20 YEARS Integrated Research and IRADe Action for Development

ग्रिड-इंडिया GRID-INDIA

Northern Regional Capacity Building Workshop

Session-2 : Transmission Congestion and Transfer Capability

3rd July 2024

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Grid-India

Overview

1. Transfer Capability - Overview
2. Transfer Capability v/s Transmission Capacity
3. Current Regulatory Provisions
4. Assessment Methodology
5. TTC/ATC Declaration by Grid-India
6. Congestion in Real-Time Operations
7. Way Forward

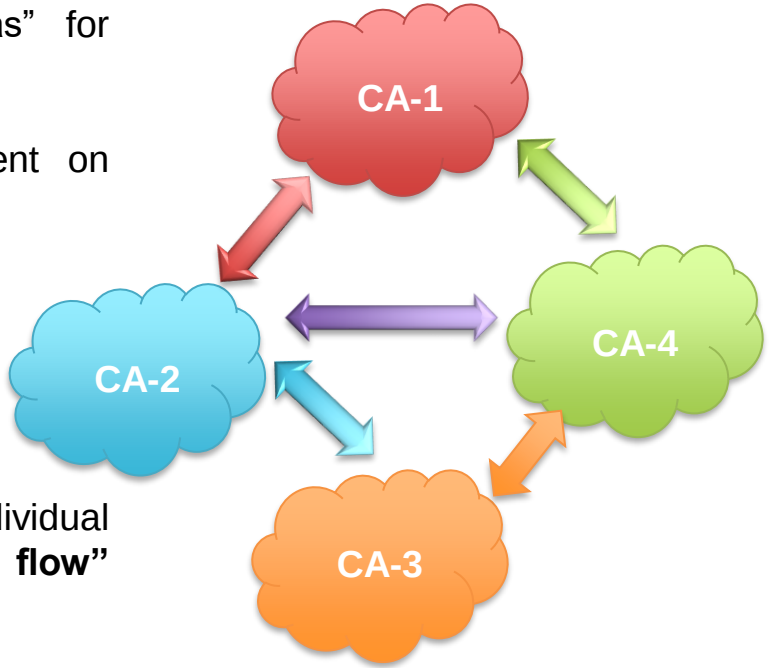
Transfer Capability: Introduction

- Power System is usually demarcated into “Control Areas” for operation, control and commercial ease

- Power Flow between control areas is, however, dependent on response of the path to the transfer determined by:

  - Network Topology
  - Spatial Distribution of Generation
  - Spatial Distribution of Demand
  - Other factors such as prevailing voltage profile etc.

- Collective response of all the elements (having different individual capacities) in a network determines the **“permissible power flow”** across various sections of the network.



This “permissible power flow” is often termed as **Transfer Capability** of the network

Transfer Capability: Genesis

- On 24th April 1996, in the United States, Federal Energy Regulatory Commission (FERC), order 888 and 889 issued promoting wholesale competition through open access non-discriminatory transmission services by public utilities and an open access same-time information system respectively,

- The erstwhile North American Electric Reliability Council (NERC) brought out a document in June 1996 defining the various terms and their determination and applicability. Contents now part of NERC Reliability Standards under Modeling, Data and Analysis (MOD)

- In India, RLDCs started a similar exercise, post introduction of Short Term Open Access (STOA) at the inter state level in May 2004 by CERC and formation of a synchronous NEW grid in August 2006.

Transfer Capability: Chronology in India

Date	Milestone
30th Mar 2009	Definition of 'transfer capability' first appears in the amendments to the March 2006 Grid Code effective from 1st April 2009
22nd Dec 2009	Transfer Capability (TTC, TRM and ATC) defined in CERC's *Measures to relieve congestion in real time operation) Regulations, 2009*
31st Dec 2009	Transfer Capability (TTC, TRM and ATC) definitions appear in the CTU's procedure approved by CERC for *"Grant of Connectivity, Medium Term Open Access (MTOA) and Long Term Access (LTA)"*
28th Apr 2010	Grid Code 2010 defines Transfer Capability (TTC, TRM and ATC)
11th June 2010	Detailed procedure for Assessment of Transfer Capability (NLDC) approved by CERC under CERC Regulations dated 22nd Dec 2009 mentioned above
1st Oct 2023	Indian Electricity Grid Code, 2023 defined timelines for Transfer Capability Declaration
Oct 2023	NLDC procedure on "Methodology for Assessment of Transfer Capability" – prepared as part of operating procedure as per the mandate in IEGC, 2023

Transfer Capability: Definitions

Total Transfer Capability (TTC): means the amount of electric power that can be transferred reliably over the inter-control area transmission system under a given set of operating conditions considering the effect of occurrence of the worst credible contingency;

Transmission Reliability Margin (TRM): means the amount of margin earmarked in the total transfer capability to ensure that the interconnected transmission network is secure under a reasonable range of uncertainties in system conditions;

Available Transfer Capability (ATC): means available power transfer capability across control areas or across regions or between ISTS and state network or between cross-border interconnections declared by the concerned load despatch centre for scheduling transactions in a specific direction with due consideration for the network security. Mathematically, ATC is the Total Transfer Capability less Transmission Reliability Margin

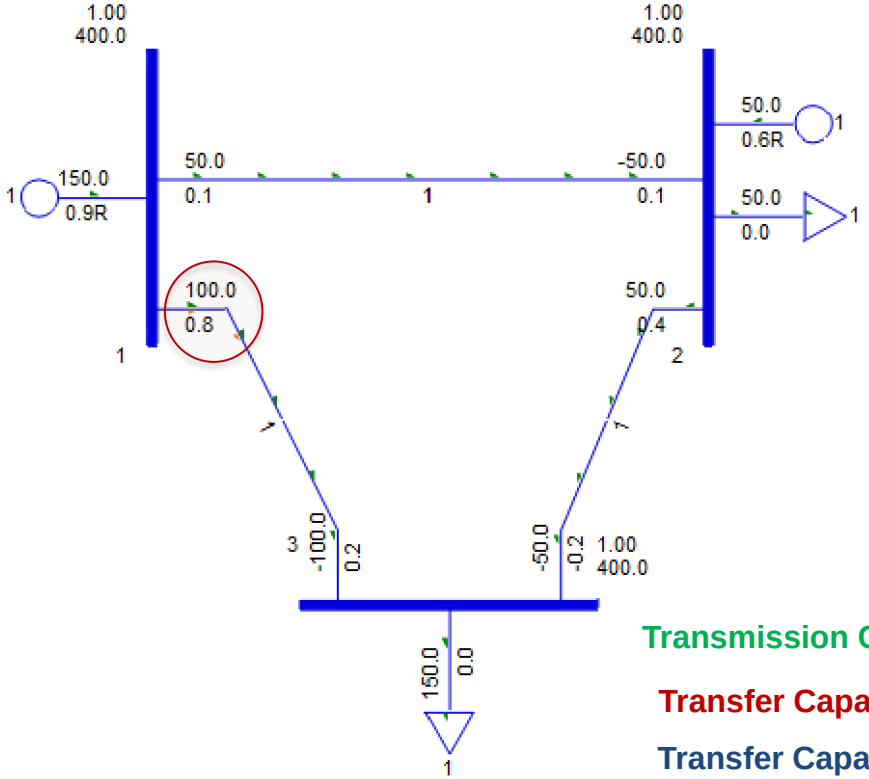
Source: CERC IEGC Regulations, 2023

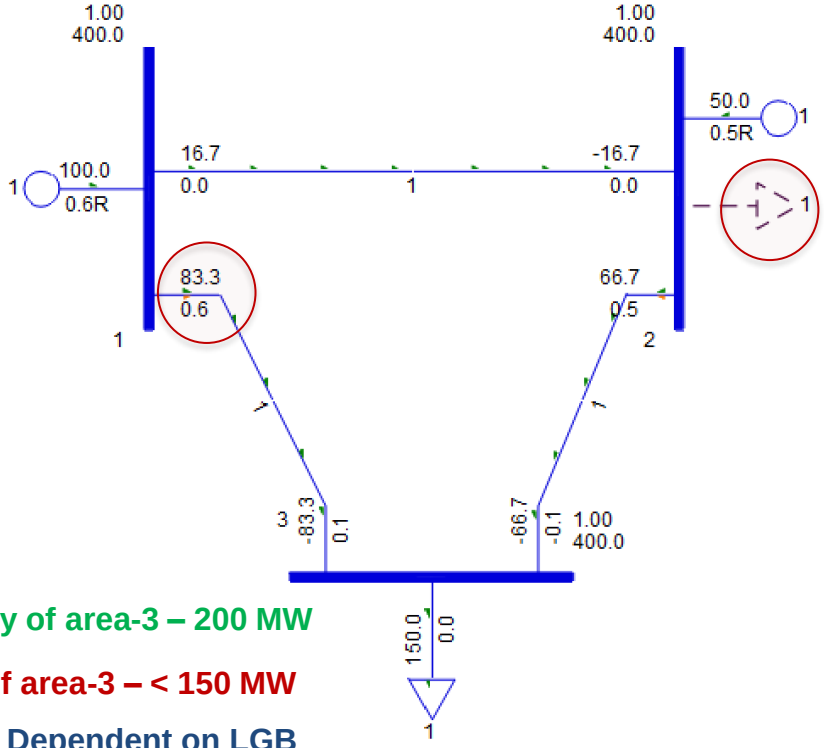
Transfer Capability vs Transfer Capacity

S. No.	Transmission Capacity	Transfer Capability
1.	Is a physical property in isolation	Is a collective behavior of a system
2.	Depends on design only	Depends on design, topology, system conditions, accuracy of assumptions
3.	Deterministic	Probabilistic
4.	Constant under a set of conditions	Always varying
5.	Time independent	Time dependent
6.	Non-directional	Directional
7.	Determined directly by design	Estimated indirectly through simulation studies
8.	Declared by designer/ manufacturer	Declared by the System Operator

Transfer Capability of a corridor ≠ arithmetic sum of individual transmission capacities of all parallel transmission lines in that corridor

Transfer Capability vs Transfer Capacity





Transmission Capacity of area-3 – 200 MW

Transfer Capability of area-3 – < 150 MW

Transfer Capability – Dependent on LGB

Understanding so far…

- What is Transfer Capability?
- Requirement of Transfer Capability in any Power System ?
- Factors affecting Transfer Capability ?
- Transfer Capability v/s Transfer Capacity ?

Car Maximum Speed - 100 kM/hr

Highway Maximum Speed Limit - 100 kM/hr

Time Taken – minimum 1 hour to ……
Various Bottlenecks, Intersections, Disturbances …

Current Regulatory Provisions

IEGC, 2023 – Chapter 6 – Operating Code

Clause 33. OPERATIONAL PLANNING STUDY

(3) SLDCs shall perform ***day-ahead, weekly, monthly and yearly operational studies*** *for the concerned State for:*

- ***(a) assessment and declaration of total transfer capability (TTC) and available transfer capability (ATC) for the import or export of electricity by the State. TTC and ATC shall be revised from time to time based on the commissioning of new elements and other grid conditions and shall be published on SLDC website with all the assumptions and limiting constraints;***
- *(b) planned outage assessment;*
- *(c) special scenario assessment;*
- *(d) system protection scheme assessment;*
- *(e) natural disaster assessment; and*
- *(f) any other study relevant in operational scenario*

Current Regulatory Provisions

IEGC, 2023 – Chapter 6 – Operating Code

Clause 33. OPERATIONAL PLANNING STUDY

*(4) RLDCs and NLDC shall perform **day-ahead, weekly, monthly and yearly** operational studies for:*

- ***(a) assessment of TTC and ATC at inter-regional, intra-regional, and inter-state levels;***
- *(b) planned outage assessment;*
- *(c) special scenario assessment;*
- *(d) system protection scheme assessment;*
- *(e) natural disaster assessment; and*
- *(f) any other study relevant to operational scenarios*

***(5) RLDC shall assess intra-regional and inter-state level TTC and ATC and submit them to NLDC. NLDC shall declare TTC and ATC for import or export of electricity between regions including simultaneous import or export capability for a region, and cross-border interconnections 11 (Eleven) months in advance for each month on a rolling basis**. TTC and ATC shall be revised from time to time based on the **commissioning of new elements and other grid conditions** and shall be published on the websites of the NLDC and respective RLDCs with all the assumptions and limiting constraints.*

Current Regulatory Provisions

CERC, Connectivity and General Network Access to the Inter-State Transmission System, Regulations 2022,

Clause 28.1 states that *“T-GNA may be applied for any period from 1 (one) time block and up to 11 (eleven) months. “*

Clause 29.1 of the same regulation states that *“T-GNA shall be granted within the Available Transfer Capability (ATC) on the ISTS after accounting for the GNA of the GNA grantees.”*

Harmonious reading of all the provisions in GNA regulations and IEGC regulations indicates that transfer capability by SLDCs, RLDCs and NLDC shall be assessed and declared 11 (Eleven) months in advance for each month on a rolling basis.

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Current Regulatory Provisions

National Load Despatch Centre (NLDC) Procedure for Transfer Capability Assessment Methodology

Grid Controller of India Limited
(Formerly Power System Operation Corporation Limited)
National Load Despatch Centre (NLDC)

Procedure for Assessment of Transfer Capability

Prepared in Compliance

to

compliance to regulation 28 (3) and 28 (4) and in accordance with *regulation* 31(2)(d), 33(3)(a), 33(4)(a), 33(5), 33(9), 44(1)(e), 44(1)(f), 44(2)(e), 44(3)(f) of *Central Electricity Regulatory Commission IEGC Regulations, 2023*

September 2023

Procedure is a part of the operating procedure of NLDC & RLDCs prepared as per regulation no. 28(3) and 28(4) of the IEGC – 2023

Jurisdiction of Transfer Capability Assessment

a) SLDC :

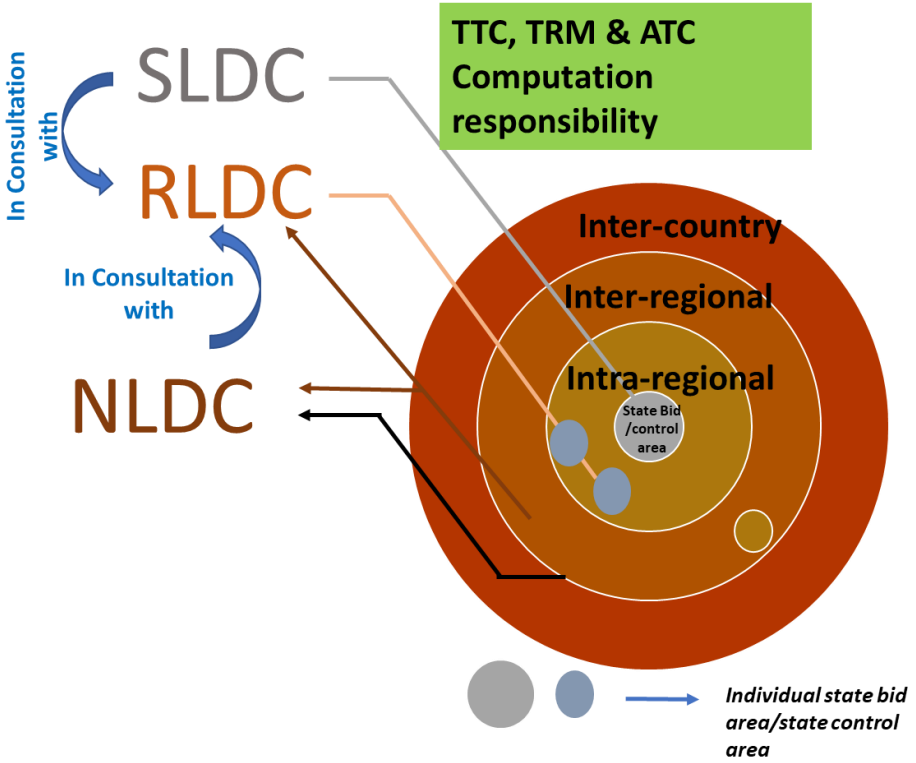
Shall assess and declare TTC/ATC & TRM for intra state system and export and import capabilities of state in total in consultation with RLDCs.

(b) RLDC :

Shall assess and declare TTC/ATC & TRM of intra-regional/inter-state system.

(c) NLDC :

Shall assess and declare TTC/ATC & TRM of inter-regional in consultation with RLDCs along with declaration of cross-border TTC/ATC



Transfer Capability: Assessment Methodology

- Transfer Capability of any corridor limited by minimum of:
  - Thermal Limit
  - Stability Limit
  - Voltage Limit
- Ideally unique value for each time block
- Minimum computed value for a particular forecasted LGB to be considered as safe limit
- Offline Simulation Software currently being used for transfer capability computation

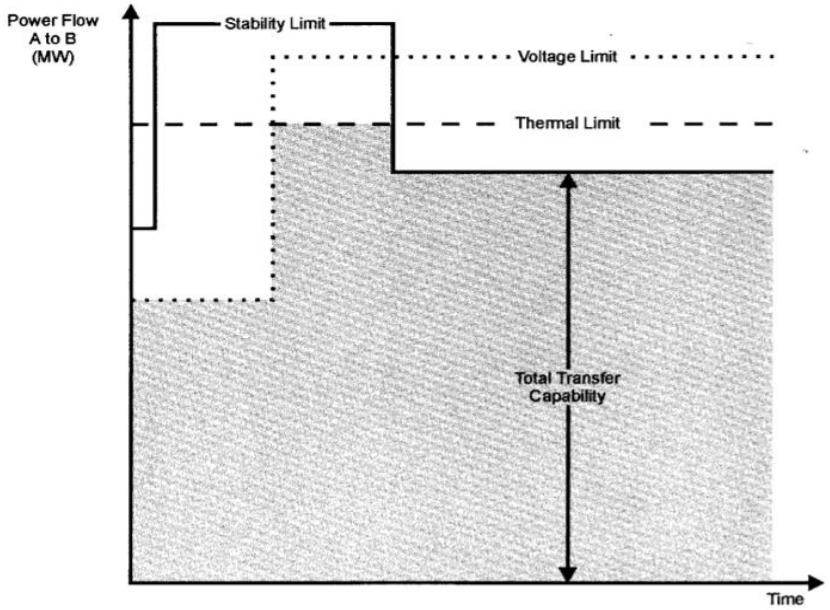
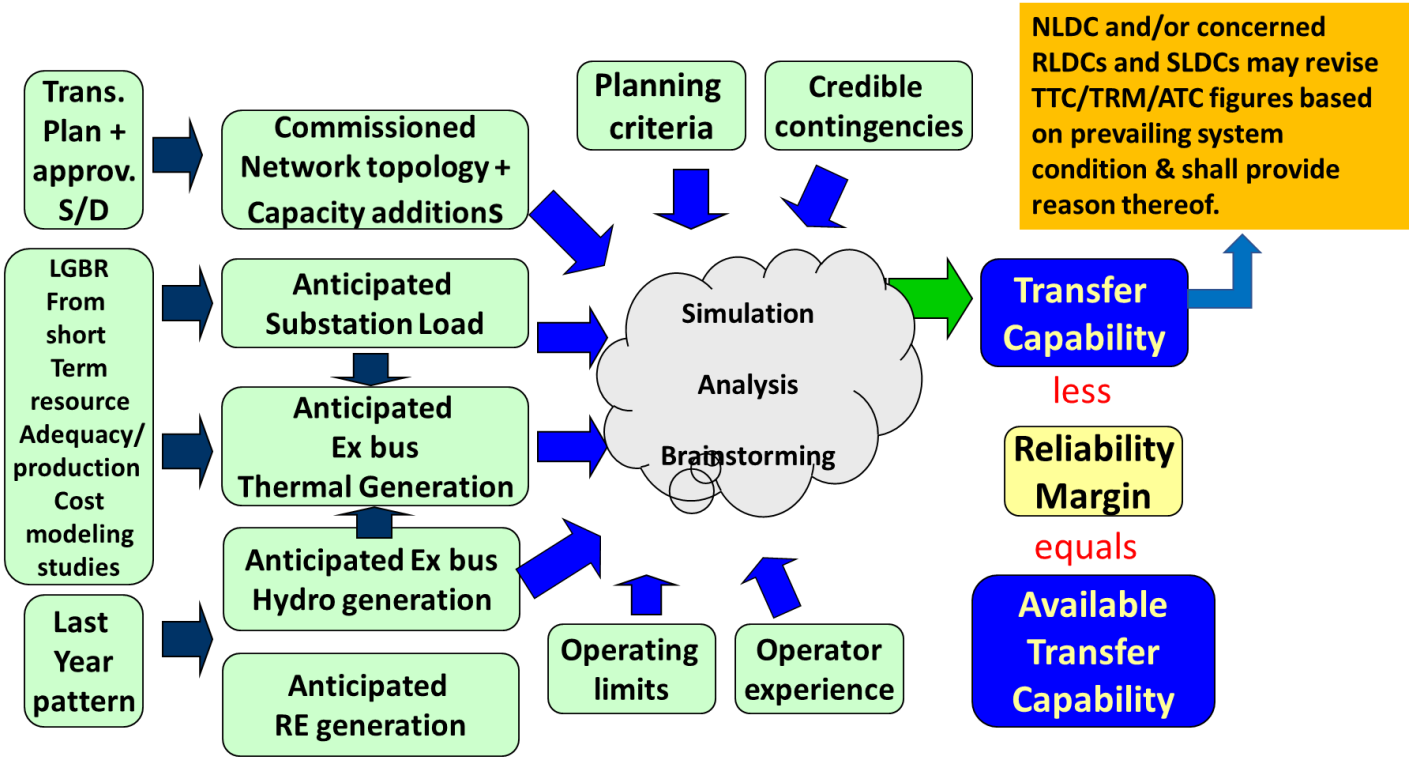


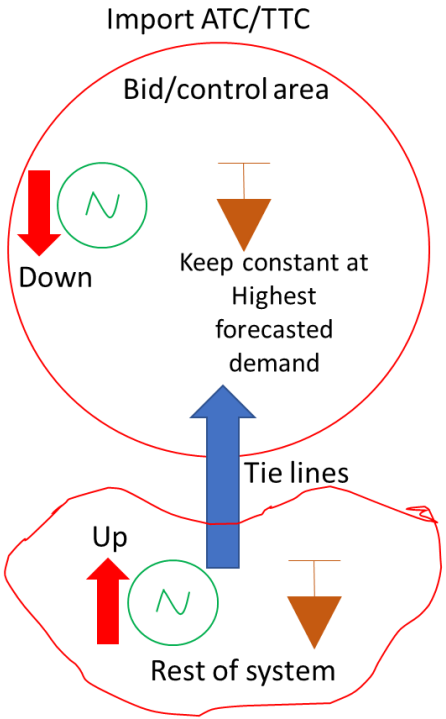
Figure 1: Limits to Total Transfer Capability

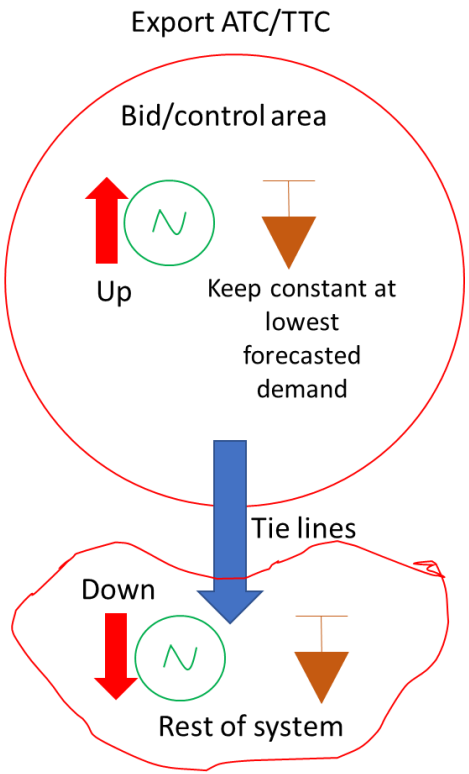
TTC = Minimum of {Thermal Limit, Voltage Limit, Stability Limit}

Transfer Capability: Assessment Methodology



Incremental Despatch





Credible Contingencies

Credible Contingencies

- Outage of single transmission element (N-1) in the transmission corridor or connected system
- Outage of a largest unit in the importing control area station

Details available in **CEA, Grid Standards, Regulations 2010**

https://cea.nic.in/wp-content/uploads/2020/02/grid_standards_reg.pdf

Total Transfer Capability shall be limited by :

- Violation of grid voltage operating range or
- Violation of transmission element operating limit in the base case or
- Violation of emergency limit in the contingency case

Permissible Loading Limits for Transmission Elements

- The loading limit for a transmission line is usually its thermal loading limit
- The loading limit for an ICT is its name plate rating
- Thermal loading limits of Transmission Lines vary with:
  - Conductor Type
  - Ambient and Conductor Temperature

Thermal Loading Limits for ACSR Moose equivalent Conductors

Conductor Type (metallic area) and Dimension	Ambient Temperature (deg C)	AMPACITY FOR Maximum Conductor Temperature (deg C)					
		65	75	85	95	120	150
ACSR Moose (597 Sq.mm) Dia:31.77mm	40	528	728	874	NA	NA	NA
	45	378	631	798	NA	NA	NA
	48	247	565	749	NA	NA	NA
	50	83	516	714	NA	NA	NA

CEA Manual on Transmission Planning Criteria, 2023

https://cea.nic.in/wp-content/uploads/psp___a_ii/2023/03/Manual_on_Transmission_Planning_Criteria_2023.pdf

Steady State Voltage Limits

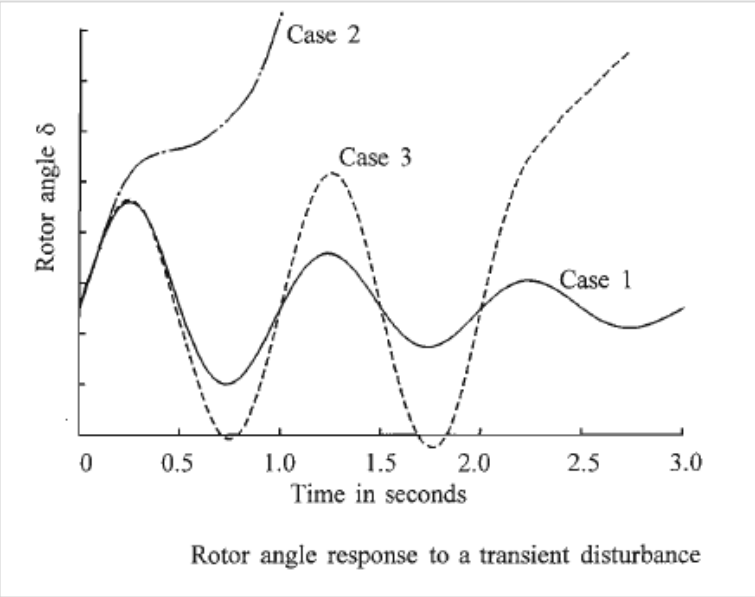
S. No.	Nominal System Voltage (kV rms)	Maximum (kV rms)	Minimum (kV rms)
1	765	800	728
2	400	420	380
3	220	245	198
4	132	145	122
5	110	121	99
6	66	72	60
7	33	36	30

CEA, Grid Standards, Regulations 2010

https://cea.nic.in/wp-content/uploads/2020/02/grid_standards_reg.pdf

Stability Limit

- The system is said to be stable if under any one of the specified contingencies, the system remains stable and sustains integrity so that no generator loses synchronism and no part gets isolated from the rest of the system



Rotor angle response to a transient disturbance

The contingencies are specified in CEA Grid Standards, 2010

Reliability Margin

- Myriads of assumptions in Transfer Capability Determination

- Transmission Reliability Margin (TRM) is therefore required because of the inherent uncertainties in assumptions and providing necessary flexibility in real-time

Defined based on the minimum of,

1. **Equipment Loading (Thermal or any other operational Limit)**
2. **Voltage Stability**
3. **Transient Stability**

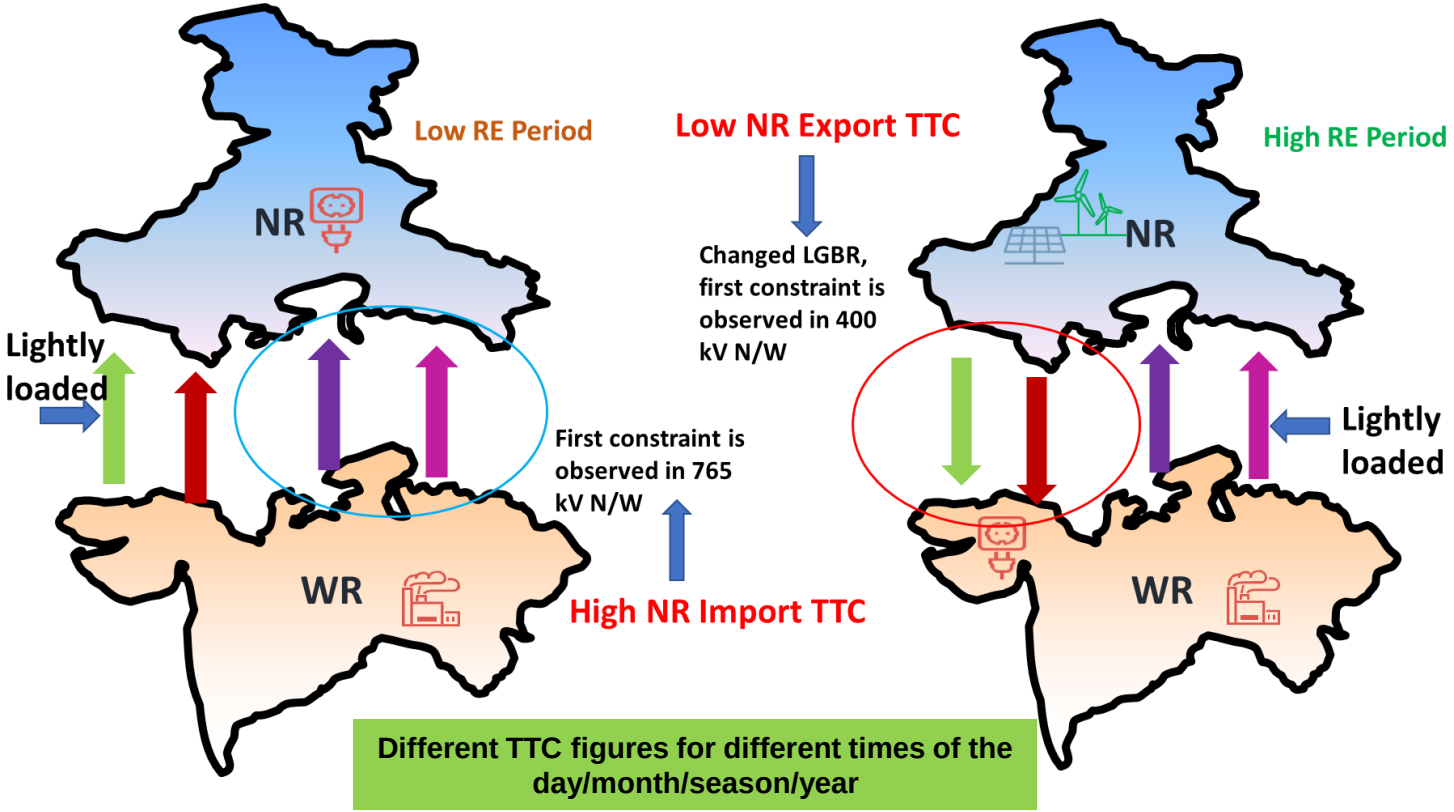
- **Size of largest generating unit in the importing control or bid area OR**
- **Two percent (2%) of the total anticipated peak demand met in MW of the control/bid area**

Total Transfer Capability
less
Transmission Reliability Margin

Transfer Capability: Limitations and Changing Dynamics

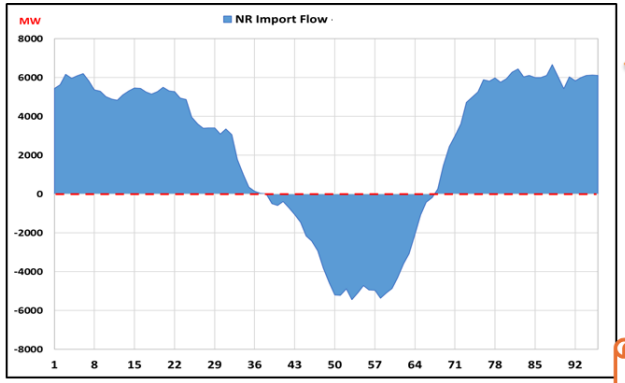
- Terminal Equipment Surprises at few locations
- ICTs / Lines with radial nature load as limiting constraints – Operator experience of paramount importance
- Significant change in inter-regional flow pattern with large scale RE integration

Transfer Capability: Assessment In Different Time Periods

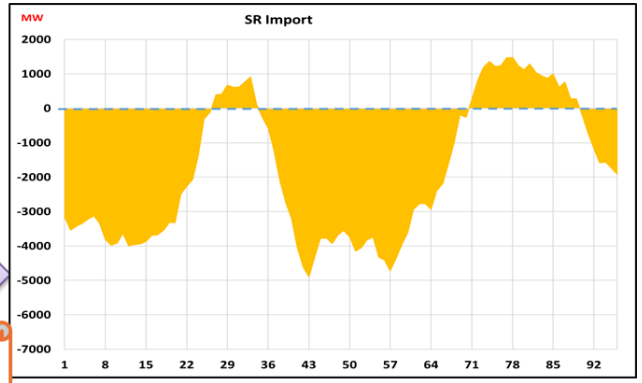


Different TTC figures for different times of the day/month/season/year

Behavioral Change in Flow Patterns

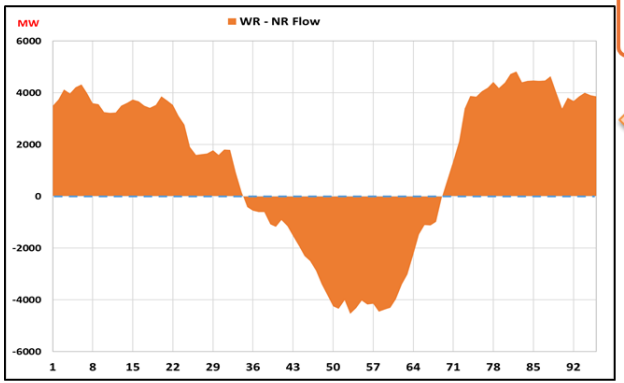


NR Import

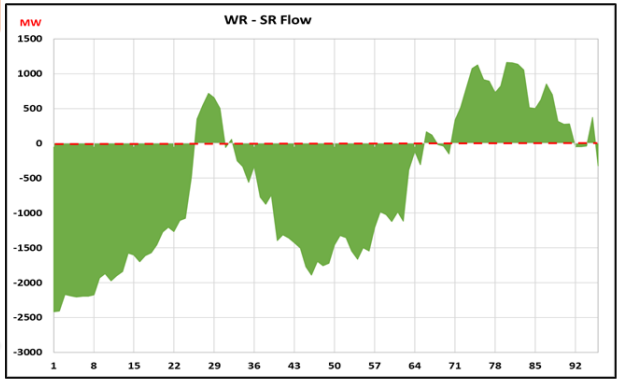


SR Import

Bi-directional Flows
The New Normal !!

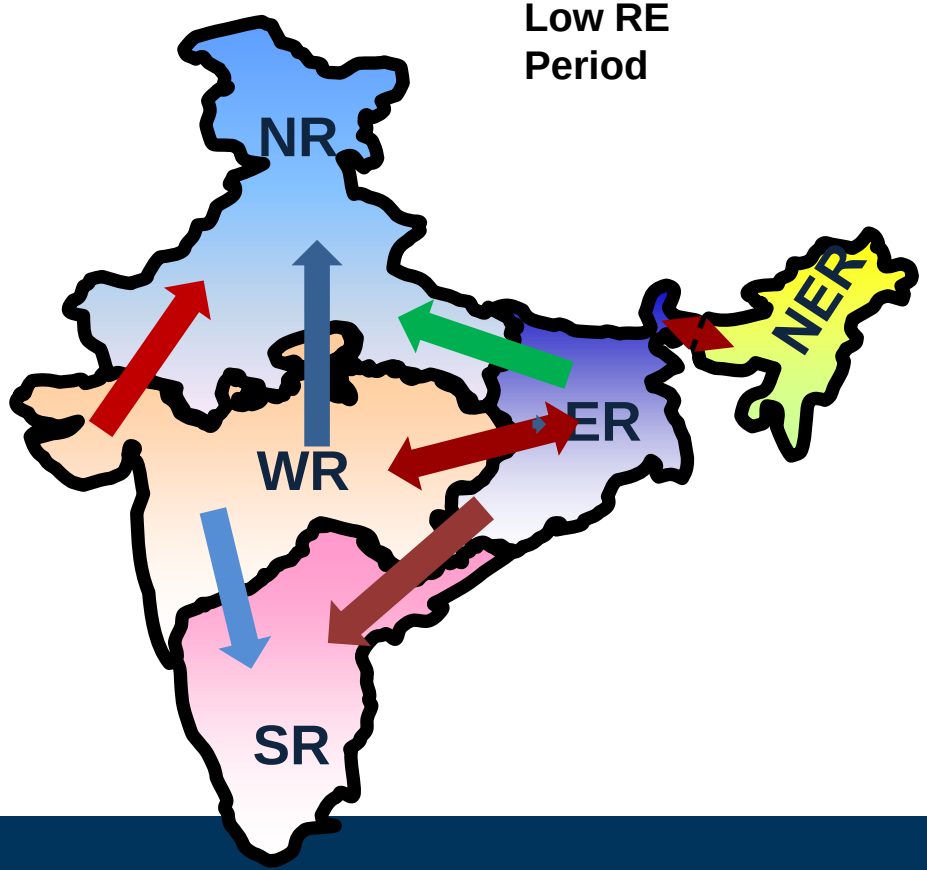


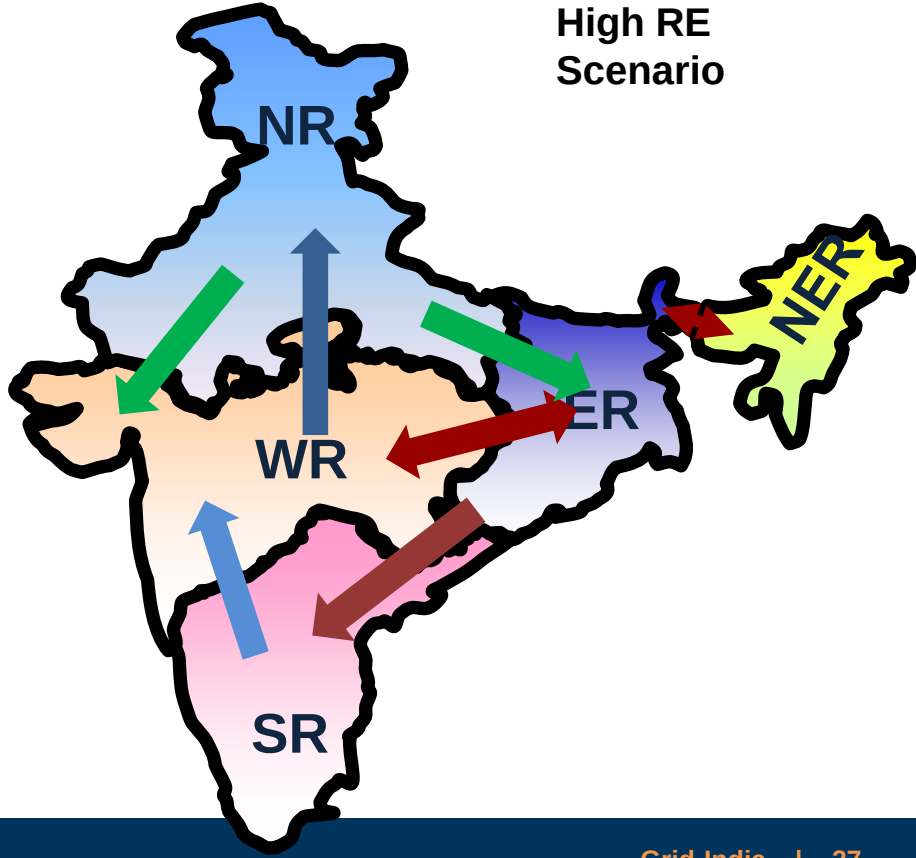
WR - NR



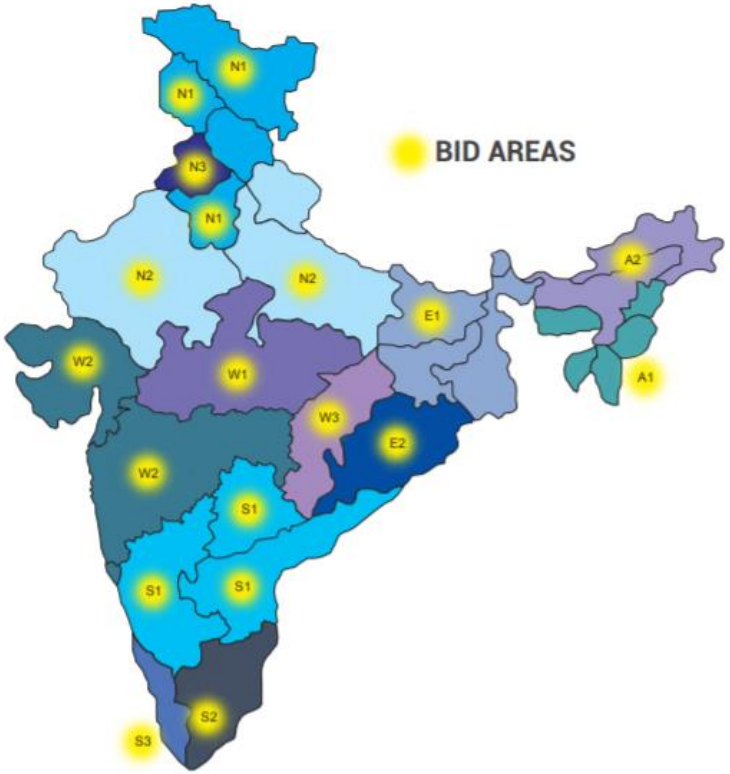
WR -SR

Behavioral Change in Flow Patterns





Bid Areas in Indian Power System



Bid Area	Region	States covered under Bid Area
N1	North Region	Jammu and Kashmir, Himachal Pradesh, Chandigarh, Haryana
N2	North Region	Uttar Pradesh , Uttaranchal, Rajasthan, Delhi
N3	North Region	Punjab
E1	East Region	West Bengal, Sikkim, Bihar, Jharkhand
E2	East Region	Orissa
W1	West Region	Madhaya Pradesh
W2	West Region	Maharashtra, Gujarat, Daman and Diu, Dadar and Nagar Haveli, North Goa
W3	West Region	Chhattisgarh
S1	South Region	Andhra Pradesh, Telangana, Karnataka, Pondicherry (Yanam), South Goa
S2	South Region	Tamil Nadu, Pondicherry (Puducherry), Pondicherry (Karaikal), Pondicherry (Mahe)
S3	South Region	Kerala
A1	North East Region	Tripura, Manipur, Mizoram, Nagaland
A2	North East Region	Assam, Arunachal Pradesh, Meghalaya

Transfer Capability Declaration by Grid-India

- Declared for each bid area – 11 months in advance
- Transfer Capability for Cross-border connections also being declared on 11 month ahead basis
- Regular revisions, as and when required, based on change in anticipated LGB, Network Topology or T-GNA margin
- 02 day ahead revisions (D-2) based on approved planned outages
- Same day revisions in real – time because of emergency/forced outages

https://posoco.in/download/atc_nldc_oct24_rev0/?wpdmdl=54384

Transfer Capability Declaration by Grid-India

National Load Despatch Centre
Total Transfer Capability for Jun 2024

Issue Date:Jun 25 2024 | Issue Time:09:42:10 | Revision No :20

Corridor	Date	Time Period(hrs)	Total Transfer Capability(TTC)	Reliability Margin(RM)	Available Transfer Capability(ATC)	Approved GNA(MW)	Margin for T-GNA (MW)	Changes w.r.t. Previous Revision	Comment
ER-NER	01 Jun to 18 Jun	00:00 to 18:00	900	60	840	NA		0	
		18:00 to 22:00	550	60	490	NA		0	
		22:00 to 24:00	900	60	840	NA		0	
	19 Jun to 19 Jun	00:00 to 09:00	900	60	840	NA		0	
		09:00 to 18:00	800	60	740	NA		0	
		18:00 to 22:00	470	60	410	NA		0	
		22:00 to 24:00	800	60	740	NA		0	
	20 Jun to 20 Jun	00:00 to 09:00	900	60	840	NA		0	
		09:00 to 18:00	800	60	740	NA		0	
		18:00 to 22:00	470	60	410	NA		0	
		22:00 to 24:00	800	60	740	NA		0	

Corridor	Date	Time Period(hrs)	Total Transfer Capability(TTC)	Reliability Margin(RM)	Available Transfer Capability(ATC)	Approved GNA(MW)	Margin for T-GNA (MW)	Changes w.r.t. Previous Revision	Comment
	Jun	06:00 to 18:00	5500	300	5200	NA		0	
		18:00 to 24:00	5500	300	5200	NA		0	
WR-NR	01 Jun to 08 Jun	00:00 to 24:00	22150	1000	21150	NA		0	
	09 Jun to 09 Jun	00:00 to 08:00	22150	1000	21150	NA		0	
		08:00 to 24:00	19600	1000	18600	NA		0	
	10 Jun to 18 Jun	00:00 to 24:00	22150	1000	21150	NA		0	
	19 Jun to 20 Jun	00:00 to 24:00	19600	1000	18600	NA		0	
	21 Jun to 22 Jun	00:00 to 06:00	19600	1000	18600	NA		0	
		06:00 to 18:00	15400	1000	14400	NA		0	
		18:00 to 24:00	19600	1000	18600	NA		0	
	23 Jun to 25 Jun	00:00 to 06:00	22150	1000	21150	NA		0	
		06:00 to 09:00	22150	1000	21150	NA		0	
		09:00 to 16:00	17850	1000	16850	NA		0	
		16:00 to 18:00	22150	1000	21150	NA		0	
		18:00 to 24:00	22150	1000	21150	NA		0	

Transfer Capability Declaration by Grid-India

Limiting Constraints

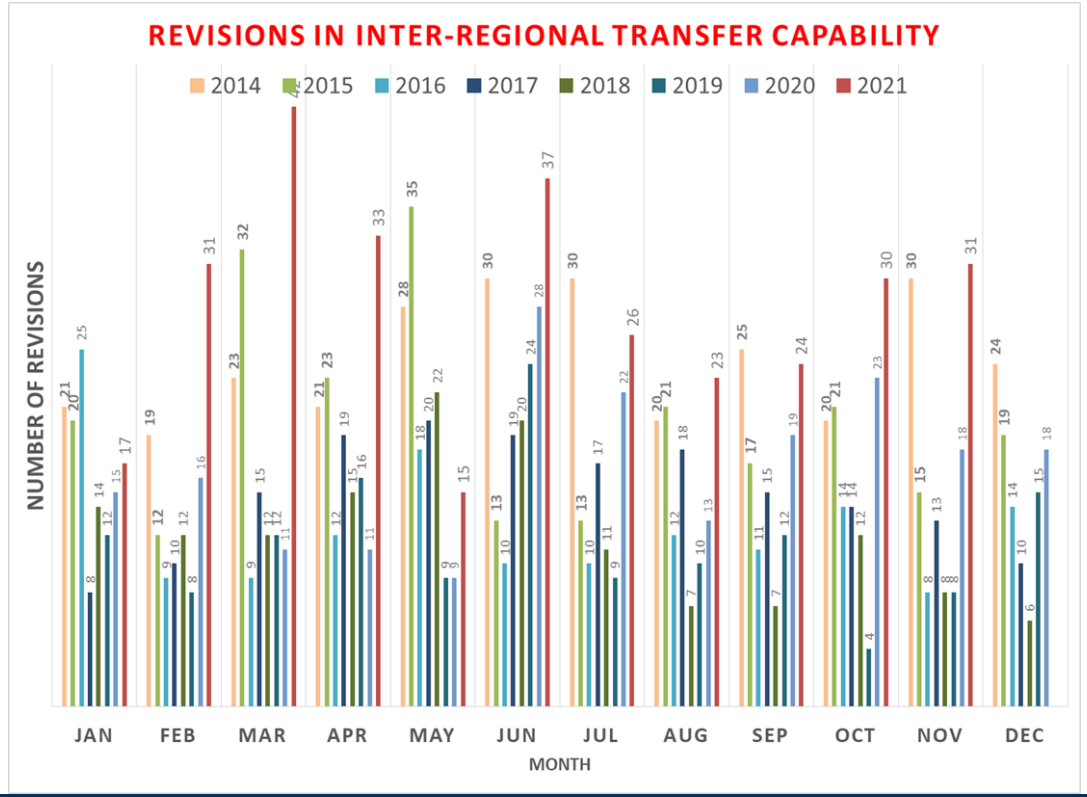
Corridor	Constraints	Revisions
WR-NR	1. N-1 contingency of one ckt of 765 kV Vindhyachal-Varanasi will overload the other circuit. 2. N-1 contingency of one ckt of 2*1500 MVA 765/400 kV ICTs at Agra-PG will overload the remaining ICT. 3. Low Voltages in major load Centers in the northern region during solar hours.	0-16,17-18-19,20
NR-ER	1. Overloading of one circuit of 400 kV New Ranchi – New PPSP D/C on the tripping of the other circuit 2. Overloading of one circuit of 400 kV Kahalgaon – Farakka D/C on the tripping of the other circuit 3. Overloading of 400 kV Farakka – Sagardighi – 1 on the tripping of 400 kV Farakka – Sagardighi - 2	0-20
WR-ER	1. Overloading of one circuit of 400 kV New Ranchi – New PPSP D/C on the tripping of the other circuit 2. Overloading of one circuit of 400 kV Kahalgaon – Farakka D/C on the tripping of the other circuit 3. Overloading of 400 kV Farakka – Sagardighi – 1 on the tripping of 400 kV Farakka – Sagardighi - 2	0-20
ER-NR	Inter-regional flow pattern towards NR	0-20
WR-SR	Outage of any one of the 2x1500 MVA, 765/400 kV ICTs at Maheswaram overloads the other ICT	0-20
ER-SR	1. Low Voltage at Gazuwaka (East) Bus.	0-20
SR-WR	a) Angular separation between Kudgi & Kolhapur (PG) under N-1 of 400 kV Kudgi - Kolhapur (PG) D/C touches 30 deg b) N-1 non-compliance of 2*1500 MVA, 765/400 kV ICTs at Section– A at Raigarh - PS(Kotra) with increase in HVDC Raigarh – Pugalur Bipole – II power order beyond 950 MW in SR to WR Direction (Solar Hours) c) N-1 non-compliance of 2*1500 MVA, 765/400 kV ICTs at Section– B at Raigarh -PS (Kotra) with increase in HVDC Raigarh – Pugalur Bipole – I power order beyond 450 MW in SR to WR Direction (Solar Hours) d) N-1 Contingency of 400 kV Pune – Kalwa will overload 400 kV Pune -Khargar and vice-versa	0-20
ER-NER	a) N-1 contingency of 400 kV Bongaigaon - Azara line b) High Loading of 220 kV Balipara-Sonabil D/C	0-20
NER-ER	a) N-1 contingency of 400 kV Bongaigaon-Alipurduar I or II b) High Loading of 400 kV Bongaigaon-Alipurduar II or I	0-20
NR_IMPORT	1. N-1 contingency of one ckt of 765 kV Vindhyachal-Varanasi will overload the other circuit. 2. N-1 contingency of one ckt of 2*1500 MVA 765/400 kV ICTs at Agra-PG will overload the remaining ICT. 3. Low Voltages in major load Centers in the northern region during solar hours. 4. Inter-regional flow pattern towards NR	0-16,17-18-19,20
NR_EXPORT	Outage of any one of the two circuits from 400 kV Kankroli to 400 kV Zerda shall overload the other circuit.	0-20
NER_IMPORT	a) N-1 contingency of 400 kV Bongaigaon - Azara line b) High Loading of 220 kV Balipara-Sonabil D/C	0-20
NER_EXPORT	a) N-1 contingency of 400 kV Bongaigaon-Alipurduar I or II b) High Loading of 400 kV Bongaigaon-Alipurduar II or I	0-20
SR_IMPORT	1. Outage of any one of the 2x1500 MVA, 765/400 kV ICTs at Maheswaram overloads the other ICT 2. Low Voltage at Gazuwaka (East) Bus	0-20
SR_EXPORT	a) Angular separation between Kudgi & Kolhapur (PG) under N-1 of 400 kV Kudgi - Kolhapur (PG) D/C touches 30 deg b) N-1 non-compliance of 2*1500 MVA, 765/400 kV ICTs at Section– A at Raigarh - PS(Kotra) with increase in HVDC Raigarh – Pugalur Bipole – II power order beyond 950 MW in SR to WR Direction (Solar Hours) c) N-1 non-compliance of 2*1500 MVA, 765/400 kV ICTs at Section– B at Raigarh -PS (Kotra) with increase in HVDC Raigarh – Pugalur Bipole – I power order beyond 450 MW in SR to WR Direction (Solar Hours) d) N-1 Contingency of 400 kV Pune – Kalwa will overload 400 kV Pune -Khargar and vice-versa	0-20

Transfer Capability Declaration by Grid-India

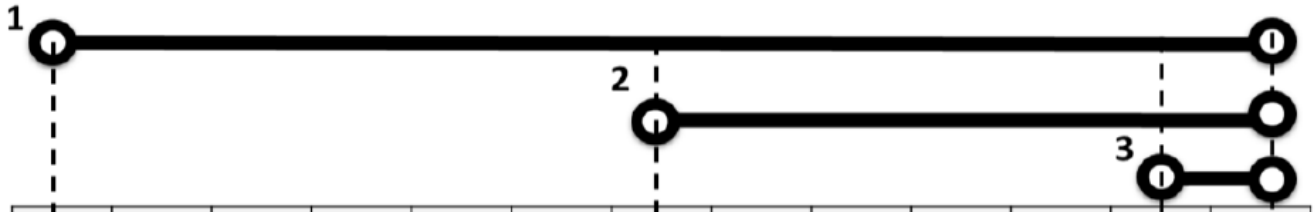
Revision Summary

Revision	Date Of Revision	Period Of Revision	Reason for Revision/Comment	Corridor Affected
1	28 Dec	01 Jun to 30 Jun	Change in T-GNA Margin due to grant of additional 174 MW GNA to Uttar Pradesh from outside Northern Region	NR_IMPORT
		01 Jun to 30 Jun	Change in T-GNA Margin due to grant of additional 55 MW GNA to Mizoram from outside North Eastern Region	NER_IMPORT
2	26 Jan	01 Jun to 30 Jun	TTC/ATC revised in view of change in load generation balance and inter-regional flow pattern towards NR	WR-NR
		01 Jun to 30 Jun	TTC/ATC revised in view of change in load generation balance and inter-regional flow pattern towards NR	ER-NR
		01 Jun to 30 Jun	TTC/ATC increased with the Commissioning of 765/400 kV, 1500 MVA ICT - 3 at Nizamabad and Change in LGB	WR-SR
		01 Jun to 30 Jun	TTC/ATC increased with the Commissioning of 765/400 kV, 1500 MVA ICT - 3 at Nizamabad and Change in LGB	ER-SR
		01 Jun to 30 Jun	TTC/ATC revised in view of change in load generation balance and inter-regional flow pattern towards NR	NR_IMPORT
		01 Jun to 30 Jun	TTC/ATC increased with the Commissioning of 765/400 kV, 1500 MVA ICT - 3 at Nizamabad and Change in LGB	SR_IMPORT

Transfer Capability Declaration by Grid-India



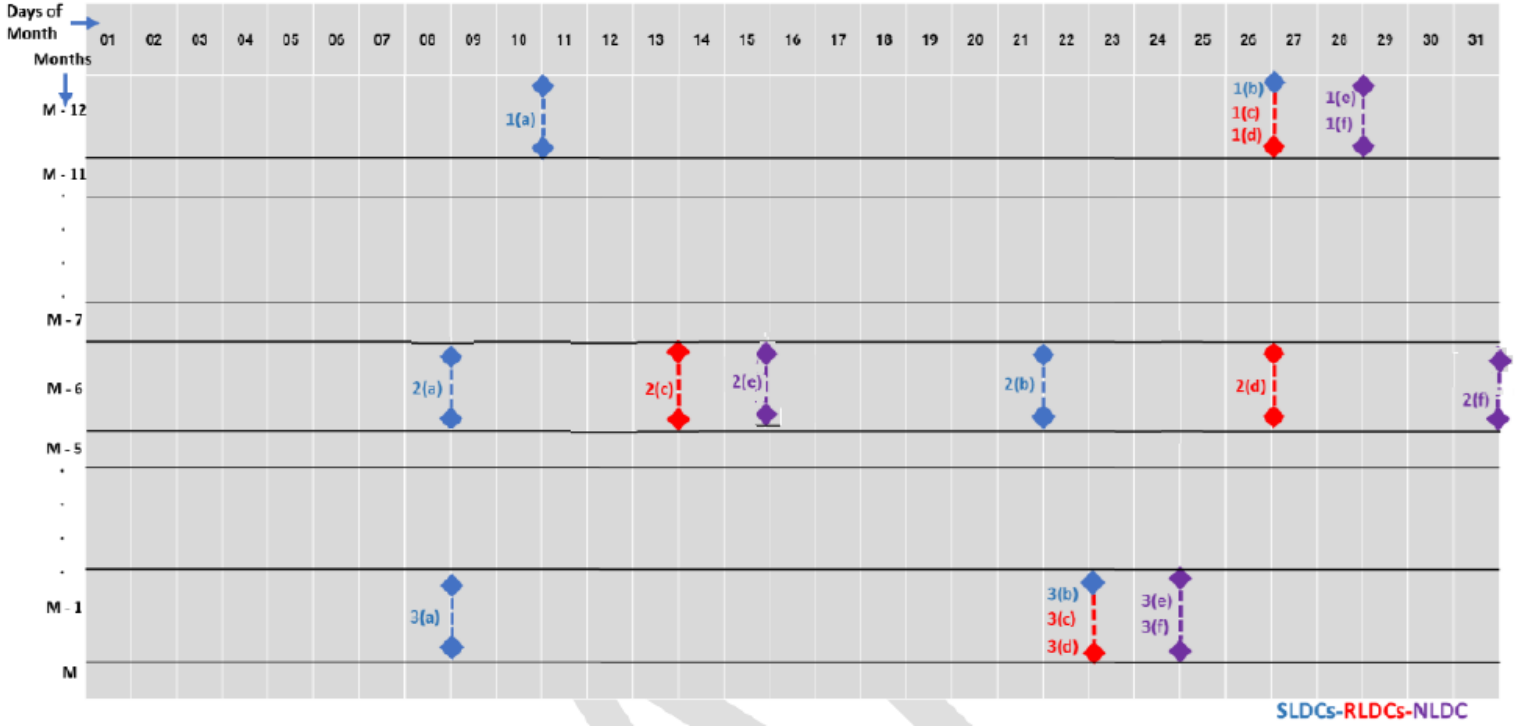
Timelines for Study Cases



Preparation of 3 Sets of Simulation Base-Cases

1. Base cases to be prepared in **Jan 2024** for Revision – 0 TTC/ATC Declaration for **Jan 2025**
(For TTC Declaration)
2. Base cases to be prepared in **July 2024** for 6 Month Ahead Interconnection Studies for elements to be integrated in **January 2025**
(For Interconnection Studies)
3. Base cases to be prepared in **December 2024** for 1 Month Ahead TTC/ATC Declaration & Operational Studies for **January 2025**
(For TTC Declaration and Operational Planning Studies)

Timelines for Study Cases

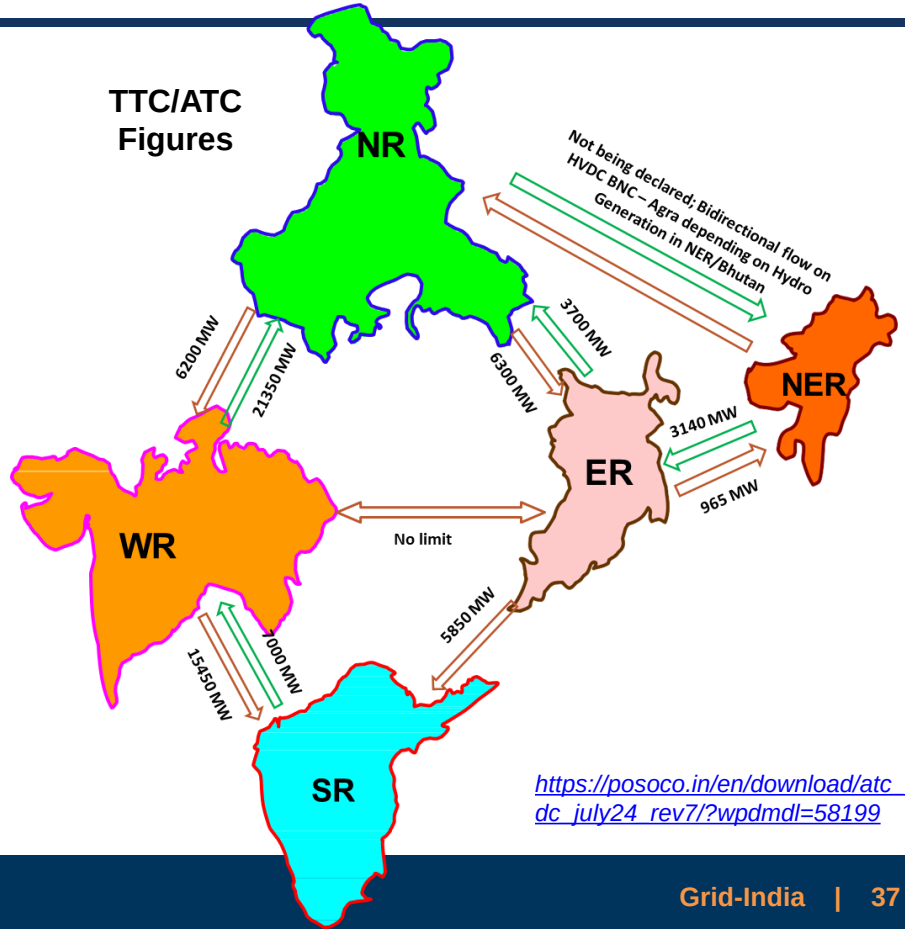


Congestion

Congestion means a situation where the demand for **transmission capacity or power flow on any transmission corridor exceeds its Available Transfer Capability;**

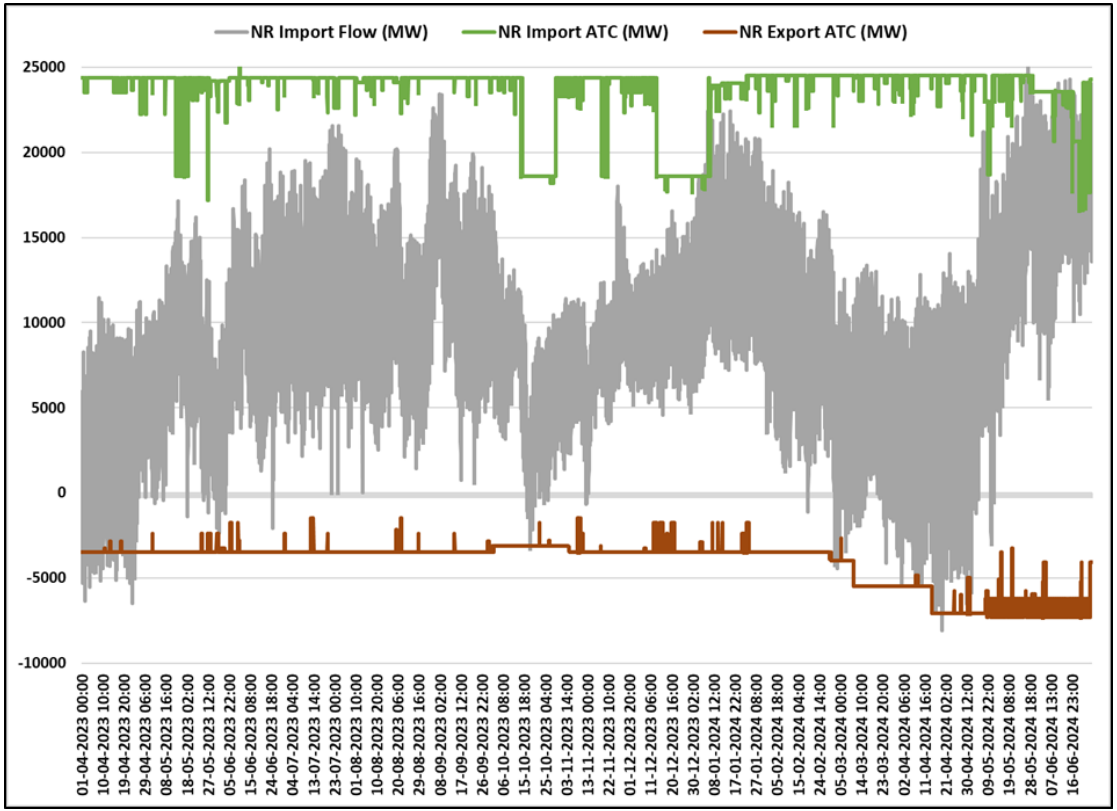
Source: IEGC, 2023

Congestion in Real-Time



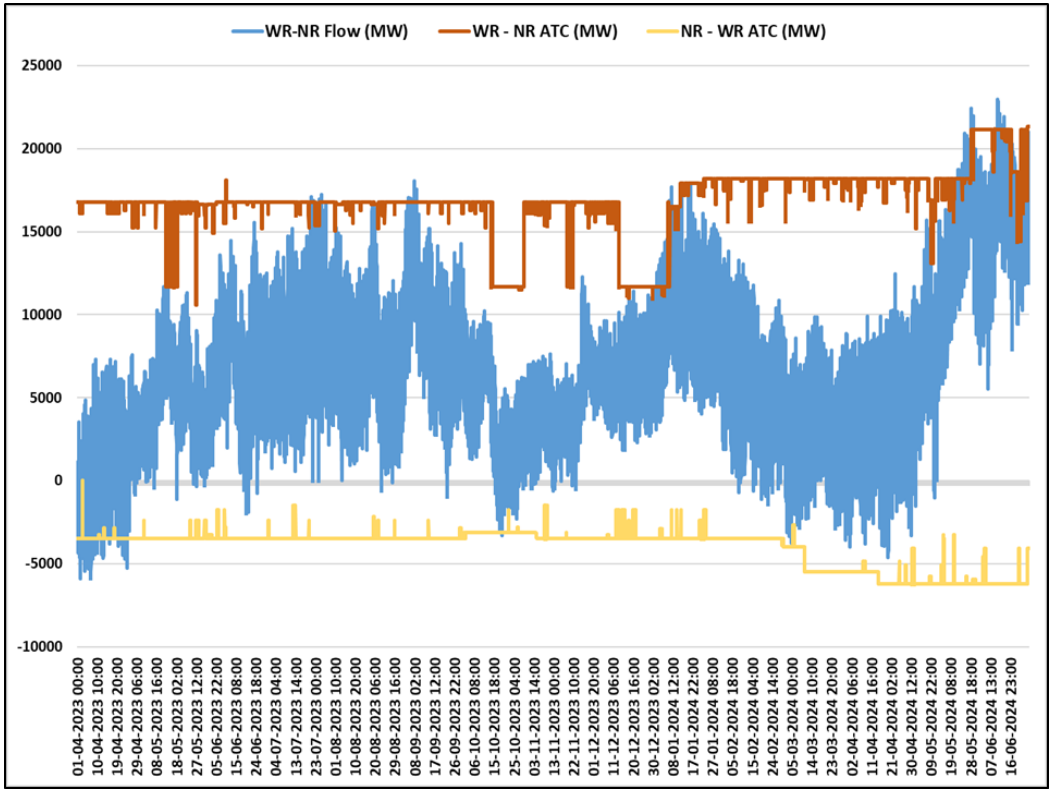
https://posoco.in/en/download/atc_ndc_july24_rev7/?wpdmdl=58199

Congestion in Real-Time



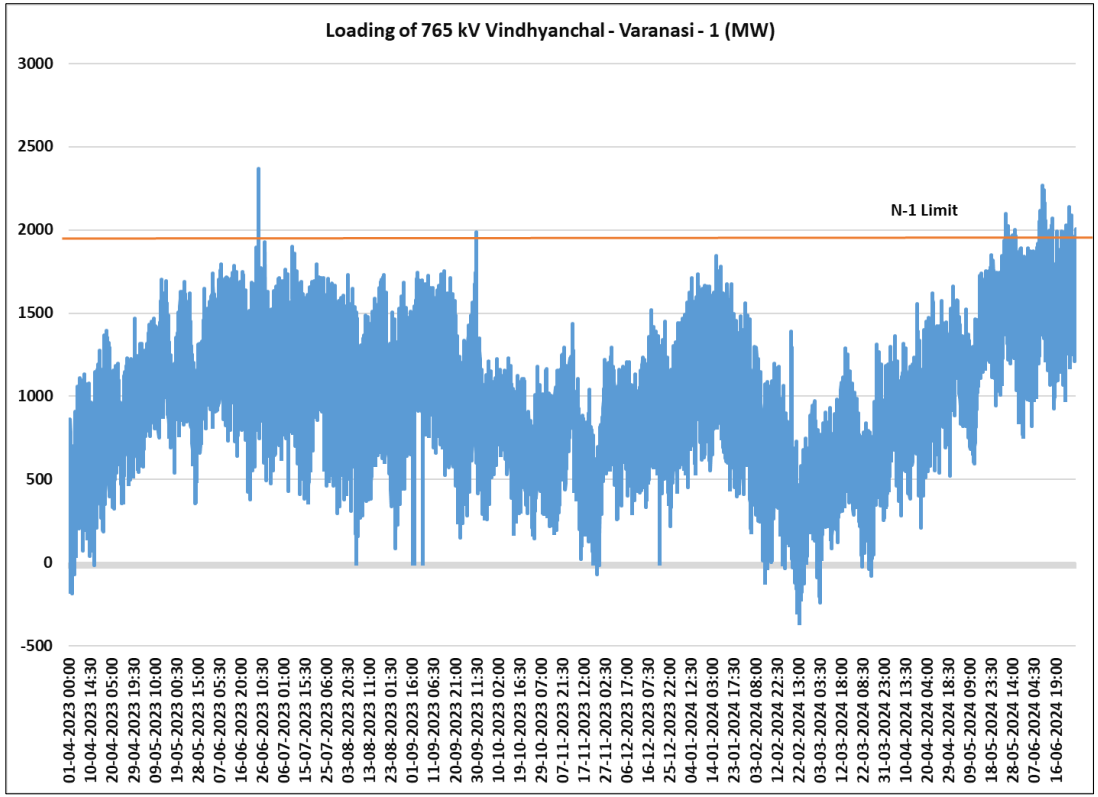
1. Congestion in WR-NR corridor and NR Import during summer months
2. High loading on WR-NR EHV lines (765 kV V'chal – Varanasi D/C)
3. Different TTC/ATC during solar and non-solar hours
4. Low voltages during solar hours
5. Optimal utilization of HVDCs

Congestion in Real-Time



1. Congestion in WR-NR corridor and NR Import during summer months
2. High loading on WR-NR EHV lines (765 kV V'chal – Varanasi D/C)
3. Different TTC/ATC during solar and non-solar hours
4. Low voltages during solar hours
5. Optimal utilization of HVDCs
6. Congestion in NR-WR corridor during peak solar period and low demand in NR

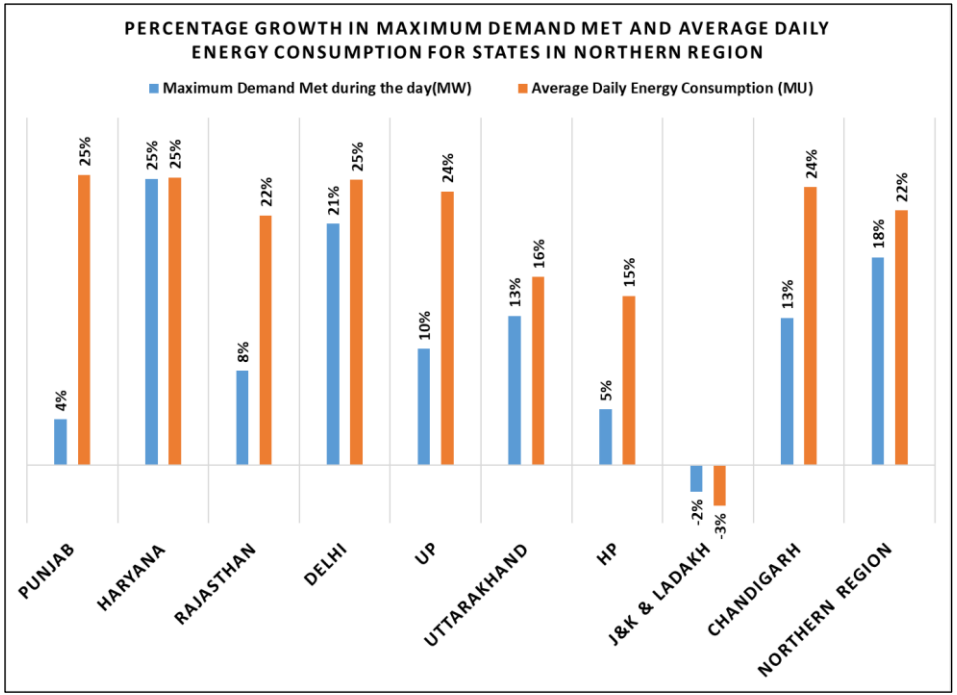
Congestion in Real-Time



1. Validation of limiting constraint in real-time

2. Review of TTC/ATC figures if any mismatch observed in real-time v/s simulated scenario

Congestion in Real-Time



Growth Comparison between Q1* of 2024-25 with Q1* of 2023-24 (*1st April to 25th June)

*Max Demand Met is max value in given range and Daily Energy Met is Avg value

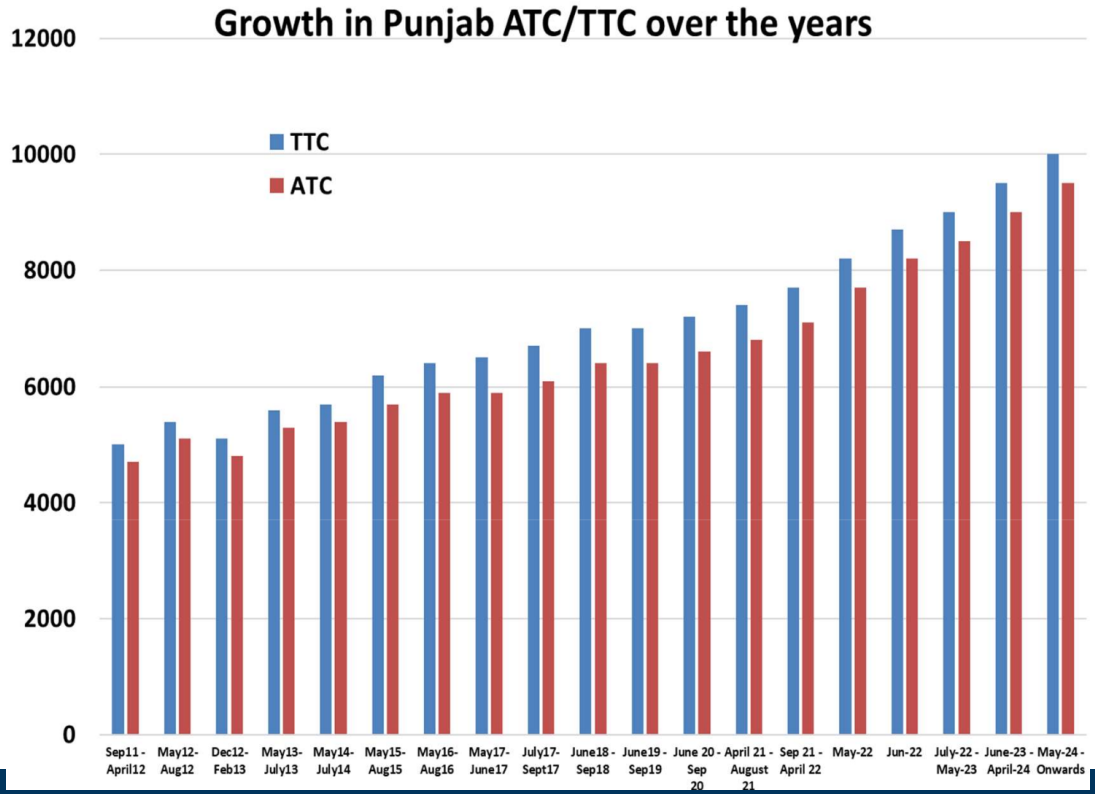
State/Region	Maximum Demand Met during the day(MW)		Maximum Daily Energy Consumption (MU)	
	MW	Date of Occurrence	MU	Date of Occurrence
Punjab	15860	18-06-2024	345	25-06-2024
Haryana	14394	19-06-2024	293.4	19-06-2024
Rajasthan	17949	20-01-2024	379.1	30-05-2024
Delhi	8568	18-06-2024	177.7	18-06-2024
UP	30032	13-06-2024	658.8	17-06-2024
Uttarakhand	2863	14-06-2024	68.2	29-05-2024
HP	2235	20-01-2024	40.8	12-06-2024
J&K(UT) and Ladakh(UT)**	3636	29-06-2023	66.8	26-01-2024
Chandigarh	443	13-06-2024	9.1	18-06-2024

***Up to 26th June 2024**

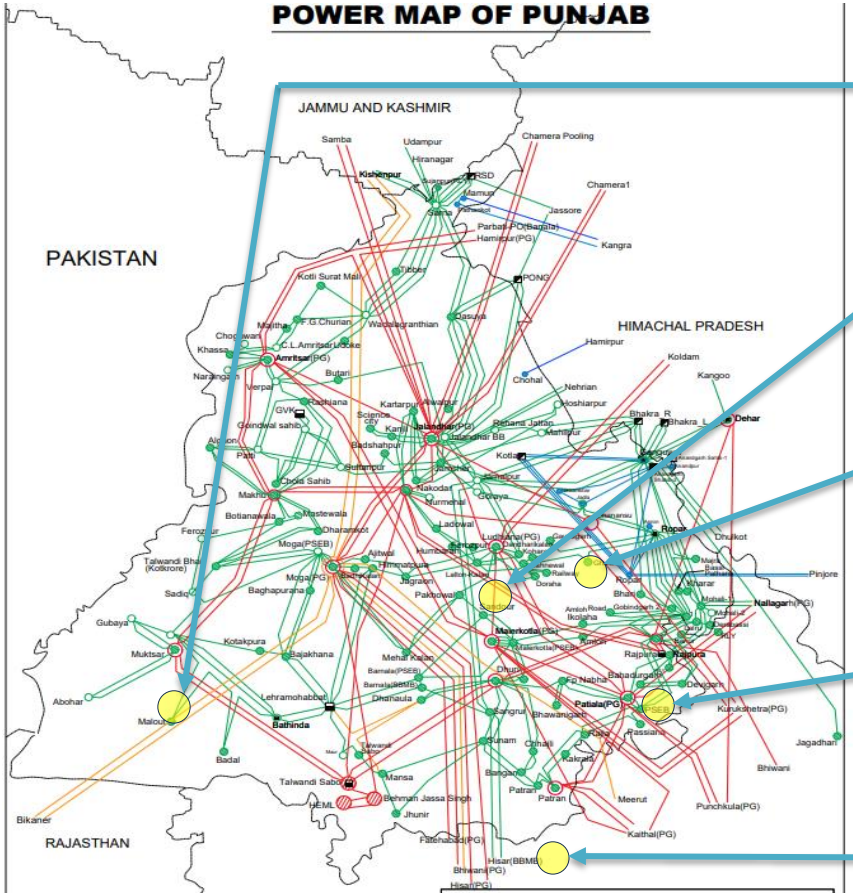
Congestion in Real-Time

S. No.	Corridor	TTC (MW)	ATC (MW)	Limiting Constraints
1.	**Punjab** (Constraint Details)	10000	9500	➢ N-1 contingency of 400/220KV ICTs at Rajpura, Ludhiana, Muktsar. ➢ Loading close to N-1 contingency limits at 400/220 kV Patran, Malerkotla, Dhanansu and Jalandhar ICT ➢ 220 kV underlying network at Jalandhar, Ludhiana and Amritsar
2.	**UP** (Constraint Details)	16500	15900	N-1 contingency of 400/220kV Azamgarh, Allahabad (PG), Gorakhpur (UP), Sarnath, Lucknow (PG) ICTs
3.	**Haryana** (Constraint Details)	10800	10500	N-1 contingency of 400/220kV ICTs at Deepalpur and Panipat (BBMB)
4.	**Rajasthan** (Constraint Details)	7600	7000	N-1 contingency of 400/220kV Heerapura, Jodhpur, Bikaner, Ajmer, Merta, Hindaun and Bhinmal ICTs Low voltages at Hindaun, Alwar etc.
5.	**Delhi** (Constraint Details)	7300	7000	N-1 contingency of 400/220kV Mundka, HarshVihar and Bawana (bus-split) ICTs.
6.	**Uttrakhand** (Constraint Details)	1700	1600	➢ N-1 contingency of 400/220kV Kashipur ICTs. High loading of 220kV Roorkee-Roorkee and 220kV CBGanj-Pantnagar lines
7.	**HP** (Constraint Details)	1680	1580	➢ High loading of 220kV Hamirpur-Hamirpur D/C. Overloading of 2*200MVA Kunihar transformers
8.	**JK&Ladakh UT** (Constraint Details)	2800	2700	➢ N-1 contigency of 400/220KV ICTs at Amargarh 220 kV underlying network at Amargarh, Wagoora

Congestion in Real-Time



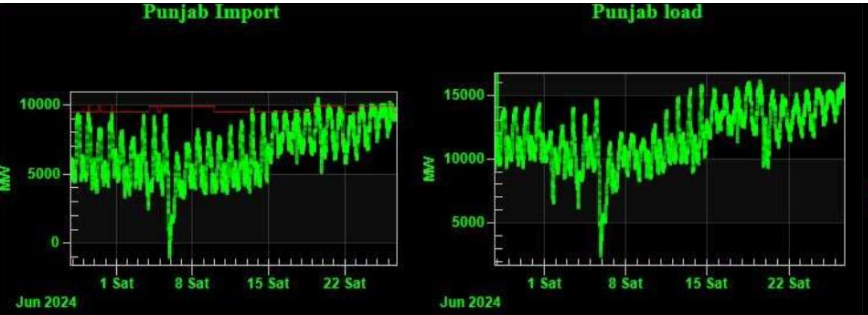
- Punjab was formed as separate bidarea in Sep 2011
- ICT augmentation done at PGCIL stations such as Patiala, Ludhiana, Moga and also PSTCL stations such as Rajpura, Nakodar, Makhu, Muktsar etc.
- Significant enhancement of Punjab ATC/TTC over the years
- Due to separate bid-area creation proactive approach seen from Punjab SLDC/ PSTCL side
- All NR states except Chandigarh U/T have started assessing import transfer capability of their control area and sharing the same with NRLDC/ NRPC

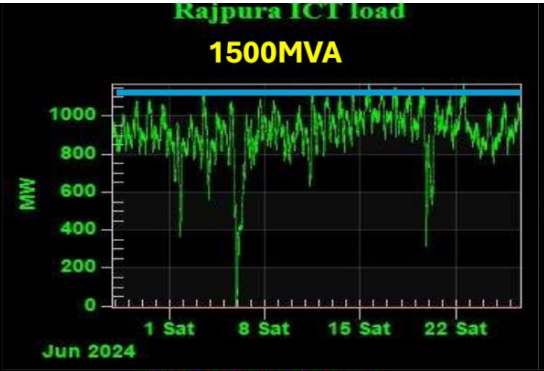

POWER MAP OF PUNJAB
JAMMU AND KASHMIR
PAKISTAN
HIMACHAL PRADESH
RAJASTHAN
400/220 kV Muktsar
400/220 kV Ludhiana
400/220 kV Dhanansu
400/220 kV Rajpura
400/220 kV Patran

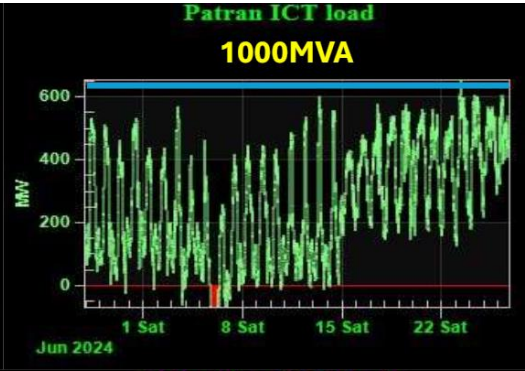
Punjab Map

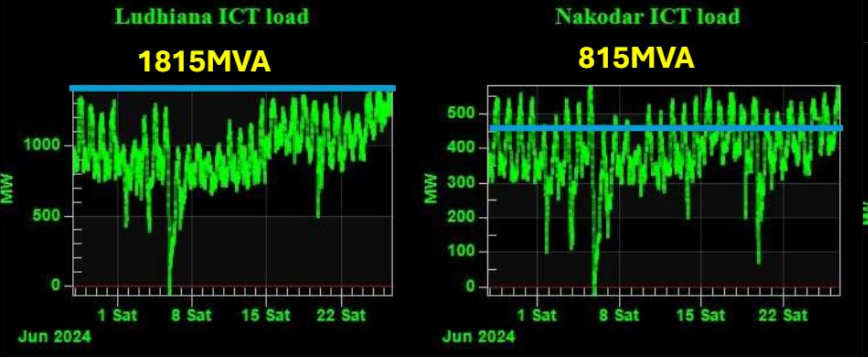
Congestion in Real-Time

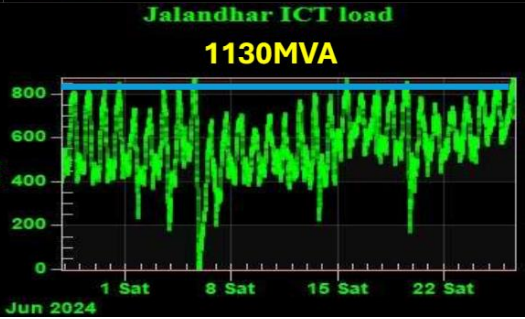
Punjab



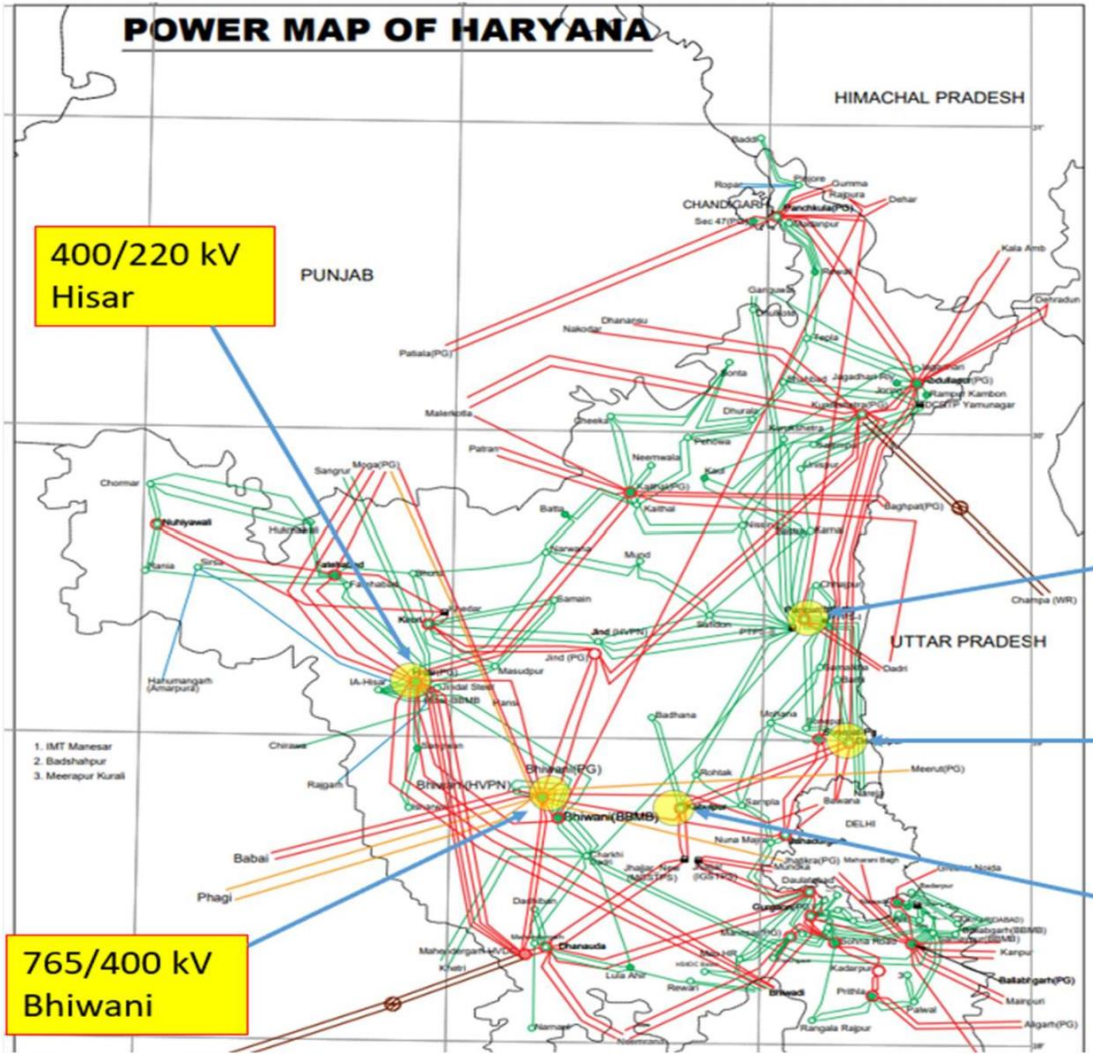






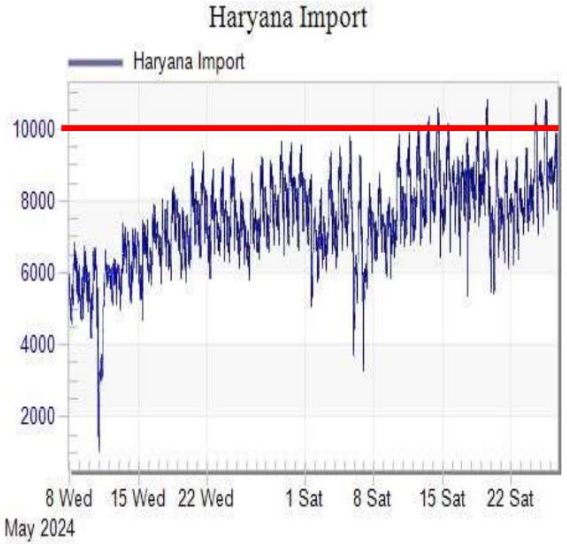


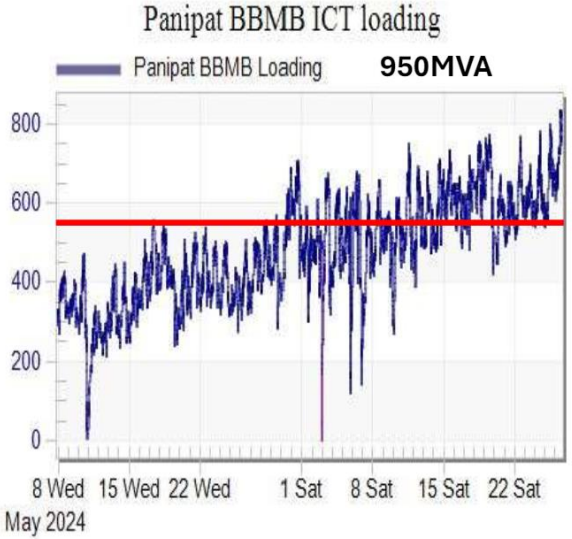
Haryana Map

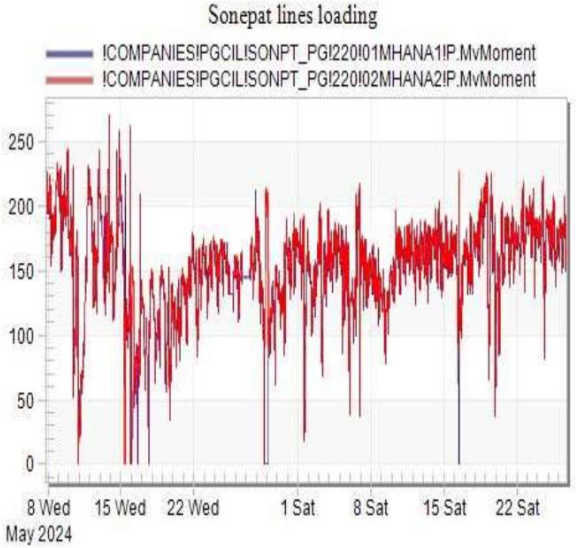

POWER MAP OF HARYANA
HIMACHAL PRADESH
PUNJAB
CHANDIGARH
UTTAR PRADESH
DELHI
400/220 kV Hisar
400/220 kV Panipat
400/220 kV Deepalpur
400/220 kV Kabulpur
765/400 kV Bhiwani
1. IMT Manesar
2. Badshahpur
3. Meerapur Kurali

Congestion in Real-Time

Haryana

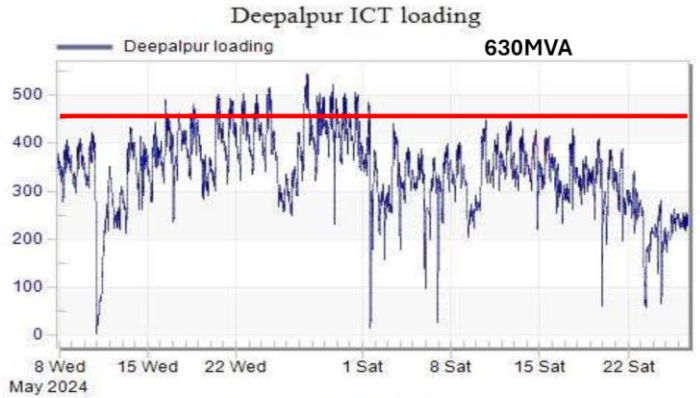


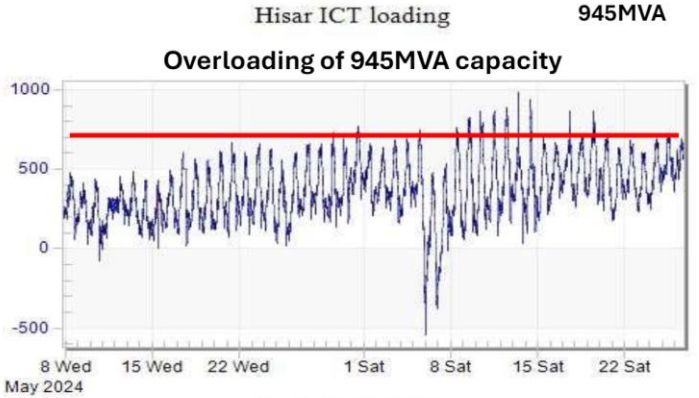


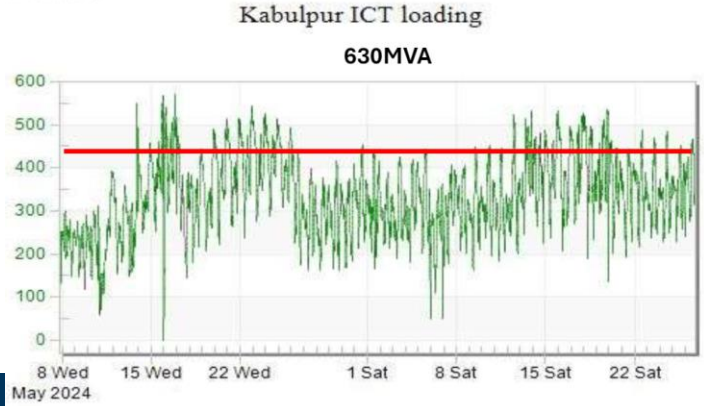


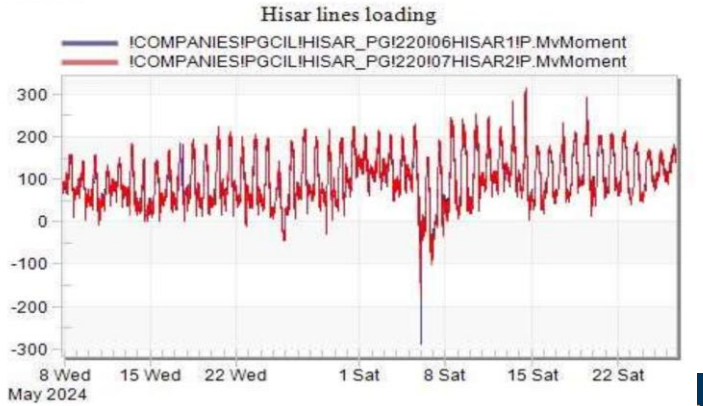
Congestion in Real-Time

Haryana

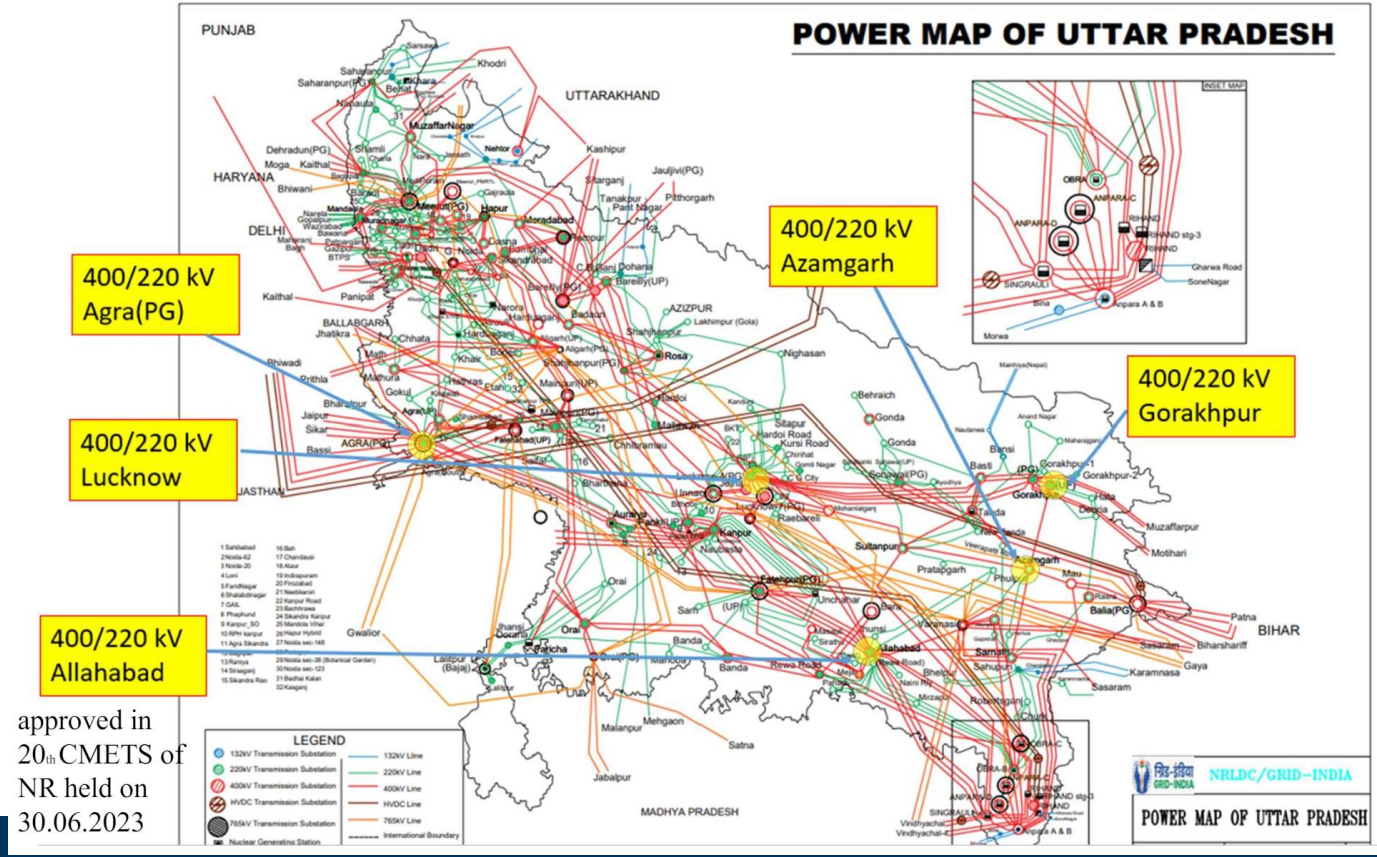








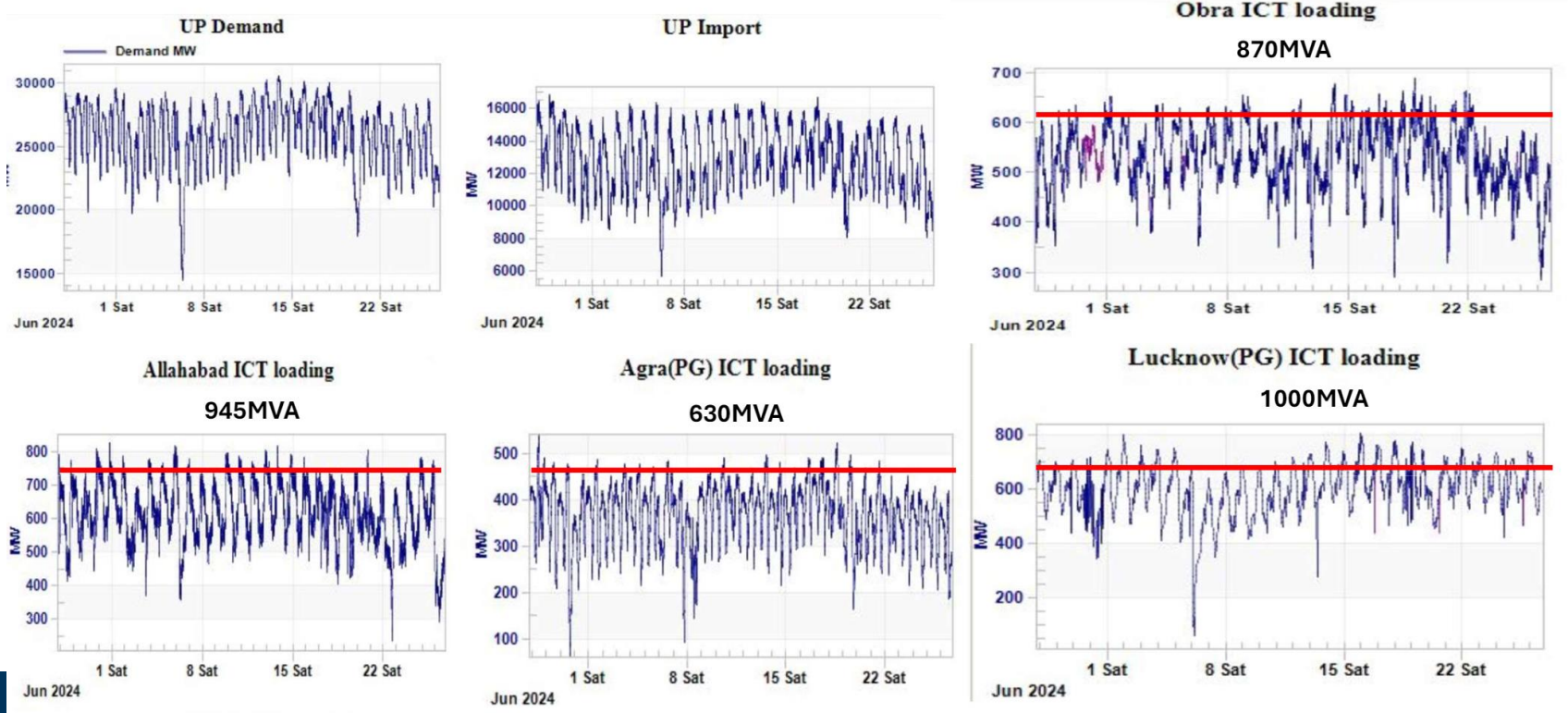
Congestion in Real-Time



approved in 20th CMETS of NR held on 30.06.2023

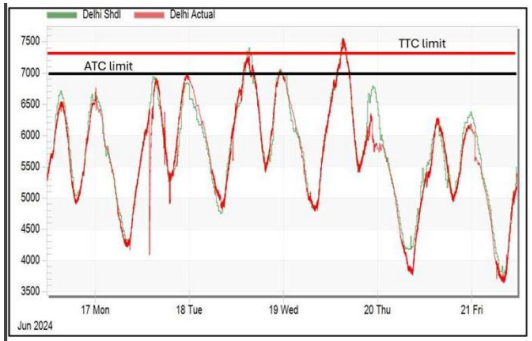
Congestion in Real-Time

Uttar Pradesh

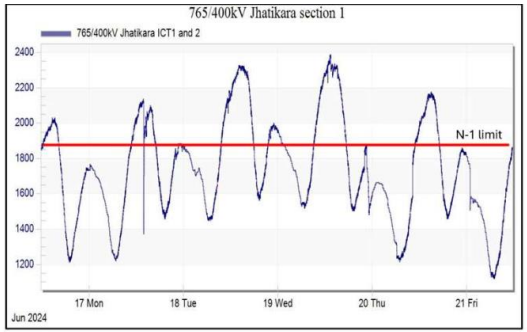


Congestion in Real-Time

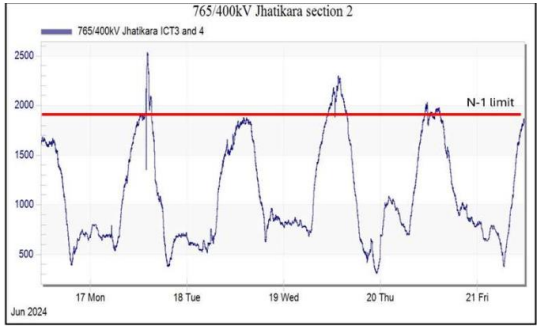
Delhi



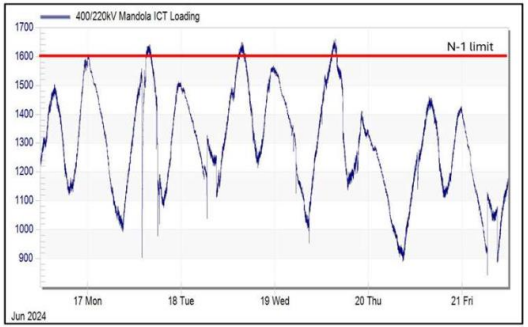
Delhi Schedule as well as actual crossing ATC/TTC limits



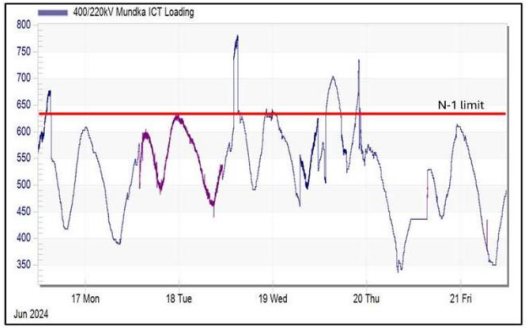
N-1 non-compliance of 765/400kV Jhatikara ICT 1 & 2



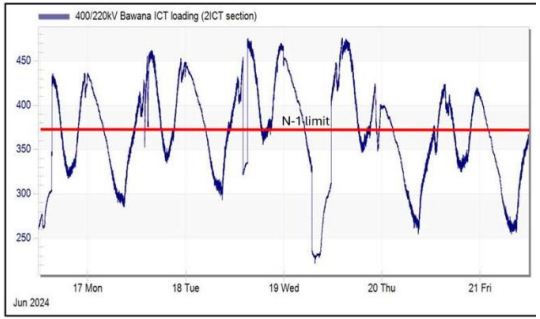
N-1 non-compliance of 765/400kV Jhatikara ICT 3 & 4



N-1 non-compliance of 400/220kV Mandola ICT 1,2,3 & 4

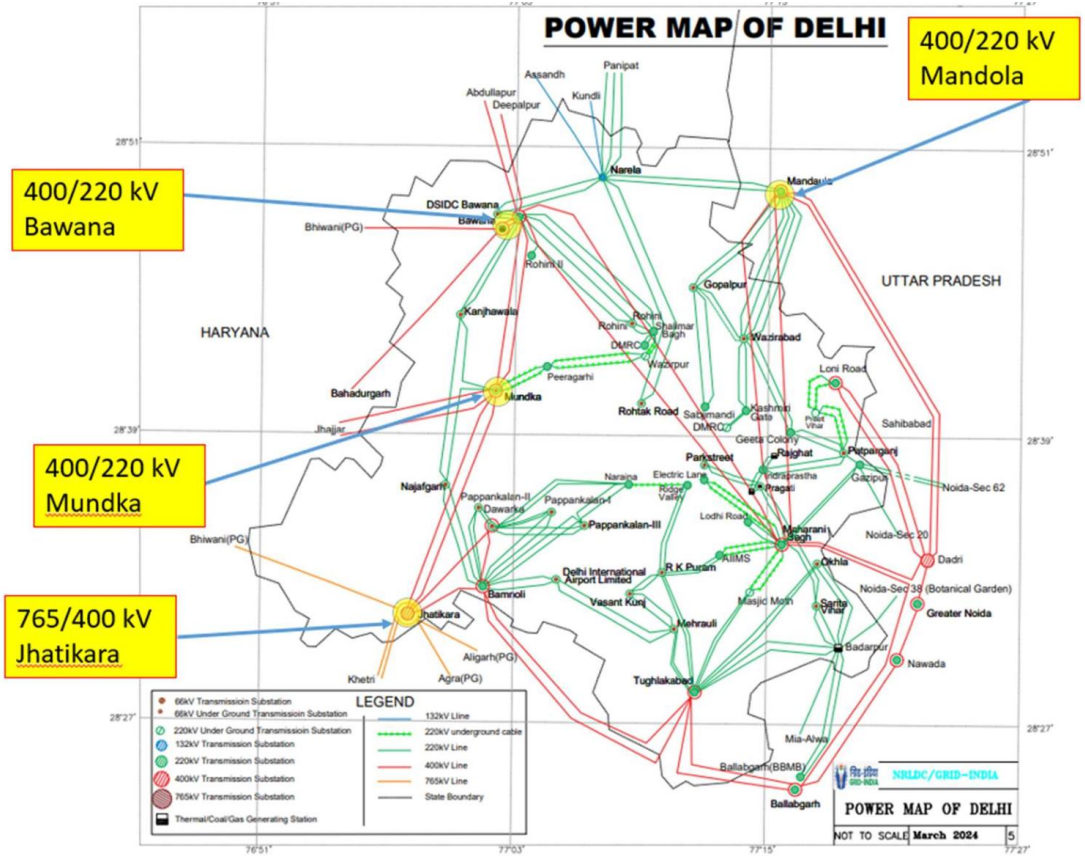


N-1 non-compliance of 400/220kV Mundka ICT 1,2 & 3 (SPS implemented)



N-1 non-compliance of 400/220kV Bawana ICT 2 & 3 (SPS implemented)

Congestion in Real-Time



Way Forward

- Periodic assessment and declaration of state TTC/ATC important from system security perpective
- Going forward, each state would be configured as a bid area
- TTC/ATC of each state would be required for T-GNA transactions
- Each SLDC shall declare ATC and T-GNA margin for both import and export, pertaining to its control area at least for the following periods:
    - Solar Peak
    - Non-solar Peak
    - Non-solar Off-peak
    - Morning Peak
- Declaration to be done at least 12 months in advance with subsequent revisions
- Sharing of base cases and assumptions with RLDCs
- Periodic feedback to system planners on constraints observed in import/export capability

Thank You !!

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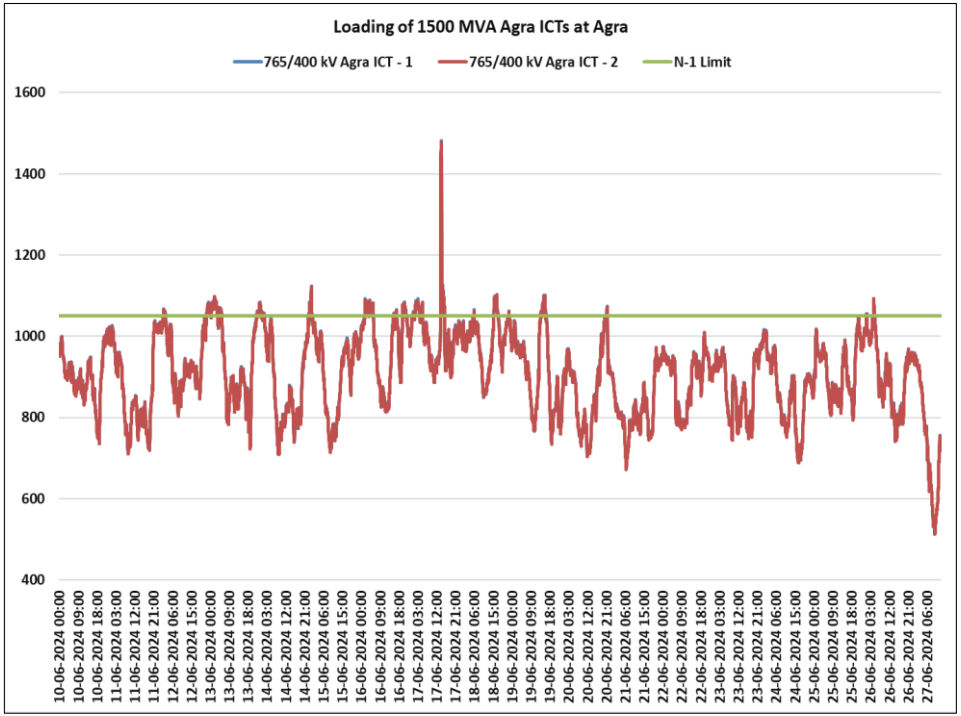
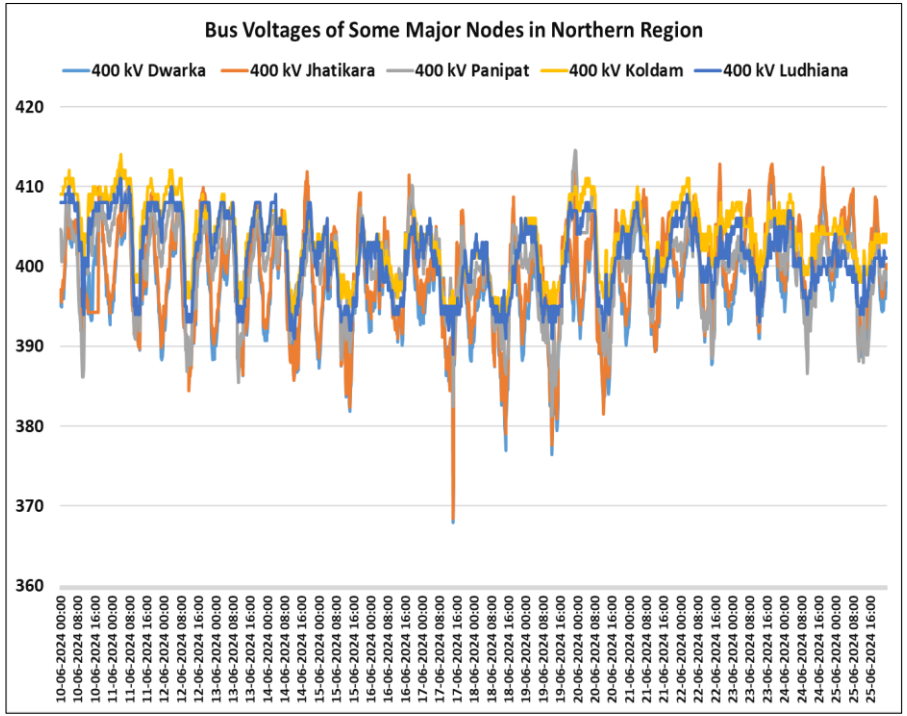
Congestion in Real-Time





CERC – Measure to Relieve Congestion, Regulations 2009

4. Applicability of Congestion Charge.

(1) To relieve congestion in the real time, a congestion charge shall be applied as a commercial measure. The congestion charge will be payable by a Regional entity or entities causing congestion in the inter-regional link or intra-regional link and receivable by a Regional entity or entities relieving congestion.

(2) Congestion charge may be imposed on any Regional entity or entities in any Region or Regions for causing congestion and paid to any Regional entity or entities in any Region or Regions for relieving congestion as per the detailed procedure under these regulations formulated by NLDC and approved by the Commission.

(3) The congestion charge shall be payable by the overdrawing regional entity in addition to the Unscheduled Interchange charges which would be payable as per Central Electricity Regulatory Commission (Unscheduled Interchange charges and related Matters) Regulations,2009 or any reenactment thereof.

CERC – Measure to Relieve Congestion, Regulations 2009

5. Rate of congestion charge:

The Commission may, from time to time, by order specify the rate of congestion charge applicable to whole or a part of the region.

6. Notice for application of congestion charge:

When, in the opinion of the National/Regional Load Despatch Centre, flow of electricity on an interregional /intra-regional corridor/ link used for transfer of electricity has crossed the ATC of such corridor/link, the NLDC/RLDC shall issue a warning notice to the defaulting entities. If the flow of electricity on the inter-regional /intra-regional corridor/ link exceeds the TTC, the NLDC/RLDC may, after notice through fax/voice message and through posting on its website and the common screen available on the Energy Management System, which is common to NLDC, RLDC and SLDCs, decide to apply congestion charge on the defaulting entities from a particular time-block in accordance with regulation 4:

Provided that notice of at least two clear time blocks shall be given by the Regional Load Despatch Centre before congestion charge becomes applicable, not counting the time block in which the notice is issued.

CERC – Measure to Relieve Congestion, Regulations 2009

7. Notice for withdrawal of congestion charge:

When in the opinion of the National / Regional Load Despatch Centre, flow of electricity on the affected - 5 - transmission link /corridor has come down to the ATC, it may, after notice through fax/voice message and through posting on its website and the common screen available on the Energy Management System, withdraw congestion charge from a particular time-block:

Provided that notice of one time block shall be given by the Regional Load Despatch Centre before congestion charge is withdrawn, not counting the time block in which the notice is issued.

Transfer Capability: Assessment

(9) Each SLDC shall undertake a study on the impact of new elements to be commissioned in the intra-state system in the next six (6) months on the TTC and ATC for the State and share the results of the studies with RLDC.

Transfer Capability: Assessment

(2) The National Load Despatch Centre, in discharge of its functions under the Act, shall be responsible for the following:

(e) Finalizing the TTC and ATC with all assumptions and limitations based on inputs received from RLDCs and publishing the same on its website, at least three (3) months in advance, and revising them based on contingencies from time to time.

Transfer Capability: Assessment

(3) The State Load Despatch Centre in discharge of its functions under the Act and for stable, smooth and secure operation of the integrated grid, shall be responsible for the following in its control area:

(f) Declaring Total Transfer Capability and Available Transfer Capability in respect of import and export of electricity of its control area with inter-State transmission systems in coordination with the Central Transmission Utility, State Transmission Utility, and concerned RLDC and revising the same from time to time based on grid conditions. Assessment of TTC and ATC shall be done on a continuous basis at least three (3) months in advance and revised based on contingencies from time to time.

Current Regulatory Provisions

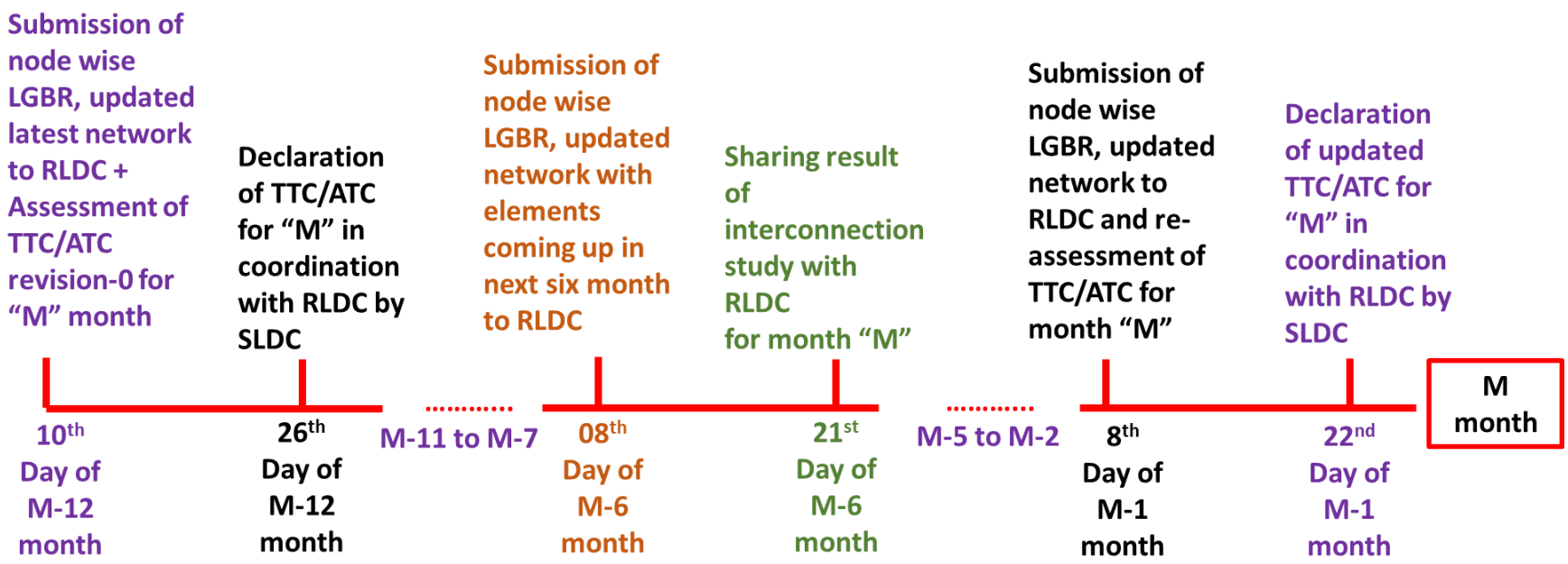
(1) The Regional Load Despatch Centre, in discharge of its functions under the Act, shall be responsible for the following, within its regional control area:

(e) Assessment of transmission capability for inter-State transmission system for secure operation of the grid including but not limited to:

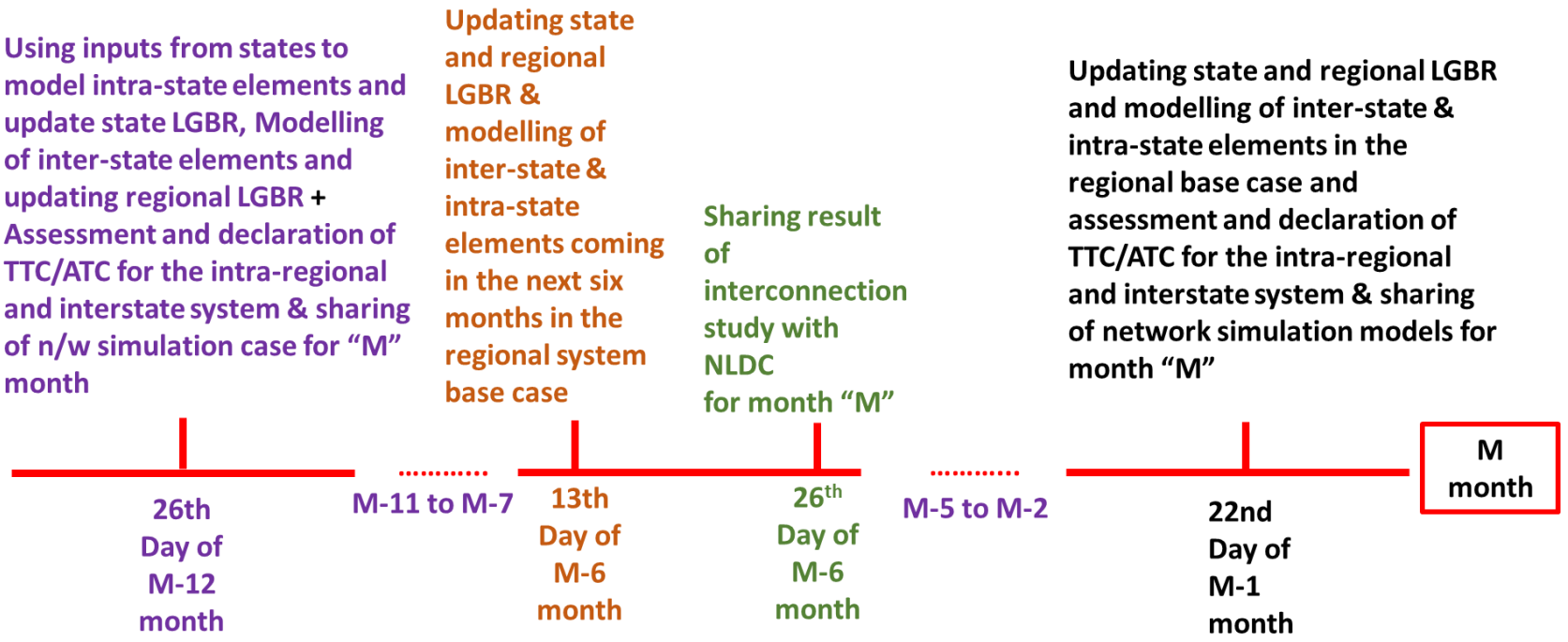
- *(i) Assessment of TTC and ATC for inter-regional, intra-regional and inter-State levels for its region and submit it to the NLDC.*
- *(ii) Assessment of TTC and ATC for import or export of electricity for a State in coordination with the concerned SLDC and submit to NLDC.*
- *(iii) Assessment of TTC and ATC shall be done on a continuous basis at least three(3) months in advance and revised based on contingencies from time to time.*

(f) Publication of TTC and ATC, as finalised by NLDC, with all the assumptions and constraints on its website.

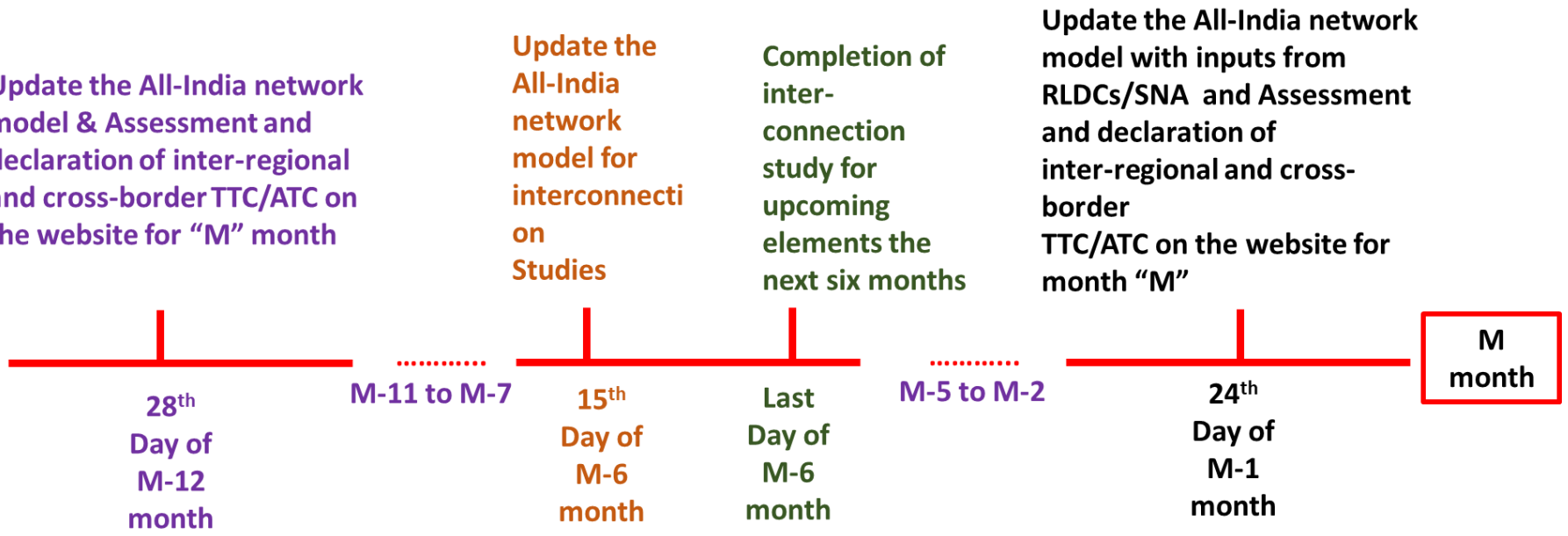
Timelines for Study Cases

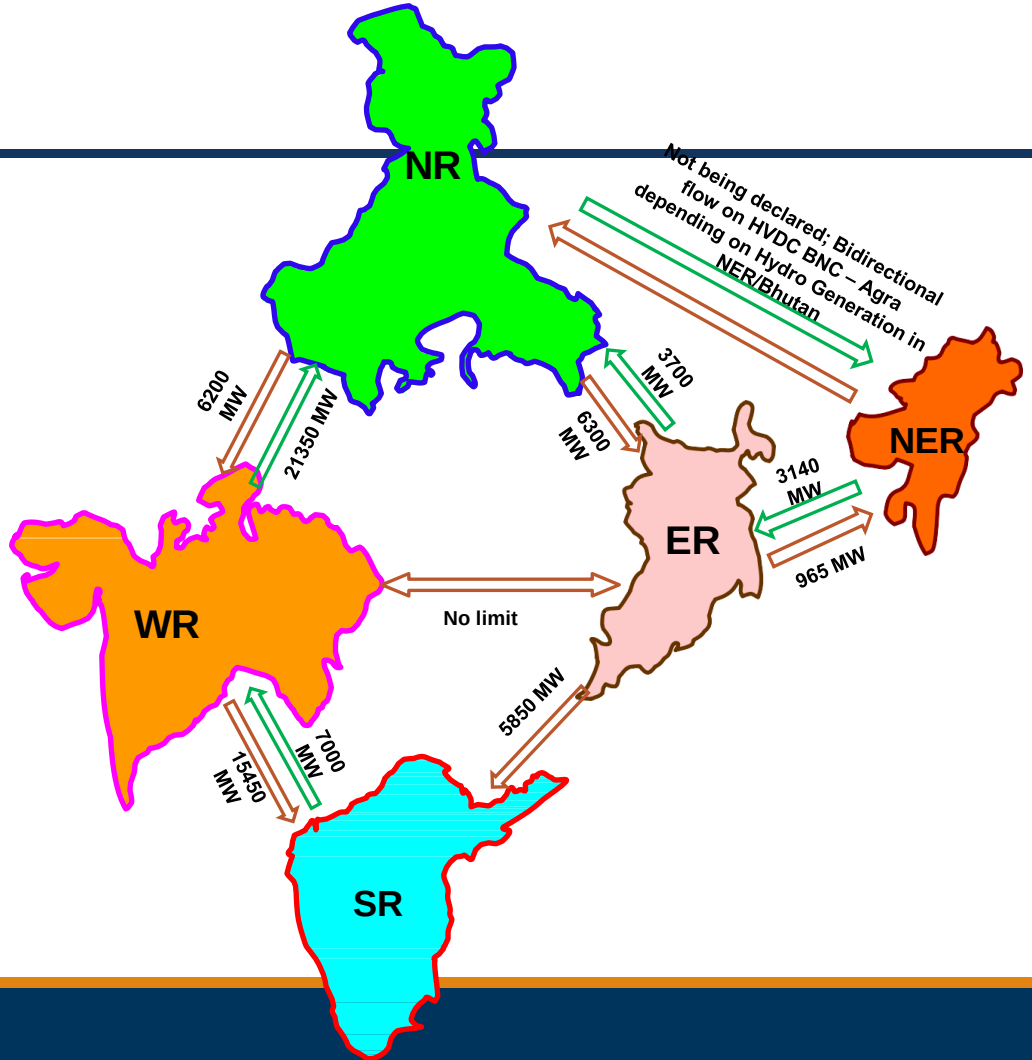


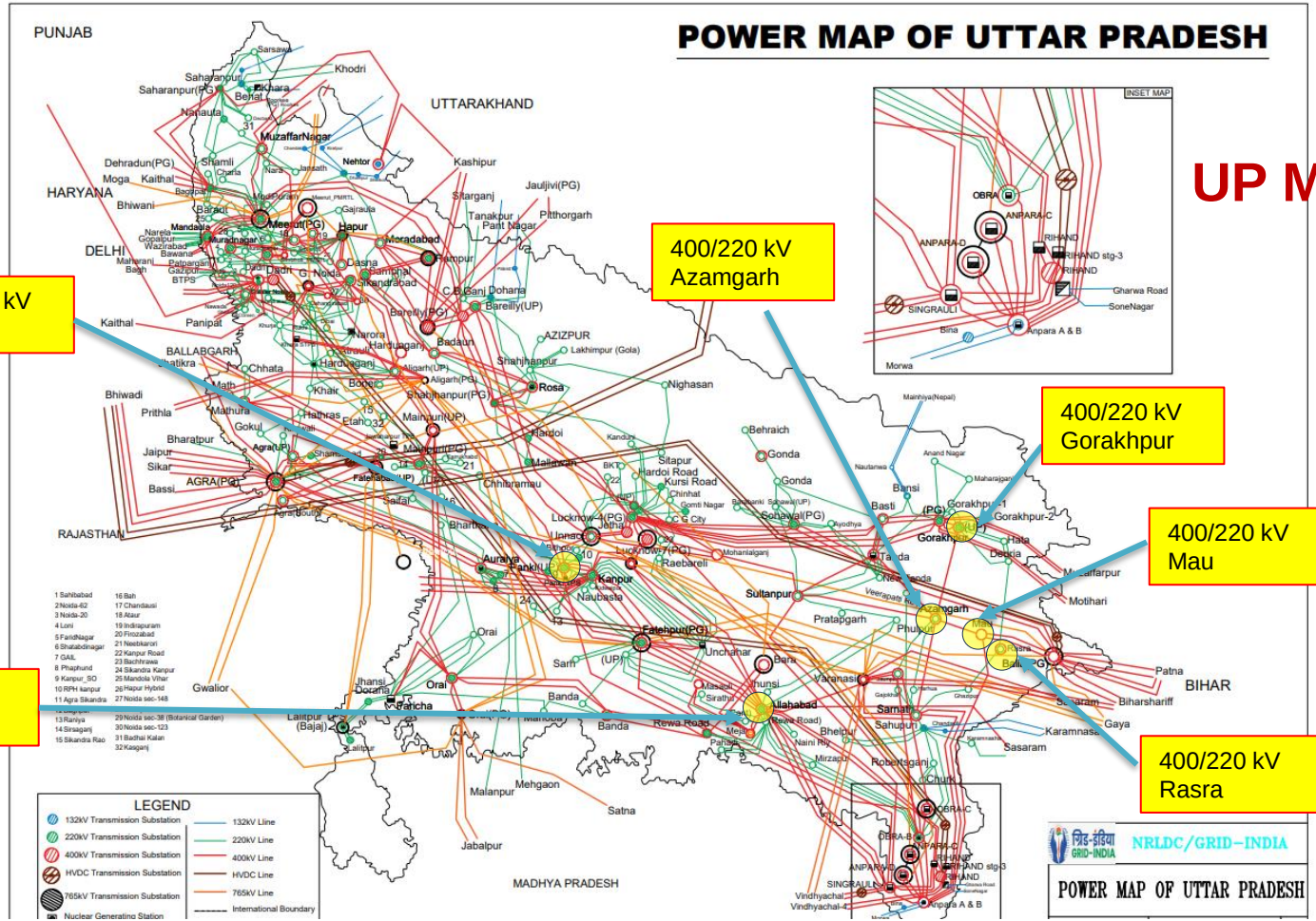
Timelines for Study Cases



Timelines for Study Cases




NR
WR
ER
NER
SR
Not being declared; Bidirectional flow on HVDC BNC – Agra depending on Hydro Generation in NER/Bhutan
6200 MW
21350 MW
3700 MW
6300 MW
3140 MW
965 MW
No limit
5850 MW
7000 MW
15450 MW


POWER MAP OF UTTAR PRADESH
PUNJAB
UTTARAKHAND
HARYANA
DELHI
RAJASTHAN
BIHAR
MADHYA PRADESH
400/220 kV Panki
400/220 kV Azamgarh
400/220 kV Gorakhpur
400/220 kV Mau
400/220 kV Allahabad
400/220 kV Rasra
INSET MAP
OBRA
ANPARA-C
ANPARA-D
RIHAND
RIHAND stg-3
SINGRAULI
Gharwa Road
SoneNagar
Anpara A & B
Morwa
LEGEND
132kV Transmission Substation
220kV Transmission Substation
400kV Transmission Substation
HVDC Transmission Substation
765kV Transmission Substation
Nuclear Generating Station
132kV Line
220kV Line
400kV Line
HVDC Line
765kV Line
International Boundary
NRLDC/GRID-INDIA
POWER MAP OF UTTAR PRADESH

UP Map

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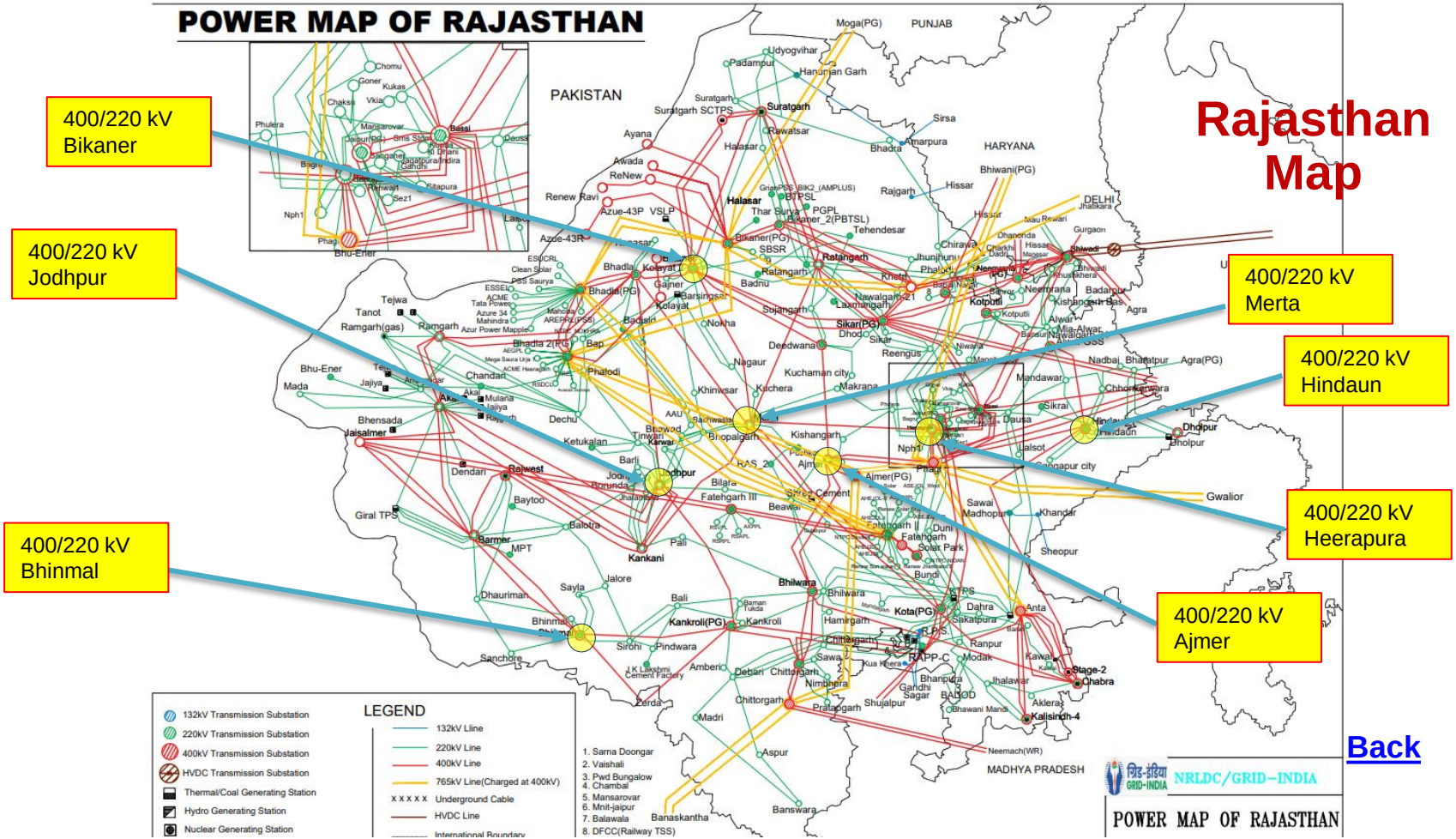
POWER MAP OF RAJASTHAN
Rajasthan Map
400/220 kV Bikaner
400/220 kV Jodhpur
400/220 kV Bhinmal
400/220 kV Merta
400/220 kV Hindaun
400/220 kV Heerapura
400/220 kV Ajmer
PAKISTAN
PUNJAB
HARYANA
DELHI
MADHYA PRADESH
LEGEND
132kV Transmission Substation
220kV Transmission Substation
400kV Transmission Substation
HVDC Transmission Substation
Thermal/Coal Generating Station
Hydro Generating Station
Nuclear Generating Station
132kV Lline
220kV Line
400kV Line
765kV Line(Charged at 400kV)
Underground Cable
HVDC Line
1. Sarna Doongar
2. Vaishali
3. Pwd Bungalow
4. Chambal
5. Mansarovar
6. Mnit-jaipur
7. Balawala
8. DFCC(Railway TSS)
NRLDC/GRID-INDIA
POWER MAP OF RAJASTHAN

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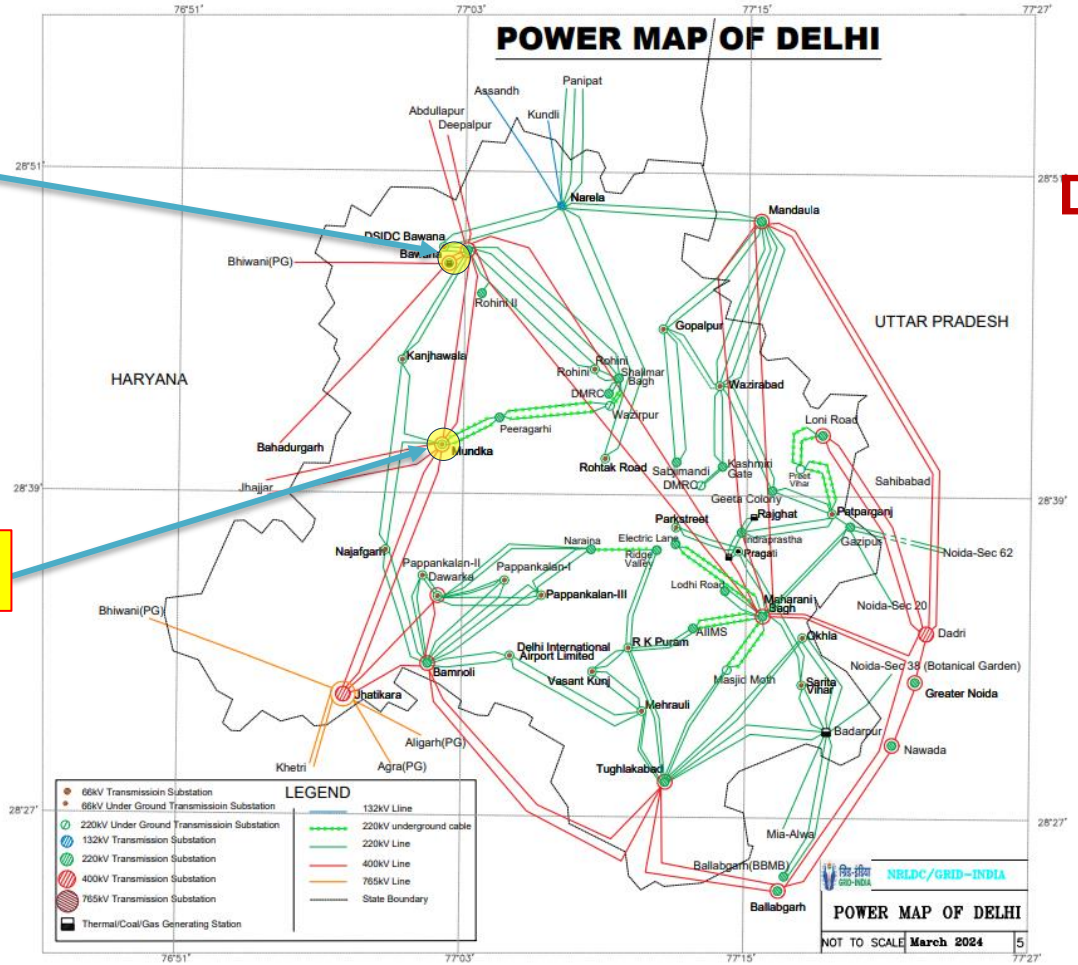
Delhi Map

400/220 kV Bawana

400/220 kV Mundka



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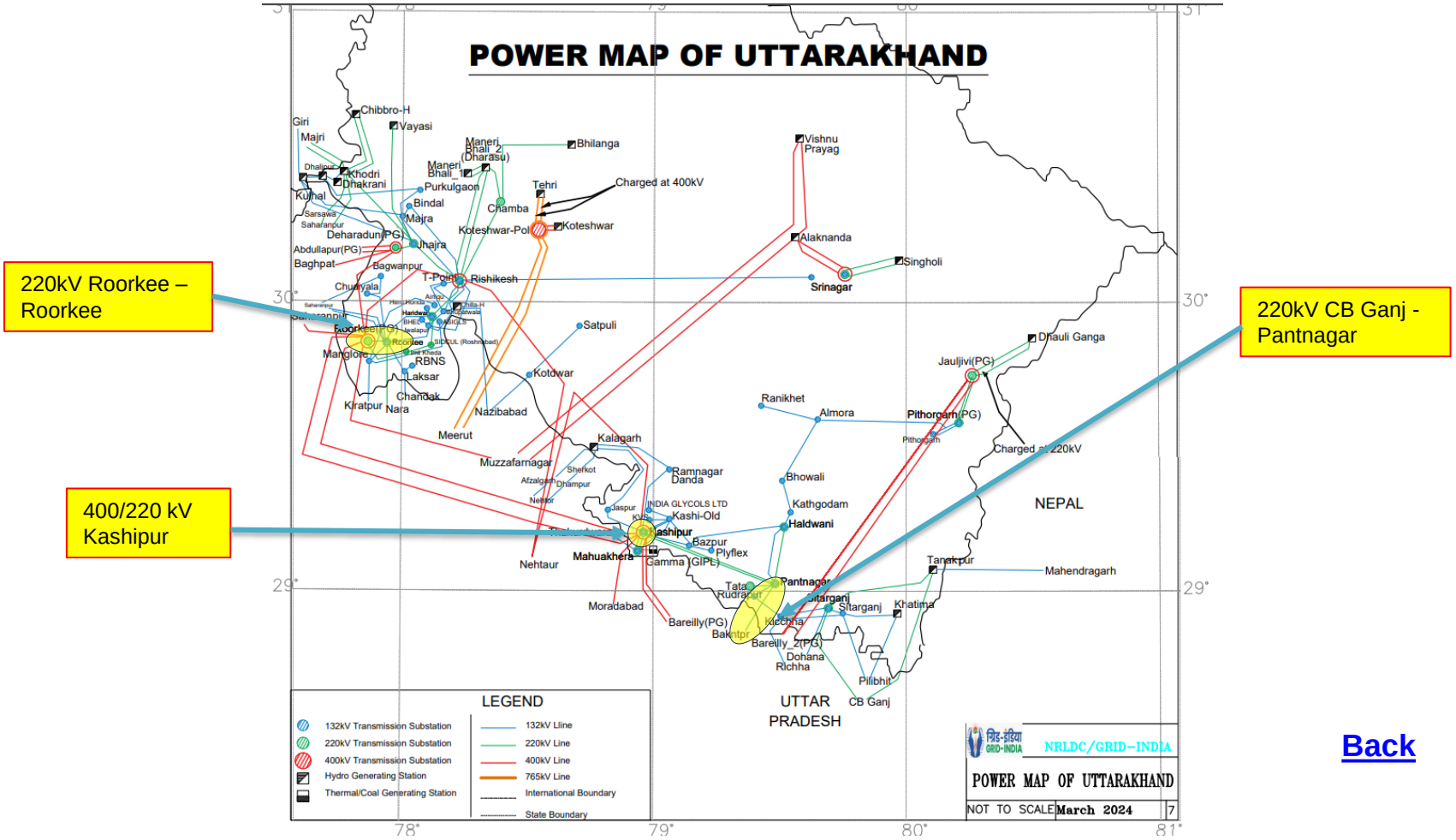
POWER MAP OF UTTARAKHAND
220kV Roorkee – Roorkee
400/220 kV Kashipur
220kV CB Ganj - Pantnagar
Chibbro-H
Vayasi
Giri
Majri
Maneri Bhali_2 (Dharasu)
Bhilanga
Maneri Bhali_1
Dhalipur
Khodri
Dhakrani
Purkulgaon
Kulhal
Bindal
Majra
Sarsawa
Saharanpur
Tehri
Charged at 400kV
Chamba
Koteshwar-Pol
Koteshwar
Vishnu Prayag
Alaknanda
Singholi
Srinagar
Deharadun(PG)
Jhajra
Abdullapur(PG)
Baghpat
Bagwanpur
T-Point
Rishikesh
Chunnyala
Satpuli
Roorkee(PG)
Roorkee
Manglore
RBNS
Laksar
Chandak
Kiratpur
Nara
Kotdwar
Nazibabad
Meerut
Muzzafarnagar
Kalagarh
Ramnagar Danda
Sherkot
Afzalgarh
Dhampur
Nehtor
Jaspur
Kashipur
INDIA GLYCOLS LTD
Kashi-Old
Bazpur
Plyflex
Gamma
GIPL
Mahuakhera
Nehtaur
Moradabad
Bareilly(PG)
Bareilly_2(PG)
Dohana
Richha
Pilibhit
Ranikhet
Almora
Pithoragarh(PG)
Pithoragarh
Jauljivi(PG)
Dhauli Ganga
Charged at 220kV
Bhowali
Kathgodam
Haldwani
Pantnagar
Tata Rudrapur
Sitarganj
Khatima
Tanakpur
Mahendragarh
NEPAL
UTTAR PRADESH
CB Ganj
LEGEND
132kV Transmission Substation
220kV Transmission Substation
400kV Transmission Substation
Hydro Generating Station
Thermal/Coal Generating Station
132kV Lline
220kV Line
400kV Line
765kV Line
International Boundary
State Boundary
NRLDC/GRID-INDIA
POWER MAP OF UTTARAKHAND
NOT TO SCALE March 2024
78°
79°
80°
81°
30°
29°

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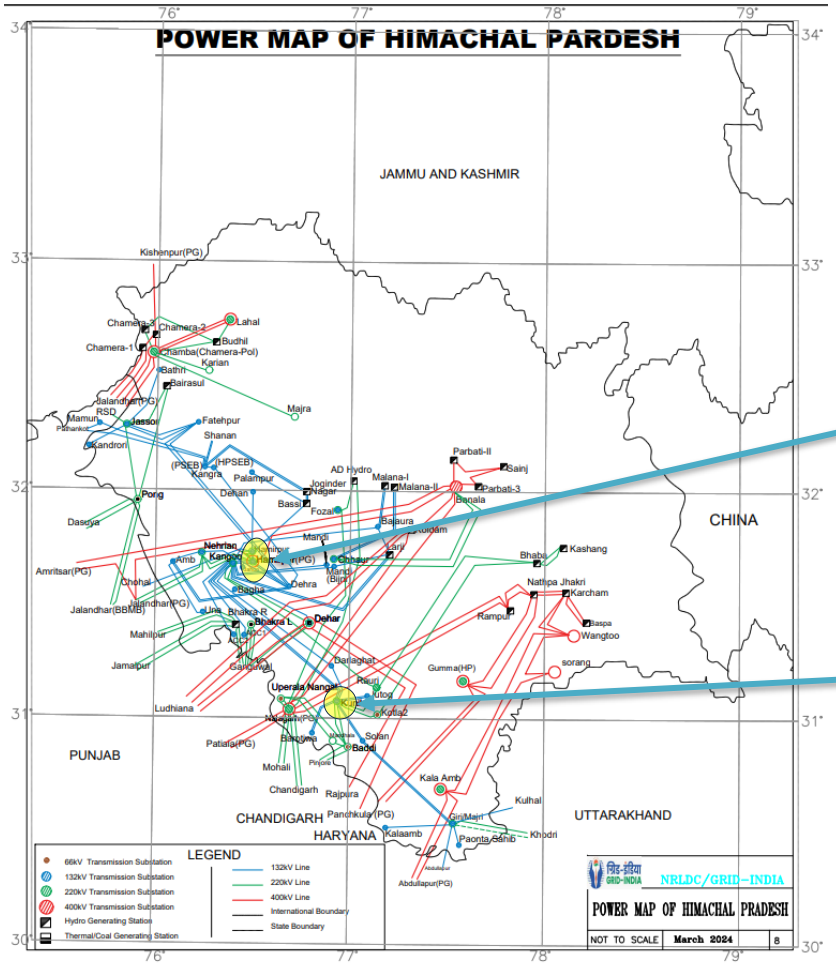

HP Map

220kV Hamirpur-Hamirpur D/C

2*200 MVA ICTs at Kunihar

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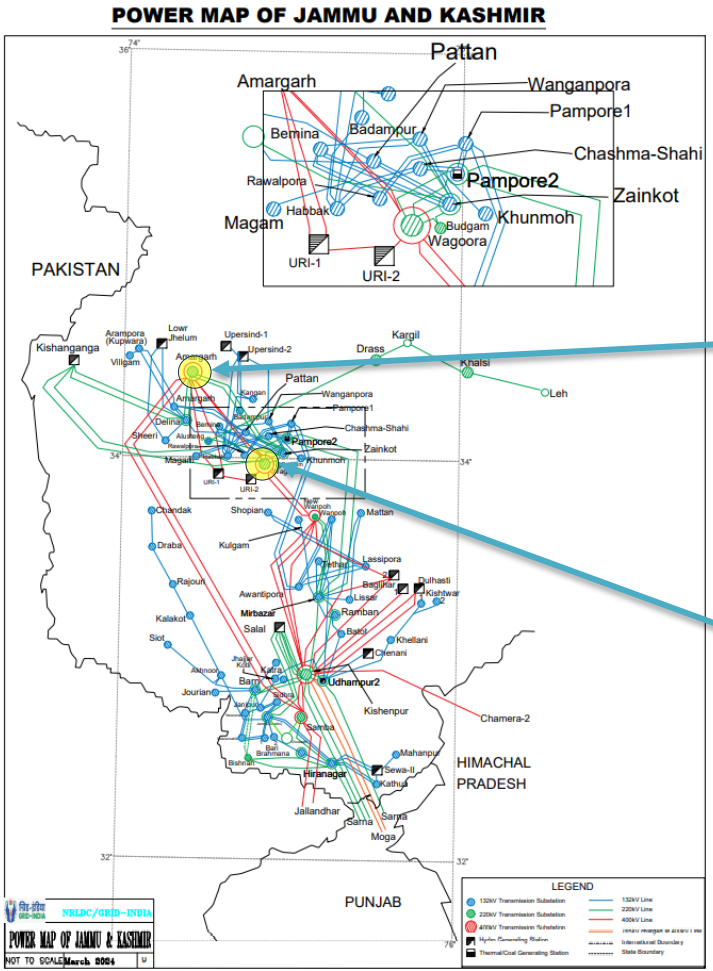
J&K Map



400/220kV Amargarh

220kV underlying network at Wagoora

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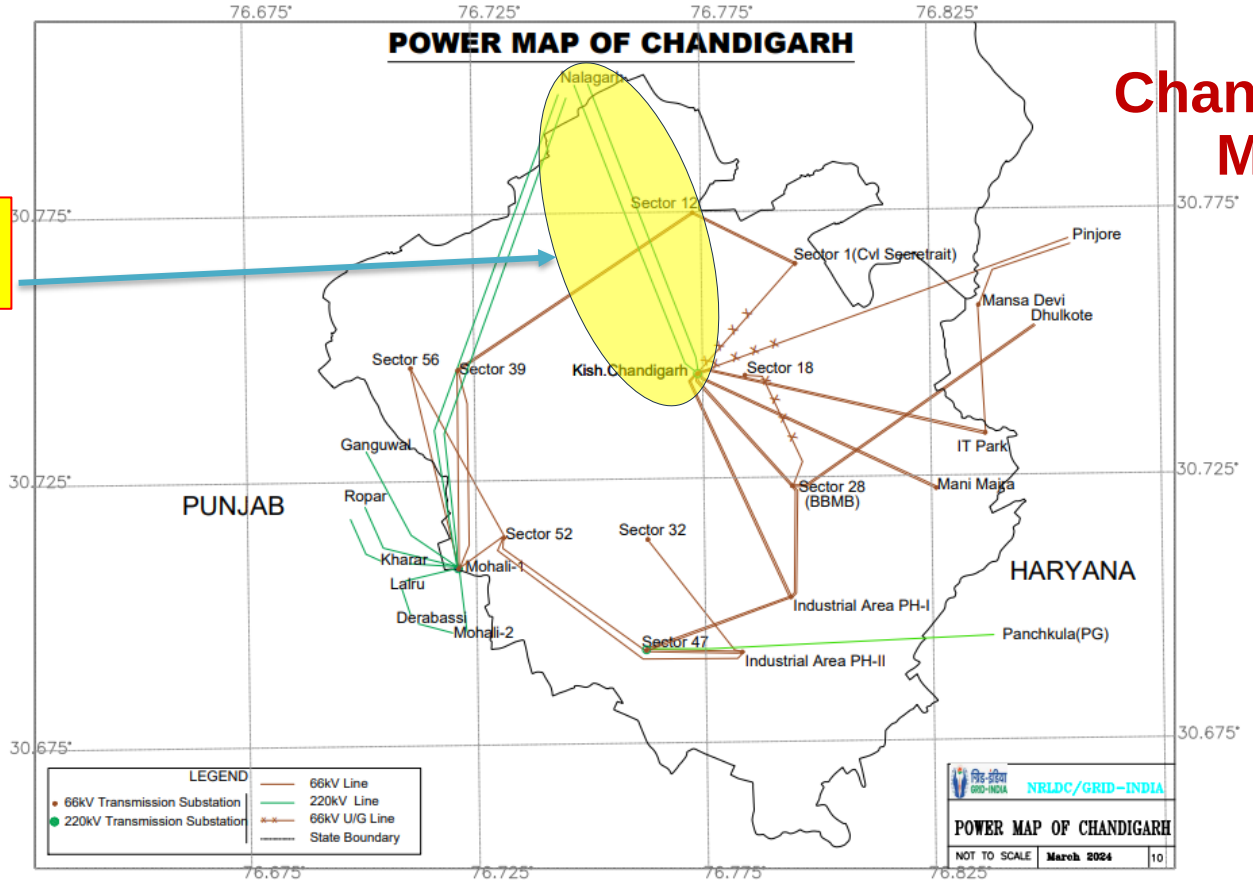
Chandigarh Map

220kV Nallagarh - Kishangarh



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