CROSS BORDER INTERCONNECTION AND POWER TRADE WITH NEIGHBOURING COUNTRIES
Indian Scenario
## GROWTH OF INSTALLED CAPACITY FROM 11TH PLAN TO 13TH PLAN (MW)

<table>
<thead>
<tr>
<th></th>
<th>At the end of 11th Plan March 2012</th>
<th>Addition during the 12th Plan</th>
<th>At the end of 12th Plan March 2017</th>
<th>Addition during the 13th Plan</th>
<th>At the end of 13th Plan March 2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal/LIGNITE</td>
<td>112022</td>
<td>69280/520</td>
<td>181822</td>
<td>56400</td>
<td>238223</td>
</tr>
<tr>
<td>Gas</td>
<td>18381</td>
<td>2540</td>
<td>20921</td>
<td>0</td>
<td>20921</td>
</tr>
<tr>
<td>Diesel</td>
<td>1200</td>
<td>1200</td>
<td>0</td>
<td>1199.75</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL THERMAL</strong></td>
<td>131603</td>
<td>72340</td>
<td>203943</td>
<td>56400</td>
<td>260343</td>
</tr>
<tr>
<td>HYDRO</td>
<td>38990</td>
<td>10897</td>
<td>49887</td>
<td>12000</td>
<td>61887</td>
</tr>
<tr>
<td>NUCLEAR</td>
<td>4780.00</td>
<td>5300</td>
<td>10080.00</td>
<td>18000</td>
<td>28080</td>
</tr>
<tr>
<td>RENEWABLE ENERGY SOURCES</td>
<td>24503</td>
<td>300000</td>
<td>54503</td>
<td>30500</td>
<td>85003</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>199,877</td>
<td>118,537</td>
<td>318,414</td>
<td>116,900</td>
<td>435,314</td>
</tr>
</tbody>
</table>
All India Generation Capacity = 235GW (*Jan’14)

- Coal: 134 GW, 58%
- Hydro: 40 GW, 18%
- Gas: 20 GW, 9%
- Nuclear: 5 GW, 2%
- Diesel: 1 GW, 1%
- Renewable: 29 GW, 12%
- Wind: 19.8 GW, 68%
- Biomass/Bagasse: 3.8 GW, 13%
- Small Hydro: 3.7 GW, 12%
- Solar: 2 GW, 7%
<table>
<thead>
<tr>
<th>TRANSMISSION LINES</th>
<th>UNIT</th>
<th>At the end of 11th Plan March 2012</th>
<th>Addition during the 12th Plan</th>
<th>At the end of 12th Plan March 2017</th>
<th>Addition during the 13th Plan</th>
<th>At the end of 13th Plan March 2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVDC Bipole line</td>
<td>ckm</td>
<td>7432</td>
<td>9440</td>
<td>16872</td>
<td>130000</td>
<td>494921</td>
</tr>
<tr>
<td>765 kV</td>
<td>ckm</td>
<td>5250</td>
<td>27000</td>
<td>32250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>400 kV</td>
<td>ckm</td>
<td>106819</td>
<td>38000</td>
<td>144819</td>
<td></td>
<td></td>
</tr>
<tr>
<td>230/220 kV</td>
<td>ckm</td>
<td>135980</td>
<td>35000</td>
<td>170980</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Transmission</td>
<td>ckm</td>
<td>257481</td>
<td>107440</td>
<td>364921</td>
<td></td>
<td>494921</td>
</tr>
</tbody>
</table>
# SUB-STATIONS

(VALUES IN MVA / MW)

<table>
<thead>
<tr>
<th>SUBSTATIONS</th>
<th>UNIT</th>
<th>At the end of 11th Plan March 2012</th>
<th>Addition during the 12th Plan</th>
<th>At the end of 12th Plan March 2017</th>
<th>Addition during the 13th Plan</th>
<th>At the end of 13th Plan March 2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVDC Bipole line</td>
<td>MW</td>
<td>9750</td>
<td>12750</td>
<td>22500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>765 kV</td>
<td>MVA</td>
<td>25000</td>
<td>149000</td>
<td>174000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>400 kV</td>
<td>MVA</td>
<td>151027</td>
<td>45000</td>
<td>196027</td>
<td></td>
<td></td>
</tr>
<tr>
<td>230/220 kV</td>
<td>MVA</td>
<td>223774</td>
<td>76000</td>
<td>299774</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL –AC Substation Capacity</td>
<td>MVA</td>
<td>399801</td>
<td>270000</td>
<td>669801</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grand Total</td>
<td>MW/MVA</td>
<td>409551</td>
<td>282750</td>
<td>692301</td>
<td></td>
<td>992301</td>
</tr>
</tbody>
</table>
HVDC line (Bipole) (Existing)
(1) Rihand (NR)- Dadri (NR) ±500 kV 1500 MW
(2) Chandrapur (WR)- Padghe (WR) ±500 kV 1500 MW
(3) Talcher-II (ER)- Kolar (SR) ±500 kV 2500 MW
(4) Mundra (WR)- Mahendergarh (NR) ±500 kV 2500 MW
(5) Balia (NR)- Bhiwadi (NR) ±500 kV 2500 MW

HVDC line (Bipole) (Under construction)
(1) Biswanath Chariyali (NER)- Alipurduar (ER)- Agra (NR) ±800 kV 6000 MW
(2) Angul (ER)- Aligarh (NR) ±800 kV 6000 MW
(3) Champa (WR)- Kurukshetra (NR) ±800 kV 6000 MW
(4) Raigarh (WR) – Paghlur (SR) ±800 kV 6000 MW

HVDC Back To Back (Existing)
1. Gazuwaka 2x500 MW
2. Chandrapur 2x500 MW
3. Vindhayachal 2x500 MW
4. Sasaram 1x500 MW
All regional grids are operating as Synchronous National Grid in the country at 50 Hz. (31st Dec’13)

IC-238 GW (incl. RES-30GW);

Cap. Addn. by 2016-17~120 GW (incl. RES-30 GW);

STATCOMs at 11 locations & SVC at 3 locations planned by 2016-17;

HVDC Bipole (±500kV) existing: 5 nos. (10,500 MW) & 4675x2 ckm.

HVDC Back-to-back: 4 nos. (3500MW);

HVDC Bipole (±800kV, 6000MW) Planned: 4 nos. (24,000 MW) 6007x2 ckm.

TCSC – 5 nos.; FSC – 33 nos.

SVC – ±2x140 MVAr at Kanpur-1992;

765kV lines: 9543 ckm. (Feb., 14)

400kV lines: over 1,24,384 ckm.

220kV lines: over 1,43,675 ckm.

IR Capacity: 35450MW (April 14)

by 2016-17: 65550 MW
**Transmission Planning & Development**

- National Grid is comprising Inter-State (ISTS) and intra-State Transmission (STUs) systems.

- Power system planning has been aligned with the Transmission Planning Criteria (n-1/n-1-1 contingency), EA,2003, National Electricity Policy, Tariff policy, Electricity Grid Code, Regulations and market orientation of the Electricity Sector.

- Transmission exercises are carried out in-coordination by CEA, CTU, STUs & other Stakeholders – system finalization & review at Regional Standing Committee on Power System Planning.

- Transmission System Development followed on Tariff Based Competitive Bidding (TBCB) Policy-Inter State (5-1-11) & Intra-State(5-1-13)

- Transmission charge recovery mechanism is based on Point of Connection (PoC) Tariff methodology

- Transmission system Plans for evacuation of 9 coal fired UMPPs (each of 4000MW) at Tilaiya (Bihar), Sasan(MP), Mudra (Gujarat), Krishnapatnam (AP), Chattisgarh (RfQ), Orissa(RfQ), Cheyyur (TN), Karnataka are on the horizon.

- Evolved Master Transmission Plans to harness hydro potential in North eastern region and northern region of the country.

- Bilateral development and strengthening of cross border transmission systems and power exchange with the neighbouring countries in the SA region.
Indo-Nepal interconnection
INDO-NEPAL

- Power exchange taking place on the principle of catering to the power needs of isolated local areas of both of the sides of the border between NEA and utilities on the Indian side namely BSEB, UPPCL and UPCL.

- 12 cross border Bilateral power exchange facilities operational at 11kV, 33kV and 132 kV level.

- The above State utilities export power to Nepal and the quantum of power exchange volume for which tariff is decided by the Power Exchange Committee (PEC) is limited to about 50 MW.
## Indo-Nepal (Existing Links)

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Voltage level</th>
<th>Interconnection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>132 kV</td>
<td>Kataiya – Kusaha/Duhabi S/C (High capacity ACSR conductor) line</td>
</tr>
<tr>
<td></td>
<td>BSEB(Bihar)-Nepal</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>33 kV</td>
<td>Ramnagar - Gandak/Surajpura(Nepal) S/C</td>
</tr>
<tr>
<td>1</td>
<td>33 kV</td>
<td>Sitamarhi – Jaleshwer S/C</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Raxaul-Birganj S/C</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Jainnagar-Siraha S/C</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Kataiya – Rajbiraj S/C</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Kataiya – Inarwa/Biratnagar(Rupni) S/C (not in service)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>UPPCL(UP)-Nepal</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>33 kV</td>
<td>Nanpara-Nepalganj S/C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>UPCL (Uttaranchal) – Nepal</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>33 kV</td>
<td>Lohiyahead – Gaddachowki/Mahendranagar (Nepal) S/C</td>
</tr>
<tr>
<td>1</td>
<td>11 kV</td>
<td>Pithoragarh – Baitadi</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Dharchula – Jaljibe</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Dharchula – Pipli</td>
</tr>
</tbody>
</table>
INDO-NEPAL

For the first 50 MW power supply the average power tariff during 2013-2015 at 33 kV level comes out to be around Rs. 5.46/unit with an additional charge or rebate of 7.5 % if drawn at 11 kV or 132 kV respectively.

For additional import beyond 50 MW by Nepal, Nepal needs to tie-up directly from Indian Electricity market through licensed electricity traders such as PTC on commercial basis, and its tariff would be beyond the purview of the Power Exchange Committee. Nepal procures 20-25 MW from India market through PTC.

Through the 132 kV Tanakpur-Mahendranagar S/C line 70 MU free power from Tanakpur HEP (120 MW) is supplied to Nepal under the Mahakali treaty. Presently, Nepal is drawing about 109-210 MW from India.
**Additional System Strengthening for Supply of Power to Nepal**

- Under the medium term measure for supply of additional power of about 100 MW to Nepal MEA is being implemented through WAPCOS (expected by August 2015).
  - 132 kV Katiya - Kusaha S/C on D/C line with Panther conductor
  - 132 kV Raxaul - Parwanipur S/C on D/C line with Panther conductor

- Agreement Signed in July ’12 for 400 kV Muzaffarpur (India) - Dhalkebar (Nepal) D/C line to be initially operated at 220 kV. expected by June 2015
  - Indian portion - 86.43 kms by CPTC,
  - Nepal portion - 39 kms by PTCN,
  - CPTC with share holders of PGCIL-26%, SJVNL-26%, IL&FS-38% & NEA-10%
  - PTCN with share holders of NEA-50%, PGCIL-26%, HIDCL-14% & IL&FS-10%)

- Power Trading: Power Sale Agreement (PSA) between NEA and PTC has been signed for import of 150 MW for 25 years
As a part of Agreement between government of Nepal and Government of the India on Electric Power Trade, cross Border Transmission Inter-Connection and Grid Connectivity, the Joint Working Group and Joint Study Committee was formed.

JWG and JSC decided for preparation of a long term integrated transmission plan for evacuation of power from the hydro Power Stations in Nepal like Arun-III HEP (4x225MW) by M/s. SJVNL, Upper Karnali (900 MW) and Upper Marsyangdi (600 MW) HEPs by M/s GMR, India and related Cross border inter-connections between the two countries.

The perspective plan will cover the generations likely to come up by 2035 and a detailed action plan will be prepared for the projects coming up to 2025.

A Joint Technical Team (JTT) comprising of experts from Nepal and India has been constituted to look into this issue.
Indo-Bangladesh Interconnection
CROSS BORDER LINK

A cross border interconnection between India and Bangladesh commissioned on 5th October, 2013. India is supplying to the extent of 500 MW to Bangladesh.

Indian Portion implemented by POWERGRID

- Baharampur (India)-Bheramara (Bangladesh) 400kV D/C line: 71 km (after completion of survey)
- LILO of Farakka - Jeerat 400kV S/C line at Baharampur: 3 km
- Establishment of 400kV Switching Station at Baharampur

Bangladesh portion by Power Grid Company of Bangladesh Ltd.

- Baharampur (India)-Bheramara (Bangladesh) 400kV D/C line: 27 km
- LILO of Ishurdi - Khulna South 230kV D/C line at Bheramara: 3 km
- Establishment of 500MW HVDC back-to-back Station and 230kV Switching Station at Bheramara
AGREEMENTS-CROSS BORDER LINK

- PPA signed between Bangladesh Power Development Board (BPDB) and NTPC Vidyut Vyapar Nigam Ltd. (NVVNL) for supply of 250 MW power from unallocated share of Govt. of India in Central Generating Stations. The price of power would be as per CERC tariff.

- BPTA signed between POWERGRID and BPDB for Bangladesh procuring an additional 250MW from the Indian market through PTC.

Under construction / Planned Cross Border Link

- In the 8th JSC/JWC meeting it was decided that 100 MW power from Palatana would be supplied to Bangladesh through radial interconnection through the following Cross Border Links

Indian side (To be implemented by POWERGRID)
- Surjyamaninagar (Tripura) – Bangladesh border 400 kV D/C line (initially operated at 132 kV) - 27 km (Twin Moose Conductor)

Bangladesh side (To be implemented by BPDB / PGCB of Bangladesh)
- Indian Border- Comilla (North) 400 kV D/c line (initially operated at 132 kV) – 15 km (Twin Finch Conductor)
- Comilla (North) - Comilla (South) 132kV D/c line – 16km

- The above scheme is expected to be completed by Dec., 2015.

- The PPA for supply of 100 MW power yet to be finalised.
To facilitate import of additional 500 MW power by Bangladesh from India through existing Baharampur (India) – Bheramara (Bangladesh) interconnection, system strengthening on Indian side and Bangladesh side has been approved in 8th JSC/JWC meeting held on 09-10th October, 2014 at New Delhi.

**System Strengthening-Indian side (by POWERGRID)**
- 400 kV Farakka - Behrampur D/C (HTLS) line (about 70 km.)
- Removal of the existing LILO of 400 kV Farakka - Jeerat S/c line at Beharampur.
- LILO of the above Farakka-Jeerat 400 kV S/c line at Sagardighi.
- LILO of Sagardighi-Subhasgram 400 kV S/c line at Jeerat

**System Strengthening on Bangladesh side (by PGCB)**
- Bheramara - Ishurdi 230 kV D/c line – 12 km.
- Additional 500 MW HVDC back-to-back converter unit (2nd module) at Bheramara (Bangladesh).

The above scheme is expected to be completed by June 2017.

In order to supply additional 1000 MW from NER to Bangladesh, the following ±800kV HVDC Bi-pole pole line has been planned:
- Rangia/Rowta (Assam, India)-Barapukuria(Bangladesh)-Muzafarnagar (UP, India) +800kV 6500/7000 MW HVDC Multi terminal Bipole line

DPR is to be prepared.
Indo-Bhutan Interconnection
**Existing Cross Border Transmission System Associated with the HEPs in Bhutan**

- India and Bhutan have terms of cooperation for exchange of power between the two countries. Bulk of power generated at Hydro Electric Projects at Chukha (336MW), Kurichu (60MW) and Tala (1020MW) in Bhutan, is exported to India after meeting the internal demand of Bhutan.

- The associated cross-border transmission systems for evacuation and transfer of power from these HEPs has been developed and is operated in synchronism with the Indian Grid.
Royal Government of Bhutan (RGoB) has embarked on to harness its huge hydro potential and identified about 75 nos. new HEPs by 2030 at various river basins.

About 26534 MW hydro potential would be harnessed by 2030 and out of this, 10334 MW hydro power developments from 14 nos. HEPs have been envisaged to be implemented during 2020.

Most of the future generation in Bhutan would be also exported to India, after meeting the internal demand of Bhutan.

Considering the above scenario, National Transmission Grid Master Plan (NTGMP) for Bhutan has been evolved by carrying out comprehensive power system studies.
RGoB is in the various phases of developing over 10 GW hydro potential by 2020 of which Punatsangchhu-I (1200MW), Punatsangchhu-II (1020MW) and Mangdechhu (720 MW) HEPs are ongoing Projects.

The ATS for the above three HEPs according to the NTGMP Plan is under construction.

Transmission links under Implementation Stage for import of power from Bhutan

- LILO of ±800kV, 6000MW Bishwanath Chariyali – Agra HVDC Bi-pole line at Alipurduar with 3000MW HVDC terminal with 400/220kV EHVAC station at Alipurduar
- Extension of ± 800 kV HVDC station with 3000 MW inverter module at Agra
- LILO of Bongaigaon – Siliguri 400kV D/C Quad Moose line at Alipurduar
- LILO of Birpara-Salakati 220kV D/C line at Alipurduar
India-Sri Lanka interconnection
Memorandum of Understanding has been signed among Govt. of India, Govt. of Sri Lanka, PGCIL and Ceylon Electricity Board on 9th June 2010 for carrying out feasibility study for interconnection of India–Sri Lanka Electricity Grid.

POWERGRID, India and CEB, Sri Lanka has been appointed as executive agencies for the above project.

1000MW, ±400kV HVDC bi-pole line from India (Madurai) to Sri Lanka (Anuradhapura): 360km

- Indian Territory (Scope: POWERGRID) Madurai to Panaikulam: 130km
- Sea Route (Scope: POWERGRID) Panaikulam (India) to Thirukketiswaram(SL): 120km
- Sri Lankan Territory (Scope: CEB) Thirukketiswaram to Anuradhapura(New): 110km
In a meeting between the officials of India and Sri Lanka regarding Feasibility Study for interconnection of India-Sri Lanka Electricity Grids, it was decided that all possible efforts would be made to reduce the cost of the project so as to make it economically viable. It was decided to work on the following measures:

i. **Reduction in length of Submarine Cable**
   
   ia. Termination of Cable at Talaimannar in Sri Lankan Territory in place of Thirukketiswaram. This would reduce the cable length by about 30km.
   
   ib. Termination of Cable near Dhanushkodi (at Setu Samudrum crossing) in Indian Territory in place of Panaikulam. This would reduce the cable length by about 45km, however would involve extensive use of pile foundation for line towers.

ii. **Explore possibility of reduction of HVDC terminal Cost**

iii. **To consider multilateral funding for carrying out cost estimate**

It was also decided that the revised cost would be carried out for 2x500MW HVDC (Conventional as well as VSC) bipole line to be implemented in two stages.
**ADDITIONAL OPTION**

- The revised route for the interconnection line would be as follows:
  - 2x500MW HVDC bipole line from India (Madurai) to Sri Lanka (Anuradhapura-New): 370km
  - **Overhead (India)**: Madurai to near Dhanushkodi: 180km
  - *[The Transition station for interface connection point between HVDC overhead lines and submarine cables in Indian Territory would be located in the sea near Dhanushkodi after crossing of setu samudrum route.]*
  - **Submarine Cable**: Dhanushkodi (India) to Talaimannar (Sri Lanka): 40km
  - **Overhead (Sri Lanka)**: Talaimannar to Anuradhapura (New): 150km
  - The remaining scope of work would remain unaltered.

- PGCIL / CEB has completed the technical study and various financial options. PGCIL is working on a revised proposal including the under sea cable connectivity to bring the cost down and make the project viable.
India- Pakistan Interconnection
At present, no transmission link is existing between India and Pakistan. Pakistan grid is at 500kV AC whereas the voltage adopted in the Indian grid is 400kV and 765kV AC.

For establishment of a cross border link to enable to supply about 500MW from India to Pakistan on commercial basis a 400kV D/C AC inter-connecting transmission line between Amritsar (India) and Lahore (Pakistan) with 500MW HVDC back to back converter station at Lahore has been prima-facie identified.

In the third meeting of the Expert Groups between held on 5th March 2014 in New Delhi, Pakistan side desired to initially draw power at 220 kV by charging the proposed 400 kV D/C line at 220 kV till the time HVDC converter station at Lahore gets established (it is yet to be firmed up).

It was also proposed by Pakistan side that a Joint Technical Team comprising of four sub-groups would be formed and the composition of JTT and sub-groups and their scope of works, deliverables, time lines and nominations would be finalized.

High Commission for Pakistan has recently forwarded a draft MoU and a proposal for formation of four subgroups to MoP. As a follow up action, MoP has constituted a JTT comprising 6 members and a technical sub-group comprising 3 members from the Indian side vide its letter dated 24th June, 2014, for preparation and submission of first report on cross border interconnection with terminal locations etc.
India – Afghanistan
TRANSMISSION WORKS

- 220 kV DC Kabul - Pul-e-Khumri 200 km. (approx) transmission line with 220/110/20 kV S/S at Chimtala Sub-Station was constructed by POWERGRID on May’ 2009.
- The assets have been taken over by MEW, Afghanistan in the month of March 2012.
- Further, for construction of 220/20 kV Doshi and Charikar substations in Afghanistan, award was placed on M/S. BHEL by POWERGRID on October 21, 2011. The project is expected to be completed within two years from the date of Government sanction for the project, i.e. by October 2013.
- GoI is also constructing Salma PH (14x3 MW) with 110 kV transmission line from Salma – Haret (160 Kms. Approx.) through WaPCos.
Thank You