CHAPTER 3

Planning and Project Conceptualisation

3.1 Planning of transmission projects by PGCIL

PGCIL is responsible for planning of inter-state transmission projects and these projects fall under the following two categories:

(i) Projects connected with evacuation of power from Central sector generating stations and

(ii) Projects connected with strengthening of power system network.

The proposal for a new transmission project is technically approved by the Standing Committee for Power System Planning (SCPSP)[12] of the concerned regions. Further, each region has a separate committee called Regional Power Committee (RPC)[13] which approves these projects from commercial point of view. Once the project is approved by RPC, it becomes a part of Bulk Power Transmission Agreement (BPTA) and beneficiaries are liable to pay transmission charges to PGCIL. After approval of the project by the concerned Regional SCPSP, PGCIL initiates action for obtaining investment approval, clearances and procurement activities.

Records relating to conceptualisation and planning of 20 selected transmission projects taken up for implementation during April 2007 to March 2012 along with the status of augmentation to the transmission network made by PGCIL up to March 2013 were examined in audit. Results of the examination are given in subsequent paras.

3.1.1 Progress in the formation of National Grid

One of the major objectives of formation of PGCIL was to bring about integrated operation of the regional transmission systems by undertaking construction of inter-regional links. This was to facilitate the growth of economic exchange of power (replacing costly[14] energy transactions within a region with cheaper ones from another region so that cost of power is reduced) which would ultimately lead to the formation of a national grid and ensure better utilisation of available generation resources. Electricity Act, 2003 envisaged 'open access'[15] in transmission to promote competition amongst the generating companies which could sell electricity to different distribution licensees across the country, leading to availability of cheaper

[12] *SCPSP for each region is constituted by CEA for carrying out its duties of integrated planning under section 73 (a) of the Electricity Act, 2003. These committees are headed by Member CEA and State Transmission Utilities, Central Transmission Utilities, Central Generating Units (CGUs), etc. are members. SCPSP provides technical approval to the projects.*

[13] *This Committee is chaired by heads of state utilities on rotational basis and CEA, State Transmission Utilities, Central sector generating units, CTU, Load Despatch Centres, traders and Discoms, etc. are its members.*

[14] *Cost of energy varies according to type of fuel, age of the plant, whether cost plus project or tariff based project, etc.*

[15] *As per definition given in the Electricity Act, 2003, Open access means non-discriminatory provision for use of transmission lines or distribution system or associated facilities with such lines or system by any licensee or consumer or a person engaged in generation in accordance with the regulations specified by the Appropriate Commission.*

power. National Electricity Policy 2005 envisaged that network expansion should be planned and implemented keeping in view anticipated transmission needs that would be incident on the system in the open access regime.

The process of integration of regional grids through construction of inter-regional links began in the 1990s, initially with High Voltage Direct Current (HVDC) links and later through synchronous interconnections[16]. Southern Region remained interconnected to the rest of the country through 4000 MW of HVDC links till it was synchronously connected through Raichur-Sholapur 765 kV single circuit on 31 December 2013 completing the technical process of formation of 'National Grid'.

Though the technical process of formation of 'National Grid' can be regarded as complete, when viewed in terms of overall inter-regional power transfer capability, the objective of formation of 'National Grid' remains to be achieved (April 2014) as explained below:

(i) Actual power flows exceeded transfer capability of four corridors in 16 months during 2009-13 as detailed in Table 3.1 indicating that the capability of these corridors was inadequate to handle the increasing demands of power exchanges amongst these regions.

Table 3.1

Instances of actual power flows in excess of Total Transfer Capability

Corridor	Month	TTC (in MW)	Actual Flow (in MW)
WR-NR	September 2009	1500	1523
	October 2009	1500	1653
	January 2010	1500	1630
	July 2011	1900	2291
	January 2013	1700	2004
WR-SR	April 2011	800	913
	July 2011	800	901
	October 2011	800	911
	July 2012	800	880
	August 2012	800	909
	September 2012	800	881
	October 2012	800	921
	November 2012	800	896
	December 2012	800	814
ER-SR	March 2011	2330	2431
	April 2011	2330	2382
	December 2011	2120	2186
ER-NER	January 2010	200	233
	March 2013	400	422

[16] *HVDC links are point to point lines through which flow of electricity can be regulated by system operators. Synchronous interconnections on the other hand are Alternating Current (AC) links, through which power flow happens as per the laws of physics. ER and NER were synchronously interconnected first, followed by WR and NR.*

(ii) In 24 years of its operation (till 31.3.2013), PGCIL built 45 inter-regional transmission lines (220 kV and above), connecting five regions, which works out to 1.2 *per cent* [17] of total lines (220 kV and above) in the inter-state transmission grid. Further, four out of six inter-regional corridors (WR-NR, WR-ER, ER-NER and WR-SR) were capable of carrying only 1.5 *per cent* to 3 *per cent* of installed power generating capacity in respective power surplus regions ***(Annexure 3.1)***.

When the issue of adequacy of inter-regional capability was discussed in the Exit Conference (April 2014), it transpired that there were no specific norms to assess adequacy of inter-regional capability with reference to operating requirements. However, MOP had reservations about using installed capacity as a benchmark for assessment of adequacy of transmission capacity of inter-regional corridors. It is, however, pertinent to note in this connection, that the European council as per their Ten year Transmission Network Development Plan 2012, had proposed a criterion for interconnection development, asking Member States a minimum import capacity level equivalent to 10 *per cent* of their installed production. Thus, comparison of adequacy of transmission system with reference to installed generation capacity would appear to be an international good practice. Capital investment made by PGCIL in eleven inter-regional links commissioned during XI plan was ₹ 4287 crore (7.7 *per cent* of the total capital investment of PGCIL in XI Plan) while capital investment in intra regional links was ₹ 51043 crore (92.3 *per cent* of total capital investment of PGCIL in XI plan). Thus, efforts of PGCIL in XI Plan were directed more towards strengthening intra regional network as compared to inter regional linkage.

(iii) POSOCO expected the present achievement of linkage of SR with National Grid to be operated as a weak link in the initial few years, as PGCIL was required to commission twenty elements in WR and SR before import of power by SR could be scheduled across the new Raichur-Sholapur link. Further, synchronous interconnection was achieved by PGCIL through a single circuit while the second circuit of Raichur-Sholapur line which is important for safe and secure operation of interconnected grid was yet (March 2014) to be commissioned by an independent transmission project developer selected through tariff based bidding by REC Transmission projects Limited, a subsidiary of Rural Electrification Corporation Limited (REC).

Low level of inter-regional transfer capability implies limited scope for transfer of power among regions. Hence the objectives for formation of National Grid *i.e.* meeting deficit from surplus region and facilitating economic exchanges remained largely unfulfilled**.**

MOP stated (March 2014) that National Grid was not restricted to links that were crossing regional boundaries but covered up-stream and downstream network as well; total transmission lines under inter-state increased from 22000 ckm in 1992-93 to more than 105000 ckm in January 2014; Inter-regional power exchange takes place on account of supply-demand

[17] ***Total lines – 3743; Inter-regional – 45 (765 kV, 400 kV and 220 kV)***

gap in inter-connected regions and are planned as per projected transfers; at present there is no congestion in long term power exchange but in certain scenario, congestion may occur under medium and short term depending upon quantum, period and duration of requirement; National grid development is a continuous process and shall keep pace with power sector development.

The reply is to be viewed against the following facts:

(i) According to note of MOP (August 1989) to Cabinet for setting up of PGCIL, the role of PGCIL is not limited to serving projected demand-supply gap but also to facilitate economic exchanges across the country and ensure better utilization of available generation resources. This is possible only if regional grids are adequately 'meshed' and integrated which is yet to be achieved as inter-regional links are still weak.

(ii) In the deliberations before the Coordination Forum[18] in August 2009, it transpired that occasional congestion indicates optimum investment in transmission while regular congestion indicates inadequacy. Analysis of power exchange data ***(Annexure 3.2)*** of Indian Energy Exchange and Power Exchange India Limited showed that instances of percentage of time[19] congestion occurred above 75 *per cent* increased from two months in 2010-11 to all 12 months in 2012-13. Similarly, volume of electricity that could not be cleared due to congestion (as a percentage of the actually cleared volume), in Power Exchange India Limited went above 75 *per cent* for 3 months in 2011-12 and increased to five months in 2012-13.

(iii) Impact of congestion and inadequacies of transmission networks is visible in large variations in the electricity prices over regions. Comparison of Market Clearing Price (MCP *i.e.* clearing price for cleared transactions in the whole country, if there is no congestion at all) with the Area Clearing Prices[20] in Indian Energy Exchange ***(Annexure 3.2)*** showed that buyers in S1 and S2 bid areas (States of Tamil Nadu, Kerala, Andhra Pradesh, Karnataka, Goa and Union Territory of Pondicherry) paid higher price during the last two years (₹ 5.1 to ₹ 7.3 per unit as against MCP of ₹3.5 per unit) to procure power. On the other hand, sellers in W3, E1 and E2 bid areas (Chhattisgarh, Orissa, West Bengal, Sikkim, Bihar and Jharkhand) received lower price (₹ 2.8-2.9 per unit as against MCP of ₹ 3.5 per unit) due to transmission contraints. These trends indicate the need for strengthening WR-SR and ER-SR links (W3, E1, E2 to S1 and S2 *i.e.* generation

[18] ***Coordination forum was constituted by MOP in February 2008 under Section 166 (1) of the Electricity Act, 2003 for smooth and coordinated development of power system in the country. The forum is chaired by Chairman, CERC and inter-alia had the following members- Chairperson CEA, Member (Power Systems) of CEA, Members of CERC, CEO of CTU, representatives from generating companies, both PSEs and private. Additional Secretary/Joint Secretary, MOP is the member convenor. The Coordination Forum held its last meeting in March 2010.***

[19] ***Number of hours congestion occurred/ Total number of hours in a month.***

[20] ***The country is divided into 12 bid areas (IEX) for power exchange transactions. The criterion for defining these areas is the location of the physical constraints in the structure of transmission network, including national and/or control area borders. In case of congestion across a transmission corridor, the net sale of upstream areas will not flow to downstream deficit areas. The cleared prices in all areas i.e. Area Clearing Prices are adjusted so that the flow of power across transmission corridor is same as available transfer capability.***

surplus to power deficient states). However, comparison with inter-regional corridors augmentation plans for the XII Plan ***(Annexure 3.3)*** revealed that no links were planned for the ER-SR corridor and 6400 MW only has been planned for WR-SR corridor (16 *per cent* of total inter-regional augmentation of 40500 MW).

(iv) As regards the argument that there is no congestion in long term power exchange, there is zero margin (WR-SR) /negligible margins (ER-SR, WR-NR)[21] as of March 2014 in three out of six inter-regional corridors over and above the capability required to cater to long term customers. Allocation of 276.83 MW power from Indira Gandhi Super Thermal Power Station, Jhajjar, Haryana to Andhra Pradesh made by MOP (customers receiving allocation from Central Sector Generating Stations are long term customers in terms of CERC Regulations of August 2009) had to be kept in abeyance (May 2014) due to the absence of available margins in May 2014. This indicated that transmission constraints were being faced by long term customers also.

Thus, though technically the 'National Grid' had come into existence with the synchronous inter-connection of SR with WR on 31 December 2013, there is a need and scope for making the inter-connections robust enough by augmenting inter regional power transfer capability to fully achieve the objectives of formation of National Grid.

3.1.2 Planning of capacity addition of inter-regional transmission corridors without giving due regard to increase in their power transfer capability

Two parameters *viz*. Transmission Capacity and Transfer Capability are relevant for assessing the capacity of inter-regional corridors. Transmission capacity of a corridor is arrived at by adding the ratings of all transmission lines connecting two regions. Transfer capability on the other hand, is the measure of the ability of the corridor, as a whole, to reliably move power from one region to another. Transfer capability is often less than the transmission capacity in view of system limitations and strength of the weakest link in the corridor. While transmission capacity is decided by physical characteristics of components and is static in nature, transfer capability is assessed by system operators considering system conditions such as generation, customer demand *etc* and is dynamic. For example, WR-NR corridor has nine lines and the sum of the physical ratings comes to 4220 MW which is denoted as its transmission capacity whereas the transfer capability of the corridor was 2000 MW (2011-12). A part of the Transfer Capability is kept as a 'Reliability margin' to handle contingencies and errors in assumptions and the balance capability, called Available Transfer Capability (ATC) is offered for scheduled power flows.

NLDC assesses the Total Transfer Capability -TTC (full capability including reliability margin) of 12 inter-regional corridors (considering power flow in both the directions across the six corridors i.e. WR-NR, NR-WR and so on) based on off-line simulation studies and real

[21] ***ER-SR margin was 93 MW in March 2014 (00 to 05 hours and 10-19 hours) and WR-NR margin was 219 MW in March 2014.***

time data. TTC so arrived at is declared on the web sites of RLDCs and NLDC for information of users who may enter into contracts for transfer of power, apply for grant of open access, *etc*. Thus, TTC is a significant factor that should be considered to assess the needs of augmentation of inter-regional capacity. However, PGCIL assesses the need for augmentation of capacity of inter-regional corridors based only on 'Transmission capacity' and does not monitor augmentation of TTC. While NLDC declares TTC in short time horizon (three months and below), such declaration in the long run was not being done by PGCIL though it was required to do so as per 'Procedure for making application for Grant of long term access and medium term open access to Inter state transmission systems' approved by CERC.

PGCIL increased (2007-12) the transmission capacity of inter-regional transmission corridors by 13900 MW. However, TTC increased from 9400 MW in 2008-09 to only 11530 MW in 2011-12. During 2011-12, TTC decreased by 750 MW as compared to that in 2010-11 (reduction in ER-SR by 350 MW, ER-NR by 100 MW, ER-NER by 100 MW and WR-ER by 200 MW).

Further, in the Annual Report for 2011-12, PGCIL indicated that cumulative inter-regional power transfer capacity of National Grid was 28000 MW. However, this being equal to summation of ratings of all transmission lines, was basically transmission capacity as against the actual power transfer capability denoted by TTC which was 11530 MW as detailed in Table 3.2 given below.

Table 3.2

TTC and transmission capacity of inter regional corridors

Corridor	Transmission Capacity (As on 31.3.2012)	TTC (Highest during 2011-12)	%age of TTC to Transmission capacity	Capital Investment made in XI Plan (₹ in crore)	%age of Total Investment
WR-NR	4220	2000	47	465	11
WR-ER	4390	1000	23	1009	24
ER-NER	1260	500	40	-	-
WR-SR	1520	1000	66 *	-	-
ER-NR	10030	4200	42	2706	63
ER-SR	3630	2830	78 *	106	2
Total	**25050 #**	**11530**		**4286**	**100**

In addition to 25050 MW comprising of 220 kV and above lines, 132 kV lines also exist along various inter-regional corridors.

* Higher TTC due to HVDC links through which power flows can be regulated.

It can be seen that TTC as a percentage of transmission capacity was less than 50 in four out of six inter-regional corridors and was less than 30 *per cent* in case of WR-ER. Thus, for better appreciation of ability of transmission network to transfer power across regions it would be a useful good practice if TTC is also declared and disclosed alongwith transmission capacity.

MOP did not offer any remarks regarding non-declaration of TTC by PGCIL in the long and medium term. However, it was contended in the Exit Conference (April 2014) that non-materialisation of assumed facilities hampered the loadability and hence TTC at a given instant might not match with the planned figure. Further POSOCO added in the Exit conference that even in Europe when the transmission capacity was of the order of 1000 MW, TTC was of the order of 60-70 per cent and when the transmission capacity increased in the range of 10000-20000 MW, TTC reduced drastically to the order of 20 to 30 per cent.

The reply is to be viewed against the fact that TTC does not increase commensurately with the increase in transmission capacity. It is thus essential to monitor and declare it in the long run as per the requirements of CERC regulations. This view was also held by POSOCO in their comments on draft National Electricity Plan to CEA when they emphasised (May 2012) that quantifying growth of transmission capacity in terms of inter regional capacity was an inadequate index of performance. POSOCO added that it was the transfer capability across regions that was important.

3.1.3 Development of inter-regional corridors

The bulk of the inter-regional augmentation efforts achieved in XI Plan and planned for XII Plan have been across the ER-NR and ER-WR corridors to wheel power from the pit-head power plants in the coal rich ER to the demand centers in the north and the west. Similarly there were plans to build a network in the 'chicken neck'[22] area of NER so that the hydro potential of NER could be tapped and power could be brought to NR and WR through NER-ER-WR corridors. 63 *per cent* of total inter-regional transmission capacity of 25050 MW[23](cumulative at the end of XI Plan) was concentrated along these corridors. (***Annexure 3.3)***. Audit examination revealed the following:

(i) Significance of short-tie *vis a vis* long-tie for import of power by NR

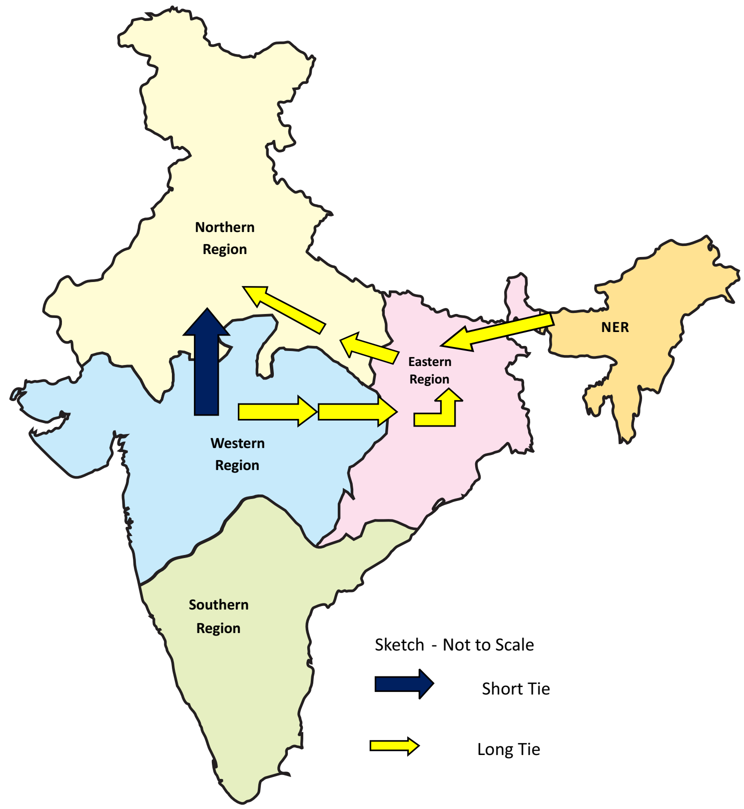
Offline simulation studies conducted by an Expert Group constituted by MOP following the two major Grid disturbances of 30 and 31 July 2012 had shown that the WR-NR link was the 'short tie' (Transmission link shorter in length and tying/connecting two regions) for import of power by NR and in the case of loss of the short tie, the longer tie of WR-ER-NR could also be lost due to angular separation and power swings[24]. This meant that import by NR was dependent on the transfer capability of the 'short tie' rather than that of the 'long tie' (depicted

[22] *Formally, Siliguri Corridor, a narrow strip of territory connecting north eastern states to the rest of India.*

[23] *Transmission capacity i.e. summation of ratings of individual lines.*

[24] *The rotors of generators connected to the grid run at the same electrical speed and in case of small disturbances affecting the speed, restorative forces bring back the rotors to the same speed. However, for large disturbances, the restorative forces may be unable to bring all the generators to the same speed. If this happens, the angular difference between the generators goes on increasing (Angular separation) which causes large variations in voltage and power flow in lines.*

in map given below). Hence high level of augmentation of the longer tie *i.e*. ER-NR, ER-WR and NER-ER-WR without appropriate augmentation in WR–NR would not yield desired results for transmission of increased power to NR.



Thus, due consideration was required to be given to aspects relating to angular separation and power swings while planning inter linkages of various regions.

MOP stated (March 2014) that the issues of angular separation and power swings were considered as along with Agra-Gwalior double circuit link (765 kV charged at 400 kV) another double circuit viz. 400 kV Zerda-Kankroli was also planned. MOP added that to address the issue, three additional links[25] were planned in the WR-NR corridor which were in different stages of implementation.

The reply is to be viewed against the fact that though Agra-Gwalior and Zerda-Kankroli were both of 400 kV, the power flow handled by the former was 72 *per cent* of the entire WR-NR flows while the latter could take only 9.47 *per cent* of flow (during 2011-12).Thus, power flows through the backup system did not materialise as planned. Further TTC of WR-ER (1000 MW) was only half of TTC of WR-NR (2000 MW) with the result that once the WR-NR tie was lost, sufficient capacity was not available in WR-ER route for required power flows. As regards additional links in WR-NR corridor, there is a need to prioritise their implementation.

[25] ***(Gwalior –Jaipur 765 kV (2 single circuits), Champa-Kurukshetra (800 kV HVDC) and Jabalpur – Orai (765 kV double circuit).***

(ii) Impact of up gradation of link on reliability of WR-NR corridor

WR-NR corridor had faced seasonal congestion during high demand periods and actual power flows (monthly) had breached TTC of the corridor on five occasions between 2009-10 and 2012-13. Agra-Gwalior double circuit line was the trunk line of the corridor which was upgraded from 400 kV voltage level to 765 kV in March 2013. As per the advisory issued (May 2013) by POSOCO to the constituents, the upgradation created a 765 kV line in parallel with a 220 kV network without any 400 kV system in the Agra-Gwalior-Bina section of WR-NR inter-regional corridor. The impact of such a formation was that in the event of loss of both the circuits of 765 kV line, there would be a 'cascade tripping' of 220 kV network. Onset of the contingency *i.e.* tripping of one of the circuits of 765 kV Agra-Gwalior actually happened on 11 June 2013 and POSOCO had to curtail energy flows to avert a major grid disturbance.

MOP stated (March 2014) that the upgradation was planned for strengthening the WR and NR inter-connection to facilitate higher power transfer. To address reliability considerations, three additional links had been planned which were under different stages of implementation.

The reply is to be viewed against the fact that WR-NR TTC, which was enhanced from 2000 MW to 5700 MW in May 2013 following the upgradation, was rolled back in October 2013, due to reliability considerations. Thus, the upgradation to 765 kV line in the WR-NR corridor which was fraught with the risk of 'cascade tripping' as per advisory of POSOCO, worsened an already delicate nature of WR-NR interconnection {discussed in para 7.4.5 (b) titled 'Inter-connection of NR with neighbouring regions} till the new links are implemented. This is further evident from the fact that the number of instances when RLDCs/NLDC issued congestion notice for WR-NR corridor increased from five in 2012-13 to 23 in 2013-14 (till February 2014).

3.1.4 Congestion due to delayed planning and approval of transmission system for transfer of power from generation projects

PGCIL did not have a policy to firm up the time for commissioning of generation linked transmission projects. As CERC regulations on "Grant of Connectivity, Long Term Access and Medium Term Open Access" allow injection of infirm power (*i.e.* power generated by a power station prior to its date of commercial operation) for a period of six months since synchronization of the power plant, commissioning of a transmission system associated with a generation project should precede the date of commercial operation of the generating station at least by six months. However, there was delay in commissioning of transmission system[26] associated with generation projects, in the State of Odisha due to which there was congestion in evacuation of power in the State.

As an illustration, it was noticed that seven generating projects[27] in Odisha involving installed capacity of 10090 MW of Independent Power Producers (IPPs) were scheduled for

[26] ***Transmission Phase-I generation projects in Odisha Part B***

[27] ***Sterlite, GMR, Nav Bharat, Monnet, Jindal, Lanco Babandh, and Ind Bharat***

commissioning between February 2010 and December 2013. However, BOD of PGCIL approved the transmission system associated with these generating projects only in December 2010 with scheduled completion by December 2013 *i.e.* coinciding with the commissioning of the last project. The delay on the part of PGCIL to plan the transmission system resulted in congestion in evacuation of power from four units of 600 MW each of Sterlite project commissioned between October 2010 and April 2012[28]. Also one unit (350 MW) of Kamalanga TPP of M/s GMR was commissioned in March 2013 while execution of the associated transmission system by PGCIL was still in progress (April 2014).

MOP stated (March 2014) that

(i) Out of seven generation projects, only two projects have been commissioned as of January 2014. If the associated transmission system was commissioned matching with the committed schedule, the same might remain unutilised till the time the generation project actually got commissioned.

(ii) Under Section 10 of Electricity Act, 2003, it is the duty of every generating company to co-ordinate with the CTU for transmission of electricity generated by it; but the generators have submitted the LTA applications late, repeatedly revised them and also delayed signing of agreement for payment of transmission charges. Generators had not completed their dedicated lines connecting the power stations to the pooling substations, though PGCIL had commissioned the substations in March 2013.

(iii) The projects were connected to the grid through interim arrangement and the transmission corridors required for evacuation of power were planned to be commissioned progressively by December 2014.

The reply is to be viewed against the facts that:

(i) The transmission system was not ready even for two projects which were commissioned, though it is an agreed principle that transmission should precede generation.

(ii) As regards the statement that the generators had not yet built their dedicated line from the generating plant to the pooling station, it is seen that CEA and PGCIL agreed in the meeting held on 15 September 2009 to provide an interim arrangement of loop-in-loop out[29] (LILO) of an inter-regional line to provide connectivity from the plant to the pooling substation, though as per the Bulk Power Transmission Agreement signed with the generator, it was the responsibility of the generator to build the dedicated line for bringing electricity from the plant to the point of connection in the grid.

(iii) As per CEA (Technical standards for connectivity to the Grid) Regulations, 2007, when a request for connection is received, the CTU shall carry out interconnection study and

[28] ***14 October 2010, 29 December 2010, 16 August 2011 and 25 April 2012.***

[29] ***The interim arrangement was that one circuit of Rourkela-Raipur – 400 kV double circuit (inter regional) would be looped in and looped out at Sterlite power station.***

determine modifications required on the existing grids to accommodate the inter-connection. Interim connectivity through LILO was given in the above two cases, without adequacy of transmission system for evacuation of power which was causing congestion in Chhattisgarh and adjoining areas[30].

3.1.5 Sub-optimal utilization of transmission lines

Presently, transmission of electricity in India is carried mainly through a grid made up of 400 kV Alternating Current (AC) network (comprising 71505 ckm of PGCIL network). PGCIL also built 22 transmission lines (4833 ckm) of high voltage level of 765 kV mainly to augment the power transfer capability[31]. However, out of these 22 lines, 14 lines were initially charged[32] at 400 kV. PGCIL justified high capacity lines in the initial stage itself on the grounds of future hydro potential and possible Right of Way (ROW) constraints[33] that would be faced during subsequent upgradation. However, the operational status (March 2014) of the 765 kV lines revealed that two of these lines (Kishenpur - Moga I and II) remained undercharged at 400 kV level for more than thirteen years (yet to be upgraded) while four lines had remained under charged at 400 kV for more than five years. (Two of them upgraded during the last one year and two lines *viz.,* Tehri-Meerut I and II were yet to be upgraded). Two of the 765 kV lines (Satna-Bina-I and Seoni-Wardha-I) were regularly kept 'open' (taken off the grid through a switching mechanism) to control high voltage, indicating inadequate power flow through them.

The implication of charging 765 kV lines at a lower voltage level of 400 kV is that the beneficiaries, who share the capital cost incurred on these transmission lines, pay for 765 kV lines[34] though actual operation of the lines is at 400 kV. Based on benchmark cost fixed by CERC vide order dated 27 April 2010, the extra cost incurred on laying of these four 765 kV lines which are undercharged at 400 kV lines was ₹158.46[35] crore (recoverable in the tariff period of 35 years). PGCIL, however, does not suffer any revenue loss as it recovers its investment, as the 'as built' capital cost is recovered through tariff.

MOP stated (March 2014) that PGCIL constructed higher capacity lines keeping in mind future hydro generation potential and also to overcome right of way and environmental issues; CEA's Transmission planning criteria allowed adoption of higher voltage levels for final system and operating one level below in the initial stage; investment in capital cost of substations

[30] ***As per POSOCO's feedback to CEA and PGCIL on system constraints.***

[31] ***765 kV line can carry over 4000 MW of power while 400 kV line can carry around 2000 MW.***

[32] ***Charged means the electric circuit is closed and power is allowed to flow through the line. 'Not-charged' means the line is not connected to the grid, the circuit is kept 'open' or kept idle on air. Keeping the line 'not charged' (or charged at a lower voltage level) is resorted to because charging the line without corresponding quantum of electricity flow would lead to voltage fluctuations and resultant grid problems.***

[33] ***Right of way denotes the right for placing of electric lines for transmission of electricity along the path through which such lines pass through; 765 kV transmission towers occupy more space (64-69 m) than 400 kV transmission towers (46-52m).***

[34] ***Transformer and associated bays at higher voltage level are constructed later and capital cost to that extent is postponed.***

[35] ***Worked out on the basis of difference in minimum cost of laying 765 kV line (₹ 60.65 lakh) and 400 kV line (₹ 43.97 lakh) per ckm with standard porcelain insulation, single circuit and Aluminium Conductor Steel Reinforced Moose. Total length of four 765 kV lines charged at 400 kV being 950 km. (i.e. ₹ 16.68 lakh (₹ 60.65 lakh less ₹ 43.97 lakh) X 950 km).***

was deferred thereby relieving tariff burden to that extent; and the undercharged lines would progressively be brought up to their full voltage level.

The fact remains that out of the useful life of 35 years of the transmission projects, there are two cases where 13 years went by just waiting for generation to come up. There may be a need to achieve a proper balance between capacity creation and operational requirement so as to ensure optimum utilisation of transmission network.

Despite a network of 1,00,200 circuit kilometres (ckm) of transmission lines in the grid (40739[36]ckm added during 1 April 2007 to 31 March 2013), PGCIL has not put in place a mechanism for assessing utilisation of transmission lines with the result that, there were pockets of congestion as explained in para 3.1.4 *supra* and areas of redundancy evident from analysis of Line Loading' of 40 of 45 interregional lines[37] in six corridors through a ratio of average power flow and maximum loadability (***Annexure 3.4).*** Average utilisation of 33 out of 40 inter-regional lines ranged between 0 to 30 *per cent* in all inter-regional corridors except WR-SR and ER-SR during 2011-12. 478 (68 *per cent*) out of 706 intra-regional lines[38] in five regions had average utilisation of 0-30 *per cent*. Utilisation was especially low in ER and NER regions.

Absence of mechanism to assess efficiency of network construction results in infirmities in system development in the form of skewed power flow across lines (WR-NR)[39], low line load factor, planning 'surprises' such as power flows in directions opposite to those envisaged while planning (ER-WR and SR-WR)[40] etc.

Regarding underutilisation of transmission lines, MOP stated (March 2014) that transmission serves a public service function and sometimes additional lines may have to be built[41] towards this objective; another aspect of public service is that after interconnection of grids, the frequency of the entire system also stabilizes.

In the Exit Conference (April 2014) also, MOP was of the view that the focus should be on availability of transmission system and not on its utilisation.

This stand is to be viewed against the provisions given in tariff policy notified by MOP in January 2006 which laid down that the overall tariff framework for transmission pricing should

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36 ***100200 Ckm (as on 31.3.2013) minus 59461 ckm (as on 31.3.2007) = 40739 ckm.***
37 ***For which data was available.***
38 ***For which data was available***
39 ***In WR-NR corridor 72 per cent of power flow was through one link viz. Agra-Gwalior link***
40 ***ER-WR corridor was planned to carry power from ER to WR in the planning horizon but in the operating horizon, the power flows were from WR to ER. Similar is the case for SR-WR interconnection***
41 ***This has been explained though an example - The transmission in the Kashmir Valley is connected to Jammu region through two 400 kV lines and two 220 kV lines. During winters due to reduced generation at Uri hydro power station and other hydro power stations in the Kashmir valley coupled with heavy power demand due to winters, the Kashmir valley imports a substantial quantum of power from the Jammu region. There have been instances in the winter of 2007, 2012 and 2014 when due to heavy snowfall, these lines went under breakdown near the Pir Panjal mountain range leading to islanding of Kashmir valley and blackout. Due to adverse weather conditions, restoration of the transmission system is also delayed as even helicopters find it difficult to land. The Kashmir Valley faces a serious power crisis during this period leading to great discomfort amongst the public. This situation can be mitigated only if additional lines over alternate route from Samba to the Kashmir Valley is constructed.***

be such as not to inhibit planned development/augmentation of the transmission system, but should discourage non-optimal transmission investment. The policy further states that financial incentives and disincentives for Central Transmission Utility (CTU) and State Transmission utility (STU) should be implemented around key performance indicators (KPI) which would include efficient network construction, system availability and loss reduction. While norms had been laid down for system availability based on which incentives are paid to PGCIL, norms had not been evolved for assessing efficiency of transmission network construction and loss reduction which prevented an assessment of the impact of sub-optimal utilisation of transmission assets.

3.1.6 Access to transmission corridors

Transmission service provider is a key intermediary between the generator and distributor of electricity and unless access to transmission corridor is provided, generation capacity is bottled up[42]. Access to the transmission system is given to users through Long Term Access (LTA), *i.e.*, for period exceeding 12 years but not exceeding 25 years or through Medium Term Open Access (MTOA), *i.e.*, for periods exceeding 3 months but not exceeding 3 years[43] or through Short Term Open Access (STOA), *i.e.*, for a period up to one month at one point of time. Further, as per CERC Regulations[44], the LTA customer and the MTOA customer shall have priority over STOA customer for use of the inter-state transmission system. The STOA customer shall be eligible for use of inter-state transmission system after LTA and MTOA customers by virtue of (i) inherent design margins (ii) margins available due to in-built spare transmission capacity created to cater to future load growth or generation addition, and (iii) margins available due to variation in power flows.

Examination of the extent of margins in inter-regional transmission corridors revealed that the average margins available under category (i) and (ii) above for STOA (*i.e.* margins available after considering the LTA/MTOA) were in the range of 41 to 85 *per cent* of Total Transfer Capability (TTC) across six inter-regional corridors. Based on above margins, there were rejections of STOA requests by POSOCO for purchase in NR (657.61 MW) and SR (898.58 MW) approximately during April 2007 to November 2012. Besides, PGCIL curtailed (February 2012) MTOA by 785 MW[45] in respect of 17 applications pertaining to SR, due to lack of margins.

This showed that in some corridors (WR-NR, ER-SR and WR-SR), the margins, despite appearing to be large were not sufficient during peak demand months to cater to open access demands. However, substantial quantum of allocated transfer capability remained unutilised

[42] ***Any constraint in the transmission chain from generation of power to load leads to a situation where generation has to be backed down. This is referred to as bottling of power.***

[43] ***Regulations do not envisage grant of access for period ranging from three years to 12 years.***

[44] ***Grant of LTA and MTOA is governed by CERC Regulations dated 7.8.2009 on 'Grant of Connectivity, Long-term Access and Medium-term open Access in inter-state transmission and related matters'. Grant of short term open access is governed by CERC Regulations dated 25.1.2008 (amended on 20 May 2009) regarding 'Open Access in inter-state transmission Regulations 2008'. The nodal agency for grant of LTA and MTOA is the CTU while the nodal agency for grant of STOA is RLDC.***

[45] ***Against the MTOA request of 1846.5 MW for the period 1February 2012 to 31 May 2012, MTOA granted was 1062 MW***

as the LTA/MTOA/STOA applicants who had been granted access had not utilised it while seeking scheduling of electricity ***(Annexure 3.5).*** Thus, there was a scope for POSOCO to optimally utilise variations in power flows and margins arising out of non scheduling of power by applicants to reduce rejections of STOA applications.

MOP stated (March 2014) that as per the Indian Electricity Grid Code, LTA customers had the freedom to seek schedule at one and half hour notice; considering this flexibility, corridor has to be made available for long term; in case the same was allocated for STOA or power exchange transactions assuming that the corridor would not be utilised by LTA customers, and if they later sought schedule, there would be congestion; STOA transactions would then have to curtailed; this would make STOA market highly uncertain unless the CERC laid down clear ground rules for long term customers under 'Use it or lose it' approach; POSOCO could do little for optimum utilisation without such an explicit mandate from CERC.

As the gap between access granted to customers and schedule actually availed by them appeared significant, there might be a need to evolve a system for offering such un-requisitioned capability to others who might utilise the same. As NLDC had the mandate to achieve maximum economy and efficiency in the operation of national grid, POSOCO may need to consider moving an appropriate proposal for optimum utilisation of un-availed transfer capability before CERC.

In the Exit Conference held on 15 April 2014, while MOP stated that there is a need to study the audit suggestion, CERC representative stated that they would examine the proposal, when received from POSOCO, in consultation with stake holders.

3.2 Scope for reducing time taken in planning activities

As per provisions contained in Works & Procurement Policy and Procedure (WPPP) of PGCIL, a time limit of eight weeks has been prescribed for approval of Feasibility Report (FR) by CMD after in-principle clearance from Central Electricity Authority (CEA). PGCIL, however, clarified that projects were finalized after joint studies with CEA; as such, the date of Regional Standing Committee meeting, in which project was approved, had been taken as the date of in-principle approval by CEA.

Examination of 20 selected projects in Audit revealed that against eight weeks stipulated in WPPP for obtaining internal clearance of FR from CMD, time of 11 weeks to 142 weeks was actually taken in obtaining such clearance after approval of 20 selected projects by the concerned Regional Standing Committee.

While assuring that PGCIL would put all efforts to adhere to the time limit for preparation and approval of FR/DPR, MOP stated (March 2014) that

(i) Despite CMD approval in eight weeks, there might be delay due to non-availability of RPC approval or GOI approval under Section 68.

(ii) In five out of nine system strengthening schemes, FR had been approved before either RPC/GOI approval. Excessive delay in two cases (Sasan/ Mundra Ultra Mega Power Projects and Northern regions system strengthening scheme V) was to align the same with the concerned generation projects which were getting delayed.

The reply, however, does not deny the fact that PGCIL did not adhere to the time limit for preparation and approval of DPR by CMD as prescribed in WPPP. Moreover, fulfilling its own obligations in time would have enabled PGCIL to pursue RPC and GOI for faster approvals. Further, in respect of six out of the above 20 projects, approval to FR was obtained from CMD, between 7 and 58 weeks after approval of these projects by RPC and sanction of these projects under Section 68 of the Electricity Act, 2003. The fact remains that Mundra UMPP was commissioned ahead of schedule and three units of Sasan UMPP had also been commissioned[46] but the related system strengthening transmission projects were anticipated to be commissioned in December 2014.

3.3 Submission of proposal for Forest clearance

PGCIL had not laid down any timelines for submission of applications for forest clearances after completion of detailed survey. Out of 164 forest clearance applications submitted by PGCIL during January 2005 to May 2012 for execution of 20 projects selected for audit, 81 applications were submitted after 3 to 41 months of completion of detailed surveys. Further, in nine[47]out of 20 selected projects (***Annexure- 3.6),*** even the earliest application for forest clearance was submitted after investment approval of the respective project. In the remaining eleven projects also, applications for forest clearance in respect of all stretches of transmission lines were not filed by PGCIL before investment approval.

MOP stated (March 2014) that various measures such as advance expenditure for survey work in forest and river crossings, targets for submission of forest proposals through internal MOU, dedicated forest coordinates in all regions etc. have been initiated to minimise the controllable delays on its part.

Audit appreciates the measures initiated by PGCIL to expedite forest clearance. However, there is a need for PGCIL to monitor the situation closely to assess the effectiveness of the measures initiated in terms of minimising delays in obtaining forest clearance.

[46] ***As per monthly report of CEA on broad status of power projects in the country –March 2014***

[47] ***Kahalgaon-II, Sasan (UMPP), Parbati-III HEP, Generation Projects in Odisha-Part B, SRSS-VII, System Strengthening in Northern Region for Sasan & Mundra (UMPP), SRSS-III, NRSS-XVIII, and 765 kV System for Central Part of Northern Grid (Part-III) projects.***