# ROAD MAP FOR DEVELOPING

# SAARC MARKET FOR ELECTRICITY

# (SAME)


PROPOSAL BY:

GOVERNMENT OF INDIA
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## INTRODUCTION

**1.0** Electricity is a special commodity which cannot be stored and its consumption fluctuates continuously and therefore, maintaining stability of the electricity grid extending to a number of countries and control areas is a challenging task. Electricity is transmitted through a separate transmission infrastructure and its market has to be organized considering the paramount need of grid security and reliability. Among the SAARC countries India has taken a lead in reorganizing electricity supply industry by taking steps to foster competition in the electricity supply industry. Under the Electricity Act, 2003, the generation sector has been liberalized, open access in transmission has been mandated by law and electricity trading has been recognized as a distinct activity. Procurement of electricity through tariff based competitive bidding through long-term PPAs has been successfully implemented. The private sector has given an overwhelming response to the opening up of the electricity generation sector and independent power producers have come forward to set up massive capacity in hydro, thermal and renewable sectors of generation.

India is a vast country and power trading opportunities arise due to unevenly distributed generation resources, regional variations in demand pattern due to geographical, seasonal and daylight time variations despite an overall deficit scenario. Trading has evolved in India as a voluntary activity born out of the necessity of distribution utilities either to mitigate their peaking shortage or to dispose of the surplus out of their total portfolios of long term contracts. **Due to the fact that all historical long term PPAs remain intact and regulated as before the transition to market scenario is smooth and gradual.**

Inter and Intra-regional transmission system together with day ahead dispatch procedure, energy accounting, financial settlement of deviations from dispatch schedules , open access regulations for transmission and power market regulations have provided the basic framework for trading.

India's first power exchange came into existence on June 27, 2008 after necessary regulatory approval. It is a nationwide, automated online, electricity trading platform conceived to bring ease, transparency and equity in day-ahead physical trading of electricity. It is a demutualised exchange with software enabled price discovery facilitating efficient utilization of power resources. It helps in meeting the peaking requirement of distribution utilities in sync with the day ahead scheduling of their other long-term and short-term bilateral portfolios.

India has a robust transmission infrastructure and it is undergoing rapid expansion in the wake of massive generating capacity addition programme. An overview of transmission system of India is enclosed at Annexure-I.

In view of the progress made by India, it is easy to visualize that other SAARC countries can also accelerate the development of their electricity supply industry through process of restructuring and reforms. It is, therefore, felt that electricity reforms are fundamental to the development of a regional electricity market where unbundled buying and selling utilities may freely enter into the commercial contracts for electricity within the SAARC region.

**1.1** There is no doubt that existence of adequate transmission infrastructure is a pre-requisite for physical trade of electricity. However, it is not necessary to have a synchronized electricity grid for the entire SAARC region. It is possible to couple the independent electricity grids of different countries through HVDC links. HVDC coupling of grids facilitates independent frequency operation of each grid and prevents the passing on of grid disturbances from one grid to another. Also, the mismatch between the AC grid voltage can also be accommodated through

HVDC inter-connections. However, the starting point has to be the assessment of trade potential and facilitation of trade supported by inter-governmental agreements and formulation of coordinated scheduling and dispatch procedures, open access for cross-country transmission and congestion management procedures for cross-country electricity transactions. Once, the above measures are to be in place, cross-country transmission inter-connections can be planned and implemented as per requirement. However, in case of countries separated by sea, the cost of transmission inter-connection is very heavy.

**1.2** It is not necessary to plan and create a common transmission grid for the SAARC countries. Each country should have the autonomy to plan and develop its own national transmission grid as per its requirements. The coupling or inter-connection between the countries can be planned depending on the need of quantum of power to be exchanged in a desired time frame and in a phased manner. Method of servicing the investment in cross-border inter-connections should be worked out before hand. The cross-border inter-connections created through bilateral or multilateral agreements, could be used for long-term as well as short-term transactions.

**1.3** It may not be necessary to have a uniform grid code for each of the SAARC Member country. For instance, even in the case of Nordpool countries, deviations from schedules are treated differently by each country according to its national grid code. Within India also each State has its own state grid code and it has to be harmonized with Indian Electricity Grid Code(IEGC) to facilitate inter-state trade transactions. The important thing is coordination among the national grid operators, a common timeline for issuing dispatch schedules, agreement on handling grid emergencies and financial settlement system.

**1.4** It is also important to develop a dispute resolution mechanism for cross-border trading which is acceptable and binding to all the participants for which a SAARC regulatory forum may have to be created.

**SAARC Regional Energy Trade Study (SRETS)**

**2.0** Recognising the immense potential benefits of electricity trade in terms of optimal utilization of hydro resources, economy of scale, improved energy security and reliability, increased reliability of power system operation, reduced environmental impact, and spin off effects in terms of faster economic growth and increased earning of electricity exporting countries and institutional capacity building in the electricity sector of the region, the SAARC Secretariat had finalized the Terms of Reference for carrying out SAARC Regional Energy Trade Study (SRETS) in January 2007. The study was supported by Asian Development Bank (ADB). The Terms of Reference for the SRETS were as follows:-

a) A sector-wise and fuel-wise study be carried out on the options, benefits and constraints of energy trade in the region, covering the demand and supply - both current and projected for optimal utilization, and development, of energy resources for the benefit of SAARC Member States.

b) The Study would cover the prevailing trade regimes, the regulatory and legal frameworks of the Member States.

c) It would examine the international and regional best practices and their relevance as well as applicability to the region.

d) It would analyse the various technological, financial and commercial options for promoting trade and related projects.

e) It would examine the viability and modalities for development of trans-national energy lines (electricity, gas and oil) keeping in view the broader concept of the Energy Ring.

**2.1** The SRETS report has been completed in March 2010. It is a comprehensive study covering overall energy scenario in the SAARC region inter-alia covering the following aspects :

- Electricity supply position,
- Future projections of electricity demand,

- Fuel for generating electricity,
- Potential of renewable energy,
- Absence of electricity market in the SAARC countries with the exception of India. Likely gains from electricity trade.
- Institutional framework of the energy sector including power sector of each SAARC country including the legal regulatory and planning infrastructure of electricity supply industry.
- Trading arrangements and the private sector participation in the electricity supply industry. Prospects of energy imports by SAARC from Central Asian Republics, Iran and Myanmar.
- International experience and best practices of organizing cross-border electricity market have been reviewed in the context of their relevance for the SAARC region and lessons to be learnt from the experience of other regions.
- Nordic pool and South Africa Power Pool have been discussed in detail including their institutional framework for cross-border electricity trade.
- Agreement among the system operators of Nordic countries for operational coordination and formulation of common electricity grid code. Salient features of the South Africa power pool in terms of the following four agreements have been brought out in the Report :

- **Inter Governmental Memorandum of Understanding** signed among member governments of SADC for the formation of South African Power Pool. This is the guiding agreement based on which the Pool was established. The pool was inaugurated by this agreement. It grants permission for the utilities to participate in SAPP and enter into contracts, and guarantees the financial and technical performance of the power utilities.

- **Inter Utility Memorandum of Understanding** among the utilities establishes the basic management and operating principles for SAPP. The MoU defines ownership of assets and other rights, for example, provision for change in status from participating to operating member. In 2007, a revised inter-utility

Memorandum of Understanding was signed following which a new committee Market Sub Committee was formed. The revised MoU enables other players within the SADC region such as Independent Power Producers (IPP) and Independent Transmission Companies (ITC) to join the SAPP and to participate in all activities of the SAPP.

- **Agreement between Operating Members** determines the interaction between the utilities with respect to operating responsibilities under normal and emergency conditions.

- **Operating Guidelines** provides the standards and the operating guidelines. It also defines the sharing of costs and functional responsibilities for plant operation and maintenance, including safety rules.

**2.2** Payment security mechanism for cross-border trade, the bilateral contracts between entities located in different countries and multilateral trading through a common power exchange have been analysed. It has been inferred that bilateral trade among the countries creates an enabling environment for graduating to regional trade. A step by step block building approach has been recommended for the SAARC countries.

**2.3** The study has documented the evolution and the current status and prospects of electricity trade between India-Bhutan and India-Nepal. The prospects of power trade between India-Pakistan, India-Sri Lanka and India-Bangladesh have also been discussed.

**2.4** The updated status/prospects of cross-border electricity grid inter-connections and the nature of current bilateral electricity trade is enclosed as follows:-

Annexure-2: Existing Electricity Trade between India-Bhutan and Future Prospects

Annexure-3: Existing Electricity Trade between India-Nepal and Future Prospects

Annexure-4: Prospects and current status of Indo– Bangladesh Transmission link

Annexure-5: India-Pakistan Power Transmission Interconnection

Annexure-6: India-Sri Lanka Power Transmission Interconnection

**Common Template for Technical and Commercial Aspects**

**3.0** A task force to evolve a Common Template of Technical and Commercial aspects of Electricity Grid Inter-connections among SAARC Member States was constituted in December 2008 in order to have better understanding of the power system of each country. The following aspects were covered in the above template :

- Power supply position
- Legal/ regulatory framework, market mechanism, technical details, international connections etc.
- Long-term projections

**3.1** Accordingly, following aspects have been covered in this compilation :

a) Organization of the Electricity Supply Industry
b) Power System Planning & Planning Criterion
c) Legal / Regulatory Issues
d) Load despatch function
e) Technical Issues
f) Balancing Supply – Demand
g) Electricity Market
h) Ancillary Services
i) Renewable Energy Resources
j) Transmission Pricing
k) Congestion Management
l) Grid discipline
m) Investments
n) Existing International Interconnections
o) Long Term Projections

**3.2** The technical benefits of grid inter-connections have also been highlighted. India provided the lead in compiling the template and the draft report was presented to the SAARC Working Group on Energy in December 2009 in Goa. Now, this common template on technical and commercial aspects of electricity grid connections needs to be finally vetted and a mechanism has to be created for continuously updating the information. A copy of the draft common template is enclosed herewith.

**Programme for Further Studies**

**4.0** As a sequel to the SAARC Regional Energy Trade Study (SRETS), the Asian Development Bank in 2009 offered technical assistance to carry out the study on the prospects of South Asia Regional Power Exchange. The Terms of Reference for this study were circulated among the SAARC Member countries through SAARC Secretariat and the same are under finalization. These Terms of Reference were also discussed in the SAARC special meeting held in Colombo in March, 2010. The proposed Terms of Reference are given below :

**Phase 1**

(i) Study the power system structure including the legal and regulatory aspects and the power transmission system security and stability standards in the participating countries and their compatibility from a regional power trading perspective.

(ii) Study power generation scheduling and dispatch procedures, energy accounting systems and financial settlement systems for electricity transactions in the individual countries and identify measures for their harmonization to allow feasible cross border power trade; analyze the institutional, regulatory and commercial requirements for cross border power trade;

**Phase 2**

(iii) Identify possible cross border power transmission interconnections and scenarios

of regionally interconnected power systems and develop the regional database required to carry out power system studies.

(iv) Develop scenarios for supply and demand in the region covered or to be covered by interconnected power systems and conduct power system studies for different regional participation scenarios and determine the technical potential for cross border power exchanges, the additional power transmission required, and the institutional, regulatory and commercial principles and procedures to be followed in formalized cross border bilateral power trade.

(v) Carry out the economic and financial analyses of different power trade options with the perspective of (a) optimization of resources at regional level, (b) improving overall reliability of electric supply in the region, and (c) environmental benefits.

**Phase 3**

(vi) Based on findings from the above activities, develop the structure of a Regional Power Exchange by scaling up the operation of existing Indian power exchanges, with any operational modifications necessary, and centrally facilitate extension of the Indian power market to cater for regional power trade.

The assignment is proposed to be completed in about 2 years.

**5.0** In the meanwhile, Terms of Reference for the SAARC Expert Group of electricity have been prepared in the meeting held in Goa in December 2009. The Terms of Reference, inter-alia include the following :

- Assessment of potential for power exchange.
- Suitable models to be adopted for cross-border trade.
- Exploring various options of cross border inter-connections
- Study of institutional and regulatory arrangements
- Mechanism for cross-border transmission access.

- Scheduling and settlement of long-term and short-term electricity exchanges and operation of suitable and secured SAARC electricity trade.
- Methodology for implementation of trans-country transmission infrastructure including financial ownership and security of assets
- Methodology for application and settlement of transmission service charges for trans-country transactions.

**Regional Regulatory Framework**

**6.0** The Government of Japan had initiated a proposal to carry out a review of electricity laws and regulatory framework of SAARC Member States. The Fifth Meeting of the SAARC Working Group on Energy (Thimphu, 29-30 April 2009) noted that review of prevailing electricity laws and regulatory framework would be useful for the SAARC Member States. The Meeting recommended that the Study be conducted by the SAARC Energy Centre (SEC) with financial assistance from the SAARC-Japan Special Fund (SJSF), as per Terms of Reference finalized by the Working Group, during its next Meeting.

The Meeting deliberated on the draft TOR received from the government of Japan. The TORs finalized by the Meeting are as follows:

**Terms of Reference for Study on Electricity Laws and Regulatory Framework of SAARC Member States**

i. Study the electricity laws and regulatory framework prevailing in the Member States:

ii. Identify the relevant provisions in the electricity laws and regulations that facilitate electricity inter-connections and electricity exchange and trade among the Member States:

iii. Suggest amendments in electricity laws regulations of Member States that hinder electricity inter-connections and electricity exchange & trade among the Member States and suggest ways to harmonize the relevant provisions;

iv. Suggest any new provisions which may be required to be considered by the SAARC Member States; and

v. The Study shall be completed by the SAARC Energy Centre (SEC) by 30 June 2010

**Inter-governmental framework**

**7.0** The Fifteenth SAARC Summit (Colombo, 2-3 August 2008) while reviewing regional cooperation in energy stressed the urgent need to develop the regional hydro potential, grid connectivity and gas pipelines. They noted that the possibility of evolving an appropriate regional inter-governmental framework may be explored to facilitate such an endeavour.

The Fifth Meeting of the SAARC Working Group on Energy (Thimphu, 29-30 April 2009) recommended that the SAARC Energy Centre (SEC) may prepare the draft Terms of Reference (TORs) for such a Framework Agreement to be finalized by the Experts Group Meeting.

**7.1** The broad Terms of Reference for the inter-governmental framework were prepared in the Expert Group meeting of regional inter-governmental framework held in Goa in December 2009 and they are as follows:

i) Promote development of Regional and Sub-regional energy projects by public and private sectors as well as public-private partnership for meeting the energy demand of more than one Member States. These projects may include developing power generation from hydro and all other available primary energy resources, power grid connectivity and gas & oil pipelines.

ii) Permit, encourage and facilitate access for investments in Regional and Sub-regional energy projects, agreed by the participating Member States.

iii) Develop harmonized codes & standards and remove barriers for transfer of technology and sourcing of equipment from among the SAARC Member States.

iv) Provide enabling environment for security of investment in energy projects and energy trade.

v) Create access for laying down cross-border power transmission lines, gas & oil pipelines.

vi) Facilitate movement of energy sector experts and professional within the SAARC Region for project development and execution.

vii) Enhance knowledge sharing and joint research in the fields of energy efficiency, reduction of transmission and distribution losses, and development of renewable energy resources.

## 8.0 Conclusion and Recommendations

- SAARC electricity market would bring about optimization of resources on a larger scale and create additional opportunities for the SAARC member countries.
- Restructuring and Reforms in the electricity sector of all the SAARC countries would pave the way for cross-country electricity transactions on commercial basis just like any other commodity.
- The role of inter-governmental agreements would be to facilitate cross-country electricity transactions. The role of SAARC Regulatory Forum (SRF) would be to provide a dispute resolution mechanism.
- The participation in the SAARC electricity market would be on voluntary basis. There will be no compulsory pooling (like PJM, Australia etc).
- Cross country transactions could be of long term, medium term or short term nature.
- The trans country grid interconnections would be developed on case to case basis and from time to time based on assessment of quantum of electricity to be traded bilaterally or multilaterally.
- Isolated grid inter-connections between India – Nepal and synchronous connections India – Bhutan already exist and are being expanded. HVDC grid interconnection between India-Bangladesh is under development.
- The Coordination among national grid operators would enable the dispatch

and financial settlement of electricity transactions on day to day basis.

- The trans-country grid interconnections would be planned jointly. However, each country would be responsible for building and maintaining the transmission lines falling in its territory.
- The electricity market window already created in India would be expanded to include the SAARC member countries to create larger market place in which buyer and seller entities of each country would be participating guided by their own needs and perceived benefits.
- The cross-country coordination, dispatch and settlement procedures would be first fine tuned on short-term bilateral transactions. At an appropriate time the operation of the day-ahead Indian Power Exchanges would be scaled up to the entire SAARC region.
- At present the bilateral transactions between India-Nepal and India-Bhutan are settled based on actual energy and there is no commercial mechanism for financial settlement of deviations from dispatch schedules. As we scale up, a more structured approach would have to be adopted to maintain sanctity of contracts in line with the mechanism already being evolved in Indian electricity market.

**Action Plan**

**9.0 It is proposed to create one common expert group to develop the following draft documents:**

**i. SAARC Inter-Governmental Agreement (SAG)**

**ii. SAARC Regulatory Forum (SRF)**

**iii. SAARC transmission inter- connection agreement between transmission utilities (STIA)**

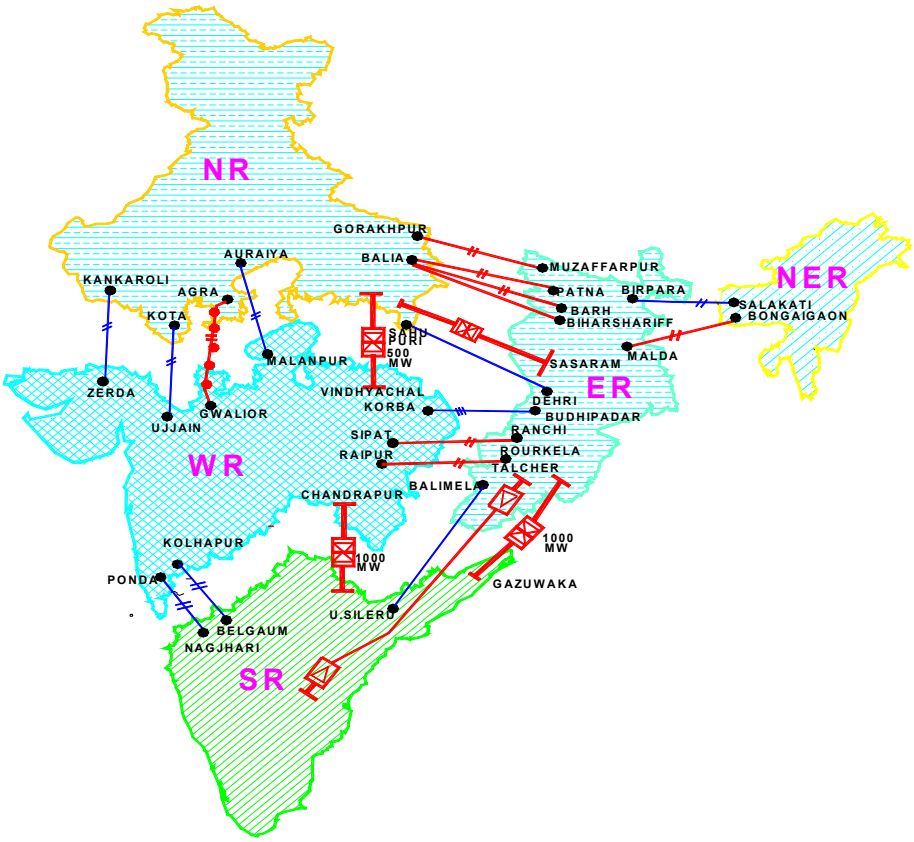
**iv. SAARC System Operaters Agreement (SSOA)**

**India is willing to take a lead in the matter.**

**Annexure-1**

## An Overview of Transmission System of India

The country has been demarcated into five electrical Regions viz. Northern (NR), Eastern (ER), Western (WR), Southern(SR) and North Eastern (NER). NR, ER, WR and NER have been synchronously interconnected and operating as single grid – Central Grid (capacity about 110,000MW). The Southern region is asynchronously connected to the Central Grid through HVDC links. Power map showing present National Grid is shown below:



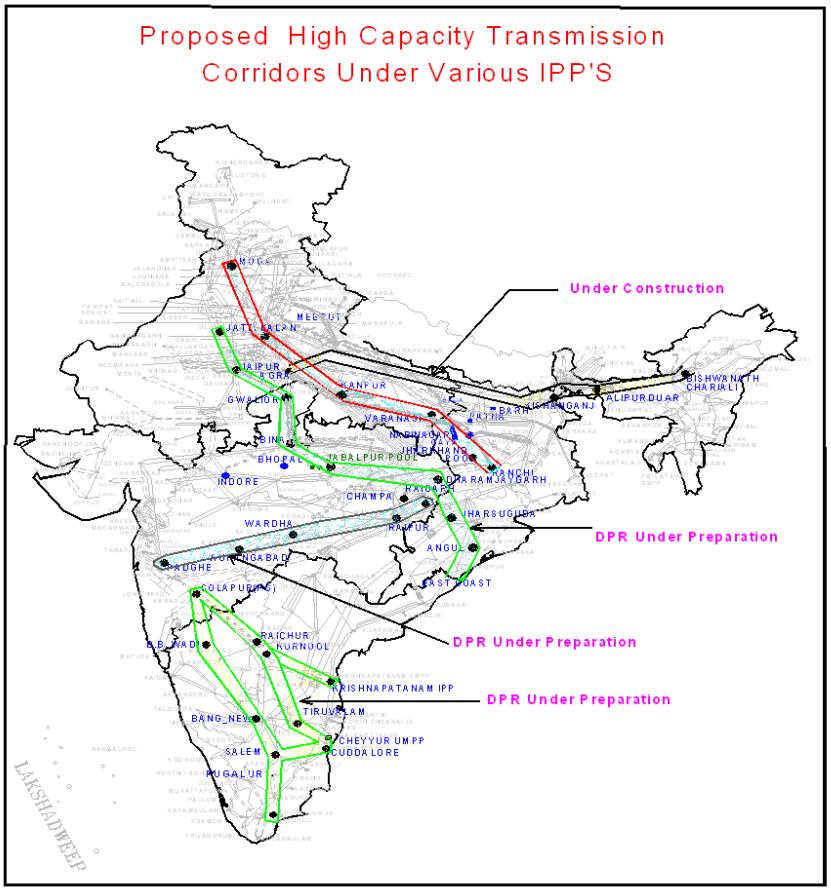

The backbone transmission system in India is mainly through 400 kV AC network with approximately 97,000 circuit kilometers of line length. Highest transmission voltage level is 765kV with line length of approximately 3500 ckm and is poised for exponential growth in the coming future. There are about 7,400 ckm of +/- 500 kV HVDC lines. These are supported by about 1,28,000 ckm of 220kV transmission network. All the five regions are interconnected through National Grid comprising hybrid AC/HVDC system. Present aggregate inter-regional transmission capacity of the National Grid is about 20,750 MW.

The present transmission system has to meet the firm transmission needs as well as Open Access requirements. The need of Long term Access (LTA) is normally met by transmission system strengthening required for future generation additions. The Short Term Open Access (STOA) facilitates increased trading in electricity, utilizing the inherent margins.

**Future Plan In Transmission**

The Inter-Regional transmission capacity of National Grid is planned to be increased to 32650 MW by 2011-12. High capacity transmission corridors comprising 765kV AC and ±800kV 6000MW HVDC system along with 400kV AC and ±500kV/600kV 2500MW/6000MW have been planned to facilitate transfer of power from remotely located generation complexes to bulk load centres.

Power map showing proposed high capacity transmission corridors is shown below:



**Annexure-2**

## Existing Electricity Trade between India-Bhutan and Future Prospects

India and Bhutan have terms of cooperation for decades for exchange of power between the two countries. Both the countries recognize the benefits for their initiatives, their contribution to the economic growth and in addressing the energy security concerns. Bulk of power generated at Hydro Electric Projects at Chukha (336MW), Kurichu (60MW) and Tala (1020MW) in Bhutan, which have been implemented with technical and financial assistance of India, is exported to India after meeting the internal demand of Bhutan. Power Trading Corporation(PTC) of India is the nodal agency dealing with the purchase and sale of surplus power of Bhutan through the long term power purchase agreement (PPA) signed between Department of Energy (DoE), Royal Govt. of Bhutan (RGoB) and PTC on individual hydro electric project in Bhutan.PTC has back to back PPA with distribution utilities in India. India also exports power to Bhutan during winter period when there is reduced hydro generation in Bhutan.

The associated cross- border transmission systems (ATS) for evacuation of power from Chukha, Kurichu and Tala HEPs which have been developed in Bhutan with technical and financial assistance from India, are given below:

**Chukha HEP (336MW):**

- 220 kV,1xD/C, Chukha(Bhutan) -Birpara ( West Bengal)
- 220 kV,1xS/C, Chukha(Bhutan) -Birpara( West Bengal) via Singheagon

**Kurichu HEP (60MW):**

- 132 kV,1xS/C, Kurichu(Bhutan) -Gelephu(Bhutan)-Salakati (Assam)

In order to meet contingency of the above 132kV line and to improve the reliability of power evacuation from the Kurichu HEP, 132kV Deothang- (Bhutan)-Rangia(Assam) S/C line has been constructed under the financial aid of Govt. of India.

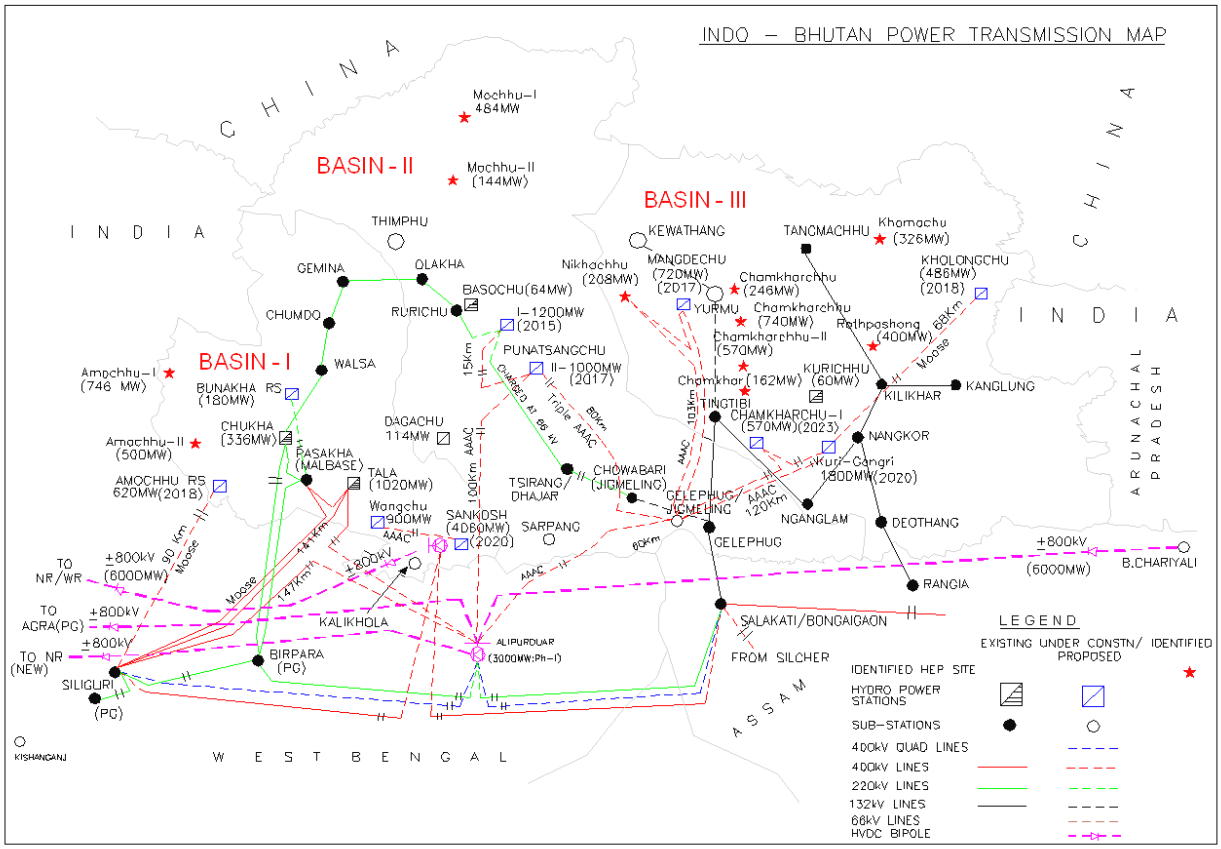
**Tala HEP (1020MW):**

- 400kV, 2xD/C Tala (Bhutan) – Siliguri(West Bengal) line ( one of the circuit of a D/C line is LILOed at Pasakha/Malbase S/S in Bhutan)

In addition to above links, the following distribution lines are also existing to facilitate power exchange for meeting need based requirement.

- 33k Rangia(Bhutan)-Tamulpur-Samudrapjongkhar S/C(Assam) ( op.at 11kV)
- 11 kV, 1xS/C,Udalguri(Bhutan) -Daifam(Assam)
- 11 kV, 1xS/C,Banarhat(Bhutan) -Samtse(West Bengal)
- 11 kV, 1xS/C,Jaldhaka(Bhutan) - Sibsoo(West Bengal )

The power map showing the above interconnections is given below:



**Composite Transmission System for Evacuation of Power Punatsangchhu-I HEP (1200 MW), Punatsanchhu-II (990MW), Mangdechhu (720MW) and Nikhachhu (210MW) HEPs.**

A comprehensive transmission plan for power evacuation from Punatsangchhu-I, Punatsanchhu-II, Mangdechhu and Nikhachhu HEPs was evolved with long term perspective optimizing RoWs requirements in Bhutan and India. Bulk exportable surplus power from these projects (2014-16) are proposed to be pooled at Alipurduar in India, close to Bhutan border for further transmission to the beneficiaries in India.

For power evacuation from Punatsangchhu-I, the transmission system will comprise of Punatsangchhu-I HEP –- Alipurduar 400 kV D/C with Triple AAAC conductor, LILO of one D/C of the 400 kV Tala-Siliguri 2xD/C at Alipurduar, 400/220kV, 315 MVA ICT at Punatsangchhu -I and LILO of 220kV Rurichhu/Basochhu-Tsirang 220kV line. Power from Punatsangchhu-II will be evacuated by LILO of Punatsangchhu-I – Alipurduar 400 kV D/C line and by 400kV Punatsangchhu-II - Alipurduar D/C line with Triple/Quad AAAC conductor ( to be routed via Gelephu/Jigmelling Pooling Station to be developed under Mangdechhu HEP). For power evacuation from Mangdechhu and Nikhachhu projects, the transmission system will comprise of 400kV Mangdechhu- Jigmeling /Gelphu D/C Triple AAAC line with 400/220 kV, 315MVA Jigmeling /Gelephu S/S and LILO of Punatsangchhu-II - Alipurduar D/C line at Mangdechhu. The 400kV Mangdechhu – Jigmeling /Gelphu D/C line is proposed to be LILOed at Nikhachhu matching with the commissioning of Nikhachhu HEP.

For power pooling at Alipurduar and further transmission from thereon to the Indian grid over HVDC as well as AC systems, it is envisaged to establish a 2x315MVA, 400/220kV AC & HVDC sub-station with ±800kV, 3000MW HVDC converter module at Alipurduar with LILO of ±800kV 6000MW Biswanath Chariyali-Agra HVDC Bipole line and LILO of Bongaigaon – Siliguri 400kV D/C AC line (quad). The ±800 kV HVDC station at Agra will be expanded with an additional 3000 MW inverter module.

**Evacuation System requirement for Sankosh HEP (4060 MW):**

For evacuation of power from Sankosh HEP, it is envisaged in the DPR stage that a dedicated ±800 kV, 6000MW HVDC Bipole line from Sankosh HEP to a suitable de-pooling point preferably in NR/WR in India, along with 6000MW converter module each at Sankosh HEP (rectifier end) and at de-pooling point (inverter end), could be set-up. The technological aspects for adopting HVDC system may be explored during detailed engineering stage enabling to meet the DC and AC system requirements. In case there is space constraints for setting up of HVDC station at the HEP Plant site/switchyard, its location may be selected nearby the Plant, where adequate space will be available. In such a situation, power generated at the Hydro station may be injected to the HVDC switchyard over 400kV 2xD/C Quad conductor lines for its evacuation by the ±800 kV HVDC Bipole link. In addition to the proposed HVDC system, LILO of one (D/C) of the 400kV Bongaigaon-Siliguri 2xD/C lines at the HVDC station is considered.

**National transmission Grid Master Plan in Bhutan:**

Royal Govt. of Bhutan (RGoB) has embarked on the development of over 10,000 MW hydro power projects in Bhutan by 2020. While some power from HEPs would be set out to meet the demand in Bhutan, major portion would be surplus to be exported to India. DoE, RGoB has desired that a holistic and integrated transmission road map for Bhutan should be developed for facilitating export of power from Bhutan to India and supply to load centers within Bhutan.

In this context, DoE, RGoB had requested the Central Electricity Authority (CEA), India to prepare the National Transmission Grid Master Plan (NTGMP) for Bhutan. DoE, RGoB had also desired that the grid master plan should be in place before the completion of DPRs of hydro electric projects making up total capacity addition of 11636 MW by 2020 so that power evacuation arrangements for the projects are available while finalizing DPRs. It was also desired that the prospective HEPs which may come up by 2030 should be kept in view during NTGMP planning.

MoU between CEA and Department of Energy (DoE), Govt. of Bhutan was inked on 22nd Dec'09 in Delhi appointing CEA as Consultant during the visit of the King of Bhutan to India.

**Annexure-3**

## Existing Electricity Trade between Nepal-India and Future Prospects

Indo-Nepal Power Exchange began in year 1971 with exchange of about 5 MW of power on the principle of catering to the power needs of isolated local areas on both sides of the border. The power exchange takes place between Nepal Electricity Authority and utilities on the Indian side namely Bihar State Electricity Board (BSEB), Uttar Pradesh Power Corporation Limited (UPPCL) and Uttaranchal Power Corporation Ltd. (UPCL) India. India also supplies 70MU from Tanakpur HEP (120MW) to Nepal under the Mahakali Treaty. Under the bilateral power exchange, BSEB exports/imports power from Nepal where as, UPPCL and UPCL only export power to Nepal. There are 21 interconnections facilities for power exchange through 11kV, 33kV, 132kV transmission lines. Out of these interconnections, some 11kV and 33kV levels were not being utilized, and both Indian and Nepalese sides had bilaterally decided to discontinue those links to reduce metering and accounting related problems. The following transmission lines are being utilized for power exchange between India and Nepal.

**BSEB (Bihar)-Nepal:**

**132 kV line**

1. Kataiya - Duhabi
2. Gandak east - Gandak/Surajpura(Nepal)

**33 kV line**

3. Birganj - Raxaul
4. Kataiya - Biratnagar(Rupni)
5. Kataiya - Rajbiraj
6. Sitamarhi – Jaleshwer (re-conductoring with dog-conductor for 6-spans undertaken by BSEB)

**11 kV line**

7. Biratnagar – Jogbani (bilaterally discontinued its operation)

**UPPCL(UP)-Nepal:**

**33 kV line**

1. Anandnagar - Bhairwan line
2. Nanpara-Nepalganj line

**UPCL (Uttaranchal) – Nepal:**

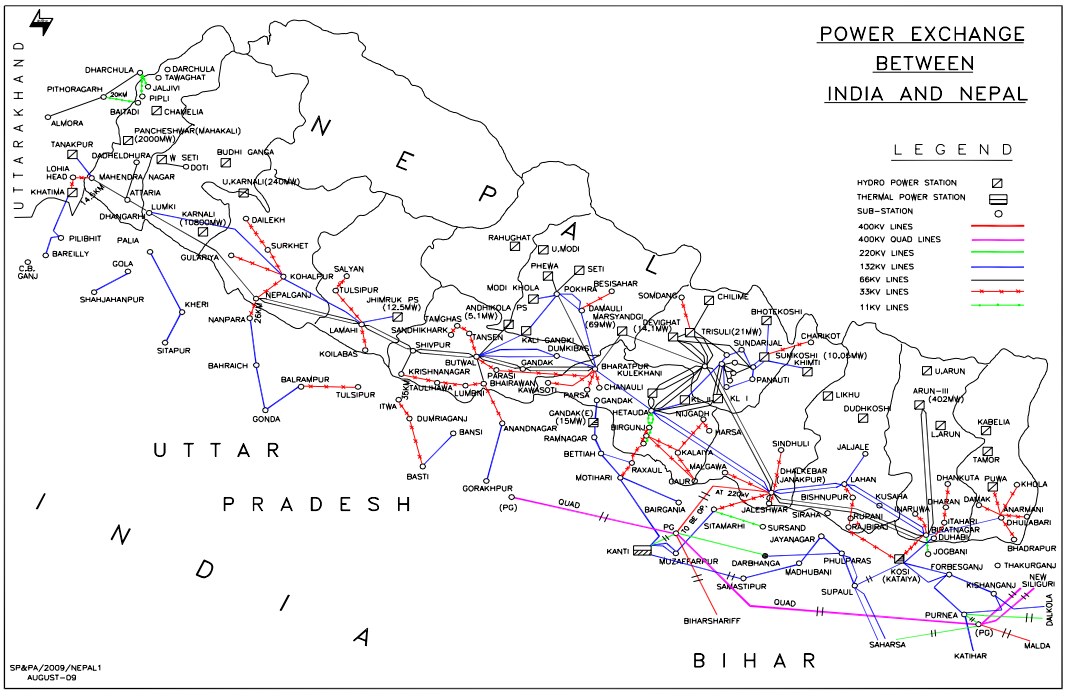
**33 kV line**

1. Lohia - Mahendranagar (Nepal) (it is being revived by UPCL to supply load of 5 MW at Mahendranagar in Nepal)

**11kV line**

2. Pithoragarh – Baitadi
3. Dharchula – Jaljibe
4. Dharchula – Pipli

The power map showing the above Indo-Nepal cross border transmission links is given below:




Through the 33kV Birganj –Raxaul line, Bihar imports power from Nepal to meet the load of the Raxaul area in Bihar. With the implementation of the 132kV Betiah –Raxaul

S/C line being implemented by PGCIL with a target date of completion by June, 2010, Raxaul load will be supplied from BSEB's own grid and operation of the 33kV Raxaul-Birganj line could be utilized for export of power to the tune of 7-8MW to Nepal.

For additional import of power beyond 50MW by Nepal and bulk power exchange, it was considered that creation and investment on new 11kV, 33kV and 132kV interconnections would not be viable proposition as it would lead to increase the loss and operational problems. For exchange of power on a bulk scale from the electricity markets of the two countries, it is envisioned to gradually switch over to power transfer through high capacity/voltage cross- country transmission corridor on the long term perspective based on certain commercial tie-up with the Indian electricity market, which would enable to make cross border power exchange directly between the nodal grid points of India and Nepal and minimize the transmission losses considerably.

Initially, following four 400/220 kV transmission lines to interconnect the Indian and Nepalese grids for the purpose of Import/Export of power between the two countries were considered:

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

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

The Dhalkebar-Muzaffarpur, Butwal-Gorakhpur and Duhabi-Purnea lines were studied as alternate transmission proposals between India and Nepal, and the Dhalkebar-Muzaffarpur line was selected as it was found to be the most viable alternative both for initial transfer of power to Nepal and later for importing power from hydro projects being

developed in Eastern Nepal. The Dhalkebar-Muzaffarpur link would be constructed as 400kV D/C line initially charged at 220kV, and it will be executed through joint venture companies.

**Status for construction of the cross border 400kV Muzaffarpur-Dhalkebar D/C Twin Moose line between India and Nepal (initially to be operated at 220kV).**

The details of the proposed interconnection and its estimated completion cost based on Q4, 2008 (INR Millions) are given below:

| | |
|---|---|
| Indian portion (90 Kms) | 1470 |
| Nepal portion (40 Kms) including S/S at Dhalkebar with 160MVA, 220/132 KV Auto Transformer & Bay Equipment | 1414 |
| **Total Project Cost** | **2884** |

The following two JV companies would execute the Indian portion and Nepal portion of the transmission works:

- **Cross Border Power Transmission Company Pvt. Ltd (CPTC)** – JVC India:
  - Power Grid: 26% SHA initialed (Share Holder Agreement)
  - SJVN: 26% SHA initialed
  - Promoters (namely IL&FS & NEA): 48%
- **Power Transmission Company Nepal Ltd. (PTCN)** – JVC Nepal:
  - Promoter (NEA): 50%
  - IL & FS: 50% (with provision to divest 24% to Banks & FI of Nepal)

***Project Development Status***

In the meeting held on 8th November, 2009 at Kathmandu followed by second meeting held on 19th January, 2010 in the office of Powergrid, Gurgaon. The stakeholders viz. MEA, GoI, Govt of Nepal, NEA, PowerGrid, World Bank, SJVNL, IL & FS and PTC attended the meeting. The Action Plan for implementation of the project was decided,

the latest status of which is the following:

i) Signing of ITSA (Implementation and Transmission Service Agreement) between NEA & CPTC - May, 2010
ii) Signing of back to back ITSA between NEA & IPPs - May, 2010
iii) Signing of PPA between NEA & PTC India - May, 2010
iv) Financial close - July, 2010
v) Project implementation - December 2012

*vi) Progress of transmission work on the Indian Portion*

- Route survey completed
- Expression of Interest for EPC issued (13 leading parties participated)
- Section 68 issued by MoP
- Application for Transmission License filed in CERC, Public notice published in Newspaper on 12th Feb.,2010.
- DPR - prepared by Power Grid
- Implementation and Transmission Service Agreement will be entered with NEA and NEA will pay the Transmission charges to CPTC for import of power from India and will collect the Transmission charges from the generating utilities in Nepal and pay to CPTC for export to India.
- Draft Bidding Documents for EPC ready.
- Project is planned to be funded through equity and commercial debt.
- CTU (i.e. PGCIL) and PTC recommendations forwarded to CERC

*vii) Progress of transmission work on the Nepali Portion*

- Route survey completed and environment impact study in progress
- Expression of Interest for EPC issued
- For addressing issues arising out of synchronous operation, Dynamic System Study was carried out by PGCIL
- DPR - prepared by Power Grid
- Implementation and Transmission Service Agreement will be entered with NEA and NEA will pay the Transmission charges to PTCN for import of power from India and will collect the Transmission charges from the generating utilities in Nepal and pay to PTCN for export to India.

For initial 5-7years, it is estimated that Nepal will have a power deficit to the tune of 200-

300 MW and this shortfall is likely to be met by import from Indian Electricity market through the 400kV Muzaffarpur-Dhalkebar D/C line. With the commissioning of various upcoming hydro projects in Nepal in the next 5-7 years, NEA would have exportable surplus power for export to India after meeting their load demand/ growth, and the synchronous 400kV cross-border AC interconnection could be utilized for export to India. Further, based on the quantum of hydro electric potential (estimated to about 83,000MW) to be harnessed by Nepal, the 400kV line (op. at 220kV initially) could be charged and operated at 400kV and fully utilized to its capacity. In addition, additional high capacity AC links and suitable HVDC interconnections of adequate capacity could be explored for bulk power transfer to India.

**Annexure-4**

## Prospects and current status of Indo - Bangladesh Transmission link

In order to establish the interconnection between electrical grids between India and Bangladesh, Indian delegation visited Bangladesh on 23-26 Nov., 2009 and had a meeting with Chairman, Bangladesh Power Development Board on 24th Nov., 2009. It was decided to establish the electrical grid interconnection between the two countries through a 1x500MW HVDC Back-to-Back asynchronous link between Eastern region of India and Western Grid of Bangladesh facilitating cross-border power transfer of 500MW across the two countries. This link would enable to control power transfer in either direction up to the capacity of the HVDC unit depending upon the availability and demand on either side. Any fluctuations or disturbances of one grid would not affect the other side. The transfer capacity can be upgraded by adding a new HVDC block provided the transmission line is provided for the ultimate capacity planned.

In view of Bangladesh being power deficit country, it would initially import 250MW from India through the proposed HVDC link and subsequently, based on the power supply position of the two countries, the quantum of power exchange will be bilaterally determined. The pricing for cross-border electricity exchange would take place on a commercial mechanism under bilateral agreement.

For establishment of the HVDC interconnection between the two grids, the short circuit MVA of both the interconnecting terminal AC substations should be strong enough. In the Bangladesh side, establishment of 400kV/230kV substation at Bheramara has been identified for this purpose, which is close to the existing 230kV Ishurdi substation in the Western Grid of Bangladesh. The proposed HVDC 1x500MW unit will be established at Bheramara.and the existing 230 kV Ishurdi-Khulna South D/C line will be looped-in and looped-out at Beheramara. On the Indian side, 400kV switching station will be created at Baharampur in West Bengal ( Eastern part of India) by loop-in-loop out of the existing 400kV Farakka-Jeerat S/C line. The cross border interconnection will be established by Baharampur (India)-Bheramara (Bangladesh) 400 kV D/C line.
After joint route survey/ inspection by Indian and Bangladesh teams, the following transmission system was firmed-up.

**Indian portion:**

***Transmission line:***

- Baharampur (India)-Bheramara (Bangladesh) 400 kV D/C line (Indian portion)-85km
- Loop-in and loop-out of Farakka -Jeerat 400 kV S/C line at Baharampur (India)-3km

***Substation:***

- Establishment of 400 kV switching-station at Baharampur (India)

**Bangladesh portion**

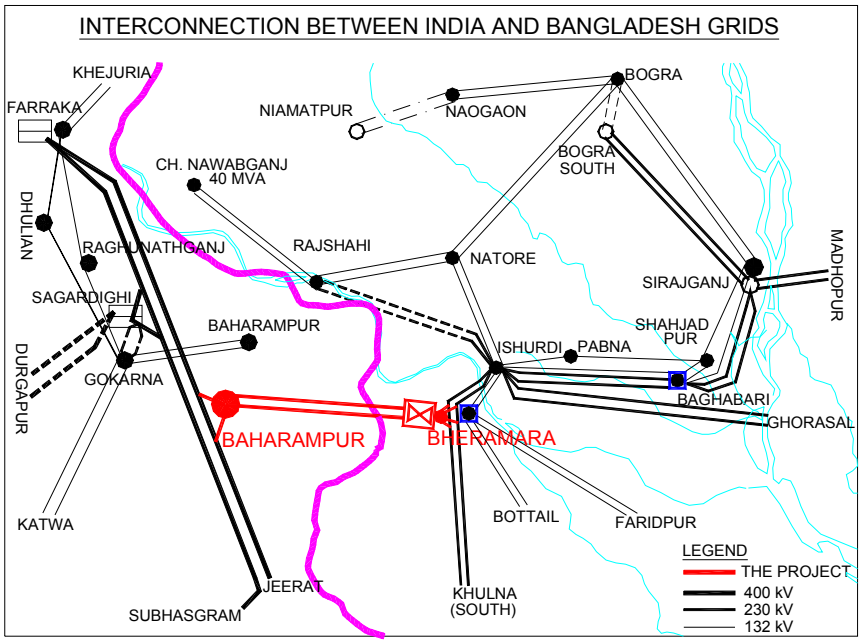
***Transmission line:***

- Baharampur (India)-Bheramara (Bangladesh) 400 kV D/C line (Bangladesh portion)-40km.
- Loop-in and loop-out of Ishurdi-Khulna South 230 kV D/C line at Bheramara (Bangladesh)-5km

***Substation:***

- Establishment of 500MW HVDC back to back station and 230 kV switching-station at Bheramara (Bangladesh)

The proposed interconnections are given below:




DPR for the proposed grid interconnection has been prepared by Joint Technical Team of Power Grid Corporation of India Limited (PGCIL) and Bangladesh Power

Development Board (BPDB) & Power Grid Company of Bangladesh (PGCB) in Jan.,2010 at an estimated cost of Rs. 869.21 crores out of which Rs. 708.88 crores is for the Bangladesh and Rs. 160.33 crores is for the Indian portion.

In the First Joint Steering Committee meeting of Indo-Bangladesh on power sector under the co-Chairmanship of both the Secretaries from India and Bangladesh held on 12.1.2010 in MoP, New Delhi regarding implementation of MoU between India and Bangladesh on cooperation in the power sector, the modality/funding for execution of the project was inter-alia firmed up. It is intended that Bangladesh portion of the transmission project would be executed by the Govt. of Bangladesh/PGCB and proposed to be funded through WB/ ADA assistance. PGCIL would provide consultancy to Bangladesh upto commissioning for the project. The Indian portion of the transmission system would be funded and executed by PGCIL.

**Annexure-5**

## India – Pakistan Power Transmission Interconnection

At present, no transmission link is existing between India and Pakistan. During 1998-1999, Government of India considered a proposal from Pakistan for export of power from Pakistan to India. However, no progress was made as the talks got bogged down on issues relating to tariff for power to be purchased from Pakistan.

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

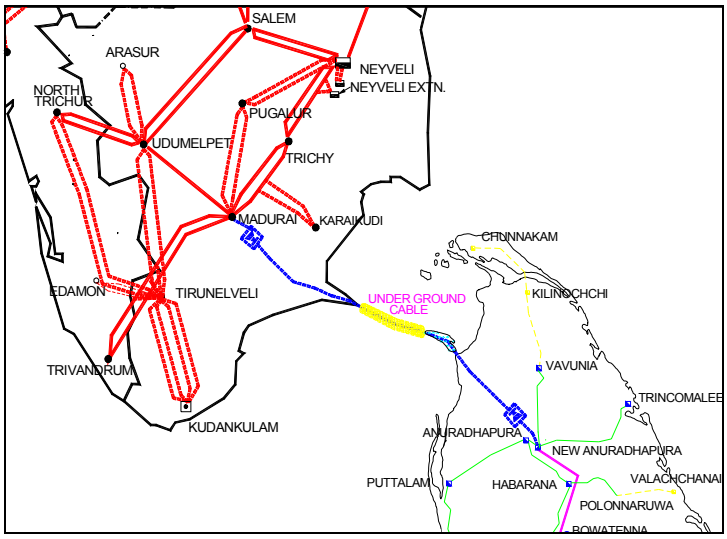
**Annexure-6**

## India – Sri Lanka Power Transmission Interconnection

A proposal to inter link India and Sri Lanka is under study. Under this proposal, feasibility of establishment of a HVDC transmission system of 1000 MW capacity using overhead lines and undersea cables from Madurai in India upto Anuradhapura in Sri Lanka is being studied. The India – Sri Lanka transmission link is tentatively envisaged to be a ± 400kV HVDC Bipole line. The link would consist of –

(i) Overhead line from Madurai to Dhanushkodi in India, 150-200 km
(ii) Dhanushkodi (India) to Talaimanar (Sri Lanka) submarine cable, 30-50 km
(iii) Over head line from Talaimanar to New Anuradhapura in Sri Lanka, 120-150 km.

The proposed interconnection is shown below.




Tentative cost of the scheme with 1000 MW capacity is estimated to be of the order of Rs 3000 Crore. Considering only 500 MW capacity in initial stage, the project cost is estimated to be about Rs 2000 crore.

India and Sri Lanka are also considering funding of a 'Feasibility Study of India-Sri Lanka Electricity Grid Interconnection' at an estimated cost of Rs 12 Crores, which would be jointly shared on 50:50 basis with the Government of Sri Lanka. The feasibility study would examine techno economic feasibility of the proposal, would facilitate estimation of capital cost and assess benefits to India and Sri Lanka. The details of the benefits that this proposed link would provide, would be determined by the 'Feasibility Study of India-Sri Lanka Electricity Grid Interconnection'.