



Huge Demand in Pakistan

- The electricity sector of Pakistan is facing high shortage in supply which has led to power outages on a large scale. The electricity demand in Pakistan is growing at a rapid pace due to increase in the population and the power demand increase of all the sectors of economy.

Year	Electricity Demand (MW)
2010-11	21755
2011-12	23491
2012-13	25356
2013-14	27488
2014-15	29513
2015-16	31722
2016-17	33204
2017-18	35618
2018-19	38607
2019-20	41832
2020-21	45257
2021-22	48885
2022-23	52777
2023-24	56863
2024-25	61158
2025-26	65700
2026-27	70396
2027-28	75177
2028-29	80203
2029-30	85532

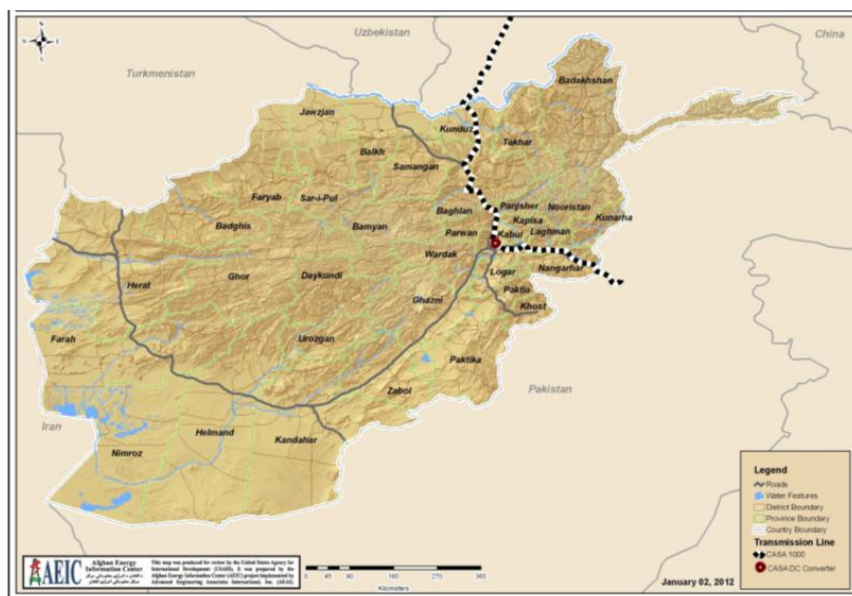
Supply-Demand Assessment in Pakistan

Year	Installed Generation Capacity (MW)	Available Capacity (MW)	Demand Forecast (MW)	Surplus/Shortfall (MW)
2010-11	22697	18158	21755	-3597
2011-12	23788	19030	23491	-4461
2012-13	26279	21023	25356	-4333
2013-14	29405	23524	27488	-3964
2014-15	33630	26904	29513	-2609
2015-16	42350	33880	31722	2158
2016-17	45338	36270	33204	3066
2017-18	50034	40027	35618	4409
2018-19	53284	42627	38607	4020
2019-20	58867	47094	41832	5262
2020-21	63683	50946	45257	5689
2021-22	68349	54679	48885	5794
2022-23	70014	56011	52777	3234
2023-24	70614	56491	56863	-372
2024-25	76214	60971	61158	-187
2025-26	79014	63211	65700	-2489
2026-27	83014	66411	70396	-3985
2027-28	84014	67211	75177	-7966
2028-29	88334	70667	80203	-9536
2029-30	N/A	N/A	85532	N/A

CASA-1000

- **CENTRAL ASIA - SOUTH ASIA ELECTRICITY TRANSMISSION AND TRADE (CASA-1000)**
- **HVDC**
- **1000 MW to Pakistan**
- **300 MW to Afghanistan**

CASA-1000



Conclusion

- Yes, Afghanistan can wheel Energy to SAARC countries, if:
- Unified National Power Grid
- To Solve the Synchronization problem
- Equip the system with modern protection and automation equipments
- Mobilize experienced and skillful operation personnel



South Asia Power Market -Prospects and Challenges

By

D. N. Raina

President

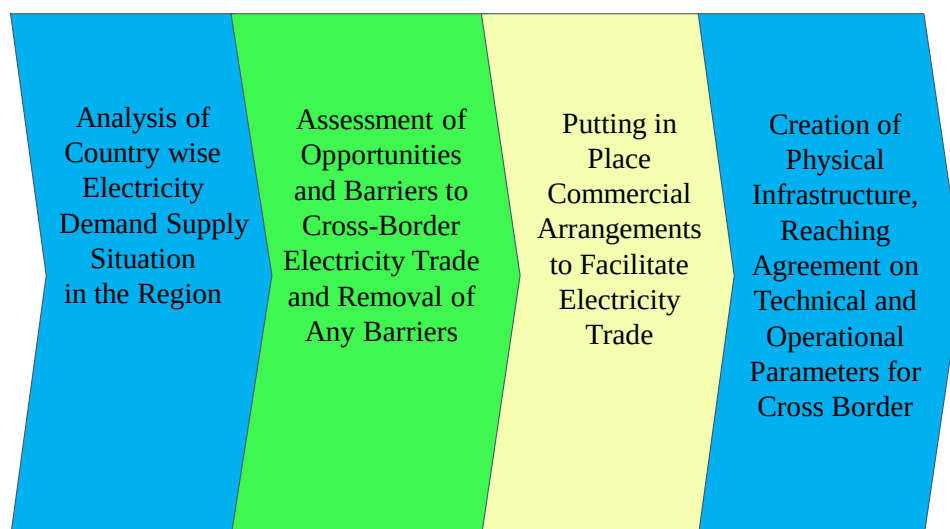
Entecsol international

rainadn@gmail.com

Kathmandu

March 6, 2013

Creation of Regional Power Market



Current Situation in SAARC

- All the countries in the region facing acute power shortages except for Bhutan especially in summer
- Demand-Supply mismatch results in long planned and unplanned outages
- Planned generation capacity additions unlikely to help overcome mismatch in near future
- Lack of Physical connectivity of power systems except between Bhutan-India and Nepal –India
- Encouraging trend :
 - under construction transmission interconnection between Bangladesh-India, India- Sri Lanka on the horizon and Pakistan-India prefeasibility study completed recently
 - Efforts of Afghanistan and Pakistan to establish the Central Asia-South Asia transmission interconnection to be the first major inter regional project for power imports in to South Asia from the neighboring region

Opportunities

- Despite prevailing shortages opportunities exist for cross border power trade due to:
 - different generation profiles
 - daily and seasonal variations in load curves
- Resource rich countries resolve to expedite their economic development through power exports
- Importing countries willingness to import electricity to sustain their economic growth
- SAARC Heads of State approval for creation of SAARC Energy Ring
- Region rich in hydropower resource that can be exploited to bridge the demand-supply gap
- Technical and managerial expertise available within the region that can be shared for mutual benefit

Barriers

- Generation capacity limitation the biggest hurdle in allowing power exports
- Electricity Laws and Regulation - only Bhutan and Nepal have provisions for encouraging cross border electricity trade
- Power Systems technical and operational parameters vary leading to establishment of high cost HVDC interconnections instead of AC interconnections
- HVDC interconnections make energy imports costlier
- One-off projects unlikely to support development of a regional power market in South Asia
- Lack of commercial arrangements and or agreements specifically to handle electricity trade

Barriers

- Open access on transmission and distribution systems
- Large investment requirement beyond the control of the governments in the region
- Export duties envisaged for power exports
- Financial weakness of power utilities hindering attraction of capital essential for create physical infrastructure

THANK YOU !

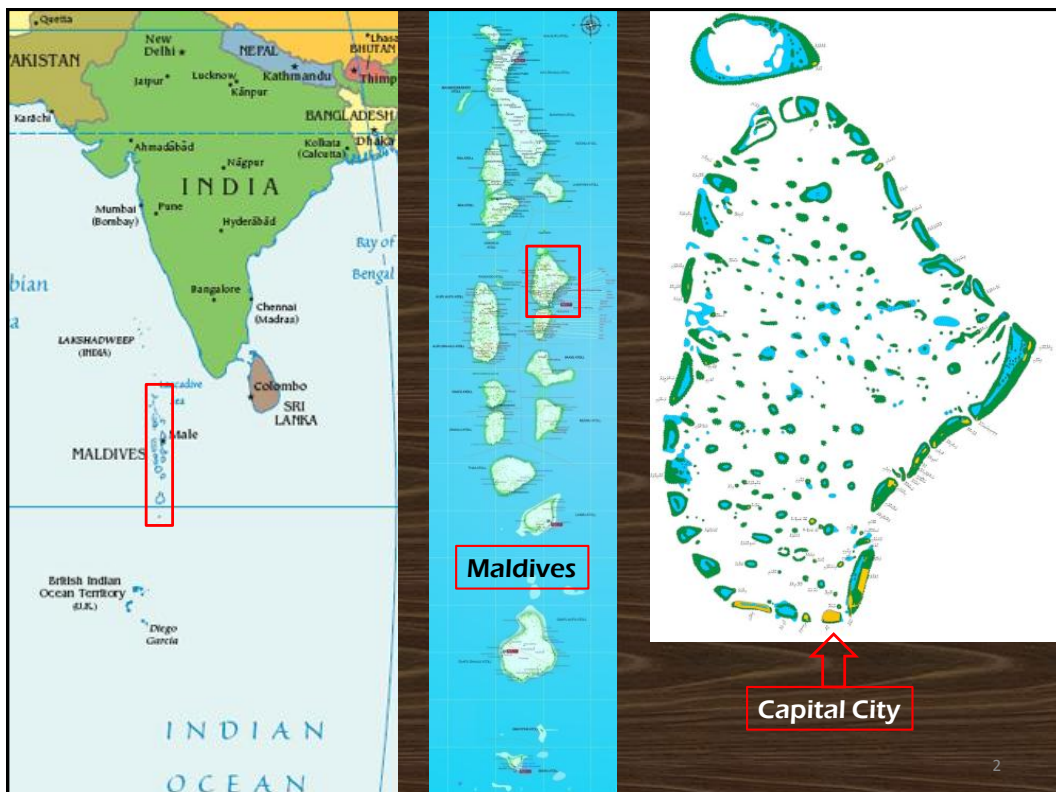
The Need for an Energy Grid in the Maldives

By:
Dr. Zaid Mohamed

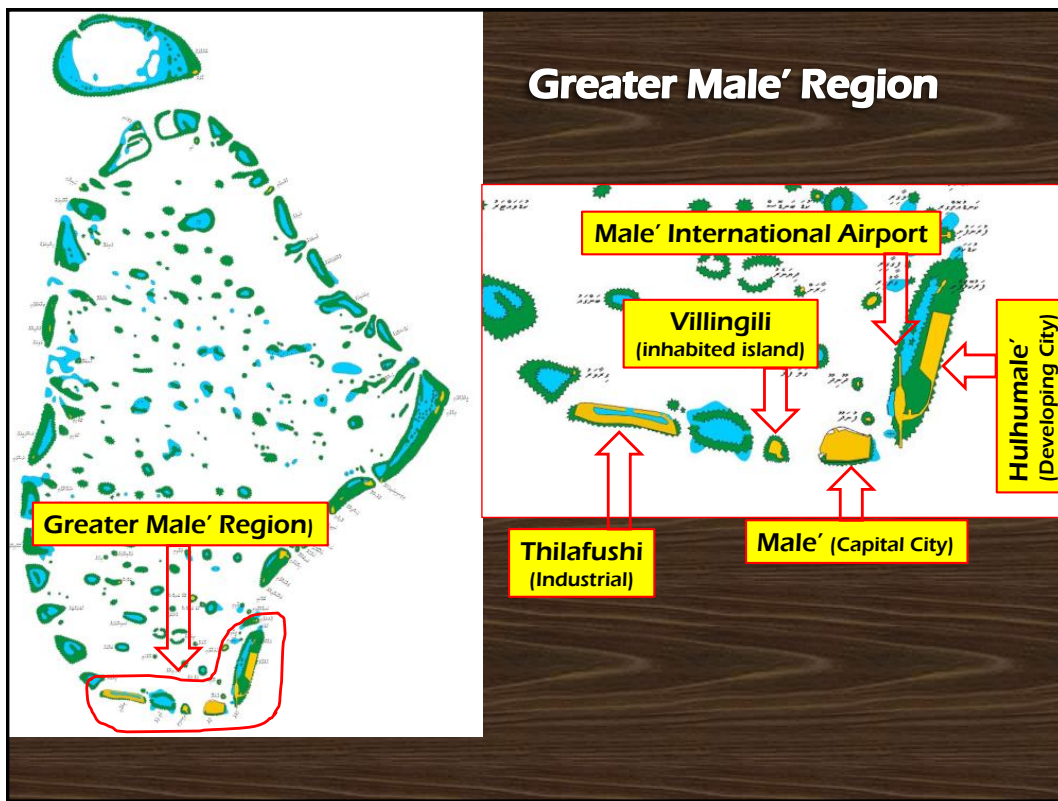
&
Mohamed Latheef

Deputy Managing Director
State Electric Company Limited
Male'
Maldives

1



2



Statistics	
Total Population	298,968
Population in the Capital	102,377
Percentage In the Capital	34%
Number of Islands	1190
Inhabited Islands	185
Number of Atolls	26
Administrative Provinces	7



STELCO History

- The State Electric Company Limited (STELCO) is an entirely State owned organization responsible for the generation and distribution and sale of electricity to consumers through out the North Central Province (NCP) of the Republic of Maldives.
- STELCO was formed back in 1949, as a government department - Electricity Department. The service started with the use of a 14kW generator providing electricity to only 50 consumers of Male'.
- Over the 63 years of service, the institution was re-named from Electricity Department to Maldives Electricity Board (MEB) and then on 19 June 1997 the name was changed to State Electric Company Limited (STELCO) as a totally state owned company by a Presidential Decree.
- By end of 2008 STELCO expanded services from North to South of the country totaling 28 islands catering 60% of the total population of Maldives.

5

STELCO Today

- In 2009 with the new government policies, 7 provinces were formed with utility companies managing all utility services in their own respective provinces. As a result, on 1st May 2009 STELCO handed over 22 island power houses to these utility companies.
- STELCO now provide its services to 28 islands in NCP with over 33000 consumers and total installed capacity of 78.38MW covering 37% of the population of Maldives.
- Diesel power plants are mainly used in STELCO
- 1 MW of Solar PV installed in Male' and few other islands under various projects.

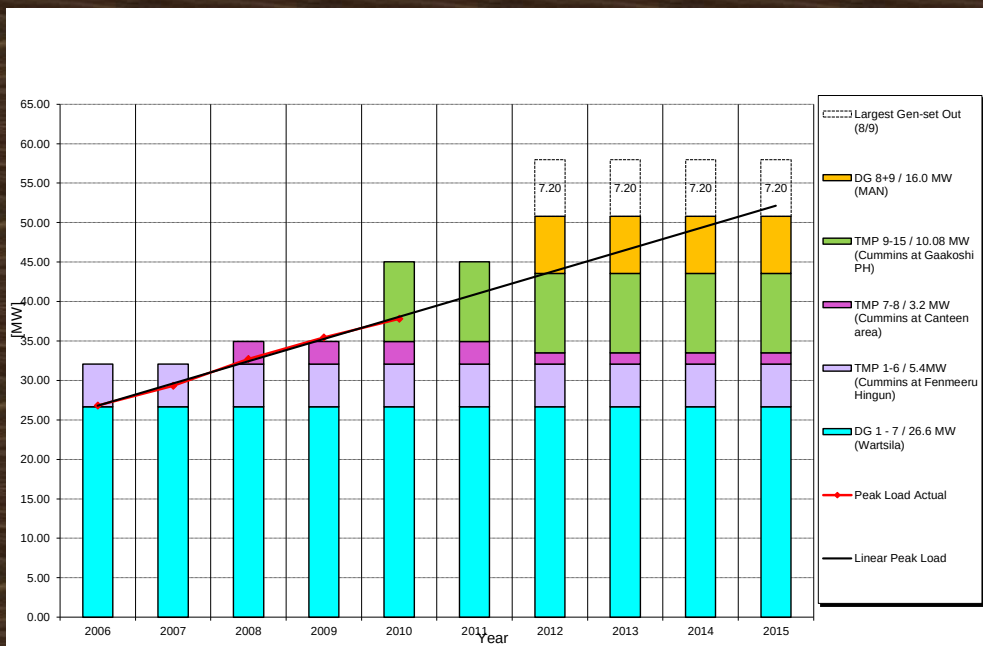
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Male'

- Current peak demand in Male' is 41MW
- Total Installed capacity is 61.42MW



Male' - Firm Capacity versus Peak Load [MW] - 2006 to 2015



Challenges in Expansion & the Need for a Grid

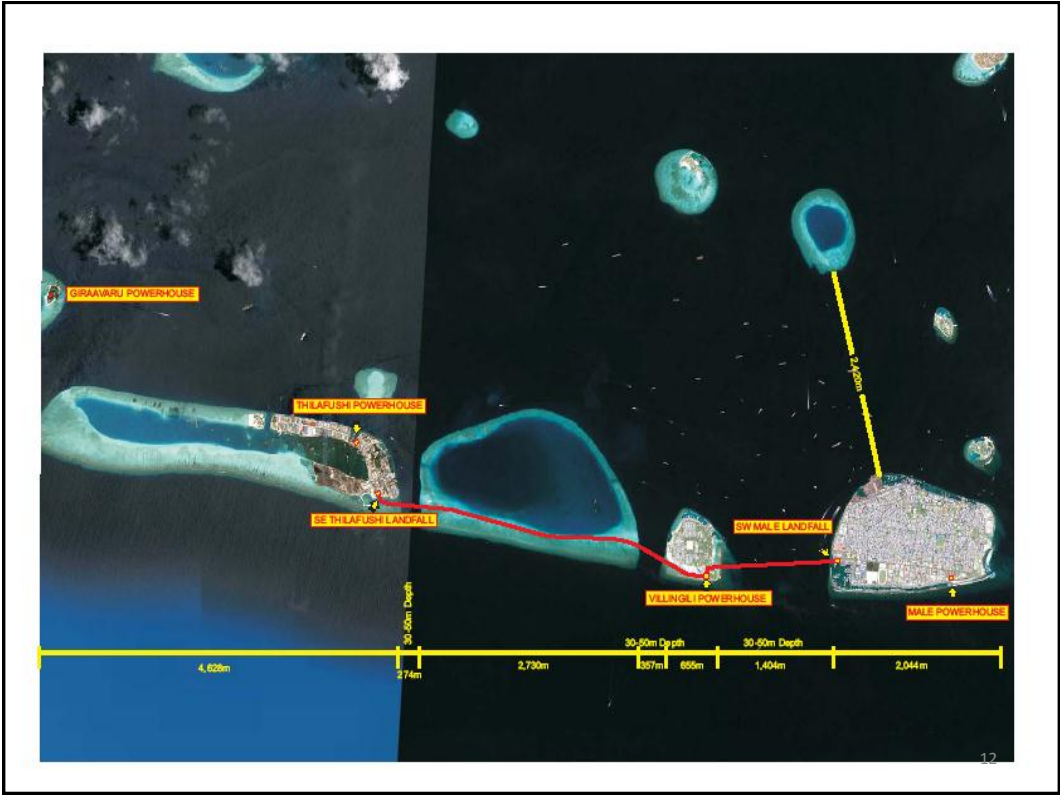
- Male' is congested
 - Land Availability
 - No available space in Male'.
 - Exhaust Emission Limitations
 - When the current power project is completed power plant emission will reach to maximum acceptable limit
 - Power System Protection
 - Will reach maximum allowable production capacity based on system Voltage (appx.55MW)
 - Network Overloading
 - Male' 11kV distribution network requires upgrades and expansion
- Power Generation outside capital island Male'??

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Potential Future Locations

- Hulhumale
 - Land is available
 - Future load center
 - Minimal distance (economically more viable)
- Thilafushi
 - Land is available
 - Future load center (commercial activities)
 - Long distance

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Island Electrification

- Average size of each island is small
- Population less than 1000 on average
- Power demand is low
- Cost of operation very high
- Revenue is small
- Operational loss

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Regional Interconnection Grids

- Improves reliability and system efficiency
- Phase 1: Interconnect islands in the same reef
 - More than 2 islands in the same reef
 - These power systems can be interconnected
 - Consider possibility of having larger power plants
- Phase 2: Interconnect islands across 2 or more reefs within the atoll.
- Phase 3: Interconnect the grids across atolls.

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Carbon Neutral Maldives

- Until 2012, all our energy production is from diesel (MGO)
- GoM has announced to be carbon neutral by 2020
- GoM is committed to produce energy from renewable sources
- Solar and wind seems the most favorable to Maldives

Challenges for Renewable Investments

- Financial & economic barriers
 - Initial investment large
 - Difficulty in getting finance/loans due to high risk of projects
 - Payback period long
- Availability of space for installations
 - Male'
 - Small or No roof tops
 - Cannot get big space in one area
 - Installations Outside Male'
 - For islands
 - Space may be available in some islands but still limited in many islands
 - Nearby offshore options available



**Expansion of RE investments at commercial scale
also requires an interconnected grid**

17

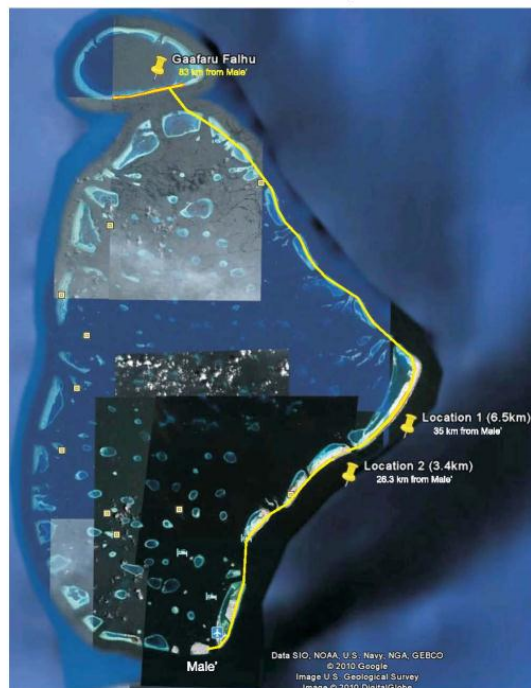


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19

Distance From Male' to Location 1, 2 and Gaafaru



20



21

RE Challenges ...

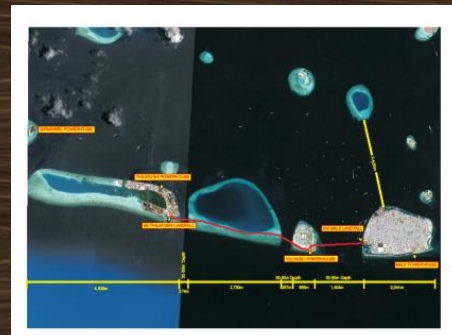
- Limitations on the level of RE injection
 - Small & Independent Grids
 - Limitation on direct feed RE systems
 - Requires larger grids
 - Submarine cable
- Technical
 - Uncertainty in technologies
 - Limited Expertise
- Institutional & Regulatory
 - Need a framework to encourage RE technologies

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Challenges ...

- Submarine cable very expensive
 - Male'-Hulhumale': Estimated US\$26.4 million
 - Male'-Villingilli: Estimated US\$10.9 million
 - Villingilli-Thilafushi: Estimated US\$26 million

Source: "Maldives Submarine Cable Interconnection Pre-Feasibility Study" prepared for USAID/SARI-Energy, by SNC Lavalin and PA Government Services, Inc. (April 2010).



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National & Regional Grid

- Currently each island is an independent power grid
 - National grid will remove this disadvantage
- Financial & Technical difficulties due the unique geographic nature of the Maldives
- Maldives can take benefit of the energy grid
 - Eliminates the constraints on power expansions
 - Help to reduce the price of electricity
 - Increase stability & efficiency
 - Land issue will also be solved

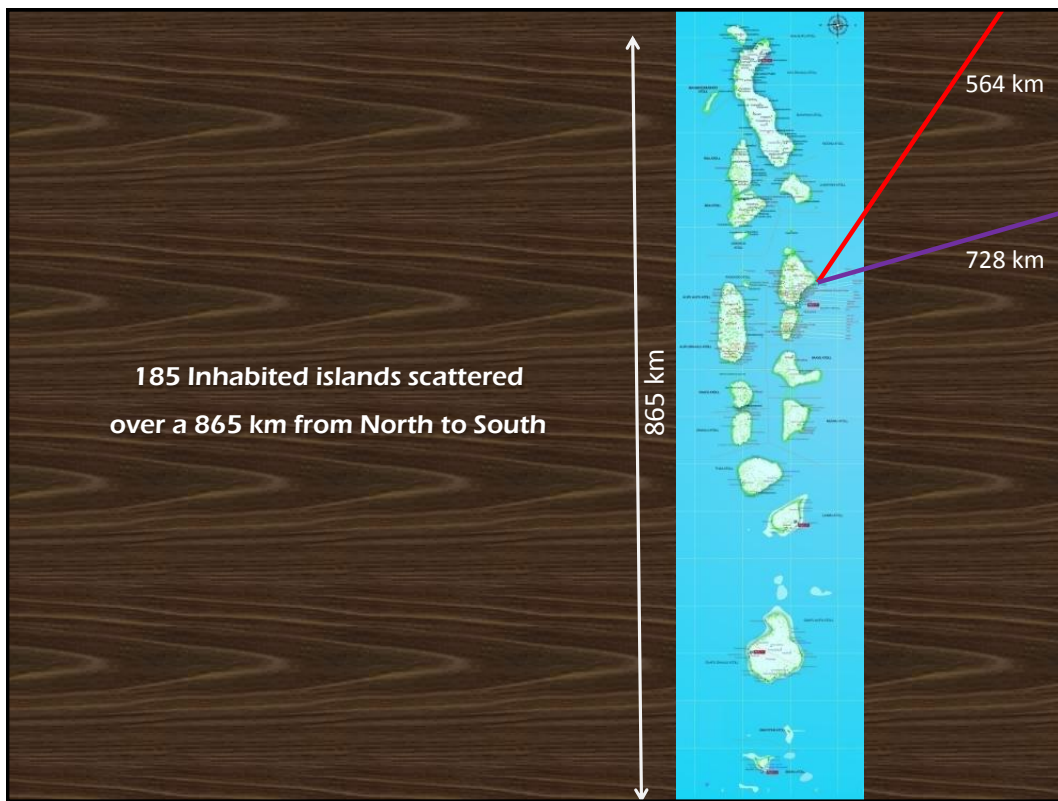
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Interconnection between neighboring countries to Maldives



Kaafu Atoll Map





Summary

- For Male', demand continues to grow at a very fast rate
- Having challenges in power expansion
- Further challenges in RE investments
- Power expansion limited by the need for a Grid
- Constraints on Grid interconnections due to financial and economic issues
- A regional grid will give a lot of advantage for the case of Maldives

Thank You

The 6th Japan-SAARC Symposium , 6-7 March 2013,
Kathmandu, Nepal

THE ENERGY COOPERATION IN SOUTH ASIA UNDER SAARC UMBRELLA

Dr. Muhammad Pervaz
Programme Leader, Technology Transfer
SAARC Energy Centre

Some Important Features and Facts of SAARC Region

- Population more than 1.6 billion, (above 1/5th of world population);
- Low per capita income with vast population living in poverty ;
- Low per capita energy consumption (514 kgoe/capita/year). EU (3,536); USA(7,051); Malaysia (2,391); China (1,695); World avg (1,788).
- Low access to electricity and low consumption(517 kwh/capita/year)
- Even at this level region is facing huge energy shortage
- High ratio of traditional biomass: More than 200 Million TOE per annum
- Lack of balance energy mix nationally;
- Energy deficient (except Bhutan) and high oil import dependence, which is on rise due to rise in demand;
- Annual commercial energy consumption 655 Million TOE;
- Commercial energy demand will be more than 2,000 Million TOE by 2030.
- Low cross border energy trade; and
- Resource potentials under-explored

How to Meet Growing Energy Demand

- Enhance indigenous resource base and promote R&D
- Diversify of **energy mix and energy supply sources**
- Sharing resources by promoting energy trade within SAARC countries and beyond
- **Enhance regional and international energy cooperation**
- Development and deployment of renewable energy resources; solar, wind, micro hydel, biomass etc
- **Optimum and Efficient** use of resources and conservation of energy
- Exploration and development of non conventional hydrocarbon resources like **shale gas and tight gas**

Primary Commercial Energy Consumption – 2011

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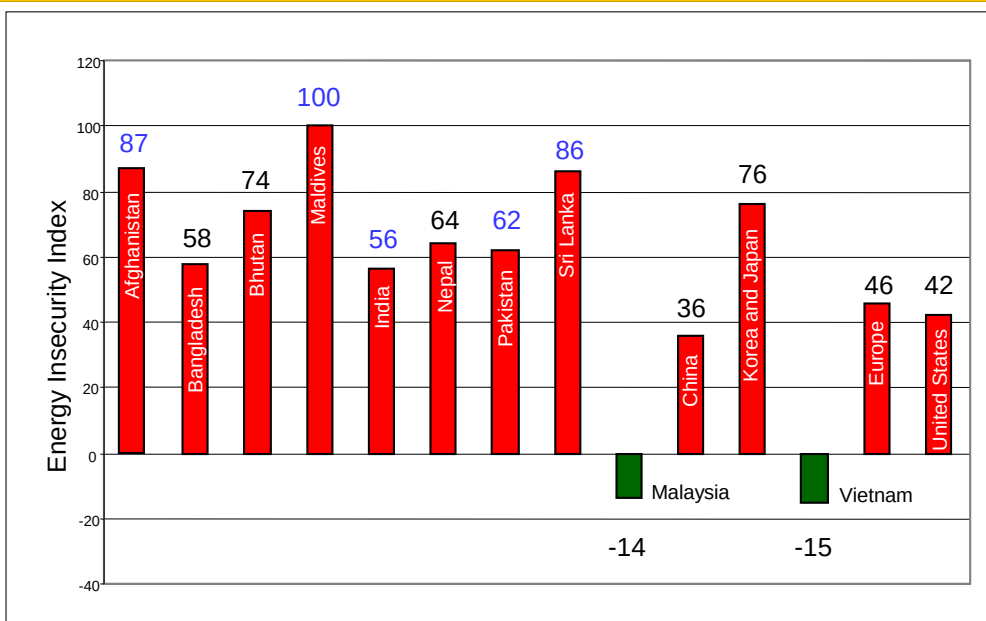
Energy Insecurity Index

Energy Insecurity Index is based on:

- Share of net imports in total oil consumption (40% weightage)
- Share of oil in total primary commercial energy consumption (35% weightage)
- Share of the Middle East oil in total oil imports (25% weightage)

All South Asian countries suffer from energy insecurity and are projected to remain so in the foreseeable future

Energy Insecurity Index



Source: <http://www.eastwestcenter.org/fileadmin/stored/pdfs/asiaenergyfuture10insecurityindex.pdf>

SAARC Institutional Mechanism for Energy Cooperation

- Ministerial Level Energy Forum;
- SAARC Working Group on Energy;
- Energy Commodities Expert Groups on:
 - Oil and Gas;
 - Electricity;
 - Renewable Energy; and
 - Technology/ knowledge sharing (including energy efficiency, coal, etc.)
- SAARC Energy Centre

SAARC Energy Centre

- Established in 2006 at Islamabad to initiate, promote and facilitate cooperation in energy sector of SAARC Member States for the benefit of all
- Funded by SAARC Member States and supervised by a Governing Board comprising all Member States
- Professional staff selected on merit from Member States
- Expert services also obtained through outsourcing
- International Cooperation established with ADB, ASEAN, UN, ESCAP, Japan, US, Germany.

Thematic Programme Areas of SAARC Energy Centre

- **Energy trade**
- **Integrated assessment of energy, transport, and environment**
- **Energy efficiency and renewable energy**
- **Technology transfer and sharing best practices**
- **Rural electricity for poverty alleviation**

Studies and Projects for Sustainable Energy Development in South Asia (1/4)

Integrated Energy Potential of South Asia: Vision 2020

The study considered recent economic meltdown and its consequences on energy. On the basis of historical data, present trends and future expectation of the Member States, the study projected future fuel based energy demand up to 2020. The study also analyzed the energy resources availability within and across the region. The study recommended a number of proposals to materialize the vision of SAARC Leaders in the implementation of SAARC Energy Ring in a phased manner

Trends of Smart Grid: Approach for South Asia

The study contains various components of smart grid, its current status and way forward for SAARC Countries.

(Above studies are available on SEC website)

Studies and Projects for Sustainable Energy Development in South Asia (2/4)

Regional Electricity Trade: Legal Framework of South Asia

This study critically reviewed electricity acts, laws, regulations, policies and guidelines of SAARC Member States and also reviewed the documents of South African Power Pool – a success story in the area of regional energy cooperation.

Regional Hydropower Plants : Opportunities in Bhutan and Nepal

The study was undertaken by considering the directives of SAARC leaders, outcome of the in-house study Integrated Energy Potential of South Asia and related information including hydropower potential Bhutan and Nepal. The study reviewed the existing Electricity Laws and Hydropower Development Policies and other related documents of Bhutan and Nepal.

(Above studies are available on SEC website)

Studies and Projects for Sustainable Energy Development in South Asia (3/4)

1. **SAARC Action Plan on Energy Conservation & Efficiency**
2. **Gender-Energy nexus**
3. **Improved Cooking Stoves: “SAARC Chullah”**
4. **Energy efficiency in brick kilns**
5. **Training in energy audit**
6. **Geothermal energy potential of South Asia**
7. **Lessons learnt in renewable energy technologies**
8. **Promoting hydropower development**
9. **Studying options for energy trade**
10. **Studying on Review of Electricity Laws and Regulatory Framework of SAARC Member States (Japan-SAARC Fund)**
11. **Dissemination Workshop Above study in 2013**
12. **Promoting extraction of non-conventional gas**

Studies and Projects for Sustainable Energy Development in South Asia (4/4)

13. SAARC Energy Data Bank
14. Feasibility Study for regional coal based power plant
15. Workshop on coal based power generation
16. Experience sharing of construction, operation and maintenance of LNG facilities.
17. Study on cogeneration in sugar and paper industries
18. Study on rural electrification policies
19. Capacity building of Energy Auditors
20. Energy pricing mechanism

Draft-SAARC – Japan Study on Review of Electricity Laws and Regulatory Framework of SAARC Member States (1/2)

Recommendations: The Draft Study proposed the establishment of the followings for Cross Border Electricity Transit and Trade:

- SAARC Regional Electricity Legal Framework (SELF)
- SAARC Regional Power Projects (SRPP):
- SAARC Investment Facilitation Program (SIFP)
- SAARC Electricity Trading Mechanism (SETM):
- SAARC Template Documents (STDs):
- South Asia Regional Power Exchange (SARPE):
- SAARC Electricity Regulatory Commission (SERC):

Draft-SAARC – Japan Study on Review of Electricity Laws and Regulatory Framework of SAARC Member States (1/2)

The study proposed the changes required for Cross Border Electricity Transit and Trade in the following areas:

- Legal
- Regulatory
- Technical
- Commercial

A consensus with regard to the legal, regulatory, technical and commercial aspects amongst the Member states; will help in handling cross border electricity trade and transit in a well defined manner. It will remove the uncertainties.

Energy Trade: A Vision for South Asia Energy Network

- Nepal and Bhutan have hydro-eclectic potential more than their requirement which can be tapped and traded among SAARC countries
- Central Asian countries and Iran has huge gas reserve which can be imported through pipeline to the SAARC countries. This gas in phases, may be transported to other South Asian countries in the similar fashion as the Trans-Siberian Pipeline extended in the Europe
- Electricity trade with resource-rich Central Asian countries (Tajikistan, Kazakhstan, Uzbekistan Turkmenistan) may expanded through Afghanistan to Pakistan and India.
- Initially the energy trade can progress in two clusters- east and west cluster- with ultimate goal to merge into greater South Asian Energy Network

Regional Energy Trade Initiatives

- **SAARC Regional Energy Trade Study (SRETS) funded by ADB identified four regional or sub-regional trade options:**
 - i. **Power Market**
 - ii. **Petroleum Refinery**
 - iii. **LNG Terminal**
 - iv. **Power Plant**
- **A follow up study on South Asia Regional Power Exchange conducted with assistance of ADB**

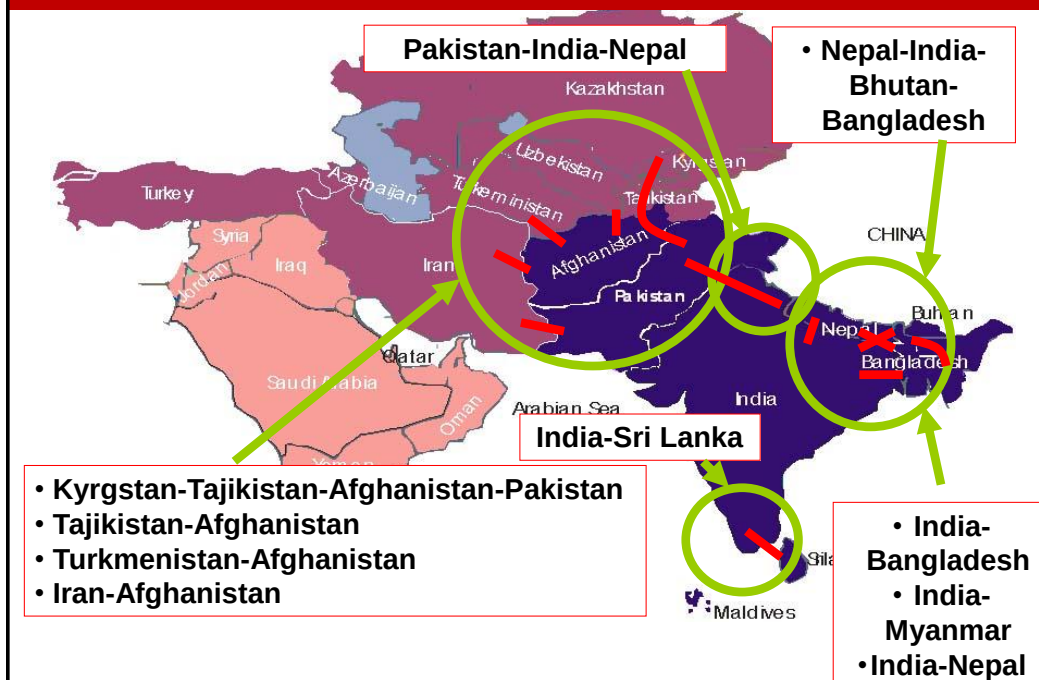
DRAFT INTER-GOVERNMENTAL FRAMEWORK AGREEMENT FOR COOPERATION IN ELECTRICITY

- Draft of a “SAARC Inter-Governmental Framework Agreement for Energy Cooperation (Electricity)” endorsed by Energy Ministers Meeting in Dhaka (15th September 2011) is under consideration of SAARC Member States
- Draft IGFA provides to allow for:
 - Unrestricted cross-border trade
 - Commercial negotiation of PPAs
 - Non-discriminatory open access
 - Private sector trading
 - Participation in power exchanges
- Ultimate objective is to create a SAARC Market for Electricity: SAME

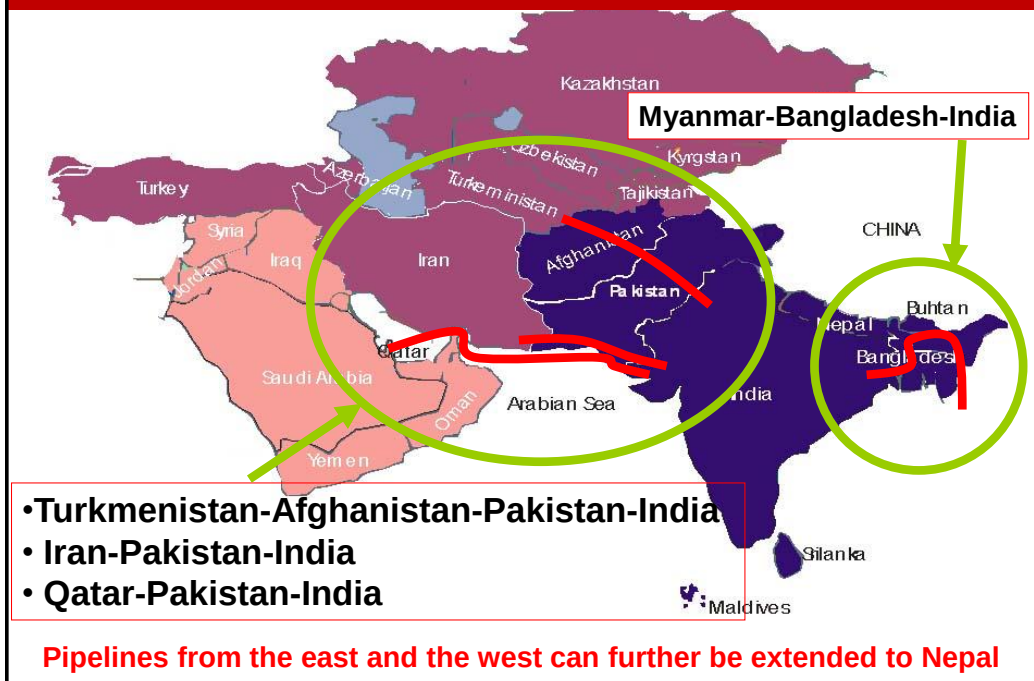
SAARC Energy Ring

- **SAARC ENERGY RING: a Vision given by SAARC Leaders at the 2004 Islamabad Summit**
- **Vision being translated into reality by SAARC Energy Centre**
- **Four Expert Groups preparing way forward based on dynamic concept of energy ring considering the followings:**
 - **Oil and Gas**
 - **Electricity**
 - **Renewable Energy**
 - **Technology Transfer (including Coal and Energy Efficiency)**
- **All the Expert Groups convened their meetings and prepared the ToRs and Work Plan for implementation**

SAARC Energy Ring – 1. Power Grid



SAARC Energy Ring – 2. GAS GRID



**SAARC Energy Centre
mitigating energy poverty through
fostering energy cooperation
within and across South Asia
for a better tomorrow**



Economics of Regional Energy Cooperation: Nepal Case Study

Dr Priyantha D C Wijayatunga
Head, Portfolio Management Unit
Nepal Resident Mission
Asian Development Bank

6th Japan-SAARC Energy Symposium
6-7 March 2013
Kathmandu, Nepal



Outline

- Need for Regional Cooperation
- Regional Energy Trade Study
- India-Nepal Interconnections
- Economic benefits
- Final Remarks

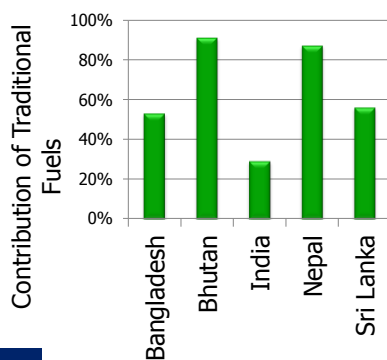


Regional cooperation?

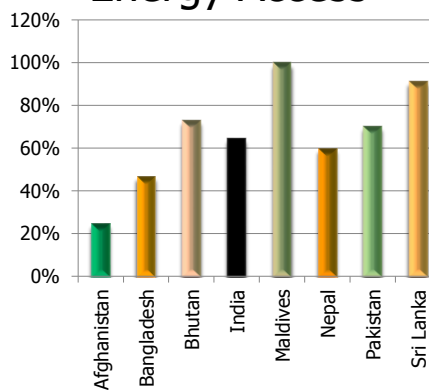
- Wide variation in resource endowments
 - Hydropower, coal, natural gas and other renewable energies
 - Sharing of low cost energy resources
- Full potential not exploited
 - Economic opportunities energy exporting countries
 - Enhanced opportunities for climate change mitigation
- Single fuel dominance
 - Energy resource diversification and energy security
- Acute power shortages

Energy Sector

Traditional Fuel Use

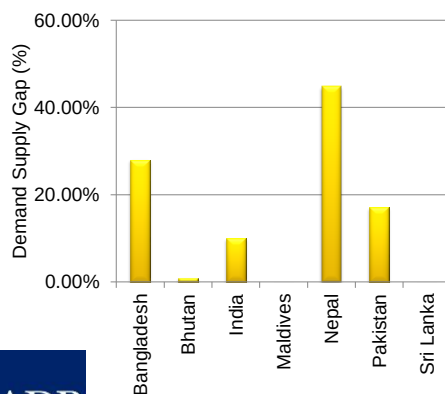


Energy Access

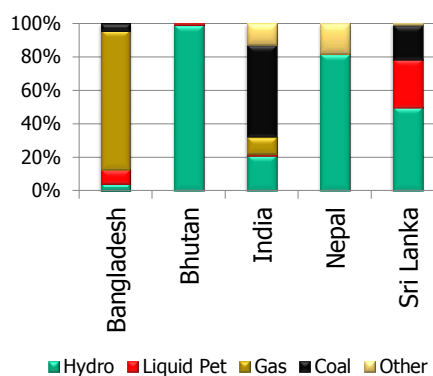


Energy Sector

Demand Supply Gap

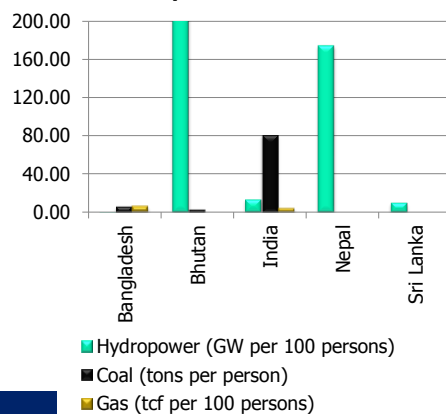


Generation Composition



Energy Sector

Per Capita Resources



Electricity Supplies

- Region to add about 63000MW of coal power (2012-2017)
- Will generate about 410 TWh per year
 - About 390 million CO₂ emissions

Short distances to connect



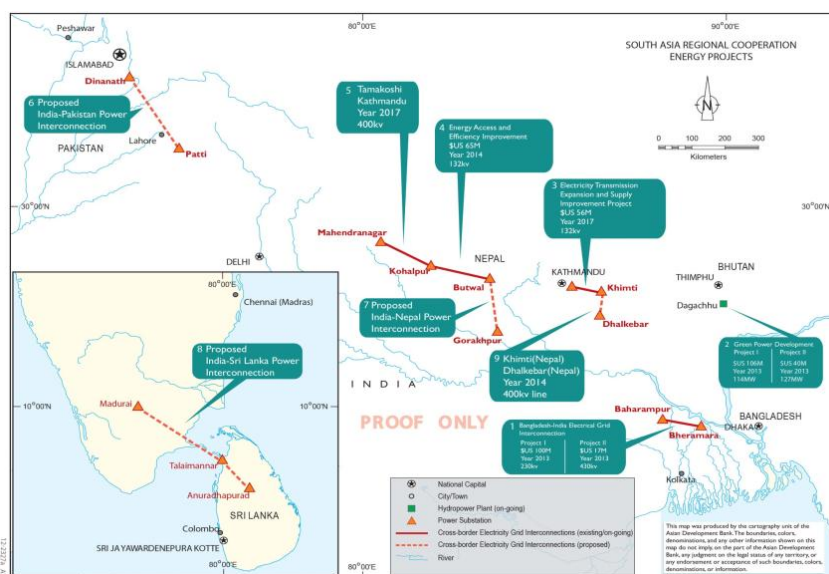
SAARC Regional Energy Trade Study (SRETS)

- Proposed projects
 - India-Nepal power interconnections
 - Dhalkebar to Muzaffarpur
 - Gorakhpur to Butwal
 - Bangladesh-India power interconnection
 - Western border of Bangladesh
 - Assist Bangladesh to import power from India
 - Bhutan-India interconnections
 - Catering increased hydropower development and cross-border trade
 - India-Sri Lanka interconnection
 - Establishment of a regional power market

Proposed interconnections



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INDIA

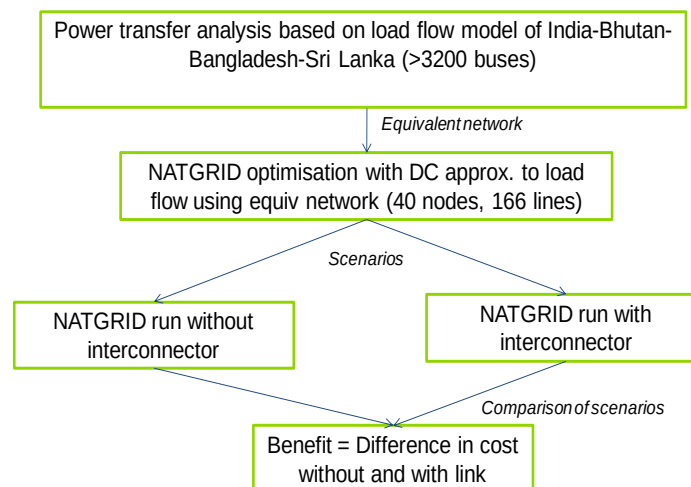


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Economic Benefits

- Benefits of regional cooperation
 - Dhalkebar-Muzaffarpur transmission line
- Analysis carried out with an investment planning model
 - Reduced integrated South Asia transmission network of 40 nodes and 166 transmission lines
 - "with" and "without" project scenarios.

Methodology





Economic Benefits

- Generation investments
 - Based on generation plans of the individual countries
- Transmission capacity and electricity demand projections
 - Based on the national plans
 - Extrapolated in certain cases



Economic Benefits

- Benefit of cross-border transmission measured
- Reduced generation costs both investment and operation
- Reduced cost of unserved energy
 - Due to increased overall effective generation capacity at the disposal of each of the countries.



Economic Benefits

- Project estimated to cost \$186 million
 - inclusive of in-country transmission network strengthening to support 1000MW of cross-border flows
- The study analysed
 - Nepal reaching a generation surplus state by 2016/17
 - Nepal remains a deficit state even by then
- Accrued benefits \$ 105-215 million per year
- Cost of the transmission around \$ 20 per year
- Interconnector highly beneficial in both scenarios
- Benefits far higher in the latter



Final remarks

- Economic rationale for India-Nepal interconnections is high
 - High energy transfers
 - Significant difference in economic costs
- Additional benefits
 - Climate change mitigation
 - Improved reliability



Thank you

Priyantha D C Wijayatunga
E-mail: pwijayatunga@adb.org





REGULATORY FRAME WORK FOR TRADE

Sher Singh Bhat

WHY MARKET TRANSITION AND TRADING?

- ☐ Demand growth rate of electricity very high
- ☐ Supply needs to be increased to meet increasing demand
- ☐ Asking rate of investment in power sector > 25 % of budget
- ☐ State cannot afford that
- ☐ Investment gap for power sector
- ☐ Public resources/ Development Aid cannot close that gap
- ☐ Private Sector perceived as vehicle of choice for electricity sector development
- ☐ Market structure should be changed to invite private sector
- ☐ Trading is inherent in all liberal markets after Monopoly

ELECTRICITY MARKETS

MARKETS	ENTITIES	LEGAL DOCUMENTS
Monopoly	Planner	Policy documents
Monopsony	Regulator	Acts
Wholesale competition	Generator	Regulations
Retail Competition	Grid Owner	Regulator's Directives
	Distribution Owner	
	Supplier	
	System Operator	
	Market Operator	
	Clearing house	

At least two entities for selling and buying needed for trade to happen

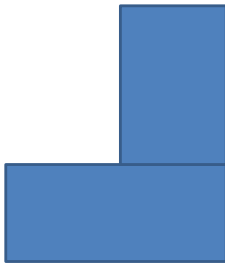
WHY REGULATIONS FOR TRADING?

- ☐ Financers of private investors are risk averse
- ☐ Prerequisite upstream ground work necessary for involvement of private sector in the energy business
- ☐ Attractive environment for private investors need to be furnished
- ☐ This requires a level playing ground for private capital
- ☐ This may be ensured through proper regulatory framework
- ☐ **That is why Regulatory Framework suitable for private investment is foundation of trading**
- ☐ These regulations must also give direction to create an economic consumer

ECONOMIC CONSIDERATIONS OF REGULATIONS



Small domestic



Mega FDI

- Private investment as vehicle of choice for mitigating energy crisis
- Mega Projects through private (domestic/ FDI) take longer time
- Fast track by engaging domestic private sector dominated by small / medium sized entrepreneurs
- This can result in a positive feedback spiral
- Spiral positive feedback loop result in the sustainable economic growth
- Relatively risky and time taking Mega projects through public or FDI can produce quantum growth
- **Regulatory framework should consider these economic dimensions**

OBJECTIVES OF REGULATORY FRAMEWORK



- ❑ It should ensure safe, reliable, efficient and affordable electric power to the electricity consumers
- ❑ It should facilitate transition from a protected monopoly service structure to a competitive environment
- ❑ It should strike and maintain balance between flourishing of electricity industry and rights of its consumers

BROAD COVERAGE OF REGULATORY FRAMEWORK



- Licensing
- Tariff
- Standards
- Consumer Affairs

COVERAGE OF REGULATORY F W

Related to Expansion	▪ Licensing to Generators, transmission providers, distributors and traders ▪ Market Development
Related to Operation	▪ Grid Code ▪ Granting Open access ▪ Procurement of Power and Transmission service from market ▪ Regulation for performance standards
Related to Tariff	▪ Regulation on Tariff determination for generation, transmission and distribution ▪ Retail Tariff ▪ Trading Margin ▪ Capex
Related to Consumer Rights and Judicial Process	▪ Adjudication ▪ Judicial Process: Public hearings ▪ Tariff petitions

POLICY GUIDELINES FOR REGULATORY FW

AREA	PARTICULARS
Internal Market Regulations GLs	➤ Procedures and reporting simple and straight ➤ Should allow the industry to grow. ➤ Protect consumer rights.
Cost of Service GLs	➤ Cost reflecting tariff is corner stone ➤ Price signal from market should also be introduced
Utilities Financial Planning GLs	➤ Utilities are customers for generators. ➤ Credit worthiness of the Utilities is crucial for private sector. ➤ Investors eventually eye the: ➤ credit worthiness ➤ accounting practices of the off-taker ➤ Dire need to bring the international accounting practices.

POLICY GUIDELINES FOR REGULATORY FW

AREA	PARTICULARS
Cross Border Energy Trade GLs	➤ Guidelines should increase competitiveness of the electricity industry within the Region ➤ This should increase the market options for producers to export their produce across the borders
T and D Utilities Benchmarking & Performance Enhancement GLs	➤ Mechanism for monitoring technical, financial, economic performance of natural monopolies of T&D ➤ This mechanism shall monitor impact of introduced policies and provide feedback for necessary actions ➤ Performance measurement mechanism to guarantee a minimum service level for the customer. ➤ Incentive regulation mechanism to allow the gains of improved performance to pass through to customer.

TARIFF REGULATION

Single or Two Part ?	▪ Usually Two Part ▪ Capacity charge and Energy Charge
Variability of Charges	▪ Both charges might be variable ▪ Might have escalable and non-escalable components
Capacity Charge Factors	▪ ROE, Interest, Depreciation, O&M, IWC
Tariff Norms	▪ ROE, Tax, Depreciation Rate (SLM, Declining balance) ▪ Capex ▪ O&M Expenses ▪ Efficiency ▪ Direct pass through items (fuel surcharge)
What value is regulated tariff ?	▪ Levelized ▪ Can be front or back loaded for same levelized value

FUNCTIONS OF REGULATORS

- **Functions related to licensing**
 - Grant licenses for generation, transmission and distribution of electric power;
 - Prescribe procedure and standards for investment programs by generation, transmission and distribution companies;
 - Prescribe fee including fees for grant of licenses and renewal thereof;
 - Prescribe fines for contravention of the provisions of Regulations;
- **Related to Standards**
 - Prescribe and enforce performance standards for generation, transmission and distribution companies;
 - Establish a uniform system of accounts by generation, transmission and distribution companies;
 - Review organizational affairs of generation, transmission and distribution companies to avoid any adverse effect on the operation of electric power services and for continuous and efficient supply of such services;

FUNCTIONS OF REGULATORS

- **Functions related to Tariff**
 - Determine tariff, rates, charges and other terms and conditions for supply of electric power services by the generation, transmission and distribution companies and notify ;
 - Encourage uniform industry standards and code of conduct for generation, transmission and distribution companies;
- **Functions Related to Consumer affairs**
 - Public hearings
- **Other Functions**
 - Tender advice to public sector projects;
 - Submit report to the Government in respect of activities of generation, transmission and distribution companies; and
 - Perform any other function which is incidental or consequential to any of the aforesaid function

RFW FOR CROSS BORDER TRADE

- ❖ **Cross Border Trading**
 - Bilateral
 - Regional Multilateral
- ❖ **RFW Concerning**
 - Infrastructure and assets
 - Markets
- ❖ **Guiding Policy Document**
 - Inter- Governmental Framework Agreement
- ❖ **Step 1: Domestic policy and regulations**
 - Acknowledge electricity as tradable commodity
 - Accept and adopt import and export of electricity
- ❖ **Step2: Bilateral and Regional Frameworks**
 - Bilateral / multilateral G2G Agreement for trading of electricity
 - Bilateral / multilateral regulatory framework for bilateral or regional trading
 - Regulatory framework to clarify Planning and implementation of combined grid, regional infrastructure, SO , market etc.



THANKS

Barrier Free : Power Market In SAARC

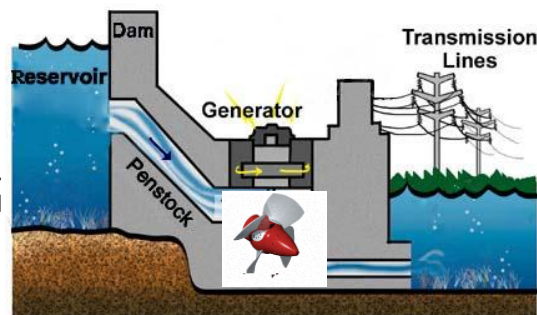


Hydro Solutions
empowering hydropower



Gyanendra Lal Pradhan

EC Member : FNCCI ,SCCI - Nepal &
Prime Minister's Economic Advisory Council
Chairman : SAARC CCI Council on
Climate change, Energy & Water

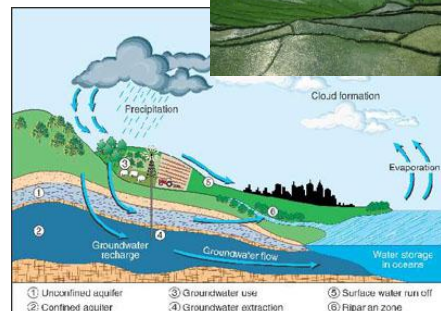
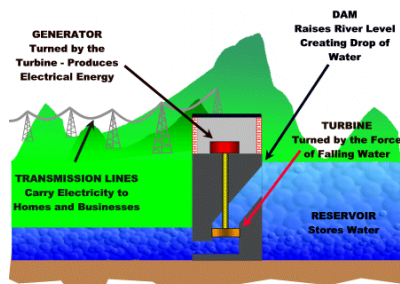


W A T E R



•Water is not only a life-line for all living beings on the earth but also a foundation for the overall development of human society.

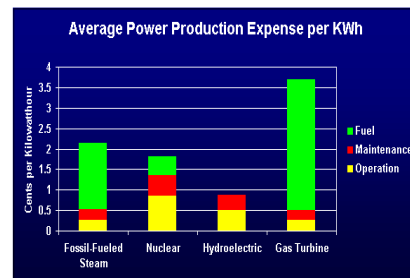
•Hydropower makes water use cheaper and efficient



“South Asia – The Garland Countries”



HYDROPOWER



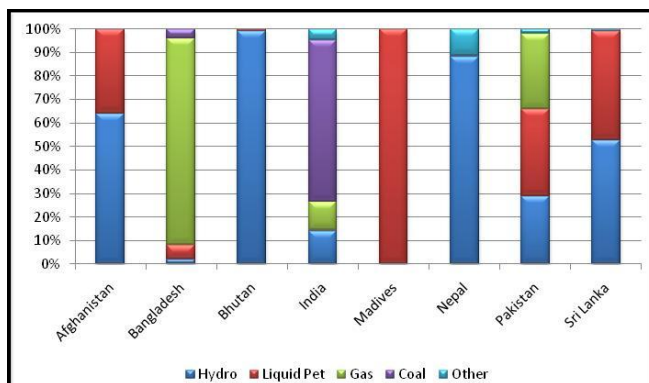
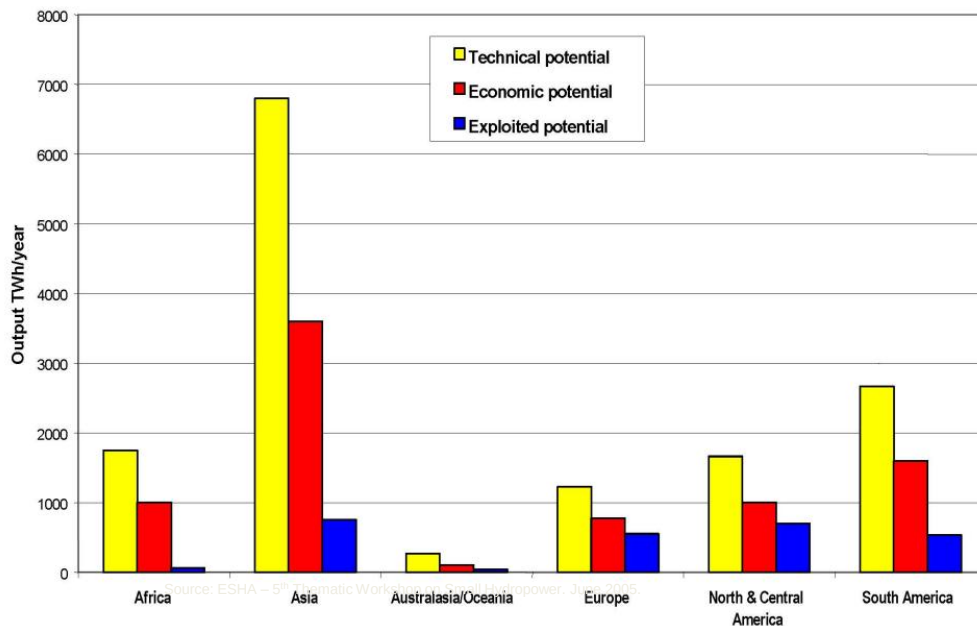
• SAARC region is endowed with estimated hydropower potential of more than 4,50,000 mega watts.

• about 10% of the potential has been developed so far.

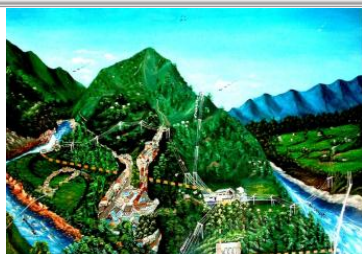
• The main reasons for slow development are reportedly non cooperation among SAARC countries.

Global hydro potential is highest in Asia

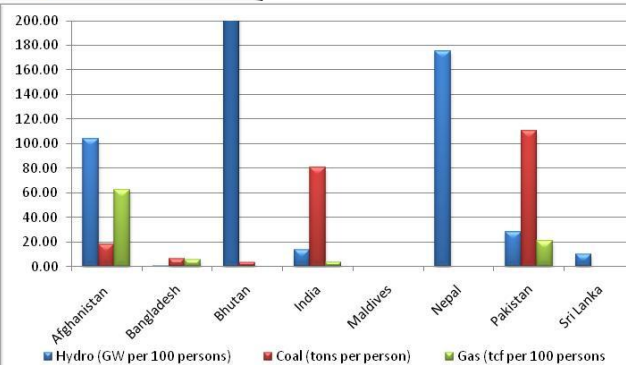
World Hydro Resource by Continent



Fuel Dominance



Energy resources





CARBON FOOTPRINT

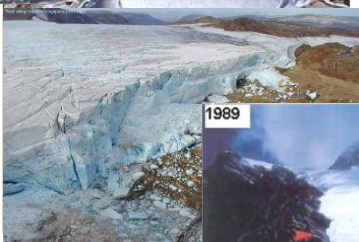
Power Sectors

Glaciers are retreating

Top-5 Countries with Highest CO₂- Emitting Power Sectors
(Format: Country Tons of CO₂)

1. United States: 2,790,000,000
2. China :2,680,000,000
3. Russia: 661,000,000
4. India: 583,000,000
5. Japan: 400,000,000



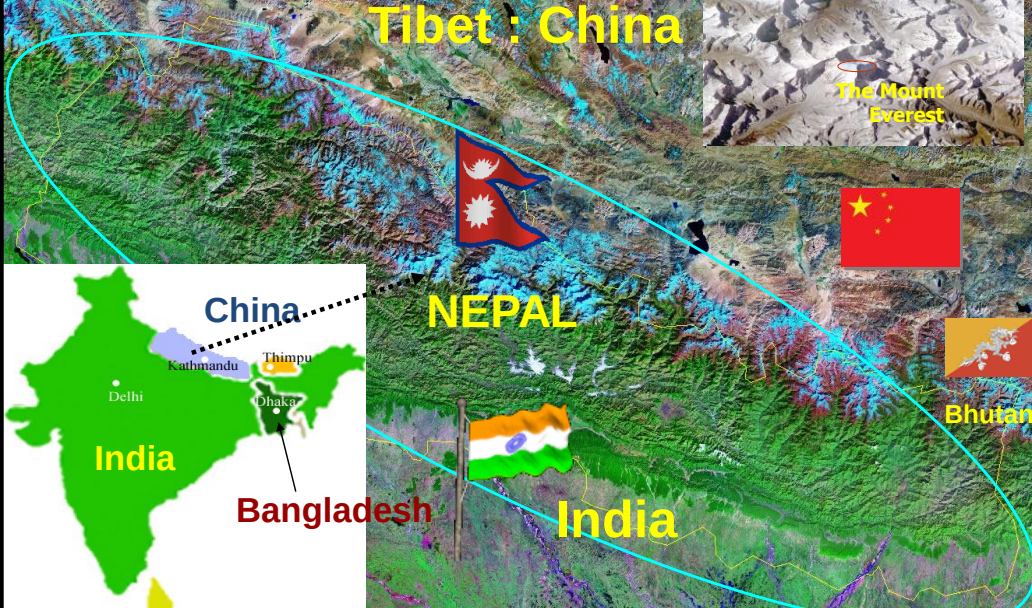




"If Himalayas live we can live"

- SAARC Region : world's fastest growing economy & lowest water & energy.
- Implications for Nepal as a regional player



Tibet : China

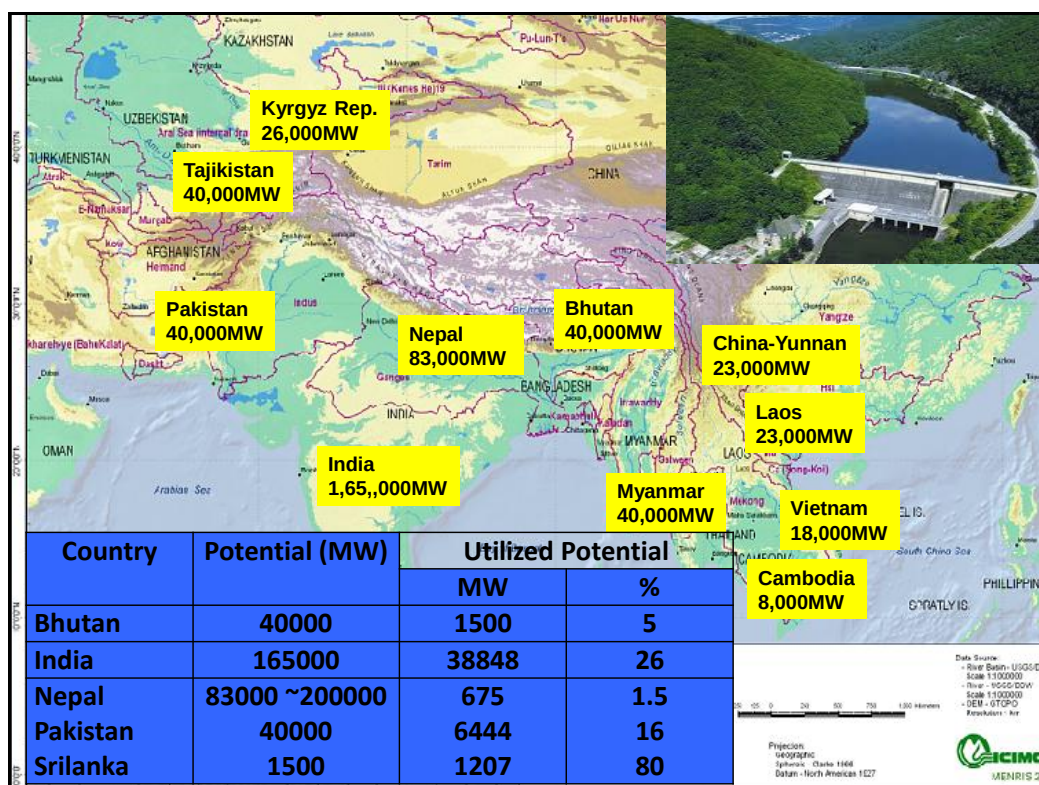


NEPAL

India

Bhutan



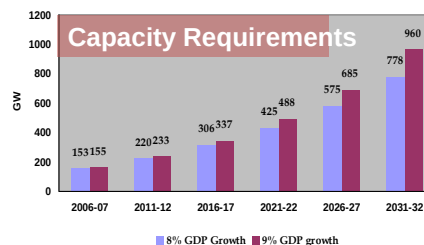
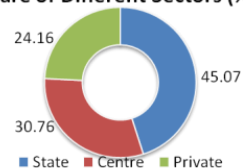


India: Power Sector

- All India installed capacity – ~187 GW, 5th largest in the world
- Thermal dependent to a large extent (66 %) – Thermal includes coal, gas and oil
- Plan to add 100 GW generation capacity in XII plan (2012-17)



Share of Different Sectors (%)



Year-wise Growth and Deficit (%)

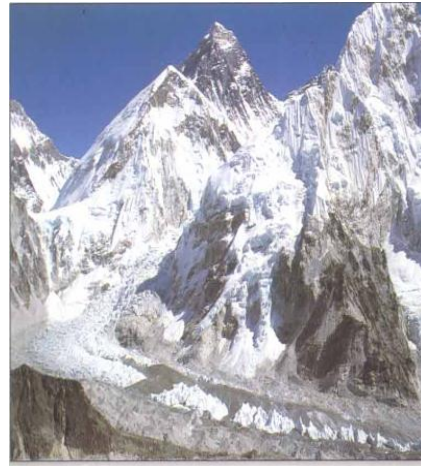
All India	Thermal				Nuclear	Hydro	RES	Grand Total
	Coal	Gas	Diesel	Total				
MW	104816	17742	1200	123758	4780	38848.	20166	187550
%	56	10	0.5	66.5	2.5	21	10	100.0



Third Pole : Nepal

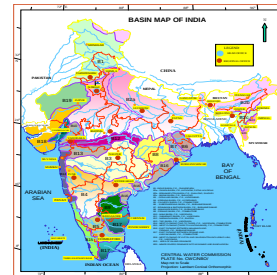
Nepal Himalayas enjoy the possession of 7 mountain peaks higher than 8,000 meters

3,252 glaciers covering an area of 5,323 sq. km and ice-reserve of 481 cubic km
2,323 identified glacial lakes covering an area of 75.7 sq. km,



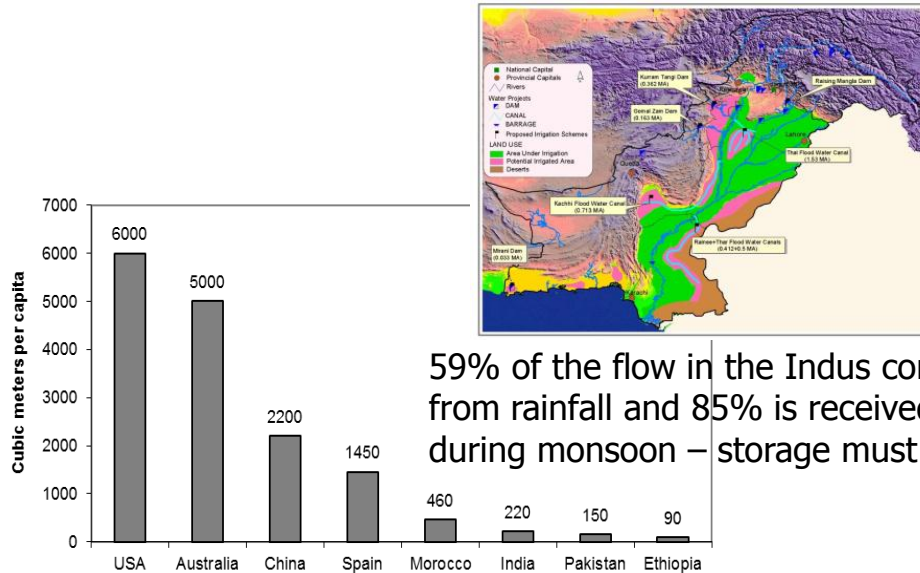
INDIA : Interconnection with neighboring Countries

- Geographically widely spread Indian Grid can facilitate interconnections with Neighboring countries
- India can provide a good demand market to harness energy resources of other countries for the Optimal utilization of energy resources



Increase storage capacity

(Pakistan : 15% of the river flow; only enough for 30 days-32% will be lost by 2025)

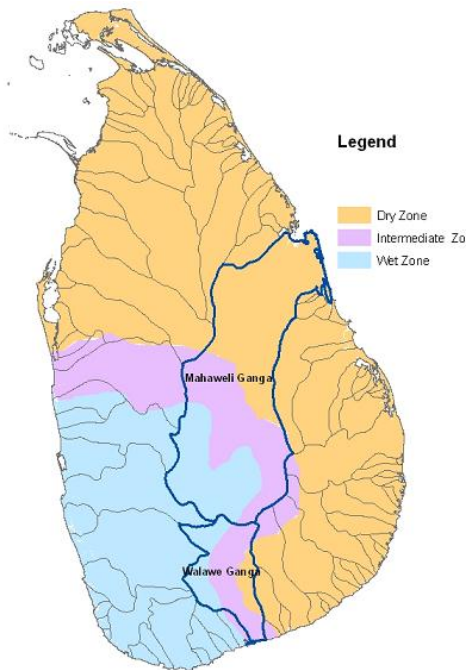


Existing Generation Capacity Pakistan



Type	Installed capacity (MW)	Derated capacity (MW)	Availability (MW)	
			Summer	Winter
WAPDA (Hydro)	6444	6444	6250	2300
GINCOs	4829	3580	2780	3150
IPPs incl. Nuclear	6609	6028	5122	5402
Rental	285	264	250	250
Total	18167	16316	14402	11102

Sri lanka

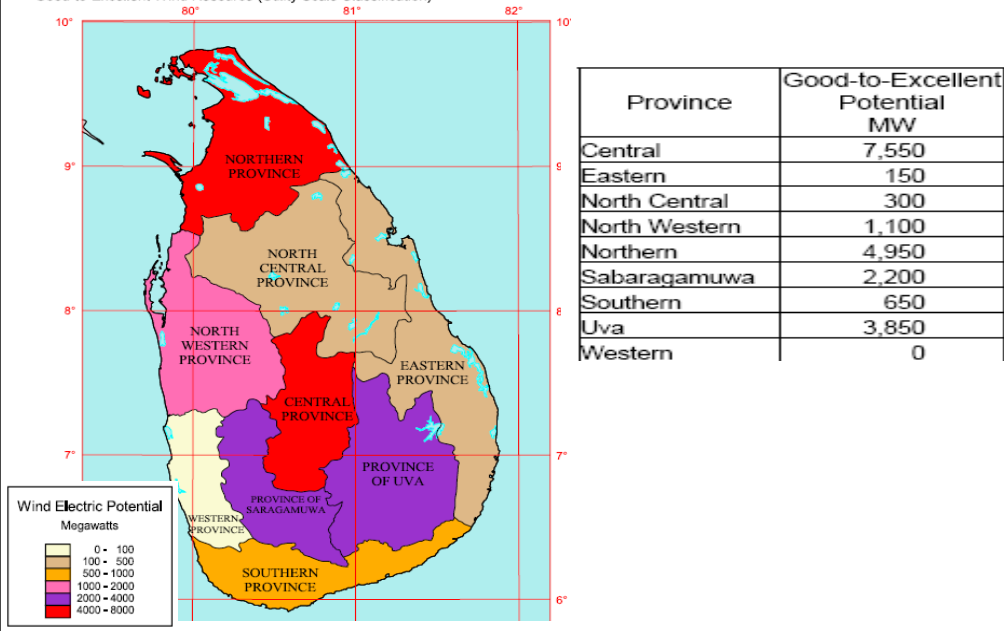


- Annual water resources of Sri Lanka, about 45 km³.
- present per capita water availability is about 2,300 per year.
- Rainfall, only source of water, annual average of 1860 mm.
- **Evapotranspiration exceeds the rainfall in about 75% of the country**

Sri Lanka - Significant Wind Power Potential

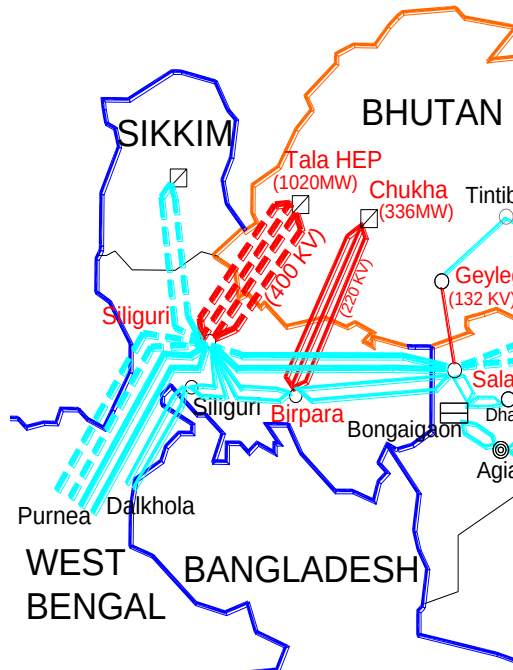
Source: USAID/NREL of US

Sri Lanka - Wind Electric Potential
Good-to-Excellent Wind Resource (Utility Scale Classification)

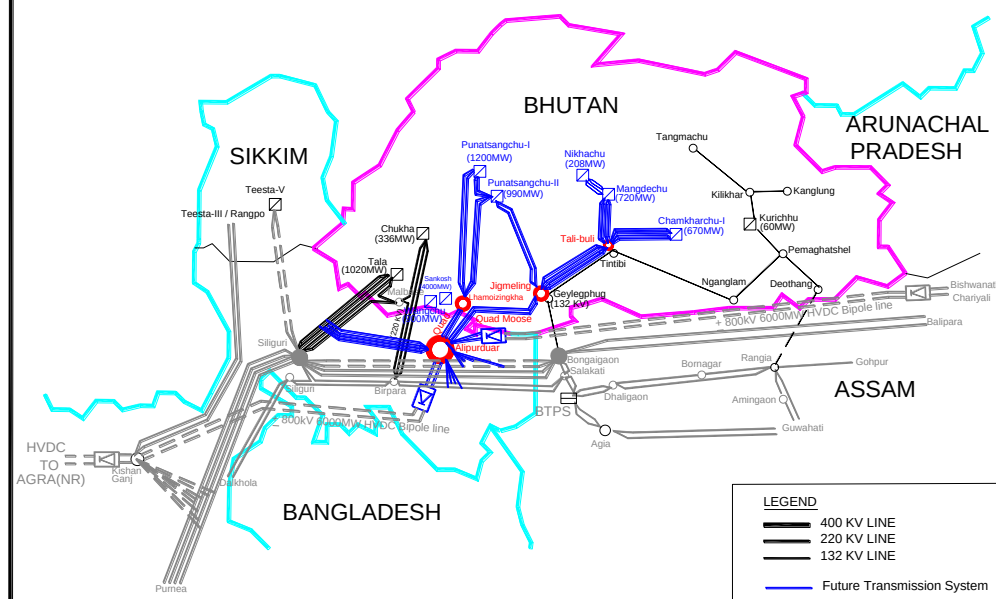


India - Bhutan Existing Projects

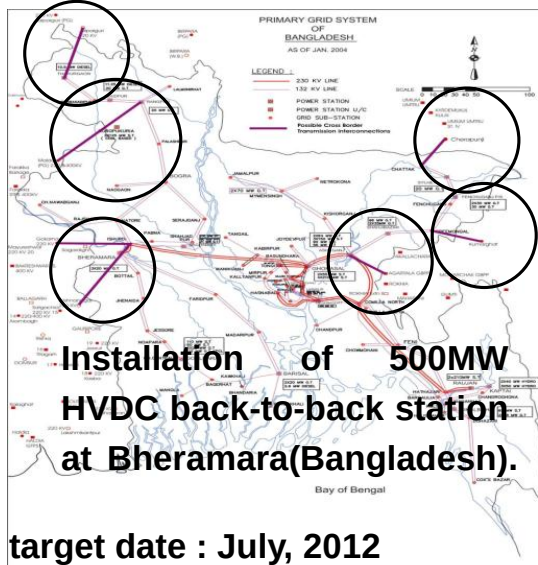
- **Chukha**
 - HEP (4x84 MW)
 - Chukha (Bhutan) - Birpara (India) 220kV 3 circuits
- **Kurichu**
 - HEP (4x15 MW)
 - Geylegphug (Bhutan) - Salakati(India) 132 kV line
- **Tala**
 - HEP (1020MW)
 - Tala(Bhutan) - Siliguri 400kV



EVACUATION FROM POWER PROJECTS IN BHUTAN



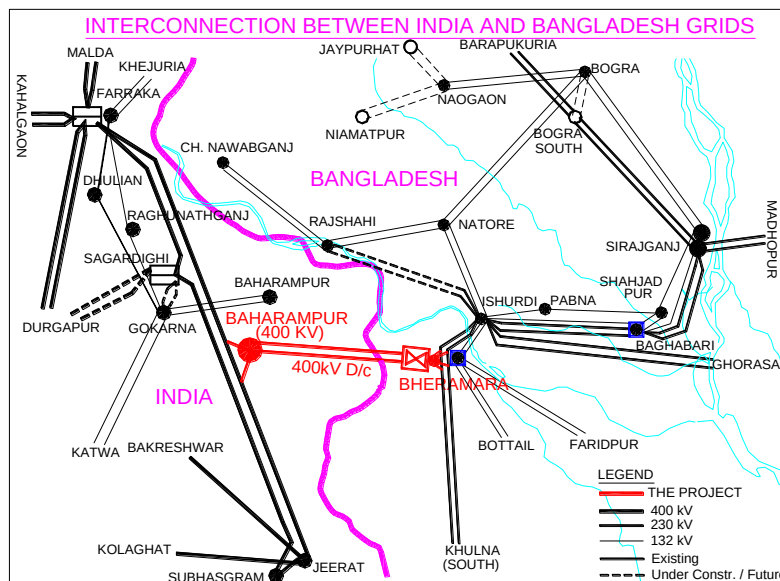
India-Bangladesh Tie-line Interconnection Possibilities / plans



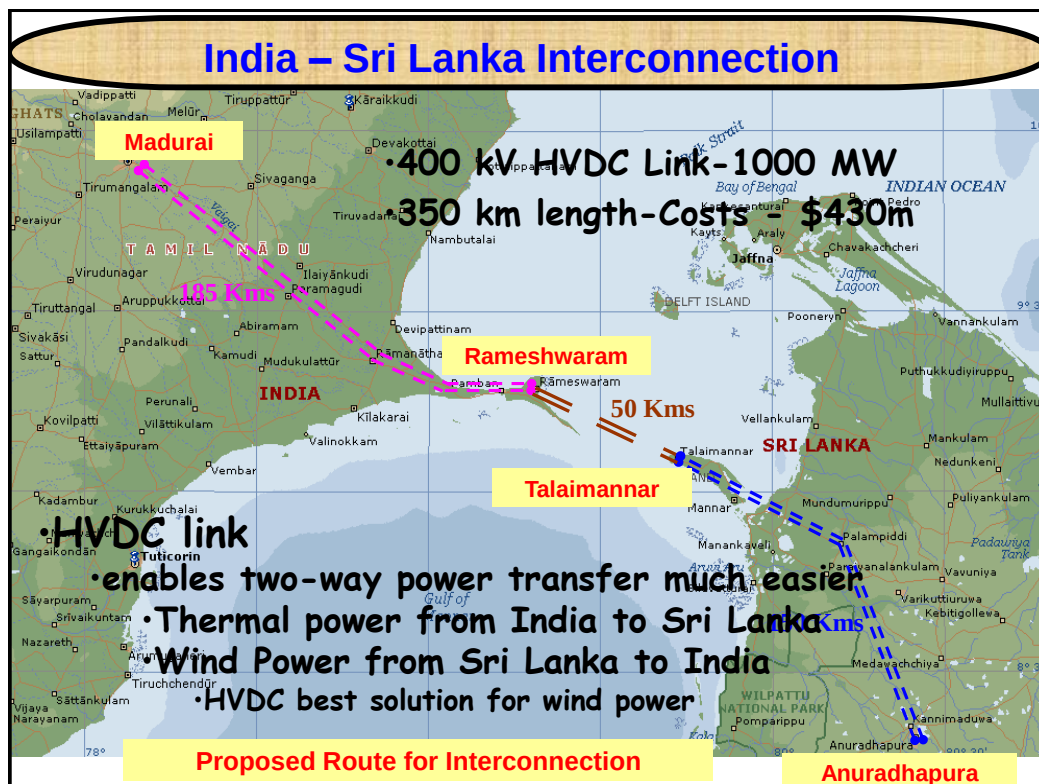
Sub-Station	Sub-Station	Approx. distance/	Approx. cost
Ashuganj	Agartala	(50 kms) at 220KV at 132KV	2.19 1.32
Ishurdi	Gokarna	(100 kms) at 220KV	4.39
Sreemongal	Kumarghat	(50 kms) at 132 KV	1.32
Rangpur	Malda	(120 kms) at 132KV at 220KV	3.16 5.27
Thakurgaon	Japlaiguri/Siliguri	(80 kms) at 132KV	2.11
Ishurdi	Krishnanagar	(90 kms) at 220KV	3.95
Chattak	Cherrapunji	(50 kms) at 132KV	1.32

- Take advantage of complimentary peak-off peak periods
- Friday weekend in Bangladesh, Saturday-Sunday in India

Bangladesh-India Grid Interconnection



- 500 MW capacity HVDC link - Could be taken to 1000 MW



Recommendations :

- Integrate Water, Energy , Food & Environment
- Develop water Storage capacity -
- Basin group countries to work together
 - A : Nepal, Bhutan, India & Bangladesh
 - B : Afghanistan, Pakistan & India
 - C: India, Sri-lanka : market sharing
- Set goal for 2020, 2025 & 2030
- Speedup water & Transmission connectivity
- Remove existing intra countries barriers in Hydropower development





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& succeed in hydropower*



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**COMMERCIAL AND LEGAL FRAMEWORKS AND AGREEMENTS OF
NEPAL-INDIA CROSS BORDER INTERCONNECTION: PARTICULAR
REFERENCE TO DHALKEBAR - MUZAFFARPUR 400 kV CROSS
BORDER-INTERCONNECCTION**

(6th Japan-SAARC Energy Symposium, 6-7 March 2013, Kathmandu)

**RAJAN DHAKAL
DEPUTY MANAGER
NEPAL ELECTRICITY AUTHORITY
GRID DEVELOPMENT**

OUTLINE OF PRESENTATION

PART 1:

- Existing Power Exchange Mechanism with India
- Institutional Mechanisms For Nepal India Power Exchange

PART 2

- Initiative towards commercial mode of interconnection
- Project features of D-M Line
- Commercial frame work of the project
- Contractual framework of the project
- Fundamentals of PSA
- Fundamental of ITSA
- Issues on commercial mode of Cross Border Interconnection and Power Trade
- Concluding Remarks

Existing Power Exchange with India

- Power exchange history Goes by some decades- started along with signing of Koshi treaty in 1954.

It was , however, in 1971 that Indo-Nepal Power exchange has commenced-5 Mw in initial years.

- **Current arrangement :**

Nepal receives power in three modes.

- (1) River Treaty: Koshi Treaty, Gandak Treaty and Mahakali Treaty.
- (2) Border Town Exchange Program
- (3) Commercial Power trading with PTC India during dry seasons

Existing Power Exchange with India

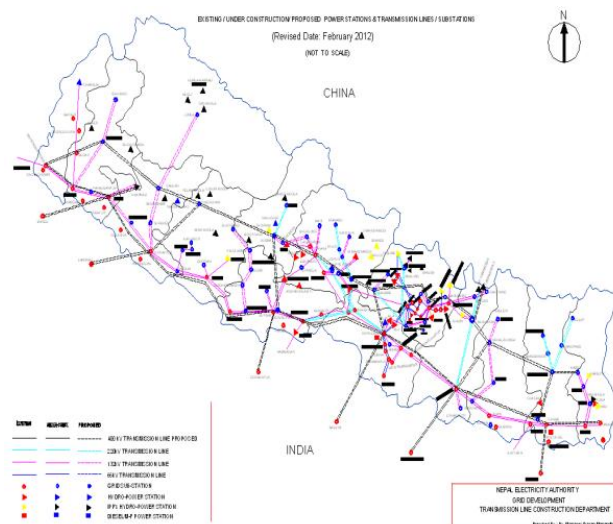
- In principle up to 150 MW is agreed in 2001 (6th Power Exchange Meeting) but yet to be realized.
- Over and above 50 MW, India wants deal the exchange at commercial rates

INSTITUTIONAL MECHANISMS FOR NEPAL INDIA POWER EXCHANGE

- **Power Exchange Committee (PEC)**
 - Constituted in 1992 to oversee the exchange and other issues
 - To meet once a year by rotation in both countries
- **Joint Committee on Water Resources (JCWR)**
 - Constituted as per agreement of August 3, 2000
 - Headed by Energy Secretaries of both countries
 - Supposed to Meets every six months
- **Ministerial Level Committee Water Resources (JCWR)**

NEPAL-INDIA EXISTING INTERCONNECTIONS

- 132 kV level:
 - Kusaha-Kataiya
 - Gandak-Ramnagar
 - Mahendranagar-Tanakpur
- Around 14 of 33 kV interconnections – all operate radially



**WHAT IS HAPPENING BETWEEN TWO COUNTRIES
IS MERELY EXCHANGE OF POWER;
NOT THE COMMERCIAL POWER TRADE**

**Initiative towards Commercial mode of
Interconnection**

- In Mid 2006 IL&FS, NEA with support from the then MOWR/MOF Nepal and Embassy of India in Nepal took initiative to facilitate the development of transmission interconnection between India and Nepal.
- Unlike previous intergovernmental modalities the project was decided to be developed and realized under commercial mode ; PPP Model
- Dhalkebar – Mujaffarpur (D-M) 400 kV Interconnection was considered to be developed on first phase.
- It was decided to establish Two JV companies each one in India and Nepal

Initiative towards Commercial mode of Interconnection contd....

- Consequently the JVC-Nepal called Power Transmission Company Nepal (PTCN) a joint venture company of NEA and IL&FS has been registered in Nepal as per Company Act 2063 of Nepal.
- Similarly JVC- India called Cross Border Power Transmission. Company India (CPTC) is registered in India.
- The JV companies have to develop, own, operate and maintain the transmission line in respective territory.

Initiative towards Commercial mode of Interconnection contd...

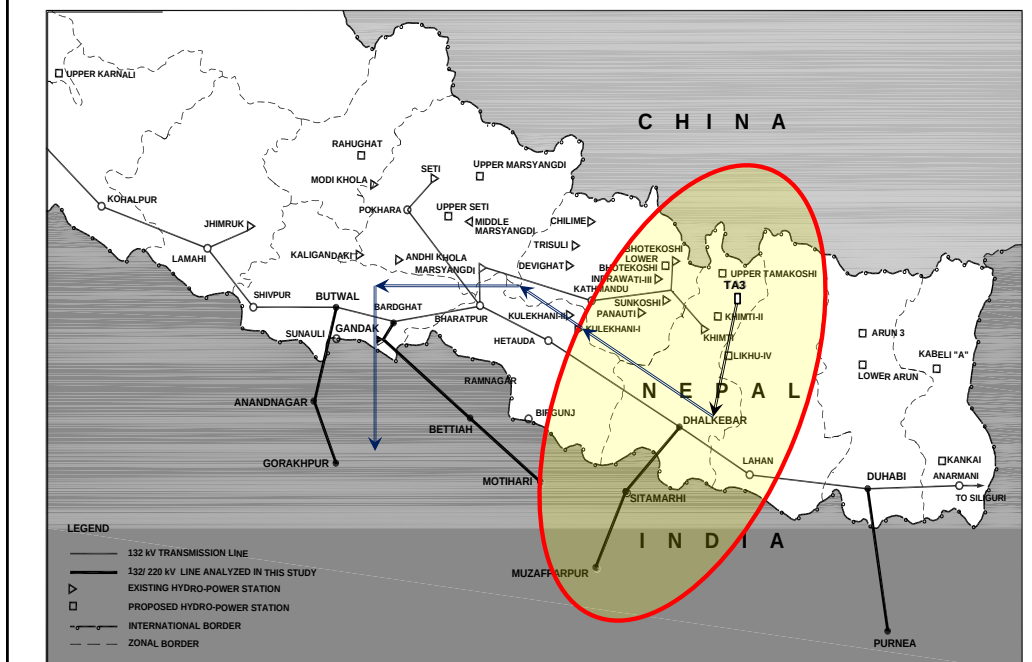
- NEA shall book the whole transmission capacity of this line and pay the Transmission Service Charge (TSC) to both the JV companies.
- NEA can tie up with other users and IPPS in Nepal or India to lease the part of the reserved capacity of the line for the export and import of electric power.
- NEA to buy 150 MW from PTC India in order to utilize the line
- NEA to enter in to PSA with PTC India and two separate ITSAs with PTCN and CPTC
- PSA has been signed on 12 December, 2011 and ITSAs has been signed on 13 December, 2011
- SHA of both company was signed on 9 July 2012

PROJECT FEATURES

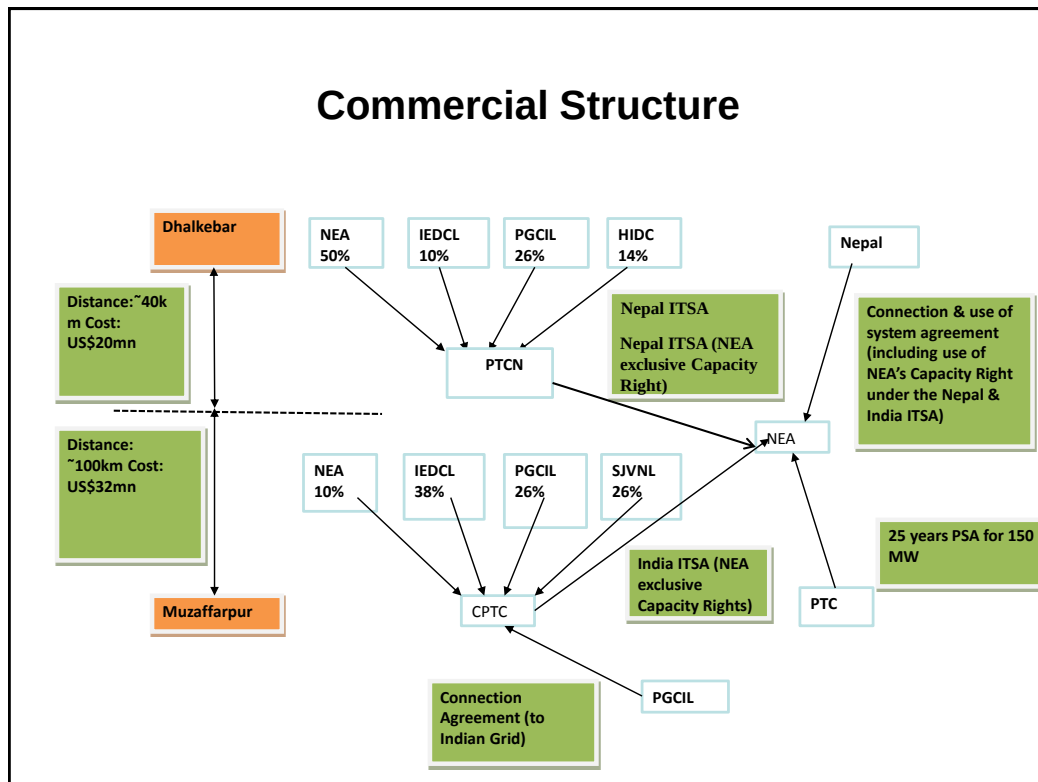
- Voltage: 400 kV (to be initially charged at 220 kV and will be in synchronous operation with India)
- Line length: 40 Km in Nepal side and 100 Km in India side
- Project cost : 52 MUSD
(20 MUSD Nepal side and 32 MUSD Indian side)
- Expected Commission: 2014/15



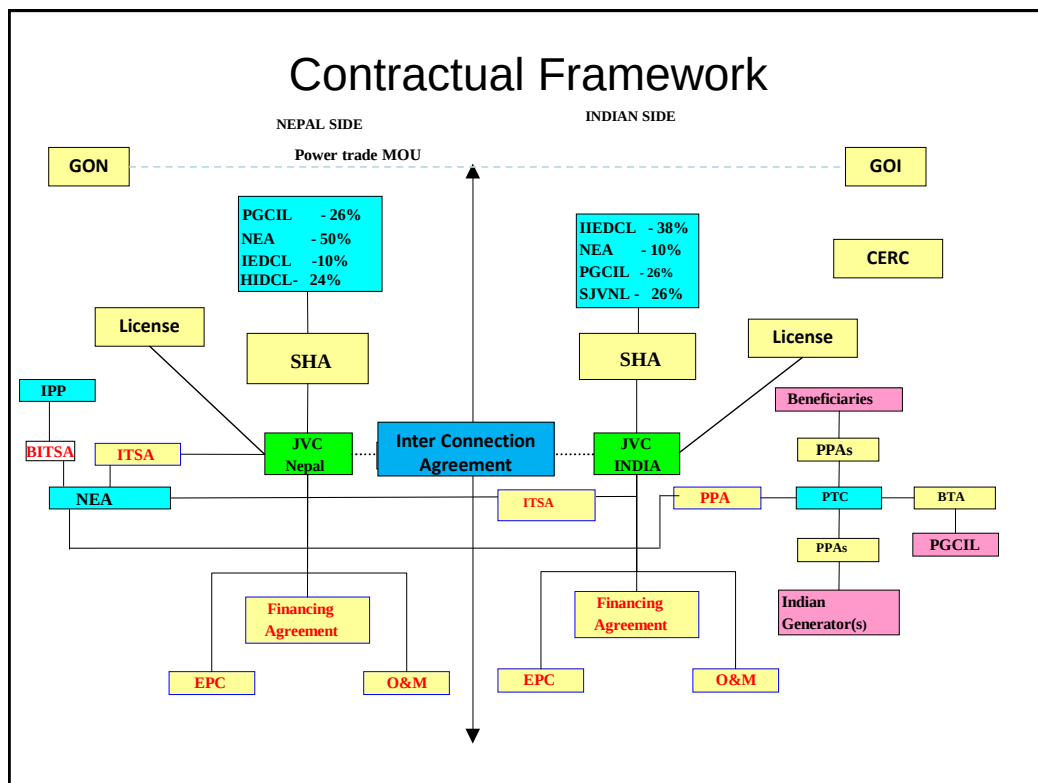
First Project: Dhalkebar-Muzaffarpur Transmission Line



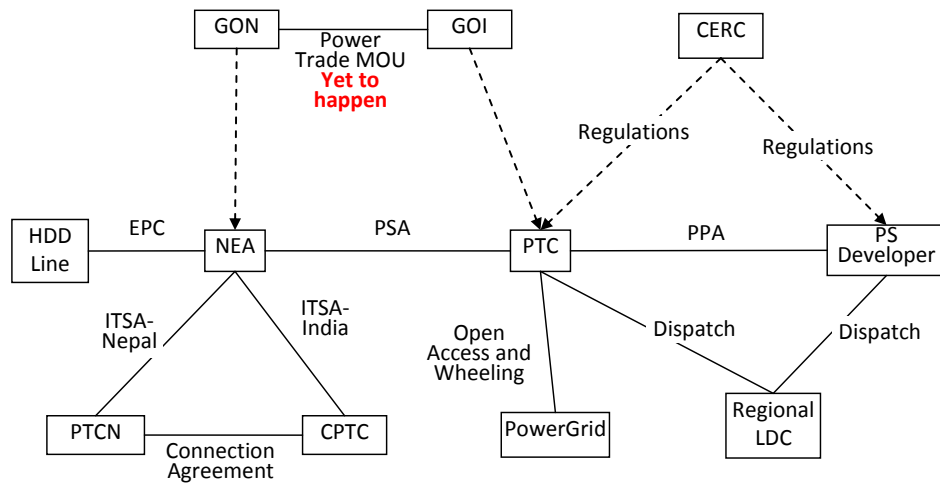
Commercial Structure



Contractual Framework



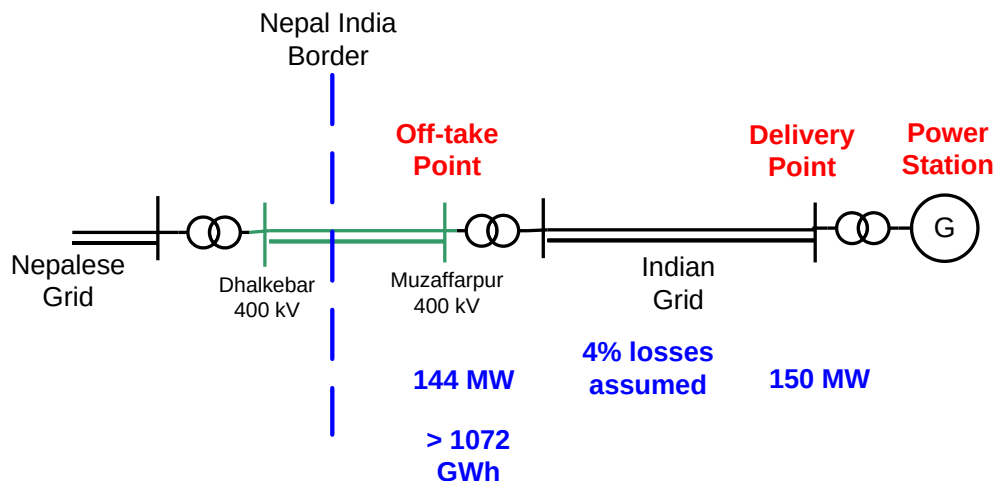
CONTRACTUAL FRAMEWORK



Fundamental Details of PSA

- **Quantity**
 - Contracted Capacity = 150 MW
 - Minimum Guaranteed Capacity = 127.5 MW (85%)
- **Term**
 - 25 years from the date the delivery
- **Commencement of Supply**
 - on “Delivery Date” to be agreed by PTC and NEA
 - not later than 42months after PSA is signed

Structure of Power Sale Agreement



Delivery of Electricity

- **PTC delivers to “Delivery Point”**
 - point of interconnection between Power Station and CTU grid
 - measure point for PTC’s capacity and energy delivery obligations, and NEA’s corresponding payment obligations
- **Open Access**
 - PTC responsible for transmission access from Power Station Delivery Point to “Off-take Point/s” (initially, 400kV bus of CTU substation in Muzzafarpur)
 - NEA responsible for transmission access beyond Off-take Point/s to NEA grid

Tariff (3 parts)

- **“Capacity Charge”**
 - payable on Available Capacity at Delivery Point as declared by PTC
 - set annual rates per kWh specified in Schedule 2 of PSA
- **“Variable Energy Charge”**
 - relates to fuel cost of Power Station
 - payable on Scheduled Energy delivered to Delivery Point
 - initial rate per kWh specified in Schedule 2 to be adjusted per CERC escalation criteria
- **“Variable Inland Transportation”**
 - relates to inland transportation of fuel to Power Station
 - set annual rates per kWh specified in Schedule 2 of PSA-to be adjusted per CERC escalation criteria

Price (continued)

- **“Transmission Charges”**
 - NEA responsible for paying/reimbursing PTC for its actual cost for using CTU’s network to deliver energy from the Delivery Point to the Off-take Point/s
- **Other**
 - NEA responsible for paying/reimbursing PTC for actual charges imposed by the applicable regional or state load dispatch center in India in respect of the Contracted Capacity
- **Change in Law**
 - Tariff subject to modification due to Change in Law
 - Increases capped at 20%

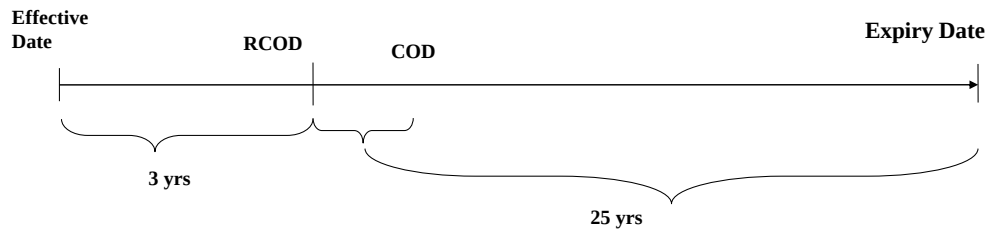
Operational Details

- **Dispatch**
 - NEA to dispatch daily (no later than 16:00 hours on the prior day) on the basis of “Availability Declaration” delivered by PTC (no later than 10:00 hours on such prior day)
- **Outages**
 - PTC to make all reasonable endeavors to ensure that scheduled outages occur between 1 June and 30 September of each contract year
- **Metering**
 - Parties will use CERC metering, as governed by Indian Grid Code

Fundamental Details of ITSA

- **Quantity**
 - 400 kV Double Circuit, Twin Moose Conductor (1200 MW)
 - Initially charged at 220 kV Double Circuit (500 MW)
- **Term**
 - 25 years from the Commercial Operation Date
- **Required Commercial Operation Date**
 - 36 Months from the effective date or 27 Months from the date of financial closure

Time Frame of Agreement



Transmission Service Charge

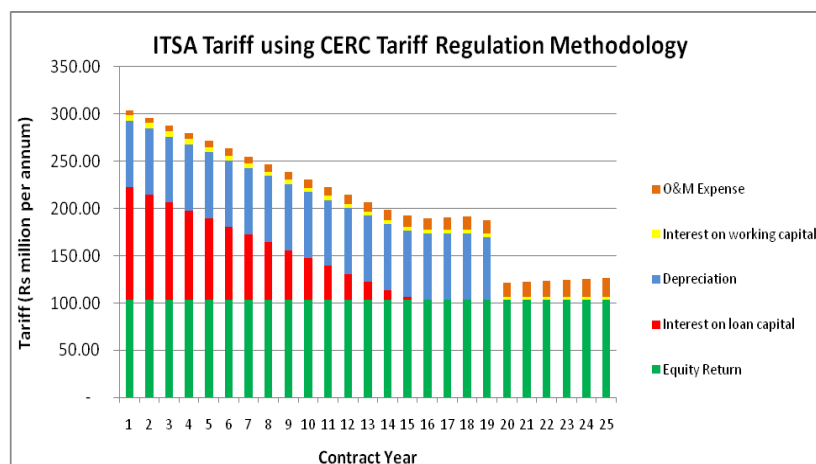
- To support project financing for the project, the Transmission Service Charge (“TSC”) will need to be on a “take or pay” basis:
 - NEA to pay the TSC linked to availability of the transmission line capacity regardless of whether it uses the capacity

Transmission Service Charge

- Basis for Annual Transmission Service Charge
 - Return on Equity: 15.5% per Annum on Post Tax Basis
 - Interest on loan capital
 - Depreciation: @5.28% per annum on straight line basis till the repayment of the principal amount of the loan
 - Interest on working capital: shall be on normative basis and shall be equal to the short-term Prime Lending Rate of Bank
 - Operation & maintenance expenses : @ 1.5 % of the total Capital cost of TLP – Nepal scalable @ 5% per annum

Transmission Service Charge

- High initial TSA tariffs reducing over term of ITSA;
- Fixed annual equity returns.



Illustrative tariffs only using Business Plan cost estimates and current CERC regulations

Payment Security Mechanism

- NEA to establish the irrevocable revolving letter of credit in favour of PTCN in a schedule Bank in Nepal with a value equal to 105% of the estimated value of one month's monthly TSC payment.
- The term of LC shall not be less than 12 months and shall be renewed time to time
- As a credit enhancement NEA to furnish the Bank Guarantee valid for 12 months for an equivalent value of twelve months Monthly TSC payment

Operational Details

- **Outages**
 - unless otherwise agreed by NEA, PTCN and CPTC may not schedule any outages during the period from 1 October to 30 May of any year
 - NEA to use reasonable endeavors to schedule maintenance of interconnected components of NEA grid in a way that minimizes disruption to TLP-Nepal

Legal Provisions of Note

- **Cross-Termination**
 - If either ITSA is terminated for any reason, the other ITSA immediately terminates as well
- **Governing Law**
 - Nepal Law for ITSA-Nepal
 - India Law for ITSA-India

ISSUES IN COMMERCIAL MODE OF CROSS BORDER INTERCONNECTION

- Absence of G to G umbrella agreement in cross border power trade
- NEA to capture all major risks as an off-taker and developer.
- Bankable Legal Agreements- off-taker has to satisfy the lender's covenants
- Inadequacy of existing legal and regulatory system
- Transparency in sharing information
- No control over Power station supplying the contracted power
- Difficulty in administering legal Agreements

ISSUES Contd...

Particular Agency being selected as Nodal Agency for dealing with cross border power trade.

Operational Issues

- Synchronization between two systems
- Loop flows
- Grid code harmonization
- Security standards and operational protocols
- adequacy of load dispatch and communication facilities to handle the commercial trade of power

Concluding Remarks

- This kind of structure in Cross border power trade is new in the region- different approach from the traditional G to G approach
- Learning by doing approach.
- The success of this modality may be instrumental in fostering commercial power trade in the region if backed by G to G umbrella Agreement and will pave the way for similar modality to be adopted in the region.
- Will create opportunities for PPP in setting up the infrastructure.
- NEA has taken initiative towards this step by absorbing major risk- as one has to start first
- Co-operation from every individual and stakeholder is anticipated to make this successfully happen

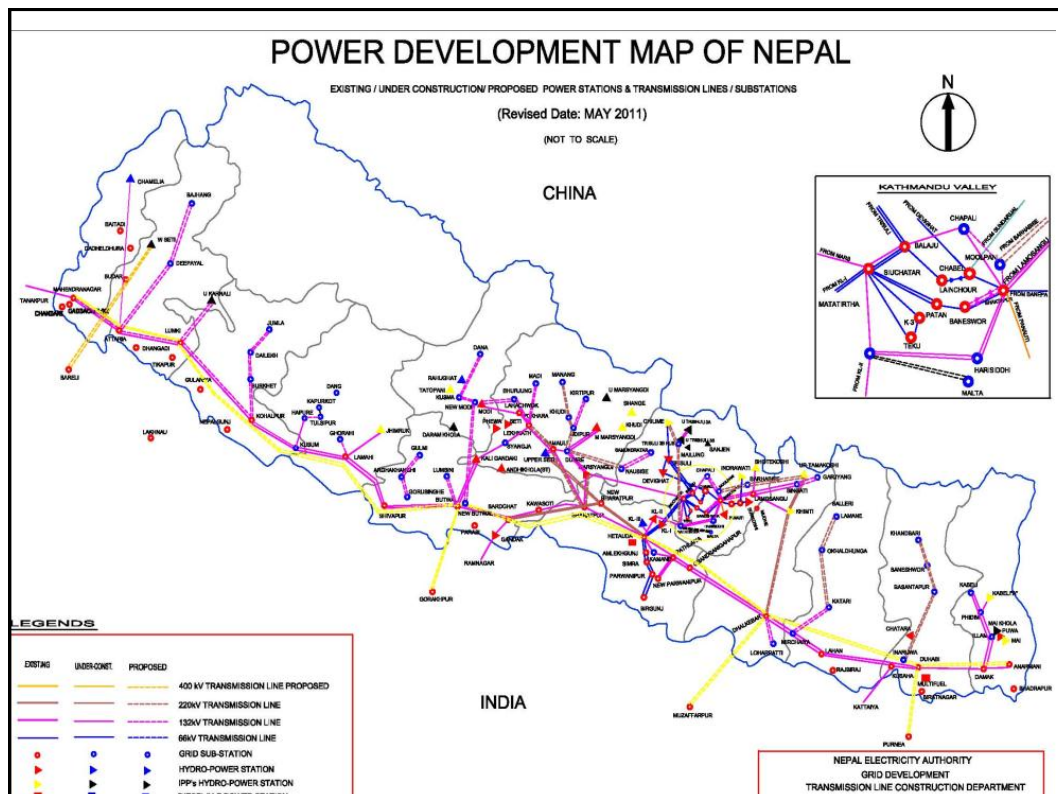
THANK YOU

Cross Border Electricity Trade between Nepal and India – Issues and Challenges



Dr. Sandip Shah

March 7th 2013



Hydroprojects – in active development in Nepal

Project	-	Capacity	Developer	Status
Arun III	-	900 MW	SJVNL	Waiting for PDA
Upper Karnali	-	900 MW	GMR	Waiting for PDA
Tamakoshi -3	-	650 MW	SN Power	Waiting for PDA
West Seti	-	750 MW	CWEI, GON	Waiting for PDA
Upper Marsyangdi	-	600 MW	GMR	Waiting for PDA
Upper Tamakoshi	-	456 MW	NEA	Construction in-progress
Upper Seti	-	140 MW	NEA	Development
Likhu – IV	-	120 MW	Bhilwara	Ready for construction
Tamor	-	450 MW	Sanima Hydro	DPR finalization
Upper Trishuli	-	216 MW	NWEDP	DPR finalization
Kirne	-	67 MW	SN Power	Waiting for PDA, PPA
Budhi Gandaki	-	600 MW	NEA	DPR
Chameliya	-	30 MW	NEA	In construction
Rahughat	-	35 MW	NEA	In Construction
Kulekhani-III	-	14 MW	NEA	In construction
Chilime Projects	-	270 MW	NEA, Public	Various stages
Total	-	6,200 MW		

Issues and Challenges

- Political consensus in Nepal on how its hydropower resources are to be developed
- Acceptance of electricity as a tradable commodity
- Realization that, in the absence of prospects of further value addition to the product, electricity is the product to be traded
- Notion of complementarities of demand and supply between the two countries
- Move towards deregulated electricity market
- Regulatory Approvals and Techno-economic clearances

Issues and Challenges

- High capacity cross-border transmission lines
- Open Access on transmission lines
- Congestion in transmission capacity
- Grid synchronization
- Peaking benefits of hydropower in a blended-supply market
- Affordability of end consumers
- Financial health of Electricity Board and Discoms

Issues and Challenges

- Electricity treated as restricted commodity in India – tariff and non-tariff barriers
- Nodal Agency for trading of power
- Project financing – high country risk and market premium
- Majority of the transactions are brokerage deals, real trading is minimal but increasing
- Power Trade Agreement
- Power Trading Agency in Nepal
- **Geopolitics of the Region**

Interconnection of India with SAARC Countries

1

Common Features of SAARC Countries

- Abundant reserves of Natural resources
- Low per capita electricity consumption
- Fast Growth in Demand & deficit of Power in some countries
- Common frequency of operation
- Similar voltage class

2

Benefits for Interconnection

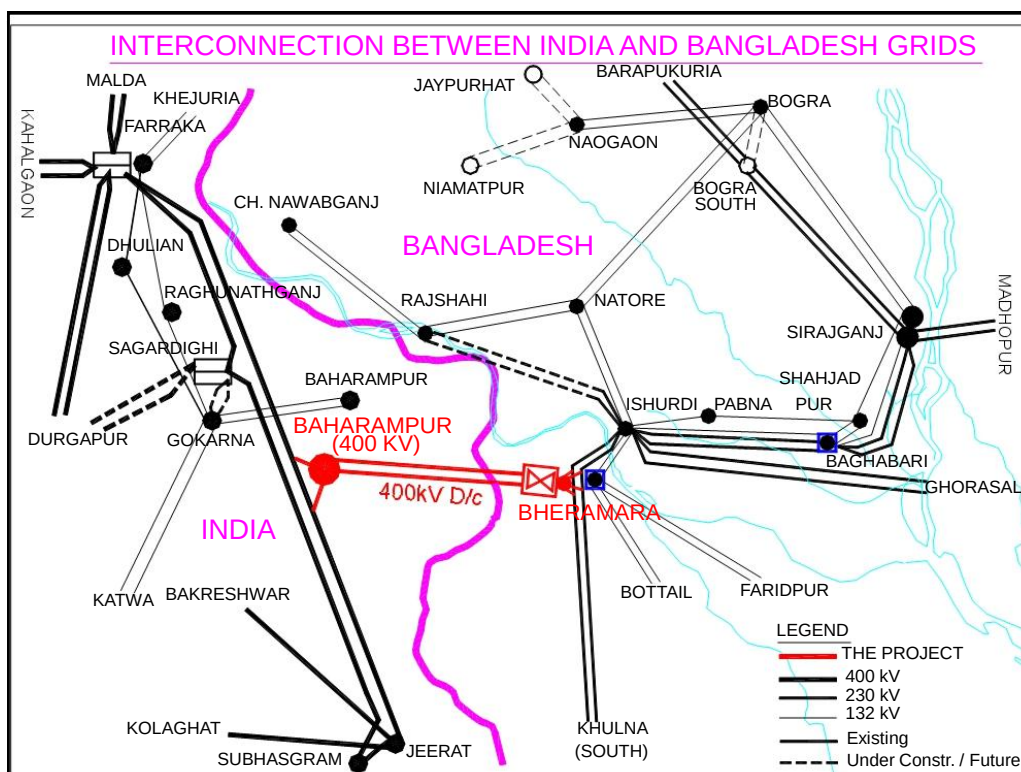
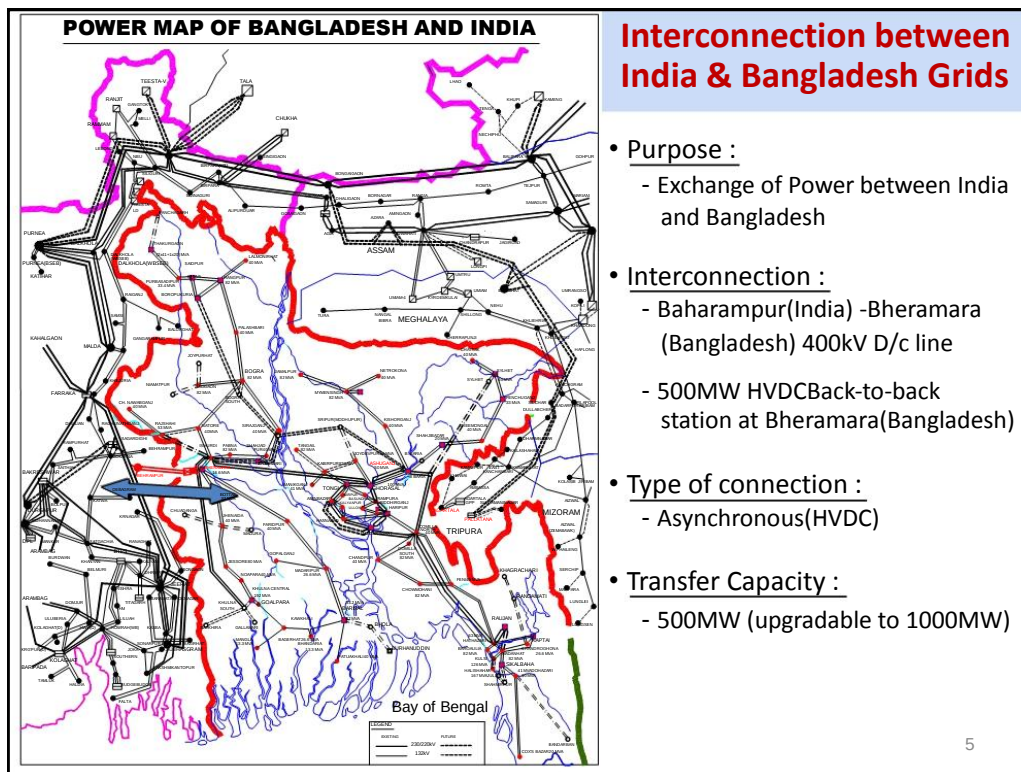
- Improving Reliability and pooling reserves
- Reduced Investment in generation capacity
- Improving load factor and increasing load diversity
- Economies of scale in new construction
- Diversity of generation mix and supply security
- Economic exchange
- Environmental dispatch and new plant siting
- Coordination of maintenance schedule

3

India & Bangladesh Interconnection

- **MOM signed** between Indian Delegation and BPDB & PGCB officials, Bangladesh on November 24, 2009 at Dhaka.
- **Executing Agency :**
 - Indian portion : POWERGRID, India
 - Bangladesh portion : PGCB (Power Grid Company of Bangladesh Ltd.), Bangladesh.
- **Cost Estimate :**
 - India Portion : Rs. 169.86 Crore (USD 37.75 million)
 - Bangladesh Portion : Rs. 736.84 Crore (USD 163.75 million)
- **Commissioning Schedule :** July, 2013

4



India & Bangladesh Future Interconnection

- In the 4th Joint Steering Committee Meeting held in Delhi on 28th February 2012, a Joint Technical Team (JTT) has been constituted to explore the possibility of future interconnection between India and Bangladesh.
- The JTT report is under finalisation and shall be submitted shortly.

7

India - Bhutan : Existing Interconnections

For import of power from following Projects

- **Chukha HEP (4x84 = 336 MW)**
 - Chukha - Birpara 220kV 3 ckts
- **Kurichu HEP (4x15 = 60 MW)**
 - Kuruchu - Geylegphug(Bhutan) - Salakati(NER) 132 kV
- **Tala HEP (6x170 MW = 1020 MW)**
 - Tala - Siliguri 400kV 2x D/c line

8

India - Bhutan : On Going Trans. System

- **Tr. System for Punatsangchu-I (1200 MW)**
- **Interconnection (Bhutan Portion) :** Punatsangchu-I HEP - Lhamoizingkha (Bhutan Border) 400 kV 2xD/c line with twin moose Conductor.
- **Interconnection (Indian Portion) :** Lhamoizingkha (Bhutan Border) - Alipurduar 400kV D/c (Quad)
- **Other Major Transmission System in India**
 - New $\pm$ 800kV, 3000MW HVDC pooling station at Alipurduar.
 - Extn. of $\pm$ 800kV, 3000MW HVDC station at Agra
 - LILO of Bishwanath Chariali - Agra 800kV, 6000MW HVDC line at Alipurduar
 - LILO of Bongaigaon - Siliguri 400kV D/c line(quad) at Alipurduar
 - LILO of Tala-Siliguri 400kV D/c line at Alipurduar.
- **Estimated Cost (Indian Part) : Rs. 4400Cr. (USD 978 million)**

9

India - Bhutan : Future Scenario

- **Hydro Potential** : About 24000 MW
- **Major Hydro Projects**
 - By 2020 : 11,784 MW (from 14 HEP)

(Existing : 1480MW, Addition by 2020 : 10,304MW, 14 HEP)

 - By 2030 : 26,504 MW (from 75 HEPs)

(Exis. : 1480MW, Add. by 2030 : 25,024MW, 75 HEP; Add. bet. 2020 and 2030 : 14,720MW, 61 HEP)
- **Major Projects by 2020**

Sl. No.	Name of HEP	Capacity (MW)	Year of commissioning	DPR by
1.	Punatsangchu-I	1200(6x200)	2015	WAPCOS
2.	Punatsangchu-II	990(6x165)	2017	WAPCOS
3.	Mangdechhu	720(4x180)	2017	NHPC
4.	Sankosh Main HEP	2500	2020	THDC
5.	Sankosh LB HEP	85	2020	THDC
6.	Kuri-Gongri	1800/3400	2020	NHPC
7.	Wangchhu	570(4x142.5)	2019	SJVNL
8.	Bunakha Reservoir	180(3x60)	2020	THDC
9.	Kholongchhu	600(4x150)	2018	SJVNL
10.	Chamkarchhu-I	770(4x192.5)	2018	NHPC
11.	Amochhu RS	540(4x135)	2018	NTPC
12.	Nikachhu	210/140	2020	DGPC
13.	Bindu Khola	13	2020	DGPC
14.	Dagachhu	126(2x63)	2020	DGPC & Tata
Total		10304		

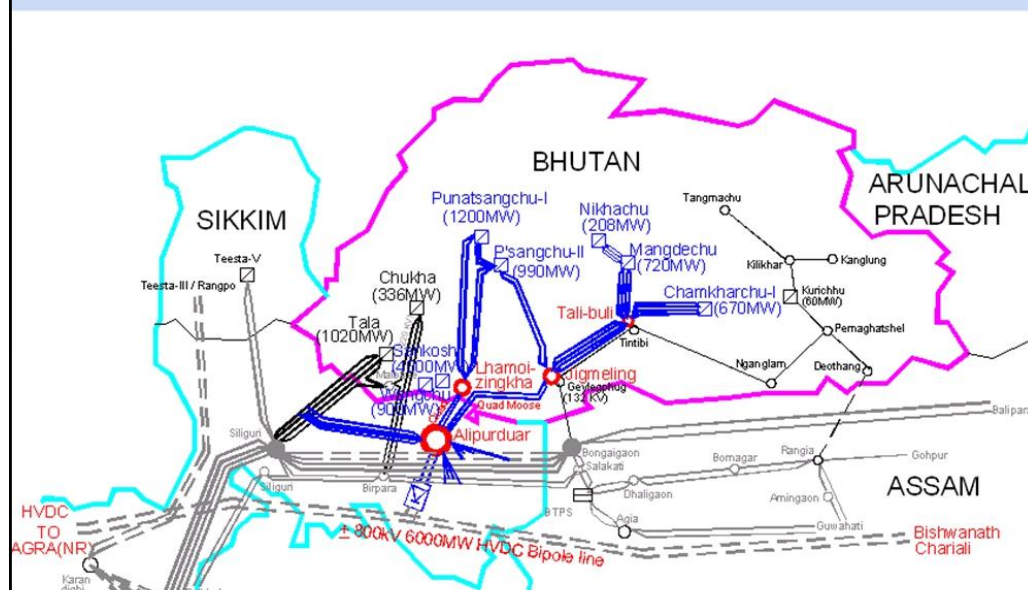
10

India - Bhutan : Transmission system from future Projects

- In view of future demand growth of Bhutan (Existing : 372MW, by 2020 : 1500MW; by 2030 : 2500 MW), it is envisaged that major portion of power from the future generation projects in Bhutan is to be imported into Indian grid.
- Total 5(five) no 800kv, 6000-7000MW HVDC high capacity corridors (2 nos. by 2020 & balance 3 nos by 2020) required for transfer of power to Indian Grid.
- The 1st of the 3000MW HVDC terminal being established at Alipurduar along with 6000MW NER-NR/WR interconnector)
- Would take care of evacuation from projects like Punatsangchu-I (1200MW), Punatsangchu-II(990 MW) & Mangdechu(720MW)
- To be commissioned in 2014-15.

11

India - Bhutan Interconnection



12

India - Nepal : Present Interconnection

Power Scenario in Nepal

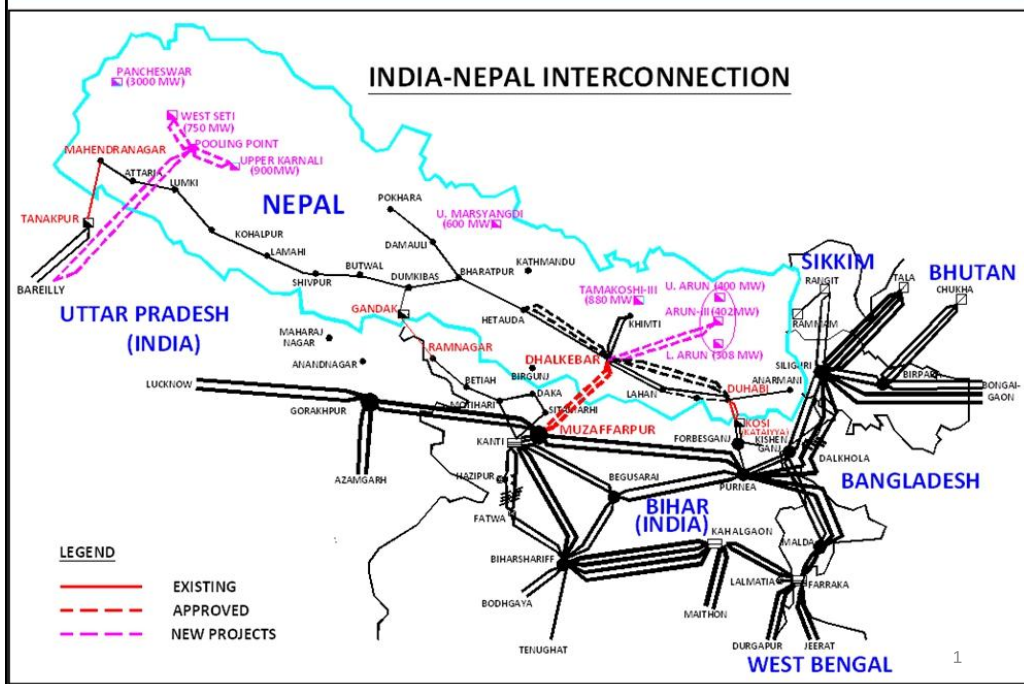
- ⌚ Installed Capacity : 617MW (Hydro - 91%)
- ⌚ Demand : 900 MW
- ⌚ Peak Deficit : 300 - 400 MW

Interconnection : 22 links at 132/33/11 kV

- ⌚ About 80-100 MW of power being exchanged in radial mode
- ⌚ Supply of 70MU/annum from Tanakpur (India) to Nepal (as per the Mahakali Agreement)
- ⌚ Net export to Nepal (about 10-15% of demand of Nepal met from India)

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India - Nepal : Interconnection



India - Nepal : On-Going Trans. System

• Transmission Line

- 400kV inter-connection (initially op. at 220kV level) between Muzaffarpur(India) and Dhalkebar(Nepal) : 125 km

• Indian Portion :

- Line length : 86.43km; Estimated cost : Rs. 131.75 Crs. (USD 29.28million)
- To be implemented by Cross Border Power Transmission Company Pvt. Ltd. (CPTC)
[Proposed equity shares of JV partners: IL&FS(38%), POWERGRID(26%), SJVNL (26%) and NEA (10%)]

• Nepalese Portion :

- Line length : 39km ; Estimated cost : Rs. 127.54 Crs. (USD 28.34million)
- To be implemented by Power Transmission Company Nepal Ltd. (PTCN)
[Proposed equity shares of JV partners : NEA(50%), POWERGRID (26%), Financial Institutions of Nepal (14%), IL&FS (10%)]

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India - Nepal : On-Going Trans. System

• Status of Implementation

Milestone	Status
Transmission License	Granted for both portions
PSA (Power Sale Agreement)	Signed on 12th December, 2011 between NEA and PTC for 150 MW
ITSA between JVs & NEA	Signed on 13-Dec-2011 between CPTC & NEA and PTCN & NEA
Shareholder Agreement (SHA)	SHAs have been signed for both the JVs are signed on 09th July, 2012.
Implementing Agency	POWERGRID as per agreement signed with CPTC (on 10th Aug, 2012) and PTCN (on 13th August)
Commissioning Schedule	July, 2014

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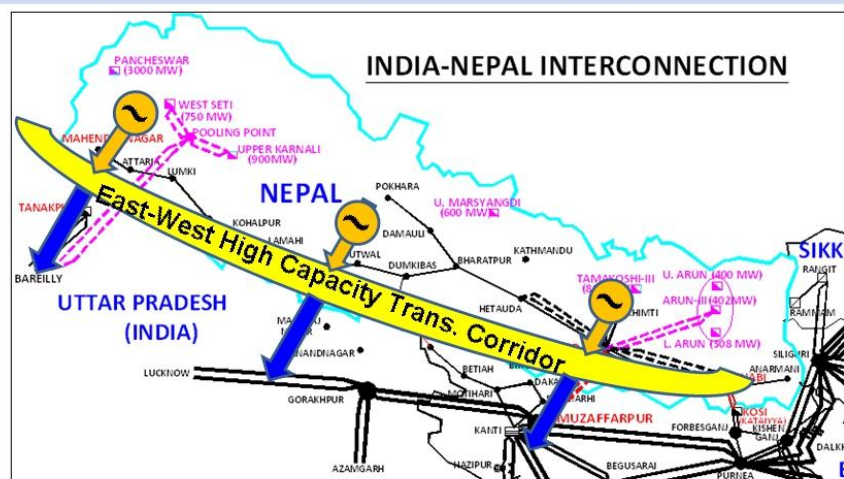
India - Nepal : Future

- **Hydro Potential** : about 83,000 MW
- **Future Hydro Projects** :

Karnali	-10,800 MW (Upper Karnali-900MW)
TamakoshiIII	-880 MW
U. Marsyangdi-2	- 600 MW
PancheshwarHEP	- 5,600 MW
SaptaKoshi	-3,300 MW
ArunHEP	- 1,100 MW
West SetiHEP	-750 MW
Lower Marsyangdih	-300 MW
- **High capacity transmission** interconnection between Nepal and India need to planned for evacuation and transfer of power from future hydel projects in Nepal.

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India - Nepal : Future Plan

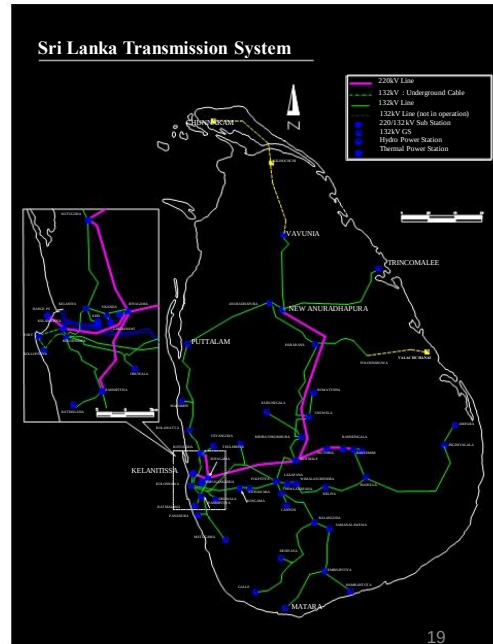


- **East-West High capacity transmission Corridor** need to be planned in Nepal
- This corridor may be **connected with hydro projects in Nepal and Load centers in India**
- Development may be carried out **through SPVs**

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Sri Lanka : Present Power Scenario

- **Installed Capacity** : 3118 MW
(Hydro - 39%, Thermal-54%)
- **Maximum Demand** : 2200MW
- **Demand Growth** : 7-8 %
- **Hydro potential** : 2000 MW out of which 1200 MW already harnessed



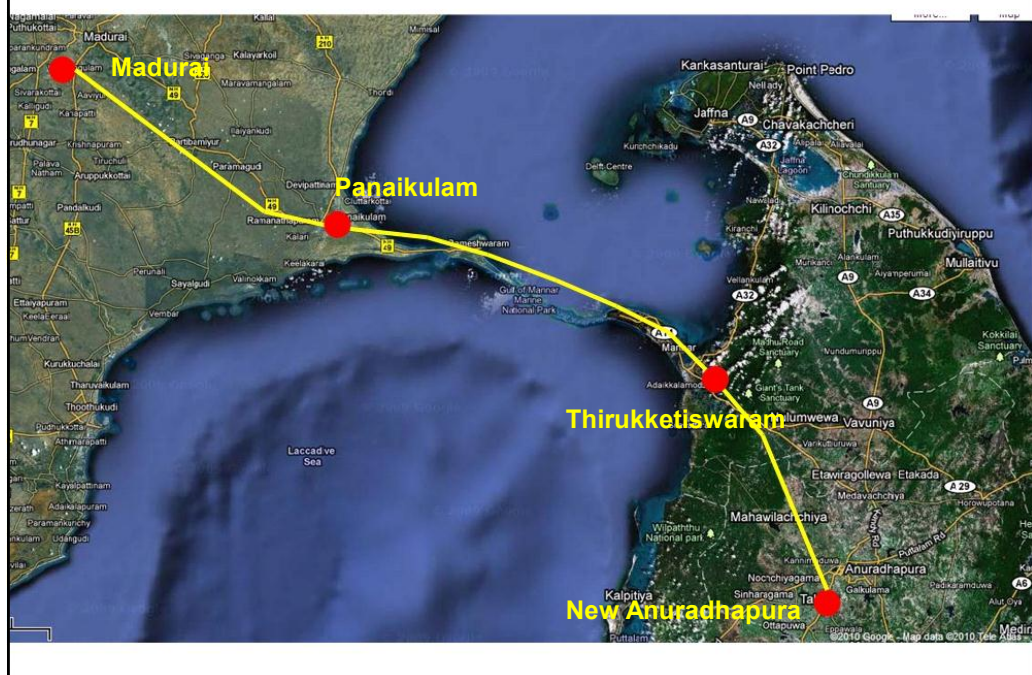
India - Sri Lanka interconnection

- **MoU Signed** between GoI & GoSL for carrying out feasibility study
- **Executing Agency** : POWERGRID (India) & CEB (Sri Lanka)
- **Proposed Interconnection** :
India(Madurai) - Sri Lanka(Anuradhapura) HVDC bipole line : 360 km
(Stage-I : 500MW; Stage-II : 1000MW)
 - 🕒 Indian Territory : 130 km
 - 🕒 Sea Route : 120km
 - 🕒 Sri Lankan Territory : 110 km
- **Tentative cost** : Rs. 5000 Cr. (USD 867 Million)
 - 🕒 Rs. 3300 Cr. (USD 645 Million) (Stage-I)
 - 🕒 Rs. 1700 Cr. (USD 222 Million) (Stage-II)
- **Feasibility Study Report** : Completed. Consultations/Clearances from various agencies are in process. Possibilities are explored for reduction of the cost of the project.

India - Sri Lanka Interconnection



Proposed Route for India - Sri Lanka Interconnection



Issues for Interconnection

- **Purpose of Interconnection**
 - Generation Linked (e.g. with Bhutan)
 - Strengthening Scheme for power exchange (e.g. with Bangladesh)
- **Techno-economical viability need to be assessed**
 - Voltage, Capacity, Mode(synchronous/asynchronous), location, time frame
 - Quantum of power exchange in either direction, its duration and source
 - Cost-benefit analysis to be carried out
- **Funding of the project**
- **Recovery of transmission charges**
- Issues like **scheduling of power exchange, operation, maintenance** etc to be firmed up
- **Regulatory Framework**
- **Institutional Arrangement** for settling **legal disputes** etc.

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Thank You

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Appropriate Market Structure of Regional Integration, Pool and Exchange Nepalese Perspective

Chandan Kumar Ghosh

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Large Power Generation, Operation and Maintenance
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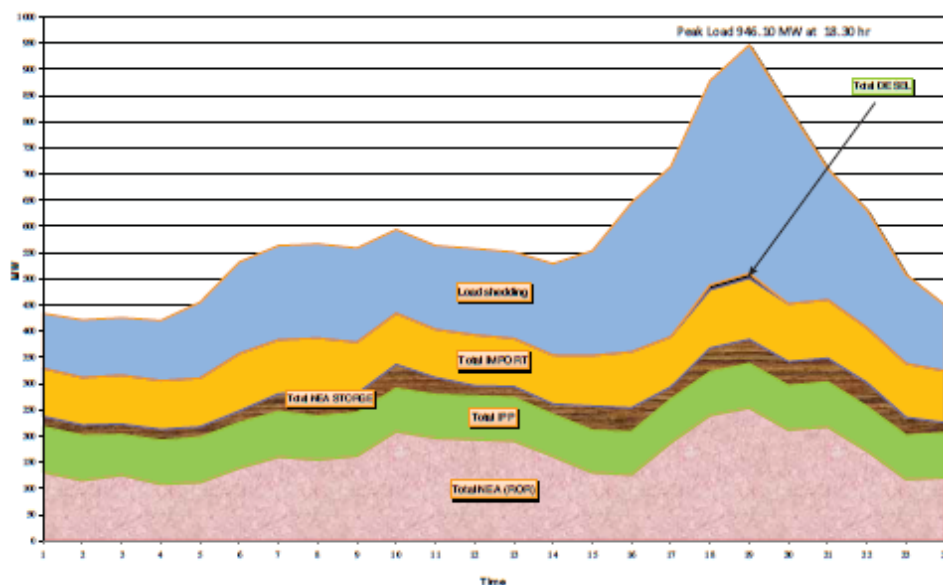
Introduction

- What should Nepal Consider
 - A Market Favourable for Hydro Energy
- Characteristic of thermal vs hydro
- Why not a mix?
 - In the SAARC Region?
- What should the Market encourage ?
- How to mitigate the risks associated in both thermal and hydro?

Assumptions

- Surplus in Year 2016/17
- Crisis still in dry season
- At least Some Cross-border Transmission Lines across Nepal and India
- Load profile of Nepal would be quite similar to the present load profile
- No Bias-Prejudice towards any particular power source

Average Load Curve of Nepal



Hydro characteristics

- Nepal has mostly hydro installations for its power needs.
- Hydro Stations are highly capital intensive.
- Run-of-river type of Hydro power stations are popular among developers.
- New Choice
 - Peaking Run-of-River type
 - Low Cost
- Storage type Hydro Power Stations
 - minimal
- The demand for energy is soaring high in South Asia. Hence, there is a good chance for Private or Public Sector to enter the market.

Characteristics of a ROR:

- No Storage in a ROR
- Drawback from the market perspective
 - cannot exploit the advantage of the demand and pricing of a free market.
 - need to sell its energy in realtime, or spill it
- Long term Contract,
 - Take-or-pay Contract
 - Monthly energy contract
 - Suitable scheme to hedge its risk for the spill.
- Investment in ROR type with a small pondage
- Some Storage type projects for Seasonal deficit balance.
- PROR than ROR.

Characteristic of Nepalese Load Curve

- Peak Load is nearly double of the Base Load
- Duration of peak load
 - normally 3 hours in the evening
 - a few hours in the morning
- No major variance from Winter to Summer
- Demand almost the same during Summer and Winter.
- Supply changes proportionately with the river discharges.
- Market Design should addresses this issue.

Appropriate Market Structure

- Pool
 - Like an Airlines Ticketing system
 - Commit early, buy cheap, no cancellation
 - Buy late, pay high or as per the demand
 - And try your luck
- Exchange
 - Bilateral treaty
 - Power Diplomacy

Pricing Mechanism : Barter

- Same mechanism in Summer or Winter
- Barter system
 - Additional surcharge for every transaction.
 - Based on committed power and not surplus power.
 - The cost of committed power is high in comparison to surplus power
 - Surplus power can be sold in a spot market as per commercial tariff

Reliability and Quality Issues

- Reserves of real power and reactive power are required
- strategically located
- Peaking ROR ramps up production during sudden surges in Power Demand.
- Purchase or outsource reserves and subsequently charge to system users on some equitable basis.
- Health Insurance

Ancillary Services 1: Black Start Capability

- Ancillary Services such as Black Start should also be priced.
- Hydropower has that advantage
- Market should reward this advantage
- The reserve capacity of a hydrostation is usable in 1 or 2 mins, where as for a thermal, it can take a half a day and for Diesel, 15 to 20 minutes at a minimum.
- Reserve capacity of a Hydrostation should be priced higher ?

Ancillary Services 2 : Reactive Power

- Voltage Support through reactive Power Generation by power plants can come at the cost of energy generation, ie, cost of fuel
- Market should encourage production of reactive power production
- UI and ABT based mechanisms instead of SPOT market could be a temporary measure before Market establishment.

Ancillary Service 3 : Standing Reserve

- The market should encourage establishment of unsynchronized, fast start-up plant (hydro, gas turbine) whose energy can be made available within 5 min or less.
- Hydro has a typical characteristics of a start-up time of less than 2 mins and a minute in average.
- Demand reduction as per operator's instruction can also be used in this category.

Ancillary Service 4 : Replacement Reserve

- The market should also encourage establishment of plants that can be brought into service with longer notice in the event of a shortfall in standing reserve.
- This could be termed hotstand by plant or deferred-start plant, designated by System Operator.

Ancillary Service 5 : Spinning Reserve Margin

- Market should have provision for a fast-response capability of a partially loaded synchronized generators to check any sudden frequency change due to loss of any generation from a station. The response time should be as less as possible to manage the system surge averting collapses.

Nodal Pricing Mechanisms

- There are many cross border points between India and Nepal.
- Likewise there could be many between India and Bangladesh
- and so on between other bordering countries.
- The regional price can be different.
- For example, the cost of energy in North-East India could be cheaper in comparison to the Eastern of Central Region.
- The solution to the problem is a Nodal Pricing Mechanism. It takes care of the Transmission Postage Stamps (fixed surcharges).

Congestion Pricing and Contingency

- Price needs to be increased in congested transmission lines
- Contingency Optimization:
- If one line of a generating station trips, there should be reserve capacity of generation or transmission.
- Pricing Signals for reserve capacity and transmission capacity should be considered while designing a market.

- Thank you
 - chandankghosh@gmail.com



Regional Power Integration - Opportunities, Barriers and findings from other Integration Modalities

6th Japan – SAARC Energy Symposium

Satish Joshi

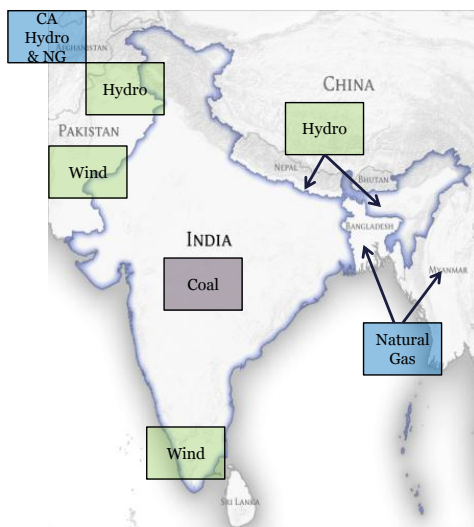
Outline of Presentation

1. Rationale for RPSI
2. Energy cooperation in South Asia
 1. Potential
 2. Barriers / Constraints to regional integration
3. Interventions needed
4. Cross Border Trade – Investment Board Nepal context
5. Lessons from implementation modalities in other regimes

Rationale for Regional Power Sector Integration (RPSI)

- **System Operational Benefits from**
 - Complementarity in energy demand and energy resource endowments
 - Optimal utilization of resources from economies of scale ; Reduced spinning reserves
 - Improved energy security and reliability in the system
 - Reduced environmental impact and climate change imperative
- **Economic and Financial Benefits from:**
 - Substantial benefit to smaller exporting economies
 - Increased revenues from trade and industrial activities, enhanced industrial productivity
 - Significant relief from energy constraints to rapid economic growth
- **National Benefits**
 - Implications of trade to energy security
 - Reduction of supply costs
 - SAPP could realize 45% savings in costs for meeting the same demand if the regional plan is adopted versus the sum of the national power development plans to meet the same demand
 - Cash flow implications – the make or buy choice in an environment with competing demands on limited resources

South Asia - Vibrant Energy Market



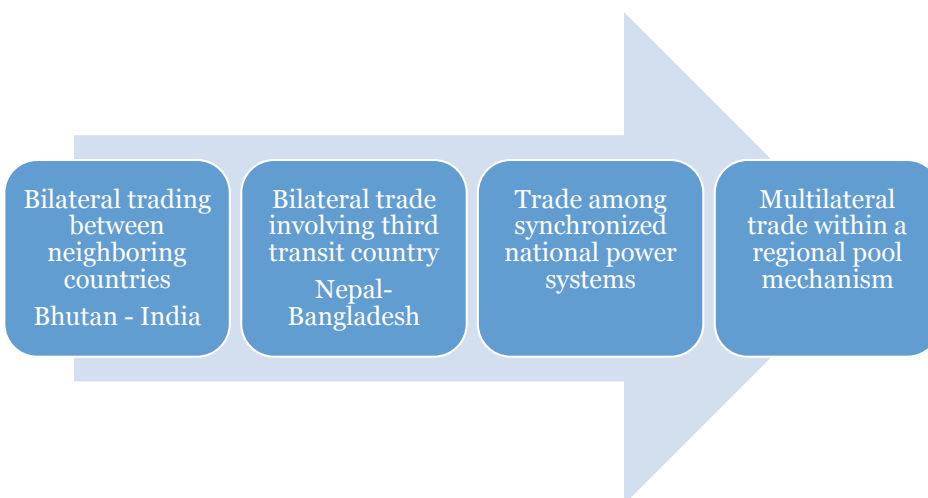
- Hydro potential from Nepal and Bhutan are seasonal and production peak is synchronized to India's peak demand
- India is fully capable of being the anchor base load with coal
- Southern peninsula excellent for wind resources
- Pakistan, Bangladesh and Myanmar are equipped for flexible generation fired on Gas
- Expanding the Power and Gas grids also gives countries a potential to develop previously undeveloped resources for common utilization

Synergies are there to be explored and developed

Existing Level of Trade

- Bhutan exported of 5,586 GWh in FY 2011-12
- Afghanistan imported 78% of is energy from Central Asia
- Nepal's import from India of 694 GWh (17.85% of its total supply) in 2011-12
- Pakistan's import of about 25MW of power from Iran

Evolution of Trading Arrangements



Barriers to Regional Integration among SAARC Member States

1. Political and Security barriers

- Political rhetoric for Regional Integration has not translated into Political Will and action
- Managing individual countries' energy security - mindset that regards energy trade as reducing energy security
- Public opposition based on nationalistic fervor

2. Infrastructure Constraints

- Lack of electrical interconnections and gas pipelines across borders (except Bhutan-India, Nepal-India, Afghanistan-Central Asia)

Barriers / Constraints to Regional Integration among SAARC Member States

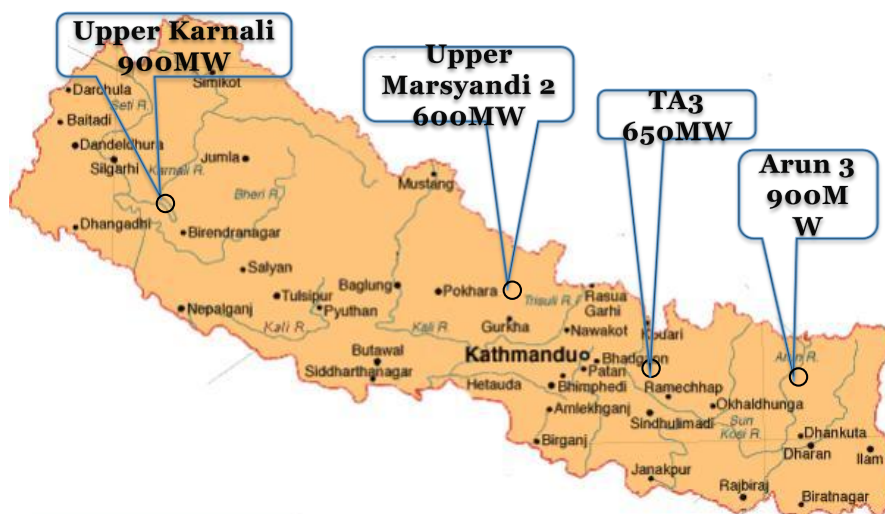
3. Legal and institutional barriers

- Policy inconsistency among member states - changes in one country have implications in another
- Absence of solvent utilities
 - Utilities as vehicles of social policy, high theft/non payment and system losses
- Ownership structures and Contracting Practices
 - Primarily state owned not conducive for export-import opportunities
 - Lack of sustainable commercial and contractual arrangements – ad hoc political agreements such as in Bhutan are acceptable in the nascent stages of trade
- Slow rate of sector restructuring

Interventions Needed - only a few

- *Further* strengthen public support for treating energy imports as enhancing energy security
- Harmonize the Legal and Regulatory Frameworks
- Promote alternative financing mechanisms for developing regional energy trade and cooperation - initiatives that enable private sector participation
 - **Nam Theun and Muzzafarpur-Dhalkebar are truly innovative models to replicate**
- Adopt energy policies in SMS need long term alignment and accelerate energy sector reforms
- Joint Government, Regulatory, TSO, Grid level understanding for promote Cross Border energy trade

Cross Border Trade - IBN Context



Cross Border Trade - IBN Context

- IBN is mandated with the implementation of 4 export (India) oriented projects with a total capacity of 3,050MW
- There are substantial regulatory, contractual and technical obstacles to viable cross border electricity trade between Nepal and India
- Failing to resolve these issues will make it difficult, if not impossible to finance hydropower projects exporting to India
- A Power Trade Agreement between Nepal and India is **absolutely essential** to ensure viability of these projects

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Challenges in Nepal India - Cross Border Trade

Nepal - India PTA must resolve the following uncertainties

- **Regulatory Uncertainty :**
 - Current GoI policy of levying INR2 (~US\$0.04) per kWh import duty makes Nepali exporters uncompetitive to Indian buyers.
 - Although GoI appears to have agreed to exempt some projects currently under development in Nepal– but this remains an uncertainty in the minds of the investors
 - Electricity has been classified as a restricted commodity requiring annual renewal of import licenses
- **Contractual Uncertainty**
 - Unclear if HPPs in Nepal exporting to India will receive the same open access to the power trading market, transmission capacity or to the regulated tariff accorded to Indian HPPs
 - Single Buyer/Trader in India: current feeling is that only state owned/backed electricity trading companies (PTC India and NTPC) are allowed to buy or sell electricity from Nepal. Investors fear this may affect their competitiveness negatively.
- **Transmission and Technical Barriers**
 - Enabling environment for the construction of Multiple Transmission Facilities
 - Coordination mechanisms providing for appropriate rights of way, design specifications and operational protocols

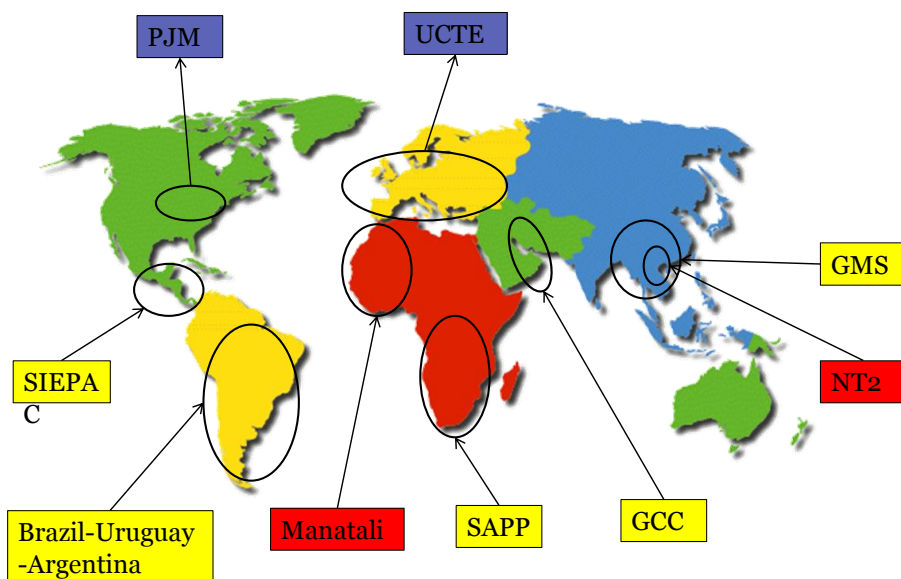
India must lead the way



- The sheer size of India's power market relative to other SMS
- India's geographic location
 - With the exception of Pakistan-Afghanistan, no trade is possible between any two countries in the region without India's involvement
- India's dominant role in the geopolitics of the region

... and other s in the region must do their part to effect necessary reforms and change public perceptions about trade domestically – trade = energy security

Regional Power Sector Integration



Key Characteristics of RPSI Schemes

		# of		GWH	Max		TRADE
SCHEME	YEAR	PARTICIPANTS	MW	PA	Trade %	PSP ¹	ARRANGEMENTS
TRANSMISSION & TRADE							
GMS	1971 (1995)	6	88,000	366,000	1%	✓	Bilateral
SAPP	1995	12 (9)	46	274,000	7%	✓	STEM, now DAM
Argentina-Brazil	2000	2 (3)	125,000	480,000	13%	✓	Bilateral
SEE	2005	9	43,600	183,000	14%	✓	EU single market
SIEPAC	2010	6	9,700	32,000			MER regional market
GCC	2010	6	73,000	290,000			Spinning reserve
NBI	2010	9	27,400	142,000			Bilateral
GENERATION							
Cahora Bassa	1977 (1997)	3	2,075	13,000			Bilateral
Manantali	2002	3	200	767			Bilateral
NT2	2009	2	1,070	5,636	100%	✓	Bilateral
DEVELOPED COUNTRIES							
PJM	1927	14	163,500	700,000		✓	Multiple Markets
UCTE/ENTSO-E	1951	24 (29)	672,000	2,300,000		✓	EU Single Market

¹ Private Sector Participation

Successes & Problems

SCHEME	SUCCESSSES	PROBLEMS AND INVESTMENTS
TRANSMISSION & TRADE		
GMS	Bilateral trade a proven model	Burden of E & Social problems on poor countries
SAPP	Regional interconnectors being developed/rehabilitated	Failure to implement Pool Plan; regional capacity shortfalls; failure to attract financing for regional generation projects
Argentina-Brazil	Regional transmission project promoted and owned by private sector	Banning of exports by Argentine government destroyed basis of Garabi project and set back market development
SEE	Progressive moves towards wholesale and retail competition	Next logical regional investment is in region with uncertain status (Kosovo)
SIEPAC	Creation of market institutions; 7th (regional) market on top of 6 national ones that are at different stages of dev	Long process (23 years from feasibility study)
GCC	Power Exchange Trading Agreement	Global LNG market distorting regional trade in gas, resulting in imports of coal for electricity generation
NBI	Investment projects underway	Lacks clear allocation of responsibility between NBI and EAPP
GENERATION		
Cahora Bassa	Consistent supply since 1997	Reliability: 18yrs out of service
Manantali	Operated satisfactorily since commissioning	Low tariffs and financial sustainability loans
NT2	Export revenues for Laos; well planned E & social safeguards	Controversy over share of private participants
DEVELOPED COUNTRIES		
PJM	DAM and real time markets, transmission auctions	Locational marginal pricing does not give investment signals
UCTE/ENTS	Legally binding agreement after 2003 supply failure	Lack of coordinated regional planning and investment

Findings - Levels of RPSI

- There are many levels and types of RPSI ranging from:
 - Simple forms of interconnection – cross border PPAs
 - Unified power markets, with full technical and regulatory harmonization, coordination of investment and competition across borders with few impediments – few have achieved this Nordpool come closest
- One size does not fit all - driven by various motivations, need to be tailored to local circumstances
 - SIEPAC oriented to deep forms of RPSI
 - GCC has limited objectives of sharing spinning reserves
- Objectives of RPSI change over time as do institutional arrangements
 - UCTE evolved from synchronous operations to a supra-national agency with statutory powers
- Moving from no integration to full integration can take decades but substantial benefits can be achieved from all levels of RPSI

Lessons learned - Optimization of Investment on Regional Basis

- Optimization of generation and transmission investments on a regional rather than national basis can offer substantial cost reductions
 - SAPP's 2025 Pool plan requires US\$89bil to construct 57GW of new generation capacity which is US\$48bil less (as saving of 45%) than the sum of the national power development plans to meet the same level of demand
- However these cost reductions go unrealized due to domestic energy supply security, economic nationalism, and sovereignty concerns
 - History has validated the reasons for caution on these grounds as in the Argentina's decision to ban export of electricity during the 2002 economic and political crisis or the unbalance generation mixes resulting in the SEE Market following the break up of Yugoslavia
- Explicit mechanisms to share benefits, such as allocating shares in cross border projects can help overcome reluctance to implement regional plans
 - Muzaffarpur-Dhalkebar

Findings - Regional Institutions

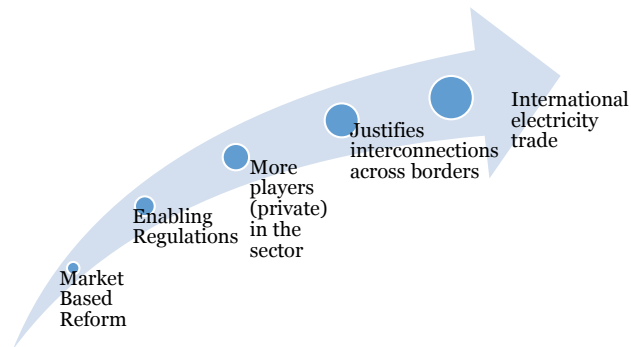
- The momentum from initial political initiative for RPSI schemes can be sustained by the establishment of regional institutions:
 - SPVs
 - Regional bodies – Power pools, regional associations of national regulators.
- Regional institutions are vital for RPSI but there is no single institutional form that is appropriate for all regional power integration schemes.
- The strongest institutions are those that grow organically from local initiatives rather than imposed from outside. Opportunities to build on existing arrangements should be explored before creating new institutions.
- SPVs provide a good model for projects serving multiple country markets
 - Nam Theun 2 Power Company, SIEPAC, Cahora Bassa, Argentina-Brazil
 - PTCN (Nepal) and CPTC (India) for Muzaffarpur-Dhalkebar Cross Border Transmission Project

Findings - Technical and Regulatory Harmonization

- Harmonization is not a pre-condition for RPSI but is often the next step after simple interconnections
- Harmonization is the establishment of common norms, rules and protocols in technical, economic, and legal matters pertaining to RPSI
 1. Technical Harmonization – assure access to and stable operation of interconnected transmission systems and avoids loading excessive costs onto neighboring systems
 2. Economic Harmonization – rules of operation of markets and adjustment of tariffs in regulated markets becomes critical as competitive cross border trade develops
 3. Legal Harmonization – agreed uniform procedures and mechanisms resulting in a common regulatory framework

Findings - Power Sector Reform

- Market based reform correlated positively to RPSI



- Deeper levels of integration will require countries to be at similar stages of reform
- Reform can have unintended consequences – pressure on cross border projects as long term contracting can become challenging,

Findings - Role of Donor Agencies

- Donors play an important role in developing RPSI through providing financing, Technical Expertise and Neutral Advisors
 - NBI – World Bank and African Development Bank
 - NT2 – WB, ADB,
 - SIEPAC – Inter-American Development Bank
- Play a key role in helping regions recognize, adopt and mitigate environmental and social impacts
- Donors must avoid imposing ambitious RPSI agenda and allow members in the region to evolve at their own pace
- Donor financing – concessional loans and grants, can distort the market allowing tariffs to be set at sub-economic levels and crowding out the private sector, eventually making the necessary adjustments painful and unpopular

Financing Options - Investment Context and Risk Ratings

- Cross border projects are considerably more complex and carries more risk for project sponsors
- From a financing perspective, energy trade project risk can be classified into two broad categories:
 - Political Risk – legal, regulatory
 - Project Risk - technical, commercial, financial
- Private participation will be challenging, but not impossible, particularly for high risk countries
- Initial projects involving high risk countries will most likely be funded by Government, donors, multilaterals, on grant or concessional loans

Potential Funders and their products

Donors

- Technical assistance for the highest risk projects
- Grants and soft loans for medium risk projects

IFIs

- Public and private sector windows
- Technical assistance
- Private sector funding via Foreign Currency Loans, Equity Funding

National Utilities

- Lack of credit ratings and relatively weak balance sheet limits funding options
- Will have to depend on state funding or indirectly by donor and bilateral/multilaterals

Private Sector

- Developer Risk Equity
- Contractors risk capital in the form of equity and supplier credit through ECAs
- VC, Private Equity, Market Lenders

Providers of Risk Mitigation Products

Event Specific

- Payout when a given event triggers a loss – PRI and PRGs
- PRGs provided by World Bank and ADBs of the world, but their exposure is normally counter guaranteed by host government of the country of investment
- PRI, provide by MIGA, protects against adverse regulatory actions, but proving the occurrence of triggering event can be challenging, denial of justice clauses

General default Guarantees

- Credit enhancements such as partial credit guarantees
- Normally covers the back end years of loans
- Objective is normally to increase tenors

Illustration of a Predominantly State-Owned Project Financing

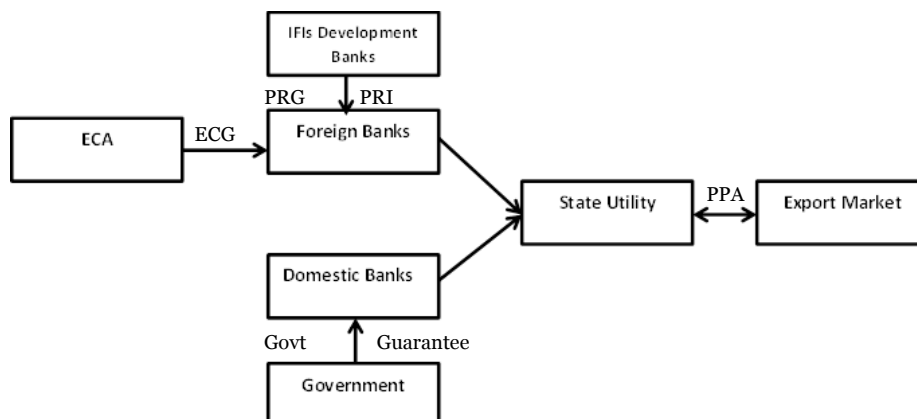
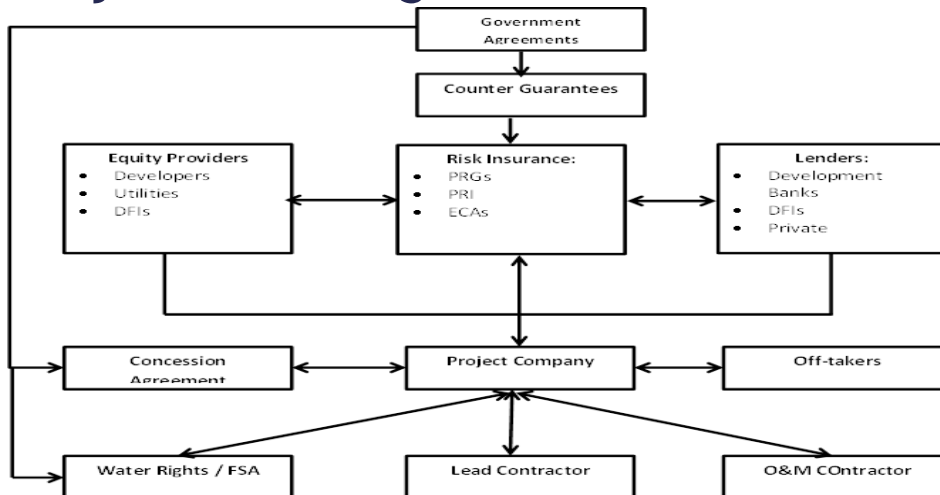


Illustration of a Predominantly Private Project Financing



Nepal Investment Board
Government of Nepal
2068

THANK YOU



South Asia Regional Initiatives for Energy Integration (SARI/EI)

Supporting Cross Border Energy Trade in South Asia

Shanker Khagi
USAID/Nepal

March 7, 2013
Kathmandu, Nepal

Good Reasons for Cross Border Energy Trade

- Continued power shortages hamper growth prospects
- Regional complementarity
- Seasonal Imbalances
- Daily Imbalances
- Strengthen economic environments
- Provide for an improved quality of life
- Energy security = Security



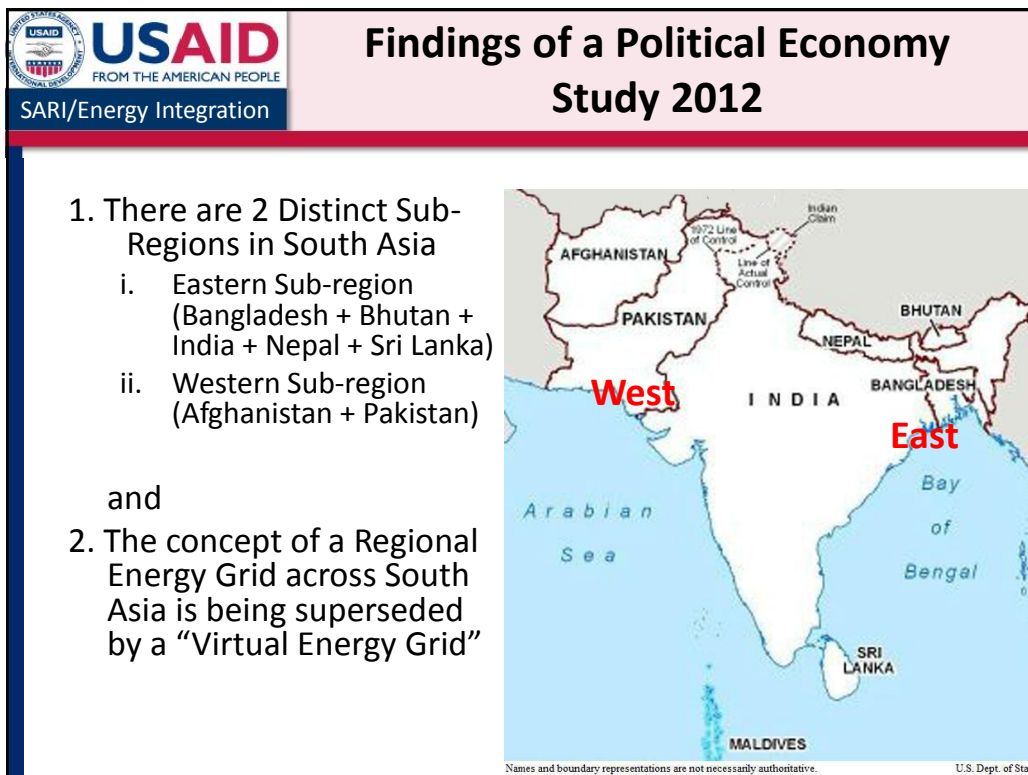
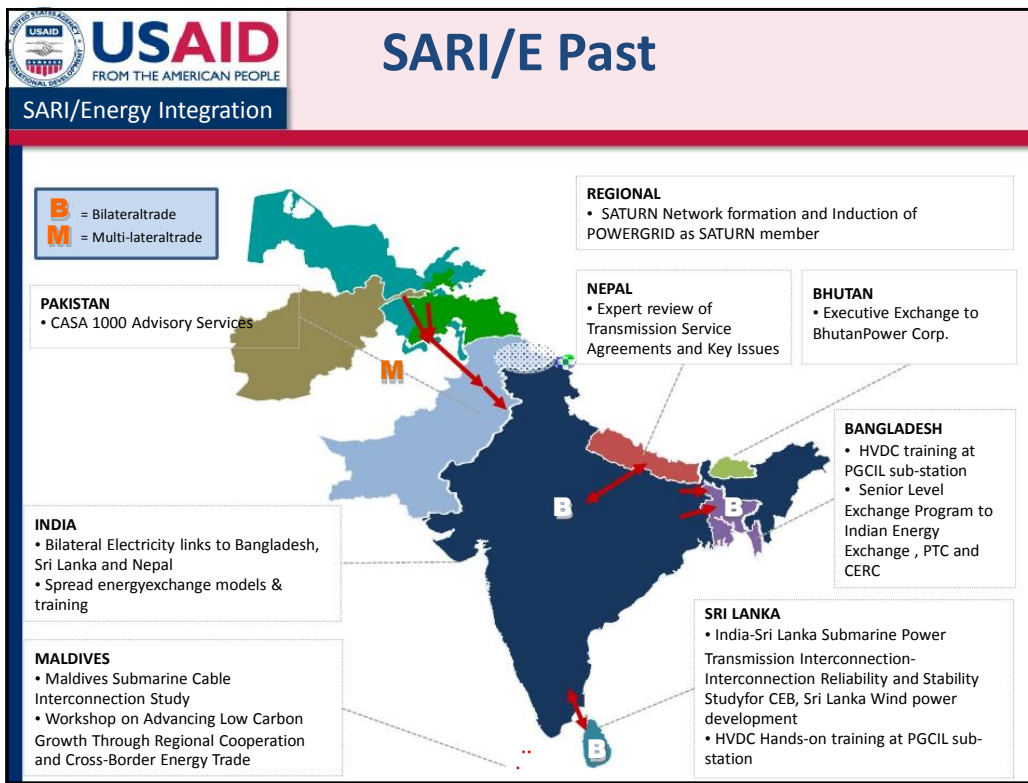
Change

- Good reasons for change aren't enough.
- There must be the political will for change.
- Political will reflects stakeholder expectations...
 - but also stakeholder concerns about the future
 - and how best to meet the challenges of the future
- Concerns are generational
- Change is generational

SARI/E Past

USAID's South Asia Regional Initiative for Energy (SARI/E)

- Launched in 2000
- Completed its 3rd Phase in 2012
- Having successfully helped position stakeholders for the future
- Looking to leveraging its success in a 4th Phase



Sub-regions

East

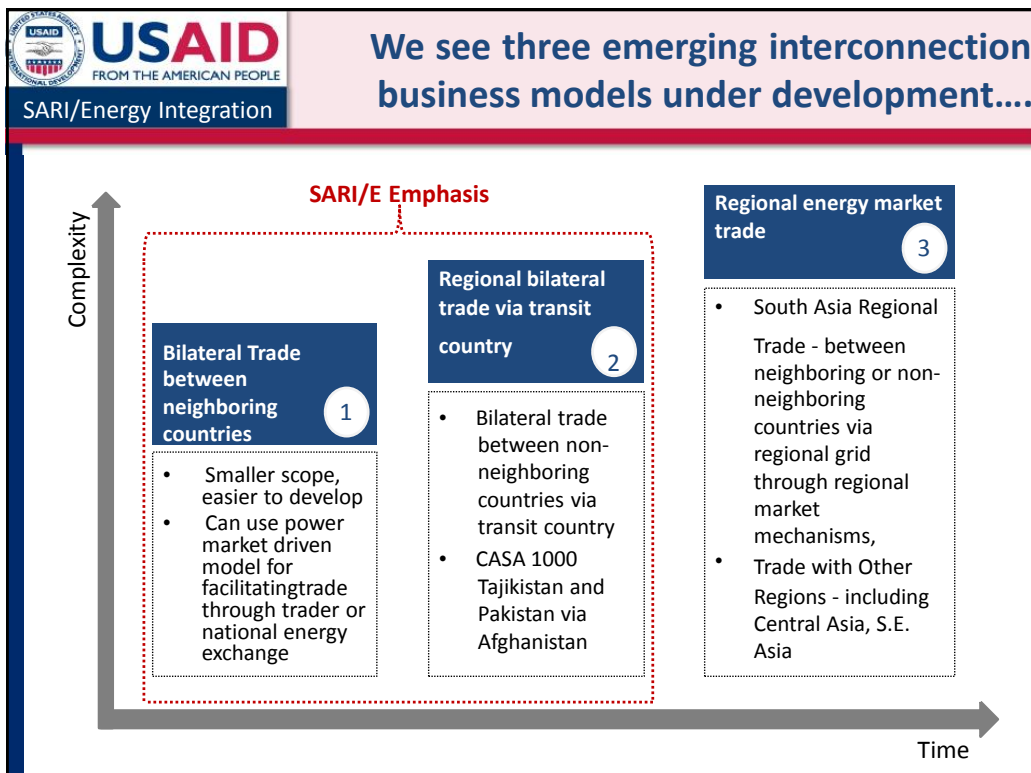
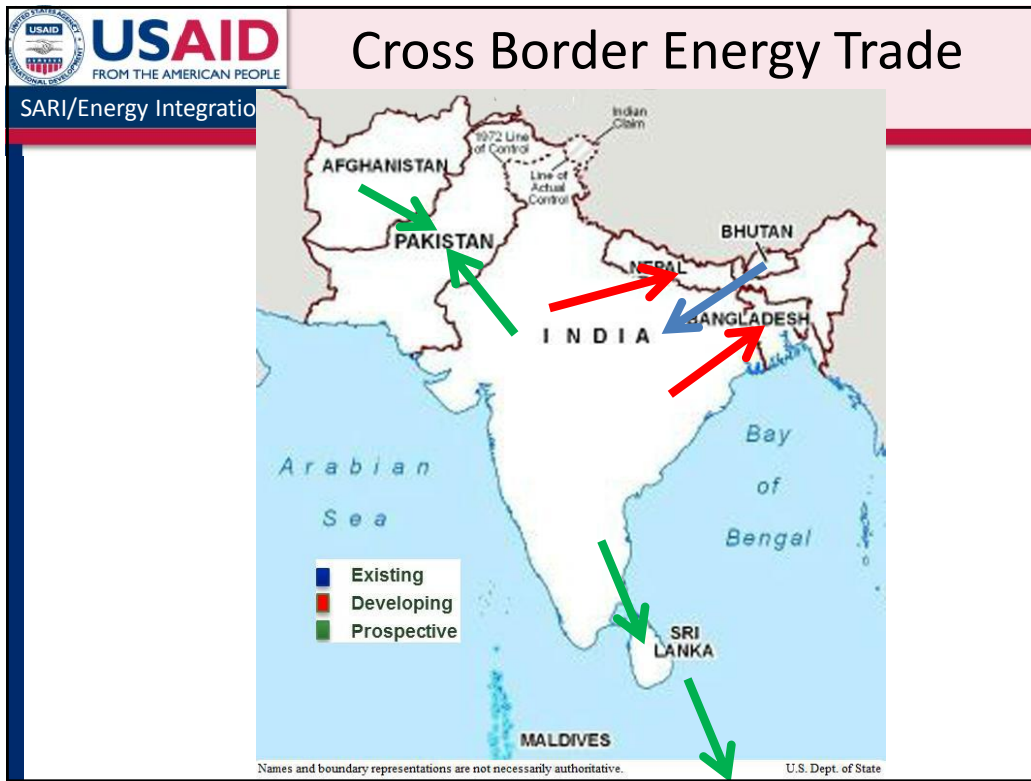
- Strong interest in developing energy markets
- Indian market is economic engine for Sub-Region
- Growing number of interconnections with India
- On track for “Virtual Energy Grid”

West

- No Markets ... but represents important vision for trade
- Ongoing of conflict and worsening political uncertainty (instability)
- Several project opportunities – high risk / high reward

A Regional Energy Grid

- A “Regional Energy Grid” – a transmission infrastructure linking the continental countries of South Asia – has been a long sought but unfulfilled objective.
- Existing, Developing, Prospective connections between India and neighboring states:
 - Are they the beginnings of the “Regional Energy Grid”?



Regional Energy Trading

- **2007 – Guidelines for power exchanges in India**
- **2008 – Indian Energy Exchange – first ever power exchange in India**
- **2014 - With unification of India's grids it will be possible for energy transactions between any two points in India**
- **Subsequently - With connections to India, it will be also be possible for energy transactions between any two points in countries connected to India.**
- **Without the requirement of building extensive international transmission networks, the Virtual Energy Grid can be used as soon as bi-lateral connections with India are in place.**

Developing the Virtual Energy Grid

- **“Hardware” Interconnections: Technical challenges are manageable but get most of sector's attention**
- **“Software” is critical to enable interconnections to happen, and needs more focused attention:**
 - Commercial trading arrangements
 - Legal and Regulatory issues
 - Media issues and public outreach

Priorities

1. Political consensus – legislation to permit cross border energy trade
2. Encouraging Public-Private Partnerships for cross border energy projects
3. Completing the interconnections between India and its neighboring countries
4. Harmonizing laws governing commercial energy trade among the countries
5. Establishing independent regulatory regimes in each South Asian country and harmonizing regulations governing cross border energy trade
6. Functionally restructuring the energy utility sector in each country.
7. Ensuring that retail energy tariffs are cost reflective in each of the countries.

SARI/EI Forward

- Project Steering Committee formed – meeting on March 12
- Task Forces to be formed on
 - Policy, Legal, Regulatory
 - Generation & Transmission Infrastructure Planning
 - Energy Trading/Exchanges and markets
- Coordinating with Supporting Institutions like SAARC, MDBs
- Promoting Public-Private Partnerships



USAID
FROM THE AMERICAN PEOPLE

SARI/Energy

Thank You!



Appendix II

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38	Mr. Rajan Giri	

Appendix III

Pictures



Opening Ceremony



Inauguration by Chief Guest, Mr. Leela Mani Paudyal, Chief Secretary, Government of Nepal



Addressing the Symposium by Chief Guest



Group Photo