भारतसरकार
Government of India
केंद्रीय विद्युत् प्राधिकरण
Central Electricity Authority
पश्चिम क्षेत्रीय विद्युत् समिति
Western Regional Power Committee
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सख्य पक्षविस/ वणि.-I/2022/ दिनांकः 14.10.2022
No.:WRPC/Comml-I/NPC/2022/ 10706

To,
The Member Secretary, NPC
Central Electricity Authority
New Delhi – 110066

विषय: "यूआरटीडीएसएम परियोजना के तहत पीएमयू स्थानों के समान दर्शन, नए विश्लेषण और नियंत्रण केंद्र के उन्नयन की आवश्यकताओं पर उप-समिति" की रिपोर्ट - के संबंध में|
Subject: Report of the "Sub-committee on the uniform philosophy of PMU locations, new analytics and requirements of up gradation of Control Centre under URTDSM project" - reg.
Ref: NPC Division letter no. 4/MTGS/NPC/CEA/2021/285-298 dated 20.09.2021

Please find enclosed herewith the final report of the sub-Committee on "The uniform philosophy of PMU locations, new analytics and requirements of up gradation of Control Centre under URTDSM project", constituted by NPC vide letter under reference.

Submitted for needful please.

भवदीय /Yours faithfully

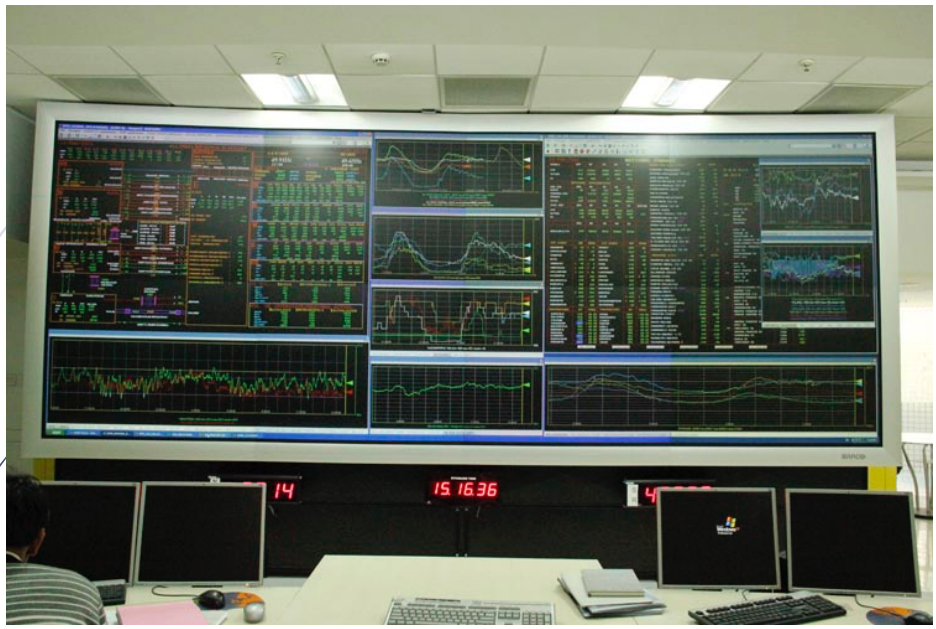
Enclosed: As above.

(P. D. Lone)
(सदस्य संयोजक/Member Convener)

Copy to: All members as per list.

October 2022

Report of the Sub-Committee on PMU Placement and Analytics under URTDSM Phase II.



National Power Committee

CEA

Acknowledgement

The Committee acknowledges the cooperation extended by RPCs, POSOCO, PGCIL and CTU for giving their valuable inputs to finalize the recommendations for the URTDSM Project Phase - II.

The Committee also acknowledges and extends gratitude to the sincere efforts of Shri Deepak Sharma EE WRPC and Shri Sachin Bhise EE WRPC, for their inputs and suggestions and putting all the inputs in proper perspective & giving shape to this report.

The committee would also like to thank Sh. Rahul Shukla, Chief Manager, NLDC and Sh. Aman Gautam, Manager, NLDC for the painstaking efforts taken to provide comments and help in the drafting of the report.

The committee puts on record the efforts of Dr Rajeev Gajbhiye, Sh. Prashant Navalkar and Sh. Gopal Gajjar from IIT Bombay who provided valuable inputs and feedback on the URTDSM Phase I and futuristic applications that can be developed.

The committee also acknowledges the efforts of M/s PRDC for arranging presentation of EPG USA and giving perspective of applications developed and used worldwide.

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Summary of the Report

- Initially a Pilot Project was implemented by POSOCO with 52 Phasor Measurement Units (PMUs) installed all over the Country progressively from 2008 to 2010. Based on the experience gained in Pilot Projects, a Feasibility Report was prepared for Nation-wide development of WAMS namely Unified Real Time Dynamic State Measurement (URTDSM) Project. A Detailed Project Report (DPR) was prepared in 2012 for implementation of 1740 PMUs on Pan-India basis. The Project was agreed for implementation in a Joint Meeting of all the five Regional Standing Committees on Power System Planning held on 5th March 2012. Also, it was decided that the project of installation of the PMUs will be taken up in two stages.
- CERC granted in principle approval for the project in Sept'2013 with 70% funding from PSDF & 30% equity from POWERGRID. CERC granted in principle approval for the implementation of URTDSM Phase-I and advised to take up Phase-2 after receiving feedback on Phase-I performance from POSOCO. POWERGRID took up the implementation of URTDSM Project in Jan'2014 and 1409 PMUs are installed in Phase-I of the Project (the increase in quantity of PMUs was due to addition of new bays etc. at the substations). Nodal PDC at strategic substations, Master PDC at all SLDCs, super PDC at 5 RLDCs, Main & backup PDC at NLDC have been installed and are fully functional. PMUs are installed at only those 400 kV lines which had connectivity of the fibre optic network.
- Data of these PMUs is being utilized by power system operators as an analytical tool for better system operation in real time as well as for off-line analysis. Operators are also utilizing various facilities provided under the project which includes the GUI application supplied by GE and 6 analytics have been deployed by IIT-B.
- In the 10th NPC Meeting held on 9th April 2021 it was decided to form a sub-committee, *under the Chairmanship of Member Secretary, WRPC with representatives from POSOCO, CTU, POWERGRID, all RPCs/NPC.* ***The Sub-Committee was entrusted to recommend uniform philosophy of PMU locations, new analytics and requirement of up gradation of Control Centre under URTDSM project and submit its recommendations to the NPC.***
- The sub-committee held 3 meetings. The first meeting was held on 10.12.2021 and the second meeting was held on 31.05.2022. In both the meetings IIT Bombay gave presentation on the analytics developed in URTDSM Phase-I, improvements in these analytics and futuristic analytics that can be undertaken under URTDSM Phase-II.

- The EPG group presentation was arranged by PRDC in the second meeting held on 31.05.2022 and the EPG LLC, USA highlighted various application analytics which are deployed by power Utilities worldwide and are being used.
- The third meeting of the sub-committee was held on 14.09.2022 to discuss the finalised draft report of the sub-committee.
- PGCIL has expressed some reservations on the recommendations of the sub-committee. The same are attached at *Annexure – 9*.
- Based on the above discussions, the report has been broadly divided into 6 Sections
  - Section-1 briefly explains the background discussions that took place in various meeting for implementation of the PMU/WAMS project on pan India basis and the progress and hardware implementation of the Phase-I of the URTDSM project.
  - Section-2 briefly explains the OEM online and offline applications and its use.
  - Section-3 deals with the PMU placement criteria and status of Phase-I analytics.
  - Section-4 outlays various issues regarding hardware, application & analytics faced in the Phase-I of the URTDSM project and feedback of stakeholders.
  - Section-5 describes in brief discussions took place on requirement of PMUs that took place in regional levels, various new applications/analytics that can be taken up in Phase-II of the project.
  - Section-6, the recommendations of the sub-Group on improvement of Phase-I applications/analytics/hardware optimisation required to be taken up Phase-II, placement/requirement of PMUs in phase-II and new applications/analytics required to be implemented in Phase-II of the URTDSM project.

Table of Contents

List of Annexure

1. Background of the URTDSM Project

1.1 Background

In the 10th NPC Meeting held on 9th April 2021 it was decided to form a sub-committee, the relevant extract of the minutes of the above meeting is reproduced below.

"*After deliberations, NPC decided that a Sub-Committee would be formed under the Chairmanship of Member Secretary, WRPC with representatives from POSOCO, CTU, POWERGRID, all RPCs/NPC.* ***The Sub-Committee shall discuss on the uniform philosophy of PMU locations, new analytics and requirement of up gradation of Control Centre under URTDSM project and submit its recommendations to the NPC.***

Consequently, the sub-committee was formed vide NPC Letter NO. 4/MTGS/NPC/CEA/2021/285-298 dated 20.09.2021 (letter enclosed at *Annexure – I*) based on nominations received at NPC.

1.2 URTDSM Project Phase-I

a) A Pilot Project was implemented with 52 Phasor Measurement Units (PMUs) installed all over the Country progressively from 2008 to 2010. Based on the experience gained in Pilot Projects, a Feasibility Report was prepared for Nation-wide development of WAMS namely Unified Real Time Dynamic State Measurement (URTDSM) Project. A Detailed Project Report (DPR) was prepared in 2012 for implementation of 1740 PMUs on Pan-India basis.

b) The Project was agreed for implementation in a Joint Meeting of all the five Regional Standing Committees on Power System Planning held on 5th March 2012.

c) Also, it was decided that the project of installation of the PMUs will be taken up in two stages.

Table 1: Proposed Stage- I

Region	Sub-stations		No of Transmission line		PMU		Nodal PDC	MPDC	SPDC	Main & B/U NLDC
	ISTS	STU	ISTS	STU	ISTS	STU				
NR	74	42	394	224	206	120	6	9	1	
WR	49	18	456	135	234	71	11	4	1	
ER	51	31	395	149	202	79	4	5	1	
SR	57	16	338	90	178	47	6	4	1	
NER	9	5	69	24	36	13	0	3	1	
Total	240	111	1652	622	856	330	27	25	5	
	351		***2274***		***1186***		***57***			***2***

Stage-I: Installation of PMUs at the locations where Fibre Optic communication is available or would be made available under microwave frequency vacating program and regional strengthening program by 2014-15 along with installation of PDCs at all SLDCs, RLDCs, NLDC, NTAMC, strategic locations in State, remote consoles at RPCs, CEA, CTU and other locations.

Table 2 : Proposed Stage- II

Region	Sub-stations		No of Line		PMU	
	ISTS	STU	ISTS	STU	ISTS	STU
NR	9	55	40	211	21	111
WR	11	58	64	280	33	145
ER	-	13	-	50	-	26
SR	3	55	10	199	5	105
NER	9	17	26	45	14	23
Total	32	198	140	785	73	410
	230		***925***		***483***	

Stage-II: Installation of PMUs at balance locations along with communications links.

d) The stage wise deployment of PMUs and PDCs is given as under

i. The project was approved with the above tabulated infrastructure in stage – I & II.

ii. Phase-I: 1186 PMUs at 351 substations (communication existing) - Rs. 278.89 Crs.

iii. Phase-II: 554 PMUs at 301 substations (with installation of 11,000 Kms OPGW) - Rs.377 Crs.

iv. Phasor Data Concentrators with 6 Analytical Software at 32 Control centres considering requirement of both i.e., Phase-I & Phase-II.

e) CERC granted in principle approval for the project in Sept'2013 with 70% funding from PSDF & 30% equity from POWERGRID. CERC granted in principle approval for the implementation of URTDSM Phase-I and advised to take up Phase-2 after receiving feedback on Phase-I performance from POSOCO.

f) POWERGRID took up the implementation of URTDSM Project in Jan'2014 and 1409 PMUs are installed in Phase-I of the Project (the increase in quantity of PMUs was due to addition of new bays etc. at the substations). The list of PMUs installed is given at *Annexure – II*.

g) In line with agreed philosophy in Joint Meeting of all the five Regional Standing Committees on Power System Planning, POWERGRID took up the requirement of URTDSM Phase – II in all Regional Power Committees. During the discussion on finalization of PMU quantity for URTDSM phase–II, requirement of additional measurements emerged. POSOCO also desired additional Analytical software using PMU data.

2. Applications under URTDSM Phase-I

2.1 PMU based real time monitoring applications:

PMU based visualization helps not only operators of affected control areas, but also in alerting neighbouring operators of a stressed grid. In the real time grid operation, PMUs data are being utilized for following purposes:

a) Real time event and alarm processing: WAMS System provides spatio-temporal aggregation of the events, magnitude related violations in frequency, Positive Sequence Voltage Magnitude, Rate of Change Frequency (ROCOF) and Angular Difference. These are processed in real time at each second in batch processing to alert the operator.

b) Visualization of frequency, Rate of change of frequency, Voltage, Power flows and Angle difference monitoring through trending at high resolution, helps in taking early actions by control room.

c) Visualization of angular difference data, real-time angular separations, Real time monitoring and analysis, obtaining angular differences.

d) Geographical network diagram provides information about the system through visual objects representing network elements, contours, rubber band zooming, panning, flyouts and pods through sub second resolution measurements and its variation in real time.

e) Contour display allows overview of the voltage/frequency profile for the entire grid, Voltage Contour visualization, Voltage contour variation before and after generator trip allows real time monitoring of voltages across all the nodes. Frequency contour identifies the coherent group of generators during incidents of low frequency oscillations in the grid.

f) Oscillatory Stability Management (OSM): Oscillation Stability Management (OSM) helps in monitoring the low frequency oscillations or small signal stability issues in the system, the oscillation frequency related information like, dominant mode frequency, energy and damping helps the operator in taking real time necessary actions by identifying root cause of oscillation. The OSM provides the information pertaining to negatively damped modes. OSM module extracts oscillatory stability parameters from small, random movements of the power system that are continuously occurring, mainly due to load changes in configured frequency, angle difference and active Power signals. Low frequency oscillations

and damping ratios are obtained using Auto Regressive Moving Average (ARMA) analysis of the measured signal. The dominant modes of oscillation are extracted, and key parameters identified – mode frequency, amplitude, and decay time. It also shows the mode shape (Right Eigen Vector) and mode chart for better Analysis of Oscillation in the system.

2.2 Off-line Applications/usages:

Some of the off-line usages are given as follows:

a) Primary frequency Response assessment requires high resolution data of frequency for any event. The monitoring of pattern of frequency posts any incident involving load/generation imbalance helps in identifying the percentage of ideal response achieved in event.

b) The oscillation detection, using UTRDSM system is used to provide necessary feedback to generators for taking corrective actions. The poorly damped oscillations indicate the review of controller settings in power system stabilizers of units.

c) The high sampling rate of PMU data helps in validations of responses and fine tuning of various power system elements.

d) The high-resolution data helps in validating the actions of system protection schemes and also parameter variations across the grid.

e) The high-resolution data helps in monitoring the operation of various transmission line protection schemes which operate in sub-second time horizon with the lines having high fault clearing times can be reported to entity along with RPC for early resolution.

f) Synchro phasor has helped to find the issues in time synchronization in event loggers, disturbance recorders details submitted by utilities also for checking of sequence of operation of the events etc.

g) PMU also helped RLDCs in validating the Power system stabilizer tuning process with high sampled data. It has provided feedback in form of oscillation/power swing where PSS tuning is required to be carried out and based on these generators had been informed.

h) PMU data was utilized in monitoring of power system during site testing of power transformers at National High Power Testing Laboratory (NHPTL) at Bina station.

The transient stability was monitored for the period of test shot. The PMU based data provided inputs on fault clearing time, faulty phases and short circuit MVA during tests.

i) Post-Disturbance Analysis: It is required to assemble and study the signals from various PMUs that are dispersed throughout the grid for the analysis. The time-synchronized PMU data from different locations of grid, helps in understanding and reconstructing the event.

3. PMU Placement criteria & Analytics in Phase – I and its status

3.1 PMU locations under Phase – I

During the Joint Meeting of all the five Regional Standing Committees on Power System Planning held on 5th March 2012, following PMU placement philosophy was decided:

a) All 400 kV stations in State and ISTS grids.

b) All generating stations at 220 kV and above.

c) HVDC terminals and inter-regional and inter-national tie lines.

d) Both ends of all the transmission lines at 400kV and above: State and ISTS sector.

3.2 Status of Phase – I (Broad configuration of PMUs, PDCs and infrastructure used)

a) The PMUs procured are having 2 set of voltage, 2 set of current measurement & some (16) digital input configuration.

b) The utilization of measurement inputs of PMU depends on the bay configuration at substations. In cases where there is one line & ICT or reactor only, one set of current input is utilized, and other input remains unutilised.

c) The PMUs are measuring line and bus voltages as per the configuration of installation. PMUs installed are of the Measurement class and wired up in the metering core of CVT/CT.

d) Nodal PDC at strategic substations, Master PDC at all SLDCs, super PDC at 5 RLDCs, Main & backup PDC at NLDC have been installed and are fully functional.

e) POSOCO's initial pilot project & States PMUs were also integrated with the URTDSM project.

f) POSOCO has informed that the PMUs were installed at only those 400 kV lines which had connectivity of the fibre optic network.

g) The List of PMUs installed in phase – I of the projects is attached at *Annexure – II.* A region wise map of the existing placement of PMUs (pictorial representation of PMUs installed is attached at *Annexure III.*

h) The number of PMUs installed on 132kV lines is 5nos., 220kV lines is 179nos., 400kV Lines is 1093nos., 765kV lines is 148nos.

3.3 Present functionalities under URTDSM:

Data of these PMUs is being utilized by power system operators as an analytical tool for better system operation in real time as well as for off-line analysis. Operators are also utilizing various facilities provided under the project.

The PMU data can be used for real time monitoring of the system and taking decisions. Under para 3.4, below the potential of the WAMS project in real time system monitoring and taking decisions is highlighted.

3.4 Existing features of URTDSM

a) Time Series Derivation Framework (TDF) TDF is the user interface of the Historian Application provided by OEM M/s GE and is being used in Control room to plot the events which occurred during last one year (at NLDC, six months at RLDCs level) to analyse details of events and its characterization. Data Storage limitations are constraints in storing historian data for longer duration.

b) Spectral Analysis (using E-Tera Phasor Analytics) Spectral analysis of PMU data enables revealing which frequencies occur in system and how they change as a function of time. Spectral analysis provides an intuitive and visual way of representing changes in power system parameters at 8 different frequency and time instances. Mainly three types of spectral trends are provided in e-terra Phasor Analytics:

   i. Power Spectral Density (PSD): Power Spectral Density (PSD) is very useful tool to identify oscillatory signals in time series data and their amplitude. It also tells at which frequency ranges variations are strong that might be quite useful for further analysis.

   ii. Coherency: Coherency, is a measure of frequency domain correlation between two signals. Coherency is always greater than zero and less than one, if two signals are loosely correlated in the frequency domain, the coherency tends to be close to zero. If there is strong correlation, the coherency tends to be close to unity.

   iii. Cross Spectral Density (CSD): Cross spectral Density as a measure of frequency domain covariance between two signals and is related to transfer function between two signals.

3.5 Analytics under Phase – I

a) Under URTDSM phase I, following 6 Analytics were developed in association with IIT Bombay:
   i. Line Parameter Estimation
   ii. Vulnerability Analysis of Distance Relay (VADR)
   iii. Linear State Estimator
   iv. Supervised Zone-3 distance protection scheme to prevent unwanted tripping of backup distance relay
   v. CT/CVT Calibration
   vi. Control for improving system security

b) Presently, first 6(six) Analytics have been deployed at control centres under URTDSM with regular updates being installed based on feedback received from constituents. Training for WR and SR constituents for all analytics has been completed.

3.6 Utilization of PMU data for taking real time decisions and offline Analysis at RLDCs and NLDC:

a) PMU helped in synchronization of NEW-SR grid by helping control room operator in taking appropriate decisions in time through the access of high-resolution data in real time.

b) The availability of PMU visualization helped in taking informed decisions in real time when any abnormality was observed in PMU placed on AC side of HVDC converter station

c) The availability of PMU data at LV side of pooling station of RE based generation sources helped in monitoring the operation in real time. The various power electronic based controls in RE generation plant for low voltage ride through (LVRT), reactive support at pooling station and power park control are closely monitored using PMU data.

d) The transmission system has also observed integration of state of art power electronic devices, these devices act in time span of milliseconds. The response can be observed at control centres with availability of PMU data. The response of FACTS devices is observed well with PMU placed at coupling transformer of STATCOM/SVC.

e) Power-system restoration: The PMUs are well-suited for online monitoring of angles, and thus are helpful for the operator during a power restoration by monitoring of standing phase angle (SPA) difference across a breaker, which connects two adjacent stations whose excessive difference can damage equipment.

4. Feedback on applications/Analytics under Phase – I

4.1 Improvements required in the Existing PMUs data Streaming/GUI

Improvements in the various applications/functionalities available in present system, if carried out can enhance its utilization. List of such improvements are given below, which are purely based on operational experience of existing system:

a) Improvement required in the visualization /GUI

i. Adding trends of phase voltage and current: It is only possible to plot trend of positive sequence voltage, frequency, df/dt, angle difference, MW and MVAr in real-time. It shall be possible to plot trend of phase voltages and currents also in real-time. Need to display phase voltage instead of positive sequence voltage. The phase voltages are required to identify the faulty phase and helps in real time in understanding the issue.

ii. Capability to visualize data for larger time window: Real-time trend given to operator has the capability of plotting real-time values up to the interval of 15 minutes only at its native resolution (25 samples/sec). For the data beyond 15 10 minutes duration operator needs go to TDF application to fetch data and see the details. TDF application is not very user friendly which leads to inconvenience to Real-time operator. There should be a single user interface, through which user can visualize real-time as-well-as historical data as per their interest and interval/duration.

iii. Trending system is having a capability to show only 8 signals and if additional signal is added in same trend window, then it results in freezing or display crash causing limited overview of the system.

iv. PMU with high sampling rate required a few locations: General data storage/display rate of PMU is 25 samples/sec, so as per Nyquist criteria oscillation of 12.5Hz can be detected. However, the PSD display in Phasor Analytics detects modes up to 4Hz only. OSM should be able to captures oscillation up to 12.5 Hz. It is needed to extend the monitored frequencies, to also cover sub-synchronous resonance, very low frequency governor modes and control modes. Higher sampling rate is needed for these applications. In addition, PDC should have capabilities to store data of higher sample rate PMU apart from existing 25 Hz. Present system allow only storage of 25 Hz data only.

v. Option to select reference angle: There should be an option to the selection of reference angle by the user (real-time as-well-as historical) and visualization of other data w.r.t same. Data stored in historian must be RAW data, so that visualization can be done as per the user requirement w.r.t any station. The angular difference values are in reference to a particular node and when the data is dumped in excel for analysing any past event, it is important that reference node is known However in many cases it is not available so make it difficult to find the reference node.

vi. Font and axis size: Formatting of PMU snapshots arrangements should be user friendly so that it could efficiently utilized for daily reporting control room shift. The auto-scaling and adequate font size need to be ensured in PMU

vii. Portability of display: Visualization is an essential part for URTDSM system which requires better interface and flexibility for real time operation. This needs advanced development platforms for retrieval and visualisation of phasor data based on the requirement of the operator in real time. Portability of display to be used in different applications may be ensured for easy reporting

viii. Non-generation of alarms: The real time applications sometimes fail to detect the oscillations. The Modes Applet and Analyst chart show normal state and Alarm/ Alert states are not observed even though Oscillations were present in the system. E-terra vision is having an issue of alarm processing as per user requirement, as and when alarm detects in a group of signals and returns to normal values in few sets of signals in group, then this alarm processing engine is clueless, what to report to operator.

ix. Freezing of display: Visualization screen gets sluggish on certain occasion when trending feature and replay feature is heavily used by operators.

x. Integration with different make of PMU: Interoperability of different PMU manufacturers has been a concern and is progressively taken up post commissioning through firmware upgrades etc. This interoperability aspect may be addressed.

xi. Logic based analytical tools: Logic based analytical tools may be implemented for enhanced situational awareness. Further improvement in alarm-based features with the different mathematical and logical conditions can be carried out.

xii. Modal analysis issues in URTDSM Analytics:

- Baselining of modes from OSM engine is a separate engineering activity and is must to set limits for mode amplitude, damping and selecting mode bands for alerting operators. However, this activity was not part of the current system.
- High noise in PMU: It has been observed that higher order frequency (near to 4 Hz) shows low damping and lower order frequency (near 0.1 Hz) shows high damping. High Noise in some of the PMU's data is another issue and the same has been flagged to GE also. The severity of noise in data is quite high in some cases. Such noisy data will result in bad Analytics and poor performance and utilization and confidence in the system. Some automated tool to be developed for such type of error detection.

b) OSM related issues:

i. Right Eigen Vector plot of modes not observed though it is seen that during that time Inter, Intra, Local and Intra Plant modes were present in the system as reported by existing pilot PMUs. Move upwards in oscillation section.

ii. Availability of statistical functions like a) Mean b) Median c) Standard Deviation d) Maximum e) Minimum and f) Average Values against each of the available parameters in PMUs. Also, the user should be able to generate Box & Whisker plots against each of the available parameters in PMU.

c) System Utilisation related issues

i. Data storage is currently configured to store 1 YEAR data irrespective of the space utilization – Storage only utilized up to ~20% only. Needs review for utilization up to 70% irrespective of time.

ii. 16 Digital slots are currently available in each PMU where only 5 are used rest can be utilized for isolator points of line, BUS, and line reactors etc., helps to improve LSE RESULTS.

iii. Each PMU can monitor 2 elements, spare slot available can be used to integrate new lines / ICT from same substation (Non- SAS SUBSTATIONS)

d) Infrastructure related issues

i. Voltage discrepancy in voltage measurement is observed in some PMU's, it's almost 5 to 10 kV difference in consecutive phases due to that positive sequence voltage is not accurate to take the decision by operator in real time. Some 12 logic/tool must be developed to detect such measurement errors and

generate alarms as well. Utilities need to be sensitized for managing issues related to measurement devices.

ii. Standby communication links have not been implemented in URTDSM project. In case of any issue with communication channel, data loss has been observed on several occasions. Considering the importance of PMUs data in real time grid operation and post facto grid event analysis, it is recommended to implement main and standby philosophy in data communication between PMU & PDC and between PDC & PDC to avoid any data loss.

iii. Frequent time synchronization issues arise in PMU's data due to the GPS issue. In few Stations GPS time synchronization source was shared among the PMUs with some intermediate converters/extenders, which use to have record of going faulty, so there is need for strengthening of GPS source and stringent daily monitoring by substation on daily basis.

iv. Loss of PPS (Pulse per second) is a common cause in case of URTDSM PMUs, mainly due to the disturbance of PPS cable during maintenance activities. Infra issue

v. Dead band defined in PMU data for frequency, voltage and df/dt, it sometimes led to discrepancy in values.

e) Historian

Access to historian data through autonomous software interface is a must requirement for any new WAMS infrastructure. An important API requirement is to get a snapshot of complete PMU measurements at a given timestamp. This is not supported by the present URTDSM historian. In Phase-II, it should be ensured that this kind of feature is available in new historian. The interface should follow well established industry open standards that support both Windows and Linux operating systems to avoid any shortcomings in applications due to lack of inter-connectivity between applications of different vendors.

4.2 Analytical Application Software's developed by IIT Bombay

IIT Bombay (IITB) and POWERGRID have initiated a joint project "Synchro phasors Analytics for Electrical Transmission Systems". Under the project, development of following six analytics by IITB was envisaged. All six analytics have been installed at control centres under URTDSM with regular updates being installed based on feedback

received from constituents. Further, Linear State Estimator (LSE) and Line Parameter Estimation are installed but the performance is not satisfactory. The summary and limitations of the envisaged/installed applications is given below:

a) Line Parameter Estimation Application of total least squares (TLS) method is used to estimate line parameters moving window technique to use voltage, current, active, and reactive power measurements from PMUs and other measuring devices to estimate the positive sequence parameters of an equivalent pi(π) model.

b) Online vulnerability analysis PMU measurements can be used to identify relays that are vulnerable to insecure tripping. In this application, each PMU on Transmission line measurements shall create a virtual relay mimic and relays are termed as vulnerable relays if the margin between their operating characteristics and the distance protection zone boundary is very low, a vulnerability index is presented where the vulnerable relays are ranked based on their risk. The errors get introduced when input relay settings are not validated.

Comment : The Zone-3 power swing blocking setting is available in all the relays and has been reported as implemented by all the utilities as per recommendation of the Committee on the blackout of 2012. Further, the Load encroachment tripping in Zone-3 can be addressed through proper setting of Zone-3 in the relay, which has also been reported to be complied by all the Utilities as per the recommendation of the Committee on the blackout of 2012. This application does not have relevance if metering cores are used.

c) Linear State Estimation PMU has the capability to directly measure the magnitude and angle of bus voltage and current. If enough voltage and current phasors are measured to make the network observable, state estimation could become linear. The measurements are voltage phasor and current phasor, and states are voltage phasor. A state estimator, essentially, removes the errors from the measurements and converts them into states. The control centre can make use of it, to make decisions on system economy, quality, and security. So far, the application is working with some errors and further testing is under progress to identify the bugs.

Comments:

Linear State Estimator Application is not having sub second measurements from ICTs, GTs, bus couplers and bus sectionalizes, due to which most of the time LSE is creating many electrical islands, and the voltage estimates at each bus are not matching the

measurements from the same bus. Due to deviation in estimates and less user-friendly application, acceptability in real time operation is very low.

The network database is not updated constantly and the state estimation with incomplete data becomes difficult. Data base should be taken from existing EMS system. Sub seconds measurements need to be taken.

***IIT-B:** The issues are focused particularly on LSE, but the changes suggested will also help in improving the results of other analytics like Line Parameter Estimation and instrument transformer calibration (LPE-RMC) and vulnerability assessment of distance relays (VADR). Feedback provided by IIT Bombay based on the WRLDC WAMS Project is as follows.*

i. *The network editor is used to enter static power system data that is used in LSE. The existing database was found to have missing / wrong data. kV lines. Lines have wrong values for R & X Values of 400 kV as well.*
ii. *PMU Mapping Errors: Some PMUS has both voltage and current channels mapped wrongly. One current channel is mapped to line voltage*
iii. *Wrong Polarity in PMU data There are lines where it is suspected that either one end PMU polarity is wrong or there is some other more serious gross error. These errors can be verified by comparing the P and Q measurements of these PMU measurements with corresponding SCADA measurements. Here it must be noted that we can identify such errors only in the transmission lines that have PMUs connected to both ends.*
iv. *Apart from these, there are following lines that give unrealistic results when state estimation is performed using their measurements. The error could be in entering their transmission line data, or their PMU measurements or even the PMU channel mapping. Transmission lines that can be checked in this way, some have wrong polarity and other have some other serious measurement issue that make overall state estimation results poor.*
v. *Some of the lines are parallel lines originating and terminating to the same substations. Hence it is possible that topology or transmission line data of such lines may be wrong. Many of these lines could have been tapped at some place, resulting in LILO but the database has not been modified. Hence special care must be taken on such lines to verify their data.*
vi. *Reduced observability: As a result of elimination of all the bad current measurements, many substations that have PMUs installed, all current*

measurements associated with that substation cannot be used. The bad measurement has a significant impact on degrading the LSE observability.

vii. *Almost 50 percent of the PMU data comes under list of bad data. This is a very high proposition for any state estimation analytics. Hence it is suggested that each of the suspected measurements is systematically checked and eliminated in step-by-step manner. It is possible that many of the above-mentioned measurements are in fact correct, but the nature of LSE analytics which impact neighbouring measurements also, make them suspect. So, after clearing some of the obvious bad data that could be identified, the same exercise as this one must be repeated to see if some of the measurements that were identified as bad data get reclassified as valid. The errors identified in database and PMU channel mapping must be eliminated first.*

Expanded observability concept** : **It is required to estimate the state of the buses where PMUs have not been installed through one or more PMUs installed at remote ends of the substation. This will avoid islands formation in the system due to measurements not available at those locations. The voltage and angle measured through the PMUs at remote locations (one or more locations) can be used to estimate the voltage and angles of these buses, if the line parameters are known. This feature should be developed and deployed in the LSE enhancement.

d) CT/CVT Calibration It is difficult to ascertain accuracy of any instrument transformer at site, once it is installed. State estimation techniques can perform "soft calibration" of these instruments to reduce errors in state estimation and identify any gross error if present in instrument transformer.

Comments: The performance of this analytic is required to be ascertained with actual on-site testing of CT/CVTs.

e) Supervised Zone-3 Distance Protection:

Distance relays are widely used for transmission line protection. These relays also provide remote backup protection for transmission lines. However, there are a few issues with backup protection as provided by distance relays

- Zone-3 based remote backup protection schemes are dependable but not secure.
- A relay mal-operation can act as a catalyst or even trigger a system collapse situation.

- Incorrect Zone 3 relay operation may be a consequence of either
  - quasi-stationary events like load encroachment, overload, undervoltage etc., or
  - electromechanical oscillations like power swings.

To overcome the problems mentioned above, an adaptive remote backup protection scheme using output of the linear least square state estimator was envisaged under analytics of phase I.

At present metering core of CT, CVT is used as inputs to the PMUs. In the event of faults, the metering class CTs generally get saturated, therefore the measurements obtained from these CTs are erroneous. Since these inputs are provided to the PMUs, any application using the transient data during the un-cleared fault period may not give desired results. The results of these analytic needs to be corroborated with the DRs obtained from the field. If protection class CT cores would have been wired up to the PMUs, this analytic would have provided reliable results. The comments at b) above are valid for this analytic also.

f) Control Schemes for Improving System Security: This analytic has been installed.

4.3 Issues in Phase – I analytics and observations:

The problems faced in the analytics have been detailed above. Analytics at 4.2 Sr. No. 1), 2), 4) & 5) needs further investigation and decision as to whether continue the development. If the results of these analytics are found to be consistent with the observations made through the DR analysis and PMU data of the local PMUs installed near the disturbance points of a sufficient number of disturbances, then these analytics could be put to use. Analytics at 4.2 Sr, No. 1) Line Parameter Estimation & 4) CT/CVT CALIBRATION are least useful from system point of view and therefore it is recommended that wherever opportunity exists, these analytics can be used for estimation of line parameters and CT/CVT calibrations. Additional PMUs required exclusively for these two analytics are not required to be included for future scope. Similarly, analytic at Sr.No. 2) Online vulnerability Analysis and analytic at Sr. No. 5) Supervised Zone-3 Distance Protection are of protection class analytics, however the PMUs and CT/CVTs used are of metering class and therefore these analytics are prone to give erroneous results as described above. Hence additional PMUs required exclusively for these two analytics are not required to be included for future scope and

the facility developed so far can be used, wherever possible. LSE, which is partly functioning, needs to be developed further, so that the same can be put to use and other deliverable analytics could further be taken up. For this, following needs to be taken care in the phase II.

4.4 Improvements needed to address above issues:

a) PMUs should not only be limited to post event analysis and should be employed for state of analytics such as Dynamic State Estimation, threats forecasting and alarming systems in real time, if possible, control systems for real time control of active/reactive power etc.

b) Several equipment's such as ICTs, Bus Couplers were not configured in the LSE. Also, PMUs were not provided on ICTs, Bus reactors, Switchable line reactors and some important substations where Fibre Optic connectivity is not available. Lack of observability & lack of communication link also led to problems in PMUs LSE.

c) Logic based analytical tools for enhanced situational awareness, Advance development platforms for retrieval and visualization of phasor data, etc. may be added in the existing system, so that system operators' visualization can be enhanced to take appropriate decisions.

d) POSOCO informed that the POSOCO pilot project & States PMUs were also integrated with the URTDSM project. However, the data was not complete, and it led to formation of Islands and therefore State estimation of complete system is not available with the existing installed PMUs. There are network modifications happening and the data was not regularly updated/made available in the system since the same is required to be updated in SCADA network database & PMU LSE database. The network and the network topology database need to be updated by putting extra effort and therefore the network database of PMU based LSE can be exactly aligned with the actual system

e) Additional PMUs should be installed at substations which are critical from system point of view, by laying of the Fibre Optic under Phase – II of the URTDSM project.

f) An engine can be developed which will enable the SCADA topology and network database to be imported in the PMU based LSE. The database should be common for both the systems (SCADA & PMU LSE).

5. Phase – II of URTDSM

5.1 PMU Placement Criteria

Inputs and views of POSOCO, IIT-B, RPCs and recommendations in various meetings on placement of PMUs under phase-II, are briefly outlined below.

a) **CTU**: During the Standing Committee on Communication System Planning in Power Sector (SCCSPPS) held on 09.03.2021, **CTU** in its agenda item suggested that the above criteria need to be reviewed in respect of NER & Sikkim as most of the transmission lines in NER & Sikkim are at 132kV/ 220 kV level. The **CTU** proposed that following locations may also be included for PMU placement:

   i. All 132 kV and above ISTS lines in NER & Sikkim
   ii. All 132 kV and above ISGS in NER & Sikkim.
   iii. (Additional factor of "distance between such stations" for extent of Wide Area Measurement also to be accounted for Placement in NER.)

   Tentative additional quantity of PMUs required in NER - 120 nos. and in Sikkim- 22 nos. Details of links for PMU placements in NER & Sikkim are attached at *Annexure IV* and *Annexure V* respectively. This requirement of PMUs in NER and Sikkim may be included in the upcoming URTDSM Phase-II project.

   Matter was discussed with IIT Mumbai & POWERGRID and it being mentioned that NERLDC may validate the list enclosed as Annexure IV & V for NER Lines/ Links w.r.t. the significance of Transmission Lines for NER network in view of expected Voltage Upgrade of Lines/ Generating Station Connectivity, Ownership / Tie Lines/ etc.

b) **NRPC**: NRPC (in 45th TCC, 48th NRPC meeting) and SRPC (in TCC & 37th SRPC meeting) proposed following additional PMU locations beyond the already agreed philosophy in standing committee:

   i. Generating Transformers (GTs) at LV side (having HV side of 220kV and above).
   ii. FACTS devices such as STATCOM, SVC, FSC, TCSC etc.
   iii. HVDC Convertor transformers
   iv. Phase Shifting Transformers
   v. Renewable Energy Pooling Stations (PS).

c) **POSOCO:** POSOCO in its feedback report on the URTDSM Project dated March 2021 has suggested following:

i. Placement at all Inter-regional lines.

ii. HVDC & FACTS Devices - At both ends of Interconnecting lines between HVDC side AC switchyard with connecting AC Sub Station, all convertor Transformer (HV Side), at STATCOM/SVC/ station Coupling Transformer (LV&HV Side) including STATCOM/SVC.

iii. Renewable Energy Generation Pooling Points.

iv. On all outgoing feeders including bus sectionalize or tie line between two stages of generating stations having different tariffs or different ownership or both

- High Voltage (HV) side & Low Voltage side of Transformers
- Reactive Power sources & Sinks shall be measured through Synchro phasor
- All CB and isolators shall be wired to Synchro phasor device as digital signals

v. Islanding, Separating & Restoration Points- At both ends of line connected black start stations or 28 restoration path lines (both ends including CB and isolators).

vi. Points where State Estimation error chances are high

- Substation shall have Three phase Bus voltage measurements through PMUs & Circuit breakers and isolator position shall be wired to PMU (for Linear State Estimator) for topology processing and full observability
- Reactive Power sources & Sinks shall be measured through Synchro phasor to avoid MVAR mismatch in Linear State Estimation.
- All 765/400 kV, 400/220 kV Interconnecting Transformers (ICT) should have PMU on both sides (LV & HV).

vii. Power Flow Gates – High power corridors need to have PMU Placements.

viii. Major Load Centres - PMUs should be installed at appropriate radial load feeding substations so that the load sensitivities to system frequency and voltage changes can be monitored.

ix. Angular Difference Monitoring Locations.

x. Major Generating Stations-

- At 400 kV and above Generating stations (132 kV in case of NER).
- Individual Unit of rating 200MW and above for Coal/lignite, 50MW and above for gas turbine and 25 MW and above for Hydro units shall have

PMU placed at the terminals of the generator(s) at either the HV or LV side of the Generator Transformers.

- In case of plant having multiple units, PMU can be placed on 50 percent of the units

xi. System Protection Scheme Monitoring

xii. Experience based locations known for small signal stability related issues.

The details of above are given at *Annexure – VI.*

d) **POWERGRID:** POWERGRID informed that the impact of additional PMUs locations and WAMS analytics, as proposed above, will be as follows:

i. The number of PMUs initially envisaged in Phase II would increase to about 2500.

ii. This increase in number of PMUs will also affect the performance of Phasor Data Concentrator (PDC) and other equipment at the Control Centre Location at SLDC, RLDC and NLDC, RPCs which may also need upgradation / installation.

iii. The additional WAMS analytics shall also require additional hardware.

iv. In view of the increase in PMU population, the existing configuration of Nodal PDC, MPDC, SPDC & Main & B/U NLDC also needs to be seen whether these additional PMUs can be accommodated in the infrastructure of Phase-I. Also, it needs to be seen whether the Nodal PDC, MPDC, SPDC & Main & B/U requires up-gradation or additional hardware is required for accommodating the additional PMUs in Phase-II.

v. Communication related issues are also required to be considered to accommodate the additional PMUs under Phase-II.

e) **Observations**: The number of PMUs initially envisaged in Phase II would increase, if the above philosophy is taken into consideration. This increase in number of PMUs will also affect the performance of Phasor Data Concentrator (PDC) and other equipment such as Historian etc. at the Control Centre Location at SLDC, RLDC and NLDC, RPCs/NPC which may also need up gradation / installation. The additional WAMS analytics shall also require additional hardware.

5.2 New Analytics under URTDSM Project Phase - II.

The proposed analytics under Phase-II of URTDSM is outlined below.

a) **NRPC & SRPC**: Additional WAMS analytics for URTDSM Phase – II were proposed by NRPC (in 45th TCC, 48th NRPC meeting) and SRPC (in TCC & 37th SRPC meeting) as follows:

i. Real time Automated Event Analysis tool
ii. Oscillation Source location tool/engine.
iii. Real time Inertia Estimation Tool
iv. big data analytics tool/engine

b) **POWERGRID**: POWERGRID has suggested following analytics for the Phase – II:

i. Real time Automated Event Analysis tool (using AI, Machine learning and big data)
ii. Event monitoring for early warning system (using AI, Machine learning and big data)
iii. *WAMS based contingency analysis and static security assessment*
iv. Oscillation Source location
v. Response of Windfarm and solar PV farms for LVRT, reactive power etc.
vi. Control of HVDC and STATCOM for damping system oscillations

The details are given in Annexure – VII.

c) **POSOCO**: POSOCO in its feedback report on the URTDSM Project dated March 2021 has suggested following analytics based on analytics being used in foreign power grids:

i. Voltage Stability Monitoring: Measurement based dynamics provide voltage sensitivities; monitoring of key corridors or load pockets; scatter plots for power voltage and power-angle monitoring.
ii. Detection of disturbances: Recognition of short circuits by watching the currents, and indication of loss of load, or loss of generation by watching the frequencies.
iii. Online monitoring of Inertia.
iv. Identification of source of Oscillation.
v. Identification of stressed corridors.
vi. ROCOF calculation over variable window.
vii. Island identification/detection.
viii. Locating contributions to poorly damped or unstable oscillations.
ix. Model Validation.

x. Higher frequency sub-synchronous oscillation analysis and early warning of resonance.

xi. Big Data Analytics

The details are given in *Annexure – VIII*.

6. Recommendations

The recommendations of the sub-group have been grouped under following categories:

6.1 Improvements in applications available in URTDSM-I

6.2 New applications for deployment in URTDSM-II.

6.3 Improvements in system infrastructure

6.4 Minimum criteria for PMU placement under URTDSM-II.

6.1 Following improvements are recommended in applications available in URTDSM-I:

a) Graphical User Interface for visualization of system dynamics

URTDSM Phase-I has a graphical user interface for visualization of power system dynamic parameters. Following improvements are recommended in PMUs data Streaming/GUI in future applications:

i. **Trending of phase voltage and current:** Based on the selection made by the operator in real time it shall be possible to trend phase voltages or positive sequence voltage and currents in real-time.

ii. **Trending of all dynamic power system parameters**

iii. **Option to select reference angle:** There should be an option to the selection of reference angle of any node by the user (real-time as-well-as historical) and visualization of other data w.r.t same.

iv. **Capability to visualize data for larger time window:** There should be a single user interface, through which user can visualize real-time as-well-as historical data as per their interest and interval/duration.

v. **Trending window:** Trending system should have a capability to show more than 8 signals without freezing of results or display crash causing limited overview of the system.

vi. **Font and axis size:** Formatting of PMU snapshots arrangements should be user friendly. The auto-scaling and adequate font size need to be ensured in PMU

vii. **Portability of display:** Advanced development platforms for retrieval and visualisation of phasor data based on the requirement of the operator in real time. Portability of display to be used in different applications may be ensured for easy reporting

viii. **Non-generation of alarms:** Alarm processing as per user requirement.

ix. **Freezing of display:** Visualization screen should not get sluggish when trending feature and replay feature is heavily used by operators.

x. **Integration with different make of PMU:** The interoperability of different PMU manufacturers needs to be addressed.

xi. **Logic based analytical tools:** Logic based analytical tools may be implemented for enhanced situational awareness. Further improvement in alarm-based features with the different mathematical and logical conditions needs to be implemented.

xii. Modal analysis issues in URTDSM Analytics:

Baselining of modes to set limits for mode amplitude, damping and selecting mode bands for alerting operators needs to be implemented.

xiii. Automated tool for detection of bad Analytics and poor performance due to errors because of High Noise in some of the PMU's data.

xiv. Display of data for a larger time horizon (more than 5 minutes at present) shall be possible. There shall be a feature to permit the operator to select the sampling rate to display the data.

xv. User shall have facility to update charts with primary & secondary axis assignment before viewing/downloading images.

xvi. User shall have the facility to make customize displays for monitoring & data retrieval. Further in one screen multiple display facility shall be provided.

xvii. Downloading of historical data should be made more user friendly

At present in Time derivation framework for downloading a signal data many other signals are getting downloaded. For example, one signal of MW is selected for one transmission line for desired period, then it is downloading time, type of signal, status, type of data, feeder name and MW values for desired period, whereas only required information was time & MW for desired duration. Time Series Derivation Framework (TDF) shall have feature to download only desired information. If multiple signals are selected, then they are being downloaded in series which is consuming a lot of the time to just re-arrange the data during analysis. For example, if MW value is selected for two feeders for desired duration, then when data is downloaded, it is coming in series one below to other. Then we need to first filter for feeder-1, copy it and again filter for feeder-2 and then plot. However, downloaded data should have been downloaded in three columns one time, feeder-1_MW, feeder-2_MW only for desired period.

TDF shall have facility to provide only required multiple feeder data for same time period in columns instead of in rows for desired period.

b) Oscillation Detection, monitoring and analytics

The application shall have following capabilities:

i. Capability to detect power system oscillations from dynamic measurements - active power, reactive power, system frequency, voltage phase angle difference and others

ii. Capability to monitor, classify oscillation modes in real time – Intra Plant modes (0.01 to 0.15 Hz), Inter area (0.15 to 1.0 Hz), Local (1 to 5 Hz) and HVDC/FACTS Controller (5 Hz and higher)

iii. Real-time display for oscillation monitoring: Capability to provide simultaneous visualization of the multiple modes (mode frequency, mode damping, mode phase, energy, amplitude etc.) to the operator on a dashboard.

iv. Detecting the dominant and poorly damped modes from the selected power system signals

v. Alarms – Provide a tool to generator alarm if pre-defined mode amplitude and damping limits, set for the safe operation of the power system, are exceeded.

vi. Alarm Settings – Ability for user to define alarm persistence settings (seconds) for mode alarm thresholds

vii. Map Displays – Location and Severity of Oscillation Modes

viii. Oscillation Severity- Show energy of oscillations by locations contributing to a specific oscillatory mode

ix. Oscillation location –Identify the source of the oscillation and display root causes such as: Generator PSS, AVR, controller issues Wind/ Solar controller issues System resonant conditions HVDC/FACTS device controller issues.

- Pinpoint the oscillation source to a generating plant/unit
- Area-wise identification of source location
- Help in identifying event root cause
- Event severity in terms of oscillation energy and affected areas
- Provide oscillation frequency
- List of locations with highest oscillation energies
- Plots of key metrics relevant to the event

x. Statistical functions- Mean, Median, Standard Deviation, Maximum, Minimum and Average Values against each of the available parameters in PMUs. The user should

be able to generate Box & Whisker plots against each of the available parameters in PMU.

xi. Logic based analytical tools for enhanced situational awareness, Advance development platforms for retrieval and visualization of phasor data, etc. needs to be added in the existing system.

c) Linear State Estimator

The Linear State Estimation analytics is the most important application which forms base for all the analytics like Contingency analysis, Vulnerability analysis, System Security analysis, Control Schemes for Improving System Security etc. The LSE analytics provided in the URTDSM Phase-I requires significant improvement in the following aspects for gainful utilization by the operators in real-time.

i. **Database Integration:** An engine shall be provided to enable the SCADA topology and network database to be imported in the PMU based Linear State Estimation. The database should be common for both the systems (SCADA & PMU LSE) so ease database management.

ii. **Bad data detection and conditioning:** Substation Level State Estimation could be considered for conditioning bad measurement within substation. A multi-layer system that is both model-less and model-based to deal with bad data detection and conditioning. In the model, raw PMU Measurements should be compared to LSE's model-based estimations in real-time for determination of the quality and usability. The LSE should also include the ability to condition bad data with estimated results. The application should be capable of bad data detection through plausibility checks, validation and conditioning. It should provide features to checking and correcting PMU channel mapping. Polarity of PMUs connected to both ends should be corrected by utilities.

iii. **Observability analysis:** It should include the capability to quantify the full extent of the observable nodes in the system based on PMU placement and measurement availability relative to the power system network model. This analysis, which occurs in near real-time, can include "islanded" or disconnected portions of the system. It should be capable of providing real-time estimations for multiple islands or disconnected systems.As the topology of the system changes in real-time, a real-time observability analysis is required to correlate the PMU measurements with the topology, so that the LSE can identify observable areas of

the system. It is suggested that each of the suspected measurements is systematically checked and eliminated in step-by-step manner.

iv. **Topology detection:** Topology processor should be capable of operating independently across multiple islands in the system. Changes to topology are detected in real-time for each observable island, and new connectivity matrices are constructed to correctly estimate the new state of the system. The network topology processor determines the present topology of the network from the telemetered status of circuit breakers.

v. **Sampling rate:** Three-phase linear state estimation at sampling rate (25 or 50 s/s for 50 Hz system): It should operate at the PMU sampling rate. Visualization of higher frequency sub-synchronous oscillation and resonance

vi. **Single-Line diagrams:** It should include a robust real-time visualization with the capability of displaying one-line diagrams with PMU and LSE data overlaid and updated in real-time. The visualization tools should the capability to create new one-line diagrams and import existing ones.

vii. **Scalability:** It should be highly scalable to accommodate the increase of PMUs and end users to the system.

viii. **Expanded observability:** The PMUs are not required to be placed at all the ends of the elements in the system, since it will result in large data handling by PDCs and super PDCs. Also, it will introduce the large latencies. The concept of expanded observability where the locations at which PMUs are not installed can be made observable through the PMU measurements at other ends. Through this the Islands formed in the system can be bridged and the complete system becomes observable.

6.2 Following new applications are recommended for deployment in URTDSM-II

a) Real time automated event detection and notification dashboard

The application should use high resolution and time synchronized data for:

i. Event Detection - line trips, generation trips, load trips, load loss, islanding, complete loss of supply at a station and other events

ii. Event characteristics - LG fault, LL fault, auto-reclosure and others

iii. Automated report generation and email

The application should be capable of indicating probably event location. The dashboard should provide link to geographical display to reach to reach the nearest PMU location on the grid map. A library of events shall be maintained. The application should have the capability of automated event mining to scan through large amounts of data (weeks, months, years) to assess grid performance by identifying and classifying events. Data and event mining include identification of the type of event, location, severity and duration. and it should provide prompt the operator with quick information about similar event (s) in the past. (The application may use AI, machine learning, big data analytics to deliver such a solution).

b) Early warning system

The application should detect contingencies and slow trends in PMU measurements (such as angular separation, voltage, power flows etc).and generate alarms to draw the attention of the operator. The application should assist system operators in

i. Identifying stress levels in both apparatus and system by detecting dynamic events linked to phase angle separations and other dynamic metrics
ii. By providing guidance towards meaningful real time contingency selection and analysis
iii. Early indicators of potential equipment failure (CTs, PTs, CCVTs etc.,) and device malfunctions
iv. Provide easy summary reports for case study preparation, post event analysis and archival purposes.

(The application may use AI, machine learning, big data analytics to deliver such a solution).

c) Voltage Stability analytics (VSA)

Synchro phasor data enables high-resolution monitoring of actual system voltages, which can be used for advanced real-time visualization of current operating conditions and voltage stability limits to assess the power system's proximity to system collapse. The application shall use LSE based power flow case to perform VSA and identify active and reactive power margins and limiting contingencies in real time operation.

d) WAMS based contingency analysis and security assessment

Static security assessment tool improves operator assist feature of grid monitoring and makes it adaptive and interactive. This tool is meant to provide and perform what-if simulations and integrate power of data mining with intuition and insights of

operators. Application shall This will help in improving grid operation efficacy. The output of the LSE should be available for static and dynamic security assessment applications.

e) Islanding detection

The application should be capable of automatically detect islanding events in the grid and identify locations (PMUs) that are in the islanded region. The islanding detection algorithm could use a combination of frequency and phase angle difference signals to detect islands and shows key metrics to the operators. The heatmap/contouring feature should allow users to visualize the islanding event on the geographic map. Islanding Detection Methods should include:

i. Frequency based island detection: If the difference in frequencies is getting larger than a certain limit, then an island state is detected.

ii. ROCOF based island detection: If the rate of change of frequency (ROCOF) between at least two neighbouring values is getting larger than a certain limit, then an island state is possibly present or is in the process of arising.

iii. Phase angle-based island detection: Phase Angle differences between voltage phasors from different PMU locations are used to detect out-of-step/islanding conditions.

f) Real time Inertia Estimation and monitoring

This application should be capable of providing an estimate of system inertia. The application shall provide features for monitoring and trending system MVA/MW capacity on bar/off-bar and the real-time kinetic energy of the system.

g) Post-mortem analytics

This application should provide offline data meta tools to facilitate post-mortem event/disturbance analysis to answer commonly asked questions related to event – When, Where, What and Why?. The application shall have following facilities

i. Disturbance analysis and root cause assessment - Quick and detailed analysis of power system events like generation trips, line trips, generation-load imbalances, and other dynamic events.

ii. Baseline daily performance and establish safe operating ranges - Examine Daily System Performance and establish reliable ranges for voltage, frequency, and other system metrics for real time monitoring systems.

iii. Establish alarm limits for use in operations - Calculate key alarm event detection parameter for different real-time applications and establish after investigating multiple events of same type

iv. Rate of Change of Frequency calculation over variable window.

v. Generator Frequency Response Analysis – Calculation of Primary/Inertial Frequency Response, frequency response characteristics of a system following a generation loss.

vi. Measurement Validation - Verify & Validate SCADA & State Estimation results with phasor data to identify differences & deviations.

vii. Stability Assessment - Identify & Locate substations approaching instability issues and quantify sensitivity limits for real time monitoring

h) Generator Model Validation

The application should have the capability to validate generator models and provide validation reports in real-time to provide the most relevant event information:

i. Automated system to perform model validation after significant events

ii. Validates multiple events

iii. Validates multiple generators

iv. Identifies good vs questionable model parameters (programmatically not visually)

i) Wide Area Control Systems

i. **WAMS based automatic load shedding (AUFLS and df/dt):** The AUFLS and df/dt based automatic load shedding schemes could be effective, if the measurements and control is based on the logic at a central location. This would identify the area/locations where load shedding, if carried out, could be effective in relieving the stress in the system and taking a calibrated decision. e.g. Load shedding will be effective in the States/regions who are importing power if the trigger frequency of the Stages in AUFLS is reached and disabling the Load shedding relays of the States/regions who are exporting power to other States/regions in real time.

ii. **Control of HVDC, PSS and STATCOM for damping system oscillations:** This is the usage of WAMS measurements for actual automatic control applications. This was one of the original thoughts behind going for WAMS installation. The power system oscillations that originate in a post fault event or spontaneous oscillations can be damped quickly using controllers of HVDC and FACTS (like

STATCON) devices. It improves the overall transfer capacity of a power corridor. Lot of actual projects are now under operation in the USA and China. India must take up such projects for capacity building for the future.

The above applications may have to be developed in consultation with the utilities and other stakeholders. Pilots may be taken up for gaining experience on these applications before deployment.

6.3 Following improvements in system infrastructure are recommended

Recommended improvement in the system utilization and its performance

i. 16 digital slots are currently available in each PMU where only 5 are used rest can be utilized for isolator points of line, bus, and line reactors etc.
ii. Each PMU can monitor 2 elements, spare slot available can be used to integrate new lines / ICT from same substation (Non- SAS SUBSTATIONS)
iii. Logic/tool must be developed to detect Voltage discrepancy in phase measurement errors and generate alarms. Utilities need to test/check PMUs during the routine calibration of VTs/SEMs.
iv. Adopting main and standby philosophy in data communication between PMU & PDC and between PDC & PDC to avoid any data loss.
v. Strengthening of time reference / GPS source and stringent daily monitoring by substation on daily basis for time synchronization.
vi. It needs to be ensured that loss of PPS (Pulse per second) should not occur due to the disturbance of PPS cable during maintenance activities.
vii. Dead band defined in PMU data for frequency, voltage and df/dt, should not cause discrepancy in values.
viii. Data storage and Historian: Data storage should be configured to store and retain data at least up to one year. Since the population of PMUs is expected to increase manifold in the coming years, the standards / best practices need to be established for Indian power system. A separate sub-committee may be constituted to formulate a criteria for data archival and retention. For the time being data beyond one year shall be stored and made easily accessible for real-time and off-line applications depending upon the space utilization. Access to historian data through a separate software interface is required to be included. The interface should follow well established industry open standards that support both Windows and Linux operating systems to avoid any shortcomings in applications

due to lack of inter-connectivity between applications of different vendors. API shall be provided to enable development of user defined applications.

ix. **PMU Testing:** PMU standards conformance tests shall be performed to verify whether the PMU meets the requirements of IEC/IEEE 60255-118-1 under steady-state, transient, and dynamic power system conditions, and the associated data transfer requirements as given in IEEE Std C37.118.2 or communication requirements given in IEC 61850. PMU field commissioning tests shall include routine visual inspection, insulation test, wiring check, basic functionality check, etc., as required by the relevant standards. In addition, a PMU field commissioning test shall verify correct phase sequence verification. Correct phasor magnitude measurement verification, Correct CT polarity, Correct indication of time, Data and control frames sending/receiving verification. System integration tests shall verify the following: expected phase angles relative to the phase angles from other locations, proper sending/receiving data/control frames to/from PDCs, Proper logging of PMU activities, such as on-line/off-line time, setting changes, etc., PMU status monitoring and trouble reporting, communications channel speed (packets per second)

x. **PDC Latency in multiple streams:** A PDC can thus create a time-aligned, system-wide measurement set. In the hierarchy mode of operation, a local PDC aggregates, time-aligns data from multiple PMUs and feeds it to local applications, and to a control center PDC. The control center PDC collects data from multiple local PDCs, may conduct data quality checks, and feed the data to a regional PDC. A regional PDC may operate in a similar manner, exchanging data with several control center PDCs. PDC latency can be affected by the number of phasors and number of input data streams. If a PDC belongs to a system with multiple PDCs then the latency of the entire network must be considered. PDC must be able to handle off nominal conditions such as high rates of incoming data, incorrect timestamps, and unsupported protocols. PDC must be able to achieve the availability and reliability target levels consistent with the application.

xi. **Sampling rate:** Installation of PMU with high sampling rate is recommended at a few locations to monitor sub-synchronous resonance, very low frequency governor modes and control modes. PDC should have capabilities to store data of higher sample rate PMU apart from existing 25 Hz.

xii. Redundant and reliable high speed communication system is vital for PMU based Wide Area monitoring system. Fiber Optic connectivity between the substation identified for placement of PMU and control center is strongly recommended.

6.4 PMU placement strategy:

a) Placement of PMUs Criterion:

The PMU placement should be based on the analytics/application being developed and put into use.

b) Limiting constraints for Placement of PMUs.

The limiting constraints in installation of additional PMUs include

i. The hardware requirement of the PDCs & Master PDCs as the current PDCs may not have enough memory to process the additional data from the PMUs.

ii. Hardware and communication requirements will also be required to be changed and upgraded.

Communication link issues cannot be entirely eliminated, but suitable measures may be taken for mitigating them. The failure modes are often related to the quality of equipment and installation. Effective measures like planning to reduce failures by employing redundancy techniques shall be taken. As more PMUs are connected to a PDC, the possibility for more latency become more frequent. PDC requirements shall be matching with PMU data requirements and appropriate matching capabilities shall be ensured in advance.

c) Type of PMUs

There are two different type of PMUs defined in IEEE standard C37.118-1. M type (Measurements) PMU is slower i.e., have higher PMU reporting and measurement latency and it is immune to errors caused by out of band frequency oscillations. P type (Protection) PMU is comparatively faster, but it does not filter out out-of-band frequency component, hence it is slightly inaccurate (only when such oscillations are present which is the case when saturation of the core.

Further, the connection of CT and CVTs to PMU input channels is a permanent choice that cannot be changed, or it takes lots of effort and time and money to change. Hence it is important to decide in the beginning of the project whether to connect PMUs to metering cores of CT and CVTs or to protection cores.

Since the PMUs in Phase-I are M type PMUs and are connected to metering core of CT/CVTs, the committee recommends that under Phase-II, M-type PMUs are to be procured and connected to the metering core. The placement of PMUs where it is expected that high fault current would be observed shall take the measurement from protection core. Using measurement core of the CT can lead to issues like saturation while measuring high fault current. Therefore, it is recommended that **few P-type PMUs shall be deployed on pilot basis (say 5 to 10 PMUs in each region).**

d) Minimum criteria of PMU locations:

Based on the above limiting constraints and proposed applications, the following locations should have PMUs (Minimum Criteria)

i. **At one end of all 400 kV and above transmission lines**
ii. **At the HV side of all ICTs connected to 220 kV and above**
iii. **On HV side of coupling transformer of SVC/STATCOM for measurement of HV Bus voltage and current of coupling transformer**
iv. **At one end of line wherever FSC/ TCSC are installed.**
v. **On HV side of converter transformers for measuring HVAC bus voltage and current of converter transformer on each converter station.**
vi. **On both ends of Inter-regional and trans-national tie lines and on boundary buses for such lines.**
vii. **At the Generating Transformers (GTs) at LV side (having HV side of 220kV and above) of the Generating units with capacity above 200 MW for Thermal units, 50 MW for Hydro units and 100 MW for Gas units.**
viii. **On all 220kV substations for measuring voltage of 220 kV bus and current of two lines/transformer catering to load centers.**
ix. **All 132 kV and above ISTS lines in NER & Sikkim and important load centers.**
x. **At RE developer end of the evacuating line connecting the Renewable Energy Pooling Stations (PS) to point of interconnection with the grid of 50MW and above.**
xi. **Islanding, Separating & Restoration Points- At one end of line which is connected to black start stations along with circuit breaker status via synchro phasors.**

xii. **Fiber Optic should be covered under Phase – II for all the above locations of the URTDSM project.**

xiii. **At all ICTs, Bus reactors, Switchable line reactors of critical substations.**

e) Future Considerations & integration of State PMUs

Following locations may also be considered for installation of PMUs under Phase-II, for future projects:

i. **Requirement of PMUs under Phase-II, as per above philosophy, be framed for the planned system up to 2024. Thereafter CTUIL may include the provisioning of PMUs in the scope of planned projects as per the above philosophy.**

ii. **The placement of PMUs for special cases such as Islanding, Separating & Restoration Points and ICTs, Bus reactors, Switchable line reactors of critical substations, load centres of NER shall be suggested by POSOCO in consultation with RPCs & CTU.**

iii. **Existing PMUs & PMUs planned in future by States should be integrated with the URTDSM Project.**

iv. **PMUs in the future projects should be made part of the system with improvements in the PDCs capabilities incorporated in the new Project.**

v. **PMU & PDC consoles at CTUIL, RPCs and CEA- Since CTUIL is entrusted with planning ISTS system, it is recommended that PMU & PDC consoles along with redundant, dedicated & secure communication link up to CTUIL premises be provided for CTUIL.**

The Power flow, Voltage, Angle data of PMU shall be integrated with CTUIL Planning system software for System studies, System planning of ISTS system, in consumable form, through standard protocols along with visualization.

Similar facilities should be made available at all RPCs and CEA if the same is not covered under Phase I. The console for CEA is supplied but could not be installed due to non-availability of dedicated secure communication link.

vi. **The up gradation of PDCs and control centre equipments be reviewed once in two (2) years, so that they can handle the data due to incremental PMU population in the system.**

vii. **PGCIL was of the view that 5 out of 6 analytics developed in Phase-I would not work, due to adoption of the above PMU placement philosophy (in all these 5 analytics PMU is required at both ends). The analytics viz Line parameter estimation, CT/CVT calibration are complementary to each other, where, in one analytic the CT/CVTs are assumed to be accurate and in the other the line parameters are assumed to be accurate (the reference used for one analytic is dependent on the other) and therefore the result of this analytics are not found to be much of use. The Online Vulnerability analysis and Supervised Zone-3 distance protection are protection class analytics as explained in the previous chapters and the results needs validation through DRs. The Zone-3 power swing blocking setting is available in all the relays and has been reported to be implemented by all the utilities as per recommendation of the Committee on the blackout of 2012. Further, the Load encroachment tripping in Zone-3 can be addressed through proper setting of Zone-3 in the relay, which has also been reported to be complied by all the Utilities as per the recommendation of the Committee on the blackout of 2012. Control System for improving system security analytic and the above four analytics, however, shall to be used wherever PMUs are available at both ends and the results be validated.**

viii. **The relevant orders of Ministry of Power, Government of India and CEA/CERC regulations for cyber security compliance should be followed. The directives of CERT-In for time synchronisation of PMUs should be followed in view of cyber security.**

ix. **Training module should be incorporated in Phase-II of URTDSM project for the State Utilities, CTU, POSOCO, CEA and RPCs.**

Annexure - I

सत्यमेव जयते

भारत सरकार/Government of India

विद्युत मंत्रालय/ Ministry of Power

केन्द्रीय विद्युत प्राधिकरण/Central Electricity Authority

राष्ट्रीय विद्युत समिति प्रभाग/National Power Committee Division

1st Floor, Wing-5, West Block-II, R.K. Puram, New Delhi-66

No. 4/MTGS/NPC/CEA/2021/ 285 - 298 दिनांक:20.09.2021

To
(As per distribution list)

विषय : "यूआरटीडीएसएम (URTDSM) परियोजना के तहत पीएमयू (PMU) स्थानों के समान दर्शन, नए विश्लेषण और नियंत्रण केंद्र के उन्नयन की आवश्यकता पर उप-समिति" का गठन-के सम्बन्ध में।

Subject: Constitution of "Sub-Committee on the uniform philosophy of PMU locations, new analytics and requirement of up gradation of Control Centre under URTDSM project"-reg.

Madam/Sir,

In the 10th meeting of NPC held on 09th April 2021, it was decided that a Sub-Committee would be formed under the Chairmanship of Member Secretary, WRPC with representatives from POSOCO, CTU, POWERGRID and all RPCs/NPC. The Sub-Committee shall discuss on the uniform philosophy of PMU locations, new analytics and requirement of up gradation of Control Centre under URTDSM project and submit its recommendations to the NPC.

Accordingly, the nominations has been sought from RPCs, POSOCO, CTU and POWERGRID via email dated 01st Sept 2021. Based on the nominations received, the Constitution of "Sub-Committee on the uniform philosophy of PMU locations, new analytics and requirement of up gradation of Control Centre under URTDSM project" is as follows:

1	Member Secretary, WRPC	Shri Satyanarayan S.	Chairperson
2	Chief Engineer, NPC	Smt Rishika Sharan	Member
3	Superintending Engineer, NRPC	Shri Saumitra Mazumdar	Member
4	Superintending Engineer, ERPC	Shri Shyam Kejriwal	Member
5	Superintending Engineer, WRPC	Shri P. D. Lone	Member Convener

EE(S) 29/09/21.

6	Superintending Engineer, TS SLDC Executive Engineer, (P&C II) TANTRANSCO Executive Engineer, SRPC	Shri P Suresh Babu Shri T Sivakumar Shri Len J.B.	Member
7	Deputy Director, NERPC	Shri Srijit Mukherjee	Member
8	Deputy Director, NPC	Shri Himanshu Lal	Member
9	Sr. GM(LD&C),PGCIL	Dr. Sunita Chohan	Member
10	General Manager, NLDC Chief Manager, SRLDC	Shri Vivek Pandey Shri Abdulla Siddique	Member
11	General Manager, CTUIL	Ms Nutan Mishra	Member

(ऋषिका शरण/**Rishika Sharan**)
मुख्य अभियन्ता एवं सदस्य सचिव,रा.वि.स /
Chief Engineer & Member Secretary, NPC

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4. Shri Shyam Kejriwal, SE, ERPC
5. Shri P Suresh Babu, Superintending Engineer, TS SLDC, TSTRANSCO, Vidhuth Soudha, Khairthabad, Hyderabad, Telangana
6. Shri T Sivakumar, Executive Engineer, (P&C II) TANTRANSCO, Chennai, TN
7. Shri Len J.B., Executive Engineer, SRPC, 29, Race Course Cross Road, Bengaluru
8. Shri Srijit Mukherjee, Deputy Director, NERPC
9. Shri Abdulla Siddique, Chief Manager, SRLDC
10. Shri Vivek Pandey, General Manager, NLDC, B-9 (1st Floor), Qutab Institutional Area, Katwaria Sarai, New Delhi
11. Dr. Sunita Chohan, Sr. GM(LD&C),PGCIL, Plot No.2, Near, IFFCO Chowk, Sector 29, Saudamini, Haryana 122001
12. Ms Nutan Mishra, General Manager, CTUIL, PGCIL, Plot No.2, Near, IFFCO Chowk, Sector 29, Saudamini, Haryana 122001

Copy to:
1. Chairperson, CEA
2. Member (GO&D), CEA

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Annexure II

S.No	Region	Sub-Region	State	Sub-Station	Owner/ Utility	kV level-1 DETAILS	Feeder name As per Contract	Feeder name As per Site Survey	As per Discussion	Additional / Deficit Feeder name as per Site	Deviation in feeder Qty.	Deviation in feeder Name as per contact vs Site	PMU
													1409
1	NER	NER	Assam	220kVMariani (New)	Powergrid	220	200kV Kathalguri , 220KV Misa , 220kV Mockochung 1 & 2	Kathalguri, Misa Mockochung 1 & 2	-	0	0	NA	3
2	ER	ER-I	Jharkhand	765/400kV Ranchi (N)	Powergrid	765	765KV Dharamjaygarh 400kv Ranchi-1,2,3,4 400kv NKSTPP-1,2 400kv J pool-1,2	765KV Dharamjaygarh-1 400kv Ranchi-1,2,3,4 400kv NKSTPP-1,2 400kv J pool-1,2 765KV Dharamjaygarh-2		1	1	765kvDharamjaygarh->765kvDharamjaygarh-1 Not in contract->765KV Dharamjaygarh-2	8
3	ER	ER-I	BIHAR	765kv Gaya	Powergrid	765	765kv varanasi-2, 765kv varanasi-1, 765kv sasaram, 400kv kodarma-1 400kv kodarma-2 400kv maithon-1 400kv maithon-2 400kv NKSTPP-1 400kv NKSTPP-2 400kv Nabinagar-1 400kv Nabinagar-2 400kv j'pool-1 400kv j'pool-2	765kv varanasi-2, 765kv Balia, 765kv gaya-fatehpur, 400kv koderma-1 400kv koderma-2 400kv maithon-1 400kv maithon-2 400kv NKSTPP-1 400kv NKSTPP-2 400kv Nabinagar-1 400kv Nabinagar-2 400kv chadna 2 400kv j'pool-2		3	0	765kv varanasi-1->765kv Balia 765kv sasaram->765kv gaya- fatehpur, 400kv j'pool-1->400kv chadna 2	11
4	NR	NR-II	Haryana	Abdullapur	Powergrid	400	Bawana-1, Sonapat(HVPNL), Sonepat-1&2, Panchkula-1&2, Karcham Wangtoo-1&2, dehradun-1&2	Bawana-1, Dipalpur, Sonepat-1&2, Panchkula-1&2, Karcham Wangtoo-1&2, dehradun-1&2	-	0	0	Sonapat(HVPNL) > Dipalpur	5
5	NER	NER	Assam	Agia	AEGCL	220	BTPS-1 BTPS-2 AZRA BOKO	220kv feeder 3 control panel 220kv BTPS-Agia FDR-2 220kv Agia-SoniSajai FDR-2 220kv Feeder 4 control panel		0	0	BTPS-1->220kv feeder 3 control panel BTPS-2->220kv BTPS-Agia FDR-2 AZRA->220kv Agia-SoniSajai FDR-2 BOKO->220kv Feeder 4 control panel	2
6	NR	NR-I	Uttar pradesh	Agra	Powergrid	400	Agra-1(UP) Agra-2(UP), Auriya-1 Auriya-2 bassi-1, bassi-2 bassi-3, Kanpur, Ballabhgarh, Bhiwadi, Gwaliar-1 Sikar-1&2, Gwaliar-2	UPPCL-1 UPPCL-2 Auraiya-1 Auraiya-2 Jaipur-1 Jaipur-2 Jaipur-3 Kanpur Ballabgarh Bhiwadi-I Bhiwadi-II Sikar-1&2, Not identified	As per Site Survey	1	-1	Agra-1>UPPCL-1 Agra-2>UPPCL-2 Bassi-1>Jaipur-1 Bassi-2>Jaipur-2 Bassi-3>Jaipur-3 Bhiwadi> Bhiwadi-I Gwaliar-I> Bhiwadi-II Gwaliar-II> Not identified	7
7	NR	NR-I	Uttar pradesh	Agra 765	Powergrid	765	Fatehpur-2, Gwalior-2, Meerut-1, Jatikara-1, Not identified, Not identified	Fatehpur-II, Gwalior-II, Meerut, Mundka Fatehpur-I, Gwalior-I,	As per site survey	0	0	Meerut-I > Meerut Jatikara-I > Mundka Not identified > Fatehpur-I Not identified > Gwalior-I	6

8	ER	ER-II	West Bengal	Alipurduar	Powergrid		400kV Bongigaon 1&2, 400kV Tala 1&2, 400kV Siliguri 1,2,3&4, B'Charyali HVDC 1&2, Agra HVDC 1&2, Punatsanghu 1&2						6
9	NR	NR-I	Uttar pradesh	Allahabad	Powergrid	400	Kanpur - 2 , Kanpur - 1 , Biharsharif , Sarnath , Singrauli - 1 , Singrauli - 2 , Rihand - 1 , Mainpuri - 2 , Rihand - 2 , Mainpuri - 1	Kanpur - 2 , Fatehpur -3 , Sasaram , Sarnath , Singrauli - 1 , Singrauli - 2 , Rihand - 1 , Fatehpur -2 , Rihand - 2 , Fatehpur -1	As per Site Survey	0	0	Kanpur - 1 > Fatehpur -3 Biharsharif > Sasaram Mainpuri - 2 > Fatehpur - 2 Mainpuri - 1 > Fatehpur - 1	5
10	NR	NR-II	Punjab	Amritsar	Powergrid	400	Jalandhar	Jalandhar	Jalandhar Banala- 1&2 Makhu- 1&2.	0	0	NIL	3
11	ER	ORISSA	Orissa	ANGUL	Powergrid	765	765kV Jharsuguda 1 ,2 400kV jindal1 &2, 400kV mannet 1 &2, 400kv GMR-1,&2 400kv Navbarath-1&2 400kv Lanco-1,2,3&4, 765kV Jharsuguda 3,4 765kV srikakulam 1 & 2, .	765kV Jharsuguda 1 ,2, 400kV jindal1 &2, 400kV mannet 1 &2, 400kv GMR-1,&2 400kv Navbarath-1&2 400kv Balangir, 400kv Talcher, Meramaundali-1&2 .		1	1	Nill->400kv Balangir, Nill->400kv Talcher, Nill->400kvMeramaundali-1&2 400kv Lanco-1,2,3&4-> Not available 765kV Jharsuguda 3,4->Not available 765kV srikakulam 1 & 2-> Not available.	10
12	NR	NR-I	Uttar Pradesh	Anpara	Uttar Pradesh	400	Sarnath-1, Sarnath-2, Mau, Singarauli, Obra-1, Obra-2, Unnao	Sarnath-1, Sarnath-2, Mau, Singarauli, Obra, Anpara-D, Anpara-D	As per site survey	0	0	Obra-1 > Obra, Obra-2 > Anpara-D, Unnao > Anpara-D	4
13	ER	ER-II	West Bengal	Arambagh	WBSETCL	400	ppsp-i ppsp-ii baekeshwar kolaghat bidhinagar	ppsp-i ppsp-ii baekeshwar kolaghat durgapur		0	0	bidhinagar->durgapur	3
14	NR	NR-I	Uttar Pradesh	Azamgarh	Uttar Pradesh	400	Gorakhpur(up),Sarnath,Mau, Sultanpur	Gorakhpur(up),Sarnath,Mau,Sultanpur	As per Site Survey	0	0	NIL	2
15	NR	NR-II	Haryana	Bahadurgarh	Powergrid	400	Bawana,Bhiwani, sonepat-1,2	Bawana,Bhiwani, sonepat-1,2	Bawana,Bhiwani (POWERGRID) sonepat-1,2	0	0	NIL	2
16	ER	ER-II	West Bengal	Baharampur	Powergrid	400	400kV Farakka, 400kV Jeerat, Bheramara (Bangladesh) 1&2	Farakka, Jeerat, Bheramara 1&2	-	0	0	Bheramara (Bangladesh) 1&2-> Bheramara 1&2	2

17	ER	ER-II	West Bengal	BAKRESHWAR	WBSETCL	400	400kv arambag jeerat 220kv bidhan nagar-i bidhan nagar-ii satgachia-i satgachia-ii gokarna-i gokarna-ii	400kv arambag jeerat 220kv bidhan nagar-i bidhan nagar-ii satgachia-i satgachia-ii gokarna-i gokarna-ii		0	0	nill	4
18	NR	NR-I	Uttar pradesh	Balia	Powergrid	400	Patna-1, Patna-2, Bargh-1, Bargh-2, Biharsharif-1, Biharsharif-2, Lko(PG)-1, Lko(PG)-2, Mau-1, Mau-2	Patna-1, Patna-2, Patna-3, Patna-4, Biharsharif-1, Biharsharif-2, Sohowal-1, Sohowal-2, Mau-1, Mau-2	As per site survey	0	0	Bargh-1 > Patna-3, Bargh-2 > Patna-4, Lko(PG)-1 > Sohowal-1, Lko(PG)-2 > Sohowal-2	7
19	NR	NR-I	Uttar pradesh	Balia-765	Powergrid	765	Gaya, Lucknow	Gaya, Lucknow, Future Line-1, Future Line-2	Gaya, Lucknow	2	2	Not identified > Future Line-1, Not identified > Future Line-2.	2
20	ER	ORISSA	Orissa	BALIMELA(H)	OPTCL	220	Jayangar-1, Jayangar-2, Jayangar-3, Upper-sileru	Jayangar-1, Jayangar-2, Jayangar-3, Upper-sileru, OPTCL-balimela	-	1	1	Nill->OPTCL-Balimela	3
21	NER	NER	Assam	BALIPARA PG	Powergrid	400	Misa PG-I Misa PG-II B'Charyali-I B'Charyali-II B'Charyali-III B'Charyali-IV Bongaigaon-I Bongaigaon-II Bongaigaon-III Bongaigaon-IV Kameng-I Kameng-II	Misa-I Misa-II Ranganadi-I Ranganadi-II B'Charyali-III B'Charyali-IV Bongaigaon-I Bongaigaon-II Bongaigaon-III Bongaigaon-IV Kameng-I Kameng-II		0	0	Misa PG-I->Misa-I Misa PG-II->Misa-II B'Charyali-I->Ranganadi-I B'Charyali-II->Ranganadi-II	6
22	NR	NR-I	Haryana	Ballabgarh	Powergrid	400	Bamnauli -1&2, Maharanibagh,Kanpur1,2, Agra, GNoida Mainpuri-1,2 Bhiwadi Gurgaon	Bamnauli -1&2, Maharanibagh,Kanpur1,2, Agra Nawada, Mainpuri-1,2 Gurgaon, Kanpur-III,	As per Site Survey	0	0	Bhiwadi > gurgaon G.Noida > Nawada Gurgaon > Kanpur-III	6
23	NR	NR-I	Delhi	Bamnauli	DTL	400	Jattikalan-1, Jattikalan-2, Ballabhgarh-1, Ballabhgarh-2	Jattikalan-1, Jattikalan-2, Ballabhgarh-1, Ballabhgarh-2	As per site survey	0	0	NIL	2
24	ER	ER-I	BIHAR	BANKA	Powergrid	400	Biharshariff-1,2 Kahalgaon-1,2	Biharshariff-1,2 Kahalgaon-1,2		0	0	NA	4
25	NR	NR-I	Uttar Pradesh	Bareilly	Uttar Pradesh	400	Barelli-1&2(PG),Unnao-1,2	Barelli-1&2(PG),Unnao-1,2	As per Site Survey	0	0	NIL	2
26	NR	NR-I	Uttar Pradesh	Bareilly-PG	Powergrid		Muradabad-1&2,Muradnagar-1&2,Barelli-1&2(UPPCL),Lucknow-1&2,Lucknow(UP)						6
27	ER	ER-I	BIHAR	BARH	NTPC	400	Patna 1,2, Gorakhpur 1&2 Patna 3 Patna 4, KHSTPP 1&2,	Patna 1,2, Gorakhpur 1&2 Balia 1, Balia-2 Kahalgaon 1&2	-	0	0	Patna 3-> Balia-1 Patna 4-> Balia-2 KHSTPP 1&2 ->Kahalgaon 1&2	4

28	ER	ORISSA	Orissa	Baripada	Powergrid	400	Jamshedpur , Jamshedpur (DVC), Keonjhar, Chanditala, KVK, Duburi,	Jamshedpur 1 Jamshedpur 2, Keonjhar, Khoragpur, Mendajhul 1, Mendajhul 2	-	0	0	Jamshedpur > Jamshedpur 1 Jamshedpur (DVC) > Jamshedpur 2, Chanditala> Khoragpur, KVK > Mendajhul 1, Duburi > Mendajhul 2	3
29	NR	NR-I	Rajasthan	Bassi	Powergrid	400	Agra-1, Agra-2, Agra-3, Jaipur-1, Jaipur-2, Bhiwadi-1, Bhiwadi-2, Sikar-1, Sikar-2	Agra, Jaipur South-1, Jaipur South-2, Phagi-1, Phagi-2, Bhiwadi, Kotputli, Sikar-1, Sikar-2	As per site survey	0	0	Agra-1 > Agra Agra-2 > Jaipur South-1 Agra-3 > Jaipur South-2 Jaipur-1 > Phagi-1 Jaipur-2 > Phagi-2 Bhiwadi-1 > Bhiwadi Bhiwadi-2 > Kotputli	5
30	NR	NR-I	Delhi	Bawana	DTL	400	Abdullapur-1,2, Bamnaulli-1,2, Mandaula-1,2 Hisar, Bhadurgarh	Abdullapur-1,Dipalpur Mundka-1,2, Mandaula-1,2 Not Available Not Available	As per Site Survey	2	-2	Bamnauli-I > Munduka-I Bamnauli-II > Munduka-II Abdullapur-II > Dipalpur Hisar,Bhadurgarh are disconnected from site.	3
31	NR	NR-II	Himachal Pradesh	Bhakra(L&R)	BBMB	220	Ganguwal-1, Ganguwal-2, Ganguwal-3, Ganguwal-4, Ganguwal-5, Mahilpur-1, Mahilpur-2, Jamalpur-1, Jamalpur-2	Ganguwal-1, Ganguwal-2, Ganguwal-3, Ganguwal-4, Ganguwal-5, Mahilpur-1, Mahilpur-2, Jamalpur-1, Jamalpur-2		0	0	NIL	5
32	NR	NR-II	Punjab	Bhatinda GND TPS	Punjab	220	Muktsat-1, Muktsat-2, Lehra-1, Lehra-2	Katore wala, Muktsat-2, Lehra-1, Lehra-2	Katore wala, Muktsat-2, Lehra-1, Lehra-2	0	0	Muktsat-1 > Katore wala,	2
33	NR	NR-I	Rajasthan	Bhilwara	Rajasthan	400	Chhabra	Chhabra	As per site survey	0	0	NIL	1
34	NR	NR-I	Rajasthan	Bhinmal	Powergrid	400	Zerda, Kankorili	Zerda, Kankorili	As per site survey	0	0	NIL	2
35	NR	NR-I	Rajasthan	Bhiwadi	Powergrid	400	Bassi-1, Bassi-2, Hissar, Ballabhgarh, Agra, Moga-1, Moga-2	Bassi-1, Kotputli, Hissar, Gurgaon, Agra-1, Moga-1, Moga-2	As per site survey	0	0	Bassi-2 > Kotputli, Ballabhgarh > Gurgaon, Agra > Agra-1	5
36	NR	NR-II	Haryana	Bhiwani	BBMB	400	Hisar, Bhadurgarh, Rajpura	Hisar, PGCIL Bhiwani, Dehar	Hisar, PGCIL Bhiwani, Dehar	0	0	Bhadurgarh > PGCIL Bhiwani, Rajpura > Dehar	2

37	NR	NR-II	Haryana	Bhiwani-PG	Powergrid	400	Bhiwani(BBMB), Bahduragarh, Hissar, Bawana, Mahendergarh-1, Mahendergarh-2, Jind-1, Jind-2	Bhiwani(BBMB), Bahduragarh, Hissar, Bawana, Mahendergarh-1, Mahendergarh-2, Jind-1, Jind-2, Rothak HVPNL-1, Rothak HVPNL-2	Bhiwani(BBMB), Bahduragarh, Hissar, Bawana, Mahendergarh-1, Mahendergarh-2, Jind-1, Jind-2, Mahendergarh-3, Mahendergarh-4, Hisar 1&2 Bhiwani 765kV Jhatikara, MOGA, Jaipur 1&2	0	0	Rothak HVPNL-1, Rothak HVPNL-2 Rothak -1 & 2 feeders are captured additionally as a part of Survey	15
38	ER	ER-II	West Bengal	Bidhannagar	WBSETCL	400	ppsp-i ppsp-ii arambag durgapur-i durgapur-ii dpl-i dpl-ii	ppsp-i ppsp-ii arambag pgcil-I pgcil-ii Available in 220kV Available in 220kV		0	0	durgapur-i->pgcil-i durgapur-ii->pgcil-ii	3
39	ER	ER-I	Bihar	Biharshariff	Powergrid								9
40	ER	ER-II	West Bengal	Binaguri	Powergrid	400	Bongigaon 1,2, TALA1,2 , Bongaigaon 3&4, Rangpo 1&2, Malbase Karandeghi 1, Karandeghi 2, Karandeghi 3, Karandeghi 4. Allipurduar 1,2,3&4,	Bongigaon 1,2, TALA1,2 , Bongaigaon 3&4, Teesta 1&2, Tala-3, Purnea 1, Purnea 2, Purnea 3, Purnea 4. Tala-4	-	3	-3	Rangpo 1&2 > Teesta 1&2, Malbase > Tala-3, Karandeghi 1 > Purnea 1, Karandeghi 2 > Purnea 2, Karandeghi 3 > Purnea 3, Karandeghi 4 > Purnea 4, Not Identified > Tala-4 Allipurduar 1,2,3&4-> Future bays	7
41	ER	ER-II	West Bengal	Birpara	Powergrid	220	chukha-i chukha-ii bongaigaon-i bongaigaon-ii malbase binaguri-i binaguri-ii	chukha-i chukha-ii bongaigaon-i bongaigaon-ii malbase binaguri-i binaguri-ii		0	0	nill	4
42	NER	NER	Assam	Birpara (salakati)	Powergrid	220	Birpara-I Birpara-II BTPS-I BTPS-II Gelaphu	Birpara-I Birpara-II BTPS-I BTPS-II Gelaphu		0	1	Gelaphu-> Not identified	3
43	NER	NER	Assam	Biswanath	Powergrid		Subansiri 1,2,3&4,Alipurdwar HVDC 1&2,Balipara 1,2,3&4, Ranganadi 1&2						4
44	ER	ER-II	Jharkhand	Bokaro	DVC	220	Jamshedpur-1&2, CTPS-1&2	Jamshedpur-1&2, CTPS-1&2	-	0	0	NIL	2
45	ER	ER-II	Jharkhand	Bokaro TPS	DVC								1
46	ER	ORISSA	Orissa	Bolangir	Powergrid	400	Meramundali Jeypore	Angul, Jeypore		0	0	Meramundali->Angul	2

47	NER	NER	Assam	BONGAIGAON	Powergrid	400	BTPS-1 BTPS-2 Balipara-1 Balipara-2 Balipara-3 Balipara-4 N.Siliguri-1 N.Siliguri-2 N.Siliguri-3 N.Siliguri-4 400kv Azara-1 400kv Azara-2	BTPS-1 BTPS-2 Balipara-1 Balipara-2 Balipara-3 Balipara-4 N.Siliguri-1 N.Siliguri-2 N.Siliguri-3 N.Siliguri-4 Silchar-1 Silchar-2		0	0	400kv Azara-1->Silchar-1 400kv Azara-2->Silchar-2	6
48	ER	ORISSA	Orissa	Budhipadar	OPTCL	220	ib vally-i ib vally-ii ib vally-iii ib vally-iv tarkera-i tarkera-ii vedenta-i vedenta-ii korba-i korba-ii korba-iii sps bhusan msp katapally-i katapally-ii bargarh-i bargarh-ii	ib tps-i ib tps-ii ib tps-iii ib tps-iv tarkera-i tarkera-ii val-i val-ii raigarh korba-ii korba-iii sps-i bhusan-I msp burla-i burla-ii bhusan-ii sps-ii aditya aluminium-i aditya aluminium-ii busandara-ii		2	2	ib vally-i->ib tps-i ib vally-ii->ib tps-ii ib vally-iii->ib tps-iii ib vally-iv->ib tps-iv vedenta-i->val-i vedenta-ii->val-ii korba-i->raigarh sps->sps-i bhusan->bhusan-i katapally-i>burla-i katapally-ii->burla-ii nill->bhusan-ii nill->sps-ii nill->aditya aluminium-i nill->aditya aluminium-ii nill->busandara-ii bargah-i->Not available at site bargah-ii->Not available at site	10
49	ER	ER-I	Jharkhand	Chaibasa	Powergrid	400	Jamshedpur 1&2, Rourkela 1&2	Jamshedpur 1&2, Rourkela 1&2	-	0	0	-	4
50	NR	NR-II	Himachal Pradesh	Chamba	Powergrid								2
51	NR	NR-II	Himachal Pradesh	Chamera 1	NHPC		Chamera-II ,Jalandhar-1&2						2
52	NR	NR-II	Himachal pradesh	Chamera 2	NHPC	400	Kishenpur, chamera-I	Kishenpur, chamera-I		0	0	NIL	1
53	NR	NR-II	Himachal pradesh	Chamera III 220kV	NHPC	220	Pooling Point-2, Budhil-1	Line-1, Line-2	220kV Chamba PG-1, 220kV Chamba PG-2	0	0	Pooling Point-2 > Line-1, Budhil-1 > Line-2	1
54	ER	ER-II	Jharkhand	CTPS B (Chanderpur)	DVC	220	Not in contract	Dhanbad 1 Dhanbad 2 Bokaro 1 Bokaro 2 CTPS Old 1 CTPS Old 2	-	NA	NA	Not in contract -> Dhanbad 1 Not in contract ->Dhanbad 2 Not in contract ->Bokaro 1 Not in contract ->Bokaro 2 Not in contract ->CTPS Old 1 Not in contract ->CTPS Old 2	3

55	ER	ER-II	Jharkhand	CTPS(Chanderpur)	DVC	220	Kalyaneshwar 1, Kalyaneshwar 2, Maithan(PG)-1&2, Bokaro1&2, Kalyaneshwar 3, Kalyaneshwar 4, Santhldi	Kalyaneshwari 1, Kalyaneshwari 2, CTPS New-1, CTPS New-2	-	5	-5	Kalyaneshwar 1->Kalyaneshwari 1, 'Kalyaneshwar 2->Kalyaneshwari 2, Not in contract -> CTPS New-1, Not in contract -> CTPS New-2	2
56	NR	NR-I	Uttar Pradesh	DADRI	NTPC		Panipath-1&2,mandola-1&2,Maharanibagh,GreaterNoida,Muradnagar,Malerkotla						5
57	NR	NR-I	Uttar Pradesh	DADRI HVDC	Powergrid		Dadri-Thermal						1
58	ER	ER-I	Jharkhand	Daltonganj	Powergrid		Sasaram 1&2						2
59	NR	NR-II	Himachal Pradesh	Dehar	BBMB	400	Panchkula, Rajpura	Dehar-Bhiwani, Dehar-Panipat	Dehar-Bhiwani, Dehar-Panipat	0	0	Panchkula > Dehar-Bhiwani, Rajpura > Dehar-Panipat	1
60	NR	NR-I	Uttarakhand	Dehradun-400	Powergrid		Abdullapur-2, Saharanpur-2						4
61	NR	NR-I	Uttarakhand	Dhauli Ganga	NHPC	220	Pithoragarh, Barelliey	Dhauli Ganga - Pithoragarh, Dhauli Ganga - Barelliey	As per site survey	0	0	Pithoragarh > Dhauli Ganga - Pithoragarh, Barelliey > Dhauli Ganga - Barelliey	1
62	NER	NER	Nagaland	Dimapur	Powergrid	220	Doyang 1 & 2, Imphal 1 & 2. Misa, N.Kohima,	Doyang 1 & 2, Imphal 1 & 2, Misa-1, Kohima, Misa-2, Dimapur-1, Dimapur-2	-	3	3	Misa >Misa-1, N.Kohima> Kohima, Not in contract->Misa-2, Not in contract->Dimapur-1, Not in contract->Dimapur-2	5
63	ER	ER-II	West Bengal	DSTPS	DVC	400	Mejia, Maithon	Raghunathpur-1 Raghunathpur-2 Jamshedpur-1 Jamshedpur-2	-	2	2	Mejia >Raghunathpur-1, Maithon > Raghunathpur-1, Not identified > Jamshedpur-1, Not identified > Jamshedpur-2.	2
64	NR	NR-II	Jammu & Kashmir	Dulhasti	NHPC	400	Kishenpur-1, Kishenpur-2	Kishenpur-1, Kishenpur-2		0	0	NIL	1
65	ER	ER-II	West Bengal	Durgapur	Powergrid	400	Jamshedpur, Farakka 1&2, Sagardighi 1&2, Maithon 1&2	Jamshedpur, Farakka 1&2, Sagardighi 1&2, Maithon 1&2, Bidhannagar 1&2.	-	2	2	Not in contract > Bidhannagar -1 Not in contract > Bidhannagar -2	5
66	ER	ER-II	West Bengal	Durgapur TPS	DVC								3
67	NR	NR-I	Haryana	Faridabad	NTPC	220	Palla-1, Palla-2, Samaypur-1, Samaypur-2	Palla-1, Palla-2, Samaypur-1, Samaypur-2	As per site survey	0	0	NIL	2
68	ER	ER-II	West Bengal	FARRAKA	NTPC	400	malda-i sagardighi baharampur durgapur-i durgapur-ii kahalgaon-i kahalgaon-ii purnea kahalgaon-iii kahalgaon-iv rajarhat malda-ii	malda-i sagardighi baharampur durgapur-i durgapur-ii kahalgaon-i kahalgaon-ii future-i kahalgaon-iii kahalgaon-iv future-ii malda-ii		2		purnea->future-i rajarhat->future-ii	5

69	NR	NR-II	Haryana	Fatehabad	Powergrid	400	Moga,Hissar, Khedar-1 Khedar-2	Moga,Hissar, Nuhawali, Khedar.	As per site survey	0	0	Khedar-1 > Nuhawavi Khedar-2 > Khedar	4
70	NR	NR-I	Haryana	Fatehpur PG- 765	Powergrid	765	765kV Varnasi-1, Sasaram-1 Agra-2	765kV Gaya Sasaram Agra-II Agra-I 400kV Allahabad-I Allahabad-II Mainpuri-I Mainpuri-II Singrauli Kanpur-I Kanpur-II Allahabad-III	-	8	8	Varanasi-1->Gaya Sasaram-1-> Sasaram Agra-2->Agra-II Not in contract->Allahabad-I Not in contract->Allahabad-II Not in contract->Mainpuri-I Not in contract->Mainpuri-II Not in contract->Singrauli Not in contract->Kanpur-I Not in contract->Kanpur-II Not in contract->Allahabad-III	11
71	NR	NR-II	Punjab	Ganguwal	BBMB	220	Bhakra-1, Bhakra-2, Bhakra-3, Bhakra(R)-1, Bhakra(R)-2, Dhar-1, Dhar-2, Jamalpur-1, Jamalpur-2, Govingarh-1, Govingarh-2, Jagdhari-1, Mohali-1, Not Identified, Daulkote-1, Not Identified	Bhakra-1, Bhakra-2, Bhakra-3, Bhakra(R)-1, Bhakra(R)-2, Dhar-1, Dhar-2, Jamalpur-1, Jamalpur-2, Govingarh-1, Govingarh-2, Jagdhari-1, Mohali-1, Mohali-2, Daulkote-1, Daulkote-2	-	2	2	Not identified > Mohali-2, Not identified > Daulkote-2	8
72	ER	ORISSA	Orissa	GMR	GMR	400	400kv Angul-1 400kv Angul-2	GMR-1(GMR-Phulpada) GMR-2(GMR-Phulpada) OPTCL-Miramundali		1	1	400kv Angul-1->GMR-1(GMR-Phulpada) 400kv Angul-2->GMR-2(GMR-Phulpada) Not in contract->OPTCL-Miramundali	3
73	NR	NR-I	Haryana	Gurgaon	Powergrid	400	Daulatabad-1,2, Maneser-1,2	Daulatabad-1,2, Maneser-1,2	As per site survey	0	0	NIL	3
74	NR	NR-II	Himachal Pradesh	Hamirpur PG- 400	Powergrid	400	Parbati pooling, Amritsar	Banala powergrid Amritsar	Banala(POWERGRID) Amritsar	0	0	Parbati pooling > Banala powergrid,	1
75	NR	NR-I	Uttar pradesh	Harduaganj	Uttar pradesh	220	Khurja-1&2, Atrauli, Hathras, Mainpuri-PG, UPPCL	Khurja-1&2, Atrauli, Metai Etah Mainpuri	As per site survey	0	0	Hathras> Metai Mainpuri- PG> Etah UPPTCL> Mainpuri	3
76	NR	NR-I	Rajasthan	Heera pura	Rajasthan	400	Bassi-1, Bassi-2, Merta, Hindaun, Dahra-1, Dahra-2	Bassi-1, Bassi-2, Merta city, Hindaun, Not identified, Not identified	As per site survey	2	-2	Merta > Merta city, Dahra-1 > Not identified, Dahra-2 > Not identified,	2

77	NR	NR-II	Haryana	Hisar	Powergrid	400	Patiala, Kaithal, Bawana, Bhiwani, Bassi, Moga-1, Moga-2, Kheddar-1, Kheddar-2	Kaithal-2, Kaithal-1, PG Bhwani, BBMB Bhiwani, Bhiwadi, Moga, Fathabad, Not Identified.	Kaithal-2, Kaithal-1, PG Bhwani, BBMB Bhiwani, Bhiwadi, Moga, Fathehabad. Bhiwani-1, Bhiwani-2, Moga- Bhiwadi (4 feeders).	1	-1	Patiala > Kaithal-2, Kaithal > Kaithal-1, Bawana > PG Bhwani, Bhiwani > BBMB Bhiwani, Bassi > Bhiwadi, Moga-1 > Moga, Moga-2 > Fathabad Kheddar-I> Not identified	7
78	NR	NR-I	Delhi	I.P.Gas turbine / Pragati Power (New Substation)	DTL	220	Rajghat-1, Rajghat-2, Patparganj-1, Patparganj-2, Pragatigas turbin-1, Pragatigas turbin-2	Rajghat-1, Rajghat-2, Patparganj-1, Patparganj-2, Pragatigas turbin-1, Pragatigas turbin-2	As per site survey	0	0	NIL	3
79	ER	ORISSA	Orissa	Ind barath	Ind barath		400kV Jharsuguda 1&2						1
80	ER	ORISSA	Orissa	Indrawati	Powergrid	400	Rengali, Jeypore,	Rengali, Jeypore, Upper Indravati		0	0	-	2
81	ER	ORISSA	Orissa	Indrawati HPS	OPTCL	400	Upper Indravati, Rengali, Jeypore	Indravati PG	-	2	-2	Upper Indravati -> Indravati PG Rengali-> Not available Jeypore-> Not available	1
82	NR	NR-I	Rajasthan	Jaipur (S)-400	Powergrid	400	Agra-2, Jaipur-2 Not identified Not identified	Agra-2, Bassi-2, Agra-1, Bassi-1	As per site survey	0	0	Jaipur-2 > Bassi-2, Not identified > Bassi-1, Not identified > Agra-1	4
83	NR	NR-II	Punjab	Jalandhar	Powergrid	400	Chamera-1, Chamera-2, Amritsar, Moga-1, Moga-2, Ludhiana	Chamera-1, Chamera-2, Amritsar, Moga-1, Moga-2, Ludhiana	Chamera-1, Chamera-2, Amritsar, Moga-1, Moga-2, Ludhiana Chamba-1&2	0	0	NIL	4
84	ER	ER-I	Jharkhand	JAMSHEDPUR	Powergrid	400	Mejia-B, Maithon, Durgapur, Baripada, Chaibasa-1, Chiabasa-2 Durgapur TPS-1,2 Adhunik-1,2 Jamshedpur-(DVC)	Mejia, Maithon, Durgapur-1, Baripada, Chaibasa-1, Rourkela Andal-1,2 Adhunik-1,2 Jamshedpur-(TATA)		0	0	Mejia-B->Mejia, Durgapur->Durgapur-1, Chaibasa-2->Rourkela Durgapur TPS-1,2->Andal-1,2 Jamshedpur-(DVC)->Jamshedpur-(TATA)	6
85	ER	ER-II	West Bengal	JEERAT	WBSETCL	400	400kV Bahrampur Bakreshwar Kolaghat RAJARHAT	400kV Bahrampur Bakreshwar Kolaghat Bubhasgram 220kV Newtown-i(rajarhat-i) Newtown-ii(rajarhat-ii) Rishra-i Rishra-ii Satgachia-i Satgachia-ii Kasba-i Kasba-ii		1	8	400kV rajarhat->bubhasgram	2

86	ER	ORISSA	Orissa	JEYPORE	Powergrid	400	Gazuwaka-1, Gazuwaka-2, Indrawathi-1, Meramandali	Gazuwaka-1, Gazuwaka-2, Indrawathi-1, Meramandali	-	0	0	nill	2
87	ER	ER-I	Jharkhand	Jharkhand Pool (Chandwa)	Powergrid		Ranchi New 1&2, Gaya 1&2, Essar 1&2, Corporate 1&2						4
88	ER	ORISSA	Orissa	Jharsuguda	Powergrid	765	765kv Angul-1, 765kv Angul-2, 765kv Dharamjaygarh-1 765kv Dharamjaygarh-2 Rourekela-1 Rourekela-2 Raigarh-1, Raigarh-2 Sterlite-1 Sterlite-2 Sterlite-3 Sterlite-4 Barath-1 Barath-2. 765kv Angul-3, 765kv Angul-4, 765kv Dharamjaygarh-3 765kv Dharamjaygarh-4	765kv Angul-1 765kv Angul-2 765kv Dharamjaygarh-1 765kv Dharamjaygarh-2 Rourekela-1 Rourekela-2 Raigarh-1 Raigarh-2 Sterlite-1(F) Sterlite-2(F) Sterlite-3(F) Sterlite-4(F) Barath-1(F) Barath-2(F) Not Existing Not Existing Not Existing Not Existing		0	10	765kv Angul-3-> Not Existing 765kv Angul-4-> Not Existing 765kv Dharamjaygarh-3-> Not Existing 765kv Dharamjaygarh-4->-> Not Existing Sterlite-1-> Sterlite-1(F) Sterlite-2->Sterlite-2(F) Sterlite-3->Sterlite-3(F) Sterlite-4->Sterlite-4(F) Barath-1->Barath-1(F) Barath-2->Barath-2(F)	8
89	NR	NR-I	Delhi	Jhatikara-765	Powergrid	765	Bhiwani, Agra	Bhiwani, Agra	As per site survey	0	0	NIL	2
90	NR	NR-II	Haryana	Jind-400	Powergrid	400	Bhiwani-2, HVPNL-2 Not identified Not identified	Bhiwani-2 Hisar-2, Hisar-1, Bhiwani-1,		0	0	HVPNL-2 > Hisar-2, Not identified > Hisar-1, Not identified > Bhiwani-1	4
91	ER	ORISSA	Orissa	Jindal	JITPL		400kV Angul 1&2						2
92	NR	NR-I	Rajasthan	Jodhpur	Rajasthan	400	Merta, Jaiselmer, Kankroli, Rajwest-1, Rajwest-2	Merta-1, Jaiselmer(Akal), Kankroli, Rajwest-1, Rajwest-2	As per site survey	0	0	Merta > Merta-1, Jaiselmer > Jaiselmer(Akal)	3
93	ER	ER-I	BIHAR	Kahalgaon(KHSTPP)	NTPC	400	Lakhisarai-1,2 Banka-1,2 Farakka-1,2,3,4 Maithon-1,2 Barh-1,2	Lakhisarai-1,2 Banka-1,2 Farakka-1,2,3,4 Maithon-1,2 Barh-1,2		0	0	NA	6
94	NR	NR-II	Haryana	Kaithal	Powergrid		Patiala 1,2,hissar 1,2,meerut-1&2						3
95	ER	ER-II	West Bengal	KALYANESWARI	DVC	220	NA	CTPS line-1,2 Mejia line Burnpur line, MTPS line-1,2, Pithakiariline-1,2		NA	NA	Not in contract->CTPS line-1,2 Not in contract->Mejia line Not in contract->Burnpur line, Not in contract->MTPS line-1,2, Not in contract->Pithakiariline-1,2	4
96	NR	NR-I	Rajasthan	Kankroli	Powergrid	400	Zerda-1, Zerda-2, RAPP-C-1, RAPP-C-2, Jodhpur, Bhinmal	Zerda, Not identified, RAPP-1, RAPP-2, Jodhpur, Bhinmal	As per site survey	1	-1	Zerda-1 > Zerda, Zerda-2 > Not identifed, RAPP-C-1 > RAPP-1, RAPP-C-2 > RAPP-2	5

97	NR	NR-I	Uttar pradesh	Kanpur	Powergrid	400	Panki-1&2, Agra, Auria-1&2, Ballabhgarh1,2,3, Allahabad-1, Allahabad-2 Singarauli	Panki-1&2, Agra, Auria-1&2, Ballabhgarh1,2,3, Fatehpur-II Allahabad Fatehpur-I	As per site survey	0	0	Allahabad-1>Fatehpur-II Allahabad-2>Allahabad Singrauli> Fatehpur-I	6
98	NR	NR-I	Uttar Pradesh	Kanpur-765	Powergrid								3
99	ER	ER-II	West Bengal	KASBA	WBSETCL	220	Jeerat-1, Jeerat-2, New town, Budge-Budge-1, Budge-Budge-2,	Jeerat-1, Jeerat-2, CESC, Subhasgram-1, Subhasgram-2,	-	0	0	New town->CESC, Budge-Budge-1- >Subhasgram-1, Budge-Budge-1- >Subhasgram-2,	3
100	ER	ORISSA	Orissa	Keonjhar	Powergrid	400	Rengali Baripada	Rengali Baripada	-	0	0	0	2
101	NR	NR-I	Uttar pradesh	Khara	Uttar pradesh	220	Samli, Shaharanpur	Samli, Shaharanpur	As per site survey	0	0	NIL	1
102	ER	ER-I	Bihar	Kishanganj (karandeghi)	Powergrid		Siliguri 1,2,3&4, Purnea 1,2,3 &4, 400kV Teesta III 1&2, Patna 1&2, Mangan 1&2						4
103	NR	NR-II	Jammu & Kashmir	Kishenpur	Powergrid	400	Wagoora-1, Wagoora-2, Baglihar-1, Baglihar-2, Dulhasti-1, Dulhasti-2, Chamer-II, Moga-1, Moga-2	Wanpoh-1, Wanpoh-2, Baglihar-1, Baglihar-2, Dulhasti-1, Dulhasti-2 (Not Commision), Chamer-II, Moga-1, Moga-2	Wanpoh-1, Wanpoh-2, Baglihar-1, Baglihar-2, Dulhasti-1, Dulhasti-2 (Not Commision), Chamer-II, Moga-1, Moga-2 Wnapoh 3&4 Samba 1&2	0	0	Wagoora-1 > Wanpoh-1, Wagoora-2 > Wanpoh-2, Dulhasti-2 > Dulhasti-2 (Not Commisioned)	7
104	ER	ER-II	Jharkhand	Kodarma TPS	DVC	400	Biharshariff-1,2, Gaya 1,2	Biharshariff-1,2, Gaya 1,2, Bokaro-1, Bokaro-2.	-	2	2	Not identified >Bokaro-1 Not identified >Bokaro-2	3
105	ER	ER-II	West Bengal	Kolaghat	WBSETCL	400	400kV jeerat arambag baripada 220kv haldia-i haldia-ii howrah-i howrah-ii	400kV jeerat arambag Kharagpur-2 Kharagpur-1 220kv haldia-i haldia-ii howrah-i howrah-ii		1	1	400kV baripada->kharagpur-2 nill->kharagpur-1	4
106	NR	NR-II	Himachal Pradesh	Koldam	NTPC	400	Not Identified, Ludhiana-2, Parbati pooling, Nalagarh	Ludhiana-1, Ludhiana-2, Parvati, Nalagarh	Ludhiana-1, Ludhiana-2, Banala PG Nalagarh	0	0	Not Identified > Ludhiana- 1, Parbati pooling > Parvati	2
107	NER	NER	Assam	KOPILI	NEEPCO	220	Misa-I Misa-II Misa-III	Misa-I Misa-II Misa-III		0	0	NILL	2
108	NR	NR-I	Rajasthan	Kota	Powergrid	400	Merta-1, Merta-2, RAPP-C-1, RAPP-C-2	Merta, Beawar, RAPP-1, RAPP-2	As per site survey	0	0	Merta-1 > Merta, Merta-2 > Beawar, RAPP-C-1 > RAPP-1, RAPP-C-2 > RAPP-2	4

109	NR	NR-I	Rajasthan	Kota TPS	Rajasthan	220	Kota-1, Kota-2, Kota-3, Kota-4, Beawar-1, Beawar-2, Sanganer, Jaipur, m nagar	Sakatpura-1, Sakatpura-2, Sakatpura-3, Sakatpura-4, Bundi, Beawar, Sanganer, Heerapura, Morak	As per SLD	0	0	Kota-1 > Sakatpura-1, Kota-2 > Sakatpura-2, Kota-3 > Sakatpura-3, Kota-4 > Sakatpura-4, Beawar-1 > Bundi, Beawar-2 > Beawar, Jaipur > Heerapura, m nagar > Morak	6
110	NR	NR-I	Uttarakhand	Koteshwar	Powergrid	400	Meerut-1, Meerut-2, Tehri-1, Tehri-2, Koteshwar-1, Koteshwar-2	Meerut-1, Meerut-2, Tehri-1, Tehri-2, Koteshwar-1, Koteshwar-2	As per site survey	0	0	NIL	3
111	NR	NR-I	Rajasthan	Kotputli-400	Powergrid	400	Bhiwadi-1, Jaipur-1	Bhiwadi, Bassi , Future Line	Bhiwadi, Bassi	1	1	Bhiwadi-1 > Bhiwadi-1, Jaipur-1 > Bassi, Not identified > Future Line.	3
112	ER	ER-I	BIHAR	LakhiSarai	Powergrid	400	Biharshariff-1,2 Kahalgaon-1,2	Biharshariff-1,2 Kahalgaon-1,2	-	0	0	NA	4
113	NR	NR-II	Punjab	Lehara	Punjab	220	Mansa-1, Mansa-2, Batinda-1, Batinda-2, Bazakhana-1, Bazakhana-2, Barnala-BBMB, PSEB	Talwandi Sabo, Dhanaula, Batinda-1, Batinda-2, Bazakhana-1, Bazakhana-2, Barnala-1, Barnala-2		0	0	Mansa-1 > Talwandi Sabo, Mansa-2 > Dhanaula, Barnala-BBMB > Barnala-1, PSEB > Barnala-2	5
114	NR	NR-I	Uttar pradesh	Lucknow	Powergrid	400	Gorakhpur-1,2,3,4, Unnao-1&2, Barelli-2, Balia-1, Balia-2, Barelli-1, Luknow(UP), Sultanpur	Gorakhpur-1,2,3,4, Unnao-1&2, Barelli-2, Sohawal-1, Sohawal-2, Roja, Sultanpur, Sarojini nagar	As per site survey	0	0	Lucknow(UP)> Sultanpur Sultanpur> Sarojini Nagar Bareily-1> Roja Balia-1> Sohawal-1 Balia-2> Sohawal-2	6
115	NR	NR-I	Uttar Pradesh	Lucknow UPPTCL	Uttar pradesh	400	Barelli(PG), Lucknow(UP), Unnao, Singarauli	Barelliy, Kursiroad, Unnao, Singarauli	As per site survey	0	0	Lucknow(UP) > Kursiroad	2
116	NR	NR-I	Uttar pradesh	Lucknow-765	Powergrid	765	Balia-1	Balia-1, Future Line, Bareilly-1	-	2	2	Not identified > Bareilly Not identified > Future Line	3
117	NR	NR-II	Punjab	Ludhiana	Powergrid	400	Malerkotla, Jalandhar, Patiala-1, Patiala-2, Koldam-1, Koldam-2	Malerkotla, Jalandhar, Patiala-1, Patiala-2, Koldam-1, Koldam-2	-	0	0	NIL	5
118	NR	NR-I	Delhi	Maharanibagh	Powergrid	400	Dadri,ballabhgarh	Dadri,ballabhgarh	As per site survey	0	0	NIL	1
119	NR	NR-I	Uttar Pradesh	Mainpuri	Powergrid		Allahabad-1&2,Ballabhgarh-1&2						3

120	ER	ER-II	West Bengal	MAITHON	Powergrid	400	durgapur ranchi maithon rb-i maithon rb-ii kahalgaon-i raghunathpur mejia b-iii jamshedpur mejia b-i kahalgaon-ii gaya-i gaya-ii mejia b-ii	durgapur-2 ranchi right bank-i right bank-ii kahalgaon-i raghunathpur mejia b-iii jamshedpur mejia b-i kahalgaon-ii gaya-i gaya-ii mejia b-ii durgapur-1		7	1	durgapur->durgapur-ii nill->durgapur-i maithon rb-i->right bank-i maithon rb-ii->right bank-ii raghunathpur->rtps mejia b3->mejia-iii mejia b1->mejia-i mejia b2->mejia-ii	7
121	ER	ER-II	Jharkhand	Maithon RB TPS	DVC	400	Ranchi (PG) 1&2, Maithon 1&2	Ranchi (PG) 1&2, Maithon 1&2	-	0	0	NIL	2
122	ER	ER-II	West Bengal	MALDA	Powergrid	400	Farakka-1, Farakka-2, Purnea-1, Purnea-2,	Farakka-1, Farakka-2, Purnea-1, Purnea-2,	-	0	0	Nill	2
123	NR	NR-II	Punjab	Malerkotla	Powergrid	400	Patiala, Dadri, Ludhiana	Patiala, Dadri, Ludhiana	-	0	0	NIL	2
124	NR	NR-I	Uttar pradesh	Mandola	Powergrid	400	Meerut-1&2, Bawana-1&2, Dadri-1&2, Bareli-1 Bareli-2 Not identified, Not identified, Not identified	Meerut-1&2, Bawana-1&2, Dadri-1&2, Meerut-III, Meerut- IV Not identified, Not identified, Not identified	As per site survey	3	-3	Barelli-1 > Meerut-III Barelli-2 > Meerut-IV	4
125	NR	NR-I	Haryana	Manesar-400	Powergrid	400	Gurgaon-2 Neemrana-2 Not identifird Not identified	Gurgaon-2 Neemrana-2 Gurgaon-1 Neemrana-1	As per site survey	0	0	Not identified > Gurgaon-1 Not identified > Neemrana-1	2
126	NER	NER	Assam	Mariani	AEGCL	220	Kaithalguri , Misa, Samaguri 1 &2	Kaithalguri , Misa, Samaguri 1 &2	-	0	0	NA	2
127	NR	NR-I	Uttar pradesh	Meerut	Powergrid	400	Mandola-1&2, Koteshwar1&2, Muzaffarnagar, Kaithal-1,2, Moga	Mandola-1&2, Koteshwar1&2, Muzaffpur, Kaithal-1,2, Not identified	As per site survey	1	-1	Moga> Not identified	4
128	ER	ER-II	West Bengal	MEJIA	DVC	220	Kalswari-1, Klaswari-2, Waria-1, Waria-2, Chandrapur-1, Chandrapur-2.	Kalyanawshri, Bunpur, DTPS-1, DTPS-2, Kalyanaswari-1, Kalyanaswari-2, Durgapur(muchipuna-1), Durgapur(muchipuna-2) Borjora-1, Borjorar-2,	-	4	4	Kalswari-1->Kalyanawshri, Klaswari-2->Bunpur Waria-1->DTPS-1, Waria-2->DTPS-2, Chandrapur-1- >Kalyanaswari-1, Chandrapur-2- >Kalyanaswari-2, Nill->Durgapur(muchipuna-1), Nill->Durgapur(muchipuna-1), Nill->Borjora-1, nill->Borjora-2,	5

129	ER	ER-II	West Bengal	MEJIA-B	DVC	400	Maithon-1, Maithon-2, Maithon-3, Jamshedpur	Maithon-1, Maithon-2, Maithon-3, Jamshedpur		0	0	-	2
130	ER	ORISSA	Orissa	MENDHASAL	OPTCL	400	Meramundali-1,2 Uttara-1,2 KVK Duburi	Meramundali-1,2 Baripada-1,2		2	2	Uttara-1,2->Not available KVK->Not available Duburi->Not available Not in contract->Baripada-1 Not in contract->Baripada-2	2
131	ER	ORISSA	Orissa	MERAMANDALI	OPTCL	400	Bolangir Mendhasal-1,2 TSTPP-1 TSTPP-2 Duburi-1,2	Angul-1, Mendhasala-1,2 Kaniha, Angul-2, Duburi-1,2, IBTPS-1,2(Sterlite-1,2) JSPL-1,2, GMR		5	5	Bolangir->Angul-1, Mendhasal-1,2->Mendhasala-1,2 TSTPP-1->Kaniha, TSTPP-2->Angul-2, Not in contract->IBTPS-1,2(Sterlite-1,2) Not in contract->JSPL-1,2, Not in contract->GMR,	6
132	NR	NR-I	Rajasthan	Merta City	Rajasthan	400	Kota-1, Kota-2, Heerapur, Ratangarh, Jodhpur	Kota, SCL-Beawar, Heerapur, Ratangarh, Jodhpur	As per site survey	0	0	Kota-1 > Kota, Kota-2 > SCL-Beawar	3
133	NER	NER	Assam	Misa	Powergrid	400	Balipara PG 1 & 2 220kV Dimapur 1 & 2 220kV KOPILI 1, 2, & 3 220kV Byrnihat 1 & 2 Samaguri 1 & 2 220kV Mariani, 220kV Mariani (N)	Balipara 1 & 2 220kV Dimapur 1 & 2 220kV KOPILI 1, 2, & 3 220kV Byrnihat 1 & 2 220KV Samaguri 1 & 2 220kV Mariani, 220kV Kaithalguri	-	0	0	Balipara PG 1 & 2 > Balipara 1 & 2 Samaguri 1 & 2 > 220KV Samaguri 1 & 2 220kV Mariani (N) > 220kV Kaithalguri,	7
134	NR	NR-II	Punjab	Moga	Powergrid	400	Mandaula-1,, Mandaula-2, Mandaula-3, Mandaula-4, Bareilly-1, Bareilly-2, Tehri pooling-1, Tehri pooling-2, Muzaffarnagar, Baghpat-1, Baghpat-2	Jalandhar-1, Jalandhar-2, Kishenpur-1, Kishenpur-2, Bhiwadi-1, Bhiwadi-2, Fatehabad, Nakedar, Hissar, Talwandi Sabo	Jalandhar-1, Jalandhar-2, Kishenpur-1, Kishenpur-2, Bhiwadi-1, Bhiwadi-2, Fatehabad, Nakedar, Hissar, Talwandi Sabo	1	-1	As per Site survey all feeder names are not matching with contract.	5
135	NR	NR-II	Punjab	Moga 765	Powergrid	765	Bhiwani	Bhiwani	Bhiwani Meerut	0	0	NIL	2
136	ER	ORISSA	Orissa	Monnet	Monnet		400kV Angul 1&2						1
137	NR	NR-I	Uttar pradesh	Moradabad	Uttar pradesh	400	Bareli-1&2, Kashipur, Muradnagar	Bareli-1&2, Kashipur, Muradnagar	As per site survey	0	0	NIL	2
138	NR	NR-I	Uttar pradesh	Muradnagar	Uttar pradesh	400	Muzaffarnagar,Dadri, Agra(UPPPCL),Muradabad, Panki	Muzaffarnagar,Dadri, Agra(UPPPCL),Muradabad, Panki	As per site survey	0	0	NIL	3
139	ER	ER-I	Bihar	MUZAFFAPUR	Powergrid		Gorakhpur 1&2, Purnea 1&2, B'Shariff 1&2						5
140	NR	NR-I	Uttar pradesh	Muzaffarnagar	Uttar pradesh	400	Vishnu Prayag-1&2, Meerut,Muradnagar, Rishkesh	Vishnu Prayag-1&2, Meerut,Muradnagar, Roorkee	As per site survey	0	0	Rishkesh--> Roorkee	3

141	NR	NR-II	Himachal pradesh	Nallagarh	Powergrid	400	N Jhakri-1&2, Patiala-1&2, Koldam-1,2	N Jhakri-1&2, Patiala-1&2, Koldam-1,2	Rampur-1&2, Patiala-1&2, Koldam-1,2	0	0	NIL	3
142	NR	NR-II	Himachal pradesh	Naptha Jhakri	SJVNL	400	Baspa-1&2, Rampur-1 Rampur-2, Abdullapur-1 Abdullapur-2	Baspa-1&2, Nalagarh-1, Nalagarh-2, Panchkula-1, Panchkula-2	Baspa-1&2, Rampur-1, Rampur-2, Panchkula-1, Panchkula-2	0	0	Rampur-1>Nalagarh-1 Rampur-2>Nalagarh-2 Abdullapur-1>Panchkula-1 Abdullapur-2>Panchkula-2	3
143	NR	NR-I	Rajasthan	Neemrana-400	Powergrid	400	Manesar-2, Bhiwadi-1, Sikar-2, Jhunjhunu-2 Not Identified Not Identified Not Identified Not Identified	Manesar-2, Bhiwadi-1, Sikar-2, Manesar-1, Bhiwadi-2, Sikar-1 Not Identified Not Identified	As per site survey	2	-2	Jhunjhunu-2 >Manesar-1, Not identified > Bhiwadi-2, Not identified >Sikar-1	6
145	NR	NR-I	Uttar pradesh	Obra-ATPS	Uttar Pradesh	400	Anpra-1, Sultanpur, Anpra-2, Unnao	Anpra-1, Sultanpur, Kanpur, Not identified	As per site survey	1	-1	Anpara-2 > Kanpur Unnao> Not identified	3
146	NR	NR-I	Uttar Pradesh	Obra-BTPS	Uttar pradesh	220	RewaRoad-1, RewaRoad-2, RewaRoad-3, Shahupuri	RewaRoad-1, RewaRoad-2, RewaRoad-3, Mughal sari 1 Mughal sari 2	As per site survey	0	0	RewaRoad-1 > Allahabad-1, RewaRoad-2 > Allahabad-2, RewaRoad-3 > Allahabad-3, Shahupuri > Mugalsari-1, Not Identified > Mugalsari-2	2
147	NR	NR-II	Haryana	Panchkula-400	Powergrid	400	Not Identified, Nathpa Jhakri-2, Not Identified, Abdullapur-2	Nathpa Jhakri-1, Nathpa Jhakri-2, Abdullapur-1, Abdullapur-2		0	0	Not Identified > Nathpa Jhakri-1, Not Identified > Abdullapur-1	4
148	NR	NR-II	Haryana	Panipat	BBMB	400	Dadri-1, Dadri-2, Panchkula-1	Dadri-1, Dadri-2, Dehar	-	0	0	Panchkula-1 > Dehar	2
149	NR	NR-II	Haryana	Panipat-ST1 / Yamuna Nagar (New Substation)	HPGCL	220	panipath-BBMB-1, panipath-BBMB-2, panipath-BBMB-3, panipath-BBMB-4, Sonipath-1, Sonipath-2.	Sewah Ckt-I, Sewah Ckt-II, Sewah Ckt-III, Sewah Ckt-IV, PTPS-Sonipat Ckt-I, PTPS-Sonipat Ckt-II		0	0	Panipat-BBMB-I >PTPS-Sewah Ckt-I Panipat-BBMB-II > PTPS-Sewah Ckt-II. Panipat-BBMB-III > PTPS-Sewah Ckt-III . Panipat-BBMB-IV > PTPS-Sewah Ckt-IV Sonipat-I > PTPS-Sonipat Ckt-I Sonipat-II > PTPS Sonipat Ckt-II	3
150	NR	NR-II	Haryana	Panipat-ST2	HPGCL	220	Safidon-1, Safidon-2, Safidon-3, Jind-1&2, Nissing-1&2, Rohtak-1&2, Kernal, Safidon-4.	Safidon-1, Safidon-2, Safidon-3, Jind-1&2, Nissing-1&2, Rohtak-1&2, Kernal, Bastara		0	0	Safidon-4> Bastara	6

151	NR	NR-I	Uttar pradesh	Panki	Uttar pradesh	400	Kanpur-1 Kanpur-2, Obra, Muradnagar, Unnao1, Unnao 2.	Kanpur-1 Kanpur-2, Obra, Muradnagar, Unnao, Not identified	As per site survey	1	-1	Unnao-1 > Unnao Unnao-2 > Not identified	3
153	NR	NR-II	Himachal Pradesh	Parbati III	NHPC		Parbati-II & parbati pooling						1
154	NR	NR-II	Himachal Pradesh	Parbati P.S. (Banala)	Powergrid	400	Parbati-II, Parbati-III, Koldam, Nallagarh, Amritsar, Hamirpur	Parbati-II, Parbati-III, Koldam, Nallagarh, Amritsar, Hamirpur	Parbati-II, Parbati-III, Koldam, Nallagarh, Amritsar, Hamirpur	0	0	NIL	3
155	ER	ER-II	West Bengal	PARULIA	DVC	220	NA	DTPS line-1,2 PGCIL line-1,2 DSP line-1,2,3 Durgapur line-1,2		NA	NA	Not in contract->DTPS line-1,2 Not in contract->PGCIL line-1,2 Not in contract->DSP line-1,2,3 Not in contract->Durgapur line-1,2	5
156	NR	NR-II	Punjab	Patiala	Powergrid	400	Kaithal-1, Kaithal-2, Nalagarh-1, Nalagarh-2, Malerkotala, Ludhiana-1, Ludhiana-2	Kaithal-1, Kaithal-2, Nalagarh-1, Nalagarh-2, Malerkotala, Ludhiana-1, Ludhiana-2	Kaithal-1, Kaithal-2, Nalagarh-1, Nalagarh-2, Malerkotala, Ludhiana-1, Ludhiana-2	0	0	NIL	4
157	ER	ER-I	BIHAR	PATNA	Powergrid	400	Ballia-1,2,3,4 Barh-1.2.3.4 Karandeghi-1,2 Nabinagar-1,2	Ballia-1,2,3,4 Barh-1.2.3.4 Kishanganj-1,2		2	2	Karandeghi-1,2->not available Nabinagar-1,2->not available Not in contract->Kishanganj-1,2	6
158	ER	ER-I	Jharkhand	Patratu	Jharkhand	220	Bodhgya-1, Bodhgya-2 Bodhgya-3, Hatia	gaya-1, Hatia-1 TVNL, Hatia-2	-	0	0	Bodhgya-1->gaya-1, Bodhgya-2->Hatia-1 Bodhgya-3->TVNL, Hatia->Hatia-2	3
159	NR	NR-I	Uttarakhand	Pithoragarh-220kV	Powergrid	220	-	Dhauliganga, Barelly		2	2	Feeder name not in contract-> Dhauliganga Feeder name not in contract-> Bareily	1
160	NR	NR-II	Himachal Pradesh	Pong	BBMB	220	Dasuya-1, Dasuya-2, Jallandaher-1, Jallandaher-2, Bairasul, Jassor	Dasuya-1, Dasuya-2, Jallandaher-1, Jallandaher-2, Bairasul, Jassor		0	0	NIL	3
161	ER	ER-I	BIHAR	Purnea	Powergrid	400	Karandeghi-1,2,3,4 Muzaffarpur-1,2 Malda-1,2 Biharshariff-1,2 Farakka, Gokarana	Siliguri-1,2,3,4, Muzaffarpur-1,2, Malda-1,2, Biharshariff-1,2, Future-1 Future-2		6	0	Karandeghi-1,2,3,4->Siliguri-1,2,3,4, Farakka->Future-1 Gokarana->Future-2	6
162	ER	ER-II	West Bengal	Purulia PSP	WBSETCL								2
163	ER	ER-II	West Bengal	Raghunathpur TPS	DVC	400	maithon ranchi-i ranchi-ii ranchi-iii dtps-i dtps-ii	maithon ranchi-i ranchi-ii ranchi-iii dtps-i dtps-ii		0	0	nill	3

164	ER	ER-II	West Bengal	Rajarhat	Powergrid		Gokarna, Farakka, Subhashgram, jeerat, Chanditala 1&2					2
165	ER	ER-I	Jharkhand	RANCHI	Powergrid	400	Rourkela-1, Rourkela-2, Sipat-1, Sipat-2, Maithon RB1, Maithon RB2, Ragunathpur 1, Ragunathpur 2, Ragunathpur 3, Corporate-1, Corporate-2, Maithon	Rourkela-1, Rourkela-2, Sipat-1, Sipat-2, Maithon RB1, Maithon RB2, Ragunathpur 1, Ragunathpur 2, Ragunathpur 3, Chitarpur-1, Chitarpur-2, Maithon-1 Ranchi NRNC-1, Ranchi NRNC-2, Ranchi NRNC-3, Ranchi NRNC-4,		3	5	Corporate-1->Chitarpur-1, Corporate-2->Chitarpur-2, Maithon->Maithon-1 Not in contract->Ranchi NRNC-1, Not in contract->Ranchi NRNC-2, Not in contract->Ranchi NRNC-3, Not in contract->Ranchi NRNC-4,	12
166	NER	NER	Assam	RANGANADI	Powergrid	400							1
167	ER	ER-II	Sikkim	RANGPO	Powergrid	400	mangan-i karandeghi-i mangan-ii karandeghi-ii siliguri-ii teesta-v- line-i teesta-v-line-ii siliguri-I 220kV New Melli 1,2,3&4, 220kV Teesta VI 1&2, 220kV Rongnichu 1&2	teesta-iii-line-i kishanganj Line-i teesta-iii-line-ii kishanganj Linei-ii siliguri-ii teesta-v- line-i teesta-v-line-ii siliguri-i. 220kV- Not available.		2		mangan-i->teesta-iii-line-i mangan-ii->teesta-iii-line-ii Karandeghi - i,ii->Kishanganj-I,ii	4
168	NR	NR-I	Rajasthan	RAPP_C	NPCIL	400	Kota-1, Kankroli-1, Kankroli-2, Nagda-1, Nagda-2	Kota-1, Kankroli-1, Kankroli-2, Future bay, Future bay	Kota-1, Kankroli-1, Kankroli-2, Future bay, Future bay	0	0	Nagda-1 > Future bay Nagda-2 > Future bay	3
169	NR	NR-I	Rajasthan	Ratangarh	Rajasthan	400	STPS-1 (Suratgarh), STPS-2 (Suratgarh), Sikar-1, Sikar-2, Merta	STPS-1, STPS-2, Sikar-1, Sikar-2, Merta	As per site survey	0	0	Suratgarh-1 > STPS-1, Suratgarh-2 > STPS-2	3
170	ER	ORISSA	Orissa	RENGALI	OPTCL	220	Rengali(0)-1,2 Nalco, TSTPP	Rengali swyd-1,2 TTPS, Kaniha		4	0	Rengali(0)-1,2->Rengali swyd-1,2 Nalco->TTPS, TSTPP->Kaniha	2
171	ER	ORISSA	Orissa	Rengali	Powergrid	400	TSTPP1, TSTPP2, Upper Indravathi, Keonjor	Talcher-1, Talcher-2, Indravati, Baripada.	-	0	0	TSTPP1->Talcher-1, TSTPP2->Talcher-2, Upper Indravathi->Indravathi Keonjor->Baripada.	2
172	NR	NR-I	Uttar pradesh	Rihand HVDC	Powergrid	400	Rihand-N-1, Rihand-N-2	HVDC Pole-1 HVDC Pole-2	As per site survey	0	0	Rihand-N-1 > HVDC Pole-1 Rihand-N-2 > HVDC Pole-2	1
173	NR	NR-I	Uttar pradesh	Rihand-NT	NTPC	400	Singrauli-1, Singrauli-2, Allahabad-1, Allahabad-2, Rihand-HVDC-1, Rihand-HVDC-2	Singrauli-1, Singrauli-2, Allahabad-1, Allahabad-2, Rihand-HVDC-1, Rihand-HVDC-2	As per site survey	0	0	NIL	3

174	NR	NR-I	Uttarakhand	Rishikesh	Uttarakhand	400	Kishenpur, Muzaffarnagar	Kashipur, Puhana(Roorkee)	As per site survey	0	0	Kishenpur > Kashipur, Muzaffarnagar > Puhana(Roorkee)	1
175	NR	NR-I	Uttarakhand	Roorkee	Powergrid	400	Muzaffarnagar, Rishikesh	Muzaffarnagar, Rishikesh	As per site survey	0	0	NIL	2
176	NR	NR-II	Punjab	Ropar GGS TPS	Punjab	220	Govindnagar-1, Govindnagar-2, Govindnagar-3, Govindnagar-4, Jamsher-1, Jamsher-2, Sanehwal-1, Sanehwal-2, Mohali-1, Mohali-2	Govindnagar-1, Govindnagar-2, Govindnagar-3, Bassi Pathana, Jamsher, Goraya, Gonsgarh, Ghulal, Kharar, Mohali		0	0	Govindnagar-4 > Bassi Pathana, Jamsher-1 > Jamsher, Jamsher-2 > Goraya, Sanehwal-1 > Gonsgarh, Sanehwal-2 > Ghulal, Mohali-1 > Kharar, Mohali-2 > Mohali	5
177	ER	ORISSA	Orissa	ROURKELA	Powergrid	400	Raigarh-1, Raigarh-2, Ranchi-1, Ranchi-2, Chaibasa-1, Chaibasa-2, TSTPP1-1, TSTPP1-2, TSTPP1-3, TSTPP1-4, Jharsuguda-1 Jharsuguda-2	Sundergarh-1, Raigarh-2 Ranchi-1, Ranchi-2, Jamshedpur-1, Jamshedpur-2, TSTPP-1, TSTPP-2 N/A N/A Sundergarh SEL-2		2	-2	Raigarh-1->Sundergarh-1, Chaibasa-1->Jamshedpur-1, Chaibasa-2->Jamshedpur-2, Jharsuguda-1->sundergarh Jharsuguda-2->SEL-2	5
178	NR	NR-I	Uttar Pradesh	Saharanpur-400	Powergrid								2
179	NR	NR-I	Uttar pradesh	Sahupuri	Uttar pradesh	220	Pusauli, Karmasa, obra-1&2, Ajamgarh-1, Ajamgarh-2 Not identified, Not identified.	Pusauli, Sarnath obra-1&2, Bhelupur-1, Bhelupur--2	As per site survey	2	2	Ajamgarh-1-> Bhelupur-1 Ajamgarh-2-> Bhelupur-2 Karmasa->132kV Not considered Not in contract-> Sarnath	3
180	NER	NER	Assam	Samaguri	AEGCL	220	sarusajai misa pg-I misa pg-II Balipara-I Balipara-II Mariani-I Mariani-II J.Nagar	sarusajai-I misa pg-I misa pg-II Balipara-I Mariani sarusajai-I Balipara-II Mariani-II		0	2	sarusajai-> sarusajai-I Balipara-II->Mariani Mariani-I->sarusajai-I Mariani-II-> Not available J.Nagar > Not available	4
181	NR	NR-II	Jammu & Kashmir	Samba	Powergrid								3
182	NR	NR-I	Uttar Pradesh	Sarnath	Uttar pradesh		Allahabad,Azamgarh,Anpara-1&2,Biharsharif						3
183	ER	ER-I	BIHAR	SASARAM(Pusauli)	Powergrid	765	765Kv Fatehpur, 400kv Daltongung-1,2 400kv Saranath-1 400kv Saranath-2 400kv Biharshariff-1,2 400kv Nabinagar-1,2 765kv Gaya, 765kv Varanasi,	765Kv Fatehpur, 400kv Dalthongung-1,2 400kv Saranath 400kv Allahabad 400kv Biharshariff-1,2 400kv Nabinagar-1,2 400Kv Biharshariff-3,4		2	0	400kv Saranath-1->400kv Saranath-1 400kv Saranath-2->400kv Allahabad Not in contract->400kv Biharshariff-3 Not in contract->400kv Biharshariff-4 765kv Gaya-> Future 765kV Varanasi-> Future	9

184	NR	NR-I	Rajasthan	Sikar	Powergrid	400	Ratangarh-1, Ratangarh-2, Agra-1, Agra-2, Bassi-1, Bassi-2	Ratangarh-1, Ratangarh-2, Agra-1, Agra-2, Bassi-1, Bassi-2	As per site survey	0	0	NIL	6
185	NER	NER	Assam	Silchar	Powergrid	400	Azara, 400kV Byrnihat, Pallatana 1 Pallatana 2,	Bongaigaon-1, Bongaigaon-2, Pallatana 1 Pallatana 2,.		0	0	Azara > Bongaigaon-1, 400kV Byrnihat > Bongaigaon-2	4
186	NR	NR-I	Uttar Pradesh	Singrauli	NTPC		Vindhyachal-1,2,Rihand- 1,2,Alahabad- 1,2,Anapara,Luknow,Kanpur						5
187	NR	NR-I	Uttar Pradesh	Sohowal-400	Powergrid	400	Balia-2 , Lucknow-2	Balia-2, Lucknow-2, Balia-1, Lucknow-1. Future Line,	Balia-2, Lucknow-2, Balia-1, Lucknow-1.	0	0	Not identified > Balia-1, Not identified > Lucknow-1 Not identified > Future Line	4
188	NR	NR-II	Haryana	Sonipat	Powergrid	400	Bhadurgarh-1,2, Abdullapur-1,2	Bhadurgarh-1,2, Abdullapur-1,2	-	0	0	NIL	4
189	ER	ORISSA	Orissa	Strelite	Strelite		400kV Jharsuguda 1,2,3&4						3
190	ER	ER-II	West Bengal	SUBHASHGRAM	Powergrid	400	rajarhat sagardighi haldia-i haldia-2	rajarhat sagardighi haldia-i haldia-2		1	0	rajarhat->jeerat	2
191	NR	NR-I	Uttar pradesh	Sultanpur	Uttar pradesh	400	Obra, Azamgarh, lko(pg)	Obra, Azamgarh, Lucknow	As per site survey	0	0	NIL	2
192	ER	ORISSA	Orissa	TALCHER	NTPC		Kolar 1&2, Rengali 1&2, Meeramandali 1&2, Rourkela 1,2,3&4, Behrampur 1&2,						5
193	ER	ER-II	Sikkim	TEESTA	Powergrid		Rangpo 1&2						1
194	NR	NR-I	Uttarakhand	Tehri	THDC	400	Koteshwar-1, Koteshwar-2	Line-1, Line-2	As per site survey	0	0	Koteshwar-1 > Line-1, Koteshwar-2 > Line-2	1
196	ER	ER-I	Jharkhand	Tenughat	Jharkhand		Biharshariff(BSEB),parratu						2
197	NER	NER	Assam	Tinsukia	AEGCL	220	Behiting 1 Behiting 2 Makum	Kaithalguri-1, Kaithalguri-2, Namrup-1, Namrup-2	-	1	1	Behiting 1 ->Kaithalguri-1, Behiting 2 ->Kaithalguri-2, Makum ->Namrup-1, Not identified->Namrup-2	2
199	ER	ORISSA	Orissa	TTPS(Talcher)	OPTCL								3
200	ER	ORISSA	Orissa	U.KOLAB	OPTCL	220	Jayangar-1, Jayangar-2, Therubali,	Jayangar-1, Jayangar-2, Therubali,	Jayangar-1, Jayangar-2, Therubali,	0	0	nill	2
201	NR	NR-I	Uttar Pradesh	Unchahar (Newly Added)	NTPC								5
202	NR	NR-I	Uttar pradesh	Unnao	Uttar pradesh	220	Barelli(UP)-1&2, Lko(PG)-1&2, Lko(UP), Agra(UP), Panki, Anpara.	Barelli(UP)-1&2, Lko(PG)-1&2, Lko(UP), Agra(UP), Panki, Not identified.	As per site survey	1	-1	Anpara > Not identified	4

203	NR	NR-II	Jammu & Kashmir	Uri	NHPC	400	Wagoora-1, Wagoora-2, UriII	Wagoora-1, Wagoora-2, UriII		0	0	NIL	2
204	ER	ER-II	Orissa	Uttara	Powergrid		Mehandsal 1&2, Khargpur1&2						2
205	NR	NR-I	Uttar Pradesh	Varanasi-765	Powergrid		Gaya-2, Fatehpur-1, Kanpur-2,						6
206	NR	NR-II	Jammu & Kashmir	Wagoora	Powergrid	400	Uri-I-1, Uri-I-2, Uri-II-1, New Wanpoh-1, New Wanpoh-2	Uri-I-1, Uri-I-2, Uri-II-1, Wanpoh-1, Wanpoh-2		0	0	New Wanpoh-1 > Wanpoh-1, New Wanpoh-2 > Wanpoh-2,	3
207	NR	NR-II	Jammu & Kashmir	Wanpoh	Powergrid	400	Wagoora-1, Wagoora-2, Kishenpur -1, Kishenpur -2, Kishenpur -3, Kishenpur -4	Wagoora-1, Wagoora-2, Kishenpur -1, Kishenpur -2, Kishenpur -3, Kishenpur -4	As per site survey	0	0	NIL	6
208	SR	SR - I	Andhra Pradesh	Chittur	APTRANSCO	400	Chinkampally, Sriperumbudur	Cudappah, Madras	Cudappah, Madras, TVLM1, TVLM2, KPATNAM1, KPATNAM2.	0	0	Chinkampally > Cudappah, Sriperambadur > Madras	5
209	SR	SR - I	Andhra Pradesh	Srikakulam (Palasa)	APTRANSCO								4
210	SR	SR - II	Tamil Nadu	Kalivanthapattu	Powergrid	400	Kolar, Sriperumbudur	Vallur-1, Vallur-2	As per site survey	0	0	Kolar > Vallur-1, Sriperumbudur > Vallur-2	6
211	SR	SR - II	Tamil Nadu	Karaikudi New	Powergrid	400	Madurai, Trichy	Madurai, Trichy	As per site survey	0	0	NIL	4
212	SR	SR - II	Karnataka	Narendra	Powergrid	400	Kaiga-1, Kaiga-2, Guttur-1, Guttur-2, Nareandra765-1, Nareandra765-2	Kaiga-1, Kaiga-2, Dawangree-1, Dawangree-2, Not identified, Not identified	As per site survey	2	-2	Guttur-1 > Dawangree-1, Guttur-2 > Dawangree-2, Nareandra765-1 > Not identified, Nareandra765-2 > Not identified	3
213	SR	SR - II	Tamil Nadu	Pugalur	Powergrid	400	Neyveli TS-2, Neyveli TS-2 Exp, Madurai -1, Madurai -2	Neyveli TS-2, Neyveli TS-2 Exp, Madurai -1, Madurai -2	-	0	0	NIL	6
214	SR	SR - I	Telangana	Mamidipally	TSTRANSCO	400	Ghanapur, Khamam 1&2, SLBPH 1&2	Ghanapur, Khamam 1&2, Srisailem 1&2		0	0	SLBPH 1 > Srisailem 1 SLBPH 2 > Srisailem 2	3
215	SR	SR - II	Tamil Nadu	Tirunelveli	Powergrid	400	Madurai-1, Madurai-2, Udumalpet-1, Udumalpet-2, Koodankulam-1, Koodankulam-2, Koodankulam-3, Koodankulam-4, Trivendram-1, Trivendram-2, Edamom-1, Edamom-2, Edamom-1(m/c), Edamom-2(m/c), Edamom-3(m/c), Edamom-4(m/c)	Madurai-1, Madurai-2, Udumalpet-1, Udumalpet-2, Koodankulam-1, Koodankulam-2, Koodankulam-3, Koodankulam-4, Trivendram-1, Trivendram-2, Edamom-1, Edamom-2, Not identified, Not identified, Not identified, Not identified	Madurai-1, Madurai-2, Udumalpet-1, Udumalpet-2, Koodankulam-1, Koodankulam-2, Koodankulam-3, Koodankulam-4, Trivendram-1, Trivendram-2	4	-4	Edamom-1(m/c) > Not identified, Edamom-2(m/c) > Not identified, Edamom-3(m/c) > Not identified, Edamom-4(m/c) > Not identified	7

216	SR	SR - I	Andhra Pradesh	Warangal	Powergrid	400	Ramagundam, Bhopalpally -1, Bhopalpally -2, Khammam	Ramagundam, Bhopalpally -1, Bhopalpally -2, Khammam	As per site survey	0	0	NIL	4
217	SR	SR - I	Andhra Pradesh	Kurnool 765	Powergrid	400	Raichur-1, Nagarjunasagar-1, Gooty-1, Kurnool(AP)-1, Kurnool(AP)-2, Nellore-1, Nellore-2, Thiruvalem-1, Thiruvalem-2	Raichur-2, Nagarjunasagar-1, Gooty, Kurnool-1, Kurnool-2, Nellore-1 (Not Erected), Nellore-2 (Not Erected), Thiruvalem-1 (Not Erected), Thiruvalem-2 (Not Erected)	Raichur(N)-2, Nagarjunasagar-1, Gooty, Kurnool-1, Kurnool-2, Nellore-1 (Not Erected), Nellore-2 (Not Erected), Thiruvalem-1 (Not Erected), Thiruvalem-2 (Not Erected) Raichur(N)-1,	0	0	Raichur-1 > Raichur-2, Gooty-1 > Gooty, Kurnool(AP)-1 > Kurnool-1, Kurnool(AP)-2 > Kurnool-2	8
218	SR	SR - I	Karnataka	Raichur 765	Powergrid	400	Kurnool-1, Kurnool-2, Raichur-1, Raichur-2, Gooty-1, Gooty-2, Sholapur-1	Kurnool-1 (Not Commision), Kurnool-2, Raichur-1, Raichur-2, Gooty-1, Gooty-2, Sholapur-1	As per site survey	0	0	Kurnool-1 > Not Commision	5
219	SR	SR - II	Karnataka	Madhugiri 765	Powergrid	400	Gooty-1&2, Yelahanka 1 &2, New Salem-1, Narendra-1,2	Gooty-1&2, Yelahanka 1 &2, Under Construction, Under Construction	-	3	-3	New Salem-1 > Under Construction, Narendra-1,2 > Under Construction,	5
220	SR	SR - II	Karnataka	Hassan	Powergrid	400	Mysore-1, Mysore-2, Neelmangalam	Mysore-1, Mysore-2, Neelmangalam	Mysore-1, Mysore-2, Neelmangalam Talaguppa Udipi-1 Udupi-2	0	0	NIL	6
221	SR	SR - I	Andhra Pradesh	Cuddappah PG	Powergrid	400	Nagarjunsagar-1, Nagarjunsagar-2, Chittoor	Nagarjunsagar-1, Nagarjunsagar-2, Chittoor	As per site survey	0	0	NIL	2
222	SR	SR - II	Tamil Nadu	Salem PS	Powergrid	400	Somanahalli-1&2, Nagapattanam PS-1, Nagapattanam PS-2, Madugiri-1	Somanahalli-1&2, Salem-1, Salem-2, Madugiri-1	-	0	0	Nagapattanam PS-1> Salem-1 Nagapattanam PS-2> Salem-2	3
223	SR	SR - II	Kerala	Cochin	Powergrid	400	Edamom-1(DC), Edamom-2(DC), North Trichur-1, North Trichur-2	Thirunelveli-1, Thirunelveli-2, North Trichur-1, North Trichur-2	As per site survey	0	0	Edamom-1(DC) > Thirunelveli-1, Edamom-2(DC) > Thirunelveli-2	4
224	SR	SR - II	Puducherry	Puducherry	Powergrid	400	Neyveli TS2, Sriparembadur	Neyveli TS2, SV Chatram	As per site survey	0	0	Sriparembadur > SV Chatram	2
225	SR	SR - II	Kerala	Kozhikode	Powergrid	400	Mysore-1, Mysore-2	Mysore-1, Mysore-2	As per site survey	0	0	NIL	2
226	SR	SR - II	Tamil Nadu	Tiruvalam	Powergrid	400	Chitoor-1, Chitoor-2, Nellore-1, Nellore-2, Sholinganallur-1, Sholinganallur-2, Kolar-1, Sriperumbudur-1, Kurnool-1, Kurnool-2	Chitoor-1, Chitoor-2, Nellore-1, Nellore-2, Kalivandhapattu-1(NC) Kalivandhapattu-2(NC) Kolar-1, Sriperumbudur-1, Kurnool-1 (Under Cont), Kurnool-2 (Under Cont)	As per site survey	0	0	Sholinganallur-1 > Kalivandhapattu-1, Sholinganallur-2 > Kalivandhapattu-2	7

227	SR	SR - I	Andhra Pradesh	765 kV Nellore	Powergrid	765	Simhapuri-1, Simhapuri-2, Nellore-1, Nellore-2, Kurnool-1, Kurnool-2, Gooty-1, Gooty-2	Simhapuri (MEPL)-1, Simhapuri, Nellore-1, Nellore-2, Kurnool-1, Kurnool-2, Gooty-1, Gooty-2	MEPL, SEPL, Nellore-1, Nellore-2, Kurnool(N)-1, Kurnool(N)-2, Gooty-1, Gooty-2	0	0	Simhapuri-1 > Simhapuri (MEPL)-1, Simhapuri-2 > Simhapuri,	6
228	SR	SR - I	Andhra Pradesh	Gajuwaka	Powergrid	400	Kalpaka-1, Kalpaka-2, Nunna, Vemagiri-1, Vemagiri-2 Jeypore-1, Jeypore-2,	Kalpaka-1, Kalpaka-2, Vijayawada, Simhadri-2, Simhadri-1, Jeypore-1, Jeypore-2,	As per site survey	0	0	Nunna > Vijayawada, Vemagiri-1 > Simhadri-2, Vemagiri-2 > Simhadri-1	4
229	SR	SR - I	Andhra Pradesh	Ghanapur	Powergrid	400	Ramagundam-1, Ramagundam-2, Gajwel, Malkaram, Mamidapally, N'sagar, Kurnool, Hyderabad-1, Hyderabad-2	Ramagundam-3, Ramagundam-4, Gajwel, Malkaram, Mamidapally, N'sagar, Kurnool, Not identified, Not identified	Ramagundam-3, Ramagundam-4, Gajwel, Malkaram, Mamidapally, N'sagar, Kurnool	2	-2	Ramagundam-1 > Ramagundam-3, Ramagundam-2 > Ramagundam-4, Hyderabad-1 > Not identified, Hyderabad-2 > Not identified	4
230	SR	SR - I	Andhra Pradesh	Gooty	Powergrid	400	Raichur -1, Raichur -2, Kurnool, N'Sagar, Hoody, Nelamangala, Madhugiri-1, Madhugiri-2, Nellore PS-1, Nellore PS-2	Raichur -1, Raichur -2, Kurnool, Kurnool PG, Bangalore, Nelamangala, Madhugiri-1, Madhugiri-2, Nellore PS-1, Nellore PS-2	Raichur(N) -1, Raichur(N) -2, Kurnool, Kurnool PG, Somanahalli, Nelamangala, Madhugiri-1, Madhugiri-2, Nellore PS-1, Nellore PS-2	0	0	N'sagar > Kurnool PG, Hoody > Bangalore	5
231	SR	SR - I	Andhra Pradesh	Khammam	Powergrid	400	Maimadapally-1, Maimadapally-2, Warangal, Kalpaka-1, Kalpaka-2, Nunna, N'sagar, Khammam-1, Khammam-2	Maimadapally-1, Maimadapally-2, Warangal, Kalpaka-1, Kalpaka-2, Vijayawada, N'sagar, Kothagundem-1, Kothagundem-2	As per site survey	0	0	Nunna > Vijayawada, Khammam-1 > Kothagundem-1, Khammam-2 > Kothagundem-2	5
232	SR	SR - I	Andhra Pradesh	Nagarjunsagar	Powergrid	400	Ramagundam -1, Ramagundam -2, Khammam, Mehaboobnagar, Cuddapah -1, Cuddapah -2. Gooty,	Ramagundam -1, Ramagundam -2, Khammam, Mehaboobnagar, Cuddapah -1, Cuddapah -2, Kurnool, Hyderabad	As per site survey	1	1	Gooty > Kurnool, Hyderabad feeder is captured additionally as a part of site survey.	4
233	SR	SR - II	Karnataka	Hiriyur	Powergrid	400	Guttur -1, Guttur -2, Nelamangla -1, Nelamangla -2	Guttur -1, Guttur -2, Nelamangla -1, Nelamangla -2	As per site survey	0	0	NIL	2

234	SR	SR - II	Tamil Nadu	Hosur	Powergrid	400	Kolar-1, Kolar-2, Salem-1, Salem-2, Bangalore, Electronic City-1, Electronic City-2	Kolar-1, Kolar-2, Salem-1, Salem-2, Somanahalli, Not identified, Not identified	As per site survey	2	-2	Bangalore > Somanahalli, Electronic City-1 > Not identified, Electronic City-2 > Not identified	3
235	SR	SR - II	Karnataka	Kolar	Powergrid	400	Hoody -1, Hoody -2, Somanhally, Hosur -1, Hosur -2, Kalvindapattu, Chinkampally, Talchar HVDC -1, Talchar HVDC -2	Hoody -1, Hoody -2, Somanhally, Hosur -1, Hosur -2, Tiruvallam, Cudappah, HVDC Pole-1, HVDC Pole-2	As per site survey	0	0	Kalivandhapattu > Tiruvallam, Chinkampally > Cudappah, Talchar HVDC-1 > HVDC Pole-1, Talchar HVDC-1 > HVDC Pole-2	4
236	SR	SR - II	Tamil Nadu	Madurai	Powergrid	400	Pugalur-1, Pugalur-2, Trichy, Karaikudi New, Udumalpet, Thirunelveli-1, Thirunelveli-2, Tuticorin-1, Tuticorin-2	Pugalur-1, Pugalur-2, Trichy, Karaikudi, Udumalpet, Thirunelveli, Kudankulam, Tuticorin-1, Tuticorin-2	As per site survey	0	0	Karaikudi New > Karaikudi, Thirunelveli-1 > Thirunelveli, Thirunelveli-2 > Kudankulam	5
237	SR	SR - I	Karnataka	Munirabad	Powergrid	400	Raichur, Guttur	Raichur, Davangere	As per site survey	0	0	Guttur > Davangere	1
238	SR	SR - II	Karnataka	Mysore	Powergrid	400	Neelamangla-1, Neelamangla-2, Kozhikode -1, Kozhikode -2, Hassan -1, Hassan -2	Neelamangla-1, Neelamangla-2, Kozhikode -1, Kozhikode -2, Hassan -1, Hassan -2	As per site survey	0	0	NIL	3
239	SR	SR - II	Karnataka	Neelamangala	KPTCL	400	Talaguppa, Hassan, Hiriyur PG -1, Hiriyur PG -2, Gooty, Mysore -1, Mysore -2, Hoody, Somanhally -1, Somanhally -2, Yelehanka	Talaguppa, Hassan, Hiriyur PG -1, Hiriyur PG -2, Gooty, Mysore -1, Mysore -2, Hoody-1, Bidadi -1, Bidadi -2, Hoody-2	As per site survey	0	0	Hoody > Hoody-1, Somanhally -1 > Bidadi-1, Somanhally -2 > Bidadi-2, Yelehanka > Hoody-2	6
240	SR	SR - I	Andhra Pradesh	Nunna/Vijaywada	Powergrid	400	Vemagiri-1, Vemagiri-2, Vemagiri-3, Vemagiri-4, Gazuwaka, Lanco-1, Lanco-2, VTS stg 4-1, VTS stg 4-2, Nellore-1, Nellore-2, Khammam	Vemagiri-1, Vemagiri-2, Vemagiri-3, Vemagiri-4, Gazuwaka, Lanco-1, Lanco-2, VTPS-1, VTPS-2, Nellore-1, Nellore-2, Khammam	Vemagiri-1, Vemagiri-2, Vemagiri-3, Vemagiri-4, Gazuwaka, Lanco-1, Lanco-2, VTPS-1, VTPS-2, Nellore-1, Nellore-2, Khammam Nellore(AP)-3, Nellore(AP)-4	0	0	VTS stg 4-1 > VTPS-1, VTS stg 4-2 > VTPS-2	7
241	SR	SR - II	Tamil Nadu	Salem	Powergrid	400	Hosur, Somanhally, Udumalpet-1, Udumalpet-2, Neyveli TS2-1, Neyveli TS2-2	Hosur-1, Hosur-2, Udumalpet-1, Udumalpet-2, Neyveli TS2-1, Neyveli TS2-2	As per site survey	0	0	Hosur > Hosur-1, Somanhally > Hosur-2	4

242	SR	SR - II	Karnataka	Somanhalli	Powergrid	400	Kolar, Salem, Nelamangala -1, Nelamangala -2, Salem new-1, Salem new-2 Nelamangala -3	Kolar, Hosur, Bidadi -1, Bidadi -2, Gooty	As per site survey	0	0	Salem > Hosur, Nelamangala -1 > Bidadi - 1, Nelamangala - 2 > Bidadi - 2, Salem new-1 > Gooty,	4
243	SR	SR - II	Tamil Nadu	Udumalpet	Powergrid	400	Arasur-1, Arasur-2, Madurai, Thirunelveli-1, Thirunelveli-2, Trichur-1, Trichur-2, Not Identiified, Not Identiified	Arasur-1, Arasur-2, Madurai, Thirunelveli-1, Thirunelveli-2, Palakad-1, Palakad-2, Salem-1, Salem-2	-	0	0	Trichur-1 > Palakad-1, Trichur-2 > Palakad-2, Not identified >Salem-1, Not identified >Salem-2	5
244	SR	SR - II	Kerala	N.Trichur	Powergrid	400	Udumalpet-1, Udumalpet-2, Cochin-1, Cochin-2, Kozhikode-1, Kozhikode-2	Palakad-1, Palakad-2, Cochin-1, Cochin-2, Not Identiified, Not Identiified	As per site survey	2	-2	Udumalpet-1 > Palakad-1, Udumalpet-2 > Palakad-2, Kozhikode-1 > Not Identiified, Kozhikode-2 > Not Identiified	2
245	SR	SR - II	Tamil Nadu	Trichy	Powergrid	400	Karaikudi, Madurai, Neyveli TS-1 Exp, Neyveli TS-2	Karaikudi, Madurai, Neyveli TS-1 Exp, Neyveli TS-2	As per site survey	0	0	NIL	2
246	SR	SR - II	Kerala	Trivendrum	Powergrid	400	Thirunelveli -1, Thirunelveli -2	Thirunelveli -1, Thirunelveli -2	As per site survey	0	0	NIL	1
247	SR	SR - I	Andhra Pradesh	Simhadri Power	NTPC	400	Kalpaka -1, Kalpaka -2, Kalpaka -3, Kalpaka -4	Kalpaka -1, Kalpaka -2, Kalpaka -3, Kalpaka -4	Kalpaka -1, Kalpaka -2, Kalpaka -3, Kalpaka -4 Vemagiri-1 Vemagiri-2 Gajuwaka-1 Gajuwaka-2	0	0	NIL	4
248	SR	SR - I	Andhra Pradesh	Nellore	Powergrid	400	Sriperumubudur-1, Sriperumubudur-2, Vijayawada-1, Vijayawada-2, Krishnapatnam UMPP-1, Krishnapatnam UMPP-2, Thiruvalem-1, Thiruvalem-2	Sriperumubudur-1, Alamathy, Vijayawada-1, Vijayawada-2, NPS-1, NPS-2, Thiruvalem-1, Thiruvalem-2	As per site survey	0	0	Sriperumubudur-2 > Alamathy, Krishnapatnam UMPP-1 > NPS-1, Krishnapatnam UMPP-1 > NPS-2	4
249	SR	SR - II	Tamil Nadu	Neyveli TS1 Ext.	NLC	400	Neyveli TS-2, Trichy	Neyveli TS-2, Trichy	As per site survey	0	0	NIL	1
250	SR	SR - II	Tamil Nadu	Neyveli TS2	NLC	400	Salem -1, Salem -2, Trichy, Neyveli TS-1 Exp, Neyveli TS-2 Exp, Puducherry, Bahror	Salem -1, Salem -2, Trichy, Neyveli TS-1 Exp, Neyveli TS-2 Exp, Puducherry, Pugalur	As per site survey	0	0	Bahror > Pugalur	4
251	SR	SR - II	Tamil Nadu	Neyveli TS2 Exp	NLC	400	Pugalur, Neyveli TS-1	Pugalur-2, Neyveli TS-2	As per site survey	0	0	Pugalur > Pugalur-2, Neyveli TS-1 > Neyveli TS-2	1

252	SR	SR - I	Andhra Pradesh	Ramagundam STPS	NTPC	400	Chandrapur-1, Chandrapur-2, Warangal, Nagarjuna Sagar-1, Nagarjuna Sagar-2, Ghanapur-1, Ghanapur-2, Gajwel, Malkaram, Dichipally	Chandrapur-1, Chandrapur-2, Warangal, Nagarjuna Sagar-1, Nagarjuna Sagar-2, Hyderabad-3, Hyderabad-4, Gajwel, Malkaram, Dichipally	As per site survey	0	0	Ghanapur-1 > Hyderabad-3, Ghanapur-2 > Hyderabad-4	5
253	SR	SR - II	Karnataka	Yelahanka	Powergrid	400	Neelamangla-1, Hoody-1, Madhugiri-1, Madhugiri-2 Somanhally-1, Hoody-2	Neelamangla, Hoody, Madhugiri-1, Madhugiri-2 Not available Not available	As per site survey	2	-2	Neelamangla-1 > Neelamangla, Hoody-1 > Hoody, Somanhally-1 > Not available Hoody-2 > Not available	2
254	SR	SR - II	Karnataka	Bidadi	Powergrid	400	Neelamangla -1, Neelamangla -2, Somnahalli -1, Somnahalli -2	Neelamangla -1, Neelamangla -2, Somnahalli -1, Somnahalli -2	As per site survey	0	0	NIL	2
255	SR	SR - II	Tamil Nadu	KudaNkulam	Powergrid	400	Tiruneveli-1, Tiruneveli-2, Tiruneveli-3, Tiruneveli-4	Madurai, Tiruneveli-2, Tiruneveli-3, Tiruneveli-4	As per site survey	0	0	Tiruneveli-1 > Madurai	2
256	SR	SR - II	Kerala	Kayamkulam PG	NTPC	220	Not Identified, Not Identified, Not Identified, Not Identified, Not Identified, Not Identified,	New Palom-1, New Palom-2, Edappon, Kundara, Not Identified, Not Identified,	New Palom-1, New Palom-2, Edappon, Kundara,	2	-2	Not Identified > New Palom-1, Not Identified > New Palom-2, Not Identified > Edappon, Not Identified > Kundara,	2
257	SR	SR - I	Andhra Pradesh	Kurnool	APTRANSCO	400	Gooty, SLBPH, Ghanapur	Gooty, Srisailam, Ghanapur	Gooty, Srisailam, Ghanapur, Kurnool(N) 1, Kurnool(N) 2	0	0	SLBPH > Srisailam	3
258	SR	SR - I	Andhra Pradesh	Mahaboobnagar	APTRANSCO	400	Nagarjunsagar, Raichur	Thallapalli, Raichur	Nagarjunsagar, Raichur	0	0	Nagarjunsagar > Thallapalli	1
259	SR	SR - I	Telangana	Srisillem LPH	TSTRANSCO	400	Kurnool, Maimadapally -1, Maimadapally -2, VTS stg 4 -1, VTS stg 4 -2	Kurnool, Hyderabad-1, Hyderabad-2, Satenapalli-1, Satenapalli-2	-	0	0	Maimadapally -1 > Hyderabad-1, Maimadapally -2 > Hyderabad-2, VTS stg 4 -1 > Satenapalli-1, VTS stg 4 -2 > Satenapalli-2	3
260	SR	SR - I	Andhra Pradesh	VEMAGIRI PGL (GMR)	GMR	400	Vemagiri -1, Vemagiri -2	Vemagiri -1, Vemagiri -2	-	0	0	NIL	1
261	SR	SR - I	Andhra Pradesh	VTS STAGE IV	APTRANSCO	400	Nunna 1&2, SLBPH 1&2	Nunna 1&2, Sattenapalli 1&2, Malkaram 1&2	-	2	2	SLBPH 1&2 > Sattenapalli 1&2, Not in contract > Malkaram 1&2	3
262	SR	SR - I	Telangana	KTPS	TSTRANSCO	220	Manuguru, L Sileru-1, L Sileru-2, KTPS V-1, KTPS V-2, Mirayalguda, K V Kota, Shapurnagar	Manuguru-1, L Sileru-1, Manuguru-2, Tie Line-1, Tie LIne-2, Mirayalguda, Nunna, Shapurnagar	-	0	0	Manuguru > Manuguru-1, L Sileru-2 > Manuguru-2, KTPS V-1 > Tie Line-1, KTPS V-2 > Tie Line-2, K V Kota > Nunna	4

263	SR	SR - I	Andhra Pradesh	VTS	APTRANSCO	220	Kondapalli-1, Kondapalli-2, Chillkallu-1, Chillkallu-2, Podili-1, Podili-2, K V Kotal, Bhimadole, Nunna, Tadikonda-1, Tadikonda-2, N sagar-1, N sagar-2, Gunadala	Kondapalli-1, Kondapalli-2, Chillkallu-1, Chillkallu-2, Podili, NR Peta, K-Kota, Not Identifed, Nunna, Tadikonda-1, Tadikonda-2, Rentachintala, Tallapalli, Gunadala	As per site survey	1	-1	Podili-1 > Podili, Podili-2 > NR Peta, K V Kotal > K-Kota, Bhimadole > Not identified, N sagar-1 > Rentachintala, N sagar-2 > Tallapalli	7
264	SR	SR - II	Karnataka	Guttur	KPTCL	400	Jindal, Munirabad, Narendra-1, Narendra-2, Kaiga-1, Kaiga-2, Hiriyur PG-1, Hiriyur PG-2	Jindal (JSWEL), Guddadahalli, Narendra-1, Narendra-2, Kaiga-1, Kaiga-2, Berenahalli-1, Berenahalli-2		0	0	Jindal > Jindal (JSWEL), Munirabad > Guddadahalli, Hiriyur PG-1 > Berenahalli-1, Hiriyur PG-2 > Berenahalli-2	4
265	SR	SR - II	Tamil Nadu	Arasur	Powergrid	400	Udumalpet -1, Udumalpet -2	Udumalpet -1, Udumalpet -2		0	0	NIL	2
266	SR	SR - II	Tamil Nadu	Alamathy	TANTRANSCO	400	Sriperumbudur -1, Sriperumbudur -2, Nellore -1, Nellore -2, North Chennai 6th Fdr Details Not Available	Vallur- 1, Vallur-2, Sriperambudur, Nellore, North chennai-1, North chennai-2	Vallur- 1, Vallur-2, Sriperambudur, Nellore, North chennai-1, North chennai-2 Sunguarchatram-1 Sunguarchatram-2	0	0	Sriperambudur-1 > Vallur-1, Sriperambudur-2 > Vallur-2, Nellore-1 > Sriperambudur, Nellore-2 > Nellore, North chennai > North chennai-1 6th Fdr > North chennai-2	4
267	SR	SR - II	Tamil Nadu	Sriperumbudur	Powergrid	400	Kalvindapattu, Chittoor, AlAmathy -1, AlAmathy -2, PudUcherry, Bahroor	Tiruvallam, Chittoor, AlAmathy-1, Nellore, Sunguvarchatram Not identified	As per site survey	1	-1	Kalvindapattu> Tiruvallam, Almathy -2> Nellore, Pudyucherry > Sunguvarchatram, Bahroor > Not identified	3
268	SR	SR - I	Karnataka	Raichur TPS	KPTCL	400	Gooty-1, Gooty-2, Munirabad	Gooty-1, Gooty-2, Munirabad, Mahaboobnagar, BTPS	As per site survey	2	2	Not identified > Mahaboobnagar, Not identified > BTPS	3
269	SR	SR - II	Kerala	Kalamassery	KSEB	220	Idukki-1, Idukki-2, Bramhapuram-1, Bramhapuram-2	220KV IDKL-1, 220KV IDKL-2, 220KV COKL-1, 220KV COKL-2	-	0	0	Idukki-1 > 220KV IDKL-1, Idukki-2 > 220KV IDKL-2, Bramhapuram-1 > 220KV COKL-1, Bramhapuram-2 > 220KV COKL-2	2

270	WR	WR-I	Maharastra	Chandrapur	MSETCL	400	Parali-1, Parali-2, Parali-3, Bhadrawathi-1, Bhadrawathi-3, Bhadrawathi-4, Bhadrawathi-2, Khaparkheda, HVDC-1, HVDC-2, Padhge.	Chandrapur-1, Chandrapur-2, Parali-3, PGCIL-1, PGCIL-2, PGCIL-3, PGCIL-4, Khaparkheda, HVDC-1, HVDC-2. Not identified	-	1	1	Parali-1->Chandrapur-1 Parali-2->Chandrapur-2 Bhadrawathi-1->PGCIL-1, Bhadrawathi-2->PGCIL-2 Bhadrawathi-3->PGCIL-3 Bhadrawathi-4->PGCIL-4 Padhge->Not identified	5
271	WR	WR-I	Maharastra	KALWA	MSETCL	400	Padhage-1, Padhage-2, Pune PG, Khargar	Padhage-1, Padhage-2, Talegaon, Khargar	-	0	0	Pune PG->Talegaon	2
272	WR	WR-I	Maharastra	Lonikand	MSETCL	400	Pardi-1, Parali-2, Karad, Koyna IV, Jejuri, Pune PG, Chakan	LonikandII ckt-1, LonikandII ckt-2, Karad, Koyna IV, Jejuri, Pune PG, Chakan	-	0	0	Parali-1->LonikandII ckt-1 Parali-2->LonikandII ckt-2	4
273	WR	WR-I	Maharastra	PADGHE	MSETCL	400	Chandrapur-1, Chandrapur-2, Bableshwar-1, Bableshwar-2, Chakan Kalwa-1, Kalwa-2, Boiser, Tarapur, Khargar Neagothane-1 Neagothane-2	HVDC-1 HVDC-2 Bableshwar-1, Bableshwar-2, Talegaoh Kalwa-1, Kalwa-2 Boiser, Tarapur-1, Khargar, Neagothane-1 Neagothane-2 Tharapur-2,		1	1	Chandrapur-1->HVDC-1 Chandrapur-2->HVDC-2 Chakan->Talegaoh Tharapur->Tharapur-1 Not in Contract->Tharapur-2	7
274	WR	WR-II	Madhya Pradesh	BHOPAL	MPPTCL	400	DAMOH-1, DAMOH-2, ITARSI-2, BINA-2, BINA-1, ITARSI-1, BHOPAL-1, BHOPAL-2	DAMOH-1, DAMOH-2, ITARSI-2, BINA-2, BINA-1, ITARSI-1, BHOPAL-1, BHOPAL-2		0	0	-	4
275	WR	WR-II	Madhya Pradesh	BINA	MPPTCL	400	Bina PGCIL-1, Bina PGCIL-2, Bina PGCIL-3, Bina PGCIL-4, Bina Power, Bhopal-1, Bhopal-2,	Bina PGCIL-1, Bina PGCIL-2, Bina PGCIL-3, Bina PGCIL-4, JP BPSCL, Bhopal-1, Bhopal-2,	Bina PGCIL-1, Bina PGCIL-2, Bina PGCIL-3, Bina PGCIL-4, JP BPSCL, Bhopal-1, Bhopal-2,	0	0	Bina power->JP BPSCL	4
276	WR	WR-II	Madhya Pradesh	Indore	MPPTCL	400	Itarsi-1, Itarsi-2, Asoj-1, Asoj-2, Nagda, Indira sagar-1, Indira sagar-2, Indore(PG)-1, Indore(PG)-2	Itarsi-1, Itarsi-2, Asoj-1, Asoj-2, Nagda, Indira sagar-1, Indira sagar-2, Hatunia-1, Hatunia-2	Itarsi-1, Itarsi-2, Asoj-1, Asoj-2, Asoj-3 Nagda, Indira sagar-1, Indira sagar-2, Indore(PG)-1, Indore(PG)-2	0	0	Indore(PG)-1 > Hatunia-1, Indore(PG)-2 > Hatunia-2	5

277	WR	WR-II	Madhya Pradesh	765/400kv Indore	Powergrid	765	765kV Bina(PG), 765kV Vadodara, 765kV Bhopal, 400kV Indore (MP)1 & 2, 400kV Pithampur 1&2	765kV Bina(PG)- Indore, 765kV Vadodara, 765kV Bhopal, 400kV Indore (MP)1 & 2, 400kV Pithampur 1&2	765kV Bina(PG)- Indore, 765kV Vadodara, 765kV Bhopal, 400kV Indore (MP)1 & 2, 400kV Pithampur 1&2	0	0	765kV Bina(PG) >765kV Bina(PG)- Indore	7
278	WR	WR-II	Madhya Pradesh	NAGDA	MPPTCL	400	Dehgam-1 &2, Shujalpur-1&2, Rajgarh-1&2 Indira sagar, Indore	Dehgam-1 &2, Shujalpur-1&2, Rajgarh-1&2 Indira sagar, Indore	-	0	0	-	4
279	WR	WR-II	Madhya Pradesh	RAJ GARH	Powergrid	400	SSP 1&2, Nagda 1&2, Kasor 1&2, Khandawa 1,2, Khandawa 3,4	SSP 1&2, Nagda 1&2, Kasor 1&2, Khandawa 1,2, Not identified.	SSP 1&2, Nagda 1&2, Kasor 1&2, Khandawa 1,2.	2	-2	Khandawa 3,4 > Not identified	6
280	WR	WR-II	Madhya Pradesh	KATNI	MPPTCL	400	Birsinghpur, Damoh	Birsinghpur-1, Birsinghpur-2 Damoh	-	1	1	Not in contract - >Birsinghpur-2	2
281	WR	WR-II	Madhya Pradesh	Sasan	Reliance Power Ltd.	765	Satna765 1&2, 765kV Vpool, Vindhyachal 1 Vindhyachal 2 400kV Jabalpur 1 400kV Jabalpur 2 Satna 1&2, 400kV Vpool 1&2,	Satna765 1&2, 765kV Vpool, Vindhyachal 1 Vindhyachal 2 Vindhyachal 3 Jabalpur 3 Not identified. Not identified.	Satna765 1&2, 765kV Vpool	4	-4	400kV Jabalpur 1 > Vindhyachal 3 400kV Jabalpur 2 > Jabalpur 3 Satna 1 > Not identified Satna 2 > Not identified 400kV Vpool 1 > Not identified 400kV Vpool 2 > Not identified	2
282	WR	WR-I	Chattisgarh	BHILAI	CSPGCL	400	KSTPS-1, KSTPS-2, KSTPS-3, Raipur-1, Seoni, Koradi, Bhadrawati Raipur-2,	NTPC Korba-1, NTPC Korba-2, Raita-1, Raipur-1, seoni, Koradi, Bhadrawati, Raita-2, Raita-3, Korba EXT-1, Korba EXT-2, Bhatapara		4	4	KSTPS-1->NTPC Korba-1, KSTPS-2->NTPC Korba-2, KSTPS-3->Raita-1, Raipur-2->Not available. Nill->Raita-2, Nill->Raita-3, Nill->Korba EXT-1, Nill->Korba EXT-2, Nill->Bhatapara	6
283	WR	WR-I	Chattisgarh	KORBA WEST	CSPGCL	400	KSTPS, Bhilai	KSTPS (NTPC), Raita	KSTPS (NTPC), Raita. Bhilai 1, Bhilai 2.	0	0	KSTPS > KSTPS (NTPC), Bhilai > Raita	2
284	WR	WR-I	Chattisgarh	Korba(E)	CSPGCL	220	Korba East Extn-1, Korba East Extn-2, Korba West, Balco-1, Balco-2, Budhipadar-1, Budhipadar-2, Raigarh, Bhilai, Bhatapar-1, Bhatapar-2	Korba East West-1, Korba East West-2, Korba DSPM, Balco-1, Balco-2, Budhipadar-1, Budhipadar-2, Raigarh, Siltara, Not Identified, Not Identified	Korba East West-1, Korba East West-2, Korba DSPM, Balco-1, Balco-2, Budhipadar-1, Budhipadar-2, Raigarh, Siltara	2	-2	Korba East Extn-1 > Korba East West-1, Korba East Extn-2 > Korba East West-2, Korba West > Korba DSPM, Bhilai > Siltara, Bhatapar-1 > Not Identified, Bhatapar-2 > Not Identified	5

285	WR	WR-II	Gujrat	SARDARSAROVAR(SSP)	SSP	400	Rajgarh-1, Rajgarh-2, Asoj, Kasor, Dhule-1, Dhule-2,	Nagda-1, Nagda-2 Asoj, Limdi, Dhule-1, Dhule-2,		0	0	Rajgarh-1->Nagda-1, Rajgarh-2->Nagda-2 Kasor->Limdi,	3
286	WR	WR-I	Maharastra	AURANGABAD PG	Powergrid								4
287	WR	WR-I	Maharastra	Bhadrawati	Powergrid	400	Raipur 1,2&3, Ramagundam 1&2, Parli , Chandrapur 1,2,3&4, Bhilai , EMCO 1&2, Dhariwal TPS.	Raipur 1,2&3, Ramagundam 1&2, Parli , Chandrapur 1,2,3&4, Bhilai , EMCO 1&2, Dhariwal (Parli-2), HVDC-1, HVDC-2	Raipur 1,2&3, Ramagundam 1&2, Parli , Chandrapur 1,2,3&4, Bhilai , EMCO 1&2, Dhariwal TPS, HVDC-1, HVDC-2	2	2	Dhariwal TPS > Dhariwal (Parli-2), Not identified > HVDC-1, Not identified > HVDC-2	8
288	WR	WR-II	Madhya Pradesh	Bina	Powergrid	765	765kV JabalpurPS-1, 2 & 3, 765kV Indore, 765kV Satna-1 & 2, 765kV Gwalior-1, 2 & 3, 765KV Seoni 400kV Sujalpur-1 & 2, 400kV Bina-1, 2, 3 & 4, 400kV Bina Power, 400kV Satna-1, 2, 3 & 4,	765kV Jabalpur-1, 2 & 3, 765kV Indore, 765kV Satna-1 & 2, 765kV Gwalior-1, 2 & 3, 765KV Seoni 400kV Sujalpur-1 & 2, 400kV Bina-1, 2, 3 & 4, 400kV BPSCL, 400kV Satna-1, 2, 3 & 4,	765kV Jabalpur-1, 2 & 3, 765kV Indore, 765kV Satna-1 & 2, 765kV Gwalior-1, 2 & 3, 765KV Seoni 400kV Sujalpur-1 & 2, 400kV Bina-1, 2, 3 & 4, 400kV BPSCL, 400kV Satna-1, 2, 3 & 4,	0	0	765kV Jabalpur PS-1 > 765kV Jabalpur-1 765kV Jabalpur PS-2 > 765kV Jabalpur-2 765kV Jabalpur PS-3 > 765kV Jabalpur-3, 400kV Bina Power > 400kV BPSCL	16
289	WR	WR-I	Maharastra	Boisar	Powergrid	400	Tarapur 1&2, Padghe, Vapi, A'bad (PG) 1&2, Magarwada 1&2,	Tarapur 1&2, Padghe, Vapi, Aurangabad 1&2 Navsari 1&2,	Tarapur 1&2, Padghe, Vapi, A'bad (PG) 1&2, Magarwada 1&2,	0	0	Magarwada 1 > Navsari 1, Magarwada 2 > Navsari 2.	5
290	WR	WR-II	Madhya Pradesh	GWALIOR	Powergrid								0
291	WR	WR-II	Madhya Pradesh	Itarsi	Powergrid	400	Jabalpur 1,2,3,4 Bhopal 1&2, Indore 1&2, Khandawa 1&2, Satpura,	Jabalpur 1,2,3,4 Bhopal 1&2, Indore 1&2, Khandawa 1&2, Satpura,	Jabalpur 1,2,3,4 Bhopal 1&2, Indore 1&2, Khandawa 1&2, Satpura,	0	0	NIL	6
292	WR	WR-II	Madhya Pradesh	Jabalpur	Powergrid	400	Itarsi 1,2,3,&4, Vindhyachal 1&2, 400kV Jabalpur pool 1&2, 400kV Sasan 1 400kV Sasan 2	Itarsi 1,2,3,&4, Vindhyachal 1&2, 400kV Jabalpur pool 1&2, 400kV Sasan 1 Vindhyachal 4	Itarsi 1,2,3,&4, Vindhyachal 1&2, 400kV Jabalpur pool 1&2, Vindhyachal 3 Vindhyachal 4	0	0	Sasan 2> Vindhyachal 4	5
293	WR	WR-II	Madhya Pradesh	Khadwa	Powergrid	400	Dhule-1, Dhule-2, Itarsi-1, Itarsi-2, Seoni-1, Seoni-2, Rajgarh-1, Rajgarh-2, Rajgarh-3, Rajgarh-4, Betul-1, Betul-2	Dhule-1, Dhule-2, Itarsi-1, Itarsi-2, Seoni-1, Seoni-2, Rajgarh-1, Rajgarh-2, Indore-1, Indore-2, Betul-1, Betul-2	Dhule-1, Dhule-2, Itarsi-1, Itarsi-2, Seoni-1, Seoni-2, Rajgarh-1, Rajgarh-2, Indore-1, Indore-2, Betul-1, Betul-2	4	-4	Rajgarh-3 > Indore-1, Rajgarh-4 > Indore-2	6

294	WR	WR-I	Chattisgarh	KORBA STPS	NTPC	400	Bhilai-1, Bhilai-2, Bhatapara, Raipur-1, Raipur-2, Pathadi, Korwa West, Vindhyachal-1, Vindhyachal-2, Birsinghpur-1, Birsinghpur-2	Bhilai-1, Bhilai-2, Bhatapara, Raipur-3, Raipur-4, Lanco, Korwa West, Vindhyachal-1, Vindhyachal-2, Vandhana, Balco	As per site survey	0	0	Raipur-1 > Raipur-3, Raipur-2 > Raipur-4, Pathadi > Lanco, Birsinghpur-1 > Vandhana, Birsinghpur-2 > Balco	6
295	WR	WR-I	Maharastra	Mapusa	Powergrid	400	Kolhapur -1, Kolhapur -1	Kolhapur -1, Kolhapur -1	As per site survey	0	0	NIL	1
296	WR	WR-I	Chattisgarh	Raigarh	Powergrid	400	Raipur 1, Raipur 4, Raipur 2, Raipur 3 Rourkela 1, Rourkela 2 Rourkela 3, Sterlite	Raipur 1, Raipur 4, KWPCL, KSK, Sundergarh, Sterlite 1, Sundergarh 2, Sterlite 1, Kotra pool 1 Kotra pool 2.	Raipur 1, Raipur 4, KWPCL, KSK, Sundergarh, Sterlite 1, Sundergarh 2, Sterlite 1, Kotra pool 1 Kotra pool 2.	2	2	Raipur 2 > KWPCL Raipur 3 > KSK Rourkela 1 > Sundergarh, Rourkela 2 > Sterlite 1, Rourkela 3, > Sundergarh 2, Sterlite > Sterlite 1, Not identified > Kotra pool 1 Not identified > Kotra pool 2.	8
297	WR	WR-II	Madhya Pradesh	Satna	Powergrid	765	765KV Bina-1, 765KV Bina-2, 765KV Sasan-1, 765KV Sasan-2, 765KV V Pool-1, 765KV V Pool-2, 765KV Satna-1, 765KV Satna-2, 400KV Vindhyachal-1, 400KV Vindhyachal-2, 400KV Vindhyachal-3, 400KV Vindhyachal-4, 400KV Bina PG-1, 400KV Bina PG-2, 400KV Bina PG-3, 400KV Bina PG-4, 400KV Jaiprakash-1, 400KV Jaiprakash-2, 400KV Sasan-1, 400KV Sasan-2	765KV Bina-1, 765KV Bina-2, 765KV Sasan-1, 765KV Sasan-2, 765KV V Pool-1, 765KV V Pool-2, 765KV Gwalior-1, 765KV Gwalior-2, 400KV Vindhyachal-1, 400KV Vindhyachal-2, 400KV Vindhyachal-3, 400KV Vindhyachal-4, 400KV Bina PG-1, 400KV Bina PG-2, 400KV Bina PG-3, 400KV Bina PG-4, 400KV Nigrie-1, 400KV Nigrie-2, Not identified, Not Identified	765KV Bina-1, 765KV Bina-2, 765KV Sasan-1, 765KV Sasan-2, 765KV V Pool-1, 765KV V Pool-2, 765KV Gwalior-1, 765KV Gwalior-2, 400KV Vindhyachal-1, 400KV Vindhyachal-2, 400KV Vindhyachal-3, 400KV Vindhyachal-4, 400KV Bina PG-1, 400KV Bina PG-2, 400KV Bina PG-3, 400KV Bina PG-4, 400KV Nigrie-1, 400KV Nigrie-2,	2	-2	765KV Satna-1 > 765KV Gwalior-1, 765KV Satna-2 > 765KV Gwalior-2, 400KV Jaiprakash-1 > 400KV Nigrie-1, 400KV Jaiprakash-2 > 400KV Nigrie-2, 400KV Sasan-1 > Not identified, 400KV Sasan-2 > Not identified,	12
298	WR	WR-I	Madhya Pradesh	SEONI	Powergrid	765	765Kv Sipat-1, 765Kv Sipat-2, 765Kv Bina, 765Kv wardha-1, 765Kv wardha-2, 400Kv Khandwa-1, 400Kv Khandwa-2 400Kv Sadhpura, 400Kv Bhilai.	765Kv Bilaspur-1, 765Kv Bilaspur-2, 765Kv Bina, 765Kv wardha-1, 765Kv wardha-2, 400Kv Khandwa-1, 400Kv Khandwa-2 400Kv Sadhpura, 400Kv Bhilai.	-	0	0	765Kv sipat-1->765Kv Bilaspur-1, 765Kv sipat-2->765Kv Bilaspur-2	8

299	WR	WR-II	Gujrat	Vapi	Powergrid	400	Boiser, Kala-1, Suzen, Kala-2, KAPP-1, KAPP-2, Kawas-1, Kawas-2	Boiser, Kala Line, Suzen Line, Not Identified, Not Identified, Not Identified, Not Identified, Not Identified, Navsari	Boiser, Kala 1, Suzen Line, Kala 2, KAPP-1, KAPP-2	4	-4	Kala-1 > Kala Line, Kala-2 > Not Identified, KAPP-1 > Not Identified, KAPP-2 > Not Identified, Suzen > Suzen Line, Kawas-1 > Not Identified, Kawas-2 > Not Identified, Not Identified > Navsari	3
300	WR	WR-I	Maharastra	Wardha	Powergrid	765	Mauda 1&2, Parli PG 1&2, Akola 1&2, Aurangabad 1&2, Seoni765 1&2, 765kV Raipur PS 1,2 Raipur 1&2, 765kV Aurangabad 1,2, 765kV Aurangabad 3,&4 765kV Raipur PS 3&4,	Mauda 1&2, Parli PG 1&2, Akola 1&2, Aurangabad 1&2, Seoni765 1&2, 765kV Raipur PS 1,2 Raipur 1&2 Warora 1&2.	-	6	-6	Not in contract->Warora 1&2 765kV Aurangabad 1,2-> Not identified at site. 765kV Aurangabad 3,&4-> Not identified at site. 765kV Raipur PS 3&4-> Not identified at site.	17
301	WR	WR-II	Gujrat	Dehgam	Powergrid	400	Sami-1, Sami-2, Ranchodpura-1, Ranchodpura-2, Nagda-1, Nagda-2, Pirana-1,Pirana-2, Wanakbori-1, Wanakbori-2, Soja-1, Soja-2, Pirana-3, Pirana-4, Jhanor-1, Jhanor-2	Sami-1, Sami-2, Ranchodpura-1, Ranchodpura-2, Nagda-1, Nagda-2, Pirana-1,Pirana-2, Wanakbori, Wanakbori(Future), Soja, Soja(Future), Gandhar-1, Gandhar-2, ICT Bays.	Sami-1, Sami-2, Ranchodpura-1, Ranchodpura-2, Nagda-1, Nagda-2, Pirana-1,Pirana-2, Wanakbori, Wanakbori(Future), Soja, Soja(Future), Gandhar-1, Gandhar-2,	2	-2	Wanakbori-2 > Wanakbori(Future) Soja-2 > Soja(Future) Pirana-3 > Gandhar-1, Pirana-4 > Gandhar-2, Wanakbori-1 > Wanakbori Soja-1 > Soja	7
302	WR	WR-I	Chattisgarh	Raipur	Powergrid	400	Bhadrawadi-1 Bhadrawadi-2 Bhadrawadi-3 NSPCL-1 NSPCL-2 Wardha-1 Wardha-2 Raigarh-1 Raigarh-2 Raigarh-3 Raigarh-4 JPL-1 JPL-2 Sipat-1 Sipat-2 Sipat-3 Pathadi, KSTPS-1, KSTPS-2, Bhatapara, Bhilai-1, Bhilai-2.	Chandrapur-1, Not available, Not available, BESCL-1, BESCL-2, Wardha-1, Wardha-2, Raigarh-1, KWPCL, KSK-3, KSK-4, Tamnar-1 Tamnar-2 Sipat-1, Sipat-2, Sipat-3, Not available Korba-3, korba-4, Bhatapara Bhilai-1, Bhadravati-3, Raipur Pooling-1, Raipur Pooling-2.		2	-2	Bhadrawadi-1->Chandrapur-1, Bhadrawadi-2->Not Identified Bhadrawadi-3->Not Identified NSPCL-1->BESCL-1 NSPCL-2->BESCL-2 Raigarh-3->KSK-3 Raigarh-4->KSK-4 JPL-1->Tamnar-2 JPL-2->Not Identified Pathadi->Not Identified, KSTPS-1->Korba-3 KSTPS-2->korba-4, Bhilai-2->Bhadravati-3 Not in contract->Raipur Pooling-1, Not in contract->Raipur Pooling-2.	12

303	WR	WR-II	Madhya Pradesh	Damoh	Powergrid	400	Birsinghpur 1, Birsinghpur 2, Bhopal 1, Bhopal 2, Katni	Birsinghpur 1, Birsinghpur 2, Bhopal 1, Bhopal 2, Katni 2 Katni 1	Birsinghpur 1, Birsinghpur 2, Bhopal 1, Bhopal 2, Katni 2 Katni 1	1	1	Katni > Katni 2 Not identified > katni 1	6
304	WR	WR-II	Gujrat	Bachhau	Powergrid	400	Mundra-1, Mundra-2, Ranchodpura-1, Ranchodpura-2, Essar TPS-1, Essar TPS-2, Versana-1, Versana-2	Mundra-1, Mundra-2, Ranchodpura-1, Ranchodpura-2	Mundra-1, Mundra-2, Ranchodpura-1, Ranchodpura-2, Essar TPS-1, Essar TPS-2, Versana-1, Versana-2	0	0	Essar TPS-1 > Under Construction, Essar TPS-2 > Under Construction, Versana-1 > Under Construction, Versana-2 > Under Construction	8
305	WR	WR-I	Maharastra	Parli	Powergrid	400	Parli 1&2, Solapur pG 1&2, Wardha 1&2, Bhadrawati, Pune New 1&2, Dhariwal TPS	MSETCL Parli 1&2, Solapur pG 1&2, Wardha 1&2, Bhadrawati-1, Pune 1&2, Bhadrawati-2.	Parli 1&2, Solapur pG 1&2, Wardha 1&2, Bhadrawati, Pune GIS 1&2, Dhariwal TPS	0	0	Parli 1>MSETCL Parli 1 Parli 2>MSETCL Parli 2 Bhadrawati>Bhadrawati-1, Pune New 1> Pune 1 Pune New 2> Pune 2 Dhariwal TPS>Bhadrawati-2	6
306	WR	WR-I	Maharastra	Pune	Powergrid	400	Lonikhand, Kalwa, Pune New 1, Pune New 2, Pune New 3, Pune New 4.	Lonikhand, Kalwa, Parli 1, Parli 2, Aurangabad 1, Aurangabad 2,	As per SLD	0	0	Pune New 1>Parli 1 Pune New 2>Parli 2 Pune New 3>Aurangabad 1 Pune New 4>Aurangabad 2	6
307	WR	WR-I	Maharastra	Navi Mumbai	Powergrid	400	Kalwa, Pune PG, Kala-1, Kala-2	Kalwa,LoniKhand, Vapi-1, Vapi-2	Kalwa,Lonikand.	0	0	Pune PG > LoniKhand, Kala-1 > Vapi-1, Kala-2 > Vapi-2	1
308	WR	WR-II	Gujrat	Navsari	Powergrid	400	Jhanor-1, Jhanor-2, KAPP-1, KAPP-2, Magarwada-1, Magarwada-2	Gandhar-1, Gandhar-2, Kala, Vapi, DGEN-1, DGEN-2	Jhanor-1, Jhanor-2, Magarwada-1, Magarwada-2, DGEN-1, DGEN-2	0	0	Jhanor-1 > Gandhar-1, Jhanor-2 > Gandhar-2, KAPP-1 > Kala, KAPP-2 > Vapi, Magarwada-1 > DGEN-1, Magarwada-2 > DGEN-2	3
309	WR	WR-II	Gujrat	Pirana	Powergrid	400	Vadodara-1, Vadodara-2, Dehgam-1, Dehgam-2, Dehgam-3, Dehgam-4	Vadodara-1, Vadodara-2, Dehgam-1, Dehgam-2, TPGL-1, TPGL-2	Vadodara-1, Vadodara-2, Dehgam-1, Dehgam-2, TPGL-1, TPGL-2	0	0	Dehgam-3 > TPGL-1, Dehgam-4 > TPGL-2	6
310	WR	WR-II	Gujrat	Gandhar(Jhanor)	NTPC	400	GPEC, Suzen, Dehgam 1&2, Navsari 1&2	GPEC, Suzen, Dehgam 1&2, Navsari 1&2	GPEC, Suzen, Dehgam 1&2, Navsari 1&2	0	0	NIL	0
311	WR	WR-I	Maharastra	Sholapur	Powergrid	765	Kolhapur-1, Kolhapur-2, Karad, Parli PG-1, Parli PG-2, Sholapur NTPC-1, Sholapur NTPC-2	Kolhapur-1, Kolhapur-2, Karad, Parli PG-1, Parli PG-2, Sholapur NTPC-1, Sholapur NTPC-2 Lamboti 765KV Raichur-1, Raichur-2, Aurangabad-1, Aurangabad-2, Pune	Kolhapur-1, Kolhapur-2, Karad, Parli PG-1, Parli PG-2, Sholapur NTPC-1, Sholapur NTPC-2 Lamboti 765KV Raichur-1, Raichur-2, Aurangabad-1, Aurangabad-2, Pune	6	6	Not identified > Lamboti Not identified > Raichur-1, Not identified > Raichur-2, Not identified > Aurangabad-1, Not identified > Aurangabad-2, Not identified > Pune	10
312	WR	WR-II	Madhya Pradesh	Shujalpur	Powergrid	400	Bina-1, Bina-2, Nagda -1, Nagda -2	Bina-1, Bina-2, Nagda -1, Nagda -2	Bina-1, Bina-2, Nagda -1, Nagda -2	0	0	NIL	4

313	WR	WR-II	Gujrat	Kakrapar	NPCIL	220	Vav 1&2, Vapi 1&2, Haldarwa 1&2	Vav 1&2, Vapi 1&2, Haldarwa 1&2 UKAI	-	1	1	Not in contract-> Ukai	4
314	WR	WR-II	Gujrat	Kawas	NTPC	220	Haldarwa 1&2, Vav 1&2, Navsari 1&2	Haldarwa 1&2, Vav 1&2, Dastan 1&2	Haldarwa 1&2, Vav 1&2, Navsari(GIS) 1&2	0	0	Navsari 1 > Dastan 1 Navsari 2 > Dastan 2	3
315	WR	WR-II	Gujrat	Gandhar	NTPC	220	Haldarwa 1&2	Haldarwa 1&2	Haldarwa 1&2	0	0	NIL	4
316	WR	WR-I	Chattisgarh	765/400kV Raigarh(Kotra) Pooling Station	Powergrid	765	765kV Raigarh (Tamnar) PS-1, 765kV Raigarh (Tamnar) PS-2, 765kV Raipur PS-1, 765kV Raipur PS-2, 765kV Champa PS, 400kV Raigarh-1, 400kV Raigarh-2, 400kV RKM-1, 400kV RKM-2, 400kV Athena-1, 400kV Athena-2, 400kV SKS-1, 400kV SKS-2, 400kV Korba-1, 400kV Korba-2, 400kV DB-1, 400kV DB-2, 400kV Visa-1, 400kV Visa-2	765kV Raigarh (Tamnar) PS-1, 765kV Raigarh (Tamnar) PS-2, 765kV Raipur PS-1, 765kV Raipur PS-2, 765kV Champa PS, 400kV Raigarh-1, 400kV Raigarh-2, 400kV RKM-1, 400kV RKM-2, 400kV Athena-1, 400kV Athena-2, 400kV SKS-1, 400kV SKS-2, 400kV Korba-1, 400kV Korba-2, 400kV DB-1, 400kV DB-2, 400kV Visa-1, 400kV Visa-2, 400kV Visa Steel-1, 400kV Visa Steel-2, 400kV NTPC-1 (COSMOS), 400kV NTPC-2 (COSMOS)	765kV Raigarh (Tamnar) PS-1, 765kV Raigarh (Tamnar) PS-2, 765kV Raipur PS-1, 765kV Raipur PS-2, 765kV Champa PS, 400kV Raigarh-1, 400kV Raigarh-2, 400kV RKM-1, 400kV RKM-2, 400kV Athena-1, 400kV Athena-2, 400kV SKS-1, 400kV SKS-2, 400kV Korba-1, 400kV Korba-2, 400kV DB-1, 400kV DB-2, 400kV Visa-1, 400kV Visa-2, 400kV Visa Steel-1, 400kV Visa Steel-2, 400kV NTPC-1 (COSMOS), 400kV NTPC-2 (COSMOS)	4	4	400kV SKS-1 > 400kV SPGCIL-1, 400kV SKS-2 > 400kV SPGCIL-2, 400kV Korba-1 > 400kV KWPCL-1, 400kV Korba-2 > 400kV KWPCL-2, 400kV Visa-1 > 400kV Visa Power-1, 400kV Visa-2 > 400kV Visa Power-2, Not applicable->400kV Visa Steel-1 Not applicable->400kV Visa Steel-2 Not applicable->400kV NTPC-1 (COSMOS not applicable->400kV NTPC-2 (COSMOS)	15
317	WR	WR-I	Chattisgarh	765/400kv Raipur Pooling Station	Powergrid	765	765kV Raigarh (Kotra) PS-1, 765kV Raigarh (Kotra) PS-2, 765kV Champa-1, 765kV Champa-2, 765kV Wardha-1, 765kV Wardha-2, 765kV Wardha-3, 765kV Wardha-4, 400kV Raipur-1, 400kV Raipur-2, 400kV GMR-1, 400kV GMR-2	765kV Raigarh (Kotra) PS-1, 765kV Raigarh (Kotra) PS-2, 765kV Champa-1, 765kV Champa-2, 765kV Wardha-1, 765kV Wardha-2, Future Extension, Future Extension, 400kV Raipur-1, 400kV Raipur-2, 400kV GMR-1, 400kV GMR-2	765kV Raigarh (Kotra) PS-1, 765kV Raigarh (Kotra) PS-2, 765kV Champa-1, 765kV Champa-2, 765kV Wardha-1, 765kV Wardha-2, 765kV Wardha-3, 765kV Wardha-4, 400kV Raipur-1, 400kV Raipur-2, 400kV GMR-1, 400kV GMR-2	0	0	NIL	9
318	WR	WR-I	Chattisgarh	765/400kV Raigarh(Tamnar) Pooling Station	Powergrid	765	765kV Raigarh (Kotra) PS 1&2, 400kV Jindal Power 1,2,3,& 4, 400kV TRN 1 & 2, 400kV Jayaswal Nico 1&2, 400kV Sarda 1&2	765kV Raigarh (Kotra) PS 1&2, 400kV Jindal Power 1,2,3,& 4.	765kV Raigarh (Kotra) PS 1&2, 400kV Jindal Power 1,2,3,& 4, 400kV TRN 1 & 2.	6	-6	400kV TRN 1 & 2 > Not identified 400kV Jayaswal Nico 1&2 > Not identified 400kV Sarda 1&2 > Not identified.	8

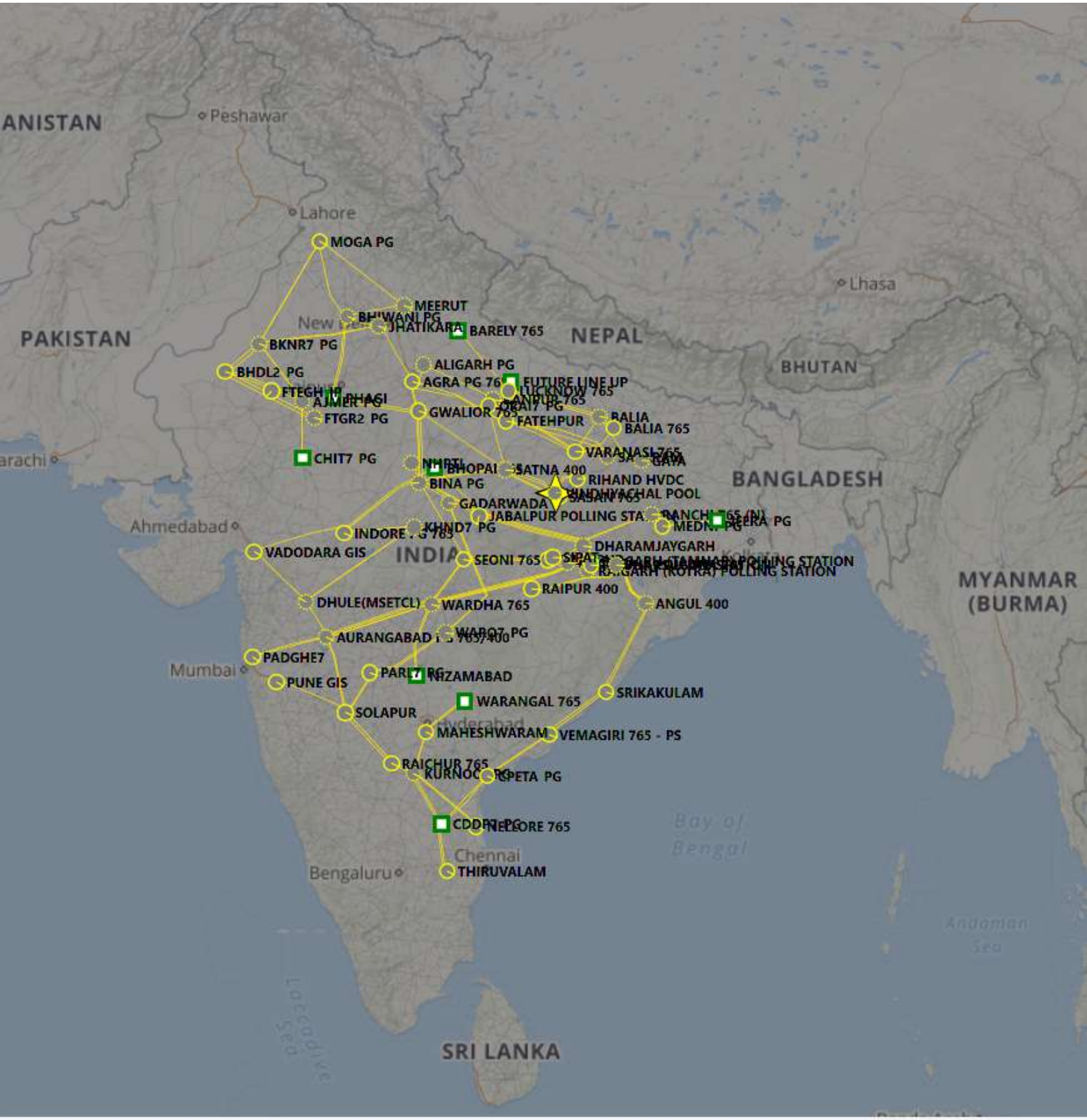
319	WR	WR-I	Maharastra	765/400kv Aurangabad Station	Powergrid	765	765kV Wardha 1, 765kV Wardha 2, 765kV Wardha 3, 765kV Wardha 4, 76kV Padghe (PG) 1 76kV Padghe (PG) 2, 765kV Dhule , 400kV Boisar 1 400kV Boisar 2 400kV Wardha 1 400kV Wardha 2 400kV Aurangabad 1 400kV Aurangabad 2	765kV Wardha 1, 765kV Wardha 2, 765kV Wardha 3, 765kV Wardha 4, 76kV Padghe (PG) 1 76kV Padghe (PG) 2, 765kV Dhule , 400kV Boisar 1 400kV Boisar 2 400kV Wardha 1 400kV Wardha 2 400kV Aurangabad 1 400kV Aurangabad 2 400kV Ankola 1 400kV Ankola 2	765kV Wardha 1, 765kV Wardha 2, 765kV Wardha 3, 765kV Wardha 4, 76kV Padghe (PG) 1 76kV Padghe (PG) 2, 765kV Dhule , 400kV Boisar 1 400kV Boisar 2 400kV Wardha 1 400kV Wardha 2 400kV Aurangabad 1 400kV Aurangabad 2 400kV Ankola 1 400kV Ankola 2	6	6	Not identified > 400kV Wardha 1, Not identified > 400kV Wardha 2, Not identified > 400kV Aurangabad 1, Not identified > 400kV Aurangabad 2, Not identified > 400kV Ankola 1, Not identified > 400kV Ankola 2.	8
320	WR	WR-II	Gujrat	Vadodara GIS	Powergrid	765	765kV Indore, 765kV Dhule, 400kV Pirana 1 & 2, Asoj 1 & 2, DGEN 1&2	765kV Indore, 765kV Dhule, 400kV Pirana 1 & 2, 400kV Asoj 1 & 2,	-	2	2	DGEN 1&2-> Not available.	3
321	WR	WR-I	Chattisgarh	765/400kV Dharamjaygarh	Powergrid	765	765kV Jharsuguda 1 ,2,3 & 4, 765kV Ranchi 1 & 2, 765kV Champa, 765kV Jabalpur Pool 1 , 2,3 & 4, 400kV BALCO 1 &2, 400kV Vandana 1 &2, 765kV WR Pool.	765kV Jharsuguda 1 ,2,3 & 4, 765kV Ranchi 1 & 2, 765kV Champa, 765kV Jabalpur Pool 1 , 2,3 & 4, 400kV BALCO 1 &2, 400kV Vandana 1 &2, 765kV Bilaspur,	-	0	0	765kV WR Pool >765kV Bilaspur	12
322	WR	WR-II	Madhya Pradesh	765/400kV Jabalpur Pooling station	Powergrid	765	765kV Dharamjaygarh-1, 2, 3 & 4, 765kV Bina-1, 2 & 3, 765kV Bhopal, 400kV Jabalpur-1 & 2, 400kV MB Power-1 & 2, 400kV Jhabua-1, 2	765kV Dharamjaygarh-1, 2, 3 & 4, 765kV Bina-1, 2 & 3, 765kV Bhopal, 400kV Jabalpur-1 & 2, 400kV MB Power-1 & 2, 400kV Jhabua-1, 2	765kV Dharamjaygarh-1, 2, 3 & 4, 765kV Bina-1, 2 & 3, 765kV Bhopal, 400kV Jabalpur-1 & 2, 400kV MB Power-1 & 2, 400kV Jhabua-1, 2	0	0	NIL	10
323	WR	WR-II	Madhya Pradesh	765/400kV Gwalior	Powergrid	765	765kV Bina 1,2 & 3, 765kV Jaipur 1 & 2, 765kV Agra 1 & 2, 765kV Satna 1 & 2	765kV Bina 1,2 & 3, 765kV Jaipur 1 & 2, 765kV Agra 1 & 2, 765kV Satna 1 & 2	765kV Bina 1,2 & 3, 765kV Jaipur 1 & 2, 765kV Agra 1 & 2, 765kV Satna 1 & 2	0	0	NIL	6
324	WR	WR-II	Chattisgarh	Vin IV Switchyard	NTPC	400	400kV V'Pool 1 400kV V'Pool 2	Vindhyachal Pooling -1 Vindhyachal Pooling -2	Vindhyachal Pooling -1 Vindhyachal Pooling -2	0	0	400kV V'Pool 1 > Vindhyachal Pooling -1 400kV V'Pool 2 > Vindhyachal Pooling -2	2
325	WR	WR-II	Chattisgarh	Vindhychal Pool	Powergrid	765	765kV Rihand III 1 & 2, 765kV Satna 1 & 2, 765kV Sasan, 400kV Sasan 1& 2, 400kV Vin IV 1 & 2, DB(MP) 1&2	765kV Rihand III 1 & 2, 765kV Satna 1 & 2, 765kV Sasan, 400kV Sasan 1& 2, 400kV Vin IV 1 & 2, 400kV Rihand III 1&2 400kV Future-1,2,3,4	-	4	4	DB(MP) 1&2-> Not available Not in contract->400kV Rihand III 1&2 Not in contract->400kV Future-1,2,3,4	11
326	WR	WR-I	Maharastra	Dhule (PVT)	Bhopal dhule company transmission LTD	765	765kV Aurangabad, 765kV Vadodara, 400kV Dhule(MSETCL) 1 & 2	765kV Aurangabad, 765kV Vadodara, 400kV Dhule(MSETCL) 1 & 2 HVDC-1,2,3,4	-			Not in contract->HVDC-1,2,3,4	5
327	WR	WR-I	Maharastra	400KV Kolapur (PG)	Powergrid	400	Karad-1, Karad-2, Mapusa-1, Mapusa-2, Solapur-1, Solapur-2,	Karad-1, Karad-2, Mapusa-1, Mapusa-2, Solapur-1, Solapur-2,	-	0	0	-	3

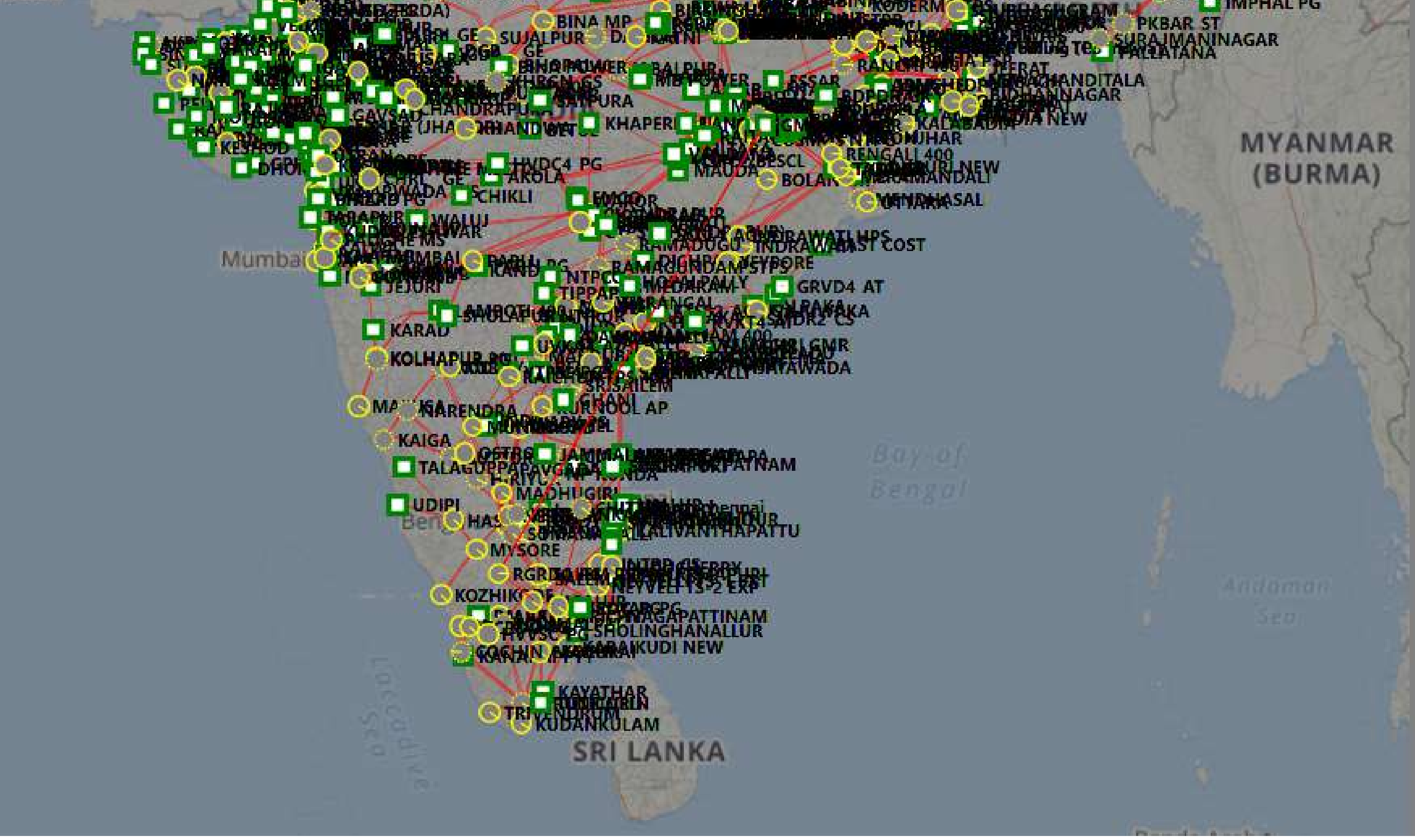
328	WR	WR-II	Gujrat	Magarwada GIS	Powergrid	400	400kV Navsari 1 & 2, 400kV Boisar 1&2	400kV Navsari 1 & 2, 400kV Kala 1&2	-	0	0	400kV Boisar 1&2->400kV Kala 1&2	2
329	WR	WR-II	Maharastra	UT DNH - Kala GIS	Powergrid	400	400kV Vapi -1, 400kV Vapi -2, 400kV Navi Mumbai -1, 400kV Navi Mumbai -2	400kV Vapi -1, 400kV Vapi -2, 400kV Navsari -1, 400kV Navsari -2	400kV Vapi -1, 400kV Vapi -2, 400kV Kudus-1, 400kV Kudus-2	0	0	400kV Navi Mumbai -1 > 400kV Navsari -1, 400kV Navi Mumbai -2 > 400kV Navsari -2	2
330	WR	WR-I	Chattisgarh	Bhatapara	Powergrid	400	Not in contract	Korba Khedamara	As per site survey	NA	NA	Not in contract > Korba Not in contract > Khedamara	2
331	WR	WR-I	Chattisgarh	Bilaspur	Powergrid	765	Not in contract	765KV- Seoni I & II, Sipat I & II, Korba, Ranchi. 400KV- Mahan I & II, Aryan I & II, Lanco I & II.	765KV- Seoni I & II, Sipat I & II, Korba. 400KV- Mahan I & II, Aryan I & II, Lanco I & II.	NA	NA	Not in contract > Seoni I & II, Not in contract > Sipat I & II, Not in contract > Korba, Not in contract > Ranchi. Not in contract > Mahan I & II, Not in contract > Aryan I & II, Not in contract > Lanco I & II	10
332	WR	WR-I	Chattisgarh	NTPC Sipat	NTPC	400	Not in contract	765KV- Bharari I Bharari II 400KV- Ranchi 1&2, Raipur 1&2 Raipur 3 Korba.	-	NA	NA	Not in contract > Bharari I Not in contract > Bharari II Not in contract > Ranchi 1&2 Not in contract > Raipur 1&2 Not in contract > Raipur 3 Not in contract >Korba.	4
333	WR	WR-II	Gujrat	VARSANA	GETCL	400	Not in contract	Adani-1. Adani-2 Adani-3, Bachau-1, Bachau-2, Hadala-1, Tappar-1, Tappar-2, Tappar-3, Tappar-4 Nakhatrana-1, Nakhatrana-2,,		0	0	Not in contract->Adani-1. Not in contract->Adani-2 Not in contract->Adani-3, Not in contract->Bachau-1, Not in contract->Bachau-2, Not in contract->Hadala-1, Not in contract->Tappar-1, Not in contract->Tappar-2, Not in contract->Tappar-3, Not in contract->Tappar-4 Not in contract->Nakhatrana-1, Not in contract->Nakhatrana-2,,	3

334	WR	WR-II	Gujrat	AMRELI	GETCL	400	Not in contract	400KvJ etpur-1, 400Kv Jetpur-2, 400Kv Chorania, 400Kv Hadala, 400Kv kasor-1, 400kv kasor-2, 400Kv shapoorji-1, 400Kv shapoorji-2, 400Kv pipava-1, 400Kv pipava-2, 220kv Dhasa-1, 220kv Dhasa-2, 220kv s'kundala-1, 220kv s'kundala-2, 220kv Inox-1, 220kv Inox-2.	-	-	-	Not in contract->400Kv Jetpur-1, Not in contract->400Kv Jetpur-2, Not in contract->400Kv Chorania, Not in contract->400Kv Hadala, Not in contract->400Kv kasor-1, Not in contract->400kv kasor-2, Not in contract->400Kv shapoorji-1, Not in contract->400Kv shapoorji-2, Not in contract->400Kv pipava-1,Not in contract->Not in contract->400Kv pipava-2, Not in contract->220kv Dhasa-1, Not in contract->220kv Dhasa-2, Not in contract->220kv s'kundala-1, Not in contract->220kv s'kundala-2	6
335	SR	SR - I	Andhra Pradesh	Vemagiri	APTRANSCO		Gautmi 1&2, Nunna 1,2,3&4,Vemagiri PGL (GMR) 1&2, Konaseema 1&2, Kalpaka 1&2, Gazuwaka 1&2, Jegrupadu Extn (GVK) 1&2						8
336	SR	SR - II	Andhra Pradesh	Kaiga Atomic Power Stn	NPCIL		Narendra 1&2, Guttur 1&2,Sirsi-2						2
337	SR	SR - II	Karnataka	Narendra 765	Powergrid		Kolhapur-1&2,Narendra-1&2,Madhugri-1,2						5
338	SR	SR - II	Tamil Nadu	Nagapattanam PS	Powergrid		Neyveli -1, Trichy-1,Salem new-1,2						4
339	SR	SR - II	Tamil Nadu	Neyveli TS I	NLC		Neyveli TS2, Neyveli TS2exp, Madurai 1&2						3
340	SR	SR - II	Tamil Nadu	PFBR Kalpakkam	NPCIL		Kanchepuram 1 &2,Arni 1&2,Sirucheri 1&2						3
341	SR	SR - I	Andhra Pradesh	Hyderabad	Powergrid		Wardha-1,2,Ghanapur-1,2						2
342	SR	SR - I	Andhra Pradesh	Vemagiri(765)-PS	Powergrid		Gazuwaka ,Vijayawada						1
343	SR	SR - I	Andhra Pradesh	Khammam-765	Powergrid		Khammam 1&2,						2
344	WR	WR-II	Madhya Pradesh	Birsinghpur	MPPTCL		Birsinghpur-1&2						7
345	WR	WR-II	Chattisgarh	VINDYACHAL	Powergrid		Jabalpur PG 1&2, Singrauli 1&2, Satna 1,2.3&4, Sasan 1&2, KSTPS 1&2						6
346	WR	WR-I	Chattisgarh	765/400kV Champa Pooling Station	Powergrid		765kV Raigarh(Kotra), 765kV Raipur PS 1 & 2, 765kV Dharamjaygarh , Kurushetra HVDC 1 & 2, 400kV KSK 1 ,2,3 & 4, 400kV Lanco 1 &2						11
347	WR	WR-I	Maharastra	765/400kV Padghe(PG) Station	Powergrid		76kV Aurangabad (PG) 1 & 2, 400kV Kudus 1&2, 400kV Kolhapur(PG), 400kV Pune(gis)						2

348	WR	WR-I	Maharastra	765/400kv Pune GIS	Powergrid		765kV Solapur 1&2, 400kV Solapur STPP 1&2, 400kV Kolhapur, 400kV Aurbd(existing) 1&2, 400kV Parli(exs) 1&2, 400kV Padghe(GIS), 400kV HEGL 1,2						5
349	WR	WR-II	Madhya Pradesh	BINA 1200kV	Powergrid								1
350	SR	SR - I	Andhra Pradesh	NP Kunta	Powergrid								
351	NR	NR-II	Haryana	Kurukshetra					As per site survey	0	0	NIL	6

Annexure III




PAKISTAN
NEPAL
MYANMAR (BURMA)
SRI LANKA
Peshawar
Lhasa
Mumbai
Bay of Bengal
Andaman Sea
WAGOORA
WANPOH
AMRITSAR
JAISALMER
SREE CEMENT
BHILWARA
PALI
BINA MP
SUJALPUR
MAINPURI
NEPAL
RANGANADI
PUNATSANGHU
PURNEA NEW
NEW KOHIMA
KAMENG
IMPHAL PG
PKBAR ST
SURAJMANINAGAR
PALLATANA
RENGALI 400
AKOLA
CHIKLI
HVDC4 PG
MAUDA
JEJURI
GRVD4 AT
KARAD
KOLHAPUR PG
KAIGA
NARENDRA
SRISAILEM
KURNOOL AP
TALAGUPPA
UDIPI
MADHUGIRI
MYSORE
NEYVELI TS-2 EXP
NAGAPATTINAM
SHOLINGHANALLUR
KAYATHAR
KUDANKULAM

List of lines for PMU installation in NER

Sl. No.	Region	Name of the Line	Length in ckt km	Charged at	Voltage Level in kV
1	NER	Tezu -Namsai S/c	95	132	132
2	NER	Pasighat - Roing	108	132	132
3	NER	Roing - Tezu	72	132	132
4	NER	Bongaigaon - salkati-II D/C line (Lenth is for Bongaigaon - salkati-II only)	1	220	220
5	NER	Balipara - Tezpur	9	220	220
6	NER	Misa - Kopili-III	76	220	220
7	NER	Salakati - BTPS-I	3	220	220
8	NER	Salakati - BTPS-II	3	220	220
9	NER	Misa - Kopili-I	73	220	220
10	NER	Misa - Kopili-II	73	220	220
11	NER	Misa - Dimapur-I	124	220	220
12	NER	Misa - Dimapur-II	124	220	220
13	NER	Misa - Samaguri-I	34	220	220
14	NER	Misa - Samaguri-II	34	220	220
15	NER	Mariani - Mokokchung I	49	220	220
16	NER	Mariani - Mokokchung II	49	220	220
17	NER	Aizwal - Kolasib	66	132	132
18	NER	Kolasib - Badarpur	107	132	132
19	NER	Agartala - Agartala-I	8	132	132
20	NER	Agartala - Agartala-II	8	132	132
21	NER	Aizwal - Kumarghat	133	132	132

List of lines for PMU installation in NER

Sl. No.	Region	Name of the Line	Length in ckt km	Charged at	Voltage Level in kV
22	NER	Aizwal -Melriat- Zemabawk(LILO	10	132	132
23	NER	Aizwal -Melriat- Zemabawk	7	132	132
24	NER	Badarpur - Badarpur	1	132	132
25	NER	Badarpur - Jiribam	67	132	132
26	NER	Badarpur - Khliehriat	77	132	132
27	NER	Badarpur - Kumarghat	119	132	132
28	NER	Dimapur - Imphal	169	132	132
29	NER	Doyang - Dimapur-I	93	132	132
30	NER	Doyang - Dimapur-II	93	132	132
31	NER	Gohpur - Nirjuli (Itanagar)	43	132	132
32	NER	Imphal - Imphal	2	132	132
33	NER	Jiribam - Aizwal	172	132	132
34	NER	Jiribam - Haflong	101	132	132
35	NER	Jiribam - Loktak-II	82	132	132
36	NER	Salakati - Gaylemphug	49	132	132
37	NER	Khandong - Haflong	63	132	132
38	NER	Khandong - Khliehriat-I	42	132	132
39	NER	Khandong - Khliehriat-II	41	132	132
40	NER	Khandong - Kopili I	11	132	132
41	NER	Khliehriat - Khliehriat	8	132	132
42	NER	Kumarghat - R.C.Nagar (Agarthala)	104	132	132

List of lines for PMU installation in NER

Sl. No.	Region	Name of the Line	Length in ckt km	Charged at	Voltage Level in kV
43	NER	Loktak - Imphal-II	35	132	132
44	NER	Nirjuli - Ranganadi	22	132	132
45	NER	Kopili - Khandong II	12	132	132
46	NER	Dimapur - Dimapur (PG) (LILO portion)	0	132	132
47	NER	Dimapur (PG) - Kohima (LILO portion)	0	132	132
48	NER	Silchar - Srikona I	1	132	132
49	NER	Silchar - Srikona II	1	132	132
50	NER	Silchar - Badarpur I	19	132	132
51	NER	Silchar - Badarpur II	19	132	132
52	NER	Part of Silchar - Hailakandi I	30	132	132
53	NER	Part of Silchar - Hailakandi II	30	132	132
54	NER	Imphal (state) - Ningthoukong	0	132	132
55	NER	Imphal (state) - Imphal	0	132	132
56	NER	Ranganadi - Ziro	45	132	132
57	NER	Bishwanath Chariali - Bishwanath Chariali (Pavoi) I	13	132	132
58	NER	Bishwanath Chariali - Bishwanath Chariali (Pavoi) II	13	132	132
59	NER	Mokokchung - Mokokchung I	1	132	132
60	NER	Mokokchung - Mokokchung II	1	132	132

ANNEXURE V

List of lines for PMU installation in Sikkim

Sl. No.	Region	Name of the Line	Length in ckt km	Charged at	Voltage Level in kV
1	ER-II	Rangpo - New Melli I	26	220	220
2	ER-II	Rangpo - New Melli II	26	220	220
3	ER-II	Rangit - Karseong (upto LILO point)	61	132	132
4	ER-II	Karseong - Siliguri (upto LILO point)	31	132	132
5	ER-II	Siliguri - Meli	92	132	132
6	ER-II	Meli - Chuzachen	21	132	132
7	ER-II	Rangpo - Chuzacheng I (upto LILO)	1	132	132
8	ER-II	Rangpo - Gangtok	17	132	132
9	ER-II	Gangtok - Rangpo	73	132	132
10	ER-II	Rangpo - Rangit	3	132	132
11	ER-II	Rangit - Rammam	27	132	132

1. **Inter-Regional and Tie Lines Lines:** It is very important to monitor the power flow on inter regional lines, though the SCADA provides this data but high sampling rate data furnished by PMUs would help in getting accurate frequency response of regions as well as proper functioning of automatic generation control. Therefore, PMU need to be placed on all inter-regional lines so that power flow can be assessed.

2. **HVDC and FACTS devices:** With the large integration of HVDC and FACTS devices in the system, it is very important that their interaction with existing system is monitored. The high sampling rate data provided by PMU would help in understanding the controller interactions and getting insights into their features. The PMUs need to be placed at AC-DC boundary and converter transformer or coupling transformer. With more numbers of power electronic devices in grid, it is possible that sub-synchronous resonance may be observed at various locations.. The reporting rates of samples need to be higher to capture the SSR phenomenon. Hence PMUs having ability to measure SSR frequencies can be installed at strategically locations.

   Elements to be covered:

(i) At Both ends of Inter connecting lines between HVDC side AC switchyard with connecting AC Sub Station.
(ii) All Converter Transformer (HV side)
(iii) At STATCOM/SVC station Coupling Transformer (LV & HV sides) including the individual STATCOM/SVC.

3. **Renewable Energy Generation Pooling points**: The RE generation is coming across all Indian power system at very fast pace, the monitoring of RE generation is very important considering must-run status of this generation. RE based generation are required, by CEA Technical Standards of Connectivity to the Grid, to perform various dynamic performances such as LVRT, HVRT etc. The performance can be assessed better if high resolution data will be available and PMU placement at low voltage side of transformer at pooling station would help in providing that.

   With Upcoming Ultra Mega Green Solar Power Project integrations in EHV grid, change in angle variations are expected on existing transmission system and the consequences in respect to operating constraints in evacuations especially in pockets where concentrated Renewable Generation. Moreover, these changes occur very fast due to the inherent intermittency of RE sources, particularly wind and solar, as well as other associated weather influences. As a sample case, in Western Region, Rewa Solar Park has an Installed Capacity of 750 MW, and the

angular separation pattern is closely following the Solar Generation pattern as shown
below:

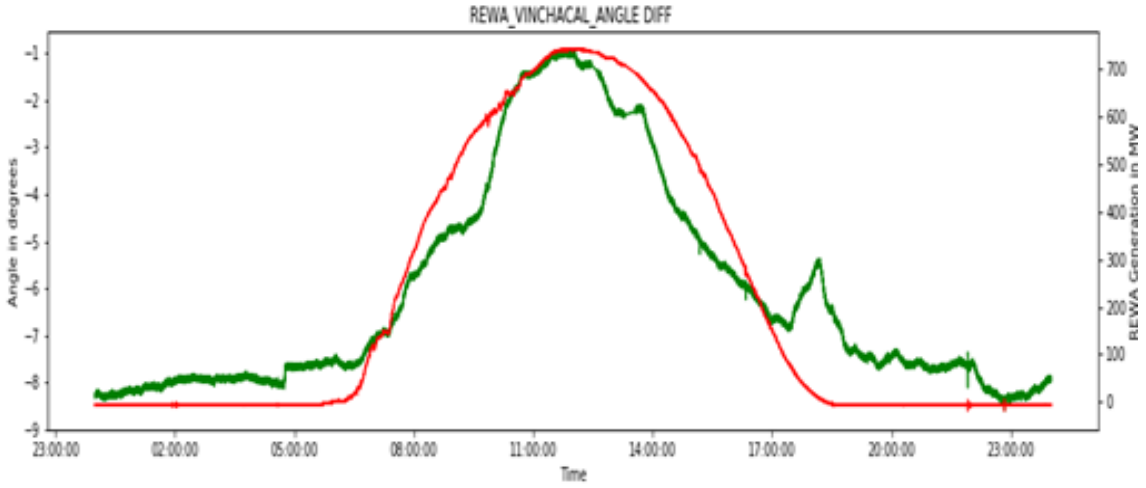


Figure: REWA Solar UMPP Angular Difference Correlation with Solar Generation

There is a variation of about 8 degrees is observed in the between Rewa and Vindyachal nodes in the span of three hours. This emphasises the importance of PMU data at solar stations. Currently PMUs are installed at 400 kV side only however PMUs are equally important at 220 kV level as well.

Elements to be Covered:

(i) On all outgoing feeders including bus sectionalizer or tie line between two stages of generating stations having different tariffs or different ownership or both
(ii) High Voltage (HV) side & Low Voltage side of Transformers
(iii) Reactive Power sources & Sinks shall be measured through Synchrophasor
(iv) All CB and isolators shall be wired to Synchrophasor device as digital signals.

4. **Islanding, Separation & Restoration:** The expected benefits from PMU installations at strategic locations include early detection of islanding conditions and remedial action by SPS (special protection scheme). Key placements can assistance with the restoration process, and resynchronization back into the main grid. Black-start investigations of alternative system configurations, including operation of transmission lines at reduced voltages with bypassing of transformers are enabled with detailed phasor measurements of potential overvoltage locations. Similarly, the PMU data can be utilized for resynchronization with data for bus and line voltage magnitude and angle along-with frequency.

Elements to be Covered: At both ends of line connected black start stations or

restoration path lines (both ends including CB and isolators).

5. **State Estimation errors:** The observability of the complete system is very important therefore, the locations where the state estimation errors are high and continuously show such behavior may be the candidate locations**.**

   Further, during URTDSM Phase-I, PMUs are envisaged only on 400 kV and 765 kV lines only. Linear State Estimator (LSE) application developed by IITB and installed under URTDSM Phase-I at various control centre i.e. RLDCs/NLDC/SLDC. After the configuration and setting up of linear state estimator, it is observed that two islands are being formed for each voltage level (400 kV & 765 kV). To avoid multiple network islands, PMU should also be placed on Interconnecting Transformers (ICT) at EHV level

   Elements to be Covered:

   a) Substation shall have Three phase Bus voltage measurements through PMUs & Circuit breakers and isolator position shall be wired to PMU for Linear State Estimator for topology processing and full observability.
   b) Reactive Power sources & Sinks shall be measured through Synchrophasor to avoid MVAR mismatch in Linear State Estimation.
   c) All 765/400 kV, 400/220 kV Inter Connecting Transformers (ICT) should have PMU on both sides (LV & HV).

6. **Power Flow Gates:** The high-power corridors after large generating complexes like Sikkim hydro, Mundra UMPP, Vindhyachal-Sasan-Rihand complex etc. The power flow on these gates need to be monitored therefore the lines emanating from these complexes can have PMU placement.

7. **Major load centers:** Load models are important for off-line stability studies as well as real time monitoring. It is difficult from simulation programs models to select a proportion of load to be of induction motor type. In addition, electronic load is growing whereas incandescent lighting (resistive load) is decreasing. However, load simulation programs do not often reflect the changing nature of power loads with respect to changes in the electrical behavior and penetration of power electronic devices. While PMUs placed at load centers will not reveal changes in the makeup of loads, they can reveal changes in the electrical characteristics and behavior of aggregated loads. PMUs should be installed at appropriate radial load feeding substations so that the load sensitivities to system frequency and voltage changes can be monitored. FIDVR (Fault Induced Delayed Voltage Recovery) based events can be better analysed.

8. **Angular Difference monitoring locations:** Phase angle difference is directly correlated with system stress, and can be used as a strategic measurement of grid

security both pre- and post- contingency. For improved wide-area phase angle difference monitoring and situational awareness, it is useful to monitor the angle difference across major transmission interfaces across the grid, including both on a local- and wide-area basis. These interfaces are defined by key stress patterns driving the need to monitor these interfaces. The PMUs which will be the most valuable for angle difference monitoring need to be identified for PMU placement.

9. **Major Generating Stations**: In a generation station, it is desirable to measure all the line currents (including the step-up transformer) and both the high-side and low-side voltages. The PMU placement at these locations in generators will provide good insights into governor frequency control, excitation control, PSS tuning etc.

   In order to confirm the mathematical model correctness used for simulation studies, model validation using PMU data plays a key role. International grid standards like NERC Reliability standards requirements have accepted Synchrophasor based model validation as an effective way to verify generator real and reactive power capability and control systems and assure their appropriate responses during system disturbances. Synchro phasor-based model validation is more economical and accurate than validation methods that take the model off-line for performance testing.

   Hence placement of PMUs on GT LV side for thermal/gas/nuclear based generation for 132kV and above generating station is required/recommended.

   Elements to be covered:

   (i) At 400 kV and above Generating stations (132 kV in case of NER).

   (ii) Individual Unit of rating 200MW and above for Coal/lignite, 50MW and above for gas turbine and 25 MW and above for Hydro units shall have PMU placed at the terminals of the generator(s) at either the HV or LV side of the Generator Transformers.

   (iii) In case of plant having multiple units ,PMU can be placed on 50 percent of the units

10. **System Protection Scheme monitoring:** The monitoring of the inputs for SPS activation is also very important; it can also help in validating the accuracy of SPS action. SPS operation can be very well validated using the PMU data. Therefore, all the points where SPS based scheme inputs are derived may be allocated PMUs.

11. **Experience based locations known for small signal stability related issues**: The nodes in the grid which have in history observed the cases of Low frequency Oscillations negative damping, Ferro resonance, Sub-synchronous resonance, out

of step protection etc. shall be considered for PMU placement. A high-resolution data capturing may be recommended for such PMUs.

Annexure - VII

The details of analytics suggested by CTU

1. Real time Automated Event Analysis tool (using AI, Machine learning and big data)
   Tool for making an automated event driven dashboard comprises of Notification of event, type of fault and characteristics of the event, display of event location (indicating PMU Location) on Grid map, Drill down capability with additional displays for each type of event. It should have machine learning capabilities and it should identify and display historical events of similar nature and gives information related to operator action taken on past events.
2. Event monitoring for early warning system (using AI, Machine learning and Big data)
   It detects events and slow trends in PMU measurements. This will assist system operators in a.) Identifying stress levels in both apparatus and system, b.) Provide guidance towards meaningful real time contingency selection and analysis, c.) Provide easy summary reports for case study preparation, post event analysis and archival purposes.
3. WAMS based contingency analysis and static security assessment
   Static security assessment tool improves operator assist feature of grid monitoring and makes it adaptive and interactive. This tool is meant to provide and perform what-if simulations and integrate power of data mining with intuition and insights of operators. This will help in improving grid operation efficacy.
4. Oscillation Source location
   This tool is required to identify, detect, and locate Oscillations, present in the grid. It shall have capability to monitor multiple oscillation modes simultaneously in real time. It shall Identify the source of the oscillation and display in unified real time dashboard to take corrective action.
5. Response of Windfarm and solar PV farms for LVRT, reactive power etc.
   With integration of large windfarms and solar PV farms at EHV levels these analytics assumes big importance. The grid code requires that these farms provide low voltage ride through (LVRT) features and also some kind of reactive power support during faults in the neighboring transmission network. With PMU measurements the adherence to grid code can be verified in real operating conditions (not just lab environment) and over complete life of the windfarms. If any problems or mismatch in performance is observed, it can be rectified early.
6. Control of HVDC and STATCOM for damping system oscillations
   This is the usage of WAMS measurements for actual automatic control applications. This was one of the original thoughts behind going for WAMS installation. The power system oscillations that originate in a post fault event or spontaneous oscillations can be damped quickly using controllers of HVDC and FACTS (like STATCON) devices. It improves the overall transfer capacity of a power corridor. Lot of actual projects are now under operation in the USA and China. India must take up such projects for capacity building for the future.

Annexure I

URTDSM Applications Required in Indian Power System		
S.No.	**Application Name**	**Used in**
1	Voltage Stability Monitoring: Measurement based dynamics provide voltage sensitivities; monitoring of key corridors or load pockets; scatter plots for power-voltage and power-angle monitoring.	Austrian Power Grid, Red Electrica de Espana
2	Detection of disturbances: Recognition of short circuits by watching the currents, and indication of loss of load, or loss of generation by watching the frequencies.	Red Electrica de Espana, FINGRID
3	Online monitoring of Inertia.	AEMO
4	Identification of source of Oscillation.	ISO New England
5	Identification of stressed corridors	-
6	ROCOF calculation over variable window	WECC
7	Island identification/detection	MISO, Red Electrica de Espana, Swissgrid, North American power grid
8	Locating contributions to poorly damped or unstable oscillations	WECC
9	Model Validation	MISO , Austrian Power Grid, GCC Interconnection Authority
10	Higher frequency sub-synchronous oscillation analysis and early warning of resonance	-
11	Big Data Analytics	-

Note: 1

POWERGRID is in view that Philosophy for PMU location as decided in Joint meeting of all the five Regional Standing committee meeting held on 5th March 2012 should not be altered as the panel of expert constituted on URTDSM Project recommended the same. The panel having renowned International and National experts from IIT Kanpur, NIST etc. under the chair of Dr. Arun G. Phadke. Moreover, the present sub-committee should provide direction for including 'additional' PMUs as desired by system operator based on their feedback. In the sub-committee meeting held on 14-09-2022, CTUIL also expressed similar views.

The present recommendation of sub-committee for minimum location of PMUs (as mentioned in Clause 6.4(d) shall be also challenging in implementation, as there would be need for maintaining transmission lines database at central level by designated nodal agency on which PMU has been already installed at one end under different schemes/packages/TBCB projects etc. by different implementation agencies. There would be issue in finalising PMU Bill of Quantities as both end of line bays may be implemented by different agency under different schemes/packages/TBCB projects etc. This would lead to further delay in executing these projects.

The Section 4.2 and Clause 6.4(e)-vii describing analytics under phase-I may not represent complete picture. The Analytics such as VADR and Supervised Zone-3 analytics are not inherently designed for protection class. The VADR detects and logs conditions of power swings and load encroachment and does not that of fault condition. The Supervised Zone-3 analytics can issue block signal in above conditions if closed loop control is implemented in field otherwise the generation of block signal shall be logged for operators for further analysis. The above scenarios (power swings and load encroachment) which are dealt by these two analytics generally appears to the candidate relay 'after' the fault. In addition, PMU data frequency under URTDSM project (25 samples/second) also does not envisage enough samples (only 2-3 samples during fault) to do any fault duration analysis. Hence, the same principal is utilised by IITB in designing analytical applications. Further, alternate methods have been developed in the Line parameter estimation and CT/CVT calibration to decouple their inter dependencies.

As per Clause 6.4(d)-xii, Fiber Optic should be covered under Phase – II for all the above locations of the URTDSM project. However, Separate project shall be allocated for installing OPGW required for URTDSM Phase II. Further, the analytics recommended for phase-II in the report may require additional deliberation to access the feasibility for implementation, data requirement and solution available in the market.

It may be also noted that the Quantity of PMUs required in line with recommendations of this report for the URTDSM Project Phase – II, Clause 6.4(d) may require upgradation of existing URTDSM control centre equipment. The same may also be included in the project at this stage itself, as it may need additional planning/design/execution time.

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