

**MINUTES OF THE FORTY FIRST MEETING**  
**OF**  
**FORUM OF REGULATORS (FOR) HELD AT NEW DELHI**

**DATE** : 27<sup>TH</sup> JUNE, 2014

**LIST OF PARTICIPANTS** : At Annexure-I (enclosed).

**Business Session – I :**

The meeting was chaired by Shri Gireesh B. Pradhan, Chairperson, Central Electricity Regulatory Commission (CERC) and Forum of Regulators (FOR). He extended a warm welcome to all members of the Forum. The Chairperson welcomed Shri S. Akshayakumar, Chairperson, Tamil Nadu Electricity Regulatory Commission (TNERC) who was attending the FOR meeting for the first time. Shri Pradhan also introduced Ms. Shubha Sarma, Secretary, CERC/FOR who was also attending the FOR meeting for the first time.

The FOR thereafter took agenda items for consideration.

**Agenda Item No. 1 :** Confirmation of the Minutes of the 40<sup>th</sup> Meeting of “FOR” held on 02<sup>nd</sup> April, 2014 at Vigyan Bhawan, New Delhi.

The Forum noted and endorsed the minutes of the 40<sup>th</sup> Meeting of FOR held at Vigyan Bhawan, New Delhi on 02<sup>nd</sup> April, 2014.

**Agenda Item No. 2 : To Consider and Approve the Balance Sheet and the Audited Accounts of “FOR” for the year 2013-14.**

Shri Sushanta K. Chatterjee, Joint Chief (Regulatory Affairs), CERC explained the salient features of the Balance Sheet of FOR for the FY 2013-14. The balance sheet and the audited accounts were considered and approved.

**Agenda Item No. 3 : Discussion on Grid Integration of Renewable Energy Sources.**

A presentation on the issues concerning “Grid Integration of Renewable Energy Sources” was made by Shri S.K. Soonee, CEO, POSOCO/NLDC (copy enclosed at **Annexure – II**). In his presentation, he highlighted the following issues :-

- **Overview of Indian Power System**
- **Regulatory Initiatives for RE Integration**
- **Transmission – Key to Reliability & Competition**
- **System Operation**

Shri Soonee presented case studies of different States highlighting inter alia grid operation experience, post implementation of the CERC IEGC and Deviation Settlement Regulations. The presentation depicted the scenarios under which injection/drawl limits imposed by the CERC Regulations were breached by the States and analysed the reasons behind the same. The data analysis done by

POSOCO revealed that in most cases, factors other than variation in renewable energy generation were responsible for breach of the limits specified in the CERC DSM Regulations. He argued that variations in load, tripping of generation etc. caused larger excursions in grid operation than the variation in RE generation and the system was capable of managing such deviations.

He, however, laid emphasis on the need for flexible generation, forecasting of renewable energy and institutionalization of Renewable Energy Management Centres (REMCs) at State and regional level for large scale integration of renewable energy.

After the presentation, the Members of the Forum expressed their views in the light of their experiences on the matter. The following issues were highlighted by the Regulators:-

- ✓ There were instances when the SLDCs in RE resource rich States were forced to back down wind generation due to system constraints
- ✓ POSCO should carry out an analysis after factoring in the total RE generation backed down and the likely impact on grid operation if the entire RE generation (including the generation backed down) were to be integrated.
- ✓ The need for forecasting and scheduling of variable RE generation was, however, appreciated and endorsed.

**Issues raised by MNRE for "FOR" intervention/consideration concerning Renewable Purchase Obligation (RPO).**

A presentation on the issues concerning “Renewable Purchase Obligation (RPO)” was made by Ministry of New & Renewable Energy (MNRE) (copy enclosed at **Annexure – III**). The following issues were highlighted for consideration for the "FOR":-

- Renewable Purchase Obligation was not being complied in all States. It was argued that enforcement of RPO by the State Regulators was critical to success of Government initiatives to augment RE capacity addition in the country.
- RPO compliance costs should be allowed in the ARR either by way of purchase of renewable energy and /or by purchase of RECs.
- The validity of RECs should be extended by at least 6 months till RPOs were complied/enforced regularly in States.
- Generation from renewable energy should be given “Must Run” status and all the electricity generated should be absorbed by the grid and for that renewable energy should be a part of the transmission planning process.
- There should be a provision of "deemed generation" in case SLDC asked renewable generators to back down.
- It was also suggested that the charges for Open Access should be rationalised. It should be on Rs. per unit (kWh) basis instead of Rs. per MW basis considering lower plant load factor of renewable energy projects.
- Emphasis was laid on the need for forecasting and scheduling of wind and solar energy. Renewable Regulatory Fund (RRF) mechanism should be put in place to ensure grid discipline.



- It was suggested that the RECs be issued to Discoms for Procurement of renewable energy beyond their RPO targets.
- Need for promotion of rooftop solar PV projects was emphasised. For this, necessary gross metering and net metering Regulations should be notified by the SERCs based on the FOR model Regulations on net metering.
- Members of the Forum were appraised about the status of separate tariff determined for roof top solar PV and net-metering Regulations notified by some of the SERCs, subsidy schemes for off-grid as well as grid connected rooftop solar PV projects. It was also informed that the MNRE was running the solar city programme wherein they were facing connectivity related issues. It was also informed that the rooftop metering regulations were yet to be notified by the CEA.

The Forum noted the updates on the development of various renewable energy programmes in the country as also the issues highlighted by MNRE. After discussion, the following was agreed :-

- ✓ Members noted the need for enforcement of RPO.
- ✓ National level long term trajectory should be part of Tariff Policy.
- ✓ It was suggested that the concept of Renewable Generation Obligation (RGO) on Conventional Thermal Power Plants need to be introduced. This could solve many of the issues around RPO compliance and differential RPO levels amongst States. This idea should be studied by analysing its impact and suggested way forward should be presented before the FOR.

- ✓ It was also suggested that MNRE could consider purchasing the unsold RECs by using National Clean Energy Fund. Existing coal cess could be increased, if need be.
- ✓ Chairperson, Tamil Nadu ERC suggested that the State had huge potential of wind but it should be harnessed economically while ensuring grid discipline and taking care of the need for proper infrastructure for its evacuation.
- ✓ It was also suggested that bundling of renewable energy with conventional energy should be done to reduce the cost of generation to attract discoms.

## **Business Session – II :**

### **Arrival of Hon'ble Minister of State (I/C) for Power, Coal and New & Renewable Energy for an interaction with the FOR.**

Shri Gireesh B. Pradhan, Chairperson, CERC/FOR welcomed the Hon'ble Minister of State (I/C) for Power, Coal and New & Renewable Energy Shri Piyush Goyal on his arrival. Shri Pradhan briefed the Hon'ble Minister about the role being played by the Forum of Regulators (FOR) in evolving consensus on several critical issues facing the power sector. One of the important functions assigned to the Forum, he highlighted, involved harmonization of regulations in the electricity sector in India. The Forum had taken a number of steps in this direction. All the members of the Forum were then introduced to the Hon'ble Minister. A presentation on the functioning of the Forum was made by Shri Sushanta K. Chatterjee, Joint Chief (Regulatory

Affairs), CERC (copy **enclosed** at **Annexure – IV**). In the presentation, the following issues were highlighted :-

❖ **Functions of the Forum**

❖ **Key Initiatives of the Forum**

In his interaction, Shri Piyush Goyal, Hon'ble Minister of State (I/C) for Power, Coal and New & Renewable Energy appreciated the important role being played by the regulators in furthering reforms in the power sector and sought their cooperation in taking the reforms forward. The Government and the regulators had the collective responsibility to promote development of the sector, and as such a coordinated effort on policy and regulatory fronts would be desirable. The Hon'ble Minister highlighted the need for bringing about efficiency in the entire eco-system of the power sector and for this, he urged that each stakeholder viz., the Government, the Regulator, the regulated entity would have to play its role as envisaged under both law and policy. He believed that a significant part of the cost recovery could be taken care of by efficiency improvement. He emphasised that the regulators were in a better position than the Government in taking bold steps as they were independent and supposed to be immune to extraneous interference/influences. The 2003 Act had significantly enlarged the spectrum of responsibility of the regulators. Now, they had the important role of development of market in electricity. He then highlighted certain specific issues for the considered views of the Members of the Forum:-

- He observed that based on the performance, presently, the power utilities in the country could be categorized into three groups –

- The first group having utilities which were performing on commercial principles and had positive earnings. The tariffs in respect of these utilities were reasonable. Tariffs in case of such utilities were also being determined regularly and timely and adequate flexibility was given to these utilities in their day-to-day functioning. Interestingly, these were the States where the tariffs were on the lower side.
  - The second group of utilities barely managed to run their operations and they were heavily dependent on grant of subsidies by the respective Governments.
  - The third group consisted of the utilities where subsidies were ill-managed, operational flexibility was inadequate, tariffs did not reflect the cost of supply. These were the States where supply to the consumers was the most erratic.
- With due regard to the current state of affairs in the sector, the solutions/course corrective measures could be categorized as short-term, medium-term and long-term.
- The short-term plan could include targeting "low hanging fruits" like improving metering, billing and collection, demand side management and energy efficiency and reducing distribution losses etc., thereby ensuring credibility in the regulatory process.
  - The medium term plan could target for providing (i) 24 x 7 quality power supply to the consumers and (ii) at least 8 – 9 hours of power to the agriculture consumers, within 1,000 days.

- The long-term plan could include measures for providing energy security to the nation for the next 25 years or so.
- The Hon'ble Minister urged the Forum to form Working Groups to work on the following crucial issues and after due deliberations, make recommendations and suggest a road map to the Government :-
  - The requirement for augmentation of generating capacity (thermal, hydro, renewable etc.) in the country be examined and suitable road map be provided.
  - Appropriate measures to meet the challenge of providing (i) 24 x 7 quality power supply to the consumers and (ii) at least 8 – 9 hours of power supply to the agriculture consumers, within 1,000 days, be analyzed and recommended.
  - A framework for renewable power obligations to all thermal power plants (new and existing) be worked out. The group could also suggest possible incentives for better compliance of renewable power obligations.
  - A framework for identifying the scope, mandatory requirements for establishment, functional requisites of Smart Grids be explored and recommendations thereof be made.
  - A framework for drawing up a scheme at national level for removal of transmission congestion, feeder segregation of rural and agriculture consumers, 100% metering be evolved.
  - The possibility of efficient energy management involving off-grid/renewable/water conservation/drip irrigation be explored for its propagation and incentivization.

- The present system of determination of floor price for Renewable Energy Certificates (RECs) could be re-looked.

The Members of the Forum expressed their views on a wide range of issues and specific issues pertaining to their States. It was highlighted that shortage of supply, high level of losses and transmission constraints were some of the major issues facing the sector today. Coal shortage was yet another factor stymieing the growth of the power sector. It was suggested by some Members that e-auction should be stopped, given the current shortage of coal supply for the power sector. On technological intervention for distribution, need for Smart Grid initiatives was emphasised. Specific issues of North Eastern States and Hilly States were also highlighted by the regulators of these States. Some of the other issues highlighted by the Members included the following:-

- Power generated from large hydro projects be treated as renewable energy.
- A separate green corridor should be planned for power evacuation from East / North East.
- Measures to harness solar power in Andaman & Nicobar Islands & Lakshadweep should be initiated in order to protect its bio-diversity as also for the sake energy security given that the islands were dependent on diesel based power generation.
- Conditions laid down in Financial Restructuring Plan be strictly adhered to without allowing any relaxation.
- Feeder segregation resulted in substantial reduction in losses in Punjab and the same model be considered for other states.

- The concept of Hydro Power Purchase Obligation be explored for encouraging hydro power generation.
- A structured plan for R&M and refurbishing / rebuilding old power plants which have completed their useful life be considered.
- Transmission and distribution network should be strengthened along with 100% metering of all categories of consumers in order to achieve substantial reduction in transmission and distribution losses.
- Funds accrued in Power System Development Fund (PSDF) be used for removing congestion in transmission network and suitable augmentation of transmission corridors.
- Principles for allocation of unallocated quota of power under the control of MoP should be reviewed for equitable distribution of power among states.

The Hon'ble Minister responded to the issues raised by the Members of the Forum. He conveyed that

- The issue relating to automatic replacement of all plants which had completed their operational life had been taken up and a decision would be taken shortly for replacing all such plants with new plants which would work on super critical technology. The fuel linkages for such plants would be protected while at the same time prioritising new fuel linkages for meeting additional fuel requirement for enhanced capacities.

- The rationalisation exercise for ensuring coal/fuel linkages to all power plants had been taken up and a road map was being drawn to ensure coal linkages to the nearest plants while allowing imported coal to be used by the plants located in costal areas. Such arrangement would be managed through bi-lateral adjustment based on gross calorific value of the fuel on quarterly payment basis between the power plants. Such arrangement was being considered as an initial step towards un-clogging the fuel transport network.
- Coal India Limited (CIL) had been formally requested to consider reduction of sale of coal through e-auction from the current level of 58 million tonnes to 28 million tonnes. Once CIL finalized its decision on this issue, more coal was expected for power sector.
- CIL had agreed for testing of coal quality at the loading / un-loading point by a pre-agreed agency, in respect of PSUs (State and Central) on an experimental basis for three months and the results thereof would be reviewed for a further suitable decision.
- Efforts were being made to ensure establishment of crushers at all coal mines to enable supply of crushed coal to the plants. Ministry of Environment and Forest was being approached for providing necessary clearances for establishing coal washeries. The possibility of setting up of power plants for using residuals flowing out of the washeries was also under active consideration of the Ministry.



➤ The Hon'ble Minister assured the Forum that the following issues would be examined by MoP –

- The possibility of prescribing of Hydro Power Purchase Obligations for generating/distribution utilities.
- The issue relating to financing agricultural pump sets (with a pay back period limited to four years) as soon as the details, as agreed, were provided by PSERC.

He invited the attention of the members to strive hard to facilitate providing the consumers with 24 x 7 quality power supply and then consider appropriate revision in tariff schedule in a calibrated manner while keeping the sensitivities of the consumers in mind.

The Hon'ble Minister assured a cooperative and collaborative environment for the regulators, which would facilitate a healthy growth of the power sector.

It was requested that best practises adopted by various ERCs be highlighted and disseminated appropriately amongst the members of the Forum. The Hon'ble Minister urged the regulators to ensure timely decision on the matters pending before them as timing of each decision had an element of cost attached to this.

The Hon'ble Minister appreciated and noted the issues raised and suggestions made by the Regulators during the course of the meeting.

Chairperson, CERC / FOR conveyed gratitude on behalf of the Forum, for the Minister's presence and meaningful interaction with the Members of the Forum. He highlighted that the State Regulators had raised issues, including

some generic issues pertaining to their States. However, he noted that not all such issues pertained to regulatory domain. The idea was to orient the Minister about the issues afflicting the sector in general and also to apprise him about the efforts being made by the regulators within the boundary of responsibility cast on them, towards development of the power sector. He assured full cooperation of the regulators in realising the vision enshrined in the Act.

### **Business Session – III :**

#### **Agenda Item No. 4 : Discussion on "Draft Model Regulations on Smart Grid".**

The Forum deferred this item and decided to take up in its next meeting.

#### **Agenda Item No. 5 : Presentation on "Status of Implementation of 'FOR' Model Regulations by various SERCs".**

The Forum noted the status.

#### **Agenda Item No. 6 : Regulatory treatment on the Grant received from the Government under R-APDRP.**

The Forum was apprised about the proposal of the Ministry of Power (MoP) to extend the R-APDRP scheme to the private sector. MoP had requested CER/FOR Secretariat to clarify the “Regulatory treatment of R-APDRP Grant in case of private discoms” and “possibility of its advantage getting transferred to consumers”.

The Forum discussed the issues involved in the context in detail and arrived at the following consensus:

- ✓ The Forum endorsed the proposal of extending the R-APDRP scheme to the private sector with due regard to the fact that the benefit would ultimately accrue to the consumers.
- ✓ As regards regulatory treatment,
  - The need for a careful prudence check of capital expenditure was reiterated. For this, the appropriate Commission could use Capital Cost Bench Mark for distribution system evolved by the FOR, to the extent relevant. The cost estimates of similarly placed projects already available with the financial institutions like PFC, REC for various schemes including R-APDRP schemes for Govt. Owned utilities could also be used for prudence check.
  - It was agreed that the following regulatory treatment of grant as specified in the CERC Tariff Regulations, 2014 should be adopted for treatment of R-APDRP grant as well:

*“9(6) The following shall be excluded or removed from the capital cost of the existing and new project:*

*.....*

*(d) The proportionate cost of land which is being used for generating power from generating station based on renewable energy:*

*Provided that any grant received from the Central or State Government or any statutory body or authority for the execution of the project which does not carry any liability of repayment shall be excluded from the Capital Cost for the purpose of computation of interest on loan, return on equity and depreciation”*

✓ It was also agreed that this dispensation be extended prospectively.

A vote of thanks was extended by Ms. Shubha Sarma, Secretary, CERC/FOR. She conveyed her sincere thanks to all the dignitaries present in the meeting. She also thanked the staff of “FOR” Secretariat for their arduous efforts at organizing the meeting.

The meeting ended with a vote of thanks to the Chair.

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**LIST OF PARTICIPANTS ATTENDED THE FORTY FIRST MEETING**  
**OF**  
**FORUM OF REGULATORS ( FOR )**  
**HELD ON 27<sup>TH</sup> JUNE, 2014 AT NEW DELHI**

S. No.	NAME	ERC
01.	Shri Gireesh B. Pradhan Chairperson	CERC – in Chair.
02.	Dr. V. Bhaskar Chairperson	APSERC
03.	Shri Naba Kumar Das Chairperson	AERC
04.	Shri Digvijai Nath Chairperson	APSERC
05.	Shri Narayan Singh Chairperson	CSERC
06.	Shri P.D. Sudhakar Chairperson	DERC
07.	Shri Subhash Chander Negi Chairperson	HPERC
08.	Shri S.K. Chaturvedi Chairperson	JERC for Goa & All UTs except Delhi
09.	Shri M.R. Sreenivasa Murthy Chairperson	KERC
10.	Shri T.M. Manoharan Chairperson	KSERC
11.	Shri Rakesh Sahni Chairperson	MPERC
12.	Shri Donray A. Shishak Chairperson	NERC
13.	Shri Satya Prakash Nanda Chairperson	OERC
14.	Shri Vishwanath Hiremath Chairperson	RERC
15.	Shri T.T. Dorji Chairperson	SSERC

16.	Shri S. Akshayakumar Chairperson	TNERC
17.	Shri Desh Deepak Verma Chairperson	UPERC
18.	Shri S.C. Jha Member	BERC
19.	Dr. M.K. Iyer Member	GERC
20.	Shri M.S. Puri Member	HERC
21.	Shri G.M. Khan Member	J&KSERC
22.	Shri T. Munikrishnaiah Member	JSERC
23.	Shri A. Chhawnmawia Member	JERC for Manipur & Mizoram
24.	Shri Virinder Singh Member	PSERC
25.	Shri C.S. Sharma Member	UERC
26.	Ms. Shubha Sarma Secretary	CERC/FOR
27.	Shri Sushanta K. Chatterjee Joint Chief (RA)	CERC
<b>SPECIAL INVITEES</b>		
28.	Shri M. Deena Dayalan Member	CERC
29.	Shri A.K. Singhal Member	CERC
30.	Ms. Jyoti Arora Joint Secretary	MOP
31.	Shri Alok Srivastava Joint Secretary	MNRE
32.	Shri Tarun Kapoor Joint Secretary	MNRE
33.	Shri P.C. Maithani Director	MNRE
34.	Shri A.K. Saxena Chief (Engg.)	CERC
35.	Shri M.K. Anand Chief (Fin.)	CERC

# Grid Integration of Renewable Energy Sources

# Outline

- **Overview of Indian Power System**
- **Regulatory Initiatives for RE Integration**
  - CERC IEGC Regulations, CEA Technical Standards
- **Transmission – Key to Reliability & Competition**
  - Green Corridors
  - Standing Committee Deliberations
  - Transmission Plans of Renewable Rich States
  - Flexible Transmission
- **System Operation**
  - Forecasting
  - Balancing Requirement
  - Recent events
  - Impact of wind variability on deviations
  - Flexible Generation
  - Renewable Energy Management Centres (REMCs)



# Some Typical Numbers ...

## Power System Related

Installed Capacity:

**248 GW**

Renewables Installed Capacity:

**31 GW – Wind (21 GW), Solar (2 GW), Small Hydro (3 GW)**

No. of 400kV & above Trans.

Line: **1050 Nos.**

**765 kV (35 Nos.)**

Number of Generating Units:

**1750 Nos.**

**500 MW & above (140 Nos.)**

HVDC Links (BTB & Bipole):

**9 Nos.**

## Grid Operation Related

Peak Demand Met:

**132 GW**

Energy Met (Avg.):

**3100 MU/day**

Max. Wind Generation:

**200 MU/day**

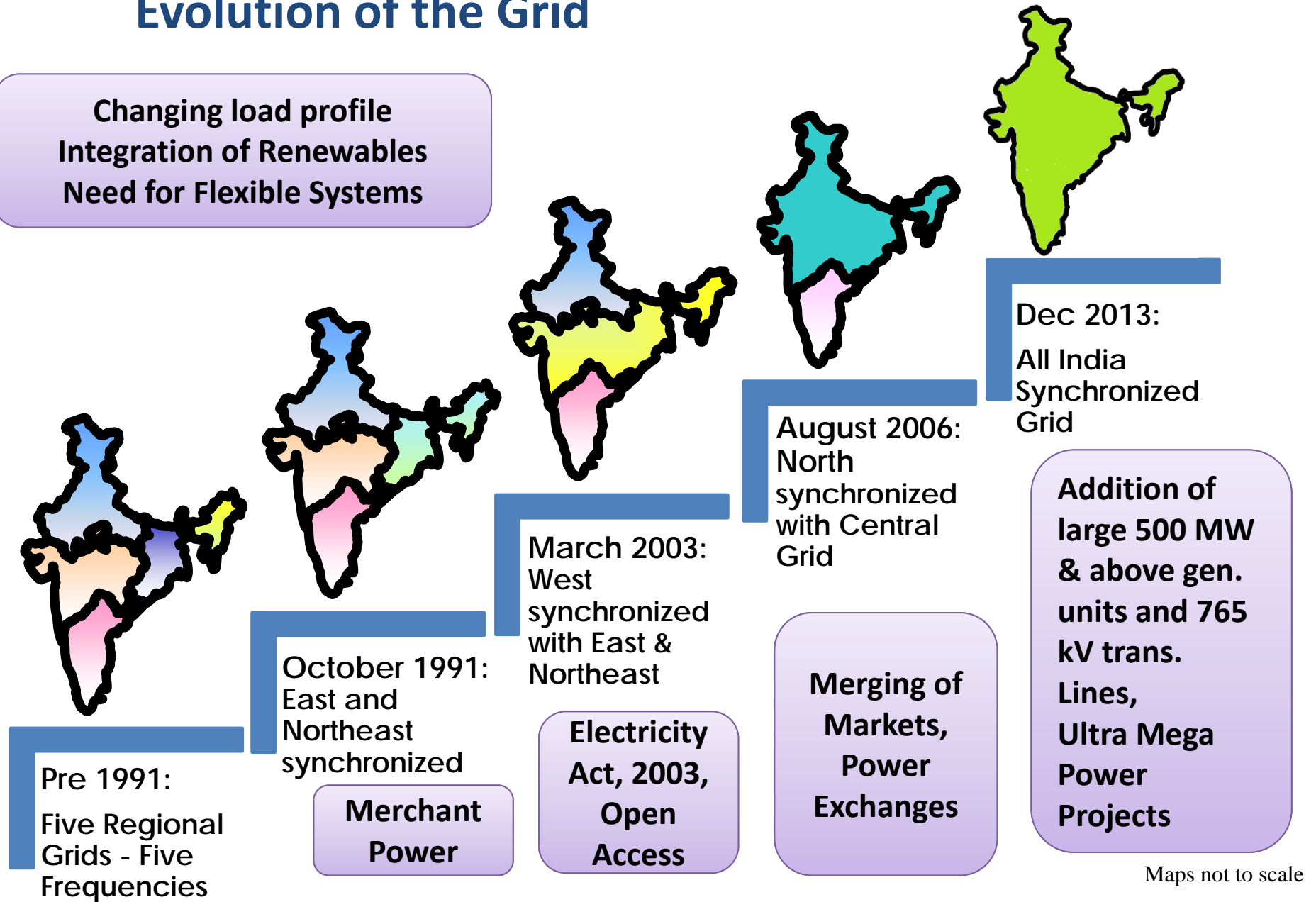
Short Term Open Access:

**240 MU/day**

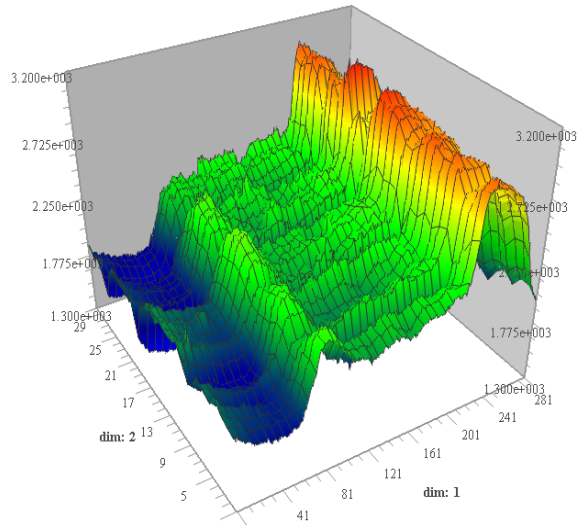
Inter-regional Exchange:

**200 MU/day**

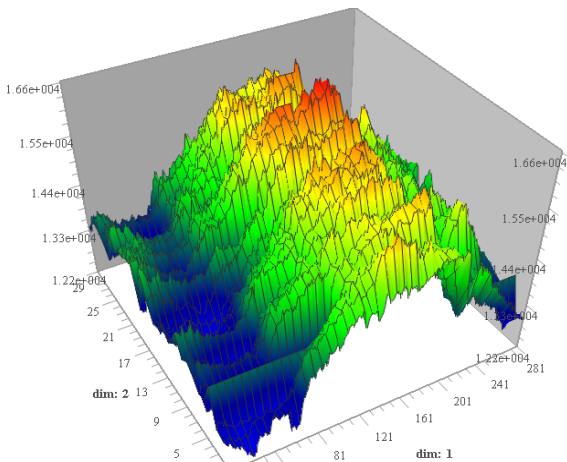
# Evolution of the Grid



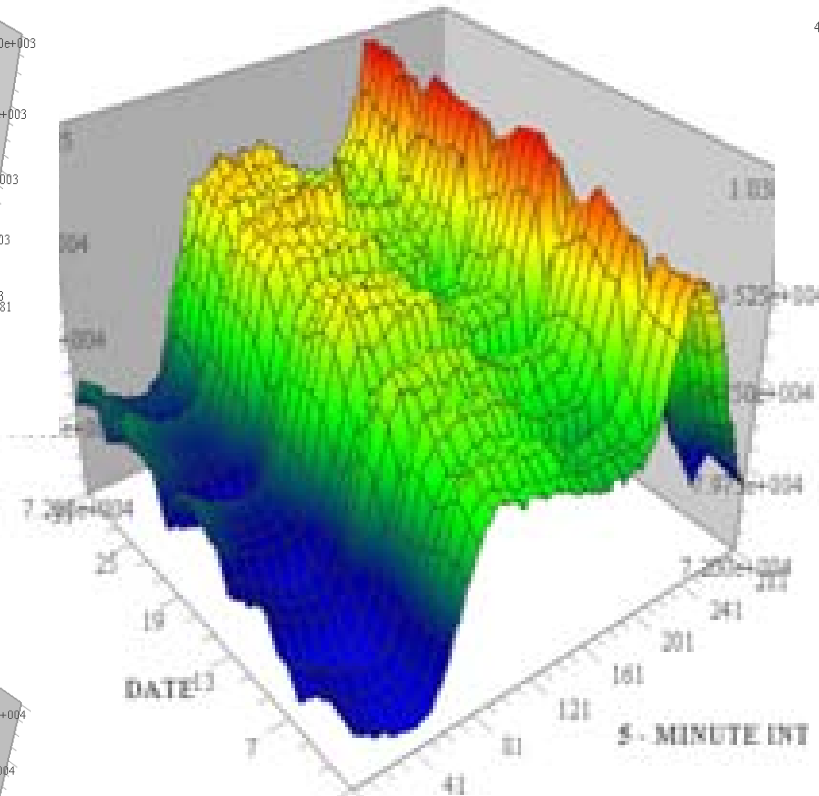
# Diversity in Demand in different Control Areas



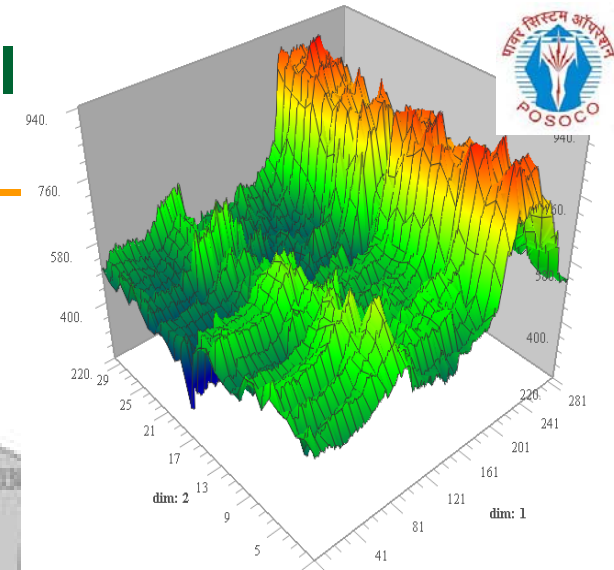
Kerala



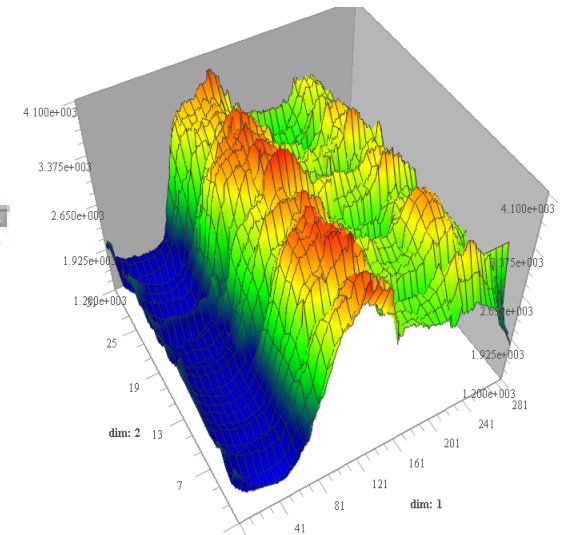
Maharashtra



All India

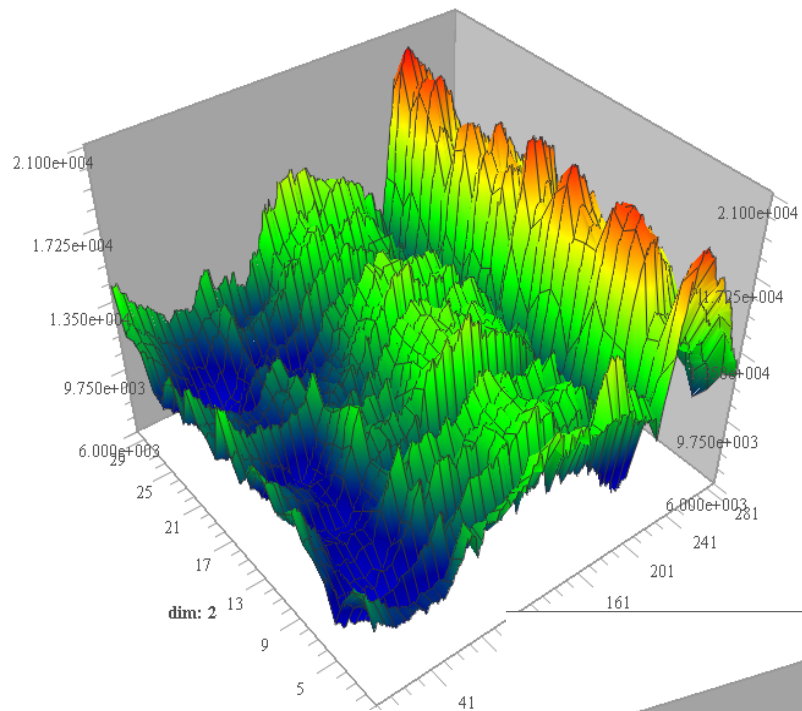


Assam

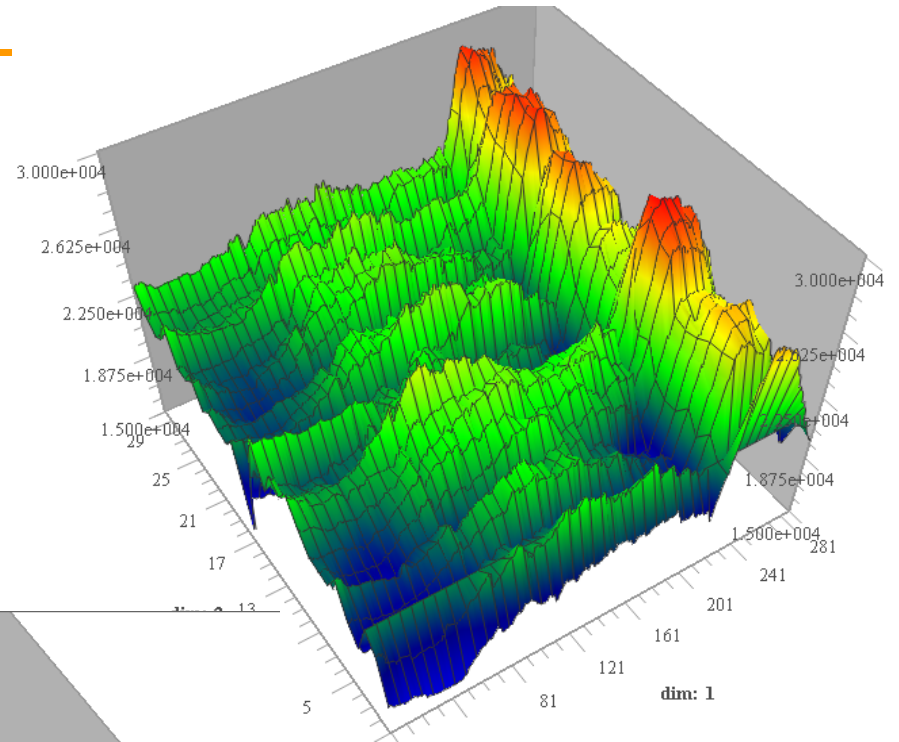


Delhi

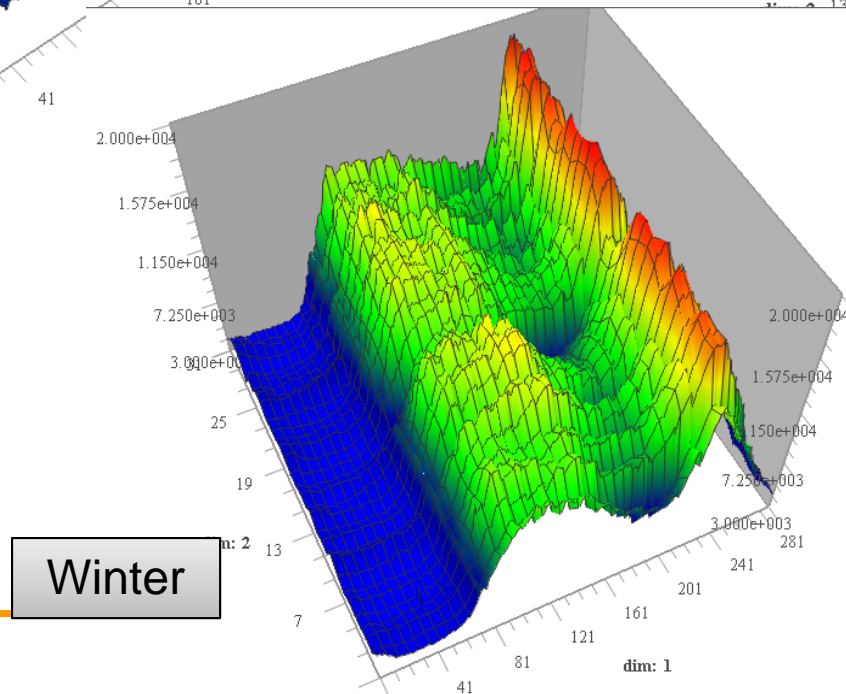
# Variation in Hydro Generation



Summer



Monsoon



Winter

# Regulatory Framework – IEGC, 2010

- **IEGC Clause 5.2 (u)**
  - **Special requirements for Solar/ wind generators**
  - Solar and wind power - must-run station.
  - Back down generation / Curtail VAr drawl/injection on consideration of grid security or safety of any equipment
  - Data Acquisition System facility - SLDC/RLDCs
- **IEGC Clause 3.4(b)-(vii)**
  - CTU shall carry out planning process
  - Renewable capacity addition plan issued by MNRE

# Regulatory Framework – IEGC, 2010

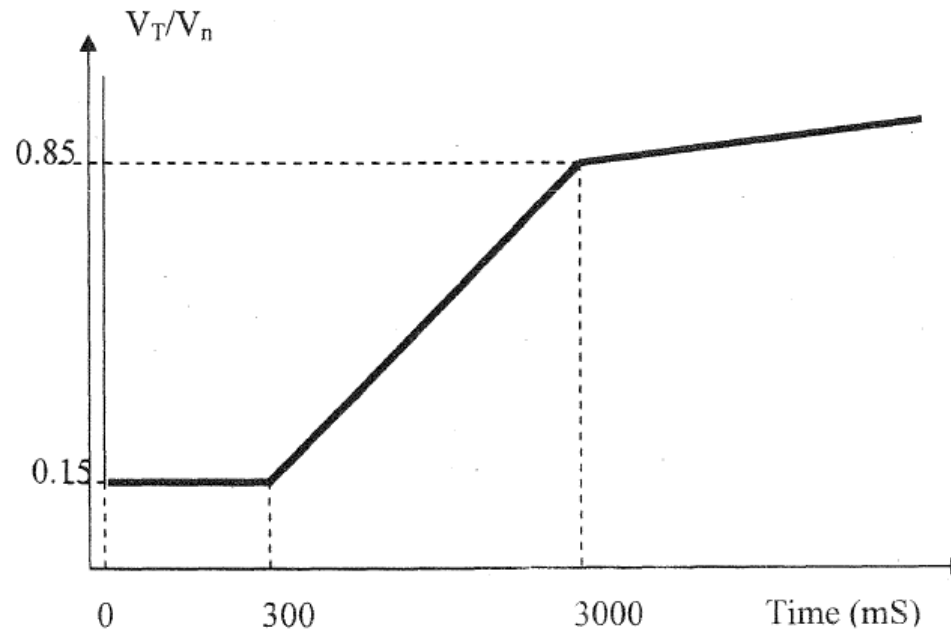
- **RRF Mechanism (IEGC) - Clause 6.1(d)**
- **Clause 6.5 (23) - Special dispensation for scheduling of wind and solar generation**
- **Wind**
  - W.e.f 1.1.2011, Scheduling - 10 MW & above, 33 kV & above
  - Revision of Schedule - from 6<sup>th</sup> time-block
  - Maximum of 8 revisions for each 3 hour time slot
- **Solar**
  - Schedule of solar generation to given to RLDC
  - Modification of schedule by RLDC– if not realistic

## Amendment: CERC Grid Connectivity Regulations '09

- **7th September, 2010 (Second Amendment)**
  - Threshold capacity for connecting to inter-State grid reduced to 50 MW for RE projects
  - Capacity less than 50 MW - can collectively aggregate 50 MW and above for connectivity
- **26th March, 2013 (Third Amendment)**
  - 5 MW to 50 MW - Renewable Capacity
  - Developed by a generating company in its existing generating station
  - Connectivity to the existing connection point with ISTS through the electrical system of the generating station

## Regulatory Framework – CEA (Technical Standards for Connectivity to the Grid) Amendment Regulations, 2013

- B2(1) Power factor within the limits of **0.95 lagging to 0.95 leading.**
- B2(3) Fault Ride Through provisions **when voltage at the interconnection point on any or all phases dips up to the levels depicted**



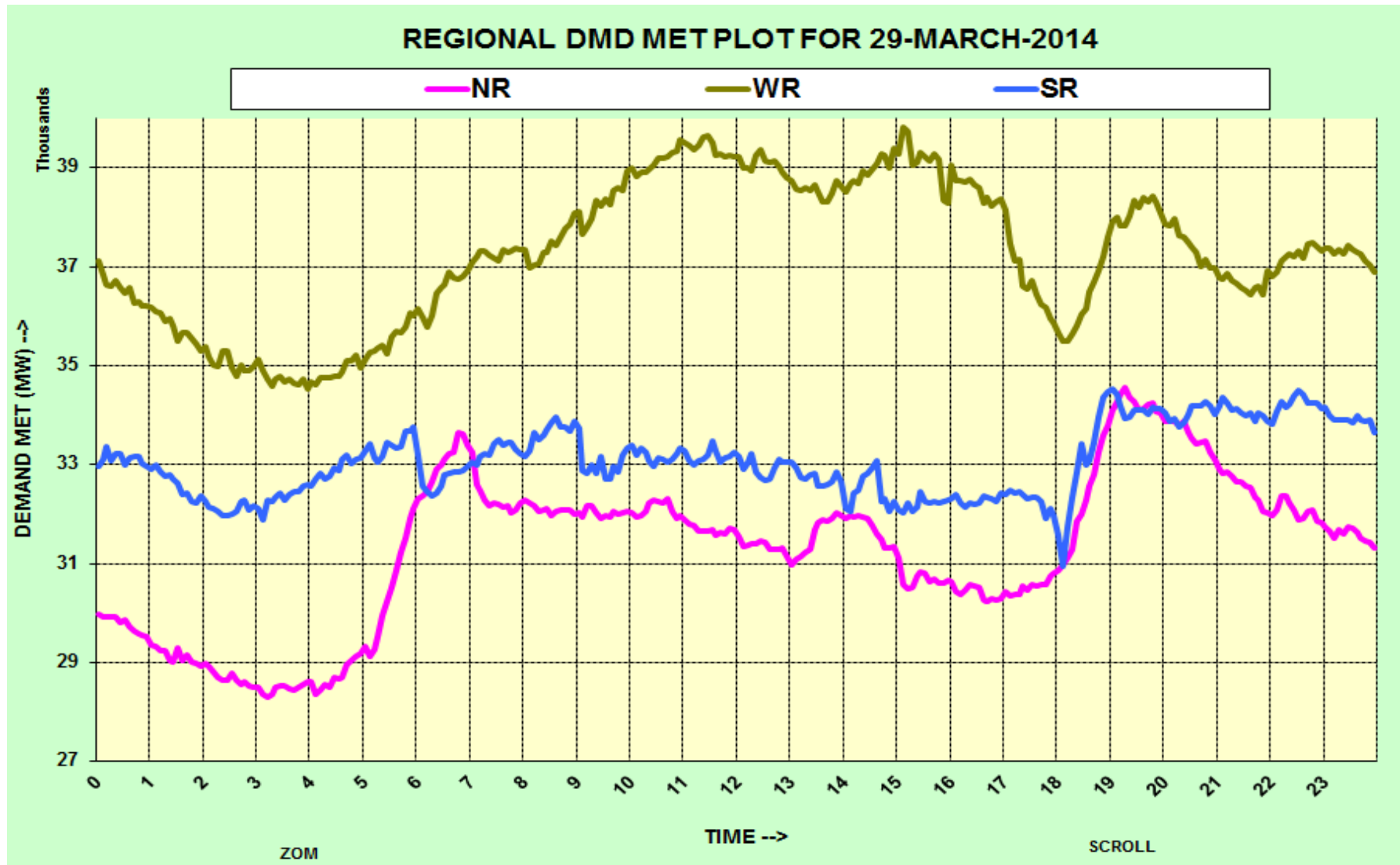
Where

$V_T/V_n$  is the ratio of the actual voltage to the nominal system voltage at the interconnection point

- B2(4) **control active power injection** in accordance with a set point, based on the directions of the **appropriate Load Despatch Centre...**

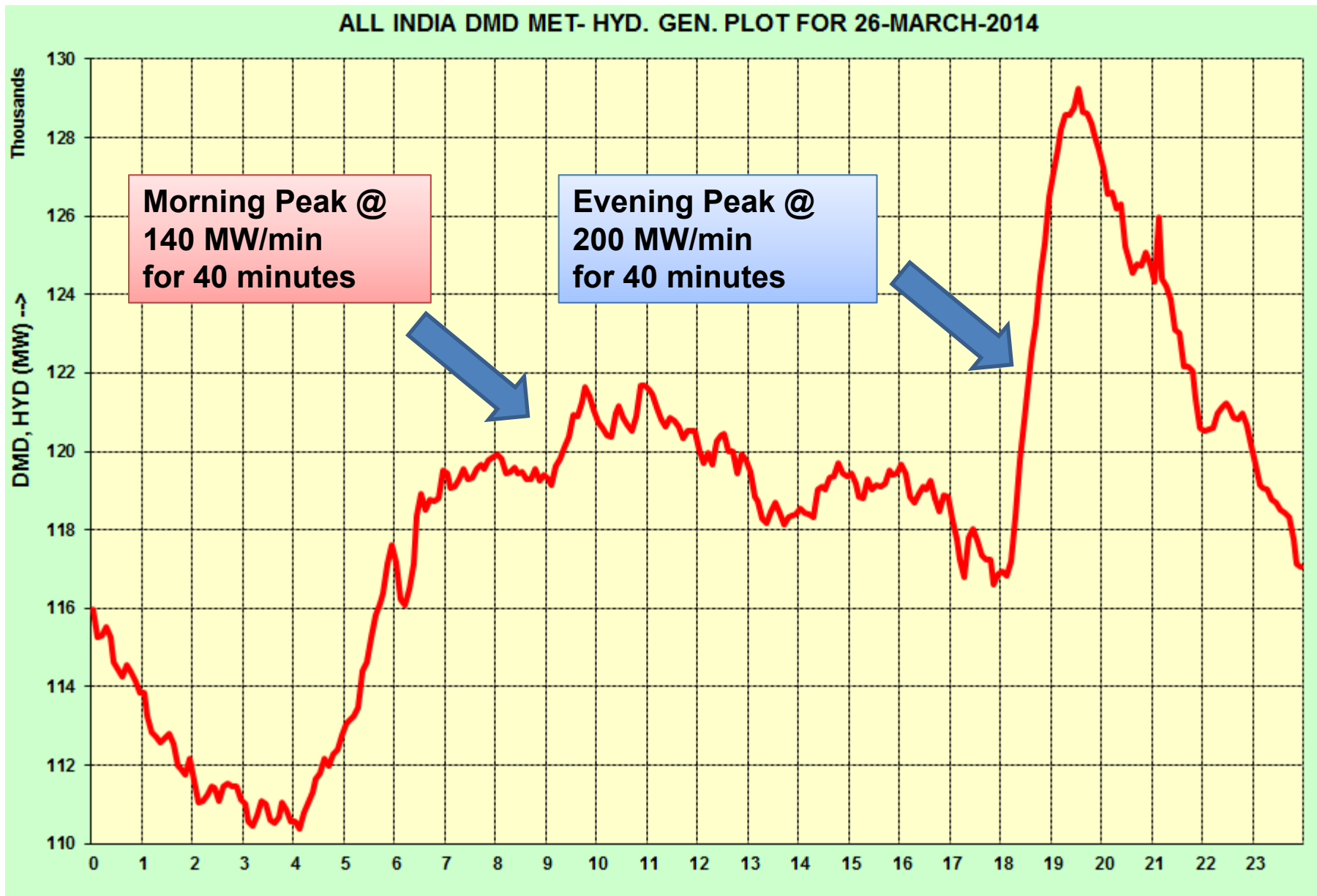


# Regional Geographical Diversity

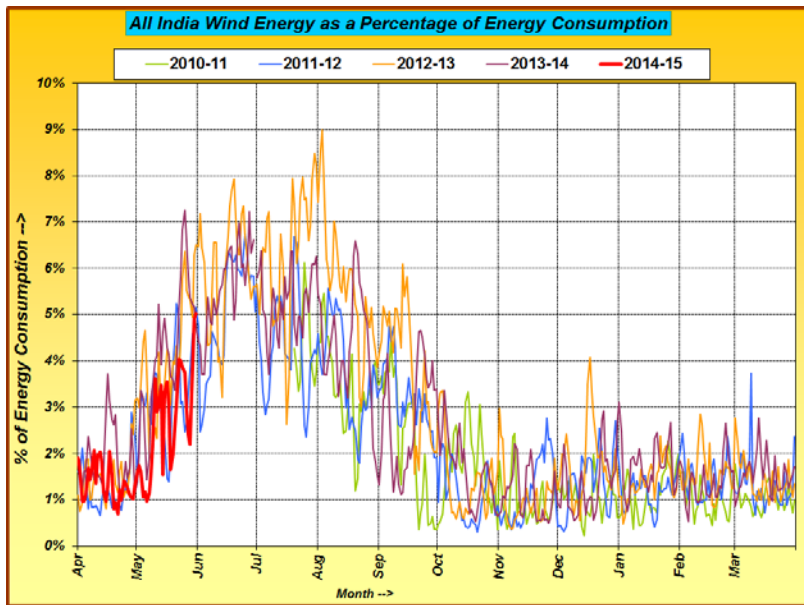


*Diversity on account of geographical location, seasons, time of day, load, etc.*

# Typical Load Curve



# All India Wind Penetration (in Energy terms)

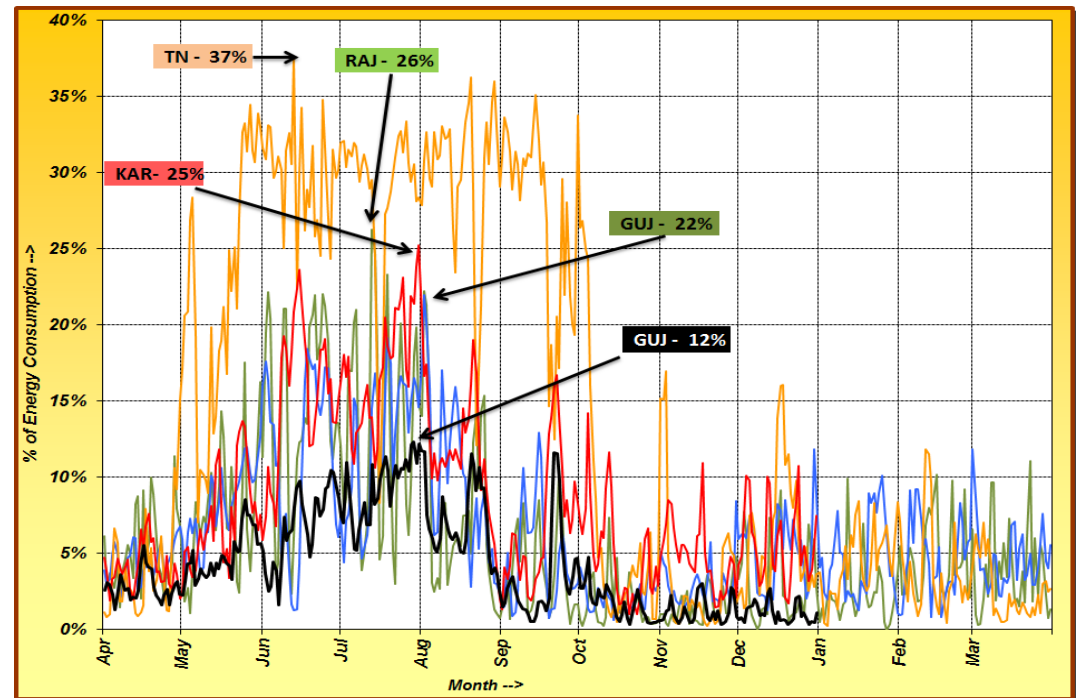


→ High Wind generation during June to August.

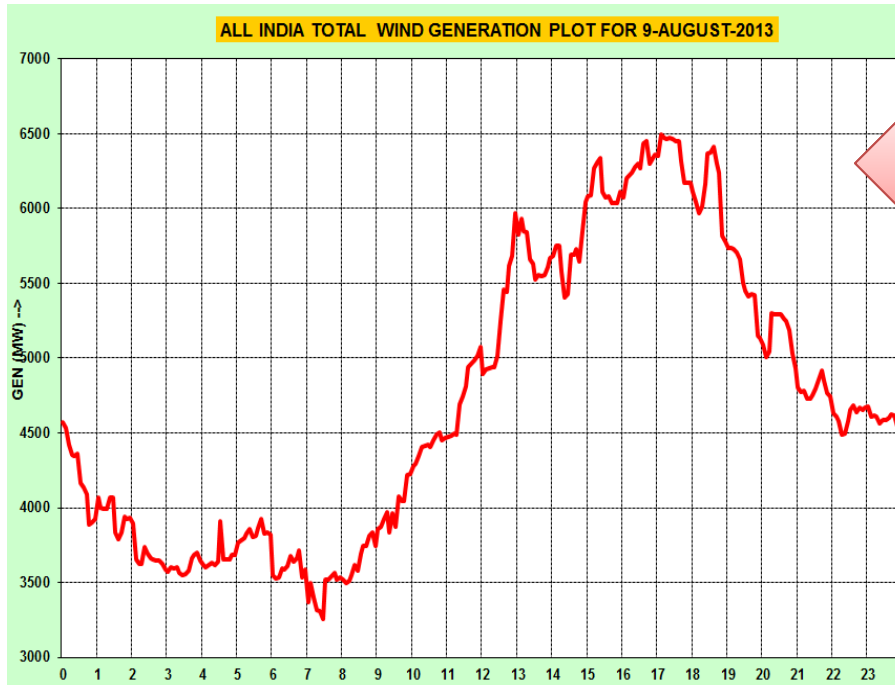
→ All India level penetration – 9% (max achieved)

→ High Penetration in States:

1. Tamil Nadu (~ 35%)
2. Rajasthan (~ 25%)
3. Karnataka (~ 25%)
4. Gujarat (~ 22%)
5. Maharashtra (~ 12%)



# RE Variation Time Constant – In Hours

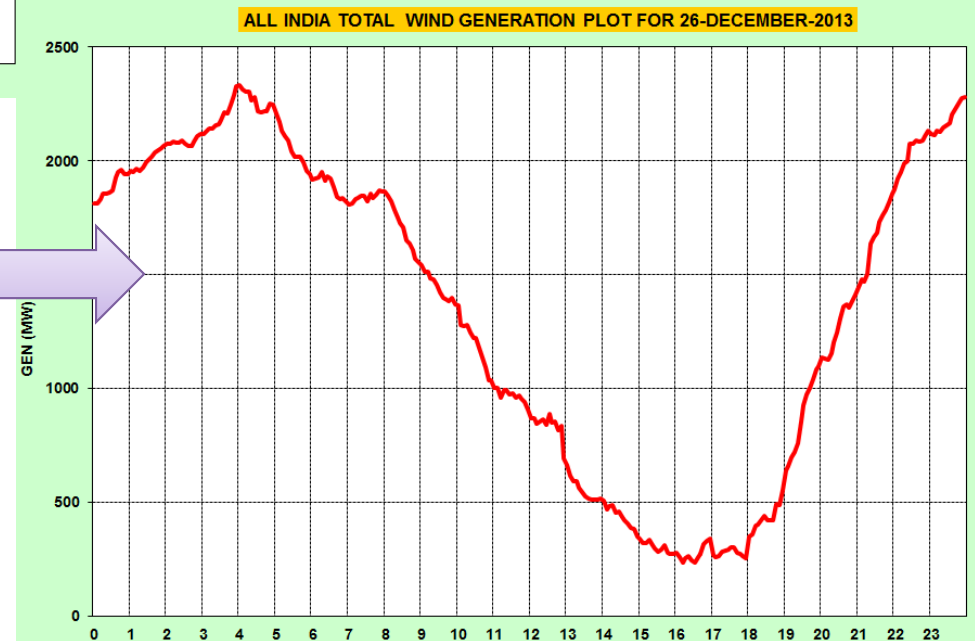


High Wind Period

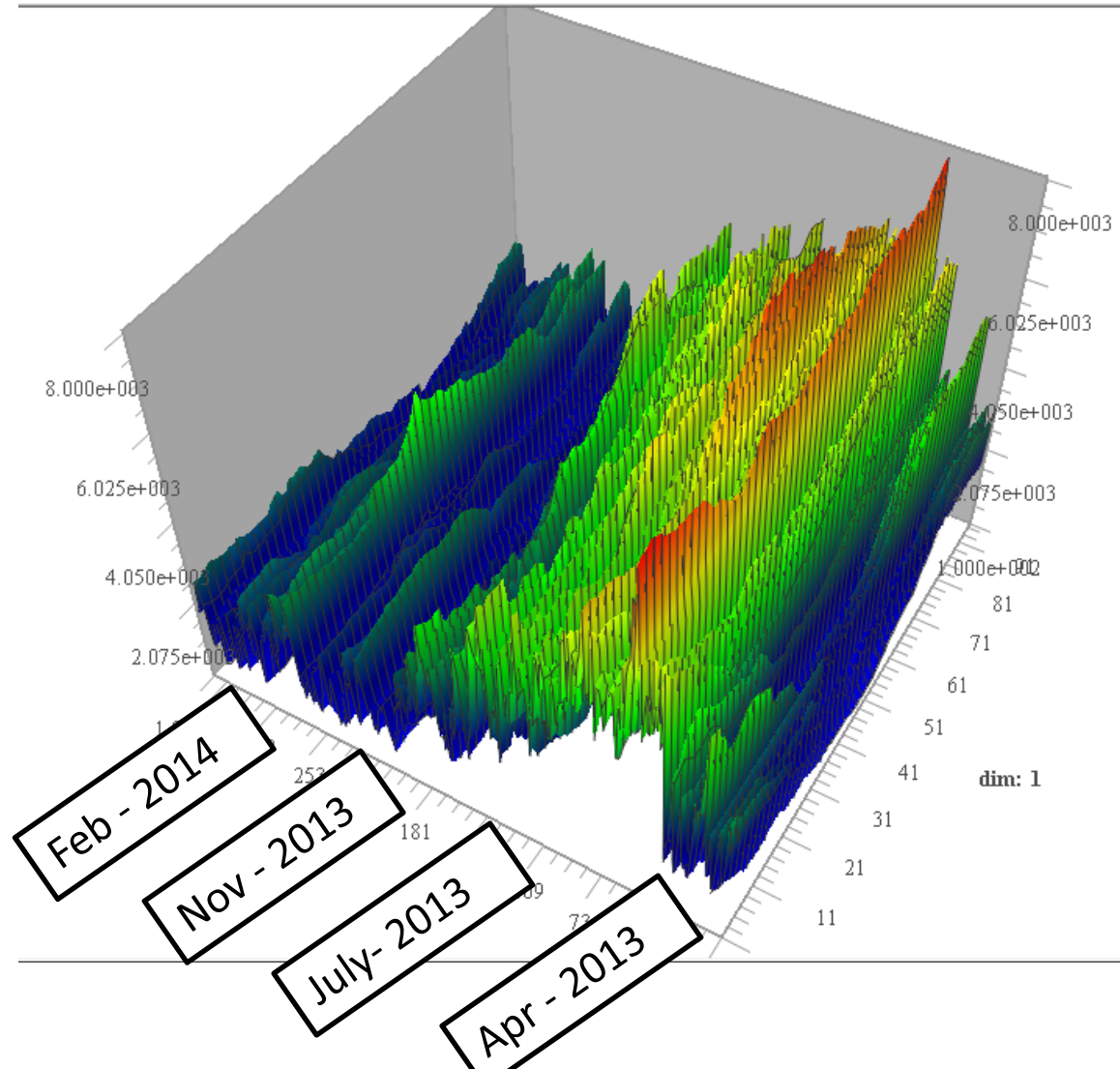
Variation from 3500 MW at 0800 hrs to 6500 MW at 1700 hrs (9 hours)

Low Wind Period

Variation from 2500 MW at 0400 hrs to 250 MW at 1700 hrs (13 hours)

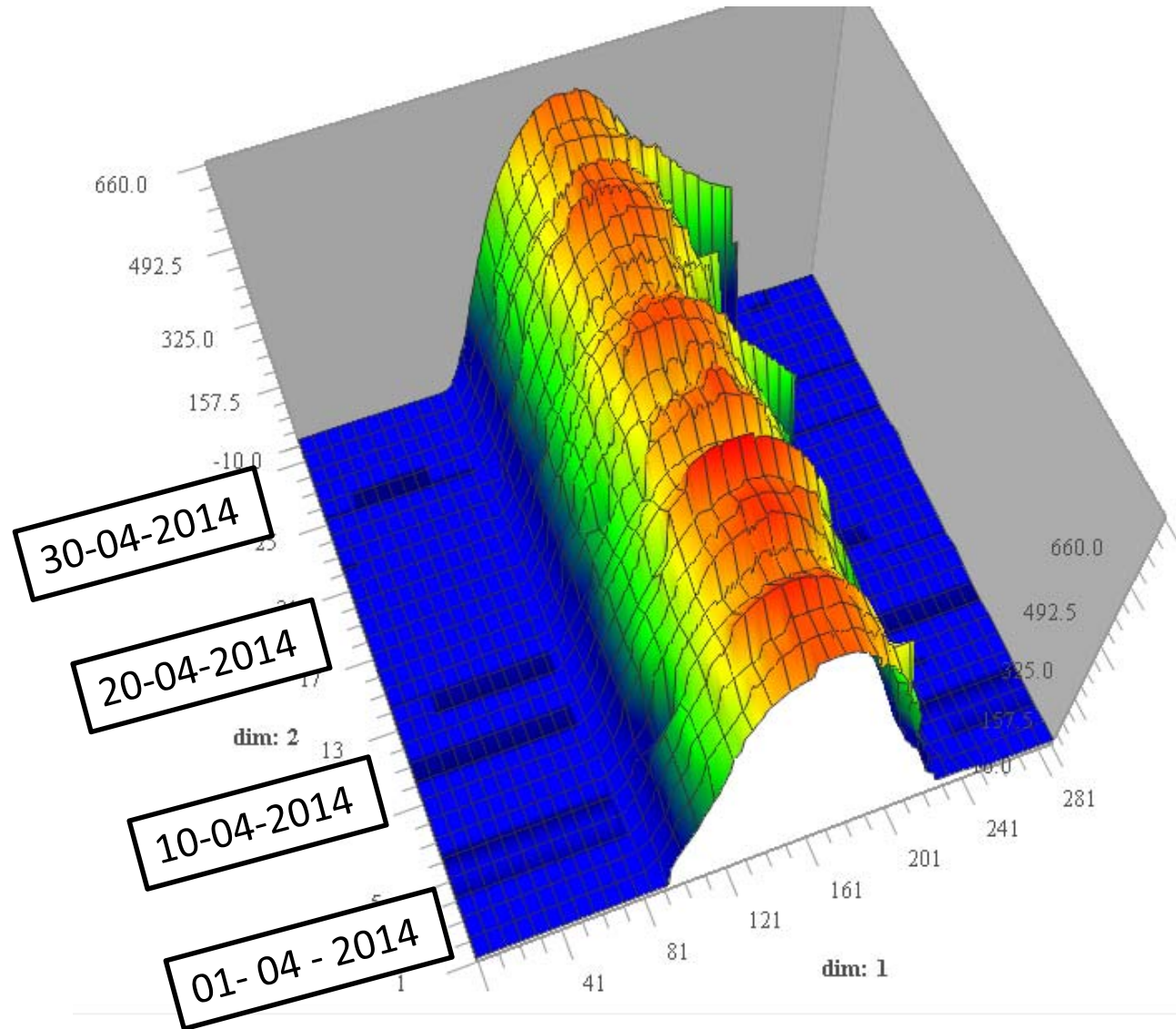


# All India Wind Generation 2013-14



\*SCADA Data

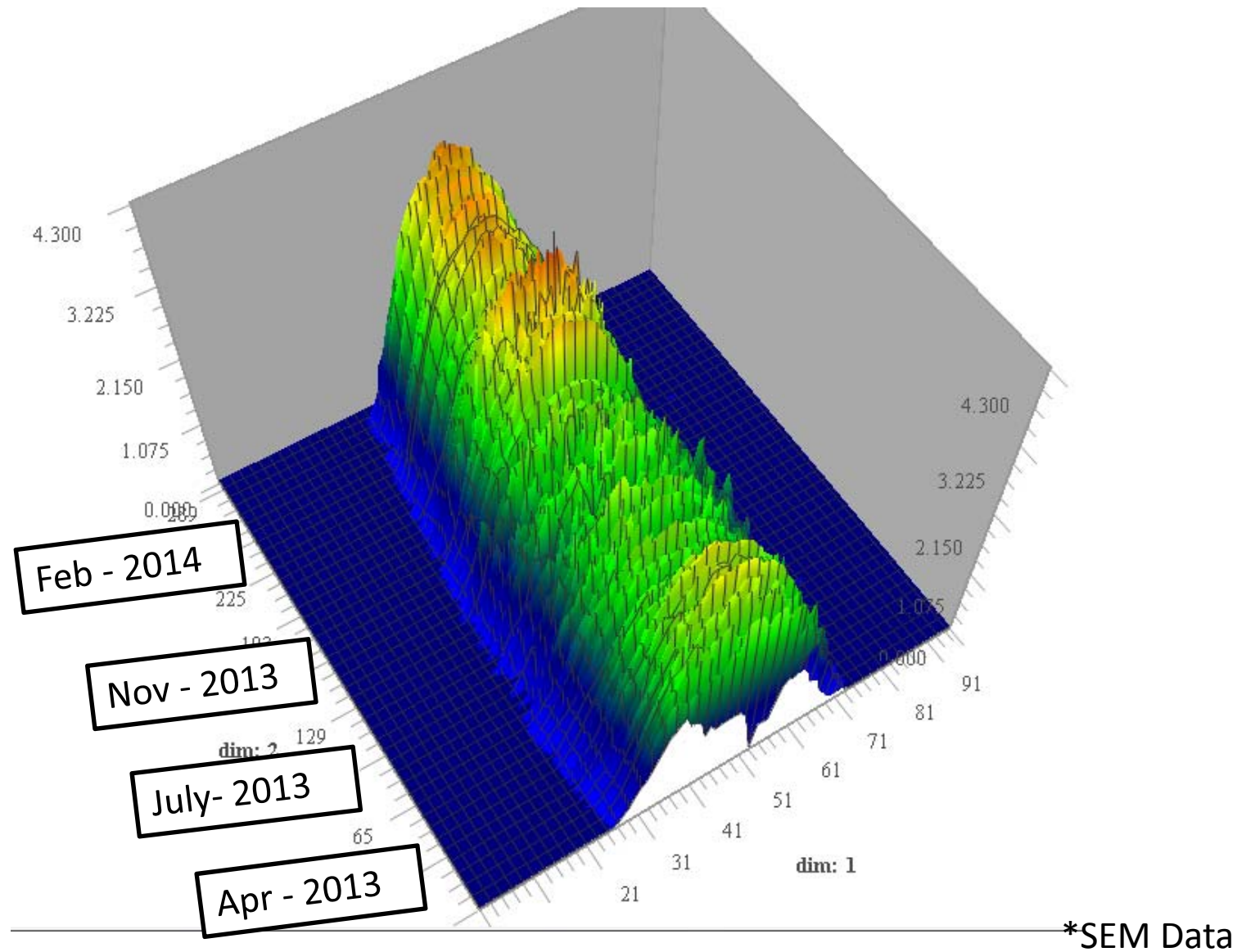
# Gujarat Solar Generation for April- 2014



\*SCADA Data



# Dadri Solar Generation for 2013 - 14



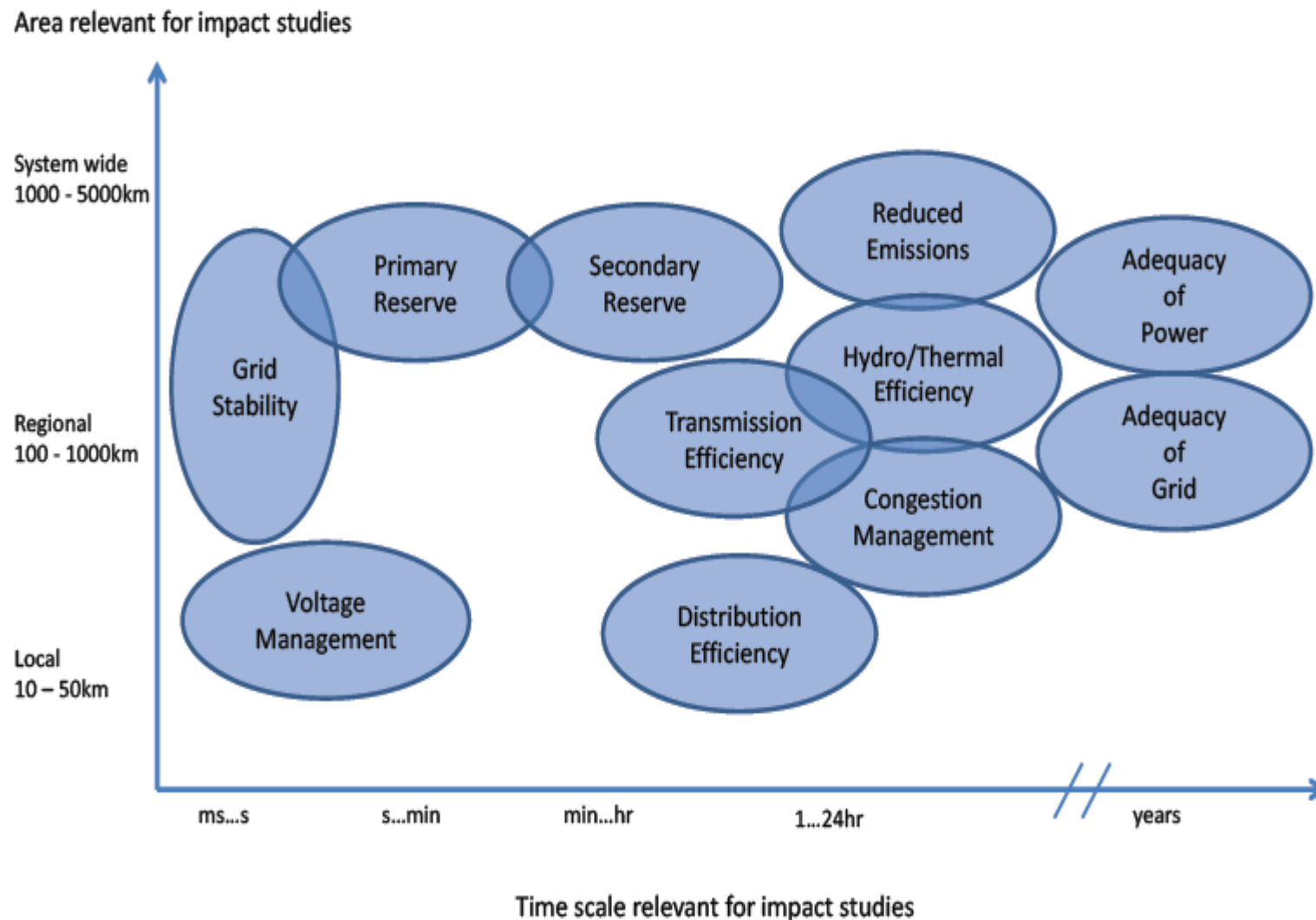
# Challenges in Renewable Energy Integration

---

- **Variability and Intermittent Generation**
  - **Frequency fluctuations:**
    - due to generation or load loss
    - poor Frequency Response Characteristics (FRC) of individual sub-systems
  - **Absence of Fault Ride Through (FRT) capabilities**
  - **Low voltage situation - heavy wind injection – Tamil Nadu:**
    - MVAR absorption by the wind generators
    - High level of loading on weak underlying network
-



# Operational / Technical Requirement of Large Scale Wind/Solar Integration



Source:- Adapted from (Holttinen H., et al., 2009)



Nuclear, Coal, Gas and Liquid movement through rail and pipelines



Renewable energy movement is through transmission corridors only

Transmission Relieving Load on Other Infrastructures !!

# Green Energy Corridors

## GREEN ENERGY CORRIDORS Transmission Plan for Envisaged Renewable Capacity

**₹ 42,000 crore investment in transmission for 40 GW**

<ul style="list-style-type: none"><li>❖ Planning of intra-State/inter-State Transmission requirements</li><li>❖ Provide Mechanism to address Wind/Solar generation uncertainty<ul style="list-style-type: none"><li>• Forecasting of generation</li><li>• Provision of flexible generations, reserves</li><li>• Demand side Management</li><li>• Energy Storage</li><li>• Policy and Regulatory Framework</li></ul></li></ul>	<ul style="list-style-type: none"><li>❖ Study Report on Green Energy Corridors<ul style="list-style-type: none"><li>❑ Submitted to MNRE/ CERC/ CEA/ Planning Commission/ MoP/ MoF</li><li>❑ Inputs from- MNRE, Forum of Regulators, State Nodal Agencies, State Transmission Utilities and CERC</li><li>❑ Transmission System classified into:<ul style="list-style-type: none"><li>• Connectivity Transmission System</li><li>• Intra-State Strengthening</li><li>• Inter-State Transmission System</li></ul></li></ul></li></ul>
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**Intra-State TS Strengthening: ₹ 20,000 crore**

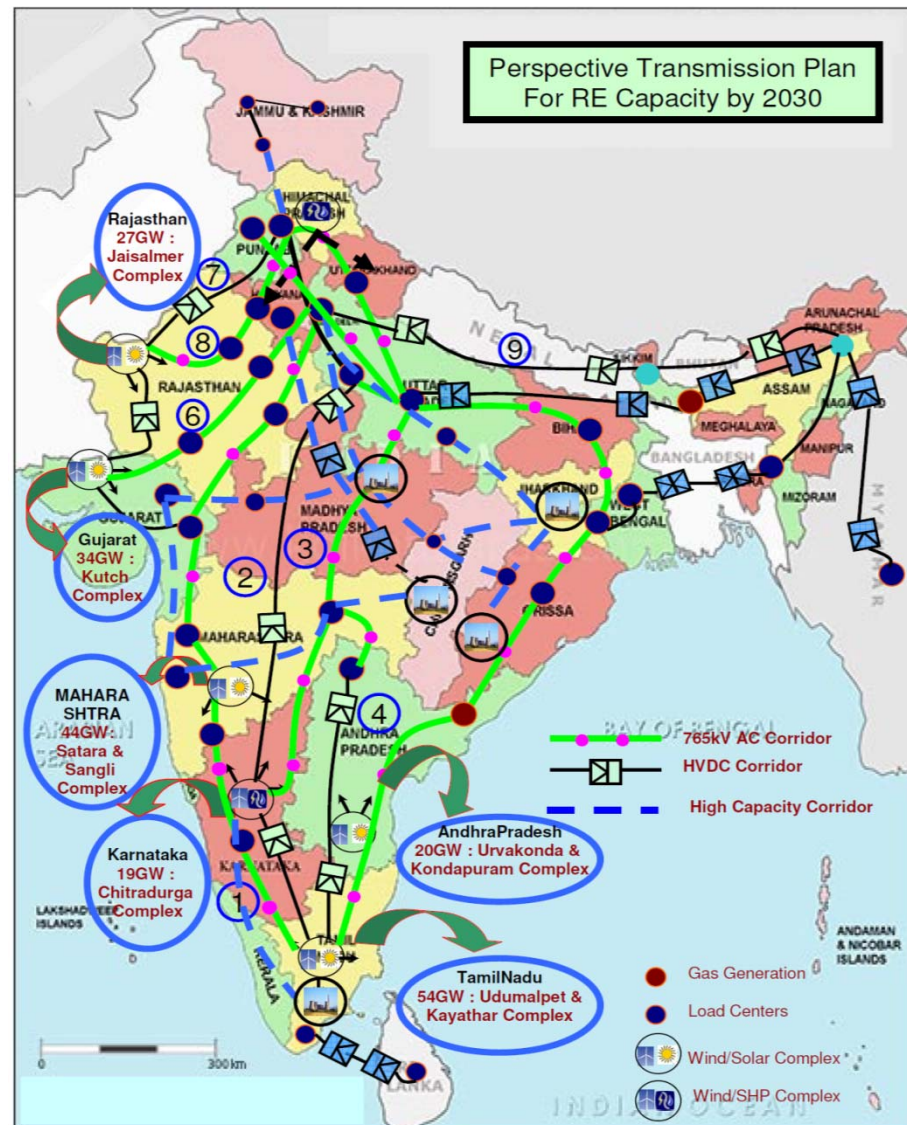
**Inter-State TS Strengthening: ₹ 22,000 crore**

includes

- Other associated works like Energy Storage, Real Time Monitoring System etc.
- Establishment of Renewable Energy Management Center

Source: PGCIL Green Corridors Presentation

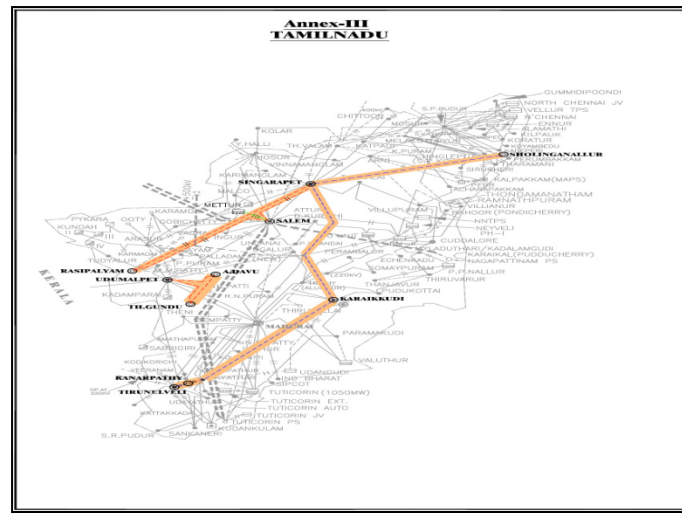
# Perspective Transmission Plan for RE Capacity by 2030



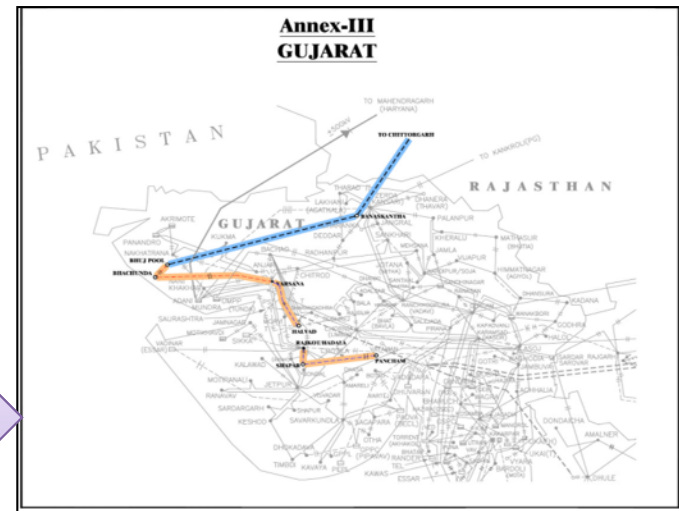
Source: PGCIL Green Corridors Presentation



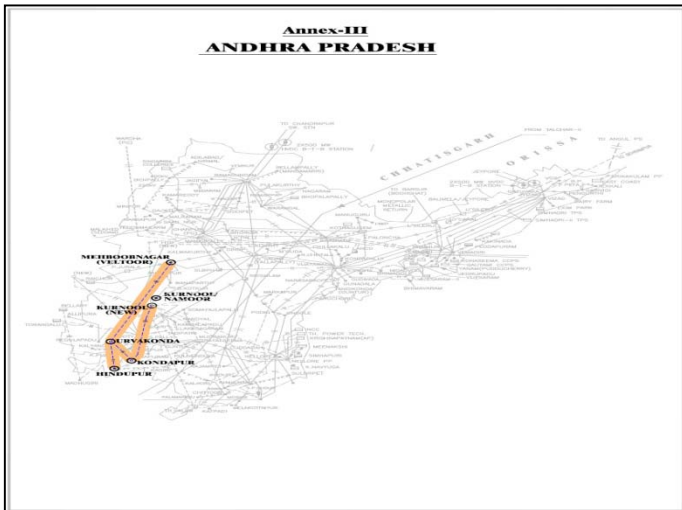
# Sub-Transmission System Strengthening for RE Integration



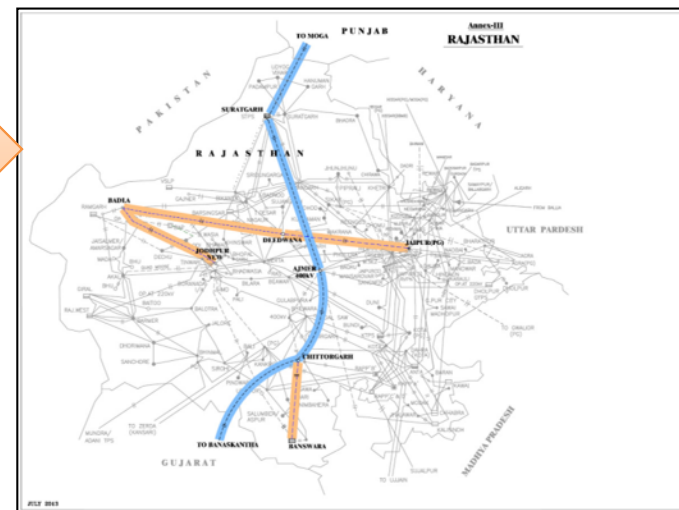
# Tamil Nadu



# Gujarat



# Rajasthan



## Andhra Pradesh

**Source: CEA Large Scale Grid Integration of Renewable Energy Sources - Way Forward**

## 36<sup>th</sup> meeting of the Standing Committee on Power System Planning in Western Region

- **Evacuation of Renewable Energy generations located in WR and NR to Northern Region states.**
- **Gujarat**
  - About 900 MW Wind and 180 MW Solar capacity additions in Kutch
  - Applications for Connectivity of 600 MW wind capacity in Kutch received by the CTU.
- **Rajasthan**
  - About 5694 MW Renewable capacity addition during 12<sup>th</sup> Plan
- **Renewable generations would be allowed to inject in the ISTS at Bhuj, Banaskantha, Chittorgarh, Ajmer etc.,**
  - **if they apply for LTA quantum which is at least 25% of their installed capacity.**
  - **Intra-state transmission system identified for RES generations in Gujarat and Maharashtra was also agreed.**

# 36<sup>th</sup> meeting of the Standing Committee on Power System Planning in Western Region

- **Western Region (Gujarat):**

- Bhuj Pool – Banaskantha 765 kV D/c
- Banaskantha - Chittorgarh 765 kV D/c
- Banaskantha - Sankhari 400 kV D/c
- 765/400/220kV (765/400 kV-2x1500 MVA & 400/220kV-2x500MVA) sub-station each at Bhuj Pool and Banaskantha.
- Associated reactive compensation (Bus reactors & line reactors)

- **Northern Region (Rajasthan):**

- Chittorgarh - Ajmer (New) 765 kV D/c, Ajmer (New) - Suratgarh (New) 765 kV D/c
- Suratgarh (New) - Moga (PG) 765 kV D/c
- Chittorgarh - Chittorgarh (RVPN) 400 kV D/c (Quad)
- Ajmer (New) - Ajmer (RVPN) 400 kV D/c (Quad)
- Suratgarh (New) - Suratgarh 400 kV D/c (Quad)
- 2x1500 MVA, 765/400 kV sub-station Chittorgarh, Ajmer (New) and Suratgarh (New)
- Associated reactive compensation (Bus reactors & line reactors).

# Flexible Transmission

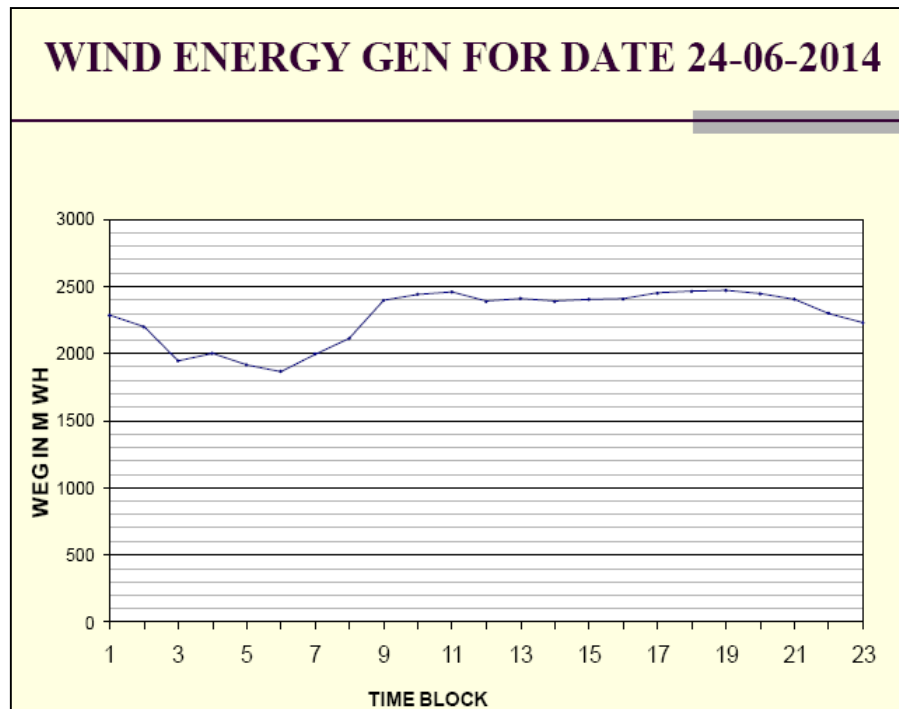
- Transmission networks with limited bottlenecks and sufficient capacity to access a broad range of balancing resources, including sharing between neighboring power systems, and with smart network technologies that better optimize transmission usage
- Requirement of HVDC
  - More than 4000 MW cut-axis indicates requirement of HVDC link



# Need for Forecasting

- **Secure Grid Operation**
  - System Operator to foresee what is expected to happen a few hours ahead
  - Able to take appropriate measures.
- **Wind Forecasting**
  - Historical data, wind speed, topological features of the area, air pressure, humidity, etc.
  - Ramp rate also important
- **Solar Forecasting**
  - Large Solar Generation Addition - JNNSM

# Wind Forecasting in Gujarat



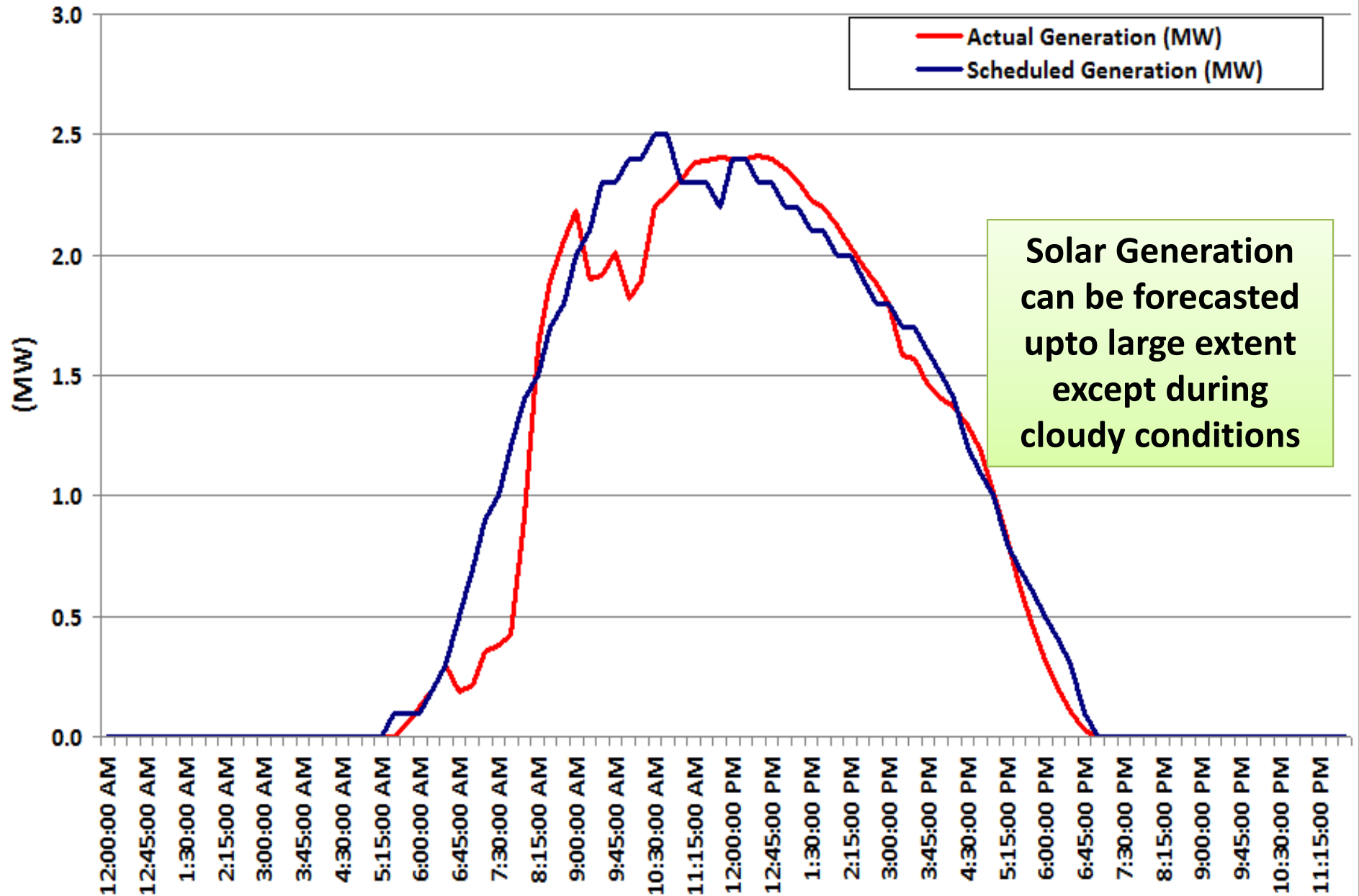
**WIND FORECASTING(GUJARAT)  
MILES/HR**

STATION	24/06	25/06	26/06	27/06	28/06	29/06
MUNDRA	22	20	17	16	17	20
OKHA	24	23	19	17	19	21
KANDLA	23	23	19	18	20	25
JAKHAU	25	23	20	19	22	19
JAMNAGAR	21	19	16	15	17	18
PORBANDAR	21	19	16	14	15	18
SUTHRI	24	23	20	19	21	24
	54.57					

\* WIND FORECASTING DATA SOURCE FROM BBC WEATHER WEBSITE

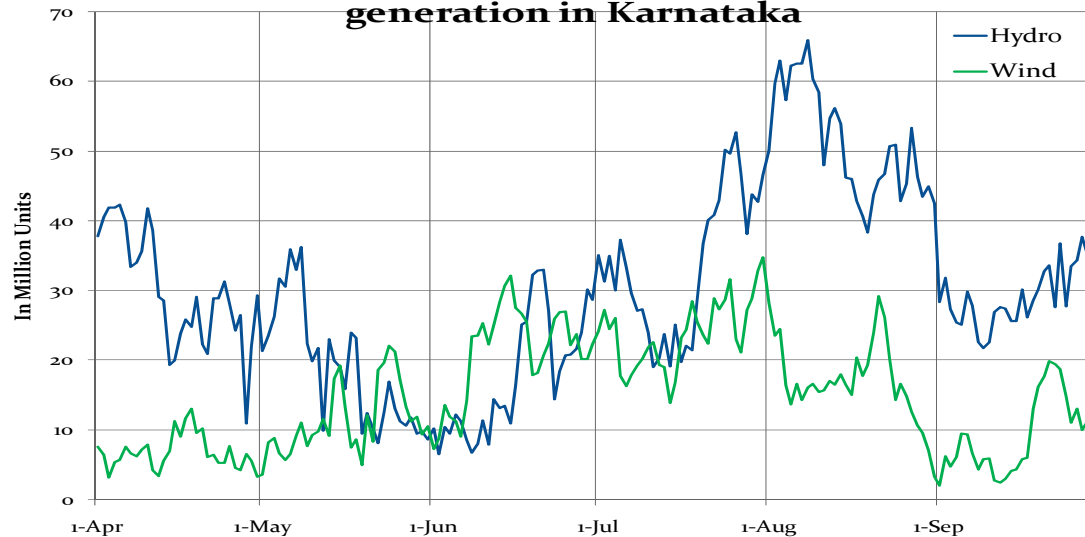
**The Gujarat RE desk prepares anticipated variation for wind / solar generation as well as load for the same day, next day and for next 7 days and updates it every three hours.**

# Typical Daily Dadri Solar Generation (MW)

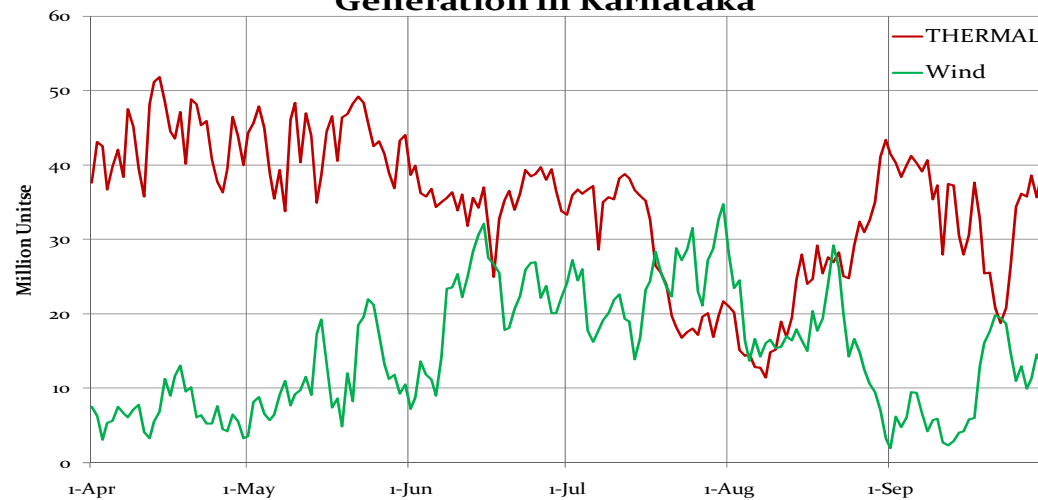


# Balancing Renewable Generation

**Flexing the Hydro for Balancing the wind generation in Karnataka**



**Flexing of Thermal for Balancing Wind Generation in Karnataka**



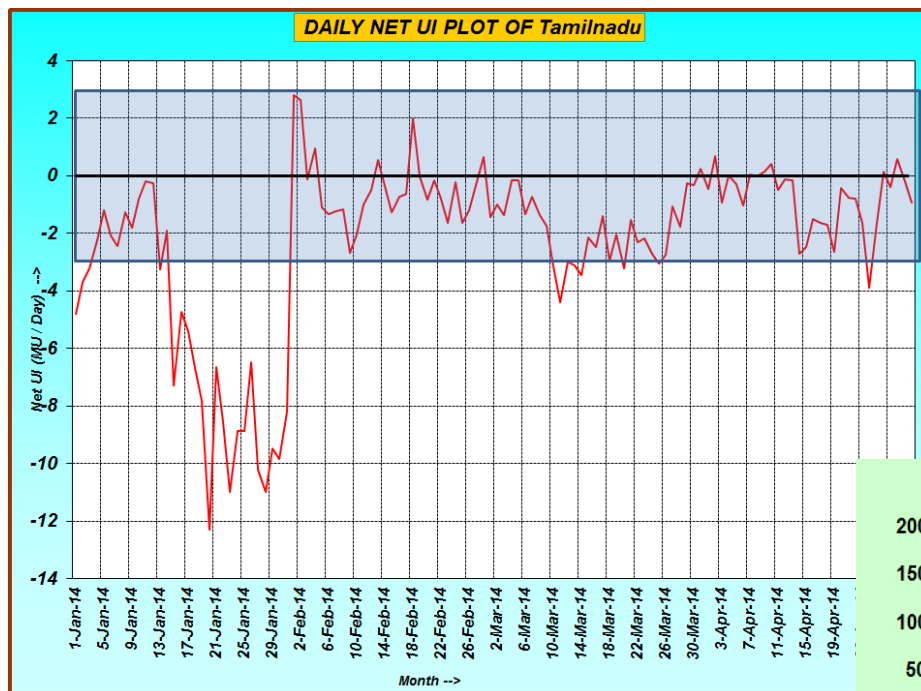
## Challenges

- Variability, intermittency and ramping
- Sudden onset or offset of wind generation

## Remedies

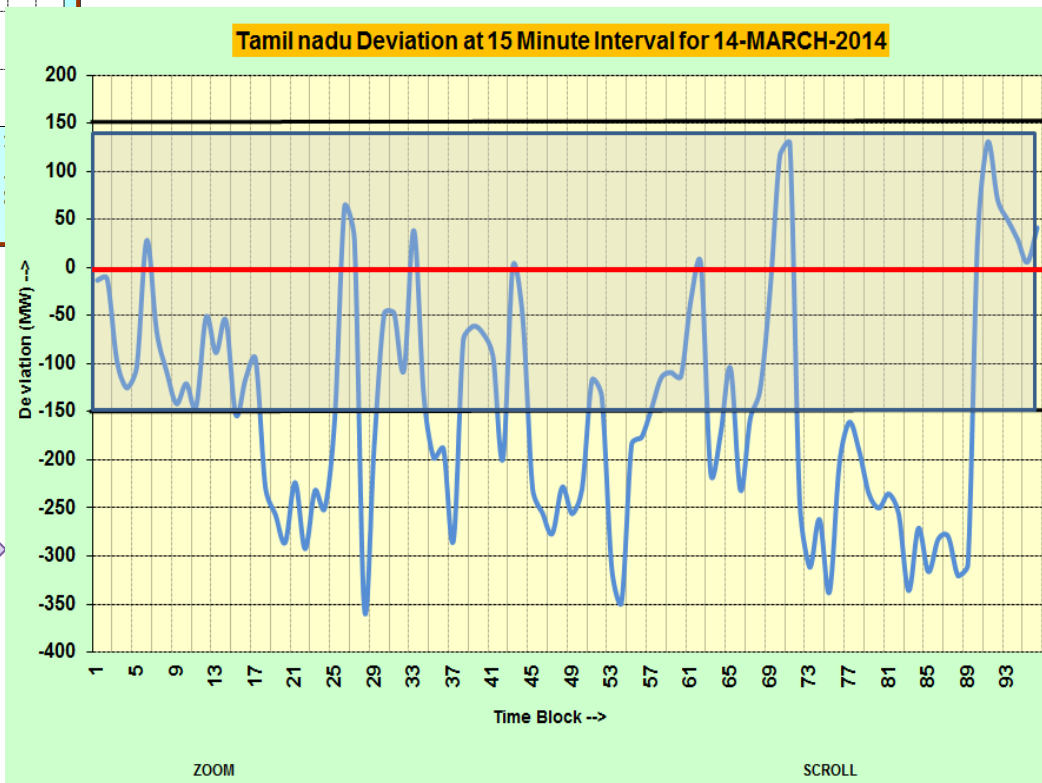
- Generation balancing by the conventional energy sources.
- Greater the penetration, greater the balancing requirement.
- Forecasting of renewable generation (Solar and wind)
- Ramp forecast is also essential.

# Net Deviation – Tamil Nadu

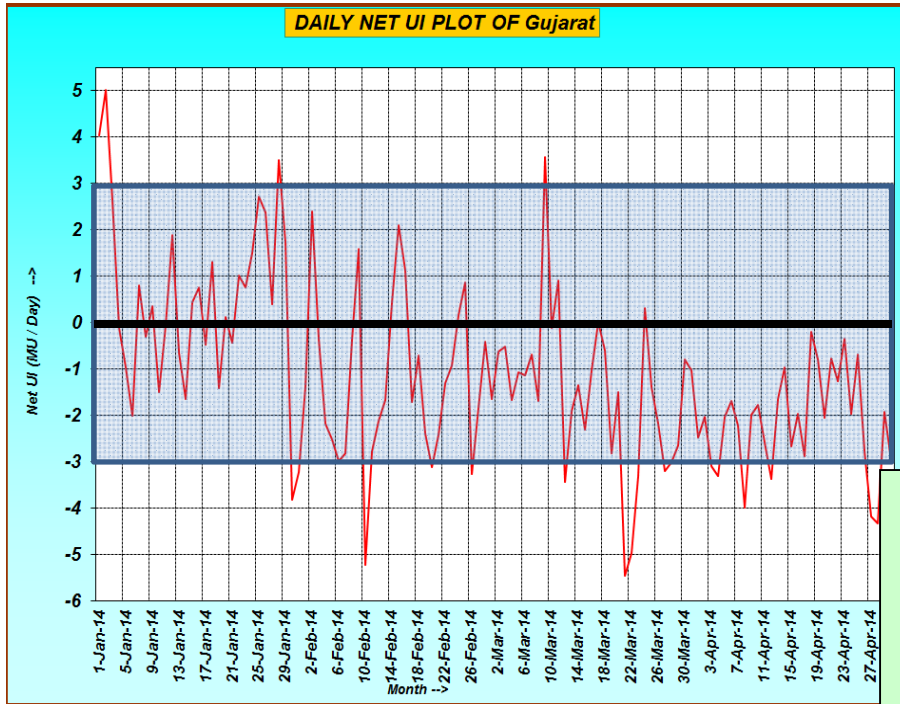


**Daily Net Deviation 01<sup>st</sup> Jan., 2014 onwards**

**96 Time-block wise Deviation on a Typical Day**

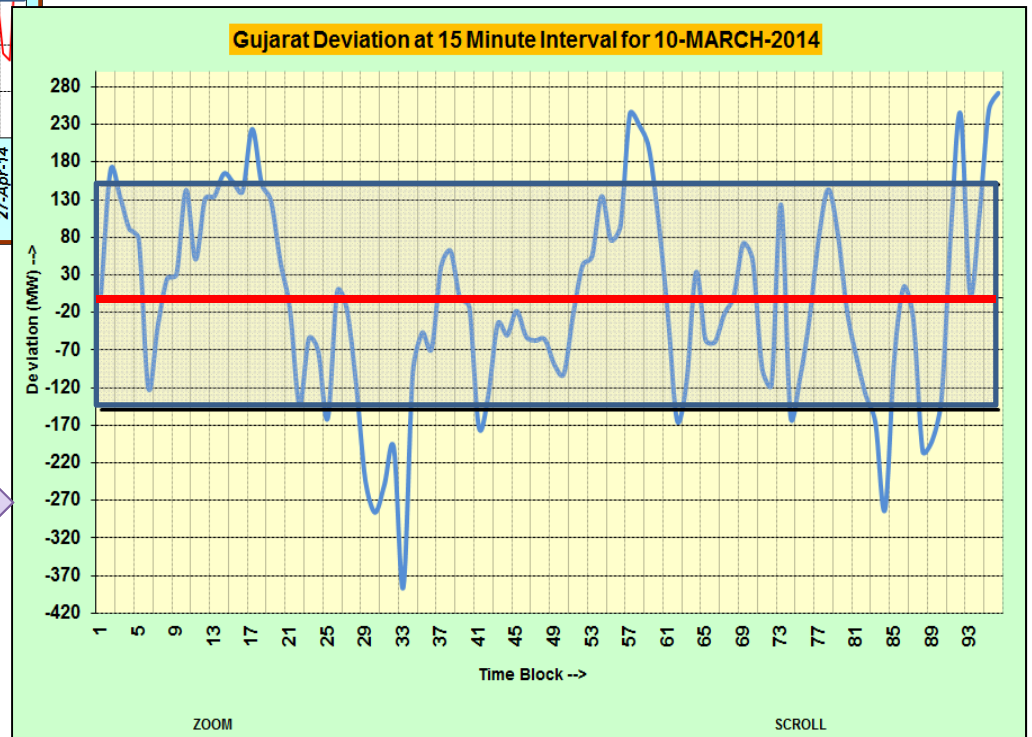


# Net Deviation - Gujarat

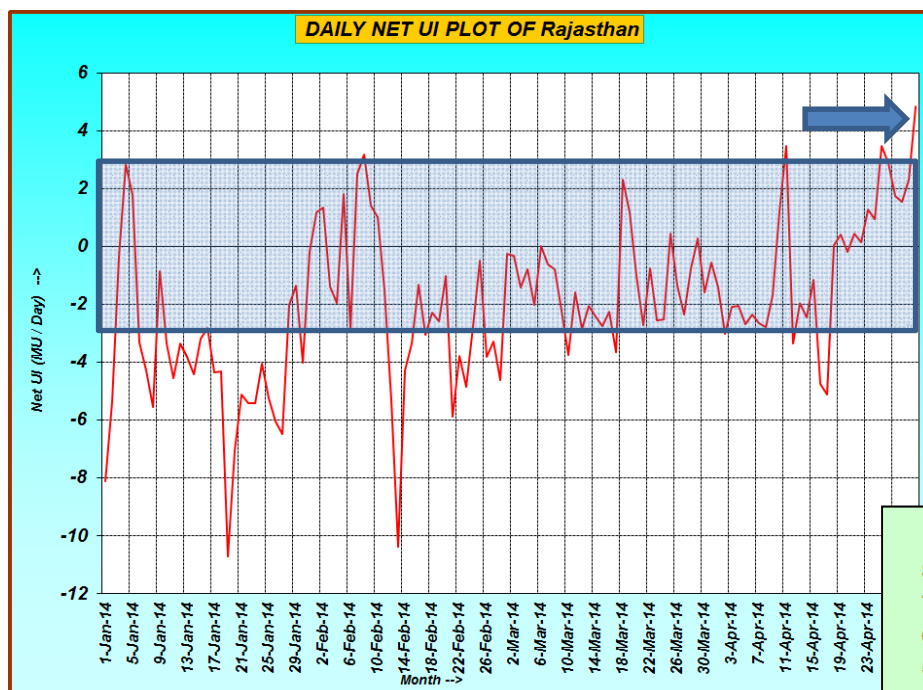


**Daily Net Deviation 01<sup>st</sup> Jan., 2014 onwards**

**96 Time-block wise Deviation on a Typical Day**

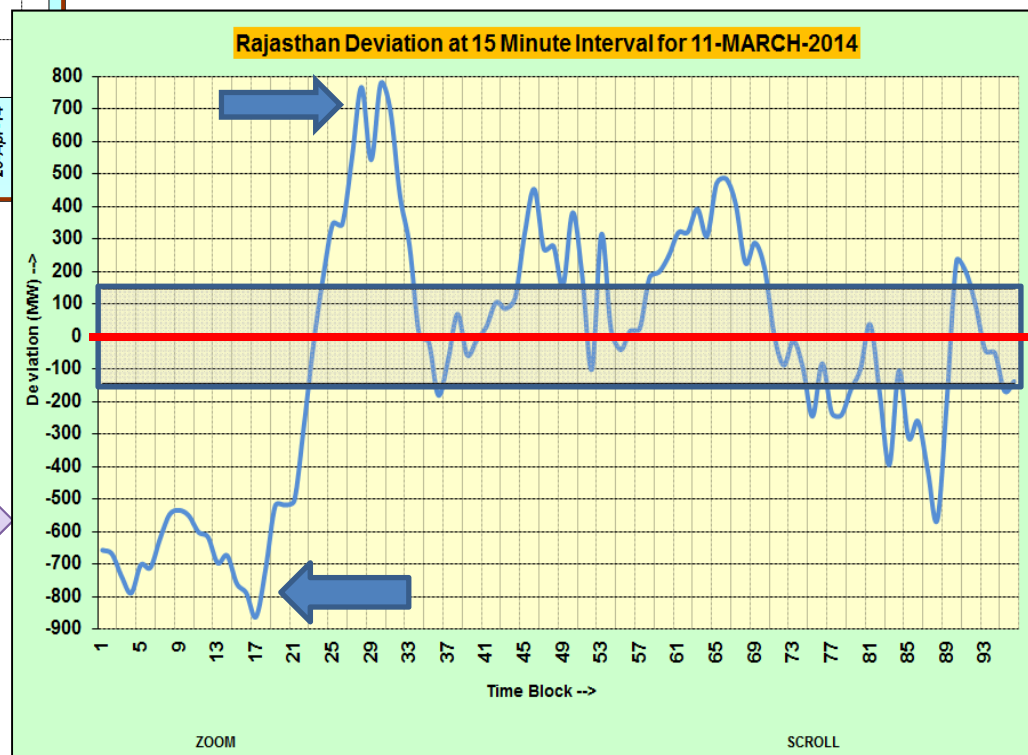


# Net Deviation - Rajasthan



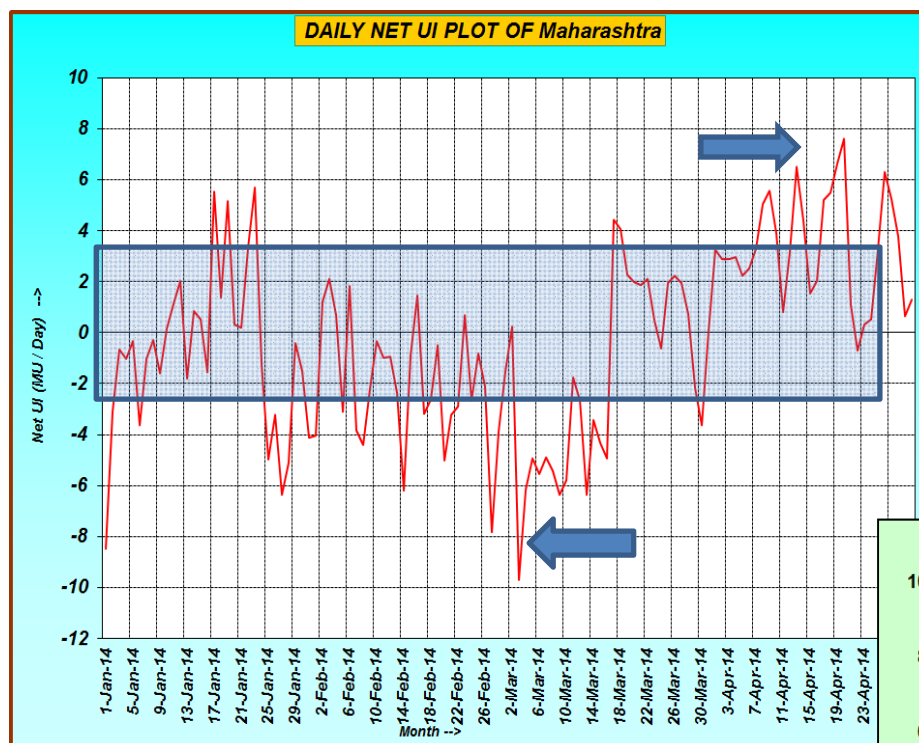
**Daily Net Deviation 01<sup>st</sup> Jan., 2014 onwards**

**96 Time-block wise Deviation on a Typical Day**



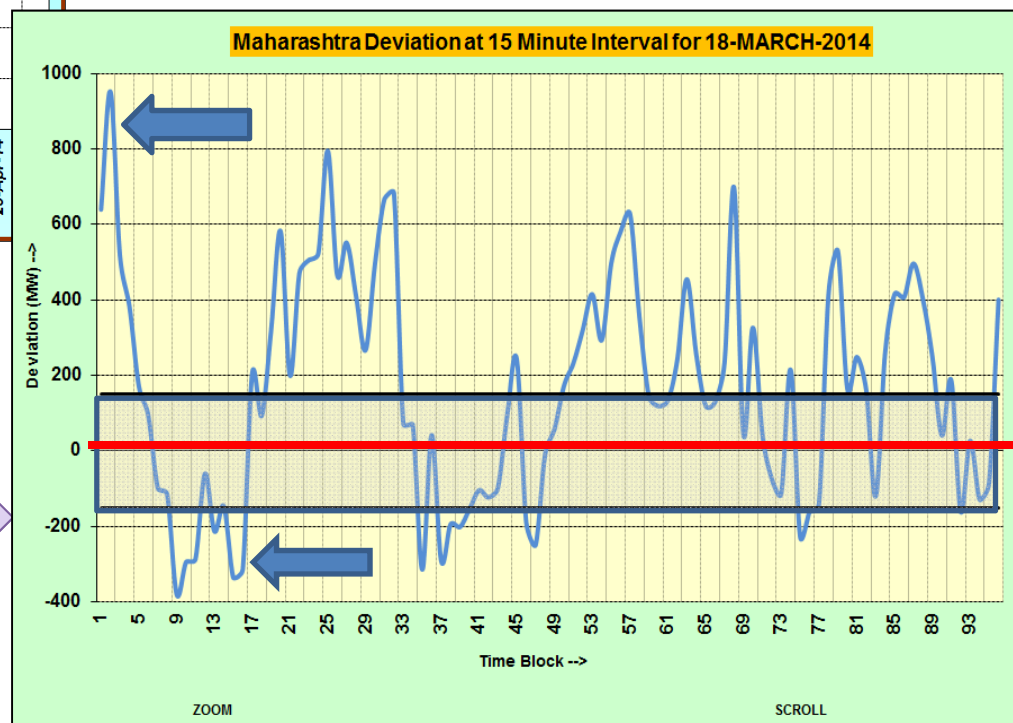


# Net Deviation - Maharashtra



**Daily Net Deviation 01<sup>st</sup> Jan., 2014 onwards**

**96 Time-block wise Deviation on a Typical Day**





# Factors responsible for deviation from the schedule by control areas

- Deviation from schedule possible on account of
  - Change in the state's demand
  - Change in the state's conventional generation
  - Change in wind generation
- Which factor is predominant?
  - Is wind generation change really responsible and to what extent?
- Analysis for 2013-14 for Gujarat and Tamilnadu based on SCADA data available at NLDC (through RLDCs)

## Data availability and analysis

- SCADA data for 2013-14 is taken at an interval of 5 minutes each for
  - State's own generation in MW
  - State's wind generation in MW
  - State's drawal from the grid in MW
  - State's demand in MW
- Impact of variability on deviation captured through
  - Karl Pearson correlation coefficient
  - 5 minute changes in deviation, demand, conventional generation and wind generation taken for analysis (288 values for each day)

# Karl Pearson co-relation coefficient

- Pearson's correlation coefficient when applied to a sample is commonly represented by the letter  $r$  and may be referred to as the *sample correlation coefficient* or the *sample Pearson correlation coefficient*. That formula for  $r$  is:

$$r = \frac{\sum_{i=1}^n (X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^n (X_i - \bar{X})^2} \sqrt{\sum_{i=1}^n (Y_i - \bar{Y})^2}}$$

**Coefficient would vary from -1 (strong negative correlation) to +1 (strong positive)**

# Analysis for Gujarat for 2013-14

Month	Co-relation coefficient between		
	Deviation change with demand change	Deviation change with conventional generation change	Deviation change with wind generation change
April 2013	<b>0.68</b>	-0.16	-0.06
May 2013	<b>0.69</b>	-0.19	-0.04
June 2013	<b>0.53</b>	-0.15	-0.11
July 2013	0.42	-0.13	-0.09
Aug 2013	0.46	-0.13	-0.05
Sep 2013	<b>0.53</b>	-0.20	-0.03
Oct 2013	<b>0.52</b>	-0.17	-0.03
Nov 2013	0.47	-0.21	-0.03
Dec 2013	0.38	-0.16	-0.02
Jan 2014	0.42	-0.18	-0.03
Feb 2014	0.51	-0.17	-0.01
Mar 2014	0.48	-0.27	-0.04
<b>Average</b>	<b>0.51</b>	<b>-0.18</b>	<b>-0.05</b>

# Conclusion-1 for Gujarat

- On an annual basis for Gujarat in 2013-14
  - Wind generation variability has negligible adverse effect on deviation from the schedule
  - Conventional generation change affects deviation 4 times more than wind generation
  - Demand changes affects deviation 10-11 times more than wind generation

# Analysis for Tamilnadu for 2013-14

Month	Co-relation coefficient between		
	Deviation change with demand change	Deviation change with conventional generation change	Deviation change with wind generation change
April 2013	0.67	-0.15	0.01
May 2013	0.58	-0.17	-0.07
June 2013	0.52	-0.06	-0.10
July 2013	0.52	-0.12	-0.15
Aug 2013	0.33	-0.15	-0.09
Sep 2013	0.53	-0.08	-0.05
Oct 2013	0.52	-0.16	-0.06
Nov 2013	0.67	-0.23	-0.01
Dec 2013	0.59	-0.22	-0.06
Jan 2014	0.57	-0.17	-0.15
Feb 2014	0.62	-0.29	-0.03
Mar 2014	0.67	-0.22	0.01
<b>Average</b>	<b>0.56</b>	<b>-0.17</b>	<b>-0.06</b>

# Conclusion-1 for Tamilnadu

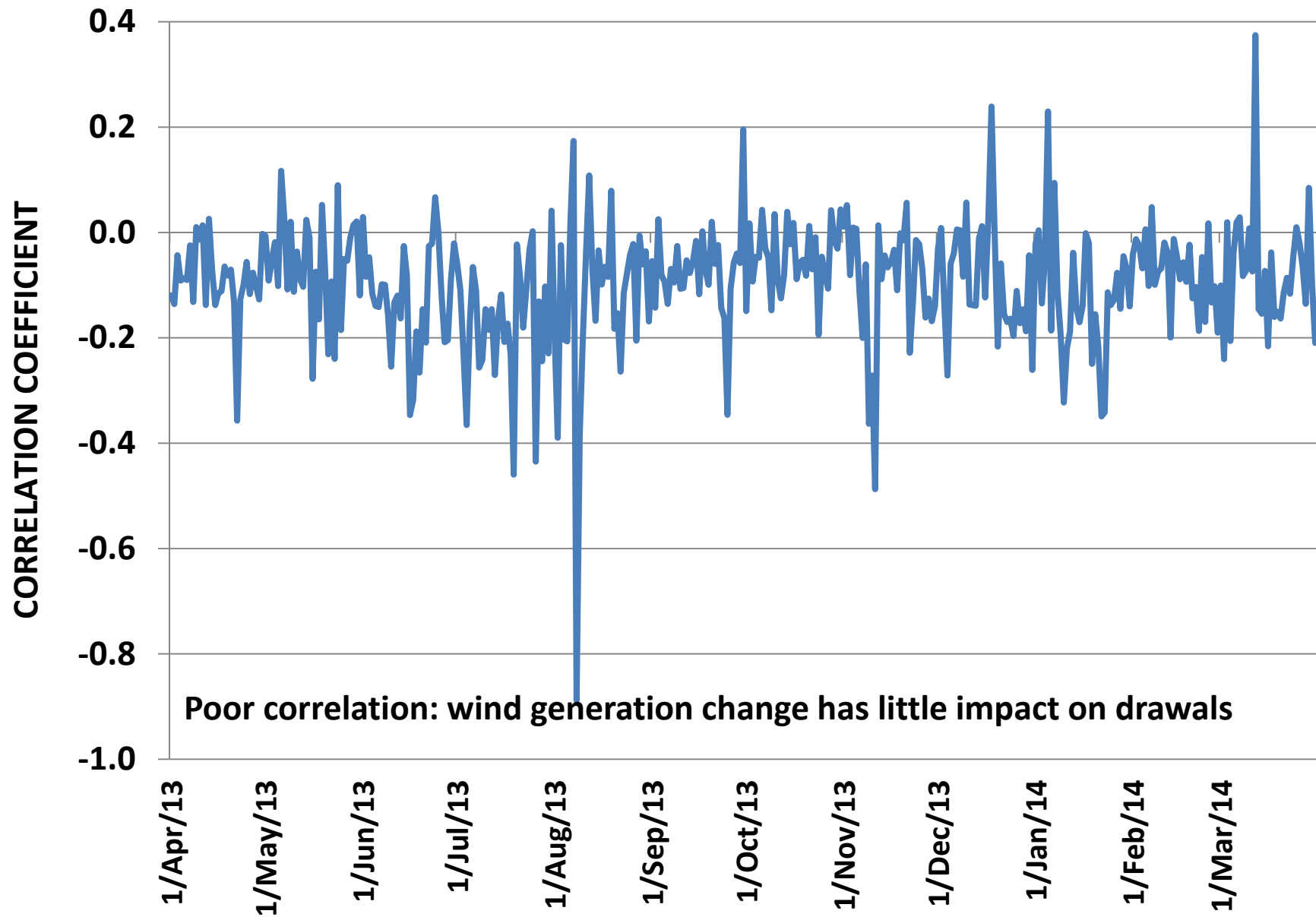
- On an annual basis for Tamilnadu in 2013-14
  - Wind generation variability has negligible adverse effect on deviation from the schedule
  - Conventional generation change affects deviation 2-3 times more than wind generation, though in high wind season, the two are comparable.
  - Demand changes affects deviation 8-9 times more than wind generation, which drops to 3-4 times in high wind season.

# Further analysis of daily behaviour

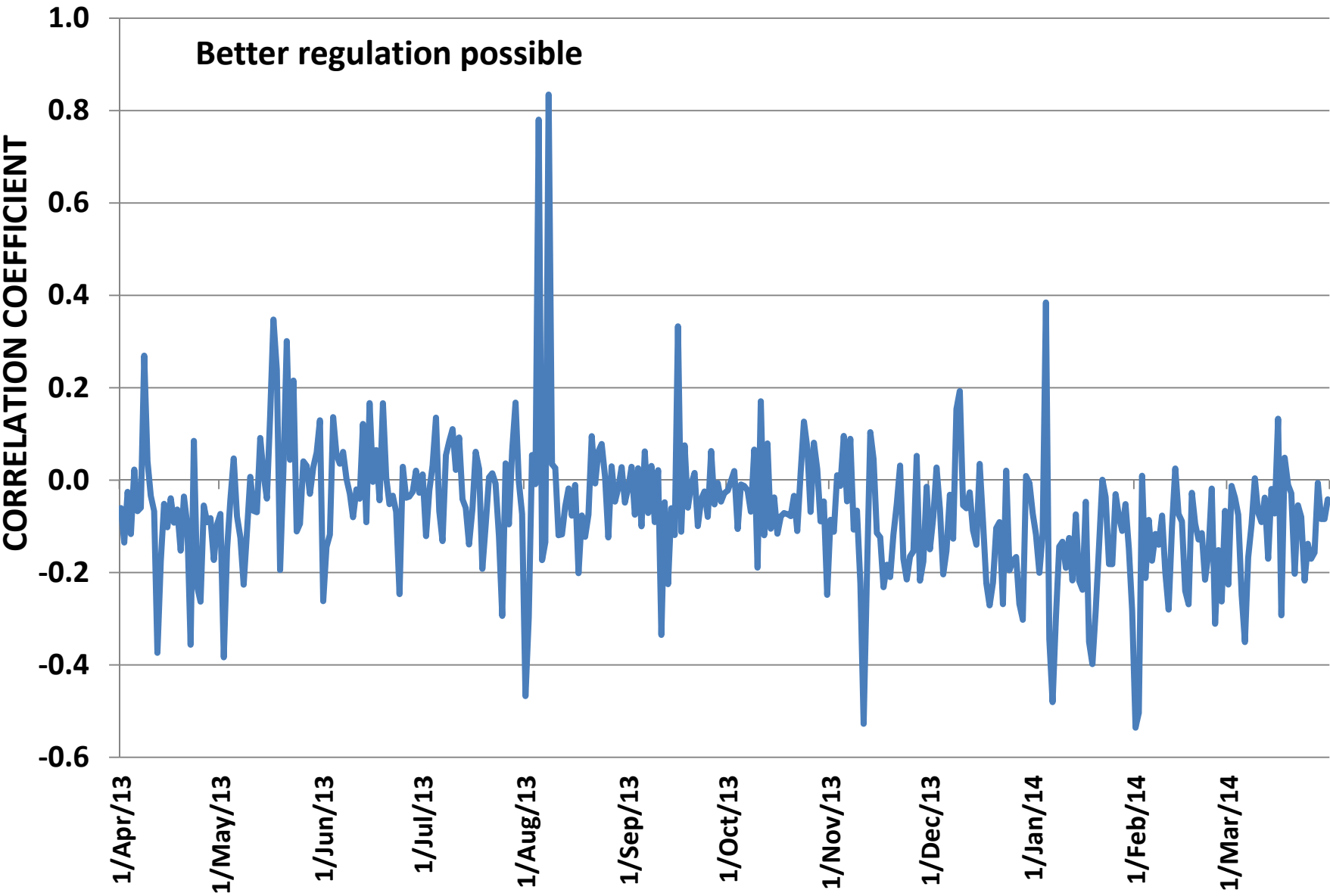
- Wind change vs drawal change correlation
  - If 100 MW reduction in wind causes increase in drawal by 100 MW always, then correlation coefficient would be (-1); no positive control actions by utilities
- Wind change vs conventional generation change
  - An index of regulation; a correlation coefficient of (-1) would indicate perfect balancing by conventional generators of the state
- Wind change vs deviation change
  - An index of regulation through all sources; a value of (-1) would indicate poor or NIL regulation



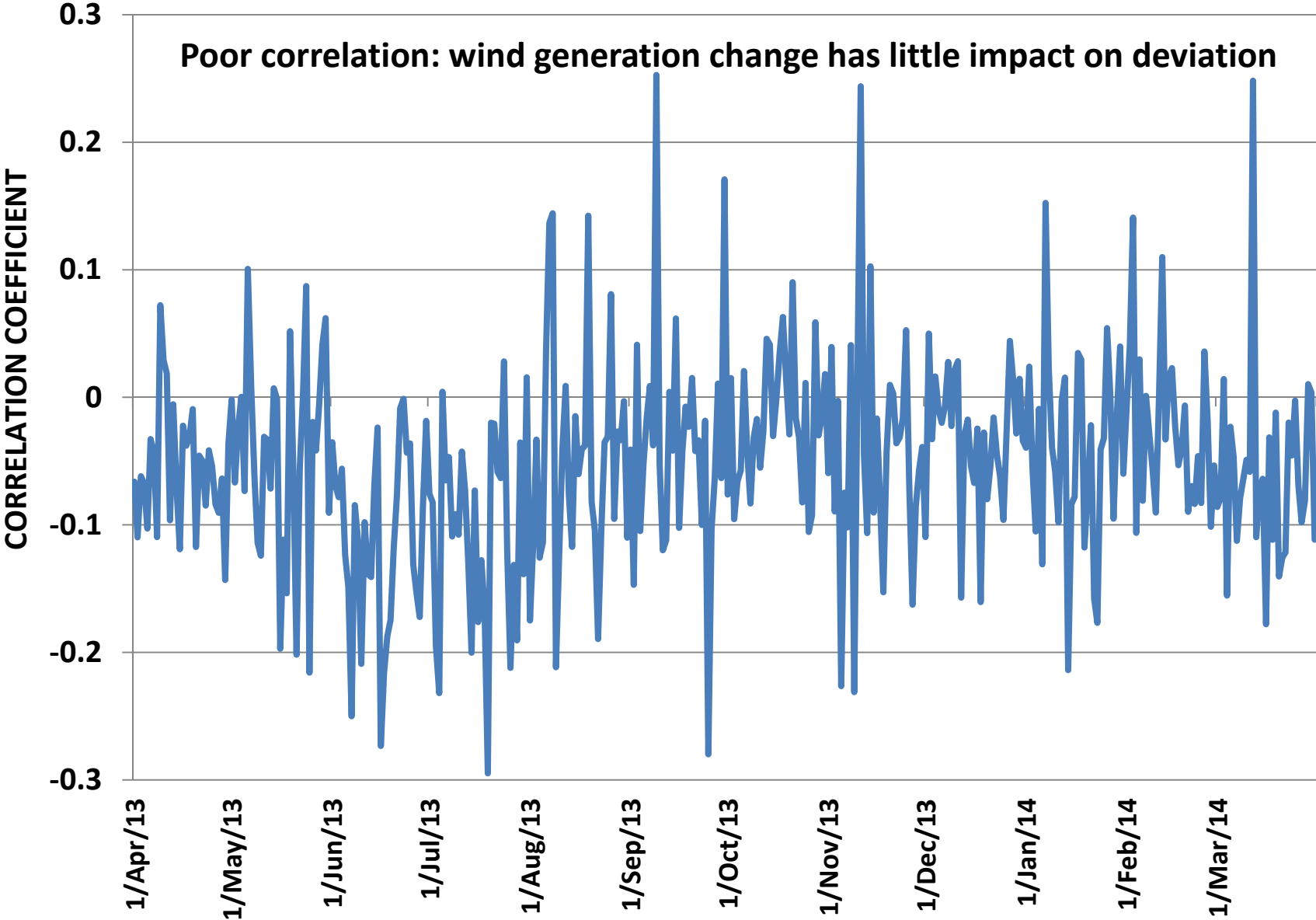
# Gujarat: Wind Change vs Drawal Change



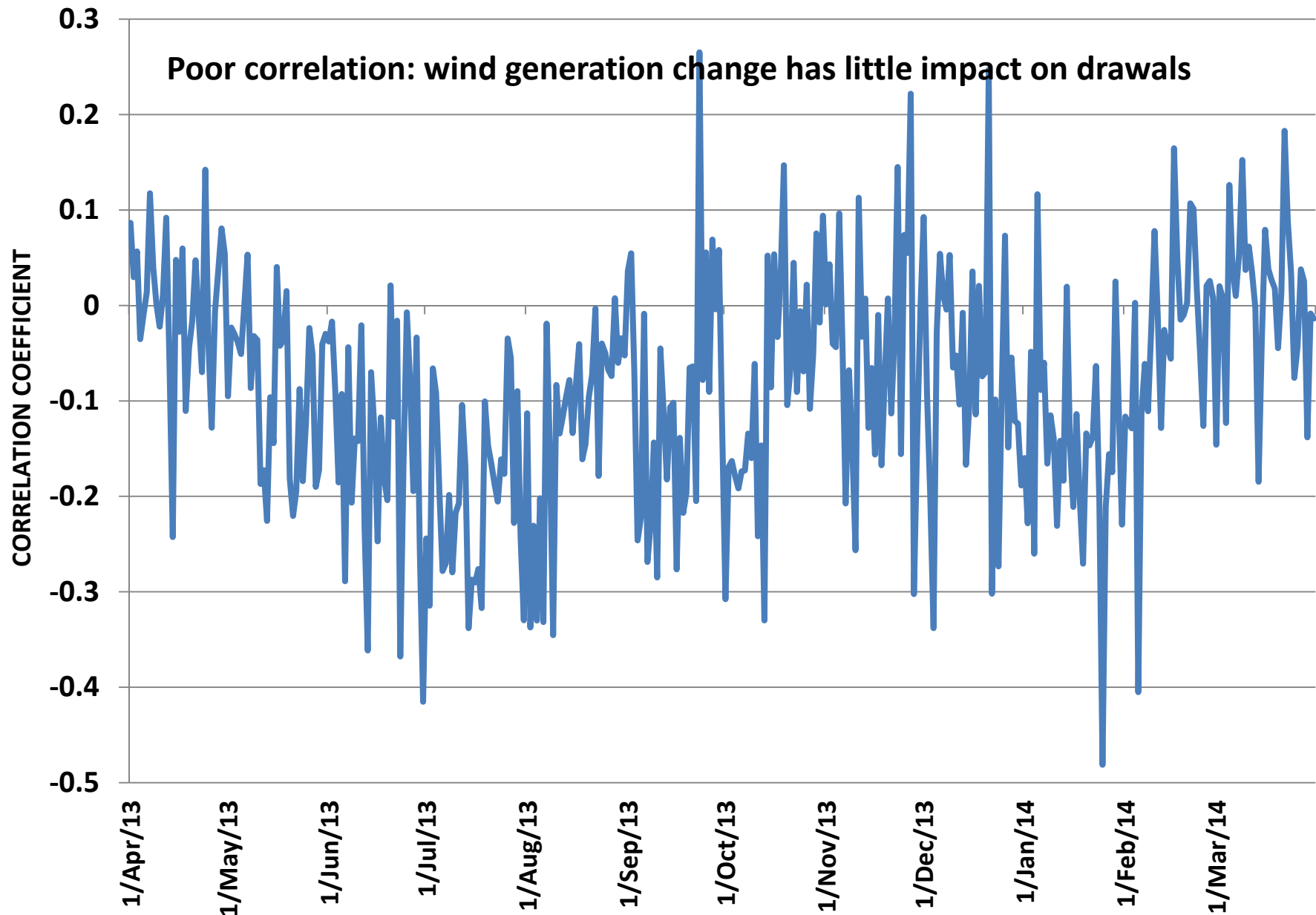
# Gujarat: Wind Change vs Generation Change (Conventional)



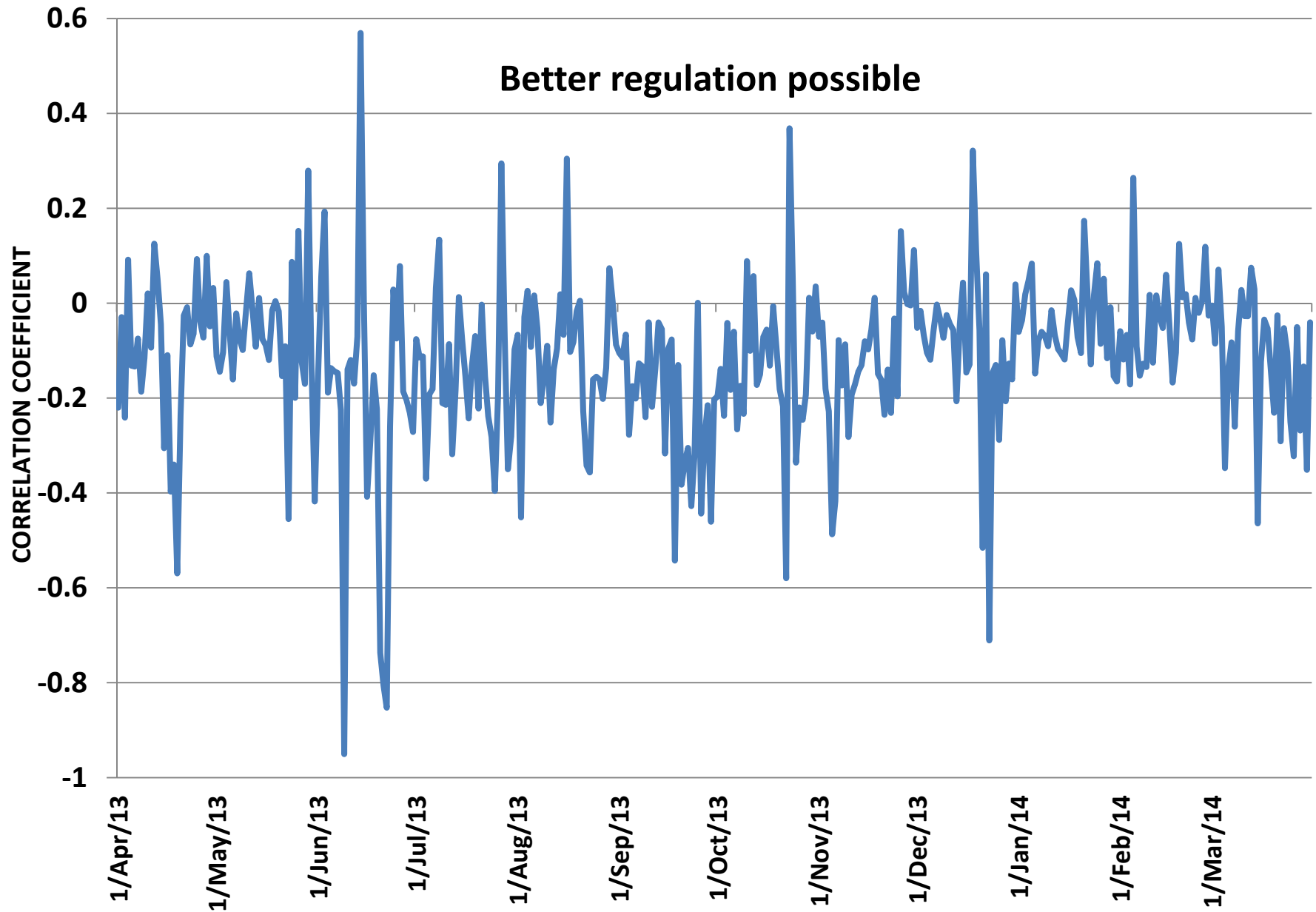
# Gujarat: Wind Change vs Deviation Change



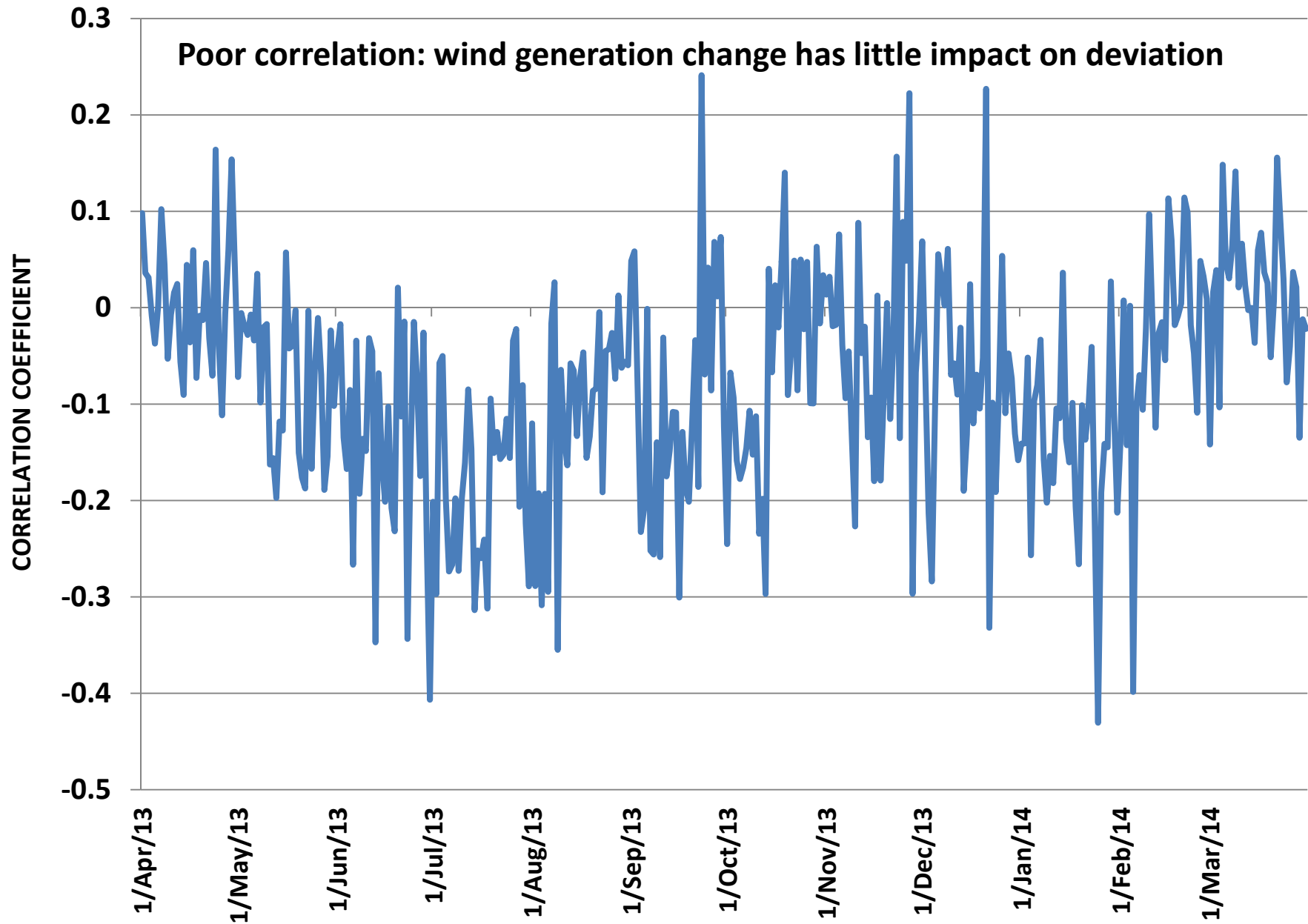
# Tamil Nadu: Wind Change vs Drawal Change



# Tamil Nadu: Wind Change vs Generation Change (Conventional)



# Tamil Nadu : Wind Change vs Deviation Change



# Way Forward for Balancing

- **Each state procures requisite balancing capability**
- **Regulatory support**
  - Incentivize flexibility of conventional generation sources.
- **Compensate the conventional generator for**
  - partial operation and
  - start up and stop costs
  - Perform the balancing function without incurring financial loss

## **Wind Generation loss events in Southern Grid**

- 1. Complete outage of 230/110KV Kayathar  
substation of TANTRANSCO  
at 1554 hrs on 02-06-2014**
- 2. Multiple element tripping and generation  
loss at 400kV Neyveli TS-2 station  
at 1910 hrs on 05-06-2014**



# 230/110kV Kayathar S/S – 1554 hrs – 02.06.2014

Wind Generation Tripping

**1135 MW**

Increase in drawl

**3000 MW to 4200 MW**

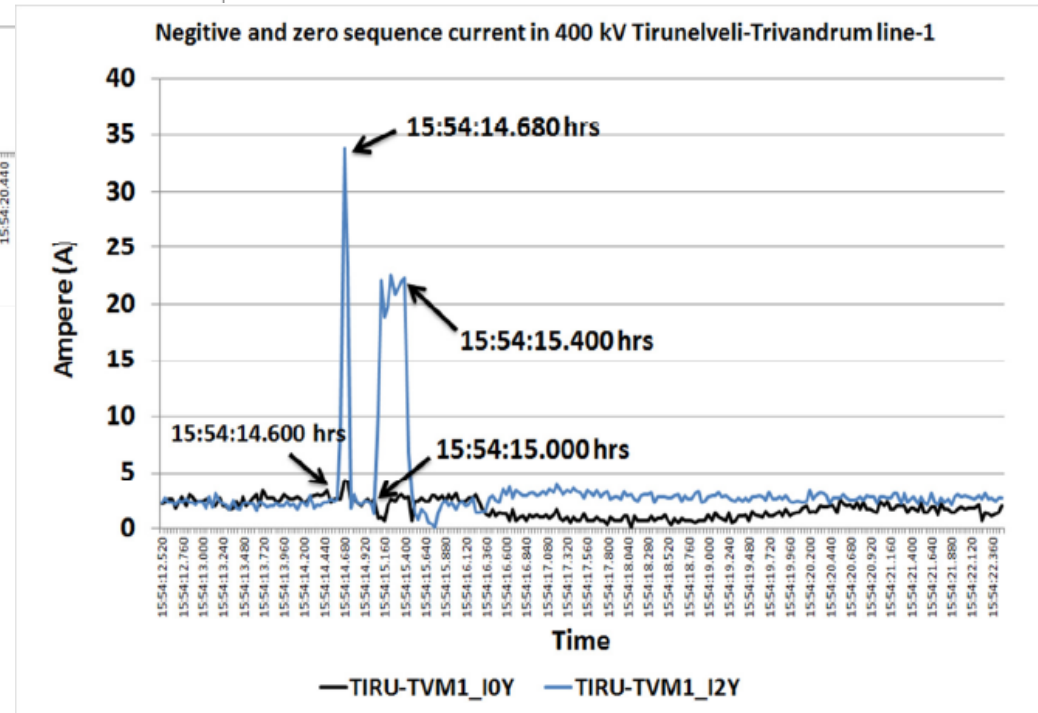
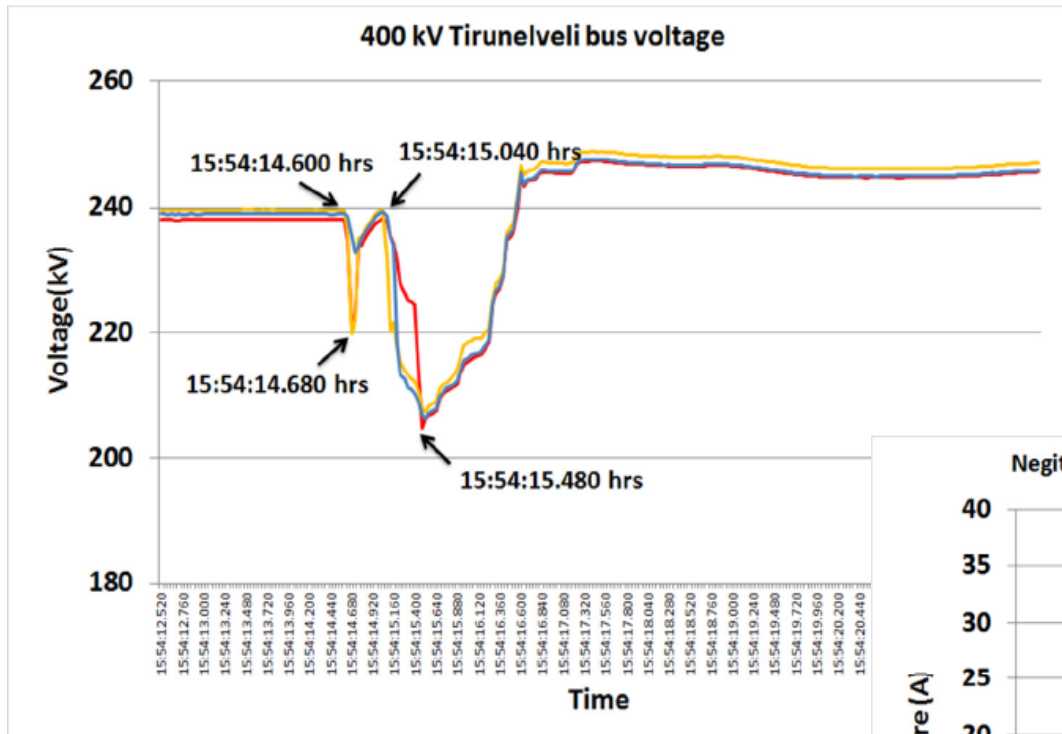
Failure of Y-phase jumper caused  
bus fault in 110 kV bus

**Absence of bus-  
bar protection led  
to delayed  
clearance of fault**

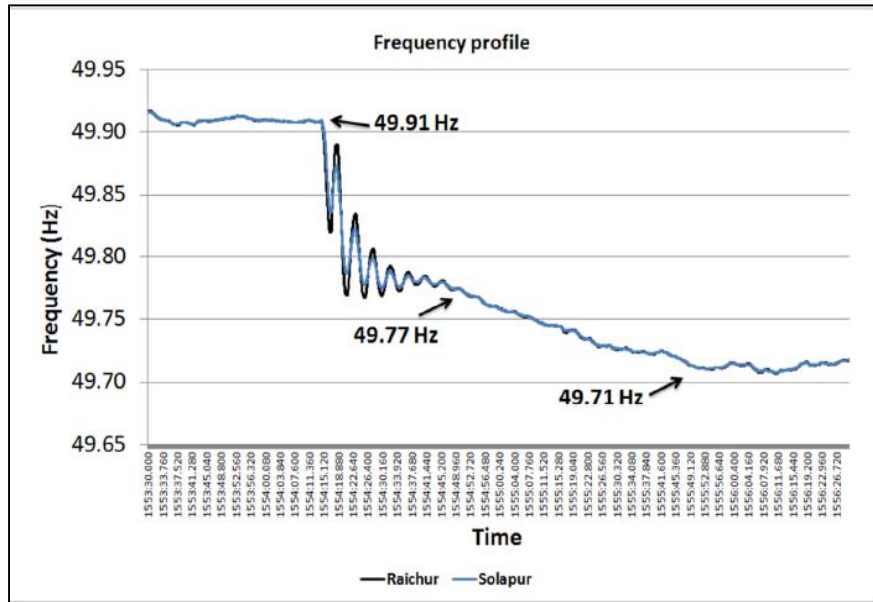
Failure of current transformer in  
110kV Periyar- Kayathar feeder at  
Kayathar

All 230kV and 110kV lines got  
tripped from remote ends in R-Y-  
B, Zone-2 from remote ends  
except 230kV Chekanoorani line-2.

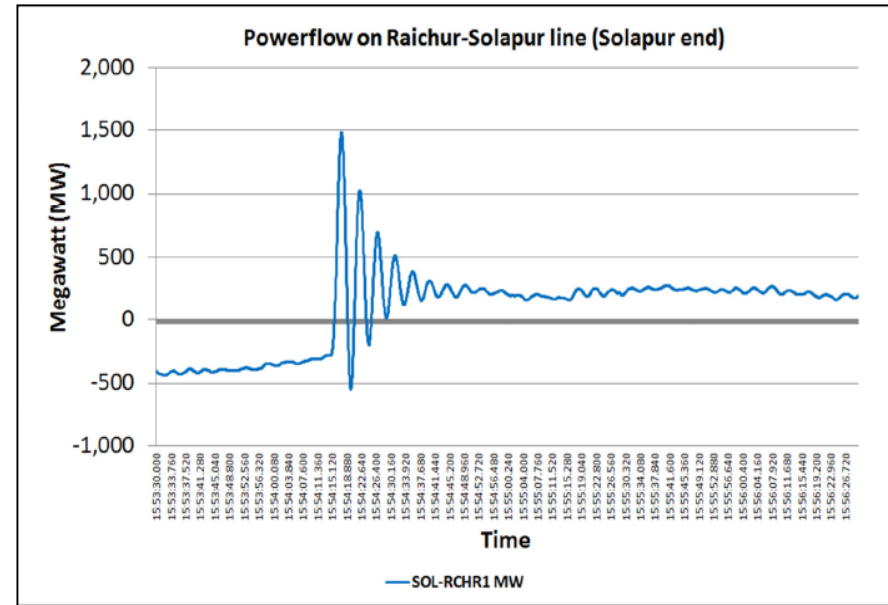
# Voltage Dip and Current Fluctuation



# Frequency Profile and SPS Operation



The change in frequency of NEWS grid was 0.23 Hz due to loss of 1135 MW of wind generation in Tamil Nadu.



SPS of 765kV Raichur-Solapur line and 400kV Wardha-Parli lines operated due to increase in power flow due to loss of wind generation.

**Load shedding of 689 MW occurred southern region**

# 400 kV Neyveli TS - 2 Station – 1910 hrs – 05.06.2014

## **Heavy storm and rain**

Lighting cable of switchyard gantry tower broken and fell over 400kV bus-1

400kV Neyveli TS2-Trichy and 400kV Neyveli TS2-Pondy cherry line tripped

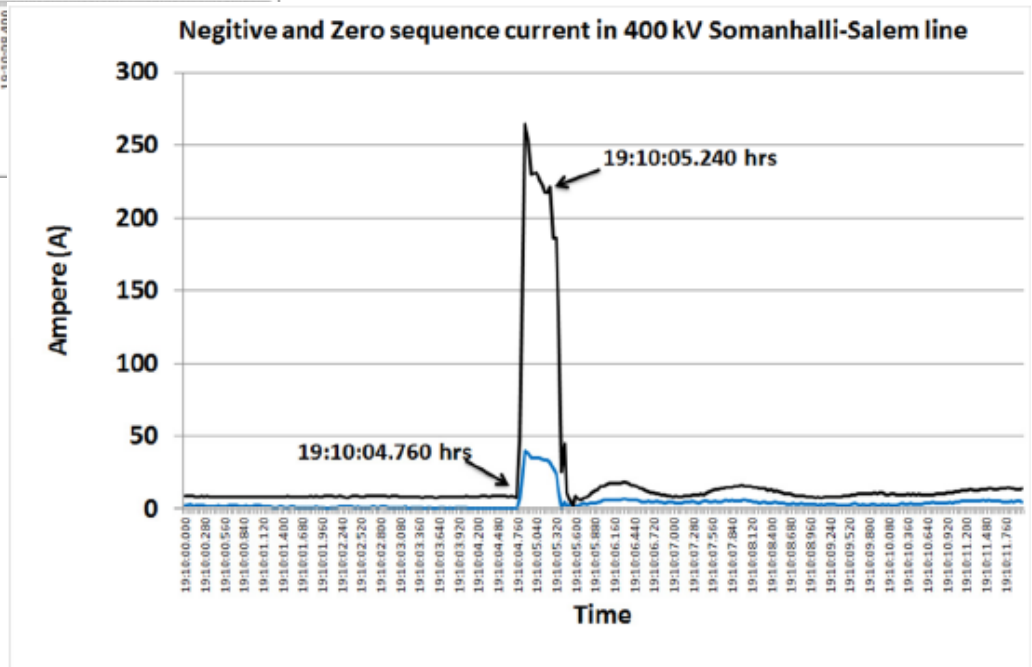
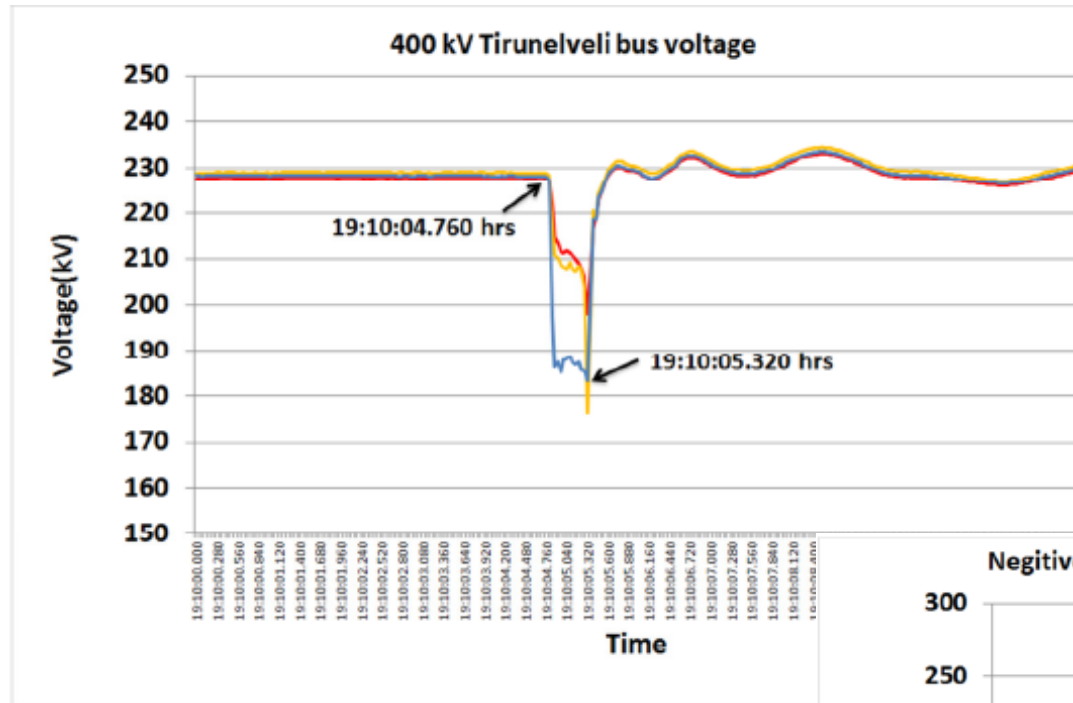
## **Operation of bus bar protection of 400 kV bus at Neyveli TS-2**

Tripping of all elements connected to 400kV bus-1 and De-energization of 400 bus-1 at Neyveli TS-2

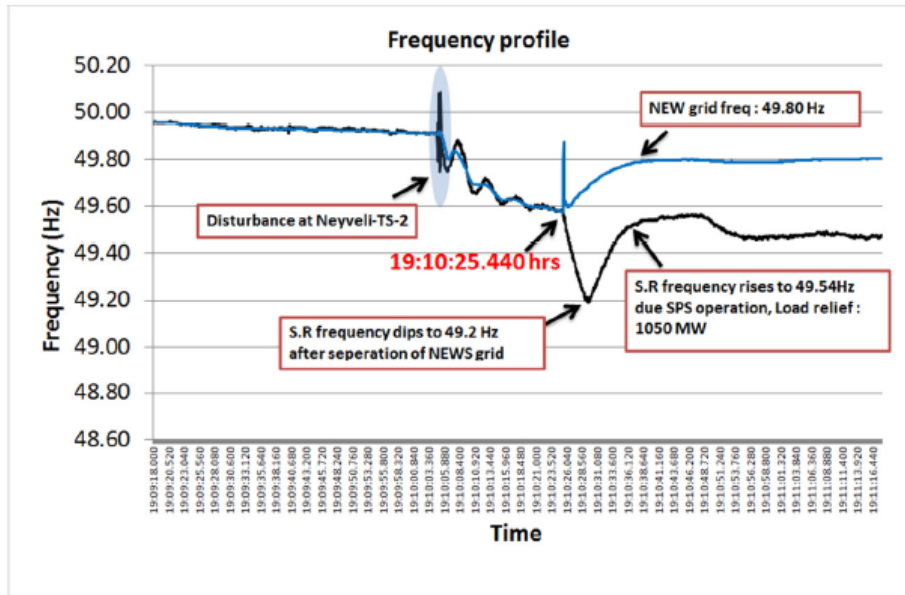
Unit of STCMS (IPP in T.N near to Neyveli) generating 250MW also tripped at 19:11 hrs

Operation of stator over load protection.

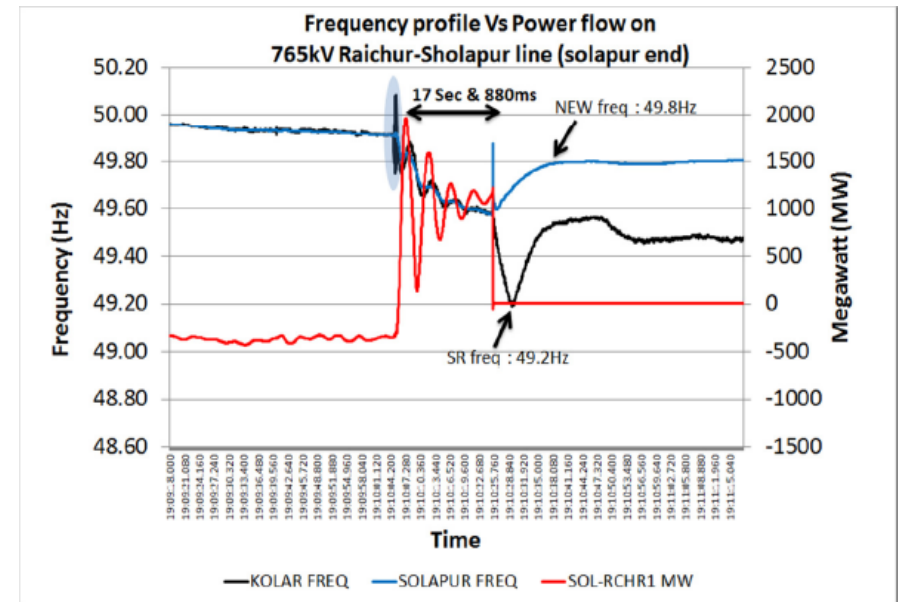
# Voltage Dip & Current Fluctuation



# Frequency Profile & Power Flow on Raichur – Sholapur Link



The change in frequency of NEWS grid was 0.2 Hz due to loss of 920 MW of wind generation in Tamil Nadu.



SPS of 765kV Raichur-Solapur line operated due to increase in power flow due to loss of wind generation.

## **Wind Generation loss events in Northern Grid**

**1. Multiple element tripping in  
Rajasthan & Wind generation Loss on  
24th June 2014 at 0934 hrs**

## 400 kV Akal S/S – 0934 hrs – 24.06.2014

220 kV Akal-Bhu line tripped due to Broken jumper near Bhu S/S

Generation Loss

**828MW**

220 kV Amarsagar-Tejwa D/C tripped

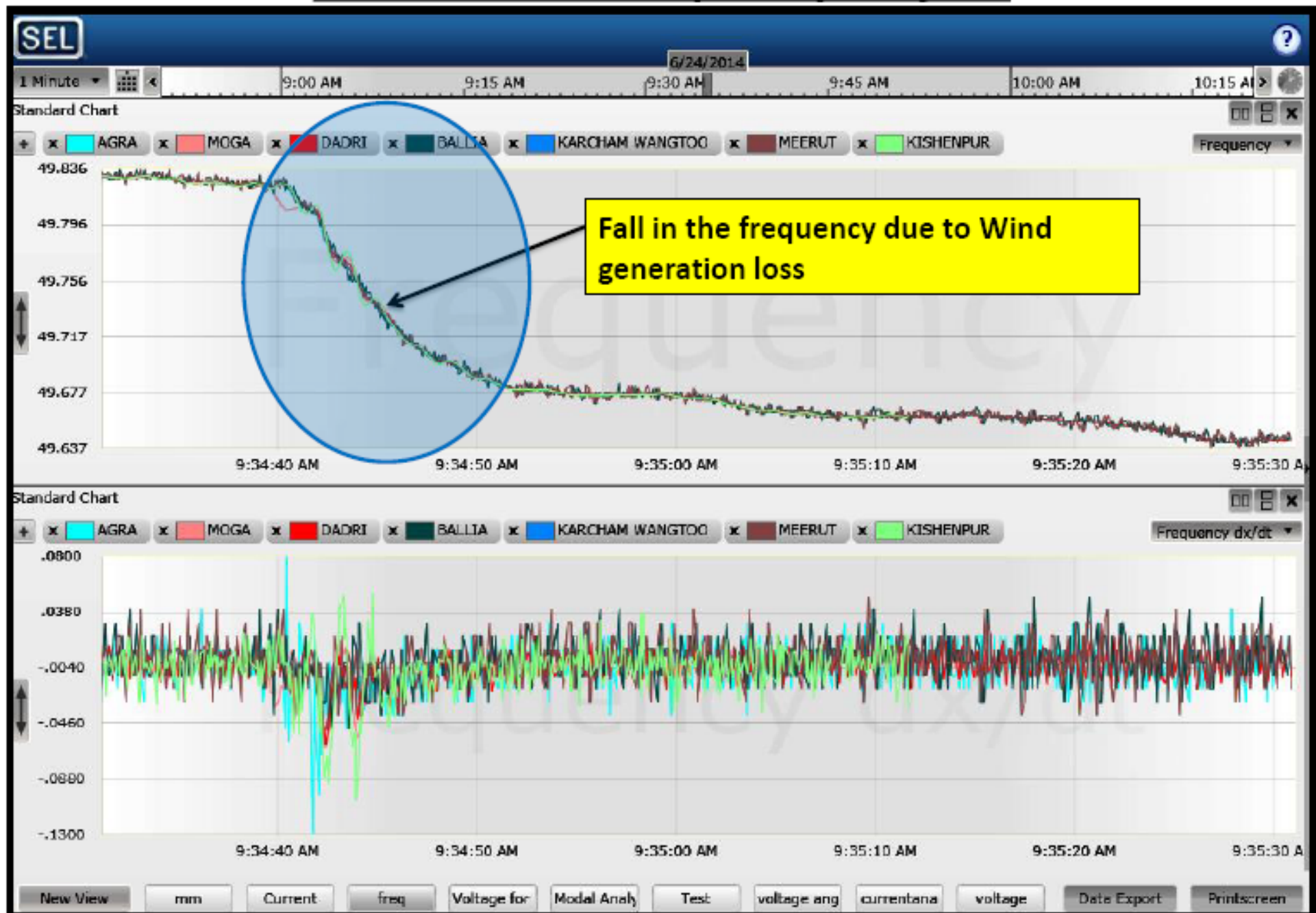
**Wind generation at Tejwa, Mada & Dagri tripped due to over voltage.**

Wind power generation loss  
Bhu, Tejwa, Mada & Dangri S/S tripped

400 kV Akal-Barmer & 400 kV Akal-Jodhpur line flow dipped and after a duration of 5 minutes picked up again



# PMU Plots of frequency & $df/dt$

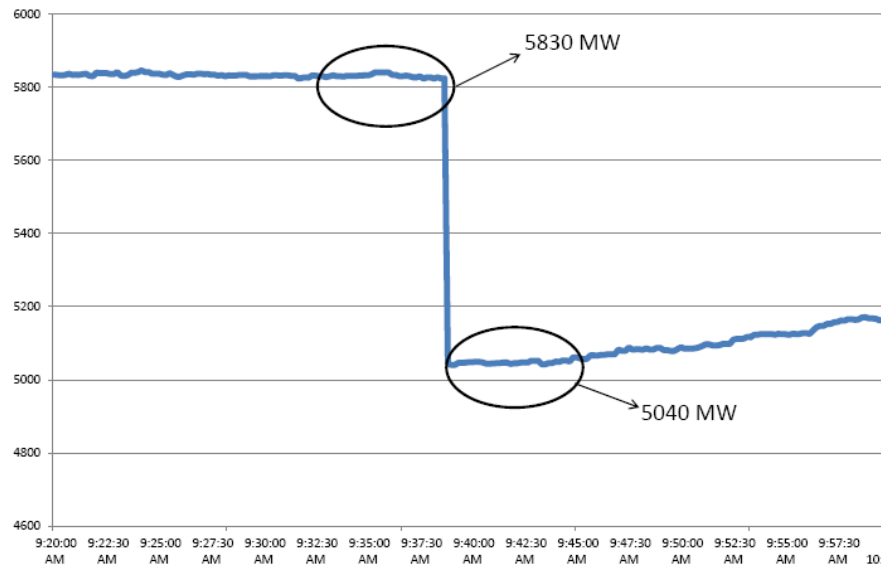


# PMU Plots of phase voltages



# Variation in Generation and Drawal

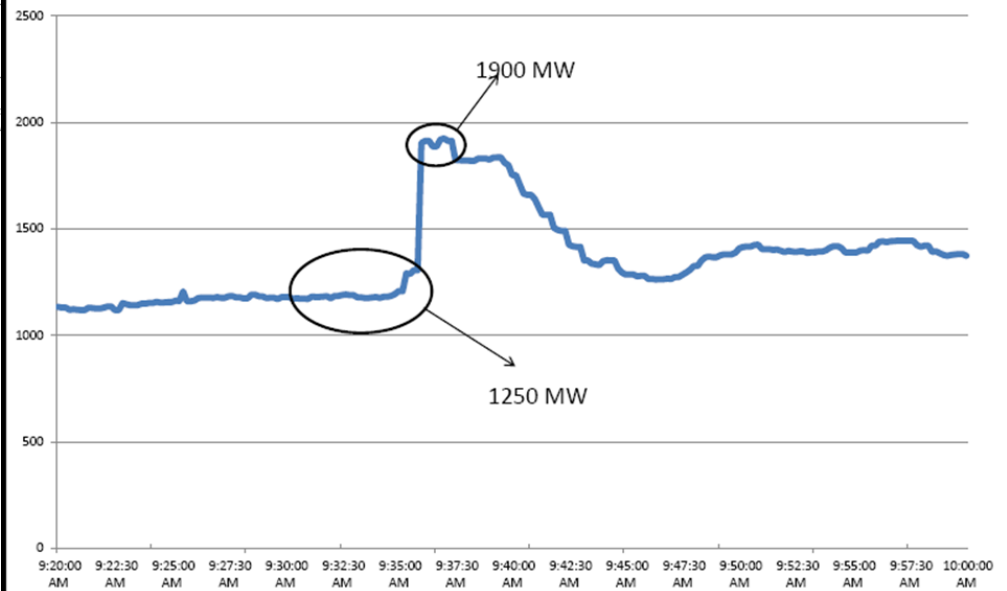
Rajasthan Generation MW



Rajasthan Generation decreased from 5830 MW to 5040 MW

Rajasthan Drawal increased from 1250 MW to 1900 MW

Rajasthan Drawl MW



# Key Takeaways from the Events

- Major cause of events - Faults at Sub Transmission Level
  - Timely clearance of fault as per CEA Standards important
- Variations in Frequency and Current
  - Operation of SPS – Load Shedding
  - Entire system at alert level
- Sub-Transmission Level Systems have to be strengthened
  - Especially in Renewable rich states
- Fault Ride Through (FRT) not available in most of the Old Wind generators.
- Over 1000 MW generation goes out instantly and comes back within half an hour!!
  - Normal wind variability is much lower than such step events

## Renewable Energy Management Centre (REMC)

- Working Group on Power for 12<sup>th</sup> Five Year Plan - Recommendation:
  - A separate Load Dispatch Centre for renewable energies shall be set up to Forecast data of temperature, wind speed and direction, solar insolation, Actual temperature, wind speed, direction and MW, MVAR and voltage from each wind farm and Metered energy data 15-minute time block wise
  - The collated data from such sub-LDCs can be transferred to the respective SLDC and RLDC so that the grid can be operated in a secure manner as well as ensuring that the renewable generation is absorbed to the fullest extent.
- Green Energy Corridors report prepared by POWERGRID
  - *Transmission Plan for Renewables Capacity Addition in 12th Plan*
    - Chapter-8 - Renewable Energy Management Centre

# Functionality of Renewable Energy Management Centre

- Forecasting of RE generation in jurisdiction area on day-ahead, hour ahead, week-ahead, month-ahead basis.
- Real time tracking of generation from RE sources and its geo-spatial visualization
- Close coordination with respective LDC for RE generation and control for smooth grid operation
- Single source information repository and coordination point for RE penetration
- On-line Dynamic security Assessment tool like Dynamic performance, Harmonic performance.

# Need for Load Forecasting by all the Entities

- Decentralised method of scheduling and despatch - merit order
- IEGC, 2010 - Regulations 5.3(e):

*“While the demand estimation for operational purposes is to be done on a daily/weekly/monthly basis initially, mechanisms and facilities at SLDCs shall be created at the earliest but **not later than 1.1.2011 to facilitate on-line estimation of demand for daily operational use for each 15 minutes block.**”*

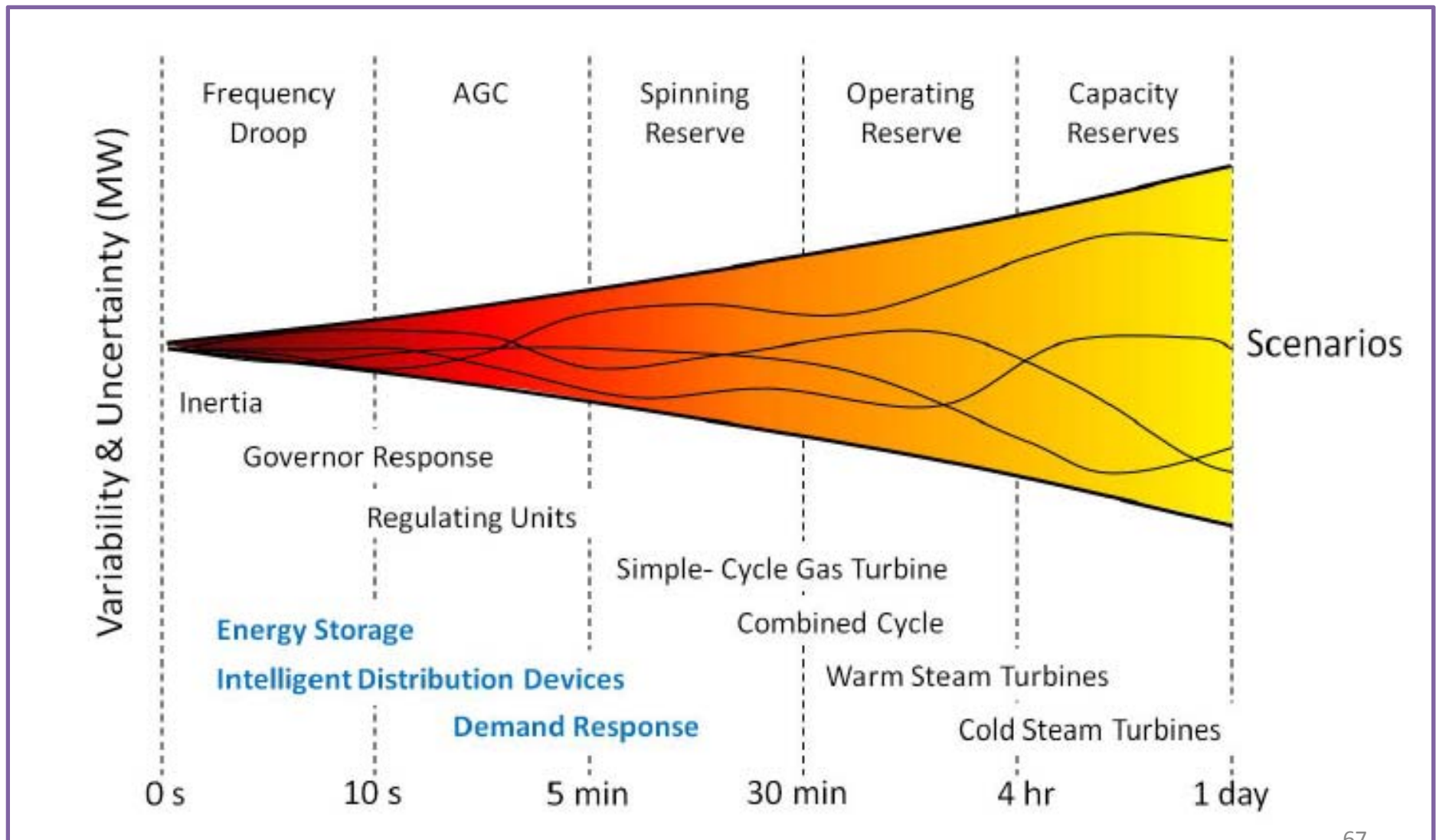
- **Forecasting in all time horizons**
  - Long / Medium Term - New schemes of extension or enhancements or capacity additions or infrastructure development.
  - Short Term Weekly / Monthly Basis – Portfolio Management
  - Day ahead 15 minute block wise - SLDCs plan considering different sources
  - Automated Demand Management Schemes be planned for contingencies.

# Requirement of balanced portfolio

- State Utilities are mandated with universal service obligations towards their customers.
- States may procure the entire power needed to the extent of 85-90% of their requirement under long-term / medium term
  - Long term : Case-I and Case-II Bidding
  - Medium term : > 3months to 3 years
  - Short term : Bilateral (including contingency) & Collective
- Deviations are like white cement
  - Only small deviations , within limits stipulated in DSM



## Growth of variability and uncertainty with time and associated resources & reserves available to maintain power-balance



## **Flexibility for the 21<sup>st</sup> century power systems**

- Signs that the power system is inflexible
  - Balancing generation and load difficult leading to frequency excursions or dropped load
  - Significant renewable energy curtailments; mostly due to excess supply and/or transmission constraints
  - Area balance violations
  - High price volatility

# Need for Flexibility

Type of Plant	Block Load on Synchronization (MW)	Average pick-up and shutdown rates (MW/min)	Time to full load (min)	Minimum 'ON' Time (min)	Minimum 'OFF' Time (min)
500/660 MW Coal Fired	90	15 up/25 down	35	120	240
500/660 MW Oil Fired	50	15 up/25 down	35	60/120	60/120
200/300 MW	45	5 up/10 down	35	120	240
110/120 MW	20	4 up/10 down	25	60	240
60 MW	2	3 up/5 down	20	60	120

*Source: Modern Power Station Practice, Volume L, Pergamon Elsevier, India 3/e 2008*

- Large 660 MW, 800 MW and 1000 MW sets being introduced
- Changing load profile, Flexible conventional generation needed to facilitate integration of renewables
- CEA Standard Technical Features for 660MW/800 MW Sets
  - Technical minimum recommended – 40%
  - Two shifting of machines envisaged

# Frequency Control Services

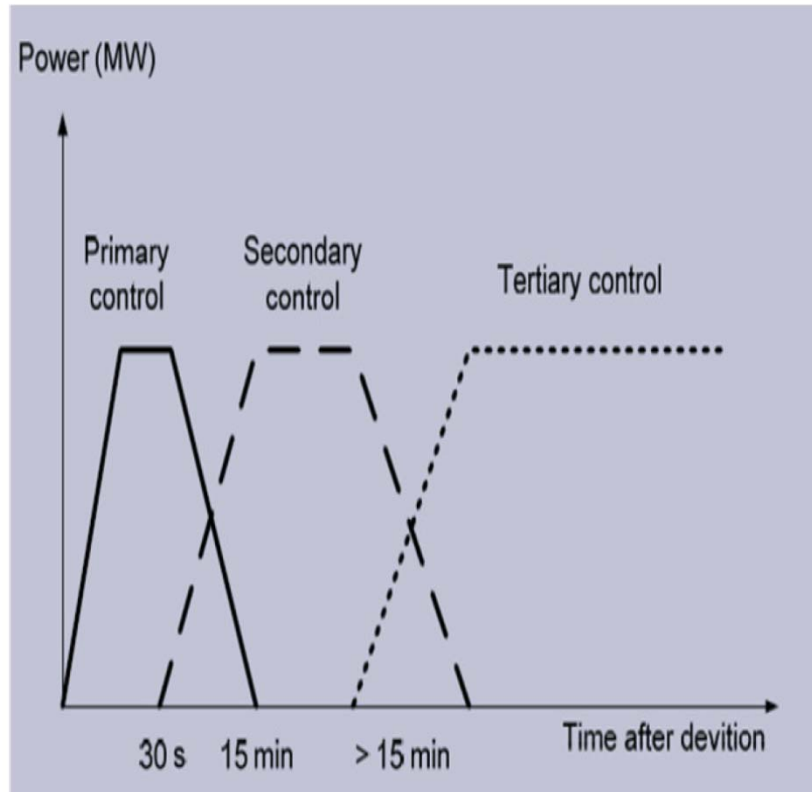


Figure 5: UCTE's classification of frequency reserves

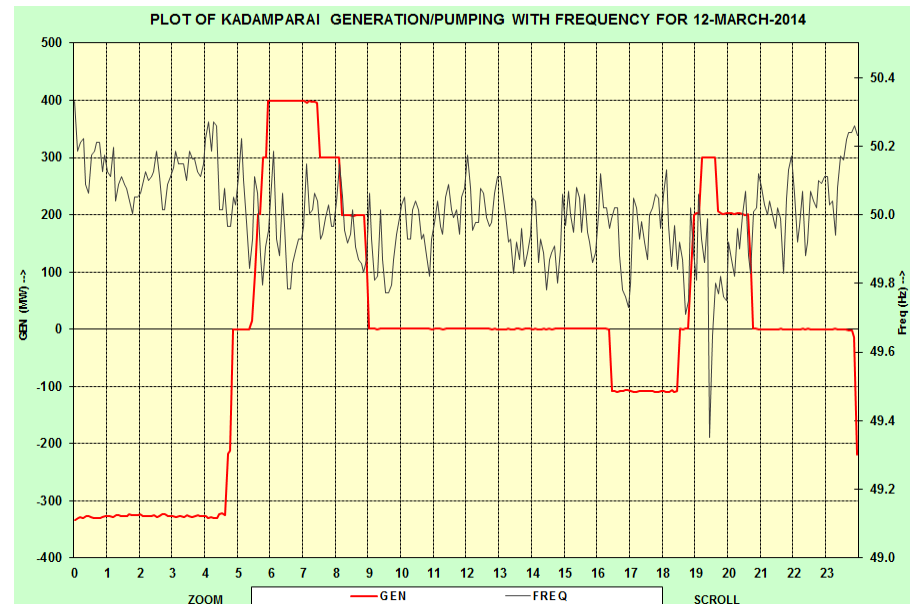
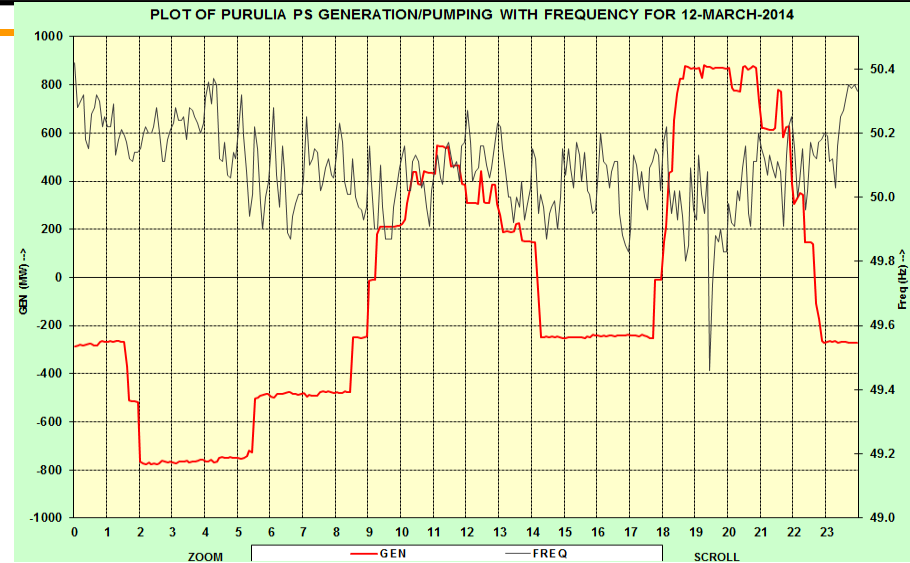
- **Primary Control**
  - Statutory provisions for primary response in the Indian Electricity Grid Code (IEGC)
  - Exemption to nuclear, CCGT, canal based hydro etc.
  - Speed droop setting between 3 to 6%
- **Secondary Control**
  - Absent by design in Indian grids
  - Roadmap for introduction of secondary control in India – manual mode to start with and graduate to automatic control in due course of time
- **Tertiary Control**
  - Re-scheduling of generation through a notice 60-90 minutes in advance.
  - Short term bilateral trades for the same day.
  - Load Management

# Spinning Reserve

- National Electricity Policy mandated 5% spinning reserve by the year 2012.
- Perceived generation shortage
  - No spinning reserve
  - Preserving some of the available power generation units for spinning reserve considered as equivalent to loss of generation in power deficient scenario – Need for a change in outlook
- Sudden generation outage /unforeseen higher demand
  - States tend to deviate from schedule or resort to load curtailment.
- In order to avoid such deviation from schedule, maintaining spinning reserve of at least 5% is a must.
- DC should be less than or equal to  $(IC - \text{Aux. cons.})$ , keeping provision for 5% margin for FGMO

# Pumped Storage Plants

- Pump Storage Plants:
  - Purulia (4x225 MW)
  - Srisaillam (6x150 MW)
  - Kadamparai (4x100 MW)
- Issues
  - Fixed timing,
  - Irrespective of frequency,
  - Frequency dependent
  - Seasonal
- Generator mode during day/peak hours.



# Installed Pumped Storage Plants

S. No.	Name of Project / State	Installed Capacity		Pumping Mode Operation	Reasons for not working in Pumping mode
		No. of units x MW	Total (MW)		
1	Kadana St. I&II Gujarat	2x60+2x60	240	Not working	Due to vibration problem
2	Nagarjuna Sagar Andhra Pradesh	7x100.80	705.6	Not working	Tail pool dam under construction
3	Kadamparai Tamil Nadu	4x100	400	Working	-
4	Panchet Hill -DVC	1x40	40	Not working	Tail pool dam not constructed
5	Bhira Maharashtra	1x150	150	Working	-
6	Srisaillam LBPH Andhra Pradesh	6x150	900	Working	-
7	Sardar Sarovar Gujarat	6x200	1200	Not working	Tail pool dam not constructed
8	Purlia PSS West Bengal	4x225	900	Working	-
9	Ghatgar Maharashtra	2x125	250	Working	-
		Total	4786		

# Potential Assessed for PSP

Sl. No.	Region / State	Probable Installed Capacity (MW)	Sl. No.	Region / State	Probable Installed Capacity (MW)
	<b>Northern</b>			<b>N. Eastern Region</b>	
1	Jammu & Kashmir	1650	1	Manipur	4350
2	Himachal Pradesh	3600	2	Assam	2100
3	Uttar Pradesh	4035	3	Mizoram	10450
4	Rajasthan	3780		Sub-Total	16900
	<b>Sub-Total</b>	<b>13065</b>		<b>Total</b>	<b>96524</b>
	<b>Western</b>			<b>Eastern Region</b>	
1	Madhya Pradesh	11150	1	Bihar	2800
2	Maharashtra	27094	2	Orissa	2500
3	Gujarat	1440	3	West Bengal	3825
	<b>Sub-Total</b>	<b>39684</b>		<b>Sub-Total</b>	<b>9125</b>
	<b>Southern</b>				
1	Andhra Pradesh	2350			
2	Karnataka	7900			
3	Kerala	4400			
4	Tamil Nadu	3100			
	<b>Sub-Total</b>	<b>17750</b>			



## Commercial mechanism

- Market mechanisms could further help large scale integration of renewable sources of energy:
  - ✓ Suitable market design to handle reserves for power balancing
  - ✓ Flexible Generators
  - ✓ Ancillary Market
  - ✓ Evening markets-through PXs
- Renewable Energy Certificate (REC) Mechanism

# Way Forward

- **Robust transmission at Inter State as well as Intra State Level**
  - Flexible transmission
- **Fault Ride Through (FRT) capabilities to be enforced**
- **Separate control rooms for Renewables (REMC)**
- **Forecasting**
  - Global at LDC level for grid security, balancing
  - Local at windfarm level for scheduling and commercial treatment
- **Balancing mechanisms**
  - Need for flexible conventional generation
- **Market Mechanisms**
  - Supply Side : Increased granularity, More frequent market
  - Demand Side : More / New products, Compliance Monitoring
  - Ancillary services



# Meeting of Forum Of Regulators

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## *Grid Integration of Renewable Energy Source: Issues for FOR consideration*

**Ministry of New and Renewable Energy**

**27 June 2014**

# Issues for FOR consideration

1. *Renewable Power to have effective “Must Run” status*
2. *Charges for Open Access*
3. *Renewable Regulatory Fund*
4. *Renewable Energy in Transmission Planning*
5. *Allowing Discoms to purchase RECs for Procuring RE beyond their RPO targets*
6. *Renewable Purchase Obligation (RPO) compliance*
7. *Review of Floor and Forbearance price of Solar REC*
8. *REC Validity period*
9. *Renewable Generation Obligation (RGO) on new Conventional Thermal Power Plants*
10. *Solar Rooftop Status*

**Details of these issues are discussed in subsequent slides.**

# 1. Renewable Power to have effective “Must Run” status

- Renewable power has “*Must Run*” status - not subject to ‘merit order dispatch’
- MNRE has received representations from wind generators of Tamil Nadu regarding frequent backing down of wind power generation –around 50% of wind generation in 2013, estimated loss of around Rs 2700 crore.
- Haryana Electricity Regulatory Commission adopted concept of “*Deemed Generation*” for solar energy - provides payment of tariff approved by Commission for refusal beyond 87.6 hours in a year.
- *Request to CERC to explore possibility for devising a model regulation that could be adopted by SERCs to protect financial interests of RE generators and deter transcos and discos and explore other options before backing down generation .*

*Letter no 8/2/2012-EFM dated 3 January 2014*

## 2. Charges for Open Access

- Charges for long term and medium term open access transactions fixed on basis of MW/month, whereas for short term open access transaction on a per kWh basis.
- Wind power has CUF in thange 20-25%, hence transmission charges based on installed capacity become quite high compared to charges based on energy generated.
  - e.g., if wind electricity generated in Tamil Nadu is purchased in Punjab, open access charges are Rs. 1.20 per kWh on MW/month basis, whereas it would be only Rs. 0.41 per kWh on per kWh basis.
- Strong need to exempt wind power from open access charges for inter-state transactions as is for solar. CERC requested for consideration of revision in the existing Open Access regulations.

*Letter No.8/1/2014-EFM dated 10<sup>th</sup> February 2014*

### 3. Renewable Regulatory Fund

- CERC approved implementation of Renewable Regulatory Fund (RRF) w.e.f. 15 July 2013. Later commercial mechanism suspended till CERC's further orders.
- Wind generators have started providing schedule for generations to SLDCs - now awaiting feedback from SLDCs.
- Before commercial operations for RRF are started the following would need to be addressed:-
  - *SLDCs have to put ABT meters at pooling stations - perhaps such meters in place only in Gujarat and for new installations in Maharashtra. Other states such as Karnataka, Rajasthan and Tamil Nadu yet to initiate process.*
  - *Limited experience with SLDCs for operating RRF mechanism - in 2013 southern states had opened UI & RRF accounts for wind generators, however, the process continued only from July to September 2013.*
  - *It would be necessary that during the period when commercial operations are suspended the reaming issues including of stabilizing the RRF mechanism is taken up on priority.*
  - *Thereafter only commercial operations shall commence.*



## 4. Renewable Energy in Transmission Planning

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- MNRE has taken up with Ministry of Power for amendment in the Electricity Act to ensure that while planning for transmission systems, Central Transmission Utility/ State Transmission Utility shall provide due consideration and priority to generation capacities based on renewable sources of energy (*Section 38 and 39 of the Act*) .
- However, even without the explicit mention, the transmission utilities shall initiate action for incorporating renewable energy in their transmission plans and accordingly get these plans approved from the respective regulators.
- *State Regulators are requested to ensure that transmission plan take up into consideration the renewable power capacity in the respective area.*

## 5. Allowing Discoms to purchase RECs for Procuring Renewable Energy beyond their RPO targets

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- Government of Gujarat has requested for change in REC eligibility norms so as to make the DISCOMs eligible for REC for purchase of renewable power in excess of RPO.
- MNRE has taken up Govt. of Gujarat's request with CERC.  
*(Letter no. SNRE/2012 dated 30 October 2012 and later letters)*
- This issue was last discussed in Forum of Regulators Working Group on 9 December 2013 and 2 April 2014.
- CERC has commissioned a study to revisit REC framework including the issue and report to come out by September 2014.
- *The issue needs to be addressed on priority on the basis of interim study report.*

## 6. Renewable Purchase Obligation (RPO) compliance

- As per an estimate from MOP in 2012-13, as against RPO levels of 5.45 % for non-solar and 0.45 % for solar the compliance was 3.74% and 0.08% respectively. As per 2013-14 ARRs, on all India basis, DISCOMs had made provision only for 50% RPO compliance.
- Poor RPO compliance is major bottleneck.
- In September 2013 MNRE had requested SERCs to ensure RPO compliance. *(Letter no 7/2/2013-EFM dated 4 September 2013)*
- *The Regulators are requested to consider exercising their statutory authority and issuer directions to ensure RPO compliance either through purchase of renewable power or RECs and enforce the same by invoking penal provisions of the regulations against defaulting entities.*
- *Further, State Regulators may consider directing DISCOMs to make provision in ARR for meeting Renewable Purchase Obligation (RPO) shortfall by keeping money aside to purchase RECs equivalent to the shortfall.*

## 7. Review of Floor and Forbearance price of Solar REC

- CERC has declared Floor and Forbearance prices for solar REC as Rs 9.30 - 13.40 per kWh for the control period from 1 April 2012 to 31 March 2017.
- Over the last three year solar PV tariff has come down drastically, (below the REC floor price).
- MNRE got the issue examined and suggested to CERC that a vintage based multiplier for solar REC may be adopted ( *Letter no 7/2/2013-EFM dated 30 July 2013*).
- This issue was further discussed in the FOR working group meeting on 9 December 2013 and 2 April 2014.
- At present CERC has commissioned a study to revisit REC framework including the issue and report to come out by September 2014.
- *The issue needs to be addressed on priority on the basis of interim study report.*

## 8. REC Validity period

- RECs validity is for 2 years. In view of poor market conditions, some of the unsold RECs are at the verge of expiry of their validity.
- A total of 50059 RECs will be expiring in the next 6 months.

Wind	37814
Bio-fuel cogeneration	9413
Biomass	2832
Total	50059

- This issue was discussed in the 23 May 2014 meeting organised by MNRE. CERC has informed that they have commissioned a study to revisit REC framework including the issue and report to come out by September 2014 .
- *The issue needs to be addressed on priority on the basis of interim study report.*

## 9. Renewable Generation Obligation (RGO) on new Conventional Thermal Power Plants

- The existing legislative mandate puts RPO on consumption- there is no obligation on the generation side.
- MNRE has suggested amendment in Electricity Act to introduce Renewable Generation Obligation (RGO) for generating 10% renewable power on the new conventional thermal power plants.
- Amendment is proposed in two parts: a) in Electricity Act to also introduce generation based obligation (which is on consumption only); and b) amend the Tariff Policy to suggest the percentage levels for generation based obligation on new conventional thermal power generators. *(MNRE Letter No.8/2/2014-EFM dated 18 June 2014)*
- *FOR may consider deliberating on the issue.*



## 10. Grid-connected SPV Rooftop systems Developments...

1 of 5

- MNRE included Grid connected SPV rooftops in the “off grid and decentralised solar Applications” scheme vide ammend no. 5/23/2009-P&C dated 30<sup>th</sup> October 2012 for SPV plants upto 100 kW capacity.
- MNRE subsidy upto 30% on the following benchmark cost of the projects is available :
  - Upto 100 kWp : 100 Rs./Wp
  - 100 to 500 kWp : 90 Rs./Wp
- MNRE has issued Guidelines for “Grid connected rooftops and small solar plants programme vide No. 30/11/2012-13/NSM dated on 26 June 2014

## 10. Grid-connected SPV Rooftop systems Status of Projects Sanctioned

2 of 5

### [A] Under National Clean Energy Funds:-

- **26.1 MWp** Projects sanctioned to SECI under NCEF. SECI invited tenders in 3 phases. Projects allocated to developers and **10 MW** sanctioned for execution of which **0.56 MW** commissioned and **4.5 MW** completed.
- **2.5 MWp** projects sanctioned to Ministry of Railways which are under execution
- **50 MWp** projects sanctioned to SECI. Tenders invited (40 MW in CAPEX model & 10 MW in RESCO Mode)  
**Total 78.6 MW**



## 10. Grid-connected SPV Rooftop systems Projects sanctioned under MNRE Programme

3 of 5

### [B] Projects Sanctioned Under MNRE Programme

- **43.255 MWp** projects sanctioned to to **10 States**; Andhra Pradesh (5 MW), Madhya Pradesh (5 MW), Rajasthan (6 MW), Punjab (5 MW), Chandigarh(2.81 MW), Kerala(1.28 MW), Uttarakhand (5 MW), Gujarat (5 MW), Uttar Pradesh(2 MW), Tamil Nadu (6.164 MW)
- **4MWp** projects under Solar City Programme in Surat, Chandigarh and Nagpur are under execution of which 2 MWp projects in Chandigarh completed.

**Total = 47.255 MWp**

## 10. Grid-connected SPV Rooftop systems Projects recently approved under NCEF

4 of 5

- **[C] Projects approved under NCEF**
  - **52 MWp** capacity in through multi Govt. agencies
  - **54 MWp** capacity in various States across the Country through State Nodal Agencies
  - **73 MWp** capacity in the Warehouses
- Total = 179 MWp**

# 10.State/Regulators initiatives for Grid Connected Solar Rooftop PV projects

5of 5

States	Metering	Order issued by Regulators	State Policy Issued	Incentives for Rooftop Owners
Gujarat	Gross Metering	Included in Solar Tariff Order	Included in Solar Policy	MNRE+FiT
Karnataka	Gross Metering	Yes	Yes	MNRE + FiT
Tamil Nadu	Net Metering	Discussion Paper	Included in Solar Policy	MNRE + State (Rs. 20,000)
Andhra Pradesh	Net Metering	No	Yes	MNRE + State (Rs. 20,000)
Uttarakhand	Net Metering	Yes	Yes	MNRE+ FiT
West Bengal	Net Metering	Yes	yes	Extension of demand cut to 50% of installed capacity for captive use
Rajasthan	Gross Metering	Yes	Included in Solar Policy	MNRE + State (Feed in Tariff)
Chattisgarh	Gross metering	Yes	Included in Solar Policy	MNRE + State (Feed in Tariff)

The background of the slide features a bright, sunny sky with soft, white clouds. In the lower-left corner, a portion of a solar panel array is visible, showing its blue and silver grid. In the lower-right corner, a tall white wind turbine stands prominently, with several other smaller turbines visible in the distance behind it.

**Thank You!**

**A  
PRESENTATION ON  
STATUS OF IMPLEMENTATION OF “FOR” MODEL REGULATIONS  
BY VARIOUS SERCs**

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**41<sup>st</sup> Meeting of Forum of Regulators**

**27.6.2014**

# FUNCTIONS OF FORUM

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- ▶ Analysis of the tariff orders and other orders of Central Commission and State Commissions and compilation of data arising out of the said orders, highlighting, especially the efficiency improvements of the utilities;
- ▶ Harmonization of regulation in power sector;
- ▶ Laying of standards of performance of licensees as required under the Act.
- ▶ Sharing of information among the members of the Forum on various issues of common interest and also of common approach.  
Undertaking research work in-house or through outsourcing on issues relevant to power sector regulation;
- ▶ Evolving measures for protection of interest of consumers and promotion of efficiency, economy and competition in power sector; and
- ▶ Such other functions as the Central Government may assign to it, from time to time.

# MODEL REGULATIONS (9)

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- × Model Regulations for Multi Year Distribution Tariff
- × Model Regulations for Protection of Consumer Interest
- × Model Terms and Conditions of Intra-State Open Access Regulations
- × Model Compliance Audit Regulations for SERCs
- × Model DSM Regulation for SERCs
- × Model Regulation for SERCs for REC Framework
- × Model Regulation on Standards of Performance for Distribution Licensees
- × Regulations for Fees & Charges Levied by SLDCs
- × Model Supply Code

# STUDY REPORTS (29)

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- ✖ Impact Assessment of Plan Assistance to the Forum of Regulators by the Ministry of Power during the 11th Plan Period
- ✖ Introducing Competition in Retail Electricity Supply in India
- ✖ Policy and Regulatory Interventions to Support Community Level Off-Grid Projects
- ✖ Preparing Incentive StruStatus for fullfilling Renewable purchase obligation Targets
- ✖ Report on Green Energy Corridors
- ✖ Report on Standardization of Regulatory accounts
- ✖ Study Report on Assessment of achievable potential of new and renewable energy resources in different states during 12th Plan period and determination of RPO trajectory and its impact on tariff
- ✖ Policy and regulatory interventions to support community level off-grid projects
- ✖ Evolving measures for the effective implementation of prepaid metering in the country
- ✖ Report on Model Regulations - Protection of Consumer Interest



# STUDY REPORTS (29) ...

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- ✖ Assessment of reasons for financial viability of utilities
- ✖ Tariff revision assessment for financial viability of DISCOM and comparison of approaches
- ✖ Detailed Procedure under REC Mechanism (First Amendment)
- ✖ Assignment on Implementation & Impact Analysis of Time of Day (TOD) tariff in India.
- ✖ Model Terms and Conditions of Intra-State Open Access Regulations September
- ✖ Financial assistance to State Agencies for Implementation of REC framework
- ✖ Regulatory Updates on Demand Side Management
- ✖ Final report on standardisation of distribution franchise model
- ✖ Study on analysis of tariff orders & other orders of State Electricity Regulatory Commissions
- ✖ Assessment of Various Renewable Energy Resources Potential in Different States, Determination of RPO Trajectory and its Impact on Tariff

# STUDY REPORTS (29) ...

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- ✖ Study to evolve an appropriate model of incentive-disincentive mechanism for Distribution Utilities.
- ✖ Model DSM Regulation for SERCs
- ✖ Model Compliance Audit Regulations for SERCs
- ✖ Capital Cost Benchmarks for Distribution Business - Administrative Staff College of India
- ✖ Report on Institutionalising Energy Efficiency & demand side management in utility sector in India
- ✖ Study on Evolving an Appropriate Model for Distribution Margin
- ✖ Comparative Analysis of Supply Codes in 10 States
- ✖ Electricity Reforms and Regulations - A Critical Review of Last 10 Years Experience - by IIM-A
- ✖ Task Force on Scheduling, Metering and Settlement of Intra-State Open Access Transactions

# **STUDY REPORT – POLICY & REGULATORY INTERVENTIONS TO SUPPORT COMMUNITY LEVEL OFF-GRID PROJECTS**

**NO SIGNIFICANT INFORMATION AVAILABLE ABOUT ACTION TAKEN  
ON THIS ISSUE**

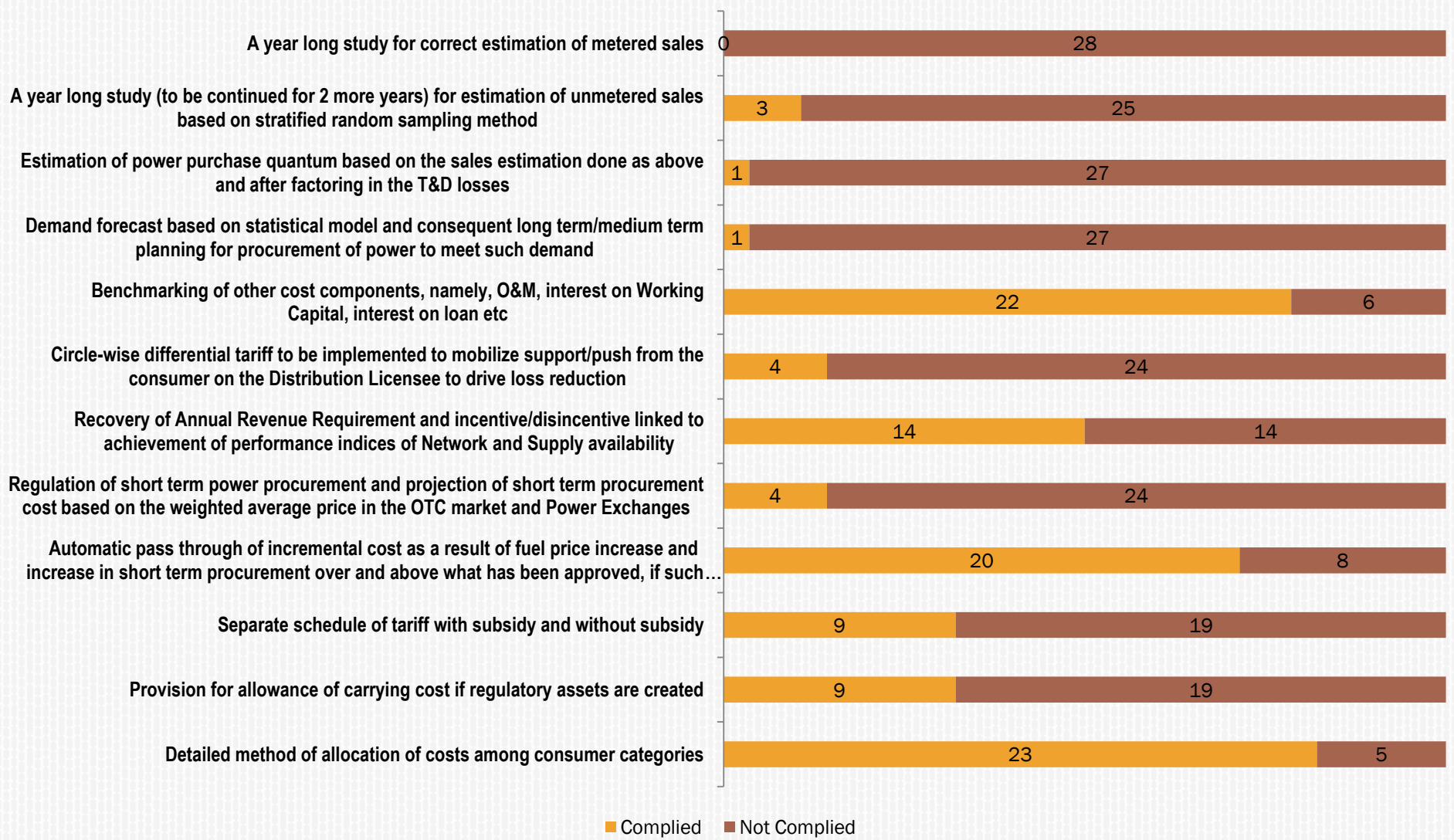
# **STUDY REPORT – STANDARDISATION OF REGULATORY ACCOUNTS**

**NO SIGNIFICANT INFORMATION AVAILABLE ABOUT ACTION TAKEN  
ON THIS ISSUE**

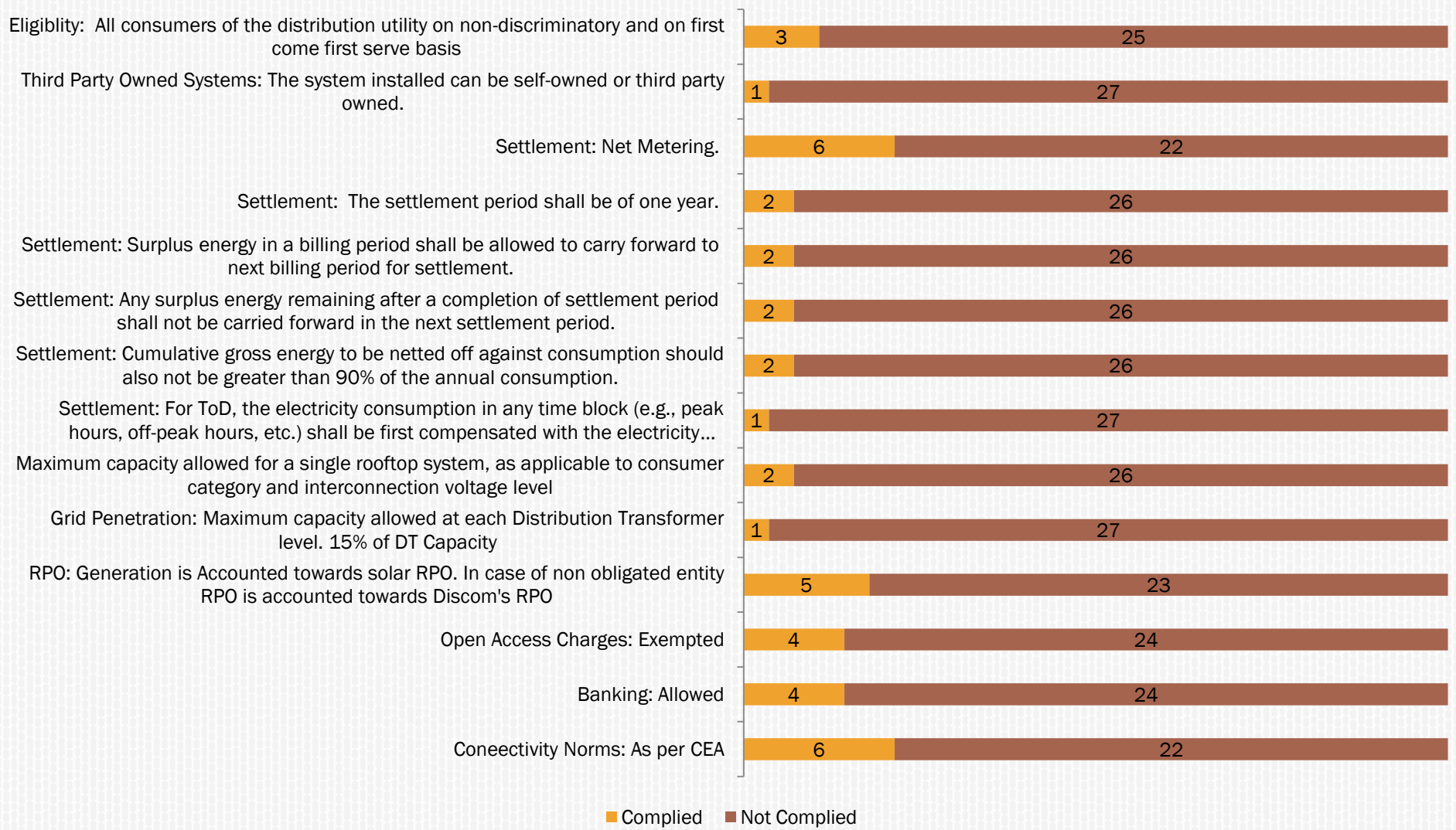
# **STUDY REPORT – EVOLVING MEASURES FOR THE EFFECTIVE IMPLEMENTATION OF PRE-PAID METERING IN THE COUNTRY**

**NO SIGNIFICANT INFORMATION AVAILABLE ABOUT ACTION TAKEN  
ON THIS ISSUE**

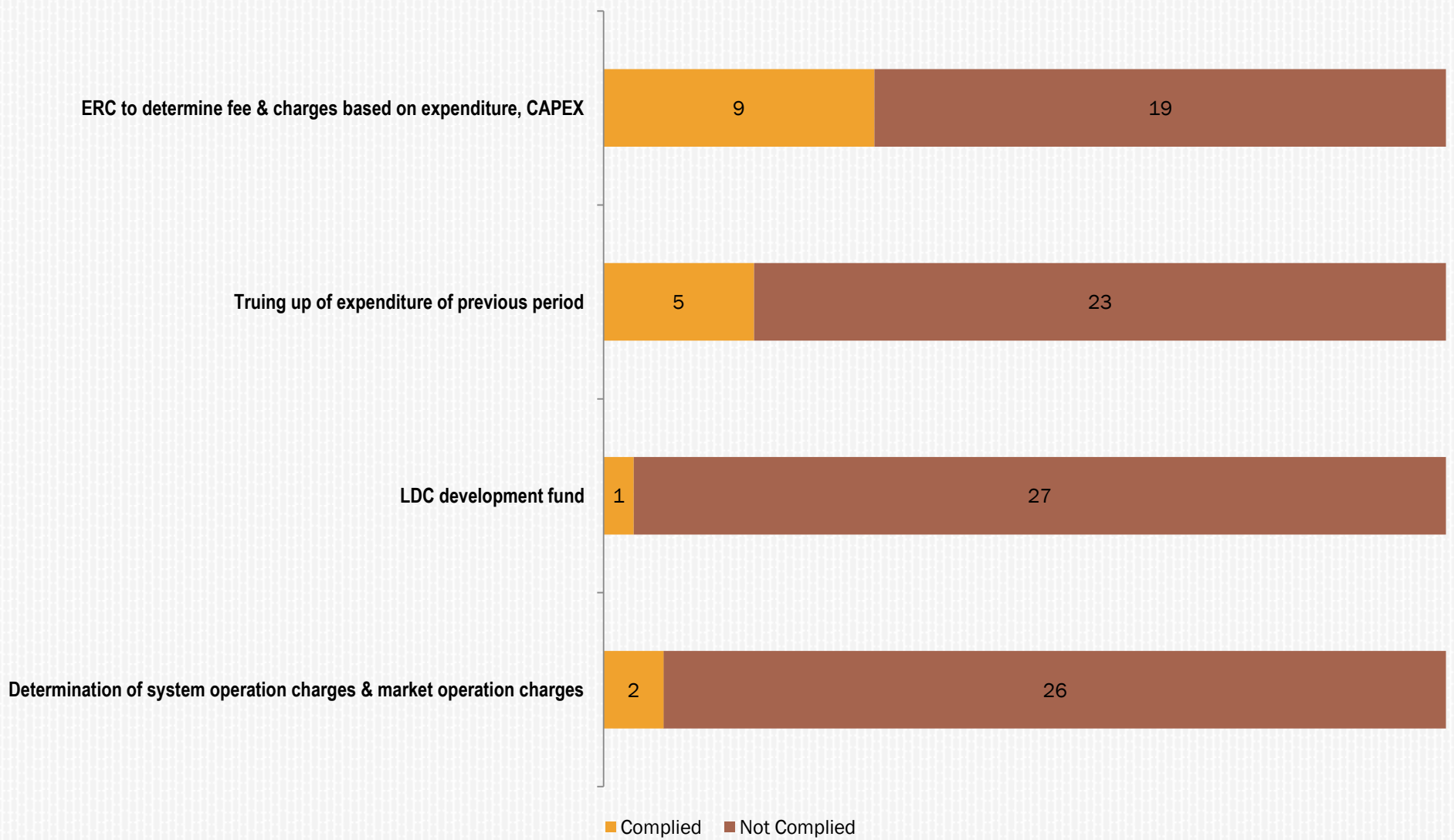
# MODEL REGULATIONS – MULTI YEAR DISTRIBUTION TARIFF



# MODEL REGULATIONS – ROOF-TOP GRID INTERACTIVE SYSTEMS BASED ON NET METERING



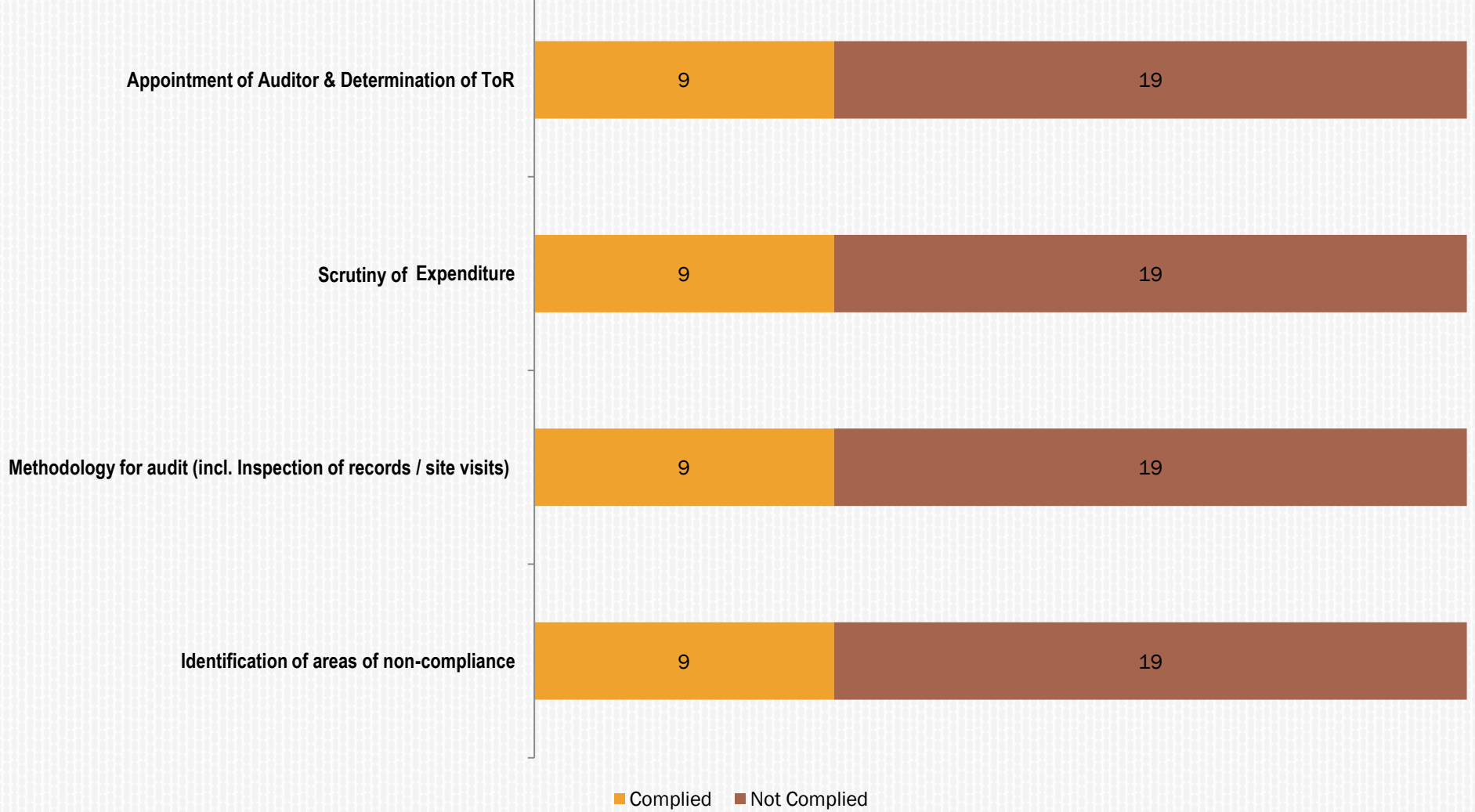
# MODEL REGULATIONS – FEES & CHARGES LEVIED BY SLDCS



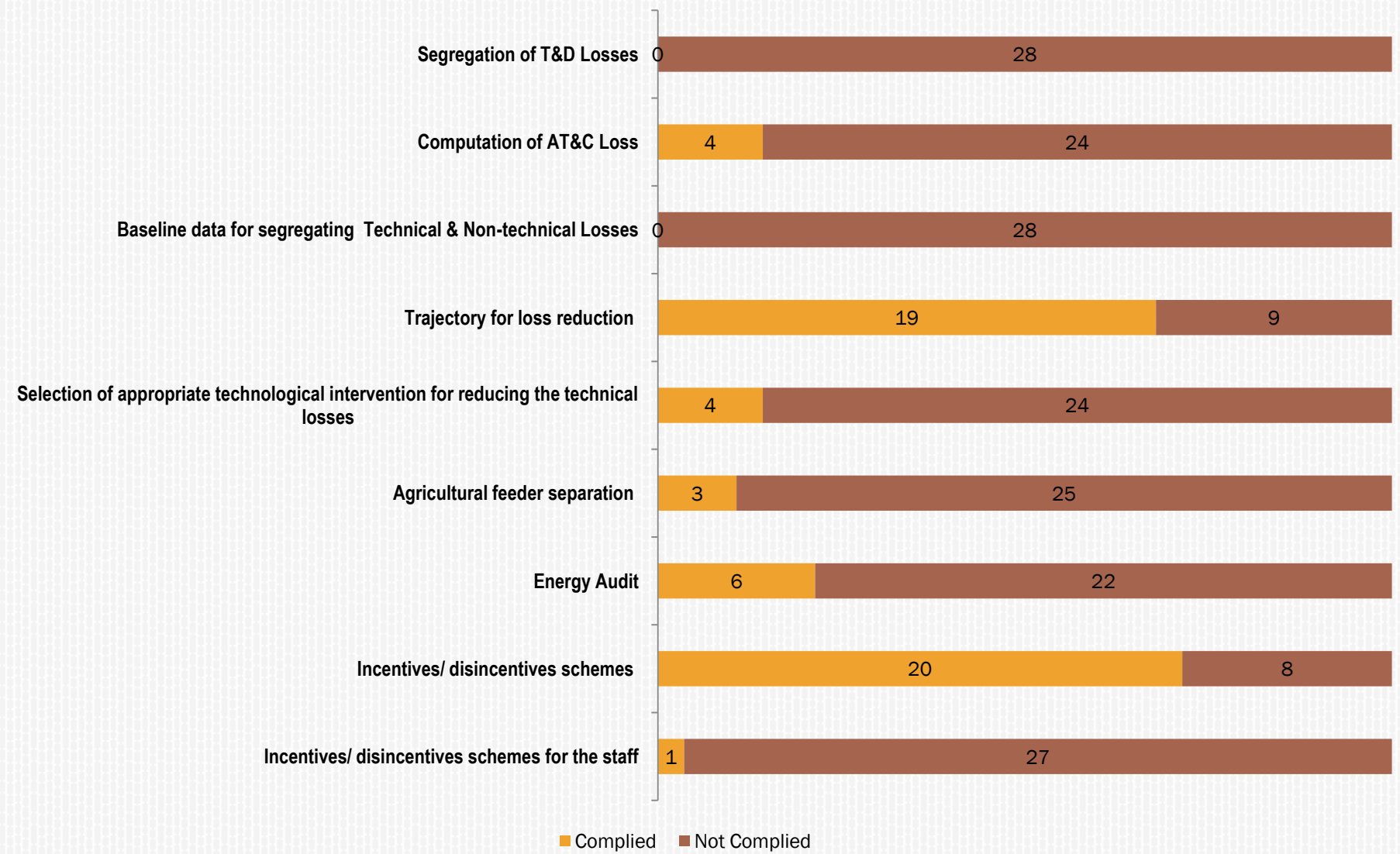


# MODEL REGULATIONS – COMPLIANCE AUDIT FOR SERC

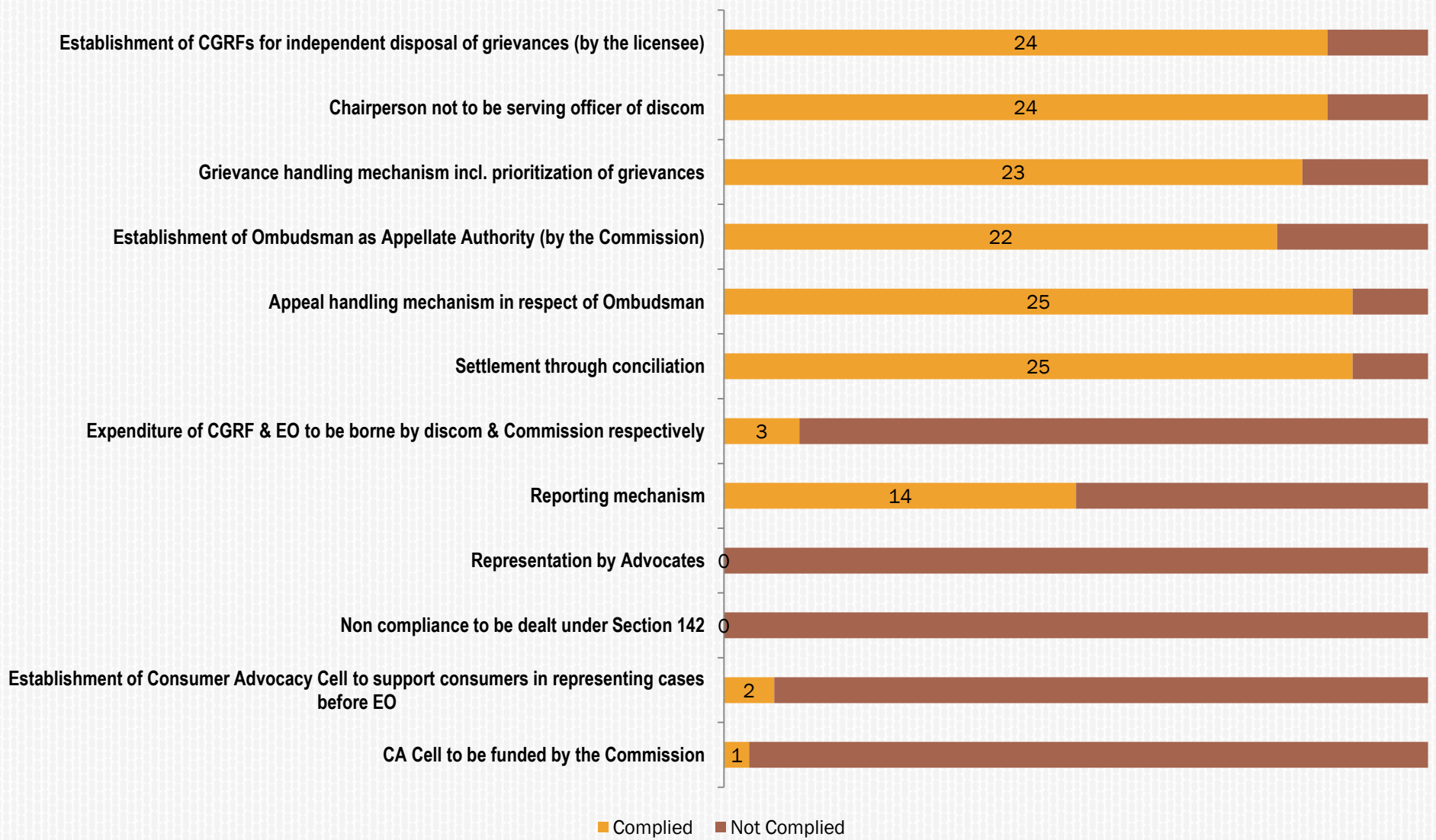
Power to conduct audits of regulated entities by the Commission for verifying their compliance with the Act, rules, regulations made thereunder, orders and directions issued by the Commission. The Commission may, by order, empanel consultants / auditors required to assist the Commission in the discharge of these functions on the terms and conditions as deemed fit



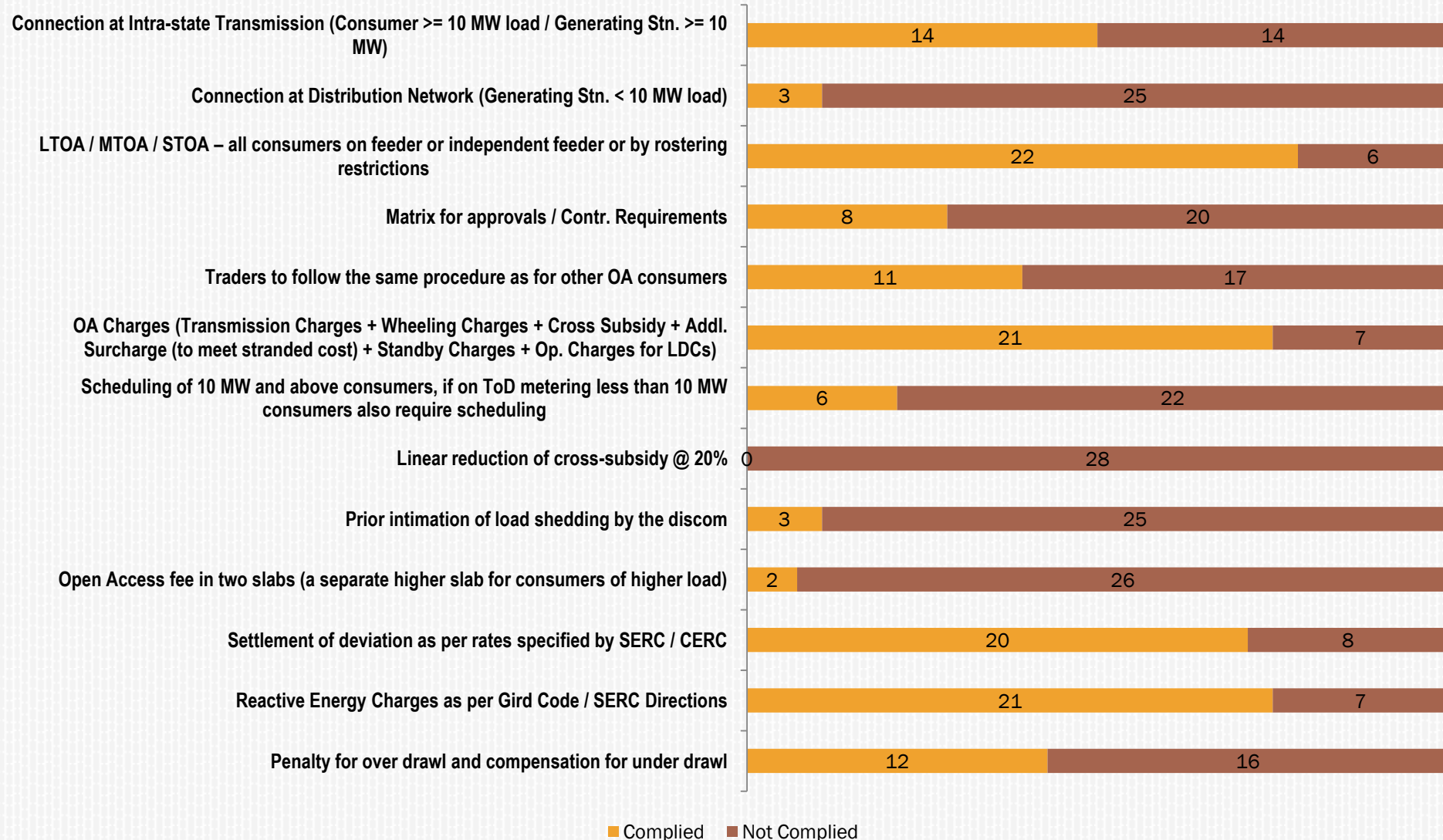
# STUDY REPORT – LOSS REDUCTION STRATEGIES



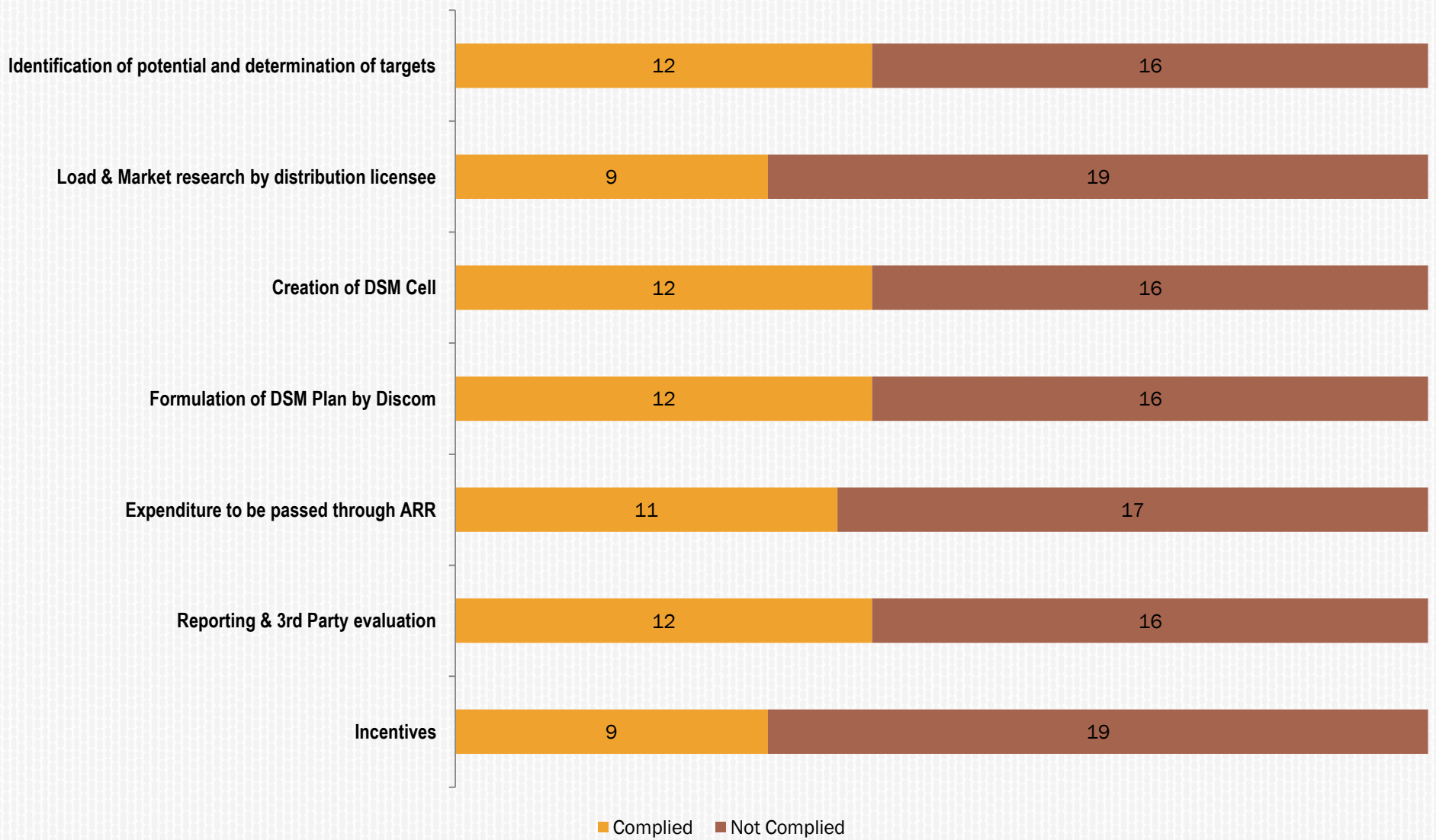
# MODEL REGULATIONS – PROTECTION OF CONSUMER INTEREST



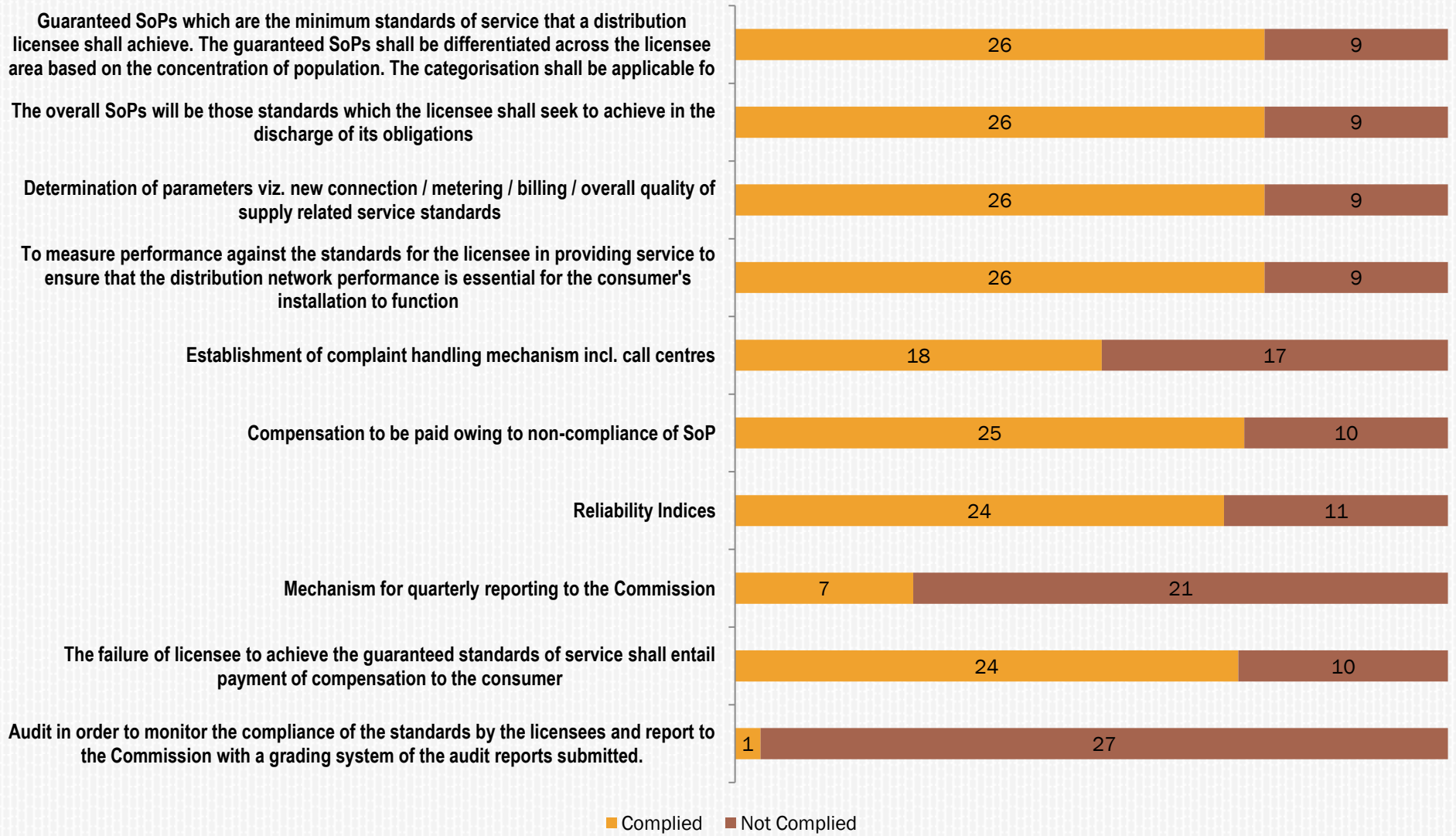
# MODEL REGULATIONS – TERMS & CONDITIONS OF INTRA-STATE OPEN ACCESS



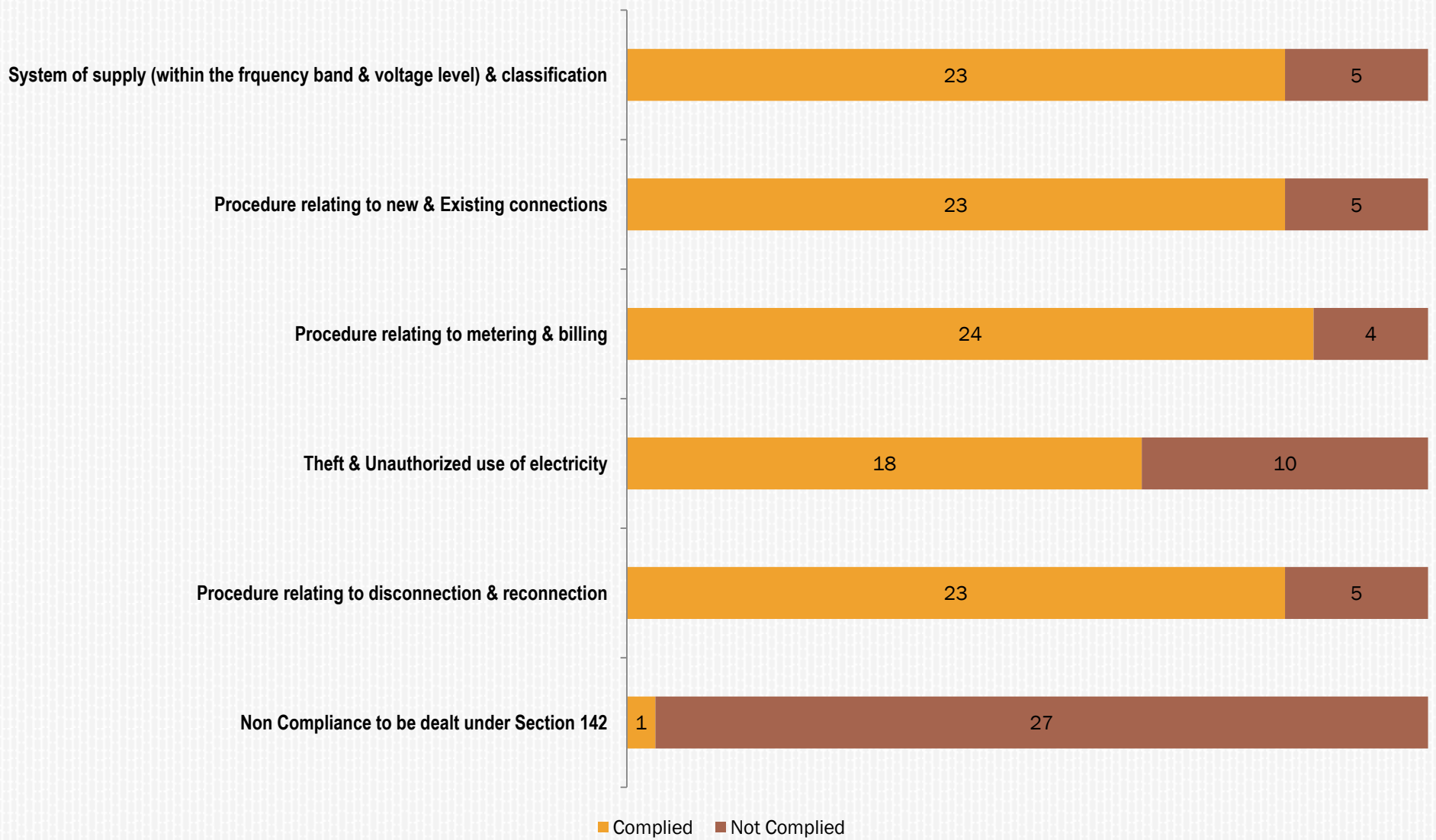
# MODEL REGULATIONS – DEMAND SIDE MANAGEMENT FOR SERCs



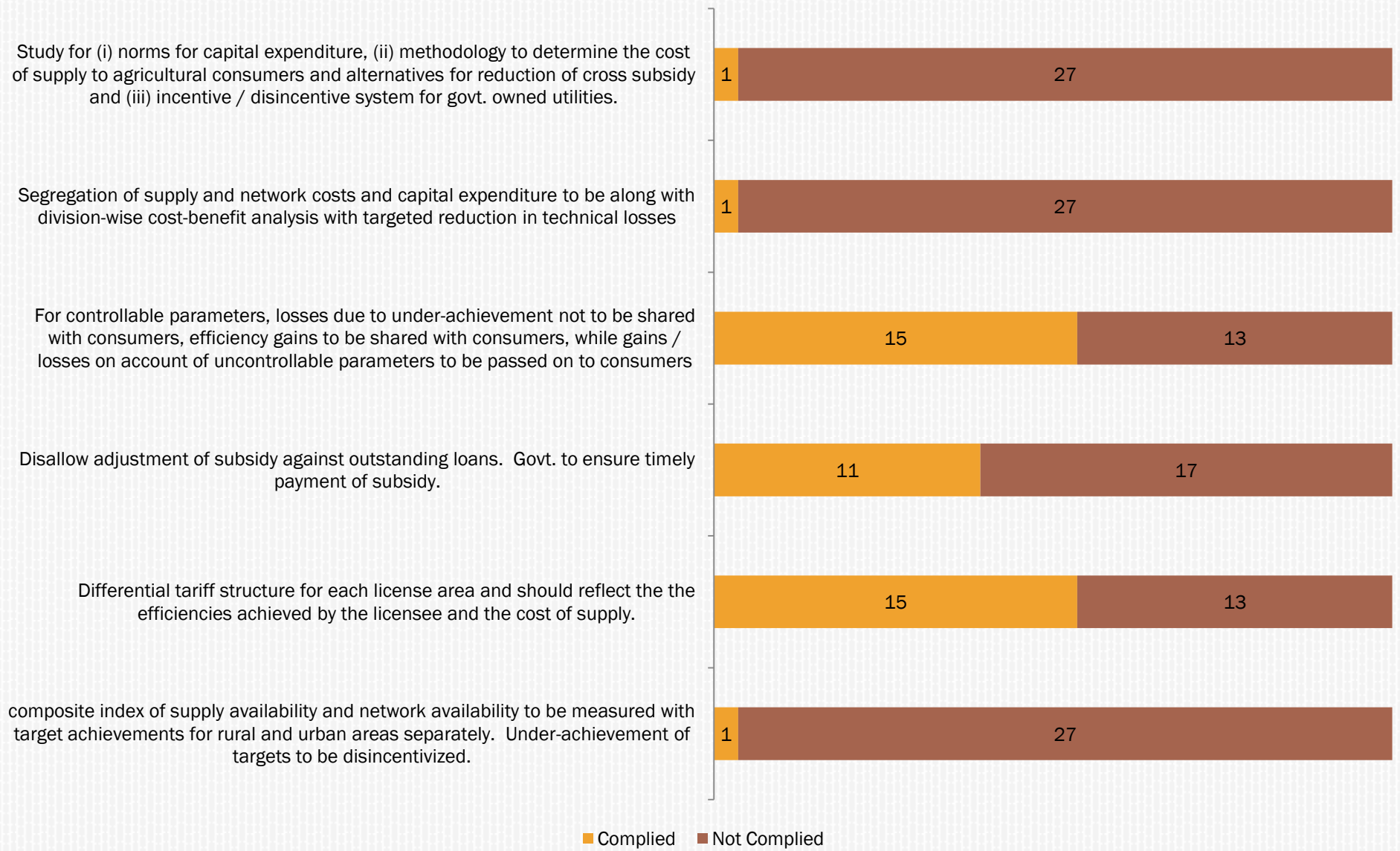
# MODEL REGULATIONS – STANDARDS OF PERFORMANCE FOR DISTRIBUTION LICENSEES



# MODEL REGULATIONS – SUPPLY CODE

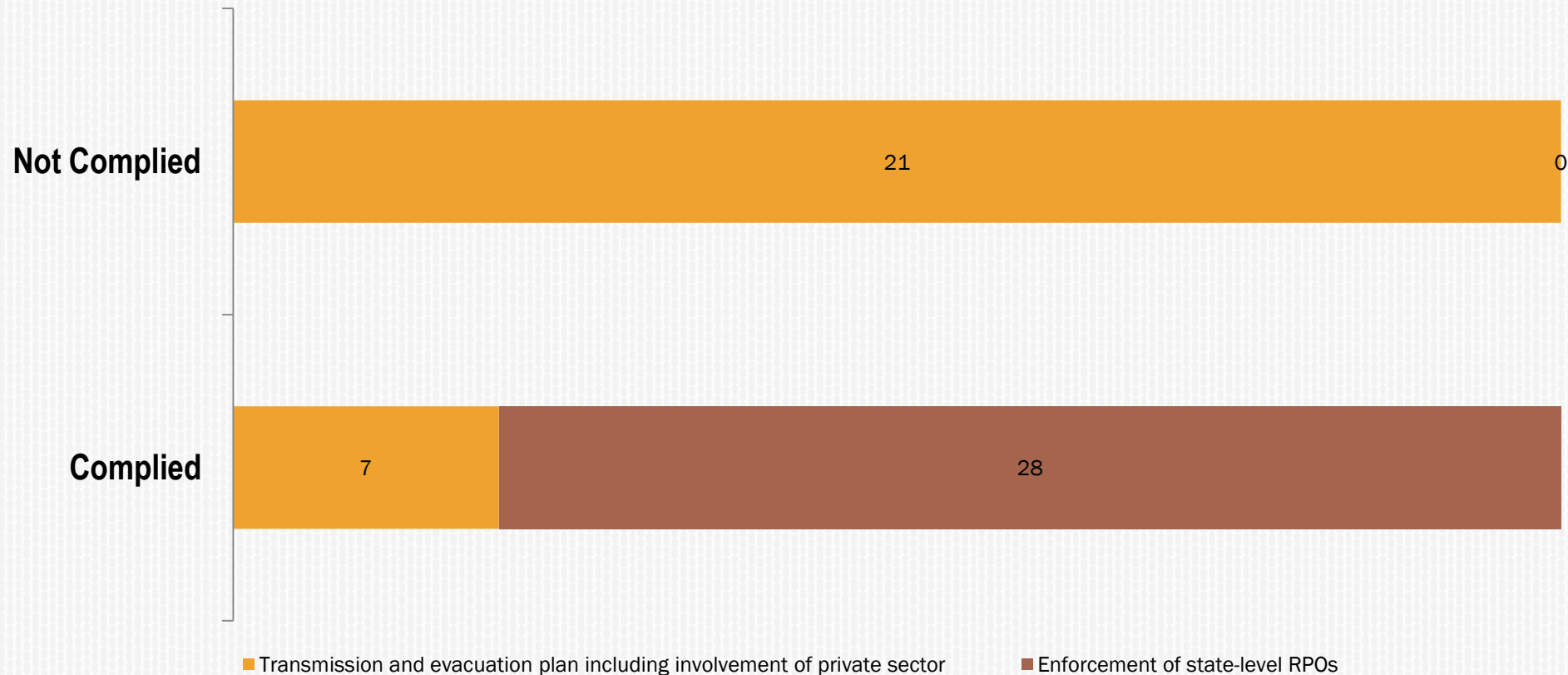


# STUDY REPORT – EVOLVING AN APPROPRIATE MODEL FOR DISTRIBUTION MARGIN

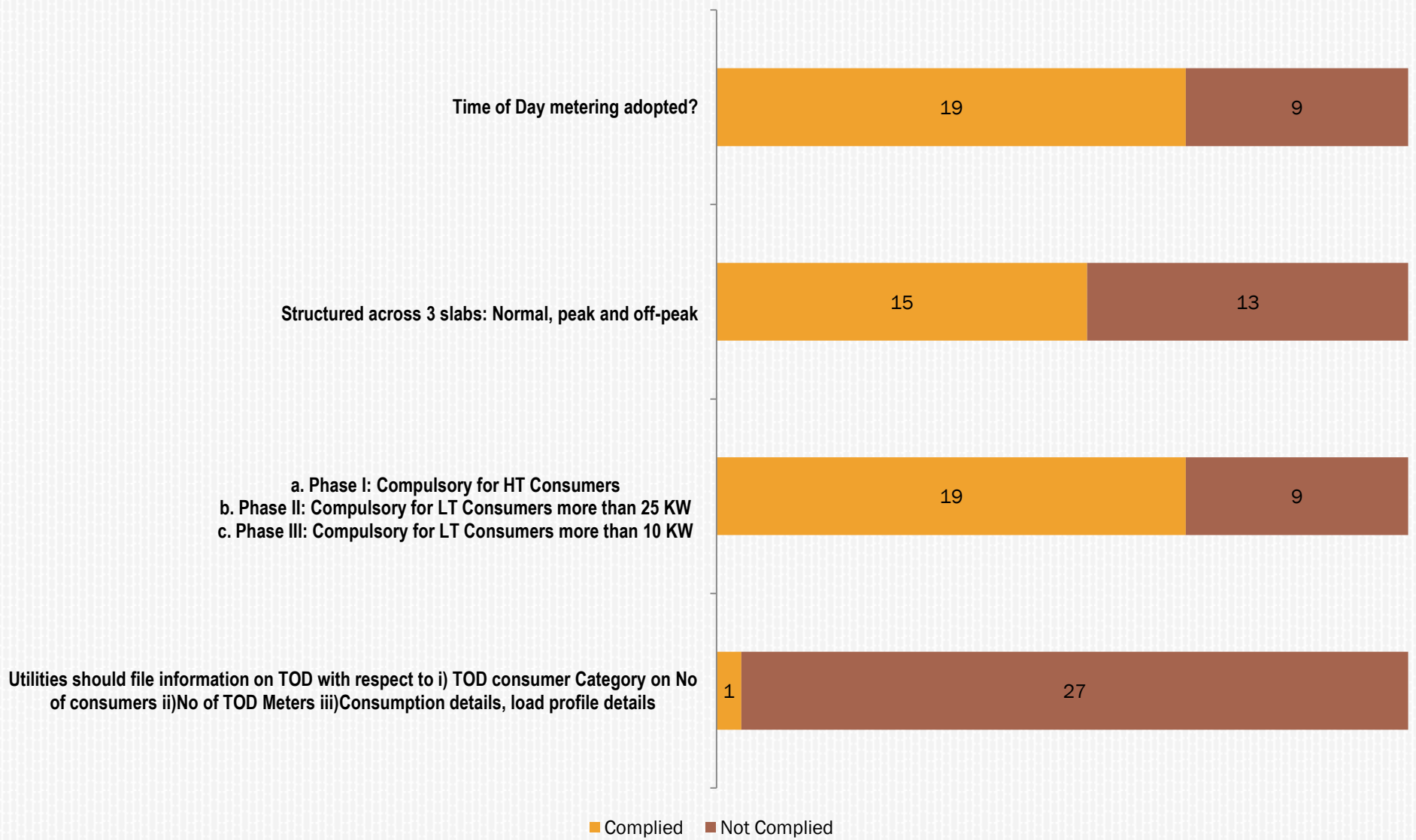




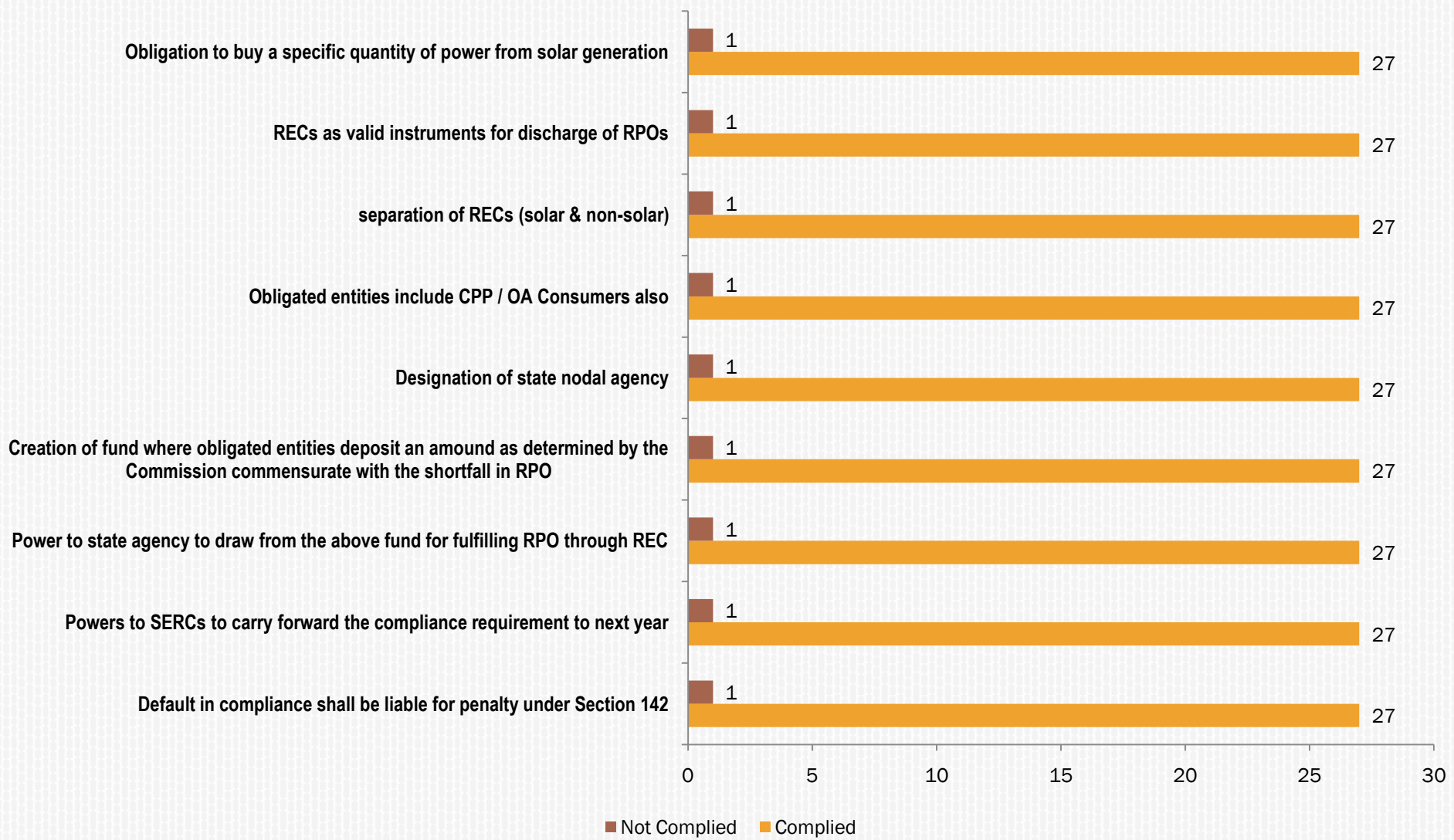
# STUDY REPORT – ASSESSMENT OF VARIOUS RENEWABLE ENERGY SOURCES POTENTIAL IN DIFFERENT STATES, DETERMINATION OF RPO TRAJECTORY AND ITS IMPACT ON TARIFF



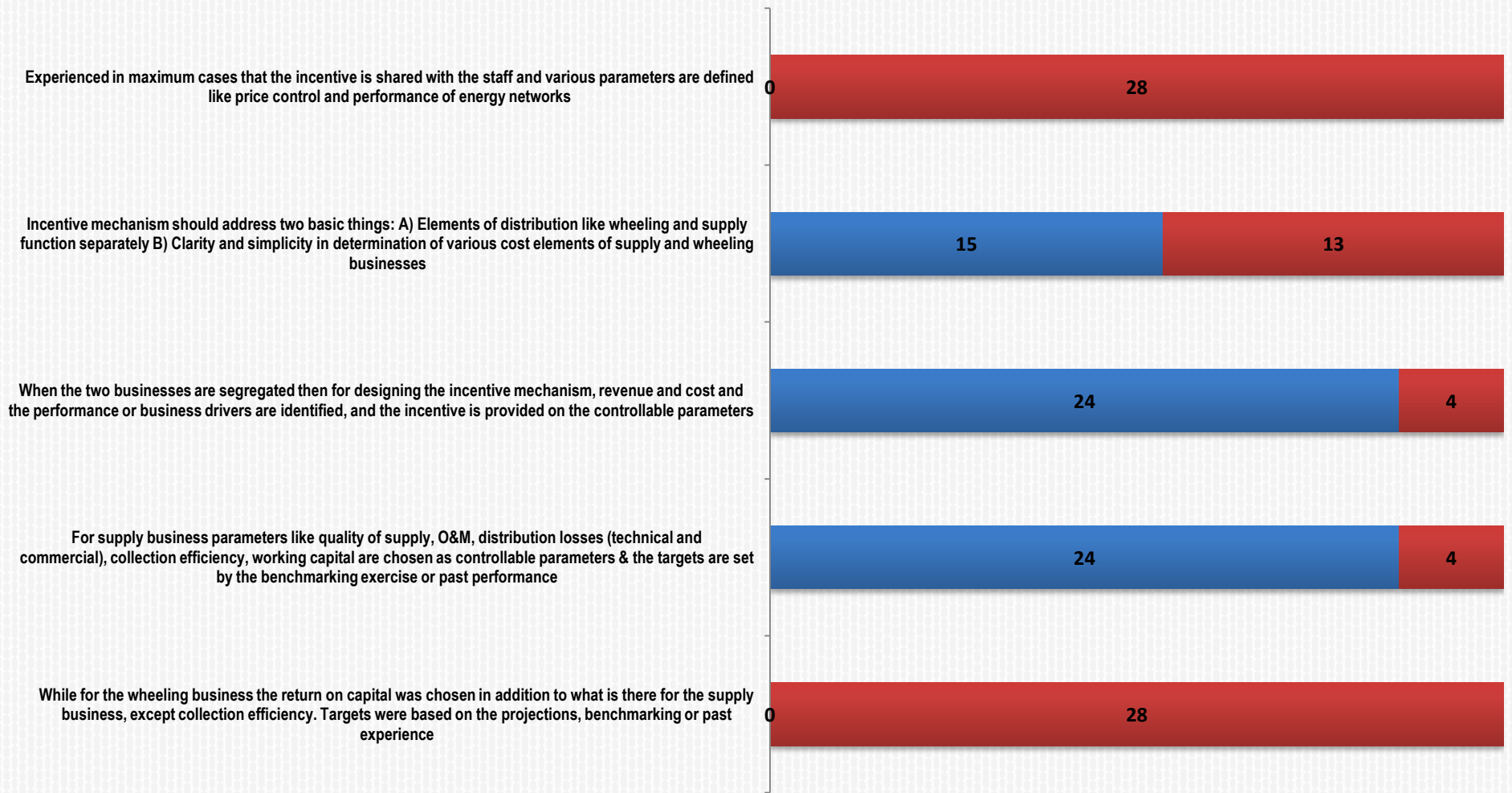
# STUDY REPORT – IMPLEMENTATION AND IMPACT ANALYSIS OF TIME OF DAY TARIFF IN INDIA



# MODEL REGULATIONS – RPO / REC FRAMEWORK



# STUDY REPORT – MODEL OF INCENTIVE-DISINCENTIVE MECHANISM FOR DISTRIBUTION UTILITIES



**Thank you**