MINUTES OF SEVENTEENTH MEETING OF "TECHNICAL COMMITTEE FOR IMPLEMENTATION OF FRAMEWORK ON RENEWABLES AT THE STATE LEVEL"

Venue	:	Upper Ground Floor, CERC New Delhi
Date	:	12-01-2018
List of Participants	:	At **Annexure – 1(Enclosed)**

1. The Seventeenth meeting of Technical Committee on Implementation of Framework for Renewables at the State level was held under the Chairmanship of Shri A. S Bakshi, Member, CERC on 12th January 2018. Shri Bakshi welcomed all the participants and the special invitees.

2. Ms. Shruti Deorah, Advisor- RE, CERC, welcomed all participants on behalf of the FOR Secretariat. She apprised the Committee of the actions taken since the 16th Meeting. Specifically, she updated the participants that- (i) Telangana State Commission invited Shri B.B Mehta, Chief (Engg.), Gujarat SLDC for exchange of information, best practices and additional initiatives undertaken by Gujarat SLDC beyond the recommendations of SAMAST report. A note from Gujarat SLDC is still awaited on the same. The presentation format used by Gujarat SLDC, which was well appreciated at the last Technical Committee meeting, was also shared with members of the Committee along with the meeting minutes. (ii) A Sample Agreement on QCA was received from Gujarat SLDC which was shared with Shri Preman Dinarajan, Chairperson, KSERC. Shri Dinarajan conveyed that he is re-drafting the model agreement which once complete can be shared with other members of the Committee for their comments. (iii) Draft Report on 5-Minutes Scheduling, Metering, Accounting and Settlement has been prepared and shared with the RPCs for their feedback/comments. The final report will be shared after incorporating their feedback/comments. (iv) FOR has to send letters to all State Commissions requesting for higher participation in specialist courses for SLDC officials. POSOCO has shared a note with CERC and the Secretaries of all State Commissions detailing about the same. (v) Meeting to discuss revisions to technical standards of meters to be held soon by the FOR Secretariat.

3. Dr. Sushanta.K.Chatterjee, Joint Chief (RA), CERC welcomed all the participants and gave a highlight of all the agenda items scheduled for the meeting.

<u>Discussions on the Agenda</u>

1. Agenda Item No. 1: Status of implementation of SAMAST Report

- **Update by Consultant for Haryana, Punjab & West Bengal**

- **Update in respect of other States by respective Members**

a. The Consultant (Idam Infra) made a presentation (Annexure-II) on the status of implementation of SAMAST in West Bengal, Haryana and Punjab.

b. **West Bengal:** The consultant apprised the Committee that the management of WBSEDCL has approved the DPR for SAMAST implementation in West Bengal and submitted the same to Appraisal Committee to avail grant/funding support through PSDF. The cost estimates that have been built in the DPR were presented. The total estimated cost is about Rs. 26 Cr which includes the Hardware – Metering infrastructure, Software, Communication Components, Training & Capacity building.

c. **Haryana:** The Consultant briefed the Committee that they had circulated draft DPR to HVPNL based on inputs provided by HVPNL. HVPNL is currently vetting draft DPR for approval from their management. The Consultant also presented the salient features of budgetary cost estimates of DPR for SAMAST implementation in Haryana. The total estimated cost is about Rs. 31.82 Cr which includes the Hardware – Metering infrastructure, Software, Communication Components, Training & Capacity building.

d. **Punjab:** The Consultant highlighted that they have circulated the draft templates for budgetary cost estimate and sample DPR template to Punjab SLDC. For Punjab, recommendations include undertaking mapping of all grid lines, revising the definition of pooling stations, placing of meters and interface points etc. Punjab SLDC is preparing inputs to DPR for SAMAST implementation in Punjab.

e. **Kerala:** Kerala Chairperson updated the Committee that the State has taken several steps as prescribed in SAMAST report, such as ToD metering. He said that a meeting with SLDC was held last month wherein it was concluded that upgradation of software is required, along with communication infrastructure and other hardware. Initial estimate received is 53 crores in total (including remote sites), but the Commission has asked the SLDC to revise the same. Revised DPR is expected by end of January, post which approval of the Board will be received by end of February, and subsequently tendering can be expected by June.

Action points/ Decisions

i) HERC to advise HVPNL to finalize DPR for SAMAST implementation in Haryana after due approval from their management at the earliest.

ii) PSERC to advise the SLDC to prepare and finalize DPR for SAMAST implementation in Punjab at the earliest.

2. **Agenda Item No. 2: Status of implementation of Regulations on Forecasting, Scheduling and Deviation Settlement**

a. The Consultant (Idam Infra) made a presentation (Annexure-II) on the status of implementation of Regulations on Forecasting, Scheduling and Deviation Settlement in Tamil Nadu, Punjab, Haryana and Telangana.

b. **Tamil Nadu:** - The consultant updated that TNERC has published draft F&S and DSM Regulations on 27.12.2017 for public comments, last date for submission of comments on the said Regulations is 27.1.2018. TNERC would finalize Regulations after discussion/ addressing public comments on the said Regulations.

c. **Punjab:** The Consultant briefed the Committee that they have shared draft F&S Regulations to PSERC and the Consultant attended various discussions at PSERC, Chandigarh. PSERC shall publish draft F&S Regulations after due regulatory process.

d. **Haryana:** The Consultant apprised the Committee that draft Scheduling & Despatch code for Haryana, draft F&S and DSM Regulations have been shared with HERC. HERC is in the process of finalizing draft F&S Regulations for public consultation process.

e. **Telangana:** The Consultant updated the Committee that draft F&S Regulations of Telangana had been circulated and the same was discussed with TSERC and TSLDC at Hyderabad. TSERC is planning to publish draft F&S Regulations for public consultation process soon.

f. Shri Bakshi also stated that the Consultant should assist other states (States other than those represented in the Technical Committee) as well for implementation of SAMAST framework, which was endorsed by all the members of the technical committee. The consultant highlighted that this would require expansion of their scope/mandate with USAID.

<u>Action points/ Decisions</u>

i) TNERC would finalize draft F&S Regulations after addressing public comments.

ii) It was decided that PSERC, HERC and TSERC shall publish draft F&S Regulations for public consultation process at the earliest possible.

iii) Subsequent to the meeting, Punjab & Haryana have published the Draft F&S Regulations for consultation. PSERC has invited comments till 22nd Feb and HERC has invited comments till 12th Feb 2018.

iv) As regards expansion of the scope/mandate of the consultant, USAID representative stated that this can be considered by them.

3. **Agenda Item No. 3: Presentation on Report (Volume-I) of Expert Group to review and suggest measures for bringing power system operation closer to National Reference Frequency**

a. Shri S. Narasimhan, of POSOCO made a presentation (Annexure- III) on the Report (Volume-I) of the Expert Group on Reference Frequency (constituted by CERC), to review and suggest measures for bringing power system operation closer to National Reference Frequency.

He apprised the committee about the background of the Expert Group, its TOR and the activities undertaken by the group.

b. Experience of grid operation in context of frequency control was shared. Various regulations that have helped tighten grid frequency over time were highlighted. Specifically, the status of Under Frequency Load Shedding (UFLS) relays and df/dt relays was also highlighted. Further, a comparison of Indian power system with that of other large power systems like Continental Europe in the context of frequency management was presented.

c. Reliability Standards of North America under BAL series were discussed regarding Primary Response, Secondary Control and Contingency/Supplemental Reserves. It was underscored that Primary response is a mandatory service there, however, California ISO has done some simulations under some high RE penetration scenario and was unable to get desired results for Primary response. CAISO submitted a proposal to Federal Energy Regulatory Commission (FERC) to procure Primary Response from market and the same was approved.

d. The Schematic of Reserves, Balancing and Frequency Control Continuum in India, as presented in the report, was discussed. Further, the aspects of Inertia monitoring with increased penetration of RE, status of Primary frequency response, Secondary frequency control with the backdrop of CERC's AGC order and Tertiary frequency control were deliberated.

e. The recommendations of the report, as reproduced below, were presented before the committee:

a. Primary Control
   - RGMO to be phased out
   - Dead band of +/-0.03 Hz to be phased out
   - Penalty for providing less primary response

b. Secondary Control
   - Implementation of AGC
   - ACE Monitoring

c. Tertiary Control

- Expanding the ambit of RRAS
- Ancillary Service Performance Metrics
- Fast Tertiary Control from Hydro

d. General
- 50 Hz Reference Frequency
- Tightening of Frequency Band
- Operationalising Reserves
- Inertia Monitoring in real time
- Introduction of Time Error Concept

Decisions

i) The Committee members decided to request RPC to share the UFLS & df/dt relays testing programs with Regulators. RPCs should also share the report of relays testing at least once in 3 years.

ii) Regarding Inertia monitoring and benchmarking, a discussion paper is to be prepared by POSOCO and shared with the Technical Committee. This report shall address inter-alia the issue of declining inertia in the system due to higher penetration of renewables, and how RE plants may be enabled to provide inertia.

iii) States should align their respective Grid Codes as per the suggestions and recommendations of the report.

4. Agenda Item No. 4: Update on Technical Assistance program by World Bank on Regulatory Interventions in Solar Rooftop Sector

Discussion

a. As a part of the Technical Assistance (TA) program to SBI, World Bank Grid connected Rooftop solar PV (GRPV) program, World Bank/E&Y held discussions with CERC and FOR on various issues which need to be addressed and regulatory interventions to be taken to ensure accelerated deployment of GRPV across States. Therefore, as part of these discussions, the development of Comprehensive Metering Regulations & Accounting Framework of GRPV deployment in India was proposed.

b. E&Y presented (Annexure-IV) on Comprehensive Metering Regulations & Accounting Framework of Grid Connected Rooftop PV deployment in India. The presentation touched upon various aspects of FOR's Draft Model Regulations for Rooftop Solar Grid Interactive systems based on Net Metering, its interpretations and adoption by various States and the implementation challenges of such rooftop projects at the State level.

c. The issues of 'Capacity Cap on DTs', 'Capacity Cap of System' and Definition of 'Eligible Consumer' were discussed in detail. It was highlighted that different States have notified different Capacity Cap on DTs & System and the Capacity Cap of '15% of peak DT capacity', as provided in the Model regulations needs to be scientifically evaluated.

d. Further, the key implementation challenges like Energy Accounting & Commercial Arrangements, interconnection Arrangements, Meters standardization and procurement etc were discussed. Shri R. N Sen, Chairperson, WBERC suggested that any kind of capital subsidy for implementation of rooftop projects should be provided to the DISCOMs as this approach will be more effective and efficient instead of providing subsidy to the consumer/user. He recommended that the DISCOM can use the subsidy to provide requisite infrastructure without any constraints to the end consumer.

e. Case studies covering key observations of Operational, Technical, Policy, Regulatory and Financial challenges of Jaipur Vidyut Vitran Nigam Limited(JVVNL) and Tata Power Mumbai were also deliberated.

f. To address these issues and challenges, Approach & Methodology as indicated below was presented:

g. E&Y requested the participants to provide their feedback on the approach used by them so that in case of any gaps, the same can be plugged. Further, they informed that the Draft Report will be prepared in 2 months and the Draft Regulations in a period of 6 months. Dr. Chatterjee proposed to include issues pertaining to Net Metering, Gross metering, RESCO model and also suggested to visit various States to understand State specific challenges.

5. Agenda Item No. 5: Discussion On Next Steps On NARUC's Assistance to FOR Technical Committee

Discussion

a. Ms. Monali Hazra, Program Management Specialist – USAID along with Lakshmi Alagappan, Director, E3 presented (Annexure V) on the National Association of

Regulatory Utility Commissioners (NARUC) assistance to the FOR Technical Committee. One of the key components of USAID's Greening the Grid (GTG) program, implemented in partnership with the Ministry of Power (MoP), is the US-India Regulatory Partnership. The partnership focuses on supporting peer-to-peer exchanges between U.S and India regulators by providing relevant international experiences and regulatory expertise that can help India meet its 175 GW renewable energy target. NARUC, USAID's implementing partner for this component of GTG, has a Memorandum of Understanding (MOU) with the Indian Forum of Regulators (FOR) for this purpose.

b. As a part of this partnership, NARUC with assistance from E3 (US based Energy Consulting Firm), will be developing a report highlighting international experiences on structures of contracts in different market models and suggest alternatives for India in the light of emerging market realities in the country.

c. Ms. Lakshmi highlighted that from Jan 8-12, 2018, NARUC/E3 team interacted with various Stakeholders like, CERC, GERC, CEA, POSOCO, SLDCs, DISCOMs, Generators, and Academicians etc. The purpose of these interactions was to identify the key questions/concerns of each stakeholder which needs to be addressed in the final report.

d. Dr. Chatterjee underscored that with the ingress of high renewables and various other programs like Energy Conservation, Energy Efficiency, Demand Response etc, future contracts may not be same as what have been happening in the past. This transition phase will lead to change the way contracting is being done and there is need to explore the option of Financial Contracts & Contract for Differences also.

e. Further, Ms. Lakshmi provided the timeline to finalize the report. She highlighted that the Scoping Visit to various stakeholders has been completed and the First draft of the report with First Regulatory Exchange will be finalized by April 2018. The Second draft, after incorporating feedback from the stakeholders will be prepared by June 2018 and the Final Guidelines will be prepared by Aug 2018.

f. Ms. Monali requested all the members of the Technical Committee to provide their feedback on the outline structure as well as the questions that the report will plan to address. This feedback may be shared directly with USAID team, with a copy to FOR Secretariat.

g. Shri Bakshi mentioned that more states are requesting assistance from the Consultant in formulating F&S and DSM Regulations, and preparation of DPR for SAMAST. Representative of the Consultant stated that this needs expansion of ambit of the consulting agreement, and further financial assistance. USAID

concurred to provide the required assistance to the Technical Committee by broadening the scope of the agreement with the Consultant.

6. Agenda Item No. 6: Presentation by Special Invitee – REConnect Energy on Practical aspects & learning from implementation of QCA Model and Forecasting & Scheduling framework in various States

Discussion

a. Sh. Vibhav Nuwal, Director – REConnect Energy presented on practical aspects & learning from implementation of QCA Model and Forecasting & Scheduling framework in various States (Annexure VI).

b. He highlighted that REConnect is working as a QCA in Karnataka & Rajasthan and is handling capacity of about 2850 MW and 2800MW respectively. They are also engaged with Gujarat & MP SLDC for forecasting. He explained the working of forecasting models and how the end results are produced.

c. Further, general roles & responsibilities, scope and requirements to be a QCA were presented. It was underscored that Penalties for forecasting error are yet to be implemented; De-pooling activities have not started yet.

d. It was informed that as QCA, the Scheduling in Rajasthan is done at each pooling station level while in Karnataka, a single aggregate schedule is given for all the pooling stations under the management of a QCA.

e. DSM impact for real time data availability was reported to be between Rs. 1-2.5/ unit, while with aggregation this impact drops to very minimal.

f. Case Studies of Karnataka, with analysis of 9 months data for a wind project of 120MW were shared. The data represented improvement in forecasting error over a period of time as the algorithm learnt, and with the availability of real-time data.

g. The challenges faced by a QCA were also shared. It was highlighted that many States which have finalized the F&S regulations do not sanction any punitive action to enable enforcement of the regulations, if they are not complied with. One exception was of Rajasthan where the regulations allow disconnecting the plant from grid if it is not complying with the said regulations.

h. In addition, it was observed that availability of meter data and streamlining of communication protocols need to be worked upon. Shri Baba underscored that the issues and challenges faced by a QCA have been addressed in the architecture of REMC.

Decisions

i) RE Connect to meet with POSOCO and discuss insights from the data, which can then be presented at the Technical Committee meeting.

Annexure-1

LIST OF PARTICIPANTS AT THE SEVENTEENTH MEETING OF THE TECHNICAL COMMITTEE FOR "IMPLEMENTATION OF FRAMEWORK ON RENEWABLES AT THE STATE LEVEL" HELD ON 12.01.2018 AT CERC, NEW DELHI

1	Shri. A. S. Bakshi, Member	CERC
2	Dr. M.K Iyer, Member	CERC
3	Shri Ismail Ali Khan, Chairperson	TSERC
4	Shri S. Akshaykumar, Chairperson	TNERC
5	Shri Preman Dinaraj, Chairperson	KSERC
6	Shri R.N. Sen, Chairperson	WBERC
7	Shri Mukul Dhariwal, Member	MPERC
8	Shri S.C. Shrivastava Chief(Engg.)	CERC
9	Shri S.K. Chatterjee, JC(RA)	CERC
10	Ms. Shilpa Agarwal, JC (Engg.)	CERC
11	Ms. Shruti Deorah, Advisor – RE	CERC
12	Shri K.V.S Baba, CEO	POSOCO
13	Shri S. K. Soonee, Advisor	POSOCO
14	Shri S.R. Narasimhan, GM, SysOpen	NLDC, POSOCO
15	Shri K.J.C. Vinod Kumar	EY
16	Shri Yuvaraj Dinesh Babu, Team Leader	EY

17	Shri Priyankar Basu	EY
18	Shri Shuvendu Bose	EY
19	Shri Simon Stolp, Lead Energy Specialist	World Bank
20	Shri Amit Jain	World Bank
21	Shri Hugo Chandler	NRP/Deloitte
22	Shri Shubhanshu Patnaik	USAID-RISE/ DELOITTE
23	Ms. Lakshmi Alagappan	E3/ NARUC
24	Ms. Priya Sreedharan	USAID
25	Ms. Monali Zaya Hazra	USAID
26	Shri Siddharth Arora, RO	CERC
27	Shri Ajit Pandit	Consultant
28	Shri Abhishak Dixit	Consultant
29	Shri Vibhav Nuwal	REConnect Energy
30	Ms. Shruti Jain	REConnect Energy

Idam Infrastructure Advisory Pvt. Ltd.

Agenda Item-1 & 2 (status update on SAMAST implementation and draft F&S/draft DSM Regulations) in Tamil Nadu, Haryana, Punjab, Telangana and West Bengal

For Discussions during 17th Meeting of FOR Technical Committee

January 12, 2018

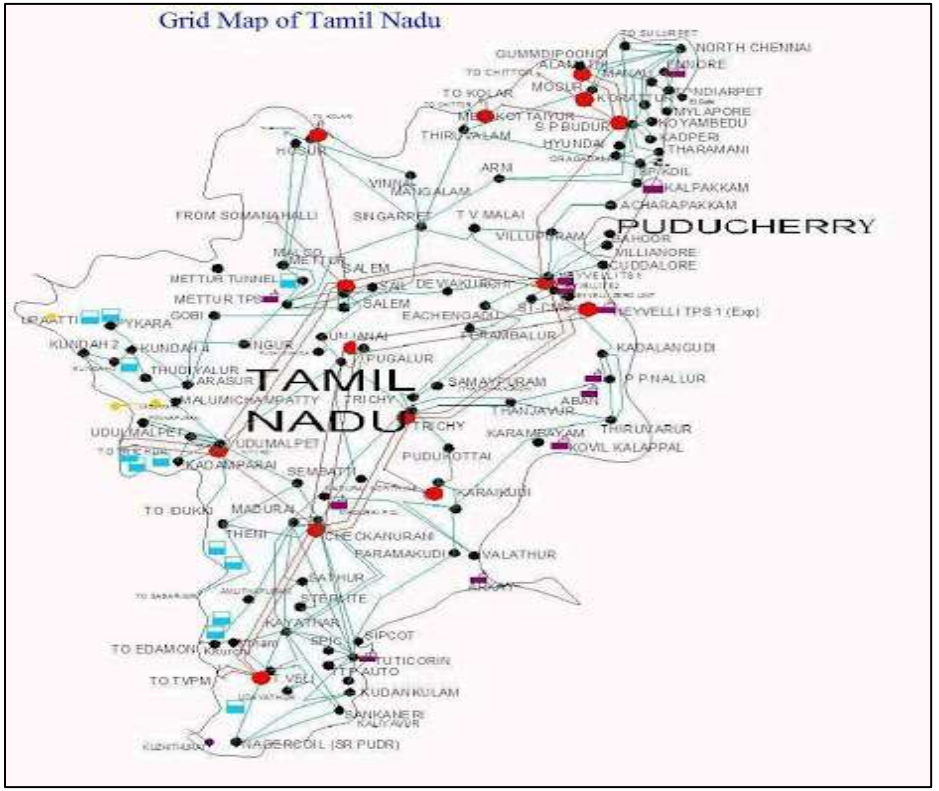
The engagement of Consultant for support to FOR and its Technical Committee is supported under USAID/GTG-RISE initiative through Deloitte.

Overview of Activities for TA support for States during December, 2017

States	Activities
Tamil Nadu	- Draft F&S Regulations - Draft DSM Regulations
Haryana	- Draft F&S Regulations - Draft DSM Regulations - Scheduling & Despatch Code for Haryana - DPR for SAMAST implementation in Haryana
Punjab	- Draft F&S Regulations - DPR for SAMAST implementation in Punjab
Telangana	- Draft F&S Regulations
West Bengal	- DPR for SAMAST implementation in West Bengal

Tamil Nadu

- The Consultant circulated draft F&S and draft DSM Regulations to TNERC.
- The Consultant attended various meeting/ discussions held at TNERC, Chennai with TNERC and TNSLDC
- The Consultant has supported TNERC in preparing and finalizing the draft F&S and draft DSM Regulations upon extensive deliberations and addressing concerns raised by various stakeholders through consultation process.
- After discussions, TNERC has published draft F&S and DSM Regulations on 27.12.2017 for public comments.



Next Steps:

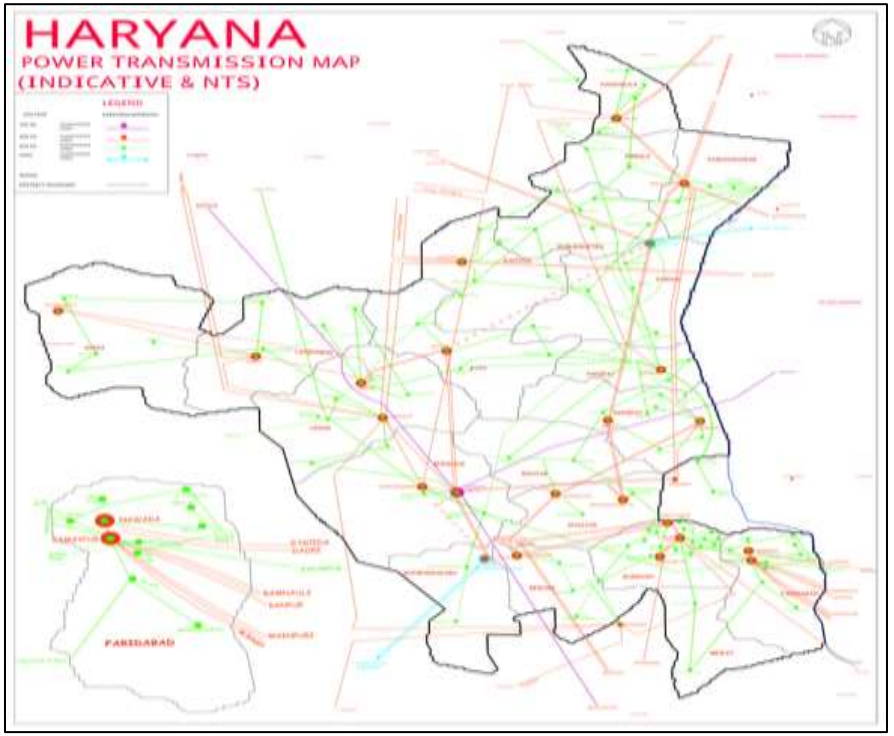
- Public Consultation is in process for finalization of F&S and DSM Regulations
- After Regulatory process draft F&S and DSM Regulations would be finalized

Regulatory Developments:

- Tamil Nadu falls under **Category 'C'** of SAMAST report
- MYT Tariff Regulations, 2005 and its amendments, TNERC MYT Regulation specifies provision determination of Capacity Charge and Energy Charge of generators
- State Electricity Grid Code, 2005 and its amendments
- Grid Connectivity and Intra-State OA Regulations, 2014, specifies treatment to the Deviation of OA generators/ consumers

Haryana ……(1/2)

- The Consultant circulated draft F&S Regulations, draft DSM Regulations and Scheduling & Despatch Code for Haryana to HERC.
- The Consultant attended various discussion/ meetings at HERC, Panchkula with HERC to address the issues/ comments raised by HERC
- During the special meeting of for Punjab and Haryana held on 22nd Dec 2017 at Delhi, HERC Chairman and Member informed that draft F&S and draft DSM Regulations shall be published for public comments shortly.



Next Steps:

- Regulatory process to be initiated by HERC for publishing the draft F&S and DSM Regulations for public consultation

Regulatory Developments:

- Haryana falls under **Category 'B'** of SAMAST report (Deviation Settlement only for Open Access Consumers)
- Generators payment on actual basis
- MYT Tariff Regulations, 2012 specifies determination of Capacity Charge and Energy Charge of generators
- State Electricity Grid Code,2009 and its amendments
- HERC Open Access Regulations 2012, specifies treatment to the Deviation of OA generators/consumers

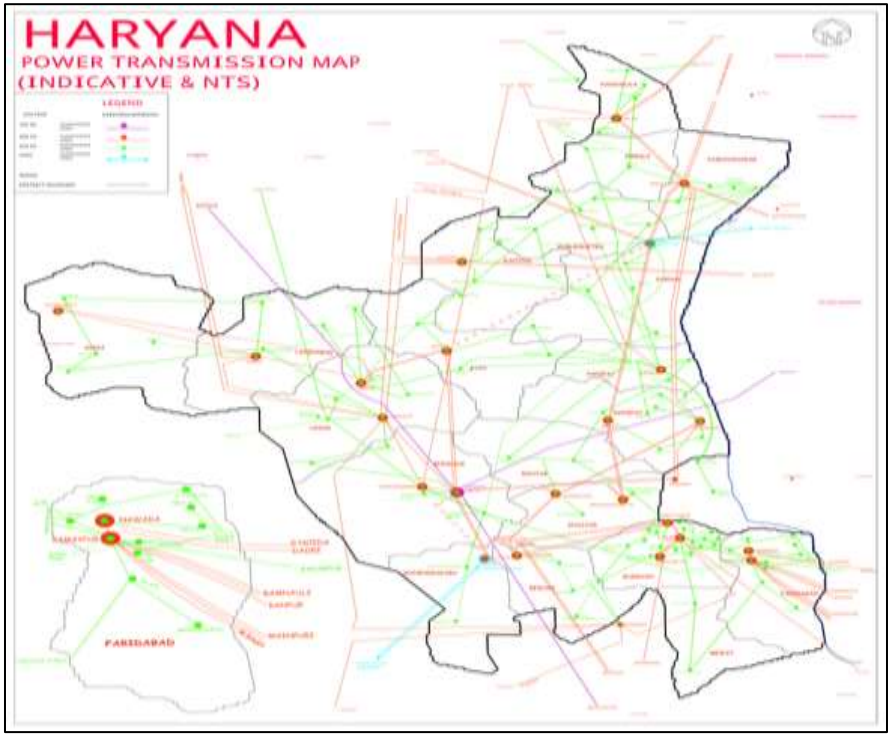
Haryana ….(2/2)

- The Consultant attended various meetings at HERC and Energy Centre, HVPNL (Haryana SLDC), Panchkula to discuss issues faced by SLDC, Haryana in preparation of DPR for SAMAST implementation
- Based on inputs of HVPNL, draft DPR for SAMAST implementation has been circulated to HVPNL
- DPR is pending before HVPNL for their internal approval

Item Description	Cost Estimate (INR Lakh)
Cost-Estimate - Hardware-Metering infrastructure	1,415
Cost-Estimate - Communication Component	629
Cost-Estimate - Software, Hardware-II, Infrastructure, Training & Capacity Building - SAMAST	1,138
COST ESTIMATE GRAND TOTAL	**3,182**

Next Steps:

- Finalisation of DPR by HVPNL Energy Centre is currently underway. Upon management approval, it would be submitted for availing funding support.



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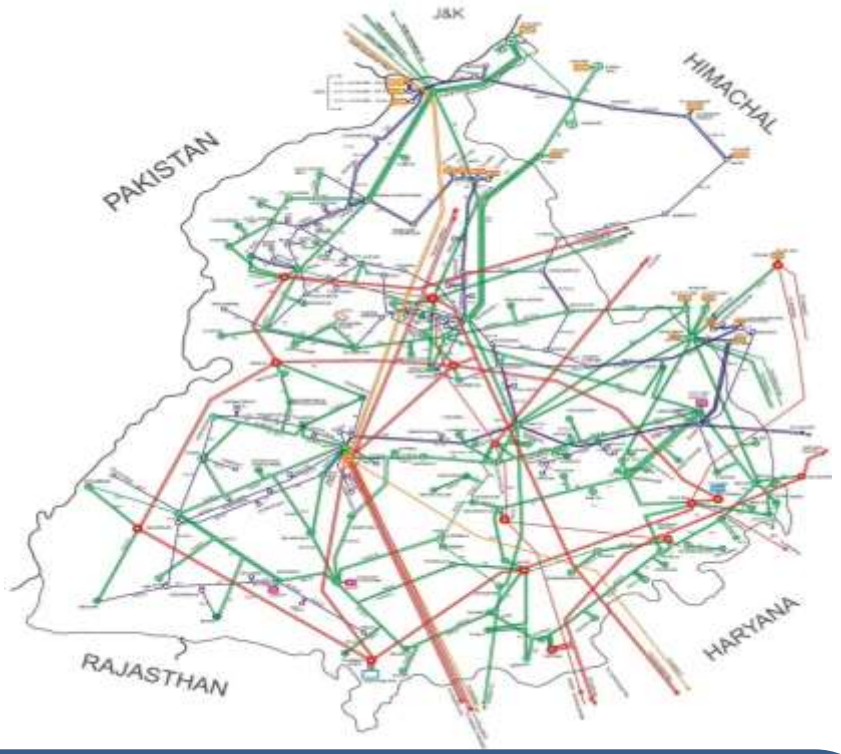
- State Electricity Grid Code,2009 and its amendments
- HERC Open Access Regulations 2012, specifies treatment to the Deviation of OA generators/consumers

Punjab

- The Consultant circulated draft F&S Regulations to PSERC and various discussions took place between PSERC and the Consultant.
- The Commission is in process of publishing draft F&S Regulations for public comments.
- Further, PSERC organized a meeting on 4.1.2018 in which representative of PSTCL, PSPCL and the Consultant were invited.
- The Consultant made presentation on SAMAST implementation in Punjab, after discussions it was agreed that SLDC, Punjab would provide draft DPR for SAMAST implementation.

SLDC	G-T	RES-T	ISTS - InSTS	D-T	HT-T	OA-T	Total
Punjab	64	4	66	407	19	0	**560**



Next Steps:

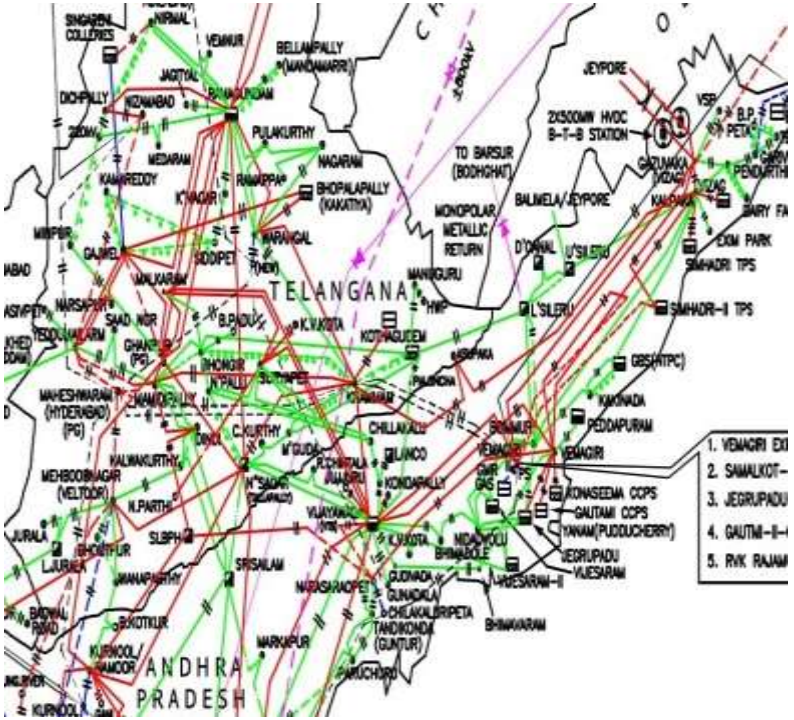
- PSERC is in process for publishing draft F&S Regulations for public consultation process.
- Punjab SLDC is currently seeking inputs and validating the interface points/metering requirements with field.
- DPR preparation by PSTCL/SLDC is currently underway.

Regulatory Developments:

- Punjab falls under **Category 'B'** of SAMAST report
- Generators payment on actual basis
- MYT Regulations, 2014 and its amendments, PSERC MYT Regulation specifies provision determination of Capacity Charge, Energy Charge and Deviation Charges of generators
- State Electricity Grid Code, 2013 and its amendments, specifies Scheduling and Despatch code
- Intra-State Open Access Regulations, 2011 and its amendments, specifies treatment to the Deviation of OA generators/consumers

Telangana

- The Consultant circulated draft F&S Regulations to TSERC and attended meetings/ discussions at TSERC, Hyderabad.
- After addressing comments/ inputs by TSERC, the Consultant circulated revised draft F&S Regulations to TSERC.
- TSERC is in process to publish draft F&S Regulations for public consultation process.



Next Steps:

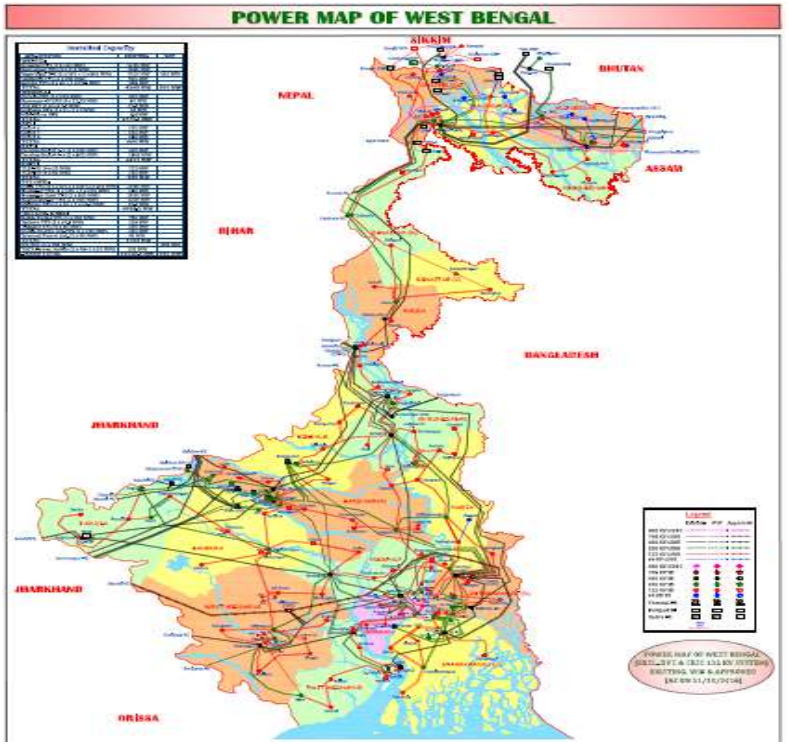
- TSERC is in process to finalize draft F&S Regulations for public comments

Regulatory Developments:

- Telangana falls under **Category 'B'** of SAMAST report
- Generators payment on actual basis
- Intra state DSM is yet to be notified and 15 minute time block has to be fully implemented in Intra state.
- TSERC Grid code is in draft stage

West Bengal

- The Consultant attended various meetings/ discussions held in West Bengal with WBSLDC and WBERC for discussion on the steps required to be taken for implementation of SAMAST
- Draft DPR for SAMAST implementation in West Bengal has been prepared and submitted to WBSLDC for their management approval.
- During the month of December 2017, WBSLDC have finalized the DPR upon due management approval and submitted the same to Appraisal Committee to avail grant/funding support through PSDF.



(INR in lac)

Cost Component	West Bengal
Cost-Estimate - Hardware-Metering infrastructure	1290
Cost-Estimate - Communication Component	213
Cost-Estimate - Software, Hardware-II, Infrastructure, Training & Capacity Building - SAMAST	1093
COST ESTIMATE GRAND TOTAL	**2596**

Next Steps:

- Awaiting response/ comments of Appraisal Committee on DPR submitted by WBSLDC

Regulatory Developments:

- West Bengal falls under **Category 'A'** of SAMAST report
- Generators payment on actual basis
- WBERC Tariff Regulations, 2011 and its amendments, WBERC tariff Regulation specifies provision determination of Capacity Charge and Energy Charge of generators
- State Electricity Grid Code, 2007 and its amendments
- WBERC Open Access Regulations, 2007, specifies treatment to the Deviation of OA generators/consumers

Thank You

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Report
of
Expert Group to review and suggest measures
for
bringing power system operation closer
to
National Reference Frequency
(Volume-I)

केन्द्रीय विद्युत विनियामक आयोग
CENTRAL ELECTRICITY REGULATORY COMMISSION

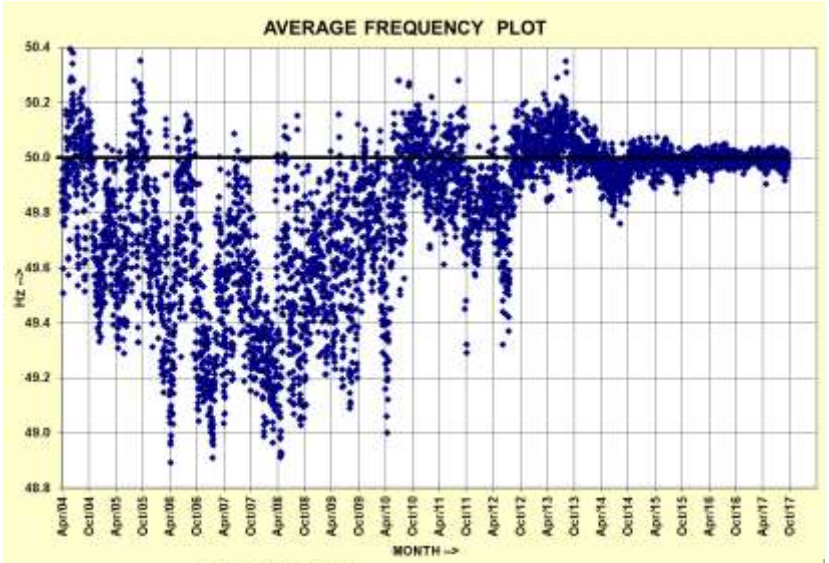
Background

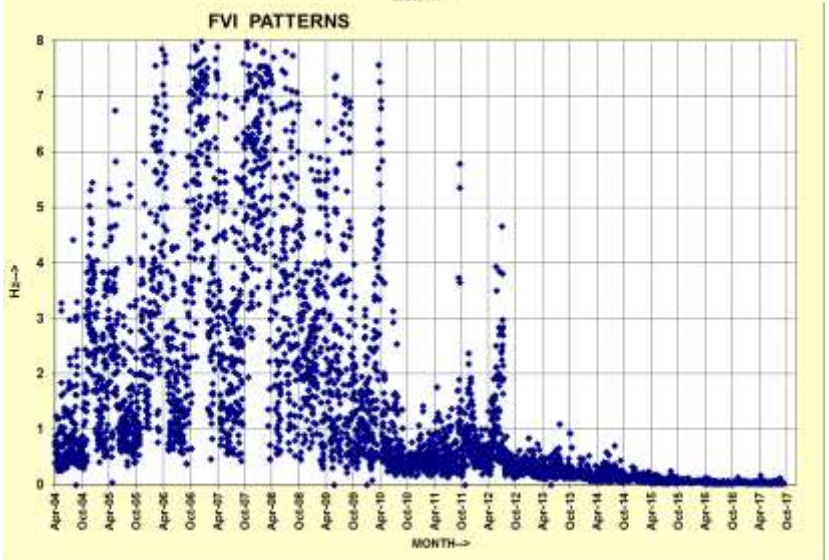
- National reference frequency declared as 50 Hz
  - CERC meeting dated 23rd March 2017
- Constitution of high level expert group
  - CERC Order dated 27th March 2017
  - Representation from CEA, POSOCO, CTU and CERC
- TOR of the expert group
  - Review the experience of grid operation in India.
  - Review international experience and practices on grid operation including standards/requirement of reference frequency.
  - Review the existing operational band of frequency with due regard to the need for safe, secure and reliable operation of the grid.
  - Review the principles of Deviation Settlement Mechanism (DSM) rates, including their linkage with frequency, in the light of the emerging market realities.
  - Any other matter related to above.

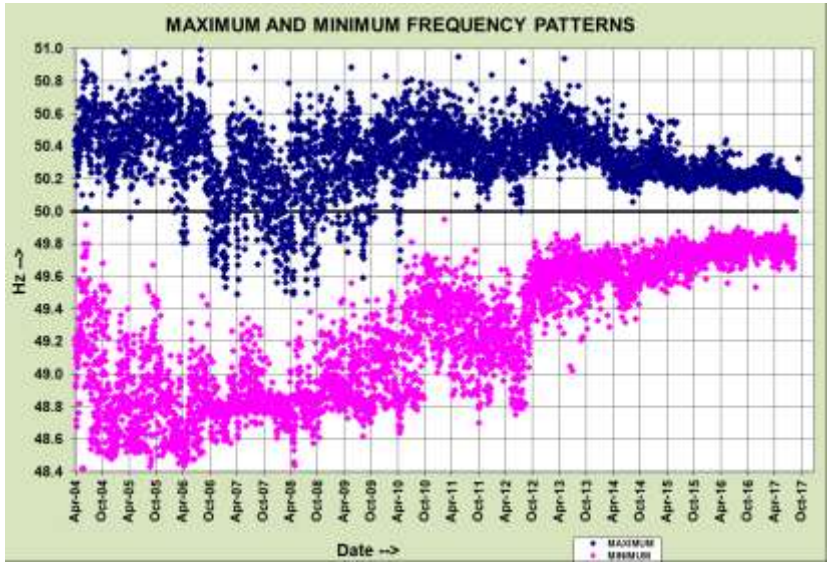
Expert Group Meetings

- 1st Meeting: 9th May 2017, CERC
  - 50Hz may be recognized as National Reference Frequency for power system operation in India.
  - Gradually phase out the Restricted Governor Mode of Operation (RGMO) by 1st April 2018
  - Invitation to academia and international experts
- 2nd Meeting : 16th June 2017, NRLDC
  - Discussion with International experts from PJM and ENTSOE
  - Discussion with Prof Anjan Bose, Washington State University
- 3rd Meeting : 19th July 2017, CERC
  - Discussion on issues related to DSM Charges and Ancillary Services
- 4th Meeting : 03rd November 2017, CERC
  - Review of draft report

Experience of grid operation in the context of frequency control

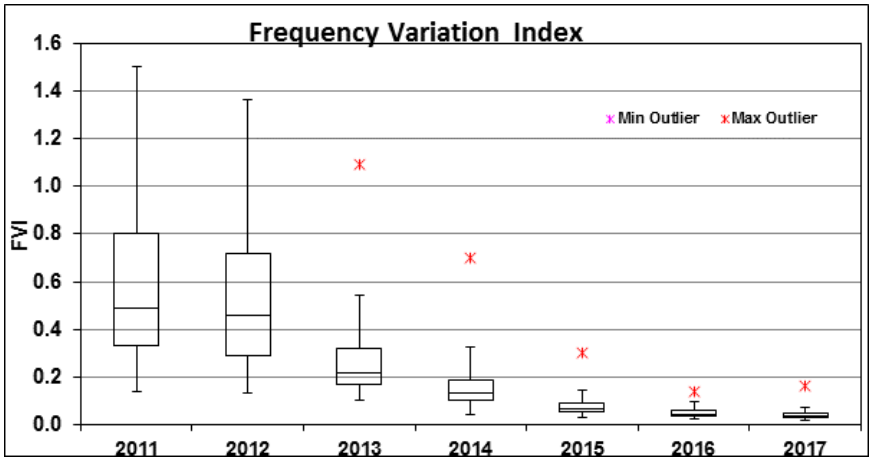


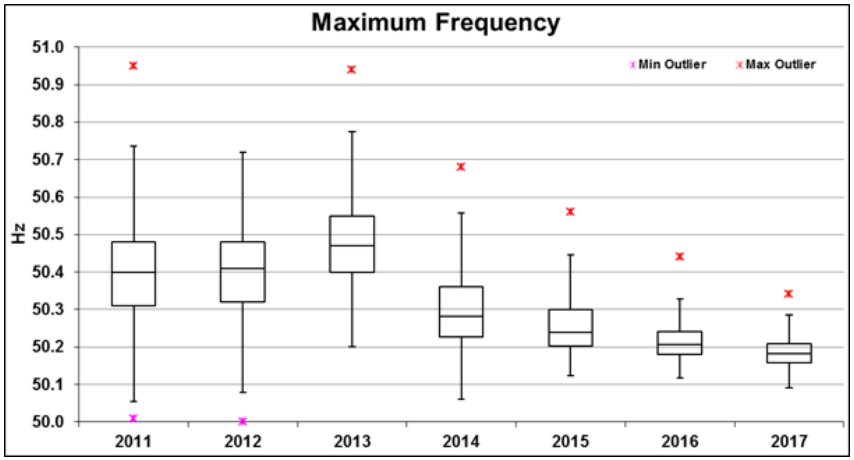


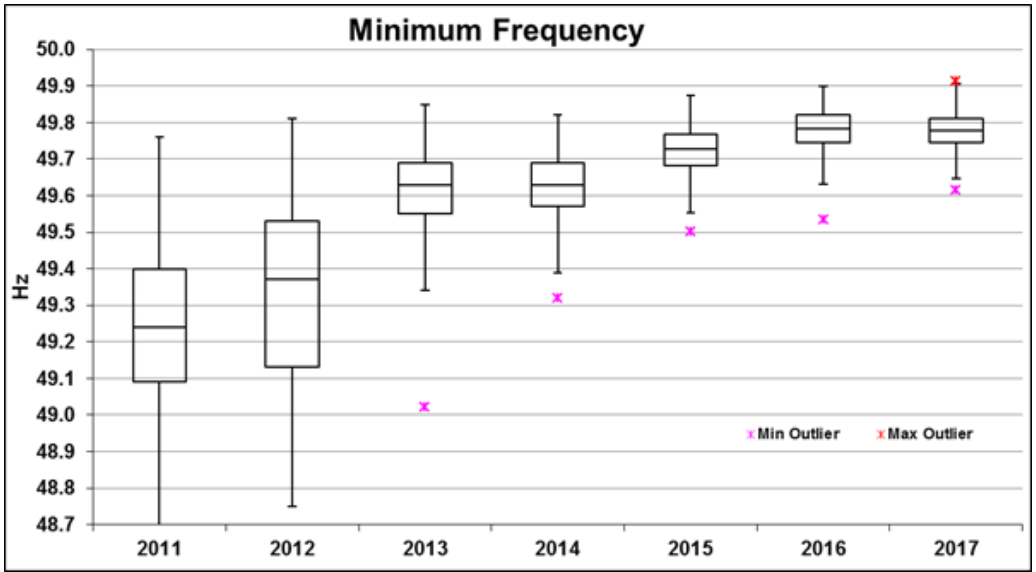


- UFLS relays have not operated in day to day normal operations.
  (Last Operated :24.05.2015; SR Separation)
- Df/dt relays have operated only in case of a major contingency
  (Last Operated : 12.03.2014; UMPP 4000 MW)

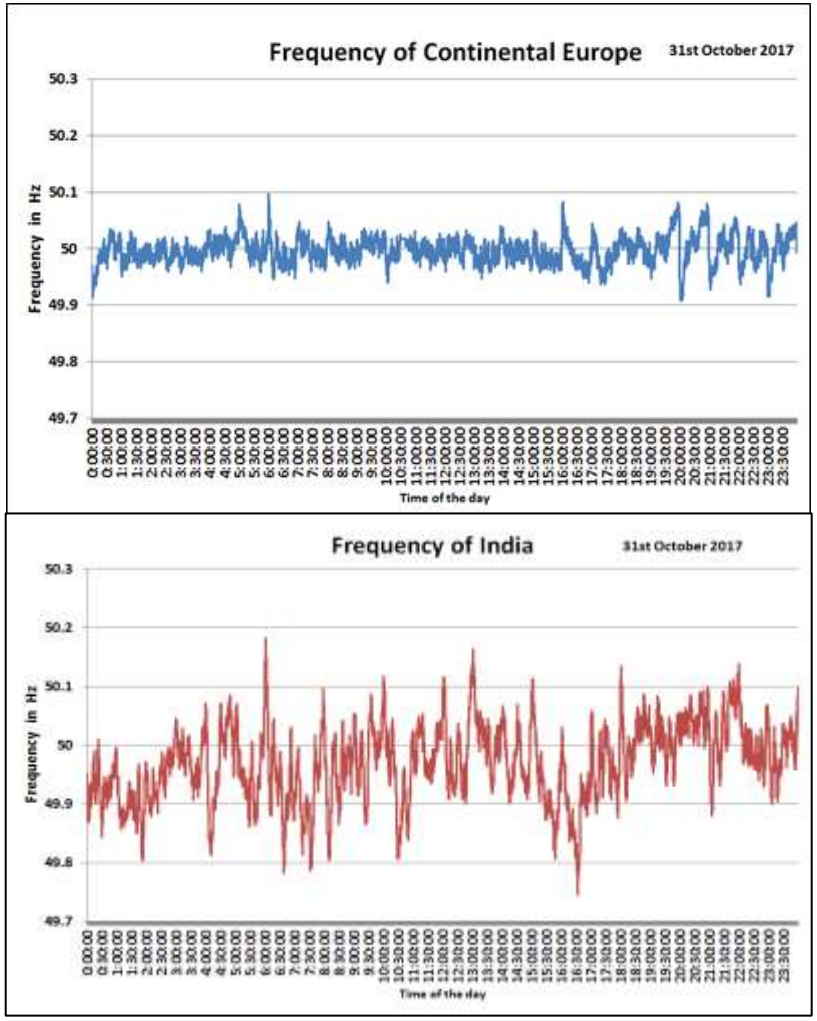
Experience of grid operation in the context of frequency control







Comparison of typical Indian frequency with other large power systems



S no	Description	Values for	
		CE	India
1	Standard Deviation (Hz)	0.019	0.042
2	Frequency Variation Index (FVI) in Hz	0.0036	0.020
3	Instantaneous maximum frequency (Hz)	50.060	50.154
4	Instantaneous minimum frequency (Hz)	49.916	49.885
5	15-minute maximum average frequency (Hz)	50.033	50.065
6	15-minute minimum average frequency (Hz)	49.965	49.952
7	% of time frequency remained within 49.90-50.05 Hz	99.61	81.08
8	% of time frequency below 49.90 Hz	0.00	0.06
9	% of time frequency above 50.05 Hz	0.39	18.86
10	Average time frequency remains below 49.97 Hz for every excursion (mm:ss)	00:38	02:10
11	Average time frequency remains above 50.03 Hz for every excursion (mm:ss)	00:33	02:48
12	No of excursions above 50.03 Hz	112	177
13	No of excursions below 49.97 Hz	139	94

CE : Continental Europe

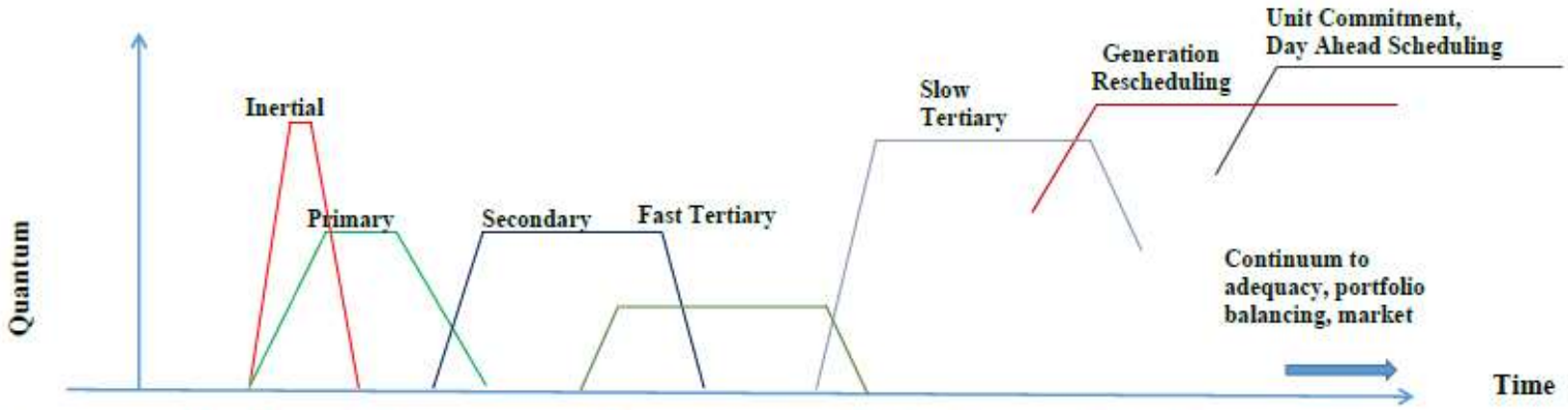
International scenario in respect of frequency control

- North America
  - Reliability Standards
  - Primary response is a mandatory service
  - BAL-003-1 : Interconnection Frequency Response Obligation
  - CAISO proposal for Primary Response Payment
    - Approved by FERC in Feb 16
  - Secondary Control
    - BAL-003-1.1, CPS1
    - FERC Order 755: Pay as per performance
  - Contingency reserve or supplemental reserve
    - Procured by ISO through market

International scenario in respect of frequency control

- Continental Europe
  - ENTSOE Network Code on Load Frequency Control and Reserves
    - Frequency Band : 49.95-50.05 Hz
    - Instantaneous Max Dip : 49.2 Hz
    - Recovery through primary response : 49.8 Hz
    - Frequency to be restored within band in 15 minutes
  - Draft European Union (EU) guideline on electricity transmission system operation
    - Frequency outside band : 15000 minutes per year
  - Reserves
    - Frequency Containment Reserve (FCR) similar to primary control
    - Frequency restoration Reserves (FRR) similar to secondary control through AGC
    - Restoration Reserves (RR) to replace FRR similar to tertiary control.

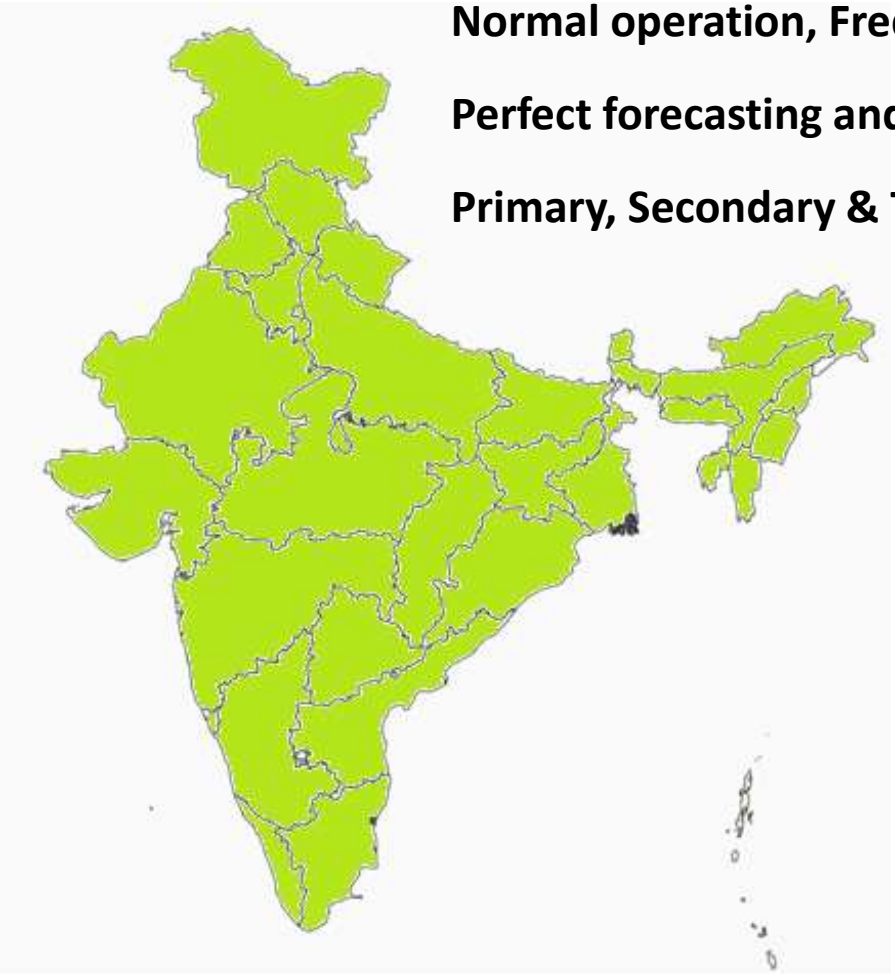
Schematic of Reserves, Balancing and Frequency Control Continuum in India



Response → Attribute	Inertial	Primary	Secondary	Fast Tertiary	Slow Tertiary	Generation Rescheduling/Market	Unit Commitment
Time	First few secs	Few sec - 5 min	30 s – 15 min	5 - 30 min	> 15 – 60 min	> 60 min	Hours/ day-ahead
Quantum	~ 10000 MW/Hz	~ 4000 MW	~ 4000 MW	~ 1000 MW	~ 8000-9000 MW	Load Generation Balance	Load Generation Balance
Local / LDC	Local	Local	NLDC / RLDC	NLDC	NLDC / SLDC	RLDC / SLDC	RLDC / SLDC
Manual / Automatic	Automatic	Automatic	Automatic	Manual	Manual	Manual	Manual
Centralized / Decentralized	Decentralized	Decentralized	Centralized	Centralized	Centralized/ Decentralized	Decentralized	Decentralized
Code / Order	IEGC / CEA Standard (?)	IEGC / CEA Standard	Roadmap on Reserves	Ancillary Regulations	Ancillary Regulations	IEGC	IEGC
Paid / Mandated	Mandated	Mandated	Paid	Paid	Paid	Paid	Paid
Regulated / Market	Regulated	Regulated	Regulated	Regulated	Regulated / Market	Regulated / Market	Regulated / Market
Implementation	Existing	Partly Existing	Yet to start	Yet to start	Existing	Existing	Existing

Source : POSOCO

Normal operation



Normal operation, Frequency 50 Hz.

Perfect forecasting and scheduling

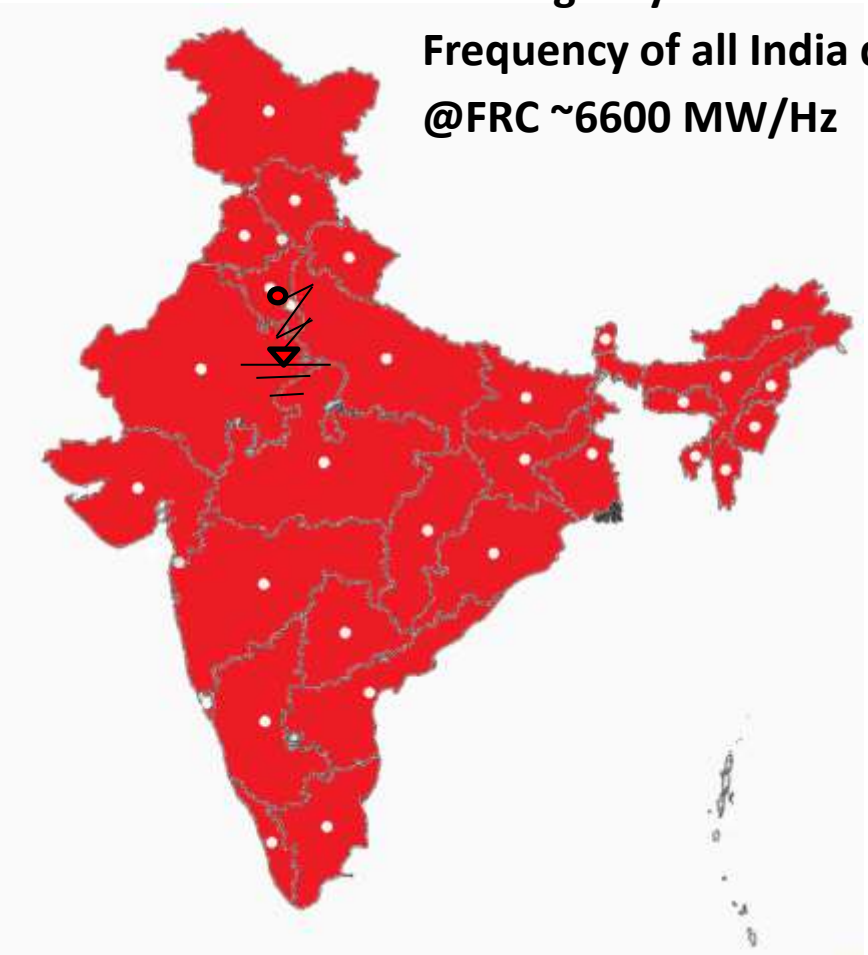
Primary, Secondary & Tertiary Reserves in place.

Contingency

Contingency of loss of 660 MW unit in NR.

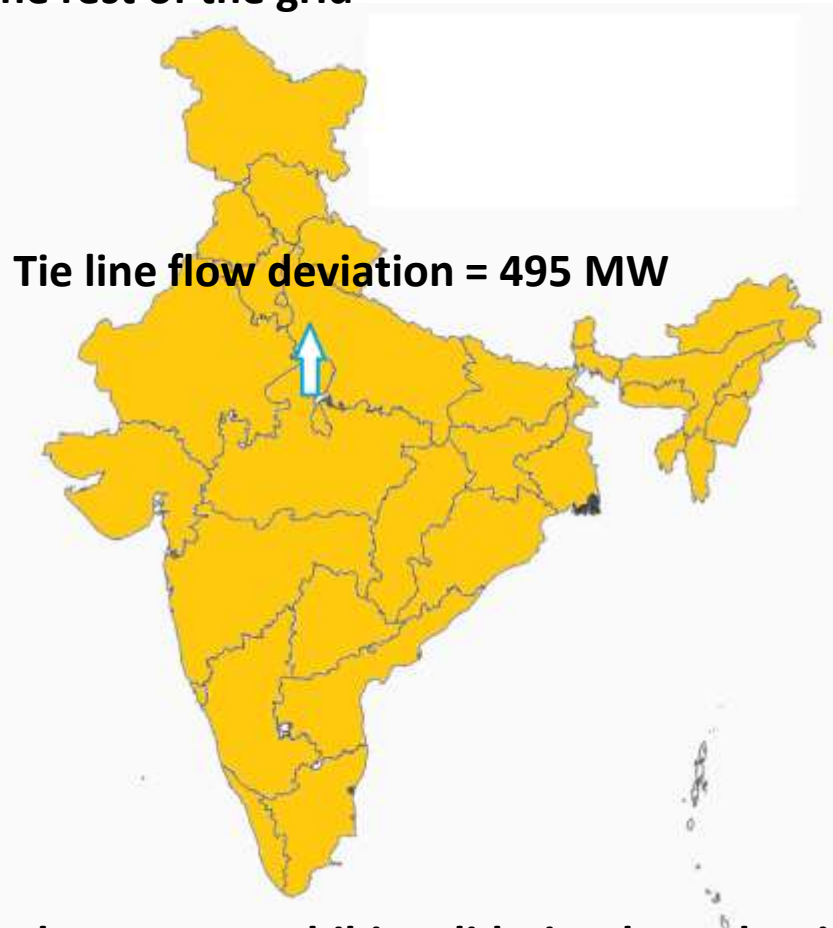
Frequency of all India drops to 49.9 Hz.

@FRC ~6600 MW/Hz



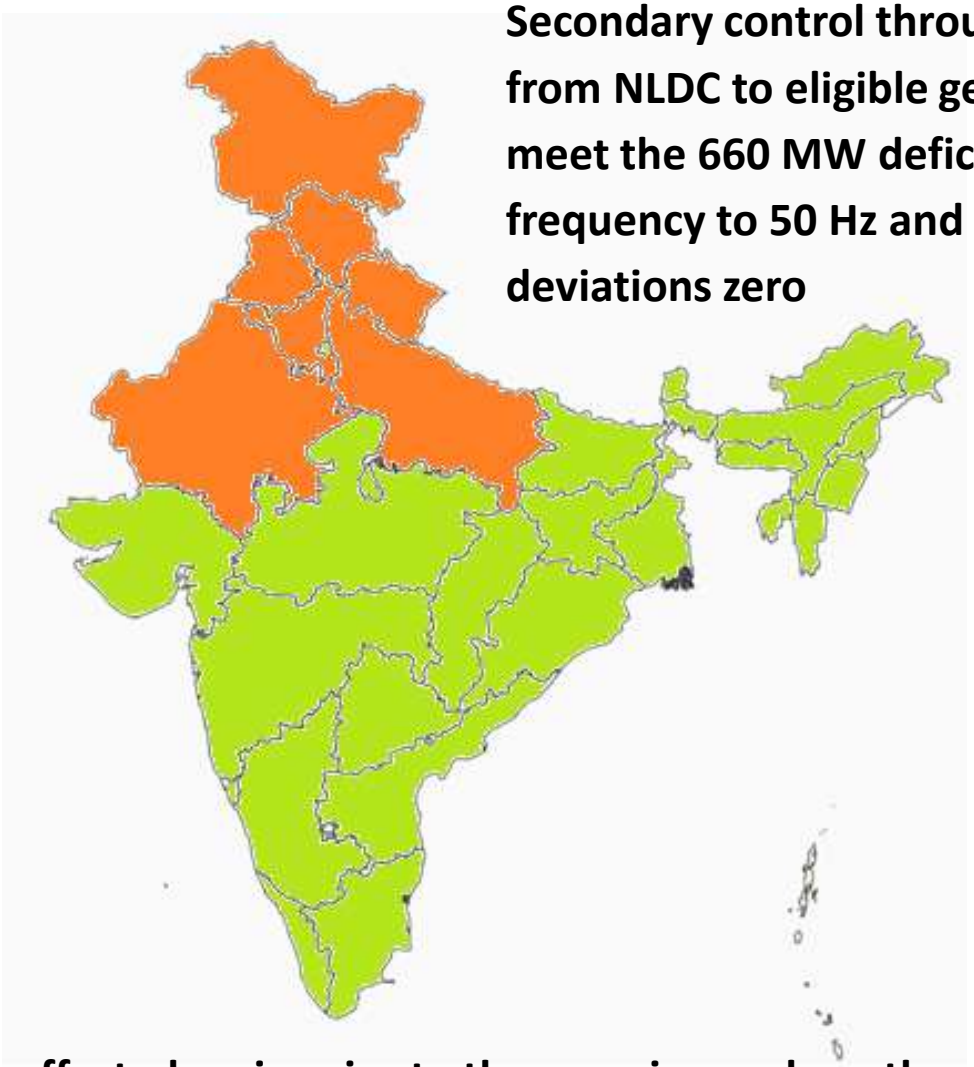
Primary response

Primary response obtained from all the generators pan India and load response due to frequency fall. NR imports extra 495 MW from the rest of the grid



All generators throughout the country exhibit solidarity through primary response!!

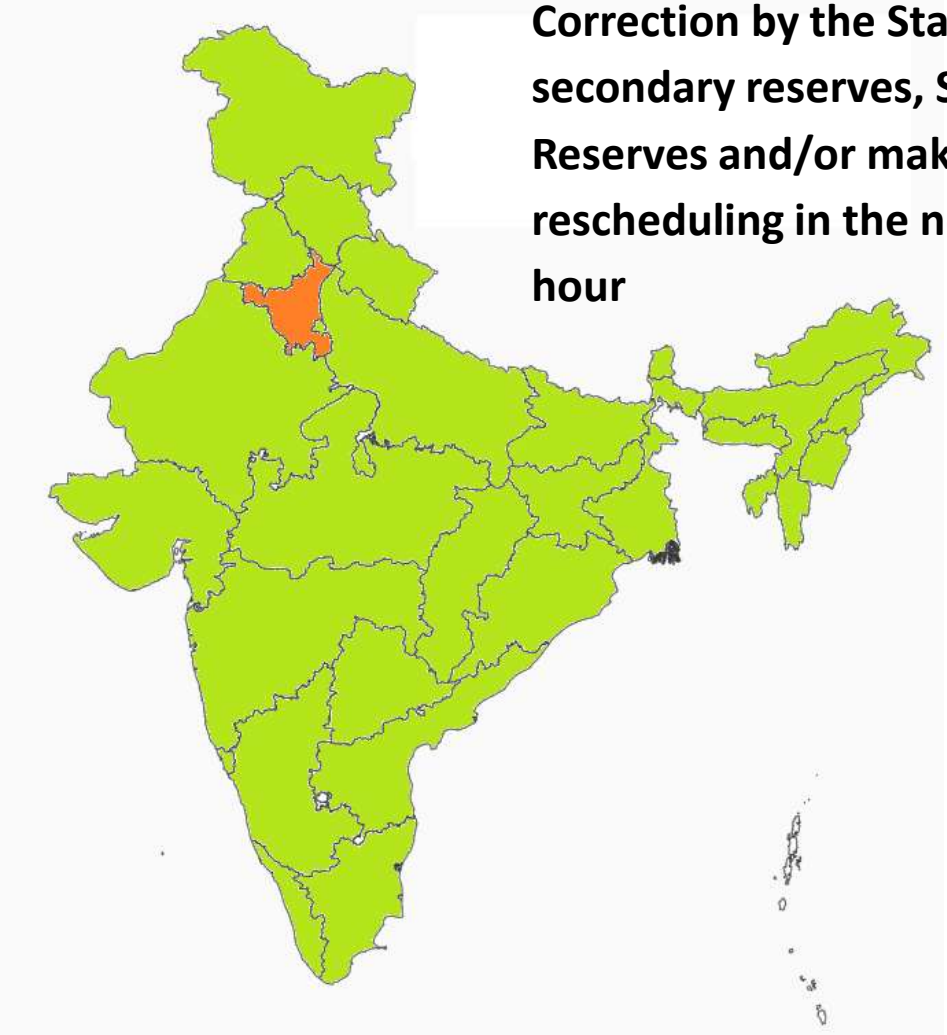
Secondary control



Secondary control through AGC signals sent from NLDC to eligible generators in NR to meet the 660 MW deficit. This will restore frequency to 50 Hz and make tie line deviations zero

Generators in the affected region rise to the occasion and say thanks to all the countrymen!

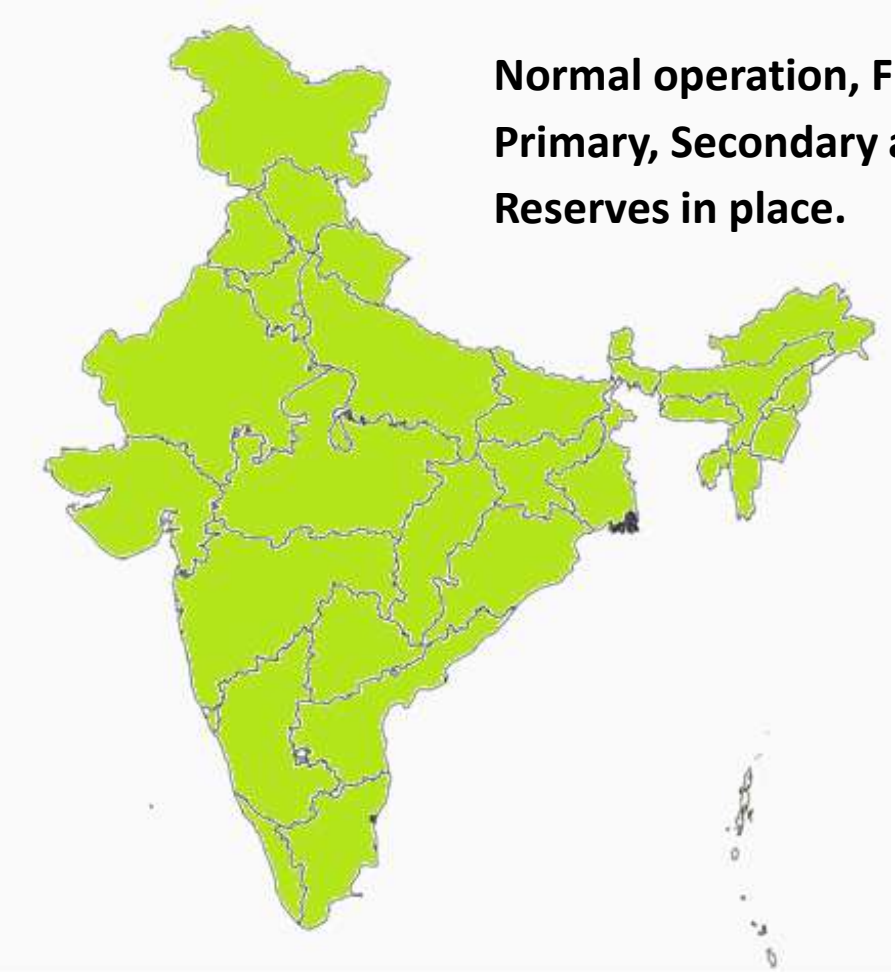
Tertiary Control



Correction by the State. To restore secondary reserves, State has to use Tertiary Reserves and/or make generation rescheduling in the next half an hour to 1 hour

The affected state has time to recoup its strength and say a big thank you!

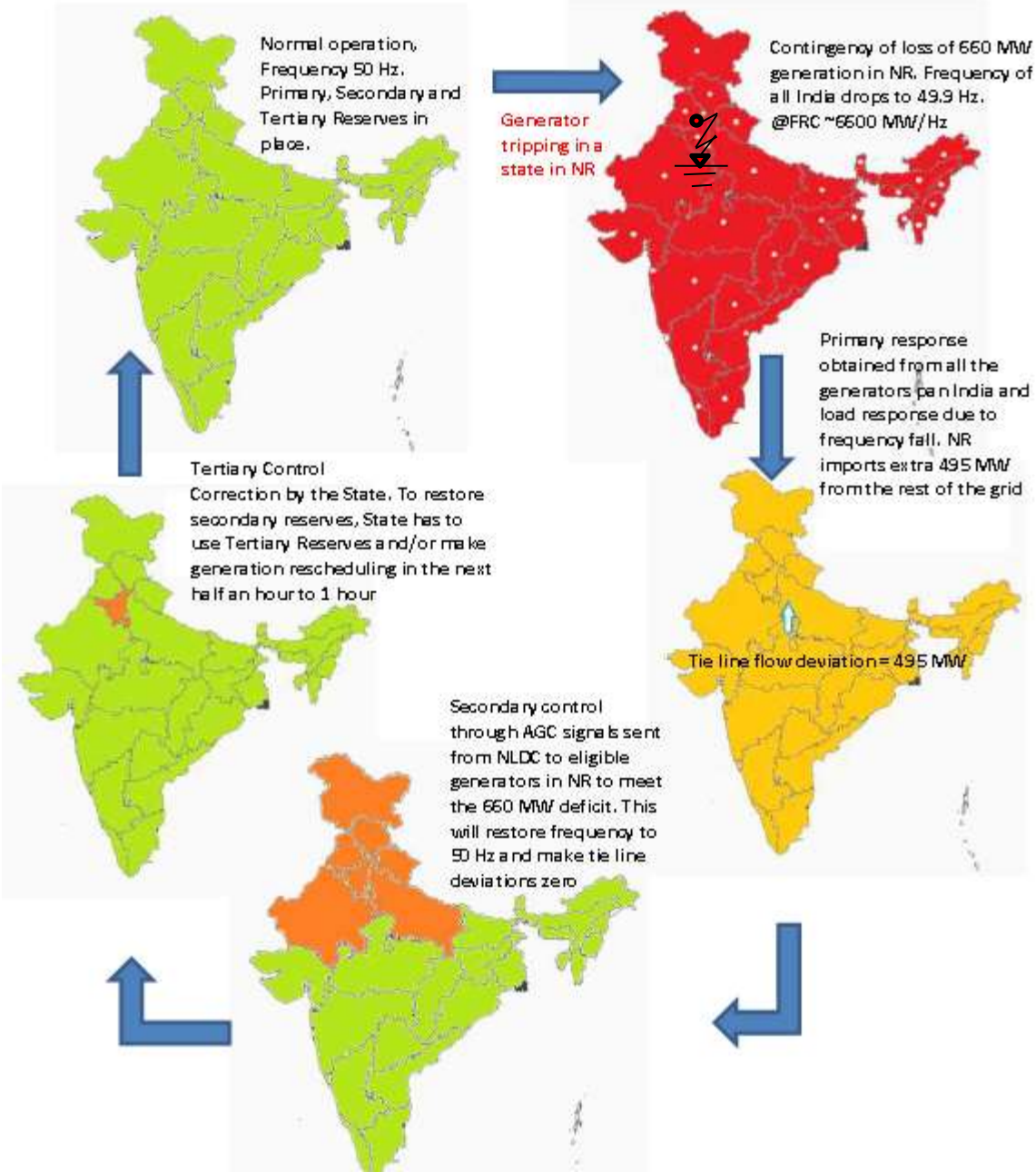
Normal operation



Normal operation, Frequency 50 Hz.
Primary, Secondary and Tertiary Reserves in place.

Grid operation goes on smoothly with the assurance that help is at hand during any crisis!

All in a day's play repeated again and again



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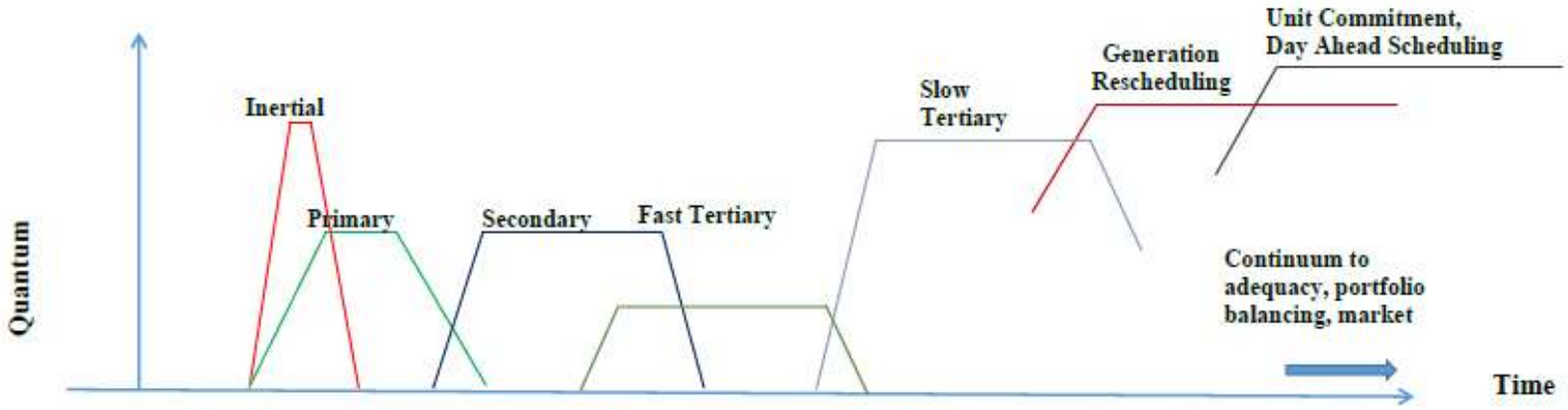

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Implementation	Existing	Partly Existing	Yet to start	Yet to start	Existing	Existing	Existing

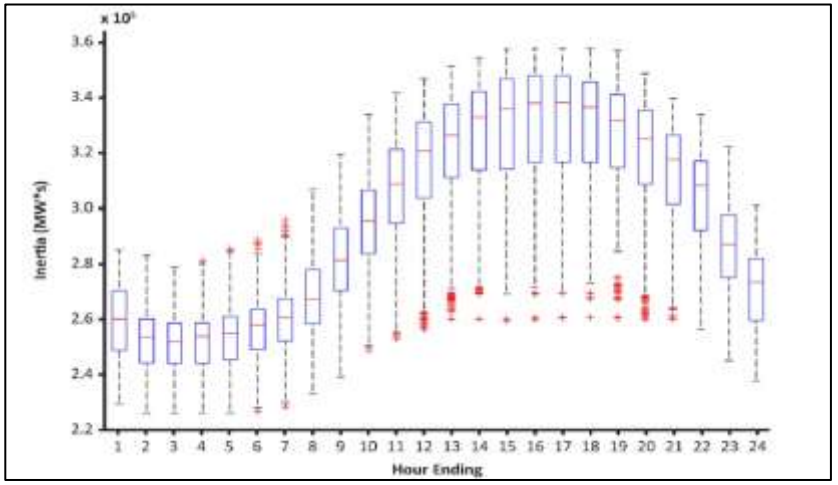
Source : POSOCO

Inertia monitoring

- Increased penetration of RE : Impact on System Inertia
- Higher Inertia older machines (4 MW-sec/MVA)
- Lower Inertia: Newer Machines (2.5-3.0 MW-sec/MVA)
- Impacts System Stability
- Need to monitor Inertia in real time
- Unit Commitment considering minimum inertia requirement

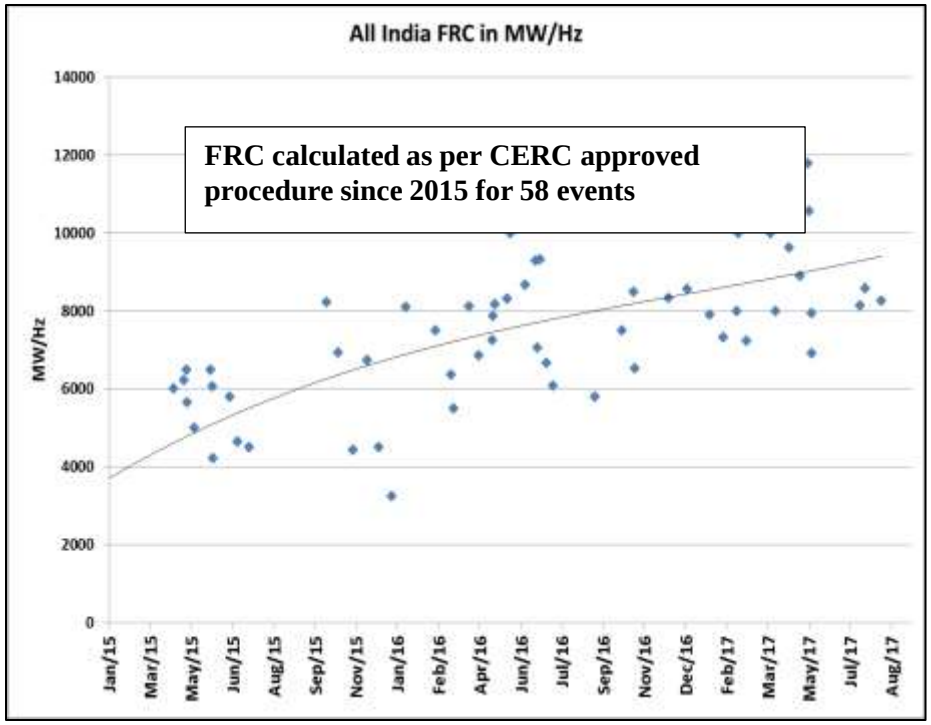
ERCOT dashboard to monitor the real time inertia

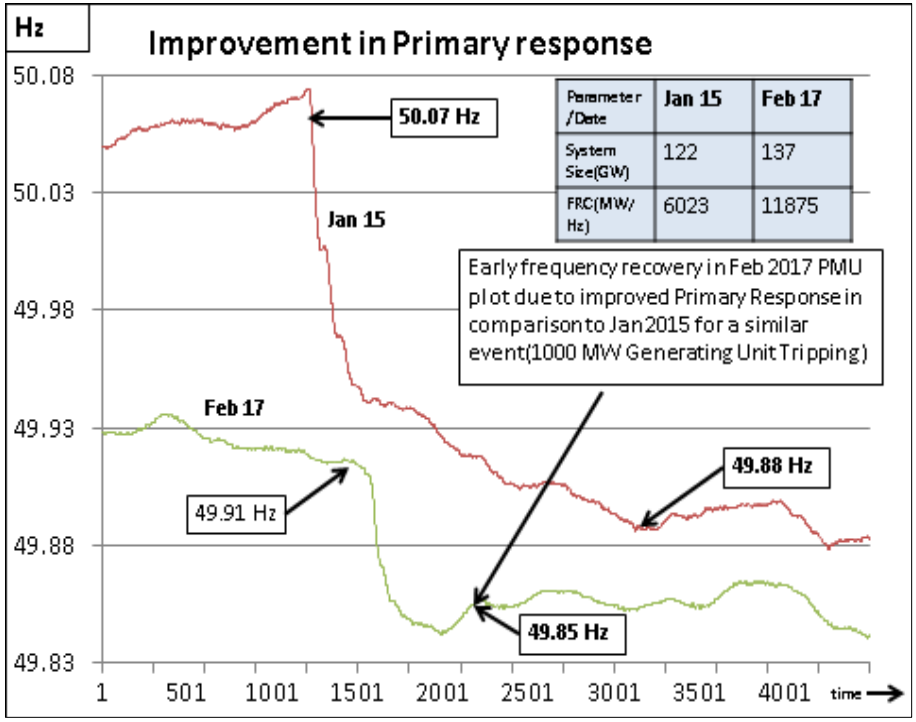
ERCOT inertia by the hour from 1st June to 15th July 2016



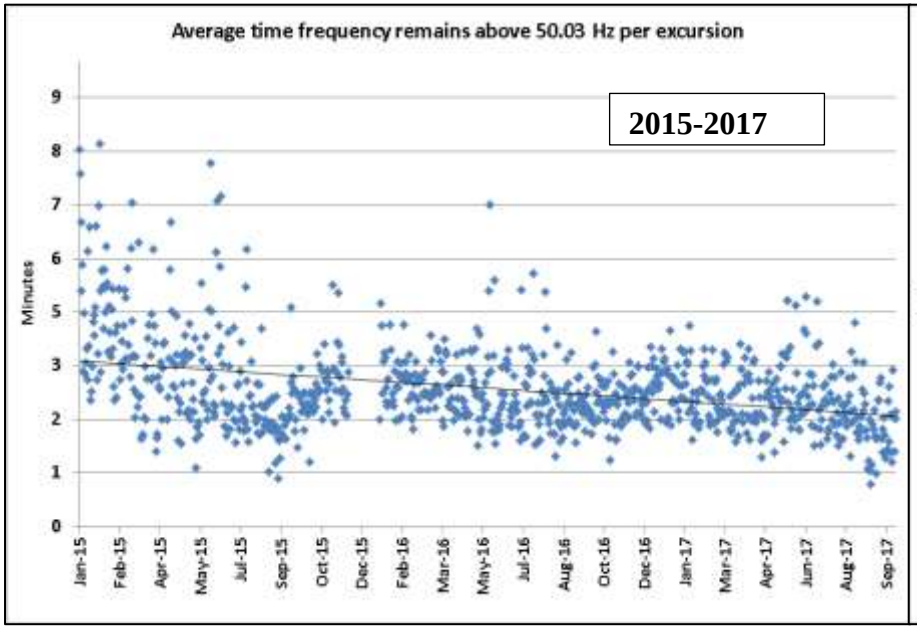
Primary frequency response in India

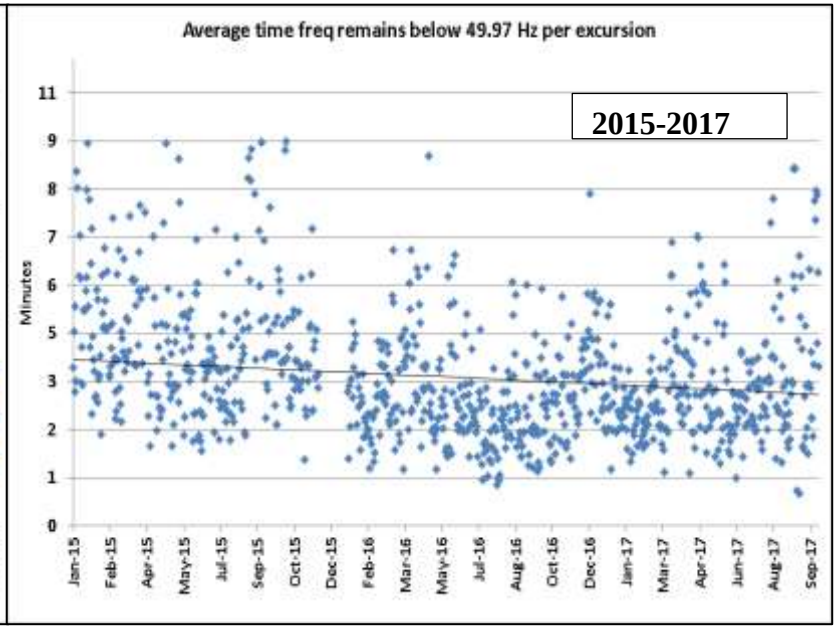
- Frequency Response Characteristics (FRC) calculation by RLDCs/NLDC as per CERC procedure

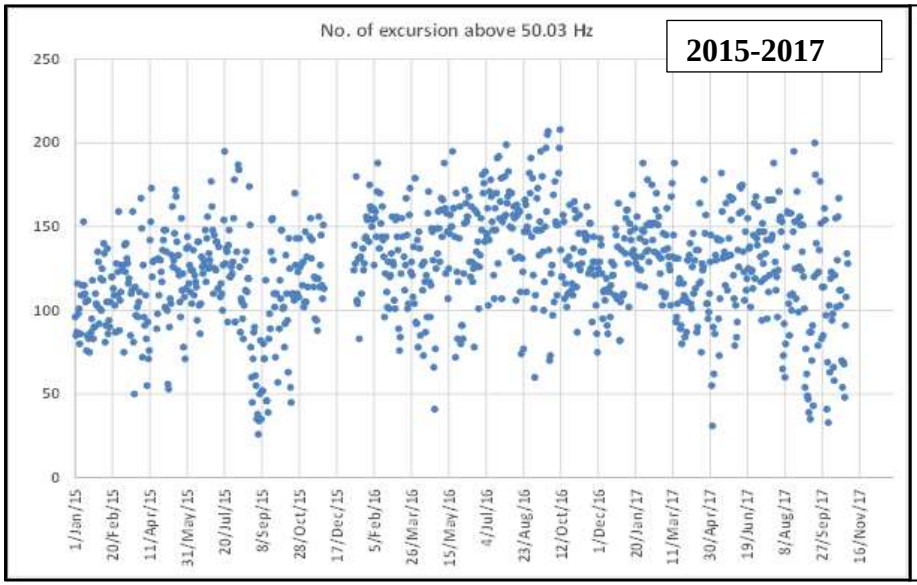


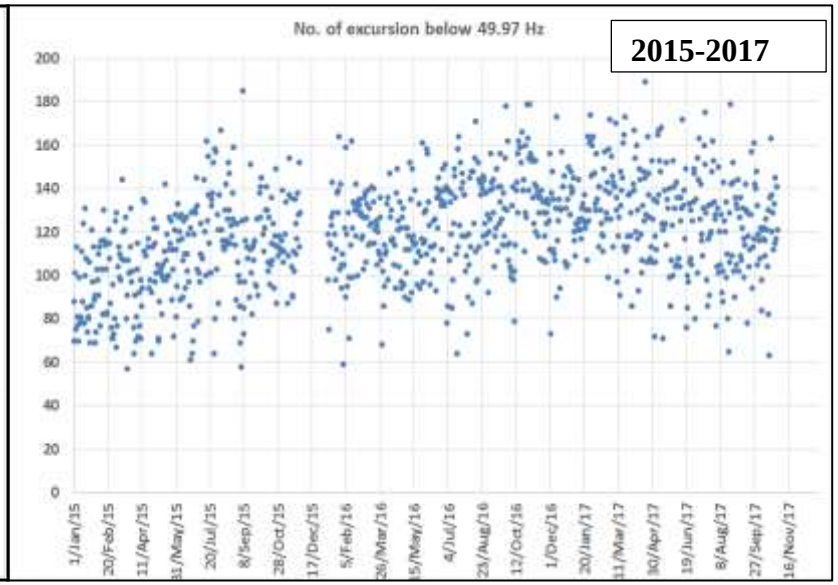


Review of primary frequency response in India









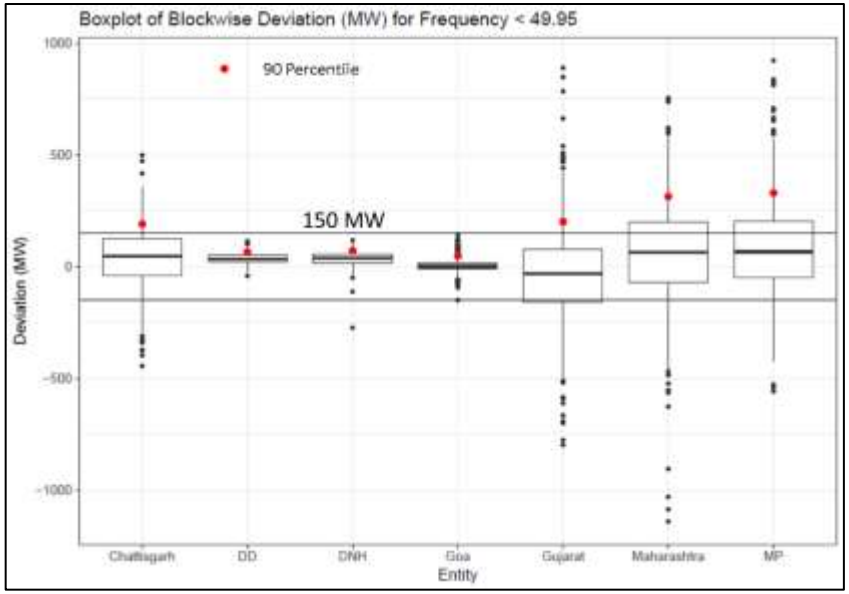
Typical Calculation for Frequency Response in Indian Context

Item	Number
Size of Largest Generating Station	4000 MW
Quasi Steady State Frequency for loss of largest generating station	49.8 Hz
Ideal Response	=4000/(50-49.8) =20000 MW/Hz
Desired Load Response (4% of All India Demand)	=0.04 * 140000 =5600 MW/Hz
Desired Response from Generators	= 20000 – 5600 = 14400 MW/Hz

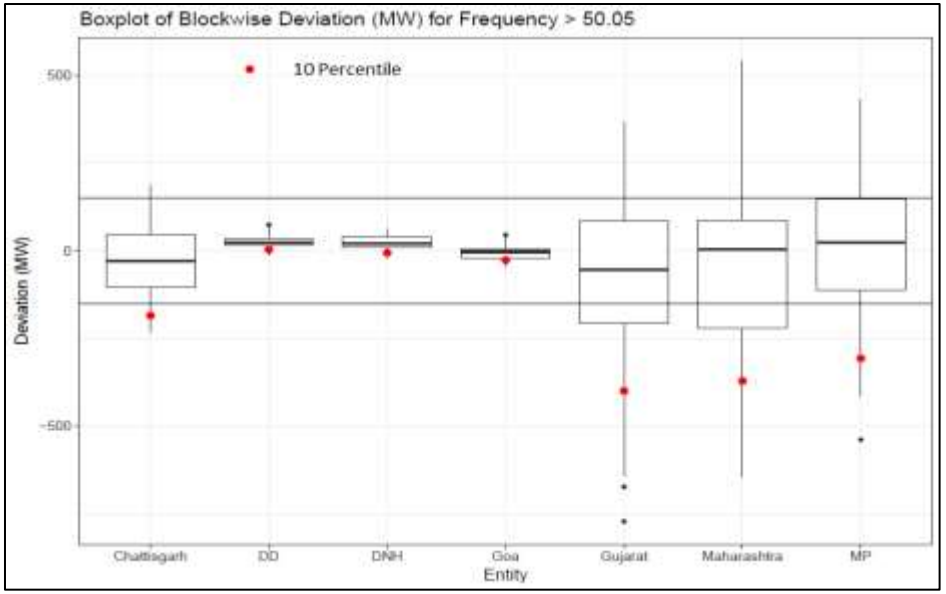
Review of secondary frequency control

- AGC Pilot Project in association with NTPC Dadri
  - Mock Test on 29th June 2017
  - CERC Order on AGC pilot project dated 06th Dec 2017
    - One pilot in each region
  - Under Continuous Operation since 04th Jan 2018
- AGC Pilot for Hydro already under consideration by KPCL
- AGC pilot for Solar / Wind to be undertaken
- AGC feature included in NLDC upgradation project
- Detailed procedure to operationalize reserves
  - submitted to CERC in July 2017

Review of tertiary frequency control and Control Area Performance



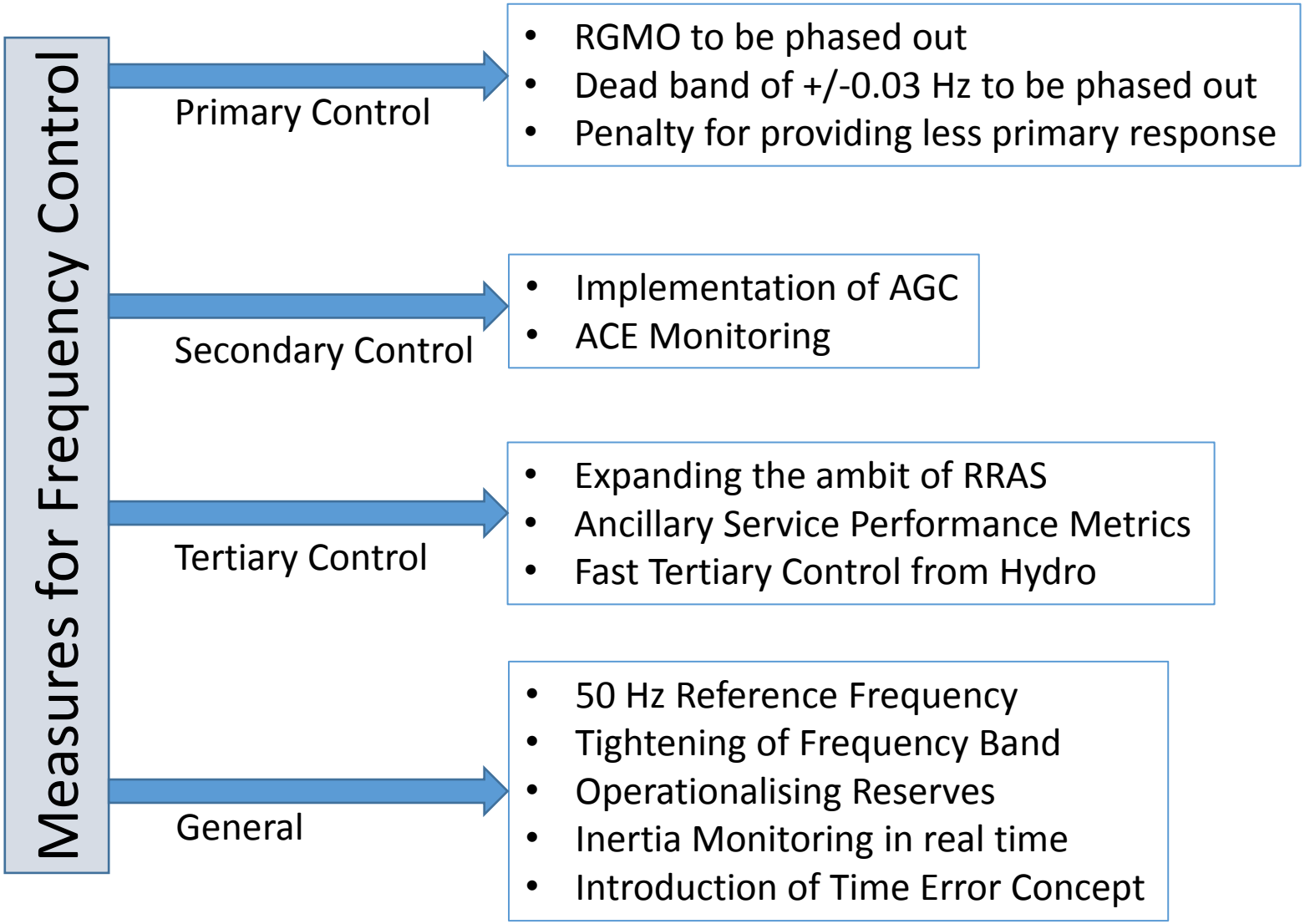
Deviation from the schedule by WR states in September 2017 below 49.95 Hz



Deviation from the schedule by WR states in September 2017 above 50.05 Hz

- States like Gujarat, Chhattisgarh, Maharashtra and MP exceeded the 150 MW limit for more than 10% of the time
- Need for performance metrics for assessing a control area's performance
- ACE should cross zero value and change sign at least once every hour
- Penalty for persistent violation

Recommendations-Summary



Thank You !

Recommendations

- **Frequency control continuum chart**
  - As given in the report to be added in IEGC
- **50 Hz Reference Frequency**
  - To be notified in IEGC
- **Inertia Monitoring in real time**
  - All India & Regional Basis
  - Provisions for minimum inertia in Standards and Code
- **Primary Control**
  - RGMO to be phased by 1st April 2018
  - Dead band of +/-0.03 Hz to be gradually phased out
  - Testing of Primary Response
  - Notification of CEA Technical Standards for connectivity to the grid in respect of RE generation at the earliest

Recommendations

- **Additional parameters to be notified in IEGC**
  - Tightening of Frequency Band to 49.95-50.05 Hz by 2020
  - Reference contingency for primary response: 4000 MW UMPP outage
  - Minimum frequency (nadir value) following the above reference contingency: 49.50 Hz
  - Quasi steady state frequency value after primary response following the above contingency: 49.80 Hz
- **Frequency Response Characteristics (FRC)**
  - RLDCs/NLDC would continue to compute FRC as being done presently
  - All India and Regional FRC computation at the 'nadir' frequency
  - Reporting to CERC for levy of penalty if actual response is less than 40% of ideal response

Recommendations

- **Roadmap for operationalizing reserves**
  - Roadmap for operationalizing reserves notified by CERC vide order dated 13th October 2015 be implemented at the earliest.
- **Secondary Control through Automatic Generation Control**
  - AGC must be implemented throughout the country
  - Performance Metrics for such AGC payments may be introduced once sufficient experience is gained
  - AGC at the intra state level to be also implemented
- **Slow tertiary control through Reserves Regulation Ancillary Service (RRAS)**
  - Expanding the ambit of RRAS at the inter-state level
  - Introduction of Performance Metrics for mark-up payments for the slow tertiary Ancillary Services
  - Introduction of slow tertiary Ancillary Services at the intra-state level

Recommendations

- **Fast tertiary control at the Inter State level**
  - Fast tertiary services through RRAS using hydro could be introduced
- **Monitoring of Area Control Error (ACE)**
  - Display, Monitoring and Archival of ACE
  - ACE to change sign, once every hour
- **Time Error**
  - Standards for cumulative time error to be notified separately by CERC

Discussion Points For Comprehensive Metering Regulations & Accounting Framework of GRPV deployment in India

Building a better working world

Table of contents

An Overview of NEM 2013

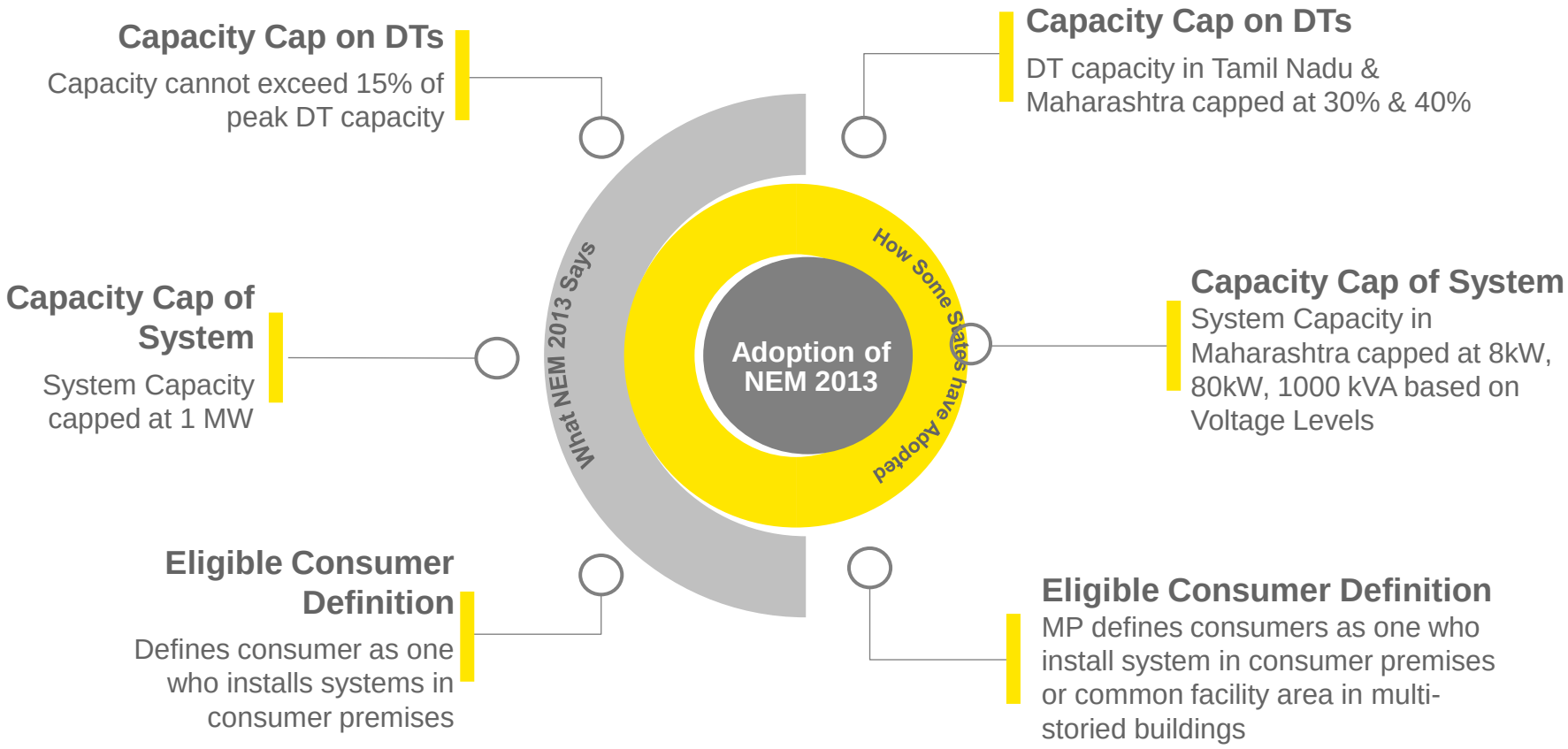
Key features

2013 NEM regulation provided a model guideline for the states to come up with state specific directives primarily for interconnection, billing & settlement, metering arrangements and RPO

- Scope & Applications
- General Principles
- Capacity Targets
- Eligible Consumers
- Interconnection to Grid
- Energy Accounting & Settlement
- Solar RPOs
- Applicability of Other Charges
- Metering Arrangements

Adoption of NEM 2013 by States

Differences in state adoption in few key features



Key Implementation Challenges

1	Energy Accounting & Commercial Arrangements	► Standardised mechanism for monitoring generation and capacity of interconnected systems ► Detailed definition of communication protocols to be adopted for monitoring
2	Interconnection Arrangements	► Standardised methodology for assessing infrastructure readiness and defining the capacity caps is required ► Defining maximum permissible generation system sizes in MW at different voltage levels ► Standardised methodology for defining power quality
3	Meters	► Standardised testing procedures for meters ► Standardised procurement, ownership, maintenance, aggregation and management of meters
4	Growing deal imbalance	► Accounting complete rooftop solar generation under DISCOM RPO ► Stipulating the formation of a dedicated rooftop solar cell in DISCOMs ► Standardised procedures for redressal of grievances related to interconnection

Need of the hour:
Are we considering all these??

1	2	3	4
Upcoming business models	**DT Capacity assessment guideline**	**Defining net meter & solar meter specifications**	**Establishment of interconnection arrangements** .

Case Study: JVVNL

Present Rooftop Solar Status in Rajasthan

Serial No	Parameters	Data
1	Total installed capacity*	129 MW
2	Commercial segment	21 MW
3	Industrial segment	85 MW
4	Public sector	23 MW
5	Installation target by 2022*	2300 MW
6	Net metering policy notification date	26.02.2015
7	Prevalent business model	CapEx

Consumer Mix of JVVNL

Serial No	Type of consumers	Percentage share
1	Residential	26%
2	Non domestic residential	9%
3	Industrial	41%
4	Agricultural	23%
5	Street light & others	1%

Case Study: JVVNL

Key Observations

1 Operational

- Lack of data availability such as timeline from application to commissioning
- Absence of IT Infrastructure
- Slow meter testing/certification process
- Limited Supplier of Meters
- Manual Billing Process
- Absence of Separate Rooftop Solar Cell

2 Technical

- Unavailability of grid / DT hosting capacity assessment procedure
- Absence of Load forecasting / flow study
- Concerns over quality of solar panels due to non-updation of empanelled vendor performances

Case Study: JVVNL

Key Observations

3 Policy & Regulatory

- Absence of RESCO model
- Absence of Smart city clause
- Weak penalty clause against implementation delays
- Non-incorporation of storage facility in NEM

4 Financial

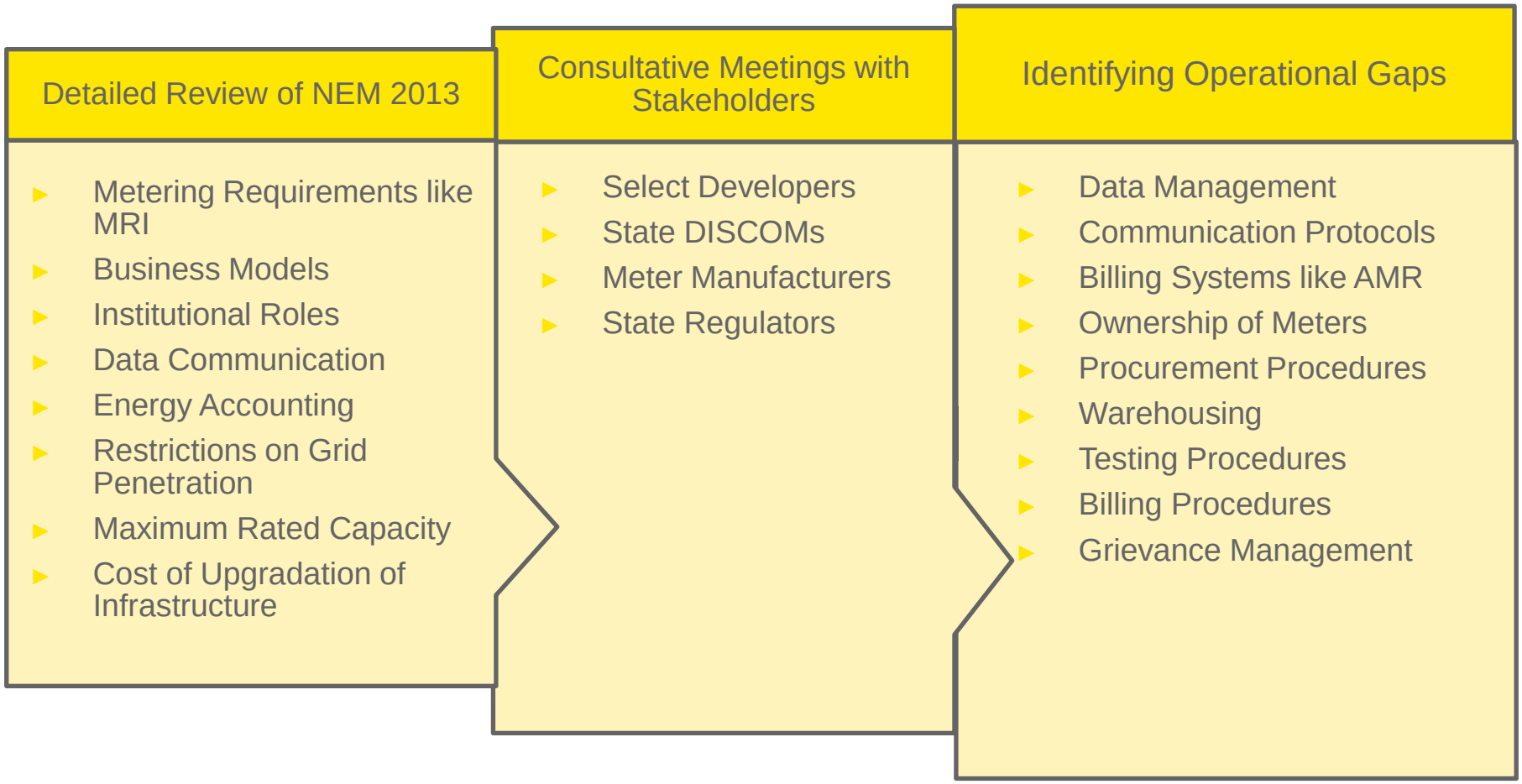
- JVVNL seeks help in conducting revenue loss assessment
- JVVNL needs support in evaluating DISCOM owned asset model
- JVVNL needs easy access to capital for debt financing in the sector

Case Study: Tata Power, Maharashtra

Key Observations

- Requirement of a dedicated rooftop cell in each of the DISCOMs for overlooking applications and management of the interconnection process
- Requirement of a “user-friendly” interface for checking the available DT load capacity
- More frequent update of the documented “Available DT capacity” may be proposed
- Indian standards for inverters to be developed
- The regulations should discourage BTM and should encourage plants >1MW
- The regulation should allow for utility owned business models
- Authority should be given to LEC to commission systems to expedite execution

EY Approach & Methodology



EY Approach & Methodology

Evaluating Gaps in Implementation

- Technical Standards as per Supply Voltage
- Safety & Supply
- Power quality including harmonics, voltage, synchronization, flickers, DC injections, frequency

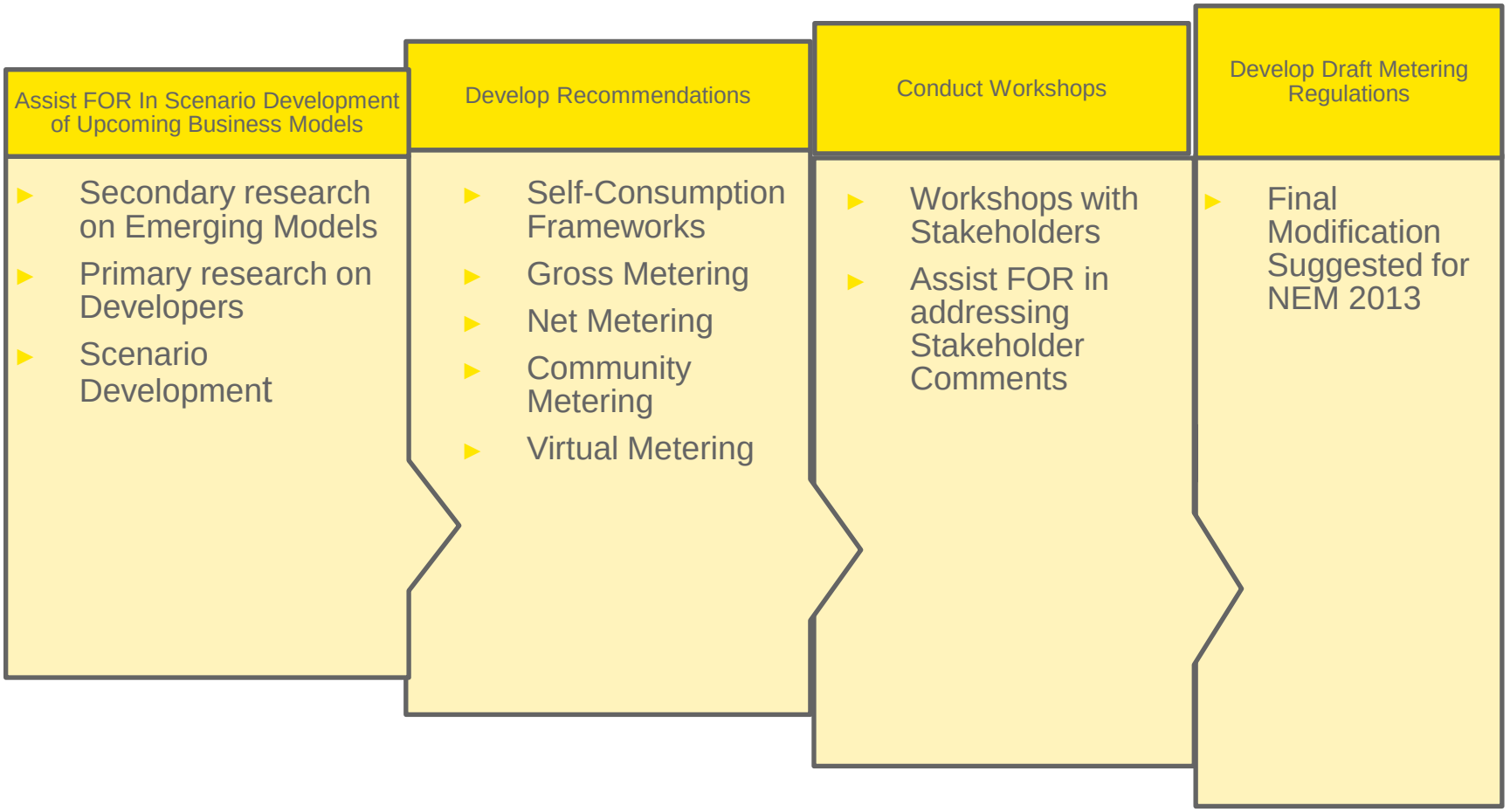
Conduct Review of International Practices

- Perform Comparative Assessment with Indian Scenario

Assist FOR in Understanding Impact of Rooftops

- Impact on DISCOM models to be analysed through Appropriate Modelling & Quantitative Assessments
- Assessment of Potential Business Models for Rooftop; Global and Local Practices
- Assessment of Impact on DISCOM Revenue

EY Approach & Methodology



Key deliverables

1. Gap assessment report on NEM 2013 and justification papers to assist FOR
2. Draft report on Comprehensive Metering Regulations and Settlement Mechanisms proposed for GRPV in India
3. Report on consultative workshops
4. Final report on Comprehensive Metering regulations and Accounting Framework proposed for GRPV in India
5. Draft metering regulations and draft order for settlement mechanisms for GRPV

Thank You

Building a better working world

Presentation on Regulatory Guideline to the Special Technical FOR Committee

By NARUC and E3
January 12, 2018

Under Greening the Grid (GTG) Program
A joint initiative of USAID and MOP

- Scoping Visit
- Key Takeaways from the scoping visit;
- Draft outline of report;
- Time line
- Feedback of the committee members on key questions

Scoping Visit

- NARUC/E3 team in India from Jan 8-12, 2017 to scope Regulatory Guidelines focused on
  - Transition of long-term contracts to energy markets, and
  - Types of contracts that are needed to incentivize generation development in energy markets

- Stakeholders consulted :
  - Regulators and other GOI stakeholders: CERC, GERC, CEA
  - System Operators: POSOCO, Gujarat SLDC
  - DISCOMs: GUVNL, Torrent Power
  - Generation Owners: NTPC, Torrent Power, Association of Power Producers
  - Academics: IIT Kanpur, IIT Delhi
  - Others: PTC, JSA Law team working on energy contracts, IEX.

Key Takeaways – Questions identified by Stakeholders

- **<u>Regulators</u>:**
  - What are the enabling conditions for market transition? Can you transition in phases?
  - What are benchmarks for the amount of load that needs to be contracted on a long-term basis, medium-term basis, and short-term basis?
  - What are typical contract lengths seen in international contexts? What are standard T&Cs in PPAs?
  - What have international jurisdictions done with regard to stranded assets? (e.g., approaches to valuing stranded assets and cost recovery mechanisms)
  - What approaches to capacity procurement exist?
  - Should underutilized assets be kept to provide balancing services in the future?
  - What hedging strategies are appropriate? How are financial futures markets regulated? Do energy regulators have oversight?
  - How are contracts dispute managed?

Key Takeaways – Questions identified by Stakeholders

- **System Operators:**
  - How can SLDCs access out-of-state generators for balancing without paying transmission charges?
  - Are there non-commercial processes that can be created to allow SLDCs to balance better? (e.g. energy banking arrangements, PPA tariff trading)
  - How are long-term planning signals produced in markets?
  - What methodologies should system operators use to determine which assets are needed for resource adequacy and grid reliability purposes?
  - What products do other exchanges/markets offer besides DAM?
  - What market oversight and monitoring processes need to be in place to ensure fair price formation?
- **Generation Owners:**
  - What can be done by regulators to prevent default of PPAs to ensure sanctity of contracts?
  - What other revenue streams can provide value to coal/gas assets?

Key Takeaways – Questions identified by Stakeholders

- **Discoms**:
  - Can 7-12 year contracts provide bankability for new generation development?
  - Can regulations be modified to allow discoms to update their schedules closer to real-time in IEX?
  - What products can be introduced to increase participation and trust in IEX? How can discoms get a better feel for price certainty from IEX?
  - What market oversight processes can enable greater trust in IEX?
  - What can be learned from looking at how merchant plants are recovering their fixed costs?
- **Others:**
  - How can tariffs be more cost-reflective?
  - What steps need to be taken to ensure trust in market structure?

Draft Outline for Regulatory Guidelines Report

- Bilateral Contracts and Market Transitions
  - What is the scope of stranded costs that should be covered under transition costs and why (e.g., should these costs be recovered at all, what is the rationale)?
  - Approaches to valuing stranded costs
  - Design of stranded cost recovery mechanisms
  - Historical examples and current RE transition related examples from U.S.
- Contracts and Investment in Wholesale Markets
  - Generation investment risks and risk allocation
  - Fundamental market flaws and examples of regulatory intervention
  - Proposed solutions and associated contractual obligations
  - Examples of resource adequacy mechanisms and their associated contracts

Draft Outline for Regulatory Guidelines Document

- Relationship between Contracts, Spot Markets, and Power System Operations
  - Description of financial and physical contracts
  - Description of common kinds of financial contracts used in the electricity industry (e.g., forward contracts, futures contracts, contracts for differences, financial transmission rights, tolling agreements, swaps, heat rate call options)
  - Examples of how financial contracts are used to bridge bilateral PPAs and energy markets in the U.S.
  - Regulation of financial contracts
- Options for India

Timelines - Regulatory Guidelines Document

- Scoping visit – January 2018 (Completed)
- First draft and First Regulatory Exchange in India - April 2018
- Second draft with stakeholder feedback incorporated - June 2018
- Final Regulatory Guidelines and second Regulatory Exchange - August 2018

Key Questions

Market Transition

- How contracts are structured today? What are the strengths and weaknesses?
- What are the main issues India is likely to face as it continues to transition to electricity markets?
- Are there likely to be stranded asset concerns?
- Would changes in contracting for generation that accompany market transition impact grid reliability?

Key Questions

Markets, Contracts, and Finance

- How are India's wholesale and retail electricity markets likely to evolve in the next 5 years?
- Do you it is the right time for segregation between physical and financial contracts?
- How will new generation be planned, approved, and financed in these markets?
- Will regulatory interventions be required to support investments in generation?

RECONNECT ENERGY

The Energy Solutions Company

Vibhav Nuwal
Co-founder & Director

Shruti Jain
Manager (F&S)

Jan 12, 2018

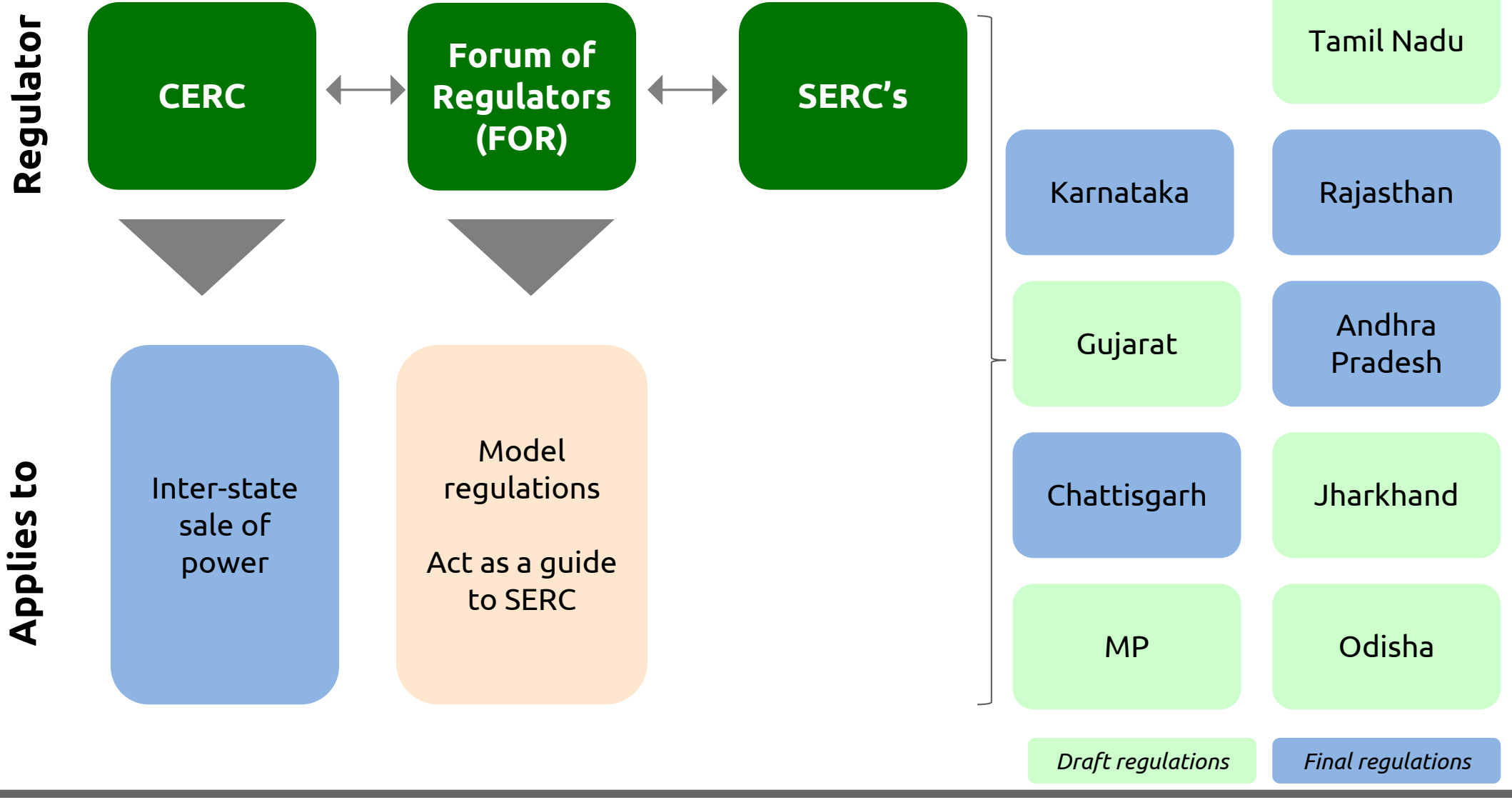
Agenda:

- **Setting the context:**
  - Status of regulations
  - Our work as QCA

- **Our experience as a QCA:**
  - How do forecasting models work?
  - General scope and requirements of a QCA
  - Experiences/ Issues faced as a QCA

- **Analysis of forecasting performance:**
  - Case-studies

Status of DSM Regulations



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Capacity that we work on

Utility Scale

GETCO

~ 5,400 MW

IWTMA
INDIAN WIND TURBINE MANUFACTURERS ASSOCIATION

~ 4,100 MW (Raj.)

~ 4000 MW + Demand (Trial basis)

पावर सिस्टम ऑपरेशन
POSOCO

WRLDC & SRLDC (RE + Demand; on Trial basis)

MW Scale (Wind & Solar)

<u>As QCA:</u>

Karnataka ~2,850 MW (68 PSS, 300+ Generators)

Rajasthan* ~2,800 MW

AP* ~750 MW

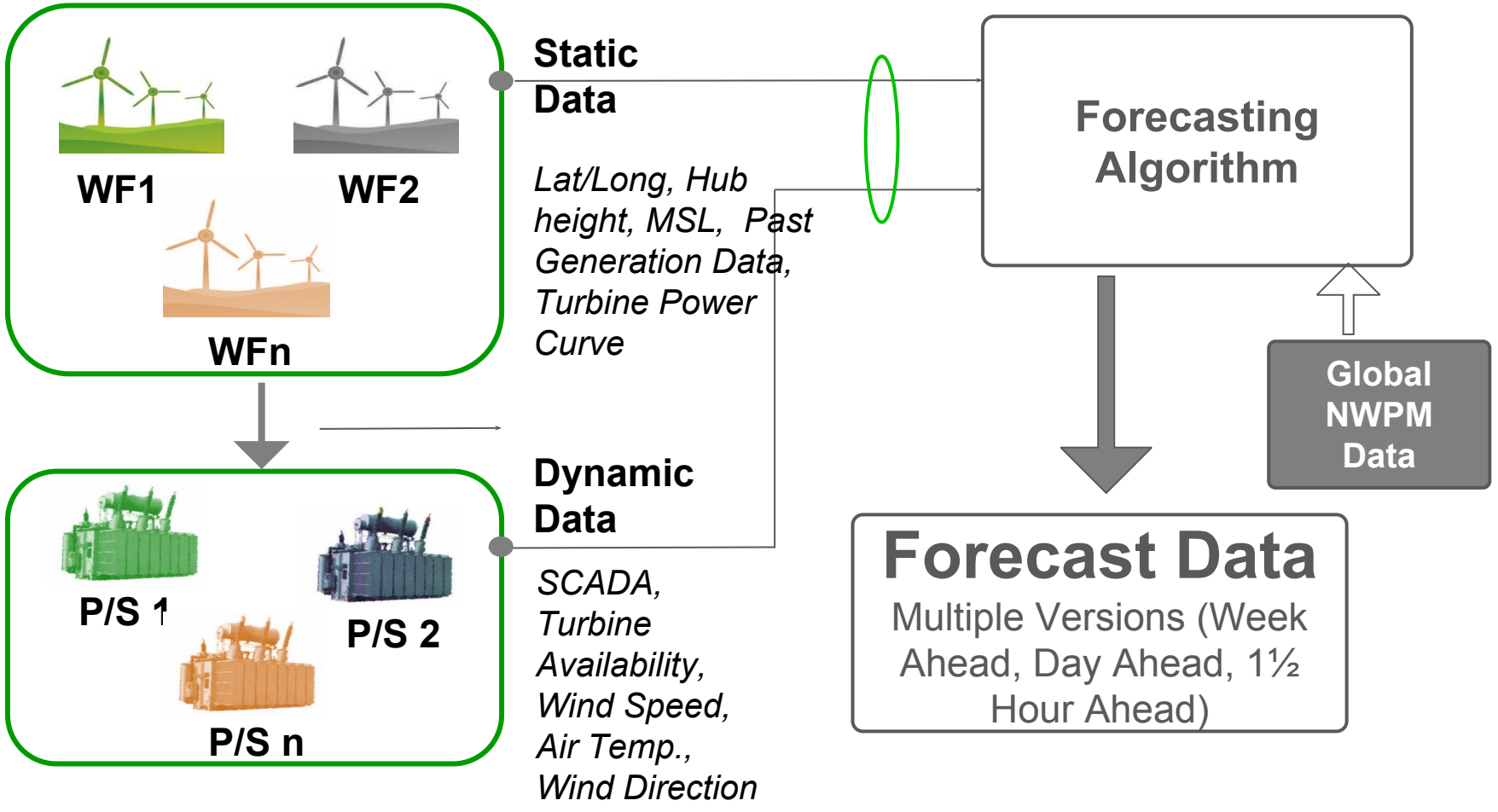
CG ~100MW

<u>In other states:</u>

~ 2,000 MW

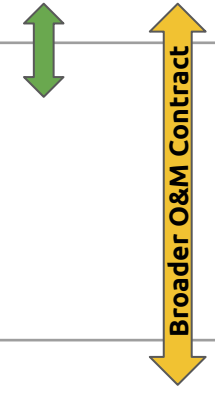
** Registration as QCA in progress; estimated capacity*

How do forecasting models work?



General Roles & Responsibilities

	Forecasting & Scheduling	Commercial settlement	DSM Charges
RE Generators	• Pay payment security as determined by SLDC • Work with/ assign responsibility to plant operator		Pay DSM charges to QCA within timelines specified by SLDC
QCA	• Create forecasts and schedule the power with SLDC	• Review and reconcile DSM statements • De-pool DSM amounts	Pay DSM charges to SLDC (only after receipt of the same from Generators)
Plant operator/ OEM	• Provide: real-time SCADA data • site information relating to maintenance, outages, etc (AvC) • month end meter data		



Contracts

General scope of a QCA

Forecasting	• Historical Weather/SCADA Data integration • Actual Generation/SCADA Data Integration • Calibrated, non-calibrated forecast & intra-day revisions
Scheduling	• Forecast data, generator specific availability data, weather data integration • Coordination with SLDC, RE OEMs, RE Generators
Physical Layer Integration	• **Hardware Layer** – meter/weather data integration • Integration of Input Data Layer (wind farm SCADA, Pooling Station SCADA, Meter Data etc.) • Communication Channel with DISCOMs, SLDC, OEMs and RE Generators
MIS and Information	• MIS, data reporting, data checks & balancing, quality control • Generator, SLDC, OEM, RE Farm specific modules
De-pooling & Settlement	• Intra-State RE DSM Settlement with SLDC and • Individual S/S or Generating Units

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General requirements to be a QCA

- Experience
  - Eg. Rajasthan - 500MW capacity for >1 year
  - Eg. Karnataka - None mentioned
  - Eg. AP - experience in the field of Wind/Solar Power forecasting and scheduling for a minimum period of 2 years
- Net worth
  - Ranges from Rs 1.5 crore to Rs 2.75 crore
- Payment security - in the form of a BG to SLDC
  - Rs 43,200/ MW for Wind and Rs 10,600/MW for solar in Karnataka
  - Rs 40,000/ MW for Wind and Rs 10,000/MW for solar in Rajasthan
  - Rs 45,000/ MW for Wind and Rs 22,500/MW for solar in AP
  - QCA's generally take back-to-back security from generators
- Undertaking to SLDC
  - Essentially lays down responsibility of QCA, eg. to pay DSM, provide payment security, abide by regulations, etc

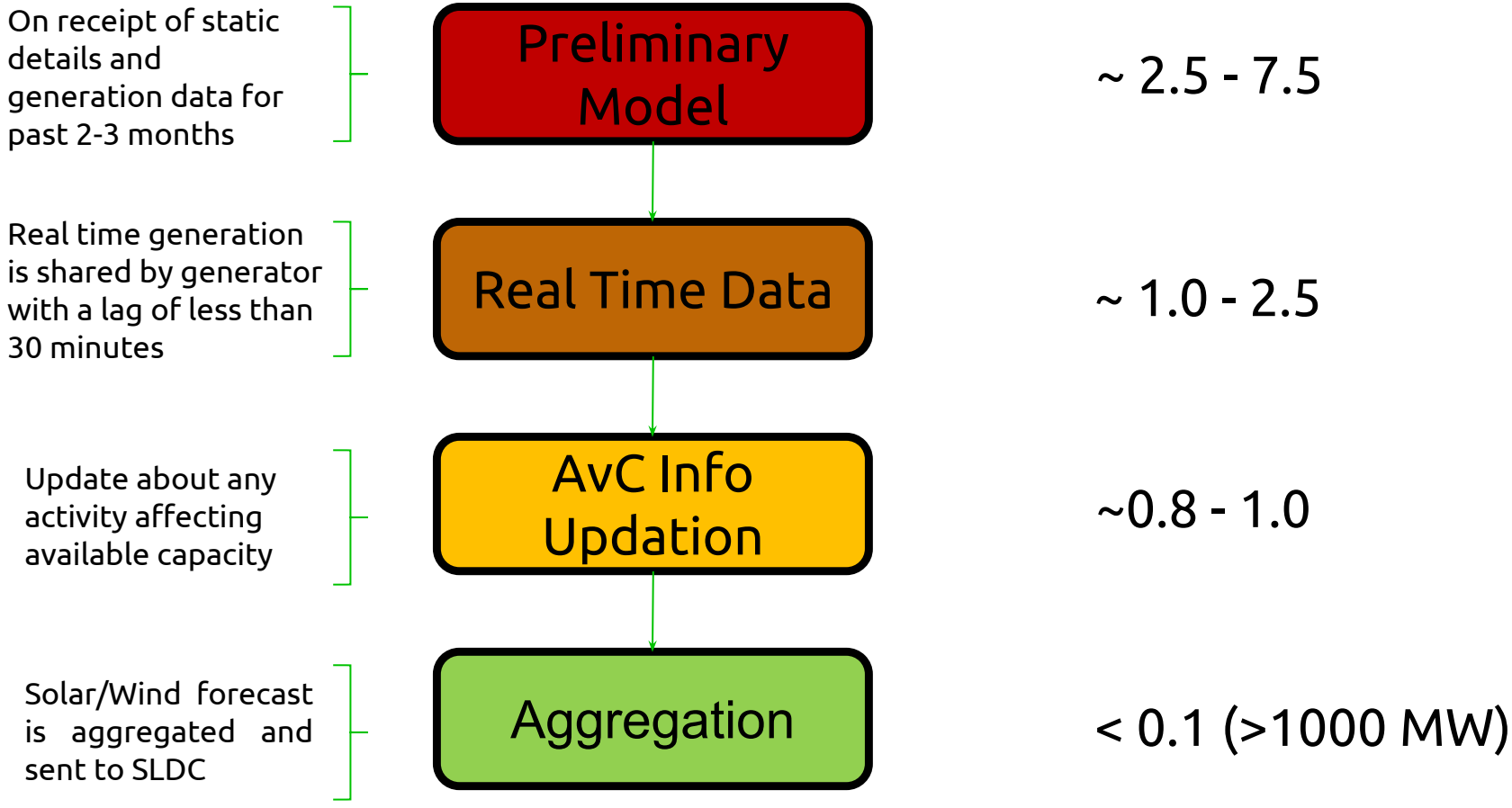
De-pooling approaches

Methodology	Incentive to participate (AvC)	Advantage of aggregation	Simple to calculate	Low potential for dispute
Available capacity	Y	Y	Y	N
Installed capacity	N	Y	Y	Y
Actual generation	N	Y	Y	Y
Actual deviation	Y	N	N	N

Notes:

- De-pooling is yet to be carried out in any state
- Aggregation and resultant low DSM will likely make simple de-pooling approaches attractive

DSM Impact


Expected DSM: Paisa/Unit
On receipt of static details and generation data for past 2-3 months
Preliminary Model
~ 2.5 - 7.5
Real time generation is shared by generator with a lag of less than 30 minutes
Real Time Data
~ 1.0 - 2.5
Update about any activity affecting available capacity
AvC Info Updation
~0.8 - 1.0
Solar/Wind forecast is aggregated and sent to SLDC
Aggregation
< 0.1 (>1000 MW)

Experience of working as a QCA

Issues faced:

- Regulations do not have “teeth” - often there is no immediate action that can be taken if a generator does not comply
  - In Karnataka there are instances of generators not complying
  - Rajasthan allows “disconnection from the grid” (21(2)(b) of approved procedures)

- Metering - issues faced include availability of data from the revenue meters, adequate communication between teams of the TransCo & Discoms
  - SCADA/ telemetry data on many sites is poor or non-existent
  - Some TLSS/MRT personnel not equipped with HHU/Software to download load survey data

Experience of working as a QCA

Issues faced (Contd.):

- Technology and capacity building at SLDCs
  - Schedules still taken on emails - impractical to aggregate
  - DSM accounts have still not been published - various constraints - significant work-load/ data; metering data availability

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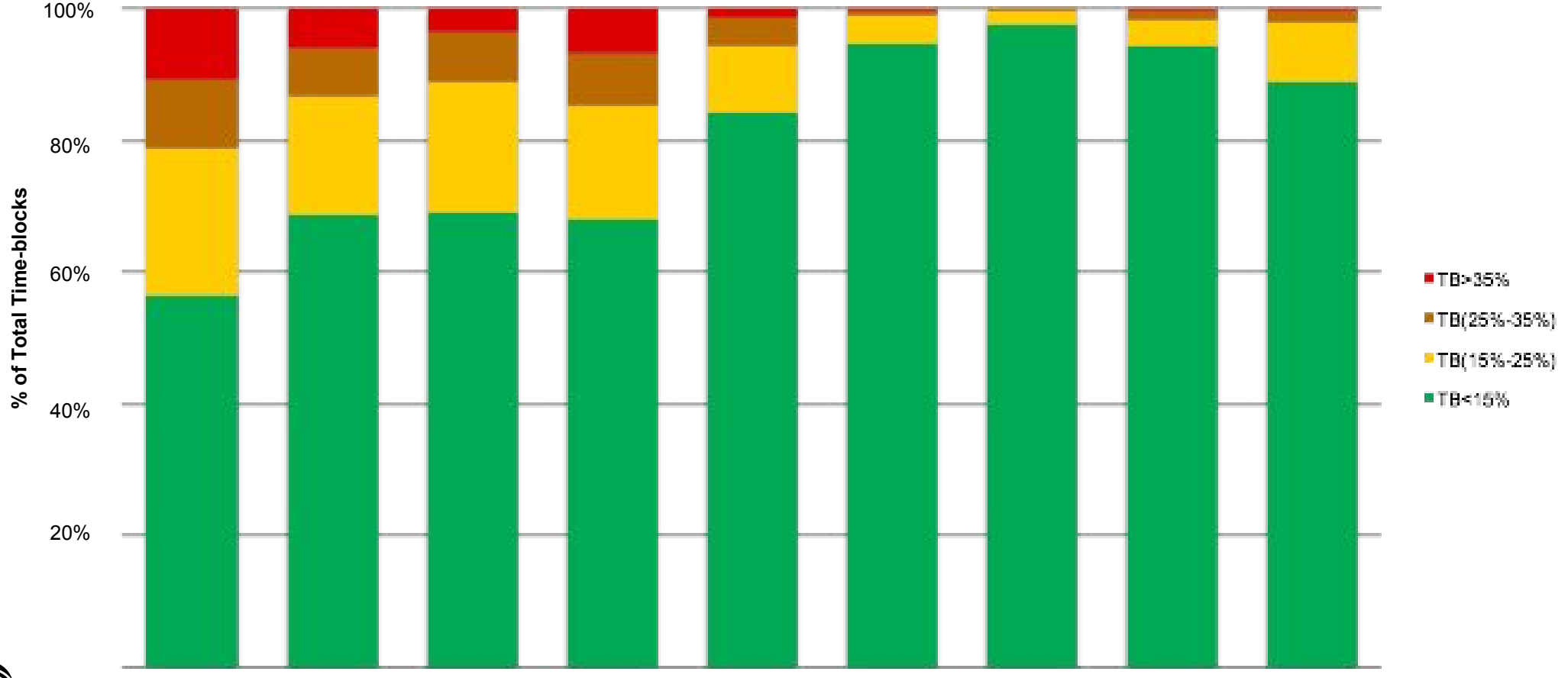
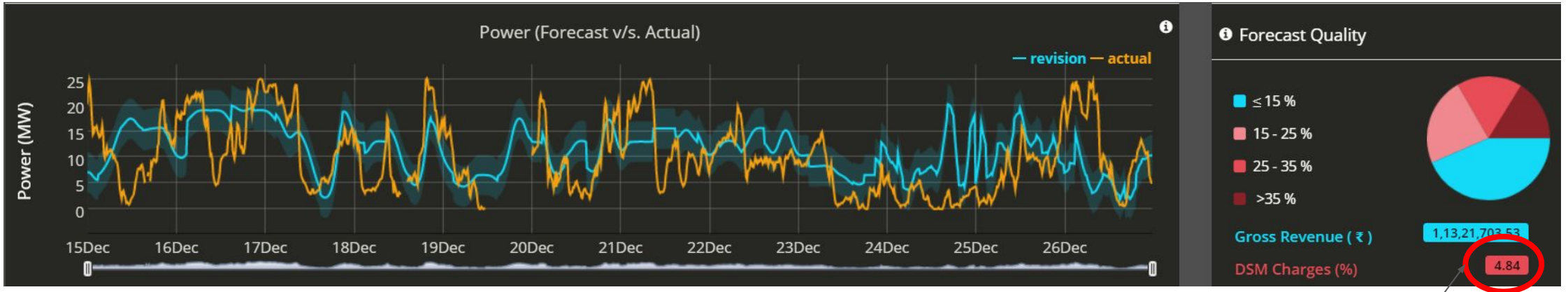
Case Studies - Accuracy improvement over time

Analysis of 9 months data of a wind project of ~120 MW

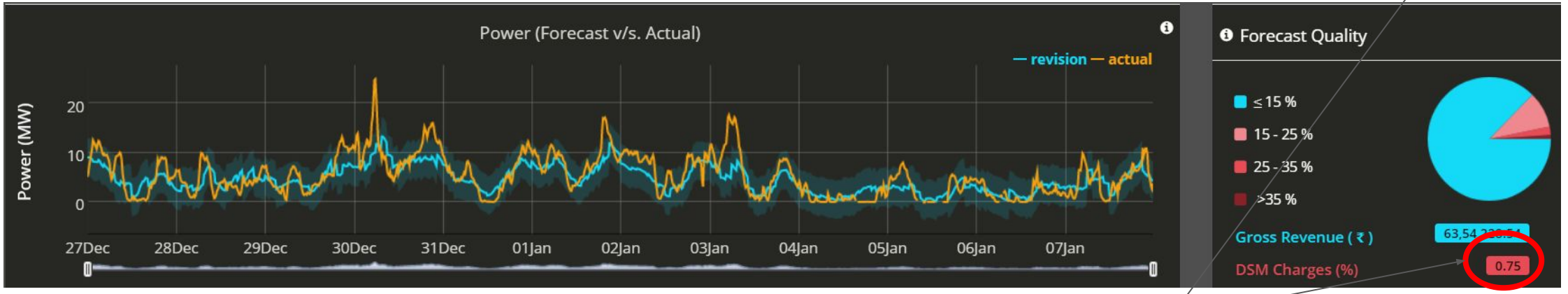


Case Studies - Impact of real-time data on accuracy

Two weeks F&S performance without real-time data



Two weeks F&S performance with real-time data



Significant improvement

Case Studies - Impact of aggregation

about

RECONNECT ENERGY

RECONNECT ENERGY

The Energy Solutions Company

We are market leaders in our businesses

Data Analytics

GRIDConnect

Electricity Markets

clickpower.in

REC Market

Approval under consideration of CERC

RECONNECT ENERGY

Best Indian Start-up, Indo-German Boot Camp (GIZ), Social Impact Lab - **Berlin, Germany**

Top 30 Global Energy Start-ups, NewEnergy Expo-2017, **Astana, Kazakhstan**

Top 50 Indian Start-ups, The Smart CEO - 2016, Bangalore, India

Best Wind Energy Forecaster of the Year (2014/15/16/17), Indian Wind Energy Forum

Technology Start-up Enterprise of the Year (Energy & Utilities) - 2017, 24MRC Network, India

Top 100 Global Energy Start-ups, Start-up energy transition Awards, Berlin, Germany

Equity Partner

INFUSE VENTURES

- India's First Cleantech Venture Fund
- **An MNRE + IIM Ahmedabad** initiative
- **Core Focus – To promote innovation in Indian Clean-Tech space with focus on Energy & Renewables**
- Key venture fund partners of INFUSE are…

Ministry of New and Renewable Energy

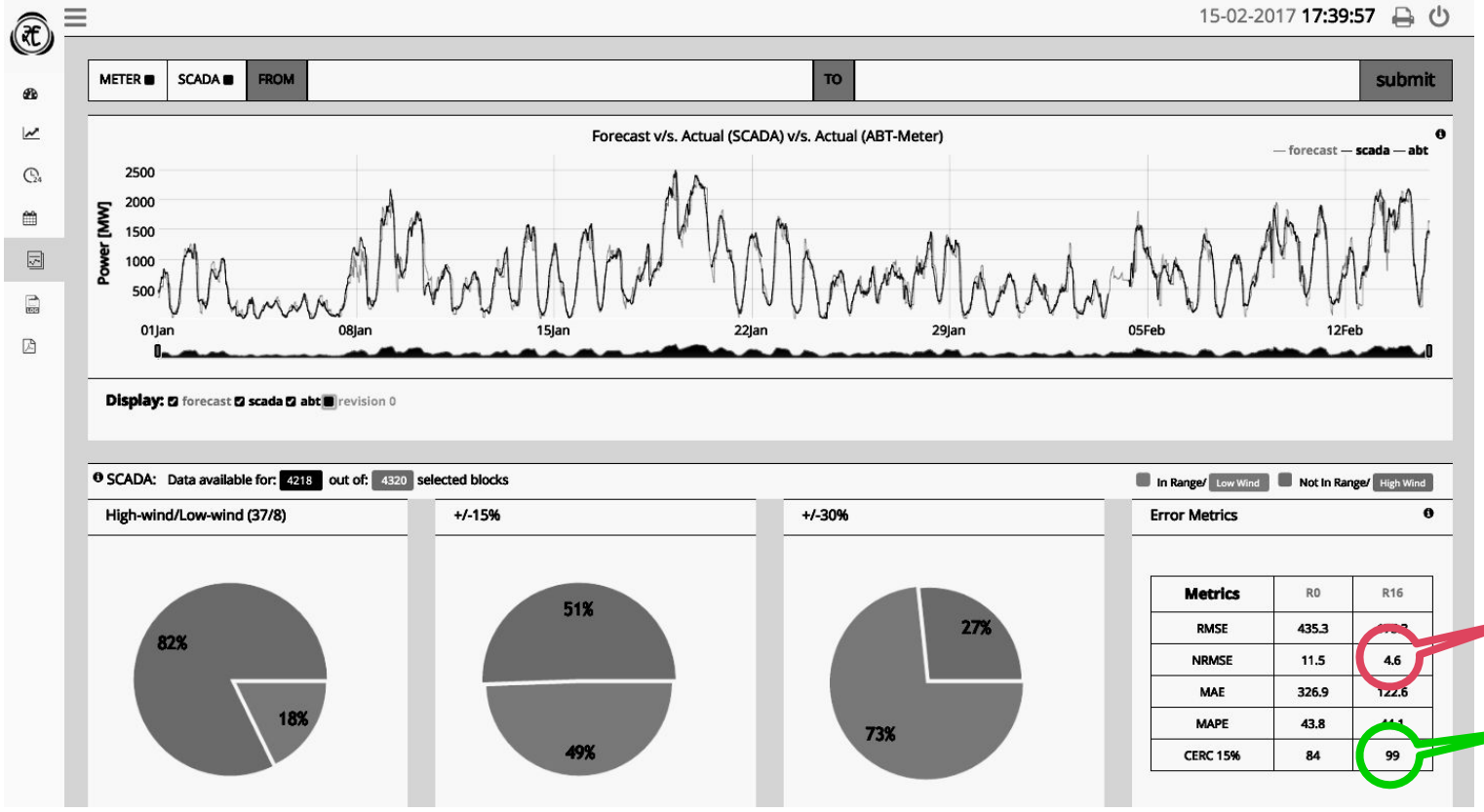
IIM AHMEDABAD

clie

IFC International Finance Corporation WORLD BANK GROUP

bp

GRIDConnect : Proprietary In-house Technology



Black - Actual Power

Light Grey - REConnect Forecast

National Benchmark: 7.0

% Accuracy as per Central Regulator's Definition

★ Technology and IP - Fully Owned and Developed by REConnect Energy

- Technology Stack: Python, R, PhP, mySQL

RECONNECT ENERGY

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