सत्यमेव जयते

Government of India
Ministry of Power
Central Electricity Authority

Resource Adequacy Plan for Transmission System of Delhi up to the year 2033-34

Table of Content

Executive Summary

Delhi's growth as commercial and industrial center has fueled its rising demand for electricity. A strong transmission system is crucial for Delhi to meet its growing electricity demand and to ensure uninterrupted power supply to the consumers.

In June 2024, Delhi witnessed an all-time peak demand of 8,656 MW, which is about 16% higher than the peak demand of 7,437 MW in 2023-24. As per the revised 20th Electric Power Survey (EPS) Report, peak electricity demand in Delhi is projected to increase to 9.3 GW by 2027-28 and to 11.06 GW by 2033-34. It is expected that the actual growth in demand might be higher than the EPS projections due to rapid urbanization, heat waves in summers, rising population, recent push to Electric Vehicles (EVs) and the ongoing expansion of Delhi Metro. Therefore, as per suggestions of DTL, peak electricity demand in 2027-28 and in 2033-34 has been considered as 9.8 GW and 13.1 GW respectively.

At present, there are primarily two power generating companies located in Delhi, Indraprastha Power Generation Company Limited (IPGCL) and Pragati Power Corporation Limited (PPCL) which have an installed gas-based generation capacity of 1800 MW. Another 84 MW is from Waste-To-Energy (WTE) plants and 305.9 MW is solar power installed capacity. Therefore, electricity demand is met through electricity imported from other States.

A comprehensive system study for strengthening of the transmission network, both ISTS and Intra-State, in Delhi has been carried out by CEA in association with DTL, CTUIL, NRLDC, NRPC and Discoms, and Resource Adequacy plan has been prepared indicating the transmission capacity required to be added in Delhi till the year 2033-34.

Based on the studies, new 400 kV and 220 kV substations have been suggested. Several transmission schemes have also been planned to integrate Renewable Energy (RE) generated from RE potential zones of Rajasthan with Delhi's transmission network. Strengthening the existing transmission infrastructure and augmenting existing sub-stations with additional interconnecting transformers (ICTs), reconductoring of various 220 kV lines etc. have also been suggested.

Short circuit studies have also been carried out. It has been observed that the fault level at various sub-stations in Delhi is either near to or higher than the designed limits. Therefore, bus splitting

arrangement have been proposed at these substations as a short term solution. In the long term, it is also suggested to replace the sub-station equipment with higher rating equipment so as to restore the bus split arrangement and enhance the reliability of power. It is also suggested that the new substations should be planned with higher short circuit capacity as per the Manual on Transmission Planning Criteria, 2023.

At present the existing transformation capacity in Delhi (ISTS + InSTS) is around 33,505 MVA (at 220 kV and above voltage level), which is planned to be increased to 54,575 MVA by 2027-28; 62,535 MVA by 2029-30 and further to 82,245 MVA by 2033-34.

Similarly, the existing transmission line length in ckm (ISTS + InSTS) is around 3,315 ckm (at 220 kV and above voltage level), which is planned to be increased to 4,545 ckm by 2027-28; 4,697 ckm by 2029-30 and further to 5,095 ckm by 2033-34.

In order to provide dynamic reactive compensation, two number of STATCOMs have also been proposed to be implemented, one each at Bamnauli and Narela substation.

Implementation of planned transmission system in Delhi is quite slow and several 400 kV and 220 kV Sub-stations planned under intra-state several years ago are yet to be awarded for implementation like 400 kV S/s at Gopalpur and Tikri Khurd, 220 kV Sub-stations at Punjabi Bagh, Nehru Place, Dilshad Garden, Seelam Pur, Maidan Garhi etc. To ensure uninterrupted 24x7 power supply to the consumers, implementation of the planned transmission system needs to be expeditiously taken up by DTL.

Chapter-1

Power supply scenario in Delhi and projected electricity demand

1.1 Background

Delhi's growth as a commercial and industrial center has fueled its rising demand for electricity. A strong transmission system is crucial for Delhi to meet its growing electricity demand and to ensure reliable power supply to its residents, businesses, VIP's areas, essential utilities and industries. As the capital city of India, Delhi experiences rapid urbanization rate, with an increasing population and expanding infrastructure. Given the presence of numerous government offices and critical infrastructures, there is a strong emphasis on ensuring uninterrupted power supply. This surge in demand for electricity requires a robust transmission network capable of efficiently delivering power from generation sources to the Distribution Companies for further supply to the end consumers. A well-developed transmission infrastructure would contribute to the city's economic growth, quality of life, and resilience against potential energy crises.

Delhi's electricity requirement is met through electricity sourced from other states particularly from Rajasthan, Himachal Pradesh, Haryana, Uttar Pradesh etc.; as Delhi does not have adequate installed generation capacity. Meeting this requirement involves developing new transmission networks, strengthening the existing infrastructure, and augmenting present substations with additional interconnecting transformers (ICTs). Several transmission schemes have also been planned to integrate Renewable Energy (RE) generated from RE potential zones in Rajasthan with Delhi's transmission network.

A comprehensive system study of the Transmission System of Delhi has been carried out by CEA in association with DTL, CTUIL, NRLDC, NRPC and Discoms, and Resource Adequacy plan has been prepared indicating the transmission capacity required to be added in Delhi till the year 2033-34.

1.2 Present Power Scenario in Delhi

1.2.1 Installed Generation Capacity

At present, there are primarily two power generating companies located in Delhi, Indraprastha Power Generation Company Limited (IPGCL) and Pragati Power Corporation Limited (PPCL) which have an installed gas-based generation capacity of 1800 MW. Another 84 MW is from Waste-To-Energy (WTE) plants and 305.9 MW is solar power installed capacity. The installed

generation capacity including shares allocated from Central Generating stations is given in Table 1.1:

Table 1.1: Installed Electricity Generation Capacity

	Capacity (MW)
State Sector	1800.40
Power tied up from Private Generating Stations	1376.12
Allocation from Central Generating Stations	3804.21
Total	**6980.73**

Source: Installed Capacity Report CEA, January, 2025

There are five Distribution Companies in Delhi viz. TPDDL, BRPL, BYPL, NDMC and MES, which are supplying power to the end users in Delhi.

1.2.2 Electricity Demand of Delhi

In June 2024, Delhi witnessed an all-time high peak demand of 8,656 MW on 19.06.2024, which is about 16% higher than the peak demand of 7,437 MW in 2023-24. Maximum Demand met pattern of Delhi for June, 2023 and June, 2024 is shown in Fig. 1.1.

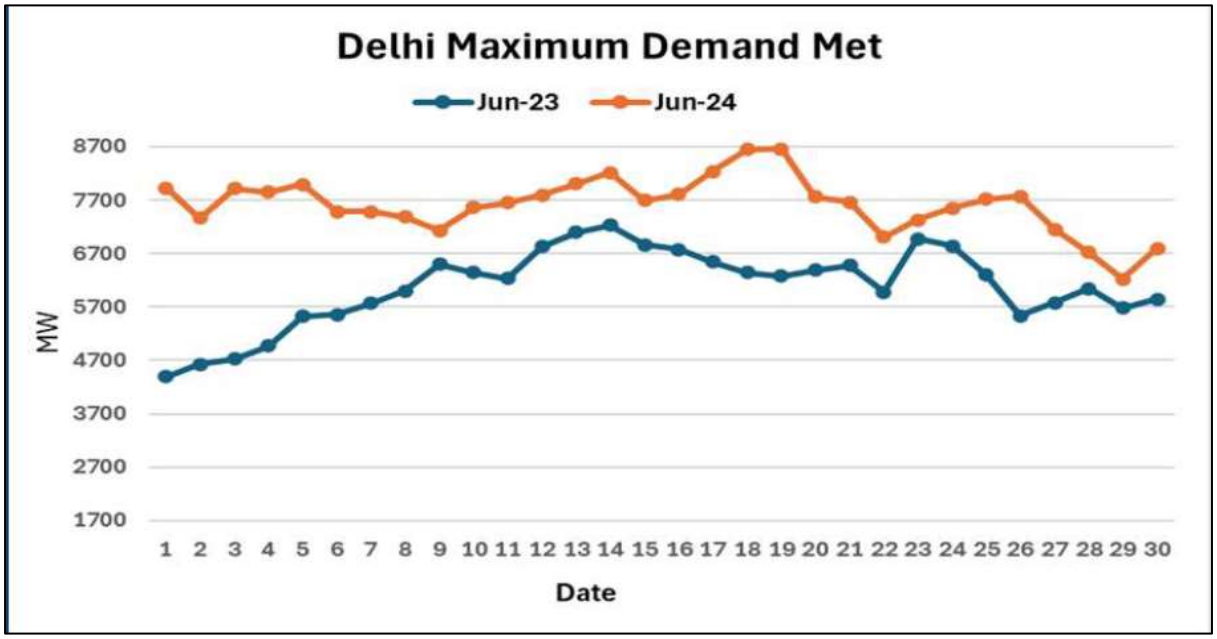

Fig. 1.1: Maximum Electricity Demand Met in Delhi

Electricity demand pattern of Delhi when peak load of 8,656 MW was experienced on 19.06.2024 is given in Fig 1.2.

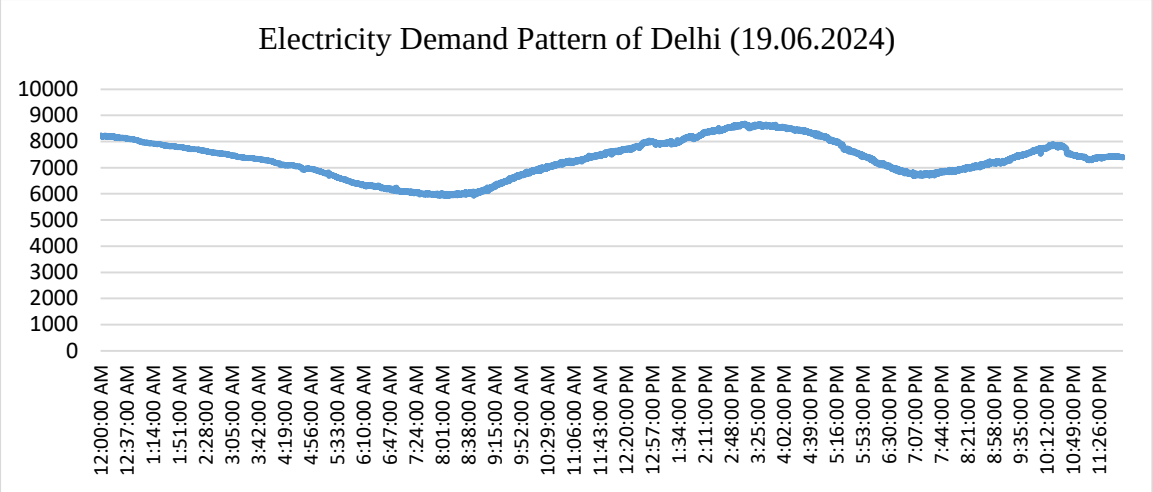

Fig 1.2: Electricity Demand Pattern of Delhi

Monthly variation of peak electricity demand in Delhi for the past two years is shown in Fig 1.3:

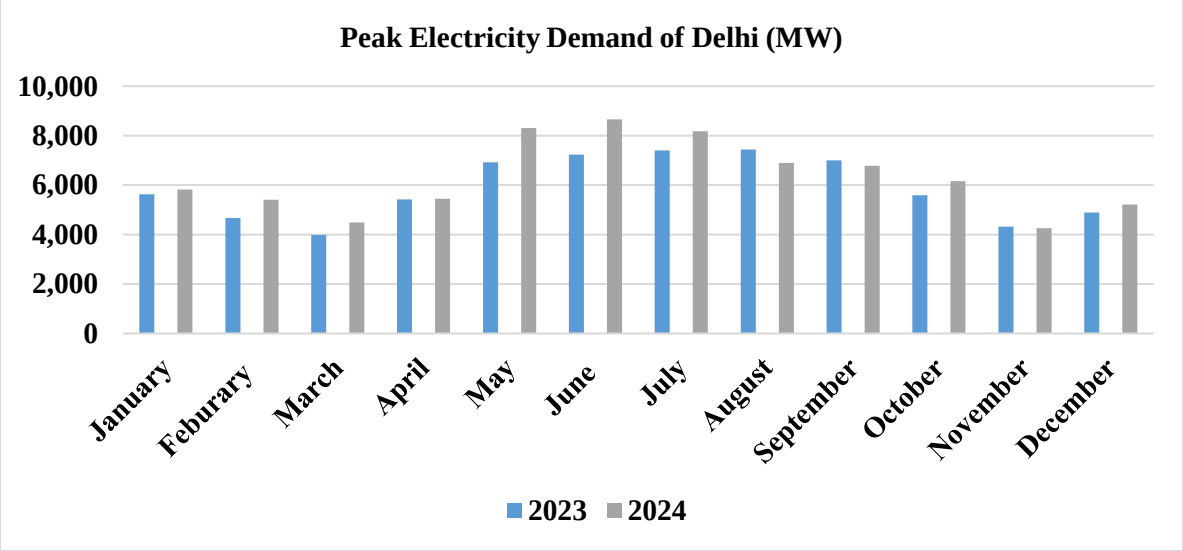

Fig 1.3: Month-wise peak electricity demand in Delhi for past two years

1.2.3 Existing Transmission Network in Delhi

Delhi has a high capacity 400 kV double-circuit (D/c) ring around the city, which includes the Mandola - Dadri - Maharani Bagh - Samaypur - Tughlakabad - Bamnauli - Dwarka - Jhatikara - Tikri Kalan (Mundka) - Bawana - Mandola D/c line. This 400 kV ring, coupled with Delhi Transco Limited's (DTL) 220 kV network serves the city's demand. There is one 765 kV substation (ISTS) at Jhatikara, which in-turn is connected to the 400 kV ring around the city.

At present, Delhi has ATC (Available Transfer Capacity) of 7,000 MW against operationalized GNA (General Network Access) of 4,810 MW (as of December, 2024).

a) Intra-State Transmission System in Delhi

The details of existing intra-state transmission network in Delhi is given in Table 1.2.

Table 1.2: Existing Intra-State transmission system

Intra-State Transmission System	400 kV level	220 kV level
Number of Sub-stations	4	43
Transformation Capacity (MVA)	4780	14780
Transmission line (ckm) (including cable)	249.2	925.87

400 kV InSTS substations:

- 2x500 + 1x315 MVA, 400/220 kV Bamnauli S/s
- 5x315 MVA, 400/220 kV Bawana S/s
- 3x315 MVA, 400/220 kV Mundka S/s
- 3x315 MVA, 400/220 kV Harsh Vihar S/s

b) Inter-State Transmission Network in Delhi

The details of existing Inter-State transmission network in Delhi is given in Table 1.3:

Table 1.3: Existing Inter-State Transmission system

Inter-State Transmission System	765 kV level	400 kV level
Number of Sub-stations	1	4
Transformation Capacity (MVA)	6000	7945*
Transmission Line (ckm)	790	1350

* includes 1x315 MVA, 400/220 kV ICT at Bawana (DTL) S/s

765 kV ISTS substation:

- 4x1500 MVA, 765/400 kV Jhatikara S/s

400 kV ISTS substation:

- 2x500 MVA + 2x315 MVA, 400/220 kV Maharani Bagh S/s
- 4x500 MVA, 400/220 kV Tuglaqabad S/s
- 4x500 MVA, 400/220 kV Dwarka S/s
- 4x500 MVA, 400/220 kV Mandola S/s

c) The power map of Delhi depicting all existing inter-state and intra-state substations and connecting transmission lines (220 kV and above voltage level) is given below in Fig 1.4:

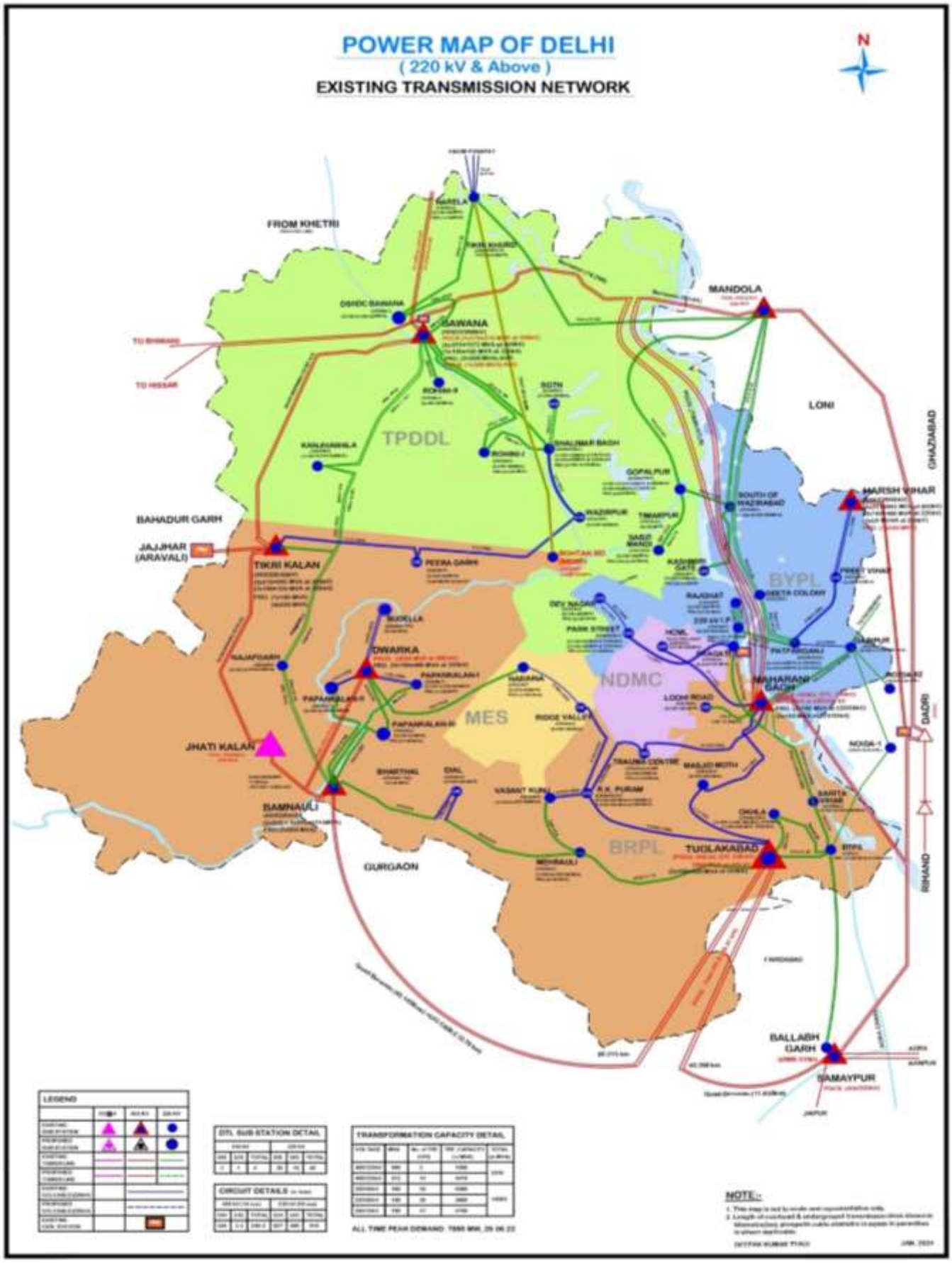

Fig 1.4: Existing Transmission Network of Delhi

1.2.4 Constraints in Transmission System in Delhi

Several planned intra-state transmission schemes in Delhi have been delayed primarily because of non-finalization of tenders, contractual issues, severe ROW issues, non-availability of land and delay in allocation of land by DDA for setting up of sub-stations. Details of the same are given below:

a) 400/220 kV Gopalpur (GIS) S/s

Establishment of 400/220 kV Gopalpur (GIS) S/s was agreed in the 39th meeting of the Standing Committee on Power System Planning of Northern Region held on 29-30th May 2017. The following intra-state transmission scheme was agreed for implementation by DTL:

- Establishment of 4x500 MVA, 400/220 kV GIS Sub-station at Gopalpur along with 125 MVAR bus reactor.
- LILO of Maharanibagh – Bawana 400 kV D/C line at Gopalpur 400/220 kV Substation on multi circuit towers.

In the 2nd meeting of Northern Region Power Committee (Transmission Planning) held on 01.09.2020, DTL informed that the Gopalpur S/s is at tendering stage and will be commissioned by 2023. Accordingly, its connectivity with Rajasthan REZ Ph-II (8.1 GW) Scheme was planned (with Narela and Maharani Bagh S/s) for dispersal of power to load centers of Delhi. 765/400 kV Narela Sub-station along with its connectivity to Maharani Bagh S/s as part of Rajasthan SEZ Ph-II (8.1 GW) Scheme is under advance stage of implementation (part system commissioned) and is expected to be commissioned by May, 2025.

In absence of Gopalpur Substation, loadings on 400/220 kV ICTs at Maharani Bagh may become critical in future in maximum solar generation scenario which may impact RE evacuation.

As per latest information provided by DTL, Gopalpur S/s is under tendering stage with implementation schedule of 30 months from date of award. Hence, its implementation is expected only in 2027-28 timeframe, subject to award in 2024-25.

b) 400/220/66 kV Tikri Khurd substation

In 2nd NRPC(TP) meeting held on 01.09.2020, establishment of 400/220/66 kV Tikri Khurd GIS with 400 kV in-feed from LILO of existing Mandola – Bawana 400 kV D/C transmission line was agreed. As per information provided by DTL, the scheme is currently under tendering stage with implementation schedule of 24 months. Considering this, the same is expected in 2027, subject to award of tender in 2025.

c) Establishment of new 220 kV sub-stations as well as augmentation of 400 kV and 220 kV sub-stations in Delhi

For drawl of power, augmentation of 400/220 kV ICTs at Bawana, Bamnauli and Mundka S/s had been planned long back by DTL. Till date, the augmentation works have not been awarded. For further dispersal of power, 10 Nos. of 220 kV new substations at Budella, Bharthal, Sarojini Nagar, Mangol Puri, Punjabi Bagh, Nehru Place, Dilshad Garden, Seelam Pur, Maidan Garhi and Maharani Bagh were planned as part of intra- state scheme for commissioning progressively till 2026-27. However, as informed by DTL, in spite of rigorous follow-up, the land for Punjabi Bagh, Nehru Place, Dilshad Garden, Seelam Pur and Maidan Garhi sub-stations has not yet been allocated by DDA. Further, tender for Bharthal, Budella, Sarojini Nagar, Mangol Puri and Maharani Bagh are yet to be awarded.

d) The intra-state transmission system in Delhi has been experiencing high loading, along with ICTs that do not comply with 'N-1' criteria, affecting various 220 kV substations. To address the same, Intra state transmission system is operated in radial mode by DTL (through bus split arrangement) to relieve ICT/line loadings [for load segregation]. This has raised concerns about the adequacy and reliability of the intra-state transmission network. The necessary transmission system strengthening required for 'N-1' compliance are outlined later in this report. (Refer Chapter-2). List of 'N-1' non-compliant substations at present is given in Table 1.4.

Table 1.4: List of 'N-1' non-compliant substations

Sl. No.	**Sub-station**	**Existing MVA Capacity**		**Peak load experienced till date (MW)**
		Breakup of Capacity (MVA)	**Total MVA**	
400 kV level				
1.	400/220 kV Maharanibagh (ISTS)	2x500 + 2x315	1630	1154
2.	400/220 kV Mundka (InSTS)	3x315	945	697
3.	400/220 kV Mandola (ISTS)	4x500	2000	1659
220 kV level (InSTS)				
4.	220/66 kV Bawana	1x100	100	48
5.	220/66 kV Gopalpur	1x160 + 1x100	260	151
6.	220/66 kV Kanjhawala	1x160 + 2x100	360	253

Sl. No.	Sub-station	Existing MVA Capacity		Peak load experienced till date (MW)
7.	220/66 kV Mehrauli	1x160 + 3x100	460	328
8.	220/66 kV Mundka	2x160	320	237
9.	220/66 kV Okhla	1x160 + 1x100	260	193
10.	220/66 kV Pappan Kala-3	2x160	320	246
11.	220/66 kV Park Street	2x100	200	131
12.	220/66 kV Patparganj	2x100	200	138
13.	220/66 kV Ridge Valley	2x160	320	184
14.	220/66 kV Rohini-II	2x160	360	166
15.	220/66 kV Sarita Vihar	1x160 + 2x100	360	224
16.	220/66 kV Shalimarbagh	1x100	100	73
17.	220/66 kV SGTN	2x160	320	216
18.	220/66 kV Wazirabad	1x160 + 3x100	460	353
19.	220/33 kV Geeta Colony	2x100	200	158
20.	220/33 kV IP	3x100	300	233
21.	220/33 kV Kashmiri Gate	2x100	200	108
22.	220/33 kV Naraina	3x100	300	202
23.	220/33 kV Park Street	2x100	200	155
24.	220/33 kV Peeragarhi	3x100	300	225
25.	220/33 kV Preet Vihar	2x100	200	126
26.	220/33 kV Rajghat	2x100	200	150
27.	220/33 kV Shalimarbagh	2x100	100	132
28.	220/33 kV Subzi Mandi	2x100	200	145
29.	220/33 kV Trauma Center	2x100	200	124
30.	220/33 kV Wazirpur	2x100	200	142

Source: DTL

e) In addition to above, Grid-India has also provided the following transmission elements which are 'N-1' non-compliant:

InSTS (Intra - State Transmission System)

(i) 2x315 MVA, 400/220 kV ICTs at Bawana (bus split operation has been implemented at Bawana and 2x315 MVA and 4x315 MVA ICTs have been kept on different bus sections).

ISTS (Inter- State Transmission System)

(i) 2x1500 MVA, 765/400 kV ICTs at Jhatikara (Bamnoli /Dwarka section)

f) DTL has highlighted that supply of transformers has been a major issue due to which 'N-1' criteria is not being met at the substations.

g) Increasing electricity demand of Delhi has to be met through power imported from other states through ISTS network, particularly from Rajasthan, Haryana, Himachal Pradesh, Uttar Pradesh, Uttarakhand etc. To meet the growing electricity demand, developing new transmission infrastructure, strengthening the existing transmission infrastructure and augmenting the existing substations with additional interconnecting transformers (ICTs) is required.

There is significant difference between the peak electricity demand in summer and winter seasons in Delhi. During winter, low loading results in high voltage levels, while summer heat spikes and the resulting high electricity demand causes low voltage conditions.

Recent incidents such as the one on 11th June 2024, when a cascaded outage at the Mandola substation led to a load loss of approximately 1600 MW also highlight the urgent need to improve the reliability of power supply.

The fault level at various sub-stations in Delhi is high and at some sub-stations, it is higher than the designed limits. Therefore, many of such substations are being operated with bus split arrangement, affecting reliability of supply.

1.3 Projected Electricity Demand:

As per the revised 20th Electric Power Survey (EPS) Report, peak electricity demand is projected to increase to 9.3 GW by 2027-28 and to 11.06 GW by 2033-34 as given in Table 1.5.

Table 1.5: Projected electricity demand in Delhi

Sl. No.	Year	Peak electricity demand in Delhi (MW)
1.	2023-24 (Actual)	7,437
2.	2024-25 (Actual)	8,656

Sl. No.	Year	Peak electricity demand in Delhi (MW)
3.	2025-26 (Projection)	9,066
4.	2026-27 (Projection)	9,251
5.	2027-28 (Projection)	9,343
6.	2028-29 (Projection)	9,671
7.	2029-30 (Projection)	9,982
8.	2030-31 (Projection)	10,240
9.	2031-32 (Projection)	10,486
10.	2032-33 (Projection)	10,767
11.	2033-34 (Projection)	11,059

As per DTL, the actual growth in electricity demand might be higher than the EPS projections due to rapid urbanization, heat waves in summers and rising population leading to increased usage of electrical and electronic appliances, especially Air Conditioners. The recent push to Electric Vehicles (EVs), High speed Rail, NCRTC Rail network, Land Pooling Scheme and the ongoing expansion of Delhi Metro would also contribute towards increase in electricity demand. As per discussions with DTL, peak electricity demand in 2027-28 and in 2033-34 has been considered as 9,797 MW and 13,167 MW respectively.

Chapter-2

Transmission System Requirement by 2027-28

2.1 Load flow studies for preparation of Resource Adequacy of transmission system in Delhi

2.1.1 Scope of Load flow studies:

System studies for the resource adequacy plan for Delhi's InSTS have been carried out using PSSE Software. The studies that have been carried out include the following:

(i) Steady state load flow studies

(ii) Contingency Analysis

(iii) Short Circuit Studies

Peak electricity demand in Delhi occurs in summer season during day time i.e. maximum solar generation scenario. Hence, for preparation of Resource Adequacy plan of Transmission system in Delhi, both the scenarios i.e. afternoon (solar peak generation scenario) and evening (no solar generation scenario) have been studied for both summer season and winter season.

The load flow studies have been carried out for two time frames: 2027-28 and 2033-34 for peak electricity demand scenario that occurs during summer season in the month of June/ July and off peak electricity demand scenario which occurs during winter season in the months of November/ March. To meet the projected electricity demand, augmentation required in both ISTS as well as Intra-State Transmission System has been worked out.

2.1.2 Transmission Planning Guidelines

(i) Delhi's transmission network has been represented at 220 kV and above voltage levels, where loads have been considered incidental on 220 kV buses.

(ii) Load power factor has been considered within ± 0.95 as per the Central Electricity Authority (Technical Standards for Connectivity to the Grid) (Amendment) Regulations, 2019.

(iii) 'N-1' criterion is generally followed for providing reliable power supply to the consumers. 'N-1' criterion has been considered for providing reliable power supply.

(iv) Transformation capacity of any single sub-station at 220 kV and 400 kV levels has been considered to be limited to 1000 MVA and 2500 MVA respectively as per the Manual on Transmission Planning Criteria of CEA (2023).

(v) Due to RoW constraints, re-conductoring in the existing 220 kV corridors with higher capacity conductors such as HTLS (High Temperature Low Sag), having the ampacity more than double that of Zebra conductor has been considered.

(vi) To limit short circuit fault levels within the permissible design values, bus splitting arrangement has been adopted at specific 400 kV and 220 kV sub-stations in Delhi.

(vii) The system voltage has been considered within the following limits as per the Manual on Transmission Planning Criteria, 2023:

220 kV	Max 245 kV, Min 198 kV
400 kV	Max 420 kV, Min 380 kV
765 kV	Max 800 kV, Min 728 kV

2.2 Load flow studies for the year 2027-28:

(i) The load flow studies have been carried out for two scenarios:

a) peak electricity demand scenario which occurs during summer season in the month of June/ July and;

b) off -peak electricity demand scenario which occurs during winter season in the months of November/ March.

(ii) Peak electricity demand of Delhi in 2027-28 as per revised 20th EPS projections is 9,343 MW. However, as per DTL the electricity demand likely in 2027-28 would be 9,797 MW, which is on higher side as compared to EPS projections. As the electricity demand of Delhi is growing rapidly, DTL's projection has been considered for studies.

(iii) For the peak demand scenario of 2027-28, the transmission elements (new lines/ reconductoring of the existing lines and new substations/ ICT augmentations) already planned by DTL to be added by 2026-27 have been considered. Peak electricity demand of Delhi occurs in month of June/ July, therefore, transmission elements planned to be added in 2027-28 (till May, 2028) have not been considered.

(iv) **Under implementation/ Planned ISTS Schemes in Delhi to be commissioned by 2026-27 have been considered in the studies, details of which are given below:**

a) ISTS schemes under implementation:

Details of ISTS schemes under implementation is given in Table 2.1:

Table 2.1: ISTS schemes under implementation

S. No.	Transmission scheme	Status
1.	3x1500 MVA, 765/400 kV Narela S/s along with Khetri -Narela 765 kV D/c line (180 km) and LILO of 765 kV Meerut -Bhiwani S/c line at Narela (LILO length 25 km) (as part of Rajasthan SEZ Ph-II Transmission scheme)	Likely to be commissioned by May, 2025
2.	Removal of LILO of Bawana – Mandola 400 kV D/c (Quad) line at Maharani Bagh/ Gopalpur S/s. Extension of above LILO section from Maharani Bagh/ Gopalpur upto Narela S/s so as to form Maharanibagh – Narela 400 kV D/c (Quad) and Maharanibagh – Gopalpur-Narela 400 kV D/c (Quad) lines (14 km)	Likely to be commissioned by May, 2025
3.	1x1500 MVA, 765/400 kV ICT augmentation (3rd) at Jhatikara Substation (Bamnoli /Dwarka section) (as part of Rajasthan SEZ Ph-III Transmission scheme)	Likely to be commissioned by Aug, 2025
4.	Sikar-II – Narela 765 kV D/c line (260 km) (as part of Rajasthan SEZ Ph-III Transmission scheme)	Likely to be commissioned by Aug, 2025
5.	Replacement of 400/220 kV, 1x315 MVA (3rd) ICT by 500 MVA at 400/220/66 kV Bawana (DTL) substation (ICT has been installed under ISTS)	Likely to be commissioned by Sept, 2025
6.	Jhatikara – Dwarka 400 kV D/c line (Twin HTLS) (17 km) (as part of Rajasthan SEZ Ph-III Transmission scheme)	Likely to be commissioned by Feb, 2026
7.	Augmentation by 400/220 kV, 1x500 MVA ICT (5th) at Mandola (PG) S/s	Likely to be commissioned by July, 2026

b) Planned ISTS schemes:

Details of planned ISTS schemes is given in Table 2.2.

Table 2.2: Planned ISTS schemes

Sl. No.	Transmission scheme	Status
1.	Augmentation by 400/220 kV, 1x500 MVA ICT (5th) at Maharani Bagh S/s	To be awarded by March, 2025 (with commissioning schedule of December, 2026)

Sl. No.	Transmission scheme	Status
2.	400 kV Bus Split arrangement at 400/220 kV Maharani Bagh S/s	Planned

(v) **Under implementation/ Planned InSTS Schemes in Delhi to be commissioned by 2026-27 have been considered in the studies, details of which are given below:**

a) Sub-stations:

Table 2.3: **Details of Under implementation/ Planned InSTS Substations**

S. No.	Substation	Status
1.	3x160 MVA, 220/66 kV Budella S/s	Under tendering (Implementation timeframe is 24 months from date of award)
2.	3x100 MVA, 220/33 kV Punjabi Bagh S/s (Vishal)	Planned (Land availability issues)
3.	Creation of 66 kV and 33 kV voltage level at 400/220 kV Maharani Bagh substation with 2x160 MVA, 220/66 kV ICTs and 3x100 MVA, 220/33 kV ICTs	Under tendering (Implementation timeframe is 24 months from date of award)
4.	Creation of 66 kV voltage level at 400/220 kV Dwarka substation with 3x160 MVA, 220/66 kV ICTs	Tender to be floated (Implementation timeframe is 12 months from date of award)
5.	Creation of 66 kV voltage level at 220 kV BTPS substation with 3x160 MVA, 220/66 kV ICTs	Planned

b) ICT augmentation:

Table 2.4: Details of under implementation/ Planned ICT augmentations (InSTS)

Sl. No.	Substation	Voltage Level (kV)	Existing Capacity (MVA)	ICTs to be added (MVA)	Status	Timeframe
ICT augmentations at 400 kV level						
1.	Bamnauli	400/220	2×500 + 1×315	2×500	Under Tendering	20 months from date of award
2.	Bawana	400/220	6×315	2×315 → 2×500* (ICT-2 & ICT-4)	Under Tendering	20 months from date of award
3.	Mundka (Tikri Kalan)	400/220	3×315	3×315 → 3×500* & 1×500	Under Tendering	20 months from date of award
ICT augmentations at 220 kV level						
4.	Dev Nagar	220/33	2×100	2×100	Under Tendering	24 months from date of award

5.	Mehrauli	220/66	3×100 + 1×160	1×160	Under Tendering	24 months from date of award
6.	Mundka (Tikri Kalan)	220/66	2×160	1×160	Under Tendering	24 months from date of award
7.	Narela	220/66	3×100	1×100 → 1×160*	Under Tendering	24 months from date of award
8.	Preet Vihar	220/33	2×100	1×100	Under Tendering	24 months from date of award
9.	Rajghat	220/33	2×100	2×100	Under Tendering	24 months from date of award
10.	Shalimar Bagh	220/33	2×100	1×100	Under Tendering	24 months from date of award
11.	Timarpur	220/33	2×100	1×100	Under Tendering	24 months from date of award

**Replacement of existing ICTs*

c) Transmission lines:

Table 2.5: Details of under implementation/ planned transmission lines (InSTS)

Sl. No.	Transmission Line	Status
1.	LILO of one ckt of 400 kV Mandola – Dadri D/c line at Harsh Vihar S/s (DTL) (incl. 400 kV cable portion) (LILO length 10 km)	Planned
2.	Budella - Punjabi Bagh (Vishal) 220 kV D/c line (UG cable) (10 km)	Planned
3.	Punjabi Bagh (Vishal) - Dev Nagar 220 kV D/c line (UG cable) (5 km)	Planned
4.	Lodhi Road - Park street - Electric Lane - Lodhi Road 220 kV S/c line (18 km)	Under Implementation (Likely CoD by March, 2025)
5.	LILO of Electric Lane - Park Street 220 kV S/c line at Dev Nagar (LILO length 5 km)	Under Implementation (Likely CoD by March, 2025)
6.	IP to New Rajghat GIS Substation 220 kV D/C U/G Cable (2 km)	Planned
7.	Kashmere Gate to New Rajghat GIS Substation 220 kV D/C U/G Cable (5 km)	Planned
8.	Dev Nagar - Subzi Mandi 220 kV D/c line (underground cable) (5 km)	Planned
9.	Ridge Valley- Naraina 220 kV D/c line (underground cable) (4.5 km)	Planned

d) Reconductoring of existing 220 kV lines with HTLS conductor (1200 Amp)

Table 2.6: Reconductoring of existing 220 kV lines (InSTS)

Sl. No.	Transmission Line	Status
1.	Bamnauli – Najafgarh 220 kV D/c line (8 km)	Planned
2.	Bawana – DSIIDC Bawana 220 kV D/c line (6 km)	Planned
3.	Bawana – Kanjhawala 220 kV D/c line (12 km)	Planned
4.	Kanjhawala – Najafgarh 220 kV D/c line (including S/c LILO section at Mundka) (15 km)	Planned
5.	Geeta Colony – Patpargaj 220 kV D/c line (4 km)	Planned
6.	Gopalpur – Sabji Mandi 220 kV D/c line (7 km)	Planned
7.	Patpargaj – IP 220 kV D/c line (4 km)	Planned
8.	IP – Pragati 220 kV D/c line (1 km)	Planned

e) Bus reactors:

- Details of Existing bus reactors is given below in Table 2.7:

Table 2.7: Existing bus reactors

Sl. No.	Substation	Voltage Level (kV)	Reactive Power Support (MVAr)
A	**ISTS**		
1.	Jhatikara	765	6x80
2.	Dwarka	400	1x125
3.	Mandola	400	1x50 + 1x125
4.	Tughlaqabad	400	1x125
5.	Maharanibagh	400	1x125
6.	Mandola	220	1x25
B	**InSTS**		
1.	Harsh Vihar	220	2x50
2.	Peeragarhi	220	1x50

- Details of Bus reactors under implementation/ planned by DTL is given in Table 2.8.

Table 2.8: Bus reactors under implementation/ planned by DTL

Sl. No.	Substation	Voltage Level (kV)	Reactive Power Support (MVAr)	Status
1.	Bamnauli	220	2×25	Planned
2.	Budella	220	1×50	Planned
3.	DIAL	220	2×25	Planned
4.	Electric Lane	220	1×50	Planned
5.	Indraprashtha	220	2×25	Planned
6.	Maharani Bagh	220	2×25	Under Tendering (CoD -24 months from date of award)
7.	Mundka	400	1×125	Under Tendering (CoD- 18 months from date of award)
8.	Mundka	220	1×25	Planned
9.	Rajghat	220	2×25	Under Tendering (CoD-24 months from date of award)

2.3 Load flow study results:

Based on the load flow studies, following transmission elements are required to be added in Intra-State by 2027-28 (by May, 2027) in addition to transmission elements already under implementation/ planned by DTL:

a) New substations along with associated transmission lines (Intra-State):

- 4x500 MVA + 3x160 MVA, 400/220/66 kV Tikri Khurd S/s with LILO of both circuits of Bawana - Mandola 400 kV D/c line (1 km) at Tikri Khurd (2x500+2x160 MVA, 400/220/66 kV ICTs may be implemented in first phase, remaining may be implemented later depending upon load growth)
- 4x500 MVA, 400/220 kV Gopalpur S/s with LILO of both circuits of Narela- Maharani Bagh 400 kV D/c line at Gopalpur S/s (LILO length 3.5 km)
- 3x160 MVA, 220/66 kV substation at Maidangarhi with Tughlaqabad- Maidangarhi 220 kV D/c line (11 km)

- 3x100 MVA, 220/33 kV substation at Nehru Place with LILO of both circuits of Maharani Bagh - Masjid Moth 220 kV D/c line at Nehru Place (LILO length 1 km)
- 5x100 MVA, 220/33 kV substation at Sarojini Nagar with LILO of both circuits of AIIMS - RK Puram 220 kV D/c line at Sarojini Nagar (LILO length 1.25 km) (3x100 MVA ICTs may be implemented by 2026-27, remaining may be implemented later depending upon the loading pattern).

b) Upgradation of 220 kV Rohtak Road substation of BBMB to 400 kV level by 2027 - 28:

As mentioned above, the electricity demand of Delhi is primarily met through a high capacity 400 kV D/c ring i.e. 400 kV Mandola – Dadri – Maharani Bagh – Samaypur – Tughlakabad – Bamnauli –Dwarka – Jhatikara – Mundka – Bawana –Mandola line, which is mainly located on the periphery of Delhi. However, no 400 kV substation exists in the Central Delhi area. In view of the severe RoW issues and non-availability of land in Central Delhi, upgradation of 220 kV Rohtak Road substation of BBMB in Punjabi Bagh area to 400 kV GIS Punjabi Bagh (New) substation is recommended with following associated transmission system:

- 4x500 MVA, 400/220 kV GIS substation at Punjabi Bagh (New) (2x500 MVA, 400/220 kV ICTs may be implemented in first phase, remaining may be implemented later depending upon the loading pattern)
- 3x160 MVA + 2x100 MVA, 220/66/33 substation at Mangol Puri
- LILO of 400 kV Narela - Maharani Bagh D/c line (2^{nd}) at Punjabi Bagh (New) S/s. (first D/c line is planned to be LILOed at proposed Gopalpur S/s) (LILO length-17 km)
- LILO of both circuits of Peera Garhi - Wazirpur 220 kV line (UG cable) at Mangol Puri (LILO length 1.5 km) and Tikri Kalan - Mangol Puri 220 kV D/c line (UG cable) (14 km)
- LILO of both circuits of Wazirpur- Mangolpuri 220 kV D/c line at Punjabi Bagh (New) (LILO length 1 km)
- Punjabi Bagh (New) - Punjabi Bagh 220 kV D/c line (4 km)

c) ICT augmentation (Intra-State):

Details of ICT augmentation required by 2027-28 (by May, 2027) is given below in Table 2.9.

Table 2.9: ICT augmentation by 2027-28 (InSTS)

Sl. No.	Substation	Voltage Level (kV)	Existing Capacity (MVA)	ICTs to be added (MVA)
1.	Geeta Colony	220/33	2×100	1×100
2.	Gopalpur	220/66	1×160 + 1×100	1×160
3.	Kanjhawala	220/66	1×160 + 2×100	1×160
4.	Pappan Kala-3	220/66	2×160	1×160
5.	Park Street	220/66	2×100	2×100 → 2×160*
6.	Patparganj	220/66	2×100	2×100 → 2×160*
7.	Ridge Valley	220/66	2×160	1×160
8.	Rohini-I	220/66	4×100	2×100 → 2×160*
9.	Rohini-II	220/66	2×160	1×160
10.	SGTN (Sanjay Gandhi Transport Nagar)	220/66	2×160	1×160
11.	Shalimar Bagh	220/66	1x100	1×100
12.	Trauma Center AIIMS	220/33	2×100	1×100
13.	Tughlaqabad	220/66	2x160	1x160
14.	Wazirabad	220/66	1×160 + 3×100	1×160

**Replacement of existing ICTs*

d) Reconductoring of existing intra-state transmission lines with HTLS conductor (700 Amp to 1200 Amp):

- Gopalpur- Wazirabad 220 kV D/c line (4 km)

e) Bus reactors (intra-state):

Details of the Bus Reactors required by 2027-28 (by May, 2027) is given in Table 2.10.

Table 2.10: Bus Reactors by 2027-28 (InSTS)

Sl. No.	Substation	Voltage Level (kV)	Reactive Power (MVAr)
1.	Gopalpur	400	1×125
2.	Tikri Khurd	400	1×125
3.	Sarojini Nagar	220	1×50

Sl. No.	Substation	Voltage Level (kV)	Reactive Power (MVAr)
4.	Maidan Garhi	220	2×25
5.	Nehru Place	220	2x25
6.	Mangol Puri	220	2x25

f) Dynamic Reactive power compensation (InSTS):

- STATCOM (2x±300 MVAr) along with MSC (4x125 MVAr) and MSR (2x125 MVAr) at Bamnauli S/s

g) Short circuit studies analysis:

Following substations in Delhi are already operating with split bus arrangement through sectionalizer/ bus coupler due to high fault level:

- 220 kV RK Puram S/s
- 220 kV Mehraulli S/s
- 220 kV Pragati S/s
- 220 kV Patparganj S/s
- 220 kV Narela S/s
- 220 kV Sarita Vihar S/s
- 220 kV Dwarka S/s
- 220 kV Tughlaqabad S/s
- 220 kV Maharani Bagh S/s

In addition to the above, bus splitting is recommended at following substations in view of the high fault level:

- 220 kV bus at Bawana S/s
- 220 kV bus at Mandola S/s
- 220 kV bus at Wazirabad S/s

Fault level before and after bus splitting arrangement is given in Table 2.11.

Table 2.11

Substation	Fault level before bus split arrangement	Fault level after bus split arrangement
220 kV Bawana S/s	52 kA	33 kA

220 kV Mandola S/s	55 kA	37 kA
220 kV Wazirabad S/s	52 kA	37 kA

From the studies, it was observed that with bus splitting arrangement at Dwarka, fault level at Bamnauli is within limits. Therefore, bus splitting has not been recommended at Bamnauli S/s.

h) Transmission system strengthening under ISTS:

- 400 kV Sectionalization bay (1 set) at 765/400 kV Jhatikara (PG) S/s to interconnect both 400 kV sections in the event of contingency
  (to be awarded in March, 2025, with implementation timeframe of 18 months)

2.4 Summary of Transmission network in Delhi by 2027-28

i. Intra-State Transmission System in Delhi

The details of the Intra-state transmission network by 2027-28 is given below in Table 2.12.

Table 2.12: Intra-State Transmission system by 2027-28

Intra-State Transmission System	**400 kV level**	**220 kV level**
Existing Substations	4	43
New Substations required by 2027-28	3	6
Total substations by 2027-28	**7**	**49**
Existing Transformation Capacity (MVA)	4780	14780
Transformation Capacity at new substations (MVA)	4000	2860
Transformation Capacity augmentation in existing substations (MVA)	2425	4600
Total Transformation Capacity by 2027-28 (MVA)	**11205**	**22240**
Existing Transmission Lines (including cable) (ckm)	249.2	925.87
Addition of Transmission Lines (including cable) by 2027-28 (ckm)	70	168
Total transmission lines (including cable) by 2027-28 (ckm)	**319.2**	**1093.87**

In addition, reconductoring of 220 kV lines is also to be done.

ii. Inter-State Transmission Network in Delhi

The details of the Inter-state transmission network by 2027-28 is given below in Table 2.13.

Table 2.13: Inter-State Transmission system by 2027-28

Inter-State Transmission System	765 kV level	400 kV level
Existing Substations	1	4
New Substations required by 2027-28	1	-
Total substations by 2027-28	**2**	**4**
Existing Transformation Capacity (MVA)	6000	7945
Transformation Capacity at new substations (MVA)	4500	-
Transformation Capacity augmentation in existing substations (MVA)	1500	1185
Total Transformation capacity by 2027-28 (MVA)	**12000**	**9130**
Existing Transmission Lines (including Cable) (ckm)	790	1350
Addition of Transmission Lines (including Cable) by 2027-28 (ckm)	930	62
Total ckm of Transmission Lines (including cable) by 2027-28	**1720**	**1412**

Chapter-3

Transmission System Requirement by 2029-30 and 2033-34

3.1 Load flow studies for the year 2033-34:

(i) Load flow studies have been carried out for two scenarios:

a) Peak electricity demand scenario which occurs during summer season in the month of June/ July and;

b) Off-peak electricity demand scenario which occurs during winter season in the month of November/ March.

(ii) Peak electricity demand of Delhi in 2033-34 as per revised 20th EPS projections is 11,059 MW. However, as per DTL's projection, the same is 13,167 MW, which is on higher side as compared to EPS projections. As the electricity demand of Delhi is growing rapidly, DTL's projection have been considered in the studies. The projected demand includes 940 MW demand due to electric vehicles as projected by Discoms. In addition, 1000 MW load on account of Data Centres is anticipated in Rani Khera and Kanjhawala area by 2033-34. However, no firm proposal regarding Data Centres load had been received subsequently by DTL/ Discoms. Hence, transmission system for the same would be planned upon firming up of location of Data Centres.

(iii) **Planned InSTS schemes in Delhi:**

Beyond 2027-28 time frame, DTL has planned conversion of following sub-stations to GIS:

- Conversion of Patparganj AIS substation into GIS
- Conversion of Subzi Mandi AIS substation into GIS

(iv) **Load flow study results:**

I. Based on the load flow studies, following transmission elements are required to be added under ISTS by 2033-34:

a) **New substations:**

Table 3.1: New substations by 2033-34 under ISTS

Sl. No.	Name of the proposed substation	Voltage Level (kV)	Total Capacity (MVA)	Breakup of Capacity (MVA)	Timeframe
765 kV Substation					
1.	Mandi	400/220 kV	2000 MVA (at 400 kV)	4×500	2029-30
		765/400	4500 MVA (at 765 kV)	3×1500	2033-34

b) **Transmission Lines under ISTS:**

Table 3.2: Transmission lines by 2033-34 under ISTS

Sl. No.	Transmission Lines	ckm	Status
765 kV Transmission lines			
1.	Neemrana 2 – Mandi 765 kV D/c line (110 km)	220	2033-34
2.	LILO of one circuit of 765 kV Neemrana 2 – Bareilly D/c line at Mandi (LILO length (20 km)	40	2033-34
400 kV Transmission line			
3.	LILO of both circuits of Bamnauli - Tuglakhabad 400 kV D/c line at Mandi (LILO length 10 km)	40	2029-30
Total (ckm)		**300**	

c) **Transmission system strengthening under ISTS (by 2033-34):**

- Augmentation by 2x1500 MVA, 765/400 kV ICTs (4th and 5th) at Narela S/s
- 1x1500 MVA, 765/400 kV ICT augmentation (3rd) at Jhatikara Substation (Mundka section)
- Replacement of 2x315 MVA, 400/220 kV ICTs at Maharani Bagh with 2x500 MVA ICTs *(based on the real time loading patterns)*

Dynamic Reactive Power Compensation (by 2030-31):

- STATCOM (2x $\pm$300 MVAr) along with MSC (4x125 MVAr) & MSR (2x125 MVAr) at Narela S/s (subject to space availability)

II. Transmission elements required to be added under Intra-State by 2033-34

a) **New substations:**

Details of new substations required by 2033-34 under intra-state are given in Table 3.3.

Table 3.3: New substations by 2033-34 under intra-state

Sl. No.	Name of the proposed sub-station	Voltage Level (kV)	Total Capacity (MVA)	Breakup of Capacity (MVA)	Timeframe
400 kV Substations					
1.	Barwala	400/220/66	2500 MVA (at 400 kV) 640 MVA (at 220 kV)	400/220 kV - 5×500 220 /66 kV - 4×160	2033-34
2.	Geeta Colony	400/220	2500 MVA	5×500	2029-30
3.	Jhatikara	400/220/66	2000 MVA (at 400 kV) 480 MVA (at 220 kV)	400/220 kV - 4×500 220/66 kV - 3×160	2033-34
220 kV Substations					
4.	Aaya Nagar	220/66	480	2×160	2029-30
				1×160	2033-34
5.	Bharthal	220/66	480	2×160	2028-29
				1×160	2029-30
6.	Central Vista	220/33	300	3×100	2028-29
				1×100	2033-34
7.	Dilshad Garden	220/66	480	2×160	2028-29
				1×160	2029-30
8.	Dhansa	220/66	320	2x160	2033-34
9.	Fateh Pur Beri	220/66	480	2×160	2031-32
				1×160	2032-33
10.	Nathu Pura	220/66	480	2×160	2031-32
				1×160	2032-33
11.	Rani Khera	220/66	640	2×160	2028-29
				1×160	2029-30
				1×160	2033-34
12.	Sabha Pur / Karawal Nagar	220/66	480	2×160	2029-30
				1×160	2032-33
13.	Seelam Pur / Rathi Mill / Dwarka Puri	220/33	300	2×100	2028-29
				1×100	2029-30

b) **ICT augmentations:**

Details of ICT augmentations required at various substation under intra-state by 2033-34 is given in Table 3.4.

Table 3.4: ICT augmentations by 2033-34 under Intra-State

Sl. No.	Sub-station	Voltage Level (kV)	Existing Capacity (MVA)	ICTs to be added (MVA)	Timeframe
ICT augmentations at 400 kV level					
1.	Harsh Vihar	400/220	3×315	1×500	2028-29
2.	Punjabi Bagh	400/220	2×500	2×500	2032-33
3.	Tikrikhurd	400/220	2×500	2×500	2032-33
ICT augmentations at 220 kV level					
4.	Mehrauli	220/66	1×160 + 3×100 (+ 1×160 by 2027)	2×100 → 2×160*	2028-29
5.	Okhla	220/66	1×160 + 1×100	1×100 → 1×160*	2029-30
6.	Okhla	220/33	3×100	1×100	2029-30
7.	Pappan Kala-1	220/66	2×160 + 3×100	1×160	2033-34
8.	Sarita Vihar	220/66	1×160 + 2×100	2×100 → 2×160*	2033-34
9.	Sarojini Nagar	220/33	3×100	2×100	2032-33
10.	Shalimar Bagh	220/66	2×100	2×100 → 2×160*	2033-34
11.	Subzi Mandi	220/33	2×100	1×100	2033-34
12.	Tikrikhurd	220/66	2×160	1×160	2032-33

**Replacement of existing ICTs*

c) **Transmission lines:**

Details of new transmission lines by 2033-34 is given below in Table 3.5:

Table 3.5: New Transmission lines by 2033-34 under intra-state

Sl. No.	Transmission lines	ckm	Status
400 kV Transmission lines			
1.	Narela - Barwala 400 kV D/c line (18 km)	36	2033-34
2.	LILO of both circuits of Narela - Maharani Bagh 400 kV D/c line at Geeta Colony (LILO length 0.5 km)	2	2029-30
3.	Harsh Vihar – Geeta Colony 400 kV D/c line (10 km)	20	2029-30
Total (ckm)		**98**	
220 kV Transmission lines			
4.	LILO of both circuits of Bamnauli - DIAL 220 kV D/c line at Bharthal (LILO length 0.05 km)	0.2	2028-29
5.	Maharani Bagh - Central Vista 220 kV D/c line (UG cable) (5 km)	10	2028-29
6.	Sarojini Nagar - Central Vista 220 kV D/c line (UG cable) (7 km)	14	2029-30
7.	LILO of Najafgarh - Kanjhawala 220 kV S/c line at Rani Khera (LILO length 2 km)	4	2028-29
8.	LILO of Mundka - Kanjhawala 220 kV S/c line at Rani Khera (2 km)	4	2029-30
9.	Seelam Pur / Rathi Mill / Dwarka Puri - Geeta Colony 220 kV D/c line (UG cable) (3 km)	6	2029-30
10.	Harsh Vihar – Dilshad Garden 220 kV D/c line (UG cable) (7 km)	14	2028-29
11.	Dilshad Garden - Seelam Pur / Rathi Mill / Dwarka Puri 220 kV D/c line (UG cable) (5 km)	10	2029-30
12.	LILO of two circuits of Mandola - Wazirabad 220 kV 2xD/c line at Sabha Pur (LILO length 2 km)	8	2029-30
13.	LILO of both circuits of Bawana - Kanjhwala 220 kV D/c line at Barwala (LILO length 2 km)	8	2033-34

Sl. No.	Transmission lines	ckm	Status
14.	LILO of both circuits of Geeta Colony - Patparganj 220 kV D/c line to proposed 400 kV Geeta Colony (New) Substation (LILO length 1 km)	4	2029-30
15.	Extension of Geeta Colony - Seelam Pur 220 kV D/c line (U/G Cable) to proposed 400 kV Geeta Colony (New) Substation (1 km)	2	2029-30
16.	LILO of both circuits of Mandola - Gopal Pur 220 kV D/c line at Nathu Pura (LILO length 2 km)	8	2031-32
17.	Mandi - Aaya Nagar 220 kV D/c line (10 km)	20	2030-31
18.	Mehrauli - Aaya Nagar 220 kV D/c line (7 km)	14	2029-30
19.	Mandi - Maidan Garhi 220 kV D/c line (10 km)	20	2030-31
20.	Mandi - Fateh Pur Beri 220 kV D/c line (3 km)	6	2031-32
21.	BTPS - Fateh Pur Beri 220 kV D/c line (15 km)	30	2032-33
22.	Dhansa - Jhatikara 220 kV D/c line (5 km)	10	2033-34
Total (ckm)		**192.2**	

d) **Bus reactors:**

Details of additional Bus Reactors required by 2033-34 under intra-state is given in Table 3.6.

Table 3.6: Additional Bus Reactors by 2033-34 under intra-state

Sl. No.	Substation	Voltage Level (kV)	Reactive Power (MVAr)
1.	Barwala	400	1×125
2.	Mandi	400	1x125
3.	Geeta Colony	400	1×125
4.	Patparganj	220	2×25
5.	Dilshad Garden	220	2×25
6.	Central Vista	220	2×25
7.	Sabha Pur / Karawal Nagar	220	2×25
8.	Nathu Pura	220	2×25

3.2 Short circuit study analysis

In the short circuit studies carried out for the year 2033-34, it has been observed that the fault level at various substations are either near or higher than the designed limits, even after considering the bus split arrangement proposed by 2027-28. List of substations with higher fault level is given below in Table 3.7:

Table 3.7: List of substations with higher fault level

Substation	Voltage Level (kV)	Fault Level (kA)
Bawana	400 kV	53 kA
Bawana	220 kV	52 kA
Sabji Mandi	220 kV	40 kA
Shalimar Bagh	220 kV	53 kA
Rohini	220 kV	42 kA
Parkstreet	220 kV	40 kA
Lodhi Road	220 kV	40 kA
Wazirabad	220 kV	47 kA
Geeta Colony	220 kV	49 kA
Harsh Vihar	220 kV	44 kA
Kashmiri Gate	220 kV	41 kA
Electric Lane	220 kV	40 kA
DSIDC Bawana	220 kV	42 kA
Kanjhawala	220 kV	40 kA
Maharani Bagh-E	220 kV	43 kA
Wazirpur	220 kV	54 kA
Peeragarhi	220 kV	54 kA
Mundka	220 kV	55 kA
Preet Vihar	220 kV	41 kA
Rajghat	220 kV	40 kA
Dev Nagar	220 kV	40 kA
Timarpur	220 kV	42 kA
Patparganj-E	220 kV	41 kA
Rani Khera	220 kV	42 kA
Sabha Pur	220 kV	42 kA
Barwala	220 kV	47 kA
Geeta Colony New	220 kV	51 kA
SGTN	220 kV	40 kA
Gopalpur	220 kV	41 kA
Dilshad Garden	220 kV	44 kA
Mangol Puri	220 kV	56 kA
Seelam Pur	220 kV	46 kA
Mandola	220 kV	40 kA
Mandola Split	220 kV	41 kA

Considering the high fault levels in Delhi, it is recommended to replace the existing equipment with the higher rating equipment. It is also recommended that all new substations should be planned with higher short circuit capacity, i.e. 80 kA for 400 kV and 63 kA for 220 kV as per the CEA Manual on Transmission Planning Criteria, 2023 which is given below:

"*The maximum short-circuit level on any new substation bus should not exceed 80% of the rated short circuit capacity of the substation equipment. The 20% margin is intended to take care of the increase in short-circuit levels as the system grows. The rated breaking current capability of switchgear at different voltage levels may be taken as given below:*

Voltage Level	**Rated Breaking Capacity**
765 kV	50 kA / 63 kA
400 kV	63 kA / 80 kA
220 kV	40 kA / 50 kA / 63 kA
132 kV	25 kA / 31.5 kA / 40 kA
66kV	31.5 kA

"

3.3 Summary of Transmission network in Delhi by 2029-30

i. Intra-State Transmission System in Delhi

The details of the Intra-state transmission network by 2029-30 is given below in Table 3.8:

Table 3.8: Intra-State Transmission system by 2029-30

Intra-State Transmission System	**400 kV level**	**220 kV level**
No. of Substations by 2027-28	7	49
No. of New Substations required by 2029-30	1	7
Total no. of substations by 2029-30	**8**	**56**
Transformation Capacity (MVA) by 2027-28	11205	22240
Transformation Capacity at new substations (MVA)	2500	2680
Transformation Capacity with augmentation at existing substations (MVA)	500	280
Total Transformation Capacity by 2029-30 (MVA)	**14205**	**25200**
ckm of Transmission Lines (including Cable) by 2027-28	319.2	1093.87
Addition of ckm of Transmission Lines (including Cable) by 2029-30	22	90.2
Total ckm of Transmission Lines (including cable) by 2029-30	**341.2**	**1184.07**

ii. Inter-State Transmission Network in Delhi

The details of the Inter-state transmission network by 2029-30 is given below in Table 3.9:

Table 3.9: Inter-State Transmission system by 2029-30

Inter-State Transmission System	765 kV level	400 kV level
No. of Substations by 2027-28	**2**	**4**
No. of New Substations added by 2029-30	-	1
Total no. of substations by 2029-30	**2**	**5**
Transformation Capacity (MVA) by 2027-28	12000	9130
Transformation Capacity at new substations (MVA)	-	2000
Total Transformation Capacity by 2029-30 (MVA)	**12000**	**11130**
ckm of transmission lines (including cable) by 2027-28	1720	1412
ckm addition in transmission lines (including cable) by 2029-30	-	40
Total ckm of transmission lines (including Cable) by 2029-30	**1720**	**1452**

3.4 Summary of Transmission network in Delhi by 2033-34

i. Intra-State Transmission System in Delhi

The details of the Intra-state transmission network by 2033-34 is given below in Table 3.10:

Table 3.10: Intra-State Transmission system by 2033-34

Intra-State Transmission System	400 kV level	220 kV level
No. of Substations by 2029-30	8	56
No. of New Substations required by 2033-34	2	3
Total no. of substations by 2033-34	**10**	**59**
Transformation Capacity (MVA) by 2029-30	14205	25200
Transformation Capacity at new substations (MVA)	4500	1120
Transformation Capacity with augmentation at existing substations (MVA)	2000	2720
Total Transformation Capacity by 2033-34 (MVA)	**20705**	**29040**
ckm of transmission lines (including Cable) by 2029-30	341.2	1184.07
ckm addition in transmission lines (including Cable) by 2033-34	36	102
Total ckm of Transmission Lines (including Cable) by 2033-34	**377.2**	**1286.07**

ii. Inter-State Transmission System in Delhi

The details of the Inter-state transmission network by 2033-34 is given below in Table 3.11.

Table 3.11: Inter-State Transmission system by 2033-34

Inter-State Transmission System	765 kV level	400 kV level
No. of Substations by 2029-30	**2**	**5**
No. of New Substations added by 2033-34	1	-
Total no. of substations by 2033-34	**3**	**5**
Transformation Capacity (MVA) by 2029-30	12000	11130
Transformation Capacity at new substations (MVA)	4500	-
Transformation Capacity with augmentation at existing substations (MVA)	4500	370
Total Transformation Capacity by 2033-34 (MVA)	**21000**	**11500**
ckm of Transmission Lines (including Cable) by 2029-30	1720	1452
Addition of ckm of Transmission Lines (including Cable) by 2033-34	260	-
Total ckm of Transmission Lines (including cable) by 2033-34	**1980**	**1452**

3.5 Operation of I.P. and Pragati Power Station as synchronous condenser

- The Delhi grid has a high concentration of load, particularly inductive loads such as motors, air conditioners, and industrial equipment. These loads tend to draw reactive power, leading to voltage drops in the system during the peak load scenarios during the months of May-August.
- Delhi witnesses significant reduction in the electricity demand during winters and as there are many 220 kV transmission lines implemented through underground cables, the transmission grid in Delhi experience significant voltage rise in winters.
- Also, with commissioning of 765 kV Narela substation and Jhatikara- Dwarka 400 kV D/c lines, more RE power would be injected into Delhi grid, which are intermittent in nature. This variability can lead to fluctuations in voltage and frequency. Synchronous condensers help balance these fluctuations by providing dynamic reactive power support, thereby facilitating the smooth integration of renewable energy into the grid.
- In view of the above, there is requirement of inclusion of synchronous condensers in the Delhi grid which would provide overall stability, voltage regulation and reactive power support during summers and winters, which in turn would help in maintaining a reliable and efficient power supply to a large and growing urban population in Delhi.

- Also, as per the information provided by DTL, due to higher price of gas, gas based generating plants in Delhi do not operate for most of the time in a year and only operate during peak load scenarios which occur during the months of May- August.
- Gas power plants can be made to run either in 'Generation Mode' or in 'Synchronous Condenser Mode' with provision of a new clutch arrangement between the Generator and Turbine. When active power generation is required, the gas turbine is connected to the generator with the clutch closed. The gas turbine rotates the generator which creates active power which is delivered to the grid. When no active power is required, the gas turbine is connected to the generator with clutch closed, in order to start the unit. Once the generator is synchronized to the grid, the clutch is opened, and the gas turbine is stopped. The generator remains connected to the grid and is then operated as synchronous condenser. For provision of clutch various constraints like space requirement, foundation modification, necessary adjustment/relocation/ shifting of existing equipment, cost of modifications etc. need to be studied.
- In view of the above, it is proposed that feasibility studies may be carried out for operation of I.P. Gas Turbine Power Station and Pragati Power Station as synchronous condenser with the help of clutch arrangement.

Chapter-4
Recommendations

1. Intra-State Transmission system augmentation required till 2027-28 (by May, 2027) in Delhi comprises of 238 ckm (220 kV and above) of transmission lines and 13,885 MVA of transformation capacity as detailed below:

	Augmentation required by 2027-28		**At the end of 2027-28**	
	400 kV	**220 kV**	**400 kV**	**220 kV**
Transmission lines (ckm)	70	168	319.2	1093.87
Transformation Capacity (MVA)	6425	7460	11205	22240

In addition, reconductoring of some 220 kV lines (about 115 ckm) with HTLS conductors is also required in the same timeframe.

2. All the planned transmission network should be timely implemented. DTL should expedite the transmission elements proposed/planned for the 2027-28 timeframe. The delay in the implementation may lead to network congestion and interruption in power supply.

3. In the past, it has been observed that many of the planned intra-state transmission schemes in Delhi have been delayed primarily because of non-finalization of tenders, contractual issues, delay in allocation of land by DDA for setting up sub-stations etc., Therefore, it is recommended that for the planned substations, DTL should take up the matter with DDA for allocation of sub-station land well in advance. Also, tendering and award of the transmission elements should be expedited.

4. Intra-State Transmission system augmentation required during 2028-29 to 2029-30 in Delhi comprises of 112 ckm of transmission lines and 5,960 MVA of transformation capacity as detailed below:

	Augmentation required during 2028-29 to 2029-30		**At the end of 2029-30**	
	400 kV	**220 kV**	**400 kV**	**220 kV**
Transmission lines (ckm)	22	90.2	341.2	1184.07
Transformation Capacity (MVA)	3000	2960	14205	25200

Action must be initiated by DTL for approval of the schemes and subsequent award well in time to ensure timely commissioning of the planned transmission schemes.

5. Intra-State transmission system augmentation required during 2030-31 to 2033-34 in Delhi comprises of 138 ckm of transmission lines and 10,340 MVA of transformation capacity as detailed below:

	Augmentation required during 2030-31 to 2033-34		**At the end of 2033-34**	
	400 kV	**220 kV**	**400 kV**	**220 kV**
Transmission lines (ckm)	36	102	377.2	1286.07
Transformation Capacity (MVA)	6500	3840	20705	29040

Action needs to be initiated by DTL for approval of the schemes and subsequent award well in time to ensure timely commissioning of the planned transmission schemes. Some of the planned schemes during 2030-31 to 2033-34 timeframe may be reviewed based on growth of electricity demand.

6. While carrying out the short circuit studies, it has been observed that the fault level at various substations are either near or higher than the designed limits. Therefore, bus splitting arrangement have been proposed at these substations as a short-term solution. In the long term, it is also suggested to replace the equipment with the higher rating equipment so as to restore the bus split arrangement and enhance the reliability of power supply. Considering the high fault levels in Delhi, it is recommended that all new substations should be planned with higher short circuit capacity as per the manual on Transmission Planning Criteria.

7. DTL should provide appropriate space provisions for 66 kV and 33 kV bays in their 220/66 kV and 220/33 kV grid substations for supply of power to DISCOMs, and new substations should have adequate space provision for extension/augmentation to meet future load growth.

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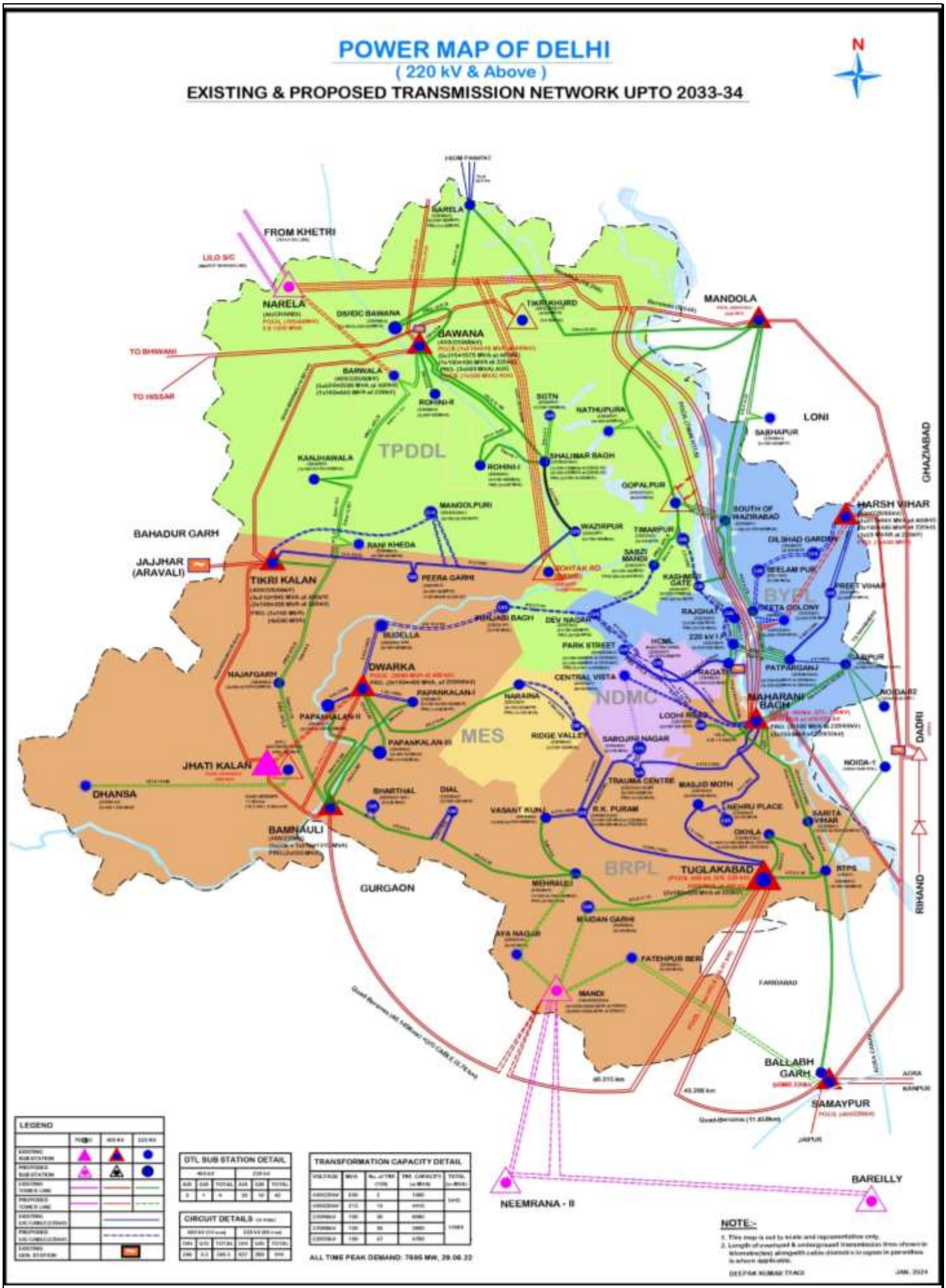
POWER MAP OF DELHI
(220 kV & Above)
EXISTING & PROPOSED TRANSMISSION NETWORK UPTO 2033-34
N
FROM KHETRI
LILO S/C
NARELA
DSIDC BAWANA
BAWANA
TIKRIKHURD
MANDOLA
TO BHIWANI
TO HISSAR
BARWALA
ROHINI-II
SSTN
NATHUPURA
LONI
SABHAPUR
GHAZIABAD
TPDDL
KANJHAWALA
ROHINI-I
SHALIMAR BAGH
GOPALPUR
HARSH VIHAR
SOUTH OF WAZIRABAD
MANGOLPURI
WAZIRPUR
TIMARPUR
DILSHAD GARDEN
BAHADUR GARH
RANI KHEDA
SABZI MANDI
JAJJHAR (ARAVALI)
TIKRI KALAN
PEERA GARHI
ROHTAK RD
KASHMERE GATE
BYPL
GEETA COLONY
PREET VIHAR
RAJGHAT
HARJASI BAGH
DEV NAGAR
BUDELLA
PARK STREET
220 kV I.P.
PATPARGANJ
GAZIPUR
NAJAFGARH
DWARKA
CENTRAL VISTA
PRAGATI
NOIDA-82
PAPANKALAN-I
NARAINA
NDMC
MAHARANI BAGH
PAPANKALAN-II
LODHI ROAD
MES
RIDGE VALLEY
SAROJINI NAGAR
PAPANKALAN-III
DADRI
JHATI KALAN
TRAUMA CENTRE
MASJID MOTH
NOIDA-1
DHANSA
BHARTHAL
DIAL
VASANT KUNJ
R.K. PURAM
NEHRU PLACE
SARITA VIHAR
BAMNAULI
OKHLA
BRPL
TUGLAKABAD
STPS
GURGAON
MEHRAULI
RIHAND
MAIDAN GARHI
AYA NAGAR
FATEHPUR BERI
FARIDABAD
MANDI
BALLABH GARH
AGRA
KANPUR
SAMAYPUR
JAIPUR
BAREILLY
NEEMRANA - II
LEGEND
OTL SUB STATION DETAIL
CIRCUIT DETAILS
TRANSFORMATION CAPACITY DETAIL
ALL TIME PEAK DEMAND: 7695 MW, 29.06.22
NOTE:-
1. This map is not to scale and representative only.
2. Length of overhead & underground transmission lines shown in kilometres(km) alongwith cable circuits in ogram parenthesis is where applicable.
DEEPAK KUMAR TYAGI
JAN. 2024