

## *X Plan Programme*

- 5.1** At the end of IX five year Plan, corresponding to the total installed generation capacity of 105 GW as on 31<sup>st</sup> March 2002 and peak demand of 73 GW, the transmission system in the country at 765/HVDC/400/230/220/132/110 kV stood at 257 thousand circuit kilometers (Tckm) of transmission lines and 292 GVA of substation capacity. The corresponding sub-transmission system and distribution system stood at 302 Tckm and 115 GVA at 66/33/22kV, 1758 Tckm at 15/11/6.6/3.3/2.2kV, 176 GVA of distribution transformers and 3680 Tckm of LT lines.
- 5.2** Considering the shortages (12.6% in peaking and 7.5% in energy) as at the end of 9<sup>th</sup> plan and to meet the demand as forecasted by the 16<sup>th</sup> EPS, the generation capacity addition requirement for the X plan was assessed to be 57 GW. However, taking into account the resource constraints and factoring that the demand growths was likely to be less than the 16<sup>th</sup> EPS projections, a moderated capacity addition programme of 41 GW comprising 14.4 GW of hydro, 25.4 GW of thermal and 1.3 GW of nuclear was fixed as the target for the X plan. Based on the list of generation projects corresponding to this programme of 41 GW, transmission requirements at 132 kV level and above including the power evacuation system as well as network strengthening were identified. This transmission programme became the basis for taking up detailed planning exercise and finalizing of their transmission development programme by the Central Transmission Utility and the State Transmission Utilities corresponding to the actual pace of 10<sup>th</sup> Plan development happening in generation and the actual area-wise load growths.

**5.3** The actual generation capacity addition during 10<sup>th</sup> plan has been at variance with respect to the 41 GW plan. Accordingly, the actual 10<sup>th</sup> Plan transmission programme has also been at variance. Apart from changes in associated transmission system corresponding to deferred /slipped /changed generation, also necessitated review of transmission needs. Accordingly, the transmission programme taken-up for execution was revised as per the actual needs matching with generation projects. The actual updated programme during the first three years of the 10<sup>th</sup> Plan and as per the current progress/ targets for the remaining two years of the Plan is detailed at Annex-5.1 to 5.7. Also, as the transmission plan corresponding to 41GW programme originally identified in the beginning is still a basis for consideration for reworking the evacuation system for the slipped/deferred generation projects as and when these generation projects materialize, the same is also given at Annex-5.8.

These Annex contain the following:

- Annex-5.1: Transmission lines and sub-station at 765kV – Existing at the end of 9<sup>th</sup> Plan and programme for 10<sup>th</sup> Plan 2002-07.
- Annex-5.2: HVDC Transmission Bipole, Back-to-back and Monopole lines and terminal station – Existing at the end of 9<sup>th</sup> Plan and programme for 10<sup>th</sup> Plan 2002-07.
- Annex-5.3: Transmission lines and sub-station at 400 kV and 220 kV completed during the year 2002-03.
- Annex-5.4: Transmission lines and sub-station at 400 kV and 220 kV completed during the year 2003-04.
- Annex-5.5: Transmission lines and sub-station at 400 kV and 220 kV completed during the year 2004-05.
- Annex-5.6: Transmission lines and sub-station at 400 kV and 220 kV programme for the year 2005-06.
- Annex-5.7: Transmission lines and sub-station at 400 kV and 220 kV programme for the year 2006-07.
- Annex 5.8: Transmission plan corresponding to 41 GW programme as was identified at the beginning of 10<sup>th</sup> Plan.

**5.4** Summary of 10<sup>th</sup> Plan transmission programme based on actual progress during the first three years and the updated targets for the remaining two years is tabulated below:

	Unit	As at the end of		
		9 <sup>th</sup> Plan i.e. 3/02	2004-05 i.e. 3/05	2006-07 i.e. 3/07
<b>TRANSMISSION LINES</b>				
(a) 765 kV	ckm	971	971	2031
(b) HVDC ± 500kV	ckm	3138	3138	3138
(c) 400 kV	ckm	49378	59175	72564
(d) 230/220kV	ckm	96994	105783	117044
(e) HVDC 200kV	ckm	162	162	162
Total of (a), (b), (c),(d) & (e)	ckm	<b>150463</b>	<b>169229</b>	<b>193949</b>
<b>SUBSTATIONS</b>				
(a) 765 kV	MVA	0	0	3000
(b) 400 kV	MVA	61325	73490	94280
(c) 230/220 kV	MVA	116363	139407	151187
Total of (a), (b) & (c)		<b>177688</b>	<b>212897</b>	<b>248467</b>
<b>HVDC</b>				
(a) Bi-pole link capacity	MW	3000	5000	5500
(b) Back-to back capacity	MW	2000	3000	3000
(c) Mono-pole link capacity	MW	200	200	200
Total of (a), (b) & (c)	MW	<b>5200</b>	<b>8200</b>	<b>8700</b>

**5.5** Development of National Grid during the 10<sup>th</sup> Plan

At the end of the 9<sup>th</sup> Plan that is by year 2001-02, the inter-regional transmission capacity was 5050 MW. The addition to the inter-regional transmission capacity during the year 2002-03, 2003-04 and 2004-05 had been 2500 MW, 1000 MW and 900 MW respectively and the programme for the year 2005-06 and 2006-07 is 2500 MW and 4500 MW respectively. Thus 4400 MW transmission capacity has been added during first three years of 10<sup>th</sup> Plan and another 7000 MW is to be added during the remaining two years of the 10<sup>th</sup> Plan. Thus total of 11400 MW would be added to the inter-regional transmission capacity during the 10<sup>th</sup> Plan period (2002-07) that would take the total inter-regional transmission capacity in

the country to 16450 MW by 2006-07. Details in respect of the above is as following:

Name of System	Power Transfer Capacity (MW)		
	At the end of 9 <sup>th</sup> Plan i.e. end of 2001-02	Addition during 2002-07	At the end of 10 <sup>th</sup> Plan i.e. end of 2006-07
<b>ER – SR :</b>			
Gazuwaka HVDC back to back	500	500	1000
Balimela-Upper Sileru 220kV S/C	100		100
Talcher-Kolar HVDC Bipole		2000	2000
Upgradation of Talcher – Kolar HVDC Bipole		500	500
<b>ER-SR total</b>	<b>600</b>	<b>3000</b>	<b>3600</b>
<b>ER –NR :</b>			
Muzaffarpur - Gorakhpur 400kV D/C (Quad Moose) with series compensation		2000	2000
Dehri-Sahupuri 220kV S/C	100		100
Sasaram HVDC back to back		500	500
Biharshariff-Balia 400kV D/C (Quad Moose)		1200	1200
Patna-Balia 400kV D/C (Quad Moose)		1200	1200
<b>ER-NR total</b>	<b>100</b>	<b>4900</b>	<b>5000</b>
<b>ER - WR :</b>			
Rourkela-Raipur 400kV D/C (without series compensation)		1000	1000
TCSC on Rourkela -Raipur 400kV D/C		400	400
Budhipara-Korba 220kV D/C+S/C	400		400
Ranchi-Sipat 400kV D/C (40% Series Comp.)		1000	1000
<b>ER-WR total</b>	<b>400</b>	<b>2400</b>	<b>2800</b>
<b>ER - NER :</b>			
Birpara-Salakati 220kV D/C	250		250
Malda-Bongaigaon 400kV D/C	1000		1000
<b>ER-NER total</b>	<b>1250</b>		<b>1250</b>
<b>NR - WR :</b>			
Vindhychal HVDC back to back	500		500
Auria-Malanpur 220kV D/C	250		250
Kota-Ujjain 220kV D/C	250		250
Agra-Gwalior 765kV S/C line-1 400kV operation		1100	1100
<b>NR-WR total</b>	<b>1000</b>	<b>1100</b>	<b>2100</b>
<b>WR-SR :</b>			
Chandrapur HVDC back to back	1000		1000
Barsur-L.Sileru 200kV HVDC mono pole	200		200
Kolhapur-Belgaum 220kV D/C	250		250
Ponda – Nagajhari 220kV D/C	250		250
<b>WR-SR total</b>	<b>1700</b>		<b>1700</b>
<b>TOTAL ALL INDIA</b>	<b>5050</b>	<b>11400</b>	<b>16450</b>

## 5.6 Development of Regional Grids during the 10<sup>th</sup> Plan

Major transmission schemes completed and programmed under the development plan of the Regional Grids during the 10<sup>th</sup> Plan is as following:

### 5.6.1 Northern Region

In Northern Region following inter-state transmission schemes associated with generation projects and system strengthening has been planned and are under execution during X plan.

S. No.	Name of Scheme	Scheme Discription
1.	Series Comp + TCSC on Kanpur-Ballabgarh 400kV S/C	In this scheme 40 % fixed series compensation and 15 % variable compensation is proposed on Kanpur-Ballabgarh 400 kV S/C line. This would increase the power transfer capability from Eastern to Western part of Northern Grid and improve stability of Northern Grid.
2.	System Strengthening in Singrauli-Vindhyachal corridor	a) Opening of existing 400 kV line between Vindhyachal-Kanpur at Vindhyachal end and connecting it to Singrauli end so as to form Singrauli-Kanpur 400 kV S/C (3 <sup>rd</sup> ckt) b) Singrauli-Vindhyachal 400 kV S/C (2 <sup>nd</sup> ckt) to utilize the vacant bay as created above
3.	Transmission system associated with Dhaul Ganga	a) Dhaul Ganga- Bareilly 400 kV D/C (initially operated at 220 kV)
4.	Northern Region System strengthening scheme-I	a) Kanpur-Auraiya 400 D/C b) LILO of Kanpur-Agra 400 SC at Auraiya c) Bareilly Switching station of PG, 400kV d) LILO of Lucknow-Moradabad 400 kV S/C at Bareilly (PG) e) LILO of Bareilly-Mandola 400kV D/C at Bareilly (PG) 2xD/C f) Bareilly (PG)-Moradabad 400kV S/C g) LILO of Sultanpur-Lucknow 400kV S/C at Lucknow PG
5.	Northern Region System strengthening scheme-II	a) Fixed series compensation of 40% on Allahabad-Mainpuri 400 kV D/C line designed for 95°C b) Agra-Jaipur 400 kV DC c) Wagoora 400/220 kV, 3rd transformer
6.	Transmission system associated with Dulhasti	a) Dulhasti-Kishenpur 400 kV 2x S/C b) Kishenpur-Wagoora 400 kV D/C c) Kishenpur 315 MVA 400/220 kV S/S
7.	Transmission system associated with Rihand-II	a) Rihand-Allahabad 400 kV D/C b) Dadri - Panipat 400 kV S/C - 2nd ckt c) Patiala- Malerkotla 400 kV S/C d) LILO of 400 kV Nalagarh -Hissar one Ckt at

		<p>Kaithal S/S</p> <p>e) LILO of 400 kV Nalagarh -Hissar one Ckt at Patiala S/S</p> <p>f) Kaithal 630 MVA 400/220 kV S/S</p> <p>g) Patiala 630 MVA 400/220 kV S/S</p> <p>h) Mainpuri 315 MVA 400/220 kV S/S (Aug.)</p> <p>i) Abdullapur 315 MVA 400/220 kV S/S 3rd ICT (Aug.)</p>
8.	Northern Region System strengthening scheme-III	<p>a) Gorakhpur-Lucknow (new) 400 kV D/C</p> <p>b) Lucknow (New)-Unnao 400 kV D/C</p> <p>c) Bareilly - Mandola 400 kV D/C</p> <p>d) LILO of 400 kV Dadri-Samaypur D/C line at Maharani Bagh-2xD/C</p> <p>e) Gorakhpur (new)-Gorakhpur (UP) interconnection 400 kV D/C</p> <p>f) Gorakhpur 1x315 MVA 400/220 kV S/S (new) with 2x63 MVAR L/R</p> <p>g) New Lucknow 1x315 MVA 400/220 kV S/S(new)</p> <p>h) Maharani Bagh 2x315 MVA 400/220 kV S/S (new)</p> <p>i) Bareilly 1x315 MVA 400/220 kV S/S (new) with 2x50 MVAR L/R</p>
9.	Transmission system associated with Sewa-II	<p>a) Sewa -Hiranagar 132 kV D/C</p> <p>b) Sewa - Khatua 132 kV via Mahanpur</p>
10.	Transmission system associated with Parbati-II	a) Parbati-Nalagarh 400 kV D/C (Quad)
11.	Transmission system associated with Koteshwar	a) Koteshwar-Tehri 400 kV D/C line
12.	Northern Region System strengthening scheme-IV	a) Provision of SVC support in NR system. (Total quantum of compensation, their size and location would be identified after further studies.)
13.	Transmission system associated with RAPP-5&6	<p>a) RAPP-Kankroli 400 kV D/C</p> <p>b) RAPP-Kota 400 kV S/C</p> <p>c) Kota 400/220 kV 2x315 MVA S/S</p> <p>d) Kankroli 400/220 kV 3x315 MVA S/S</p>
14.	Northern Region System strengthening scheme-V	<p>a) LILO of 400 kV Hissar-Jaipur at Bhiwadi</p> <p>b) Bhiwadi-Agra 400kV D/C</p> <p>c) Bhiwadi-Moga 400kV D/C</p>
15.	System strengthening in Roorkee	<p>a) Establishment of Roorkee 1x315 MVA 400/220 kV S/S by LILO of Rishikesh- Muzaffarpur S/C line at Roorkee S/S</p> <p>b) Extn. of Roorkee-Muzaffarpur line as Roorkee-Meerut line by opening at Muzaffarpur</p>
16.	Additional transformers at Moga and Amritsar	<p>a) Moga 400/220 kV 1x315 MVA (Aug) 3<sup>rd</sup> transformer</p> <p>b) Amritsar 400/220 kV 1x315 MVA (Aug) 3<sup>rd</sup> transformer</p>
17.	Supplementary Transmission system associated with RAPP-5&6	<p>a) Kota-Merta 400 kV D/C</p> <p>b) Kankroli-Jodhpur 400 kV S/C</p>

## 5.6.2 Western Region

In Western Region following inter-state transmission schemes associated with generation projects and system strengthening has been planned and are under execution during X plan.

S. No.	Name of Scheme	Discription
1.	Series Comp + TCSC on Rourkela-Raipur 400kV D/C	40 % fixed series compensation and 15 % variable compensation on Rourkela-Raipur 400 kV D/C line would not only increase the power flow on this inter-regional link but would also improve dynamic stability.
2.	Associated Transmission System of TAPP 3&4	a) Tarapur-Boisar 400kV D/C b) Tarapur-Padghe 400kV D/C c) LILO of Gandhar-Padghe 400 kV S/C at Vapi (PG) d) LILO of Gandhar-Padghe 400 kV S/C at Boisar (PG) e) Vapi (PG) 2x315 MVA 400/220 kV S/S f) Boisar (PG) 2x315 MVA 400/220 kV S/S
3.	Raipur-Bhadrawati 400kV D/C	a) Raipur-Bhadrawati 400 kV D/C
4.	Bhadrawati-Chandrapur 400kV D/C	a) Bhadrawati-Chandrapur 400kV D/C
5.	Associated Tr. System of Vindhyachal-III (2x500 MW)	a) Vindhyachal-Satna-Bina 400 kV D/C b) LILO of both ckts of Rourkela-Raipur 400 kV D/C line at Raigarh c) LILO of both ckts of Satna-Bina (MPSEB) 400 kV D/C line at Bina (PG) d) Raigarh 2x315 MVA 400/220 kV S/S e) Bina (PG) 400/220kV Switching sub-station
6.	Vindhyachal-Korba 400 kV S/C line (2 <sup>nd</sup> ckt.)	a) Vindhyachal-Korba 400 kV S/C line (2 <sup>nd</sup> ckt.)
7.	Bina-Nagda 400 kV D/C line	a) Bina-Nagda 400 kV D/C line
8.	Associated Tr. System of Sipat-I (3x660 MW)	a) Sipat-Seoni 765 kV 2X S/C b) Seoni-Khandwa 400 kV D/C (Quad AAAC) c) Nagda-Dehgam 400 kV D/C d) LILO of Korba-Raipur at Sipat 400 kV D/C e) LILO of Satpura-Bhilai at Seoni 400 kV D/C f) LILO of both ckts of S. Sarover-Dhule 400 kV D/C line at Rajgarh g) Seoni 7x500 MVA 765/400 kV and 2x315 MVA 400/220 kV S/S h) Rajgarh 2x315 MVA 400/220 kV S/S
9.	Associated Tr. System of Sipat-II (2x500 MW)	a) Khandwa-Rajgarh 400 kV D/C b) Bina-Gwalior 765 kV S/C (initially op. at 400 kV) c) Seoni 765/400 kV 3x500 MVA (Aug.) d) LILO of 400 kV Korba-Raipur 400 kV line at Bhatapara. e) Bhatapara 2x315 MVA 400/220 kV S/S

10.	Sipat-Raipur 400 kV D/C line	a) Sipat-Raipur 400 kV D/C
11.	Associated Tr. System of Kahalgaon-II Phase-II (1x500 MW)	a) Ranchi-Sipat 400 kV D/C with 40 % series compensation b) Agra-Gwalior 765 kV S/C (initially op. at 400 kV)
12.	Transmission System associated with Gandhar-II (1350 MW)	a) Gandhar (NTPC)-Rajkot (GEB) 400 kV D/C b) Gandhar (NTPC)-Kawas 400 kV D/C c) LILO of both circuits of Bina-Nagda 400 kV D/C line at Shujalpur d) Establishment of 2x315 MVA 400/220 kV substation at Shujalpur
13.	Transmission System associated with Kawas-II (1350 MW)	a) Kawas-II-Vapi (PG) 400 kV D/C Quad b) Vapi (PG)- Navi Mumbai 400 kV D/C c) LILO of Kalwa-Pune (PG) 400 kV S/C line at Navi Mumbai, d) Vapi (PG)-Khadoli (DNH) 220 kV D/C e) Establishment of 400/220 kV 2x315 MVA S/S at Navi Mumbai (GIS in case adequate land is not available). f) LILO of Apta-Kalwa and Kharghar-Kandalgaon 220 kV D/C lines at Navi Mumbai. (LILO works under preview of MSEB, 220 kV bay provision at Navi Mumbai by PGCIL) g) Installation of 400/220 kV 1x315 MVA 3 <sup>rd</sup> transformer at Vapi
14.	Multi circuit 2xD/C line between Vapi (PG) and line alignment of the 220 kV lines from Bhilad-Kharadpada & Bhilad-Magarwada, thereby creating Vapi (PG)-Magarwada 220 kV D/C and Vapi (PG)-Kharadpada 220 kV D/C line by bypassing both the lines at Bhilad	At present UT's of DNH and Daman & Diu are getting feed from Bhilad 220 kV S/S of GEB over Bhilad-Kharadpada D/C & Bhilad-Magarwada D/C 220 kV lines. In order to provide a direct linkage of both the UT's with a nearby central sector 400/220 kV S/S, it is proposed to construct a Multi circuit 2xD/C line between Vapi (PG) and line alignment of the 220 kV lines from Bhilad-Kharadpada & Bhilad-Magarwada thereby creating Vapi (PG)-Magarwada 220 kV D/C and Vapi (PG)-Kharadpada 220 kV D/C line by bypassing both the lines at Bhilad. The above arrangement would also provide relief to Bhilad S/S of GEB

### 5.6.3 Southern Region

In Southern Region following inter-state transmission schemes associated with generation projects and system strengthening has been planned and are under execution during X plan.

S. No.	Name of Scheme	Discription
1.	Series Comp on Nagarjuna Sagar-Cuddapah and Gooty-Neelnamangla 400 kV lines	a) 50% series compensation on both the circuits of Gooty-Bangalore 400 kV 2xS/C and Nagarjuna Sagar-Cuddapah 400 kV D/C
2.	Kaiga-Narendra 400 kV D/C	a) Kaiga-Narendra 400 kV D/C
3.	Establishment of Narendra 400/220 kV S/S	a) Establishment of 2x315 MVA 400/220 kV S/S at Narendra
4.	Southern Region System strengthening scheme-IV	a) LILO of Nagarjunasagar-Raichur 400 kV S/C line at Mehboobnagar b) LILO of both the circuits of Nellore-Sripumbudur 400 kV D/C line at Alamatti 400kV S/S
5.	Neelamangla-Mysore transmission system	a) Neelamangala-Mysore 400 kV D/C line b) Mysore 2x315MVA 400/220 kV S/S
6.	Madurai-Thiruvananthapuram	a) Madurai-Thiruvananthapuram 400 kV D/C line b) Thiruvananthapuram 400/220kV 2x315MVA substation
7.	Transmission system associated with Ramagundam-III	a) Ramagundam-Hyderabad 400kV D/C line b) Hyderabad-Kurnool-Gooty 400kV S/C line c) Khammam-Nagarjunasagar 400kV S/C line d) Gooty-Neelamangala 400kV S/C line
8.	Southern Region System strengthening scheme-V	a) Augmentation of Transformer capacity by 1x315 MVA at Munirabad, Cuddapah, Gooty, Khammam, Gazuwaka and 3x167 MVA at Kolar 400 kV Substations b) 1x80 MVAR Bus reactor at Nellore 400kV S/S
9.	Southern Region System strengthening scheme-III	a) Raichur-Gooty 400 kV D/C (Quad) line b) Neelamangala- Somanahaly 400 kV D/C
10.	Southern Region System strengthening scheme-VI	a) LILO of both the circuits of Gazuwaka-Vijayawada 400kV D/C line at Vemagiri 400 kV S/S b) 2 <sup>nd</sup> 1x315 MVA 400/220kV Transformer at Vijayawada
11.	Upgradation of Transfer capacity of Talcher-Kolar HVDC Bipole	a) Transfer capacity of Talchar-Kolar HVDC Bipole would be upgraded from 2000 MW to 2500 MW

#### 5.6.4 Eastern Region

In Eastern Region following inter-state transmission schemes associated with generation projects and system strengthening has been planned and are under execution during X plan.

S. No.	Name of Scheme	Description
1.	LILO of Silliguri-Gangtok 132 kV line at Melli	a) LILO of one ckt of Silliguri-Gangtok 132 kV D/C line at Melli
2.	Installation of 2nd ICT at Indravati OHPC	a) Indravati 1x315 MVA 400/220 kV 2 <sup>nd</sup> Trf. (Aug.)
3.	LILO of Rangit-Silliguri at Gangtok	a) LILO of one ckt of 132 kV Rangit-Silliguri at Gangtok
4.	Transmission system associated with Teesta-V	a) Teesta-Silliguri 400 kV D/C

#### 5.6.5 Inter-Regional Schemes

The following inter-regional transmission schemes associated with generation projects and system strengthening has been planned and are under execution during X plan.

S. No.	Name of Scheme	Description
1.	Associated Tr. System of Kahalgaon-II Phase-I (2x500 MW)	<ul style="list-style-type: none"> <li>a) Kahalgaon-Patna-Balia 400 kV D/C (Quad)-368 km</li> <li>b) Biharsharif-Balia 400 kV D/C (Quad)-166 km</li> <li>c) Balia-Mau 400 kV D/C-20 km</li> <li>d) Maithon (PG)-Ranchi 400 kV D/C-210 km</li> <li>e) Balia-Lucknow (PG) 400 kV D/C with series capacitor (to be design with 95° C conductor temp.)-320 km.</li> <li>f) Lucknow (PG)-Bareilly (PG) 400 kV D/C (to be designed with 95° C conductor temp.)-250 km.</li> <li>g) Agra (PG)-Gwalior (PG) 765kV S/C (to be initially charged at 400 kV level)-128 km</li> <li>h) 2x315 MVA 400/220 kV Patna (New) S/S</li> <li>i) 2x315 MVA 400/220 kV Ranchi (New) S/S</li> <li>j) Extension of Biharsharif, Mau, Maithon, Lucknow, Bareilly, Agra, Gwalior 400 kV substations.</li> </ul>

## **5.7 Intra State Transmission Programme**

In the 10<sup>th</sup> and 11<sup>th</sup> plan period, generation capacity additions are being planned under State / Private / Central sectors to meet future load growth of the State utilities. As per the Electricity Act 2003, the development of intra state transmission network is the responsibility of concerned state transmission utility. With the availability of strong Regional Grid systems and also the inter Regional / National Grid, the network at 400 kV and above would now onwards mostly get covered under inter-state systems and the intra-state system would require network at 400 kV and above in specific cases only. Requirement of 220kV system in intra-state network has been evolved in coordination with the overall 400kV network plan and Annex 5.3 to 5.7 include the total transmission programme for the 10<sup>th</sup> Plan period for inter-state as well as intra-state transmission system at 220kV and above.