MINUTES OF THE FORTY NINTH MEETING

OF THE

FORUM OF REGULATORS (FOR) HELD AT AHMEDABAD

Venue	:	**Hyatt Regency** **Ashram Road** **Usmanpura** **Ahmedabad (Gujarat).**
Dates	:	**26th - 28th July, 2015**
List of Participants	:	**At Annexure-I (enclosed)**

The meeting was chaired by Shri Gireesh B. Pradhan, Chairperson, Central Electricity Regulatory Commission (CERC) and Chairperson, Forum of Regulators (FOR). He extended a warm welcome to all members of the Forum. The Chairperson welcomed Shri Rabindra Nath Sen, Chairperson, West Bengal Electricity Regulatory Commission (WBERC) and Shri M.K. Shankaralinge Gowda, Chairperson, Karnataka Electricity Regulatory Commission (KERC) who were attending the FOR meeting for the first time.

The FOR thereafter took the following agenda items for consideration.

Business Session - I

Agenda Item No. 1 : Confirmation of the Minutes of the 48th Meeting of FOR held during 10th – 11th June, 2015 at India Habitat Centre (IHC), New Delhi.

The Forum noted and endorsed the minutes of the 48thMeeting of FOR held at India Habitat Centre (IHC), New Delhi during 10th – 11th June, 2015.

Agenda Item No. 2 : Discussion on "RE Status of CPPs, especially bagasse based co-generation – Benefits of preferential feed-in-tariff vis-à-vis usage of fossil fuel".

The Forum noted the observations of the Standing Committee on Energy on the issue related to "RE Status of CPPs, especially bagasse based co-generation – Benefits of preferential feed-in-tariff vis-à-vis usage of fossil fuel" during its meeting with the CERC.

The Forum was appraised of Regulation 41 of the Central Electricity Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulations, 2012 which specifies that in case of technology specific parameters for Biomass power projects based on Rankine Cycle Technology, the use of fossil fuels shall be limited to the extent of 15% in terms of calorific value on annual basis, till 31.03.2017. The Forum observed that, as per the above provision, fossil fuel should be limited to 15% in co-generation plant.

The Forum noted the observations of the Standing Committee on Energy that some CPPs (especially bagasse based co-generation) are misusing their RE status. It was informed that in Gujarat, a nodal agency monitors the usage of fossil fuels by CPPs having RE status. Chairperson, KERC conveyed that a proposal for allowing usage of 100% fossil fuel during non-season is under consideration and MNRE has supported the proposal.

Consensus:

The Forum, after having detailed deliberations on the issue, decided that the use of fossil fuels by the co-gen plants based on RE sources, should be limited to the extent of 15% in terms of calorific value on annual basis. At State level, the ERCs may designate a "Nodal Agency" to monitor compliance of the above limit and report back to the ERCs on a periodical basis the status of compliance in this regard.

Agenda Item No. 3 : Discussion on "Best Practices in Electricity Regulatory Commissions on Demand Side Management and Energy Efficiency in Distribution".

The Chairperson, CERC/FOR informed the Forum that CERC and DERC had the occasion of meeting the Members of the Standing Committee on Energy in the context of deliberations on "Energy Conservation". During the meeting, the Standing Committee on Energy made specific observations related to the "Best Practices in Electricity Regulatory Commissions on Demand Side Management and Energy Efficiency in Distribution". The Forum noted the observations of the Standing Committee on Energy.

FOR Secretariat informed that, prior to the above meeting, a Working Group was constituted to examine the issues related to "Demand Side Management". In pursuance to the decision of the Working Group, the Secretariat had requested all SERCs / JERCs to provide the updated status of notification of DSM Regulations by them, Key features of the regulations notified (i.e., identification of potential and determination of targets, load and market research by distribution licensees, creation of DSM Cells, formulation of DSM plans by discoms, facility to allow the expenditure on DSM initiatives as a pass-through in ARR, reporting and third party evaluation and incentives etc.), status of implementation of the DSM Regulations, best practices adopted by them, other regulatory updates relating to DSM etc. In response, only 15 SERCs (APSERC, AERC, BERC, DERC, GERC, HERC, JERC (Goa & UTs), JERC (M&M), KERC, MERC, SSERC, TNERC, TSERC, UPERC and UERC) have sent the details in this regard.

The Forum noted various DSM measures initiated by different ERCs, which inter alia include, facilitating supply of energy efficient appliances to consumers by discoms (in Delhi), replacement of incandescent bulbs with LEDs, currently on-going impact study (in Puduchery), replacement of fans, bulbs, agricultural pump-sets with energy efficient appliances and equipment (in Gujarat) etc.

Consensus:

The Forum, while appreciating the DSM measures adopted by various distribution utilities, decided that M/s. Energy Efficiency Services Limited may be engaged by ERCs to carry out study / evaluation on a periodical basis, on the impact of DSM programmes undertaken. The Forum agreed that all the ERCs which have not shared DSM related information with FOR Secretariat would immediately furnish the information, so that FOR Working Group could deliberate and finalize its recommendations for further consideration of the Forum.

Agenda Item No. 4 : Discussion on Report of the Sub-Group of the FOR Working Group on "Standardization of Electricity Bill".

Secretary, CERC / FOR informed the Forum that a Working Group was constituted under the Chairmanship of Shri Gireesh B. Pradhan, Chairperson, CERC to propose a standard format for electricity bill which is "easy to understand, simple to check the calculations and easy to know where and how to make payments". The Working Group constituted a Sub-Group under the Chairmanship of Shri Anand Kumar, Chairperson, MSERC to deliberate on various issues involved in standardizing the format of the Electricity Bill across States. The Sub-Group submitted its draft report and recommendations before the Working Group on Standardization of Electricity Bill.

Shri Anand Kumar, Chairperson, MSERC and Chairman of the Sub-Group explained the salient features of the proposed format of the bill. The Working Group recommended that the standard bill should contain inter alia, detailed information related to discom (including helpline contact information) consumer, connection, metering, tariff etc. in different tables so that the information is comprehensive and easily understood by the consumers. A model format of the bill was also provided along with the report.

Consensus:

The Forum approved the draft report of the Working Group on "Standardization of Electricity Bill" and decided that 30 days billing cycle should be adopted, while avoiding short-duration billing on pro-rata basis. The ERCs may carry out necessary amendments to the regulations notified by them on supply code to reflect the changes in billing format and billing duration.

Business Session - II

Agenda Item No. 5 : Presentation on "Grid Integration of Renewable Energy" by SLDC/NIWE, Tamil Nadu, SLDC, Rajasthan and SLDC, Gujarat.

Joint Chief (RA), CERC while giving a brief background, informed the Forum that in the light of ambitious target by the Government of India (GoI) for addition of 160 GW of RE generation capacity by 2022, an urgent need for robust and seamless regulatory framework for grid integration of RE sources at inter-State and intra-State level, has been felt. Earlier, the RRF mechanism evolved by the CERC, acted as a framework for grid integration of RE generation. However, the RRF mechanism was kept in abeyance due to operational constraints.

In view of the above, CERC has come up with a framework for integration of inter-State RE generation and also a suggestive framework for integration of intra-State RE generation. Before the framework on grid integration of RE generation is deliberated upon, it was felt some RE resource rich States may be invited to present/share their experience and challenges and also offer suggestions for grid integration of RE generation.

SLDC, Tamil Nadu **:** First presentation on grid integration of RE was made by the representatives of SLDC, Tamil Nadu (**enclosed** as **Annexure - II**), which inter alia, included "RE generation capacity vis-à-vis consumption" and "Issues related to day-to-day system operation and integration of RE". During the presentation, the following was submitted :-

Challenges:

a. Variable RE generation causes variations in quantum of deviation, frequency, voltage and reactive power, thereby impacts grid stability.
b. Non-availability of spinning reserve to balance wide variations.
c. The restriction in CERC Regulations for deviation quantum by 150 MW or 12% of the schedule whichever is lower makes operation of the grid very difficult.

Suggestions:

a. As RE sources are concentrated in few States (which generate surplus RE power) and also owing to its variability, such generation may be treated as pooled common energy at par with Central Generating Stations.

b. The proposed CERC Framework on Forecasting, Scheduling & Imbalance Handling for Renewable Energy (RE) Generating Stations based on wind and solar at Inter-State level only has been considered. The framework may also include RE generators connected to the intra-State network.

c. Large scale renewable generation during off-peak period cannot be absorbed locally. In order to accommodate RE generation, Central Generating Stations may be advised to back-down their generation.

d. Swapping of power within the region should be permitted as a special case on bilateral agreement.

e. The present limit of 150 MW or 12% of the schedule whichever is lower for over drawl / under drawl may be changed as 12% of the schedule only for the RE rich States during the wind season.

SLDC, Rajasthan ***:*** Second presentation on grid integration of RE was made by the representatives of SLDC, Rajasthan (**enclosed** as **Annexure - III**), which inter alia, included “RE generation capacity and potential in Rajasthan” and “Issues related to integration of RE”. During the presentation, the following observations were made :-

Challenges:

a. Variable RE generation makes it difficult to assess day-ahead drawl from the grid.

b. RoW constraints for construction of transmission lines for evacuation of RE generation.

c. RE generation causes over-voltage leading to over-fluxing of transformers and their tripping.

Suggestions:

a. Need for establishing Renewable Energy Management Centre (REMC).

b. Planning for transmission and distribution network for appropriately addressing congestion and grid management.

c. Need to establish suitable balancing mechanism.

SLDC, Gujarat : Third presentation on grid integration of RE was made by the representatives of Gujarat Energy Transmission Corporation Limited (**enclosed** as **Annexure - IV**), which inter alia, included "Existing and Planned RE generation capacity in the State" and "Issues related grid integration of RE and their impact". During the presentation, the following was suggested :

Challenges:

a. Variability of RE generation leads to under utilization of EHV network and creates trouble in reactive power management.

b. It becomes impossible to restrict OD / UD within the range of 150 MW, when RE variation is more than 1500 MW in a day.

Suggestions:

a. In order to address variability of RE generation, effective balancing mechanism may be developed through augmentation of pump storage system and gas based generation through allocation of cheaper gas to RE rich States.

b. As an effective balancing mechanism, larger balancing areas may be considered by merging SLDCs in RLDC.

POSOCO ***:*** Finally, a presentation on grid integration of RE generation was made by CEO, POSOCO (**enclosed** as **Annexure - V**), which inter alia included several issues related to eco-system for RE integration, factors responsible for deviation from schedule, effect of deviation on reliability margin, resource sharing, and other critical requirements. A brief summary of the presentation is as follows:

Issues:

a. Present eco-system provides for Separate Carriage & Content in Transmission at inter-State level, Multi-Part Tariff, Non-Discriminatory Open Access, Multi Buyer – Multi Seller environment, Robust Imbalance Handling Framework at Inter-

State level, Dispute Free Settlement Systems and Zonal Transmission Charges and Losses.

b. Urgent need for providing data telemetry to the RLDCs by all RE generators while taking care of communication infrastructure issues. At the same time Technical Characteristics of Solar generators need to specified and mandate them to share the information with RLDCs.

c. Need for a separate Institutional Entity duly recognized under regulatory framework. The entity required to be Qualified/certified/registered with System Operator, undertake scheduling/commercial settlement/de-pooling/communication/data management and co-ordination etc.

Way forward:

a. Way forward for integration of RE generation would necessarily include Forecasting Load and RE, Adequacy and Balanced Portfolio, Framework for integrating RE, Intra-State deviation handling mechanism in all States, Aggregators – New market entities, Reserves, Ancillary Services, Frequency Response, Market opportunities : more frequent clearing, Communication and data telemetry, REMCs, Compliance to

Standards, Flexibility in conventional generation and Capacity building.

Consensus:

The Forum noted the issues raised through presentations made by SLDCs of Tamil Nadu, Rajasthan and Gujarat and CEO, POSOCO. The Forum desired that, in view of increasing RE generation capacity in the country, CERC may evolve a framework for forecasting and scheduling which appropriately addresses the issues. As an important additional measure, a mechanism to augment balancing power through regional level pump storage plants and gas based generation may also be evolved. The Forum, further desired that CERC may look into the concerns raised in the context of the present limit of 150 MW or 12% (whichever is lower) of the schedule for over drawl / under drawl.

Business Session - III

Agenda Item No. 6 : Discussion on "Model Framework for Forecasting, Scheduling, Deviation Settlement Mechanism for Wind and Solar at Intra-State level".

Joint Chief (RA), CERC briefed the Forum that the Central Electricity Regulatory Commission, while considering the issues related to variability of generation from RE sources and the ambitious target of Government of India to add 160 GW of RE generation capacity, has evolved a framework for CERC framework for forecasting, scheduling, deviation settlement mechanism for wind and solar at inter-State level. The framework seeks to address the various issues related to RE generation and its grid integration besides encompassing the issues raised by RE resource rich States and the issues arising from the implementation of the erstwhile RRF mechanism. Prior to finalization of the framework, extensive interactions were held with various industry experts, research institutions (like NREL of USA, GIZ of Germany), academia, and stakeholders while keeping in mind the unique problems related to RE generation in India.

The framework proposes to have a hybrid model of forecasting which includes centralized forecasting as well as localized forecasting by the RE generators. Primarily, the framework caters to the forecasting, scheduling, deviation settlement mechanism for wind and solar at inter-State level and then a suggestive draft framework for forecasting, scheduling, deviation settlement mechanism for wind and solar at intra-State level for replication in States. Prior to adoption of the framework by States, it is suggested that ABT mechanism need to be adopted by the States as the framework requires ABT mechanism to be in place for smooth integration of RE generation at intra-State level.

A presentation was made by Adviser (RE), CERC (**enclosed** as **Annexure - VI**) on the proposed framework. The salient features of the framework are as per the following :-

1. Mandatory forecasting by RLDC as well as wind/solar generator. Commercial impact of deviation from forecast would have to be borne by the RE generator.
2. Flexibility in revision of schedule by allowing one revision in every one and half hour and the revisions applicable in 4 time blocks
3. Tolerance band of +/- 15% has been provided, meaning thereby that there would be no commercial impact for deviation within this band. With revised definition of Error [Error defined with reference to available capacity, i.e., Error (%) = 100 x (Actual – Schedule) / (Available Capacity)], this band gives wide amplitude to the wind and solar generators to manage their generation without adverse commercial impact.
4. The Deviation Charges are linked to PPA rates. Therefore, payment to Seller in effect amounts to payment at actual.
5. Penalties are symmetrical for over-injection and under-injection. Hence, no perverse tendencies should exist for scheduling below or above forecast. Penalties are linked to PPA rate to bring in generator equity.
6. Within the tolerance band where there is no penalty on the generator, the impact of deviation is being socialized completely. Also, as scheduling is being done by Regional entity, impact is not localized to host State.

7. RPO compliance will get a fillip because it is being ensured as per schedule of the buyer and any shortfall in RE injection with respect to schedule is being offset by purchase of equivalent RECs by the NLDC. REC price risk is also handled by the DSM pool.
8. The Electricity Act, 2003 provides that State Grid Code shall be consistent with the Grid Code notified by CERC. Further, Tariff Policy also requires the State Commissions to implement the ABT mechanism in line with the framework specified by CERC.
9. In pursuance of these provisions of the Act and the Tariff Policy, it is desirable that a framework on the above lines as formulated by CERC for grid integration of variable renewable energy sources of wind and solar, may also be considered and adopted by State Commissions.

Consensus :

The Forum appreciated CERC's Framework for Forecasting, Scheduling, Deviation Settlement Mechanism for Wind and Solar and also endorsed the framework proposed for wind and solar projects at the intra-State level. The Forum, further directed the FOR Secretariat to evolve draft Model Regulations related to implementation of the framework by SERCs / JERCs, based on the broad principles as presented by CERC. The Model Regulations, as approved by Chair, FOR be circulated to the States for consideration/adoption.

Any other item with the permission of the Chair.

a. Chairperson, CERC/FOR informed the Forum that Chairman, Confederation of Indian Industry (CII) National Committee on Power and Secretary General, Federation of Indian Chambers of Commerce & Industry (FICCI), through separate communications have expressed their concern about the deprivation of opportunity for private sector to bid for EPC of upcoming power plants. They have stated that EPC power plant contracts were ordered in favour of PSUs on nomination basis by the State Power Companies and requested for ensuring compliance of international competitive bidding guidelines. Copies of the communications received in CERC are **enclosed**.
b. Chairperson, CERC/FOR informed the Forum that logo of CERC was designed in late nineteen nineties. Now, with the expanded role of the Commission as a facilitator for development of the power sector, the Commission got a new logo, which appropriately symbolizes the present role of CERC. The Forum appreciated the new logo of CERC.
c. The Forum noted that during its long journey, since its inception, the Forum carried out comprehensive and in-depth deliberations on critical issues pertaining to the sector and landmark decisions were taken. The logo of the Forum was designed in 2005-06. The Forum felt that the logo of FOR needs to be re-designed so as to reflect the

crucial role being played by it in bringing harmony of regulation in power sector. The Forum directed the FOR Secretariat to follow the same process (including engaging the National Institute of Design) for designing a new logo for the Forum of Regulators.

d. Chairperson, MERC offered to host the next meeting of the Forum. It was decided to hold the 50th Meeting of the Forum of Regulators on 28th September, 2015 at Pune.

Chairperson, CERC/FOR thanked the Chairperson, Members and staff of the Gujarat Electricity Regulatory Commission for their painstaking efforts to host the meeting of FOR at Ahmedabad (Gujarat). Smt. Shubha Sarma, Secretary, CERC/FOR, conveyed 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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/ ANNEXURE – I /

LIST OF PARTICIPANTS ATTENDED THE FORTY NINTH MEETING OF

FORUM OF REGULATORS (FOR)

HELD DURING 26TH – 27TH JULY, 2015 AT AHMEDABAD (GUJARAT)

S. No.	NAME	ERC
01.	Shri Gireesh B. Pradhan Chairperson	CERC – in Chair.
02.	Shri Naba Kumar Das Chairperson	AERC
03.	Shri Digvijai Nath Chairperson	APSERC
04.	Shri Umesh Narayan Panjiar Chairperson	BERC
05.	Shri Narayan Singh Chairperson	CSERC
06.	Shri Pravinbhai Patel Chairperson	GERC
07.	Shri Jagjeet Singh Chairperson	HERC
08.	Shri Subhash Chander Negi Chairperson	HPERC
09.	Justice (Retd.) Shri N.N. Tiwari Chairperson	JSERC
10.	Shri S.K. Chaturvedi Chairperson	JERC for Goa & All UTs except Delhi
11.	Shri M.K. Shankaralinge Gowda Chairperson	KERC
12.	Shri T.M. Manoharan Chairperson	KSERC
13.	Dr. Dev Raj Birdi Chairperson	MPERC
14.	Ms. Chandra Iyengar Chairperson	MERC
15.	Shri Anand Kumar Chairperson	MSERC
16.	Shri Satya Prakash Nanda Chairperson	OERC

17.	Ms. Romila Dubey Chairperson	PSERC
18.	Shri Vishwanath Hiremath Chairperson	RERC
19.	Shri T.T. Dorji Chairperson	SSERC
20.	Shri S. Akshayakumar Chairperson	TNERC
21.	Shri I.A. Khan Chairperson	TSERC
22.	Shri Niharendu Chakraborty Chairperson	TERC
23.	Shri Subhash Kumar Chairperson	UERC
24.	Shri Rabindra Nath Sen Chairperson	WBERC
25.	Shri B.P. Singh Member	DERC
26.	Shri I.B. Pandey Member	UPERC
27.	Ms. Shubha Sarma Secretary	CERC
28.	Dr. Sushanta K. Chatterjee Joint Chief (RA)	CERC
SPECIAL INVITEES		
29.	Shri A.S. Bakshi Member	CERC
30.	Smt. Jyoti Arora Joint Secretary (R&R)	MOP
31.	Smt. Varsha Joshi Joint Secretary	MNRE


GRID INTEGRATION
of
Renewable Energy
in
TAMIL NADU

Formation of SLDC

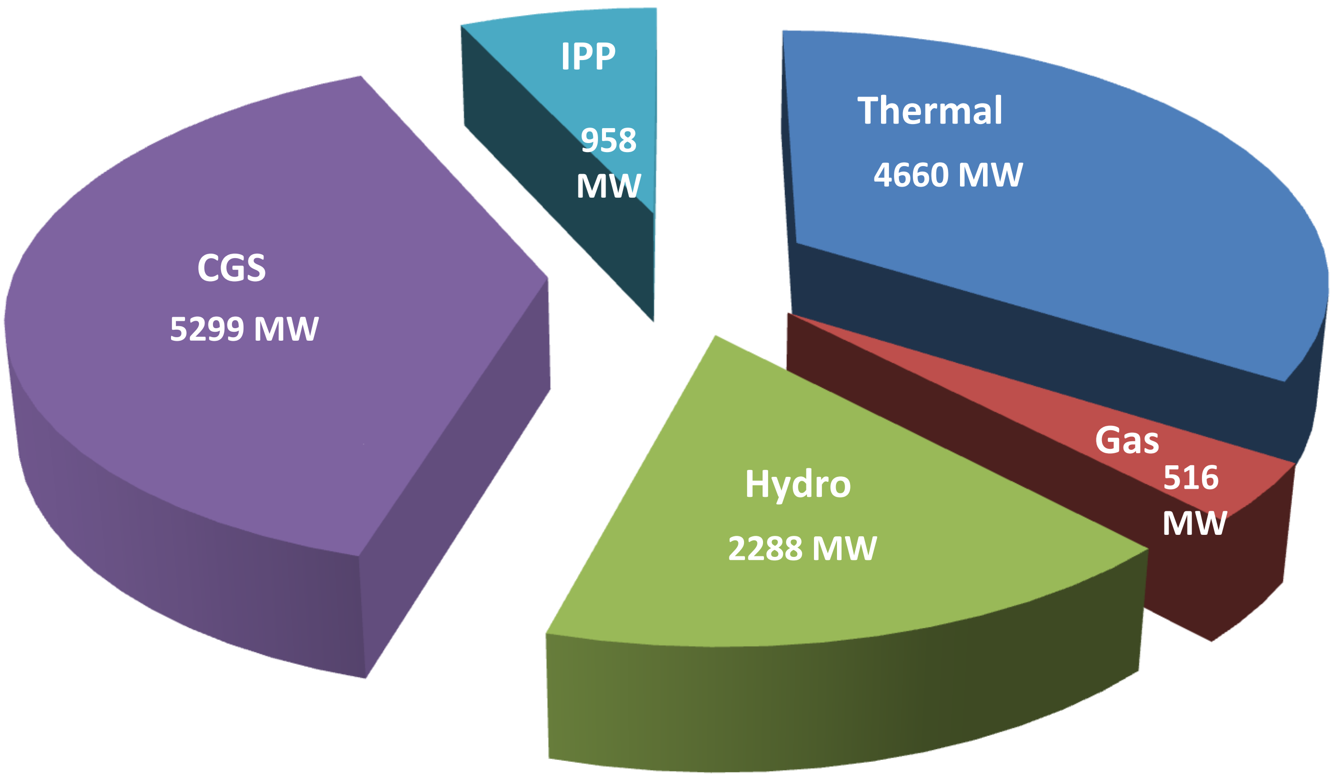
- Grid Operation in Tamil Nadu was started by November 1964.
- The first Load Despatch Centre was operated from Erode.
- Subsequently, the main Load Despatch Centre was formed in 1986 at Chennai and Sub Load Despatch Centre at Madurai.

TN : GENERATION MIX

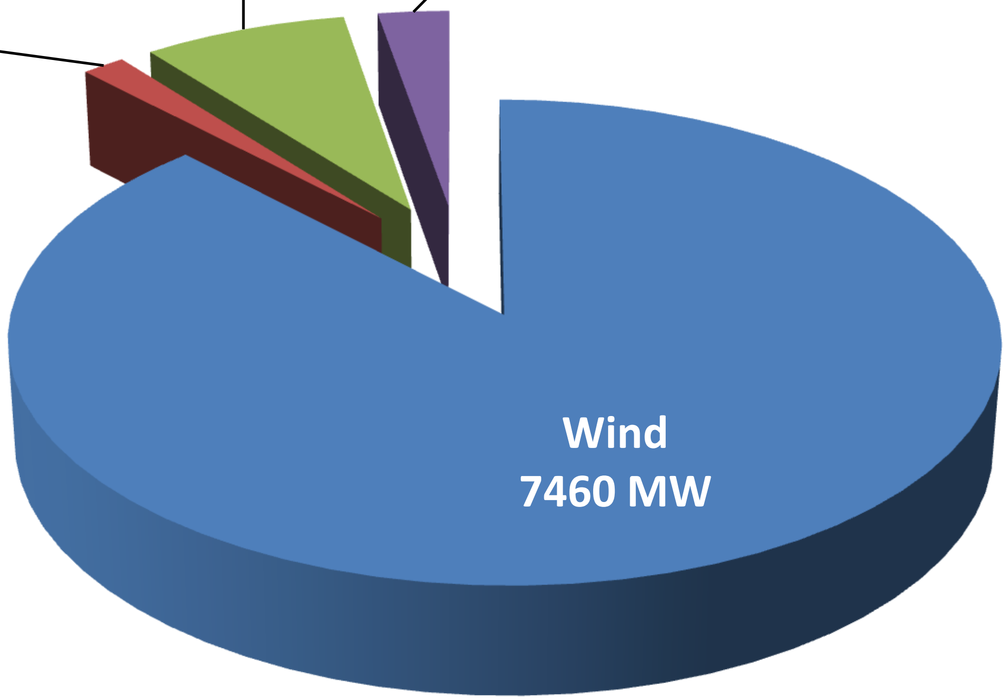
Tamil Nadu Installed Capacity

Total: 13721 MW

As on 30th June 2015



TN: RENEWABLE ENERGY MIX



As on 30th June 2015

Tamil Nadu High Energy Consumption Details

In the year 2015

Consumption	:	303.039 MU	on 08/07/2015
Demand	:	13720 MW	on 08/07/2015
Wind Energy	:	80.83 MU	on 08/07/2015
Wind Generation	:	4134 MW	on 06/07/2015

In the year 2014

Consumption	:	293.97 MU	on 20/06/2014
Demand	:	13775 MW	on 24/06/2014
Wind Energy	:	89.49 MU	on 25/06/2014
Wind Generation	:	4201 MW	on 25/06/2014

State-wise Wind Power Installed Capacity In India

STATE	Gross Potential (MW) *	Total Capacity (MW)
Gujarat	35,071	3414
Andhra Pradesh	14,497	753
Tamil Nadu	14,152	**7460**
Karnataka	13,593	2409
Maharashtra	5,961	4098
Jammu & Kashmir	5,685	--
Rajasthan	5,050	2820
Madhya Pradesh	2,931	439
Odissa	1,384	--
Uttar Pradesh	1,260	--
Kerala	1,171	55
Uttarakhand	534	--

*curtsey - as per Energy Statistics 2015 (www.mospi.gov.in)

TAMILNADU
NO.OF WEGS AND TOTAL CAPACITY
(as on 30.06.2015)

SL.NO	WIND MILLS INSTALLED BY	NO OF WEGS	CAPACITY IN MW
1	TNEB (TANGEDCO)	111	17
2	PRIVATE PROMOTORS	17,700	7460
TOTAL		17,811	7477

Various WEGs with Capacities used in Tamil Nadu

- 55 kW
- 225 kW
- 250 kW
- 350 kW
- 500 kW
- 600 kW
- 800 kW
- 1000 kW
- 1250 kW
- 1500 kW
- 1650 kW
- 2000 kW

TNEB'S PRIDE

(TNEB, TANGEDCO & TANTRANSCO)

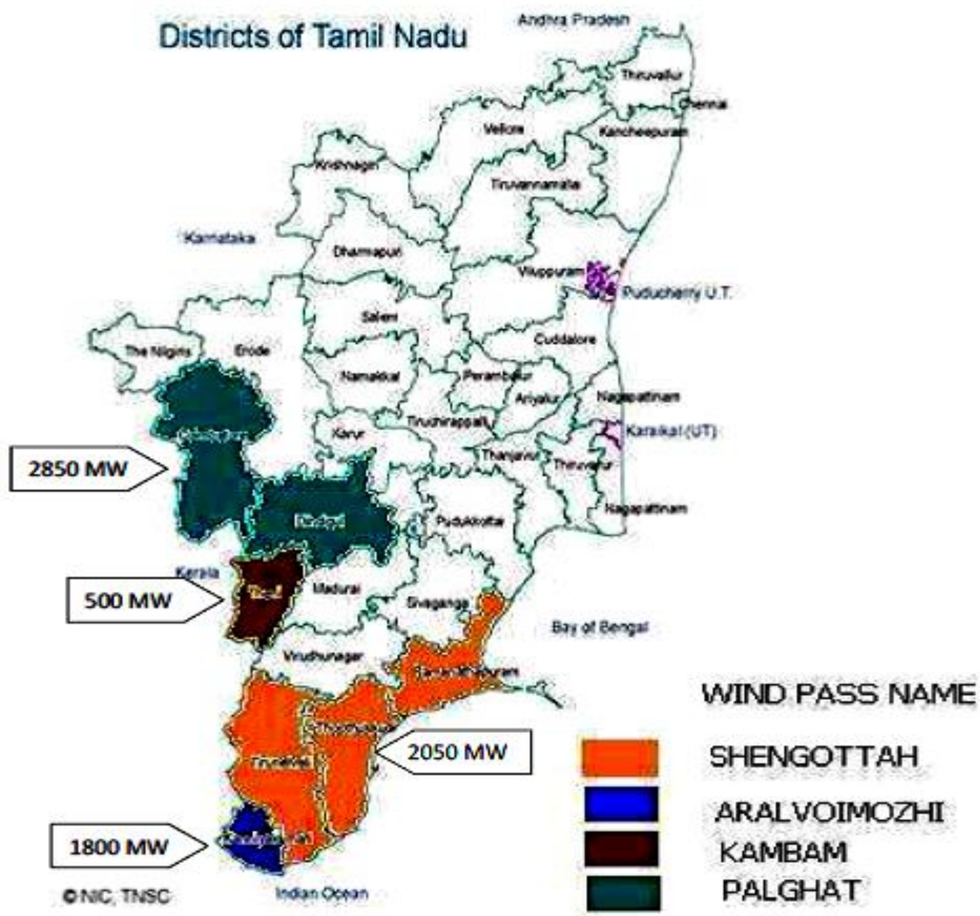
- TNEB ventured into Wind generation in 1986 with 120 wind mills with a total capacity of 17.465 MW had now it has been grown up to 7460 MW including private participation.
- Today TNEB has grown into a giant organization having an installed capacity of 13721 MW with a consumer base of 2.52 crore consumers.
- Installed capacity of wind mills is more than 35 to 40% in the total generating capacity of TANGEDCO.
- Tamil Nadu is the supporter of policy of government of India in encouraging green power aiming to ensure energy security for the nation.

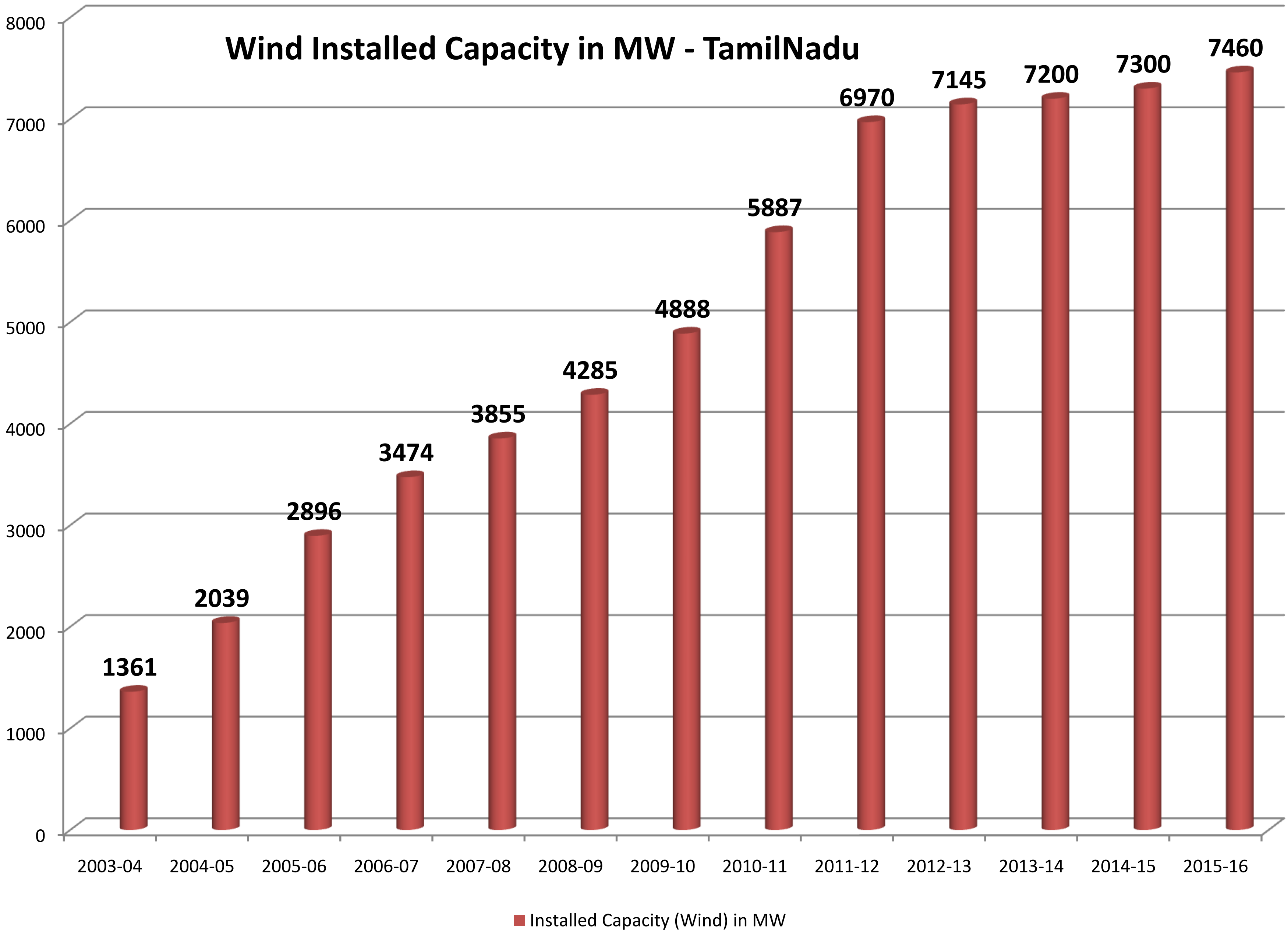
LOCATIONS IN TAMIL NADU ENDOWED WITH FAVOURABLE WIND FLOW

- **Harnessing of wind energy is highest in Tamil Nadu.**
- **The following locations are endowed with favourable wind flow:**

Name of the Passes/Districts	Area
Palghat	Coimbatore, Erode and Dindigul.
Shencottah	Tirunelveli and Tuticorin.
Aralvoimozhi	Kanyakumari, Radhapuram and Muppandal.
Theni District	Theni, Cumbam and Andipatti.
Sea Coast	Uvari, Tuticorin, Rameswaram, Poompuhar and Ennore.

TAMILNADU – THE FOUR WIND PASSES





Wind Installed Capacity in MW - TamilNadu
8000
7000
6000
5000
4000
3000
2000
1000
0
1361
2039
2896
3474
3855
4285
4888
5887
6970
7145
7200
7300
7460
2003-04
2004-05
2005-06
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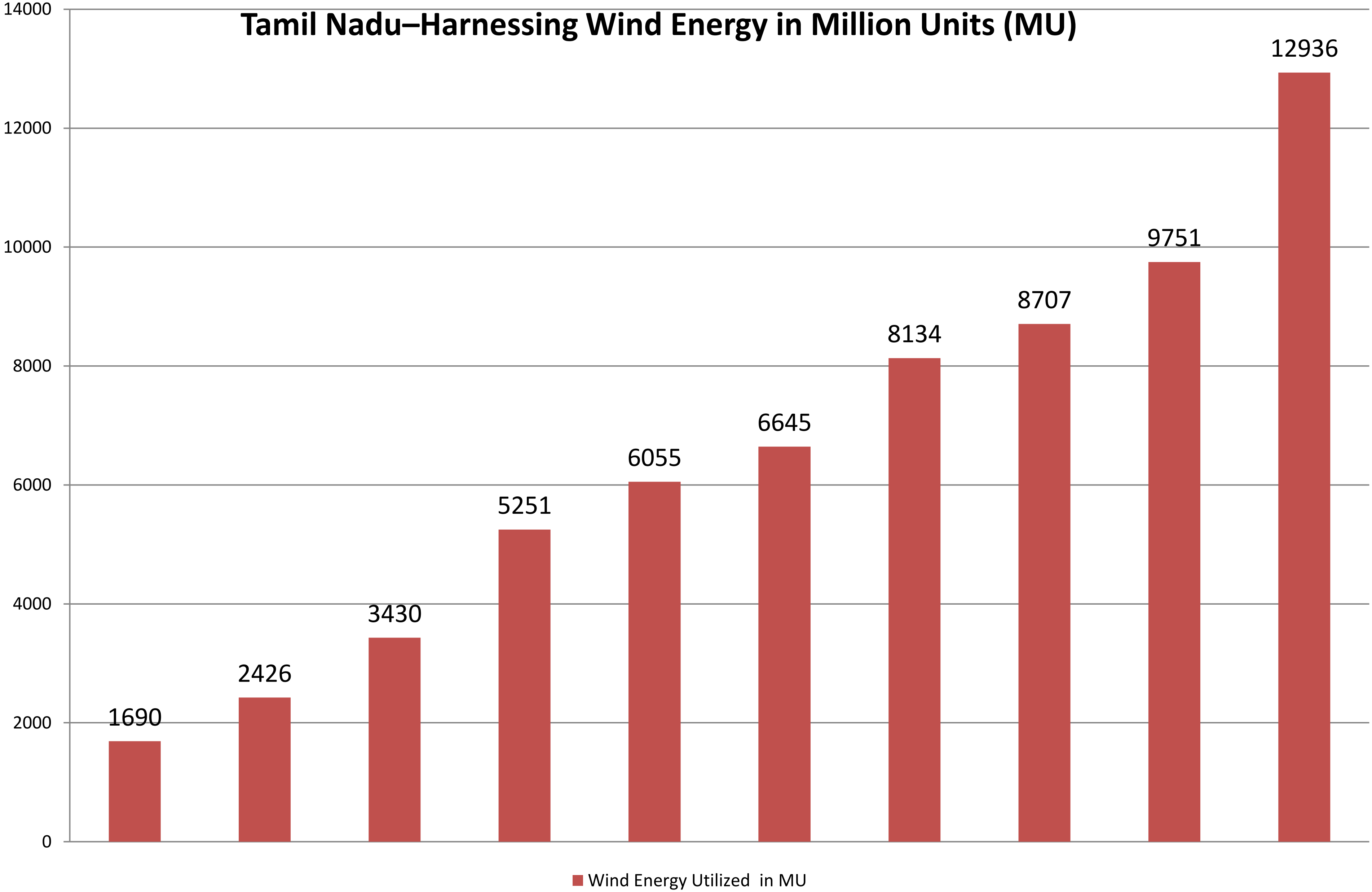
2015-16
Installed Capacity (Wind) in MW



Wind generation accommodation for the past ten years

Pre-wind season activity

- During the month of June- September inflows to the reservoirs will be maximum, to avoid surplus the utility is committed to operate the Hydro stations to the maximum extent. Further during this period only, the Dams are opened for irrigation which also increase the availability from irrigation based Hydro Stations.
- From the Hydro stations around 6000 MU has to be absorbed by TNEB judiciously regulating the Hydro reservoir till the onset of next monsoon.
- **Affecting Pump mode operation :**
  - During this season, Kadamparai pumped storage scheme with a capacity of 4*100MW has to be operated mostly in generator mode to utilize the free inflow in the upper reservoirs due to Southwest monsoon. Hence utilization of surplus wind power for pump mode operation is also restricted.

contd..

- Gas stations (300 MW) are already operated only at their minimum level due to less availability of the gas.
- IPPs are also kept shutdown during heavy wind season.
- TANGEDCO has total thermal capacity of 4660MW. Annual Over Hauling of thermal Units are being taken during this wind season to facilitate absorption of wind power. Also, backing down of thermal units up to their technical minimum is also being carried out.

Day to day operation

- High wind generation penetration causes the following.
  - -High variation in deviation quantum (more under drawal)
  - -Shoot up in Frequency
  - -Voltage drop and nil reactive power contribution
  - -High rate of equipment failure
- The output of the wind energy varies according to the available resources – wind speed / direction.
- Due to high penetration level of Wind generation capacity in the grid, when there is a sudden drop in generation due to change in wind speed below minimum rated level that will impact heavily on grid stability.
- Therefore fast-ramping conventional energy sources, energy storage, demand side management must be carried out to meet demand.

contd..

- Spinning reserves, flexible high ramp rate generation would be required to handle variability and ramping associated with wind power for power balancing. No spinning reserve is available to balance wide variations.
- During sudden pumping of wind power, the following step by step methods are carried out
  - Backing down of generation from the high cost sources
  - Backing down of generation from conventional sources up to the required quantum to restrict the deviation quantum (under drawal) within the limit prescribed by the existing regulations.

Fault Trippings

Sl. No.	Date & Time of Trippings	Incident	Wind Generation Loss in MW
1	26th June 2015 at 19:00 hrs	Fault at 110 KV Udumalpet SS	800-1000 MW
2	1st July 2014 at 17:52 hrs	Tripping of 230 KV Kayathar – TTPS line. Voltage dip observed for 400 ms	930 MW
3	5th June 2014 at 19:10 hrs	Multiple tripping at Neyveli TS-2	920 MW
4	2nd June 2014 at 15:54 hrs	Bus fault at 230/110 KV Kayathar SS	1135 MW
5	7th June 2013 at 10:47 hrs	Bus fault at 230/110 KV Kayathar SS.	1340 MW
6	28th May 2013 at 17:00 hrs	Low voltage in Udumalpet area fault at 110 KV Othakalmandapam	860 MW

Difficulties faced due to tripping

- During heavy wind season, Low voltage in Udumalpet area has been experienced which lead to tripping of wind machines.
- During the above incidents there was a loss of wind generation which tends Tamil Nadu to over draw more power from the grid.
- In one case frequency shoot-up to and dropped from 50.46 Hz to 49.18 Hz which endangers the grid stability, consequently protection schemes like UFR and df / dt acted to give relief to the system.
- Sustained over drawal in the grid leads to stringent Regulatory measures.

IEGC Comparison

Sl.No	Parameters	IEGC 2010	IEGC 2014
1	Operating Frequency	49.70 – 50.20 Hz	49.90 – 50.05 Hz
2	Action by SLDC to restrict the drawal from the grid, within the net drawal	At Frequency below 49.80 Hz	Irrespective of Frequency
3	SLDC should ensure that requisite load shedding is carried out in their control area so that there is no over drawal	At Frequency <=49.70 Hz	Irrespective of Frequency
4	Automatic Demand Management schemes (ADMS) need to be to functional so as to ensure net drawal of the entity from the grid is within schedule	When frequency is 49.70 Hz or below	Irrespective of Frequency
5	Limitation of drawal	For over drawal	For both OD & UD
6	Violation messages to be issued by RLDC	For over drawal	For both OD & UD depending upon the severity
7	Ensuring reversal of over drawal / under drawal	Not exists	at least once in every 3 Hours.
8	No sudden reduction in generation or variation in load by more than 100MW is permitted without prior intimation to and consent of the RLDC.	Particularly when the frequency is falling or is below 49.70 Hz	Irrespective of Frequency

UI Regulation Comparison

Sl.No	Parameters	UI Regulation (Past)	Deviation Settlement Mechanism Regulation (Present)
1	UI price Vector	Varies from 0 paise at 50.2 Hz to Rs.9/Kwhr at 49.5 Hz Slab rate - for each step of 0.02 Hz 16.5 paise between 50.2 -50Hz, 28.5 paise between 50- 49.8Hz & 28.12 paise between 49.8-49.5 Hz	varies from 0 paise at 50.05 Hz to Rs.8.2404/Kwhr at 49.70 Hz Slab rate - for each step of 0.01 Hz 35.60 paise between 50.05 -50Hz, 20.84 paise below 50 Hz The highest hike in charges is at frequency below 49.70 Hz ie 64% and between 49.70 to 49.90 Hz, the hike in rate is from 20% to 26%.
2	Permitted deviation in drawal	Between the frequency range of 49.70 – 50.20 Hz	permitted only between the frequency range of 49.95 – 50.05 Hz. (only 150 MW)
3	Limitation for over drawal	150 MW in a block and 3% on a daily aggregate basis for all time blocks when frequency is below 49.8 Hz.	No overdrawal when frequency is below 49.70 Hz. Above 49.70 Hz only upto 150MW

contd..

Sl.No	Parameters	UI Regulation (Past)	Deviation Settlement Mechanism Regulation (Present)
4	Additional charges for Over drawal	For over drawal at frequency below 49.70 HZ and upto 49.50 HZ 20% of the UI rate corresponding to the frequency below 49.50 Hz ie Rs 7.99 to 10.52 /Kwhr. below 49.50 HZ and upto 49.20 HZ 40% of the UI rate corresponding to the frequency below 49.50 Hz ie Rs. 9+3.6 = 12.6/Kwhr below 49.20 HZ 100% of the UI rate corresponding to the frequency below 49.50 Hz ie Rs. 9 +9 = 18/Kwh No additional UI charges for Under drawal	At frequency above 49.70 Hz, over drawal beyond 150MW will attract additional charges towards penalty. Upto 150MW – charges corresponding to frequency. 150-200MW – Additional 20% of frequency rate. 200-250 MW -Additional 40% of frequency rate. Above 250 MW -Additional 100% of frequency rate. At frequency below 49.70 Hz. no over drawal is permitted and if it persists, the same will be charged at the rate of Rs. 16.48/Kwhr.
5	Limitation for Under drawal	No limitation for Under drawal.	At frequency below 49.70 Hz - No limitation. Above 49.70 Hz - only upto 150MW At 50.10 Hz - under drawal is not permitted.
6	Additional charges for Under drawal	No penalty for under drawal. However in a time block in excess of 250MW shall be paid not exceeding the Cap rate of Rs. 4.50/Kwhr .	At 50.10 Hz, under drawal will not be paid and will attract penalty at the rate of Rs. 1.78/Kwhr.

System Operation Difficulties due to Regulations

- Accommodating more wind is limited by prevailing Deviation Settlement Mechanism, Regulation 2014, clause (7) - stipulates
  - The deviation quantum shall not be more or less of the schedule of the constituent by 150 MW or 12% of the schedule whichever is lower irrespective of frequency. This stipulation makes operation of the grid very difficult with huge quantum of wind power during wind season.
  - Due to the Deviation settlement mechanism, the host state has to pay Rs.1.78/- per unit as penalty for the energy under drawal for the frequency 50.10 Hz and above which makes additional financial burden.
  - During wind season the energy losses in under drawal by TNEB is more due to wind injection and also paying the amount to the respective CGS for the energy losses towards under drawal in addition to the payment made to the WEGs for their energy injection.
  - Tightening of frequency bandwidth of operation and restriction in injection into and drawal from the grid for a quantum of 150 MW or 12% of the schedule whichever is lower irrespective of frequency makes the grid operation more difficult.

contd..

- The utilities are not permitted to have sudden variation in generation / load by not more than 100 MW irrespective of frequency as per 5.2(j) clause of IEGC 2014.

- In Tamil Nadu the intra variation is 1000-2500 MW with this wide variation in wind generation, its difficulty to maintain the grid discipline.

Suggestions

- In case of large scale renewable generation, it is not possible to absorb the energy locally, particularly during night off peak period and even in day time when the wind generation is at its full swing.
- Few of the States have abundant renewable energy resources, while others are deficit which may also co-operate in handling the surplus quantum of wind power.
- Swapping of power within the region should be permitted as a special case on bilateral agreement.
- Transmission system is required to be planned for integrating renewable generation with the inter state grid.

contd..

- Owing to variable nature of RES energy and gift of nature, it requires support from the grid and to be treated as pooled common energy on par with Central Generating Stations.
- The present limit of 150 MW or 12% of the schedule whichever is lower for over drawal / under drawal to be changed as 12% of the schedule only for the RE rich state during the wind season i.e. from May to September of every year.
- The Hon'ble CERC has notified the Proposed Framework on "Forecasting, Scheduling & Imbalance Handling for Renewable Energy (RE) Generating Stations based on wind and solar at Inter-State level only has been considered. At present in Tamil Nadu there is no such RE generators are available. All wind / solar energy generators are connected at intrastate network only. Hence before implementing the Regulations, the status of the RE generators connected to the intrastate network may also be considered.

contd..

- Special allocation of power shall be considered by Ministry of Power for the host state to meet out the balancing mechanism due to sudden drop in wind generation.
- Spinning Reserves for Renewable rich state have to be planned and stations like NTPC has to be planned for it.
- Power Exchange market mechanism needs to be modified to enable real time power purchase / sale only for the host state. This is very essential since even if the forecasting & scheduling becomes successful, unless a way out to sell the extra power forecasted or to buy any shortfall is there, the real fruit of scheduling & forecasting may not be realized.

Long Term Project

To improve spinning reserve in Tamil Nadu control area, the following Hydro pumped storage projects were under pipeline.

- Kundah pumped storage project – 500 MW (4 X 125 MW)
- Sillahalla pumped storage hydro-electric project in the Nilgiris for 2000 MW (4 x 500 MW) – announced by Hon'ble Chief Minister of Tamil Nadu.
- Mettur Pumped storage project – 500 MW (4 X 125 MW)

To improve the Gas availability in Tamil Nadu, the Gas Storage scheme has to be implemented.

For the above projects proper funding arrangement and necessary environmental clearances can be made, so as to increase the balancing mechanism for accommodating more wind power in Tamil Nadu

Thank You

GRID INTEGRATION
OF
RENEWABLE ENERGY

STATE EXPERIENCE
(SLDC RAJASTHAN)

Power position of Rajasthan
(Installed capacity as on Mar-15)

Total Installed capacity	:	**15917 MW**
• Thermal Gen	:	9178 MW
• Hydel (356+ central share 1307)	:	1663 MW
• Gas	:	603 MW
• Nuclear	:	557 MW
• Wind	:	3214 MW
• Solar	:	605 MW
• Biomass	:	97 MW

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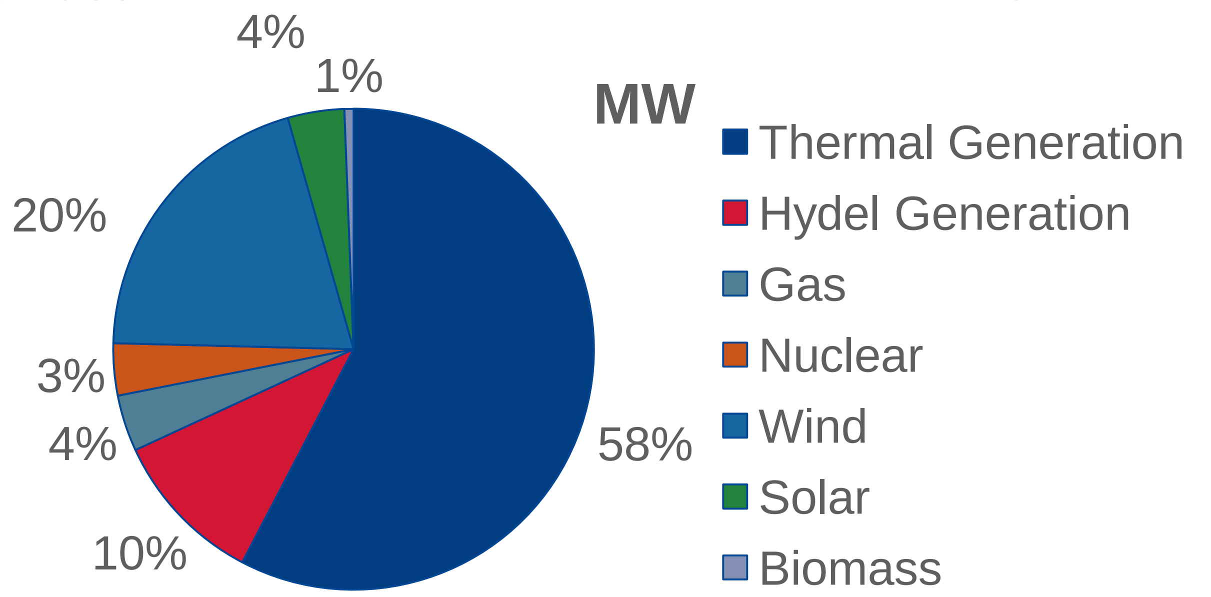


Rajasthan Power Sector: Overview

Existing Transmission network (as on 31th March'2015)		
Transmission Network (kV)	**Grid Sub Station**	**Transmission Lines (in ckt. Km)**
765	2 No. / 6000 MVA	426
400	20 No. / 15065 MVA 9 No. / 7835 MVA (RVPN) 9 No. / 6540 MVA (PGCIL) 2 No. / 1260 MVA (PPP)	9000
220	101 No. / 24075 MVA	13211
132	370 No. / 26069 MVA	15599

Rajasthan Power Sector: Overview

Under construction Transmission network		
Transmission Network (kV)	Grid Sub Station	Transmission Lines (in ckt. Km)
400	10 No. / 8780 MVA 8 No. / 7835 MVA (RVPN) 2 No. / 1260 MVA (PPP)	5556
220	37 No. / 7640 MVA	3219
132	75 No. / 3755 MVA	3117

Under Construction RVPN's 400 kV Substations

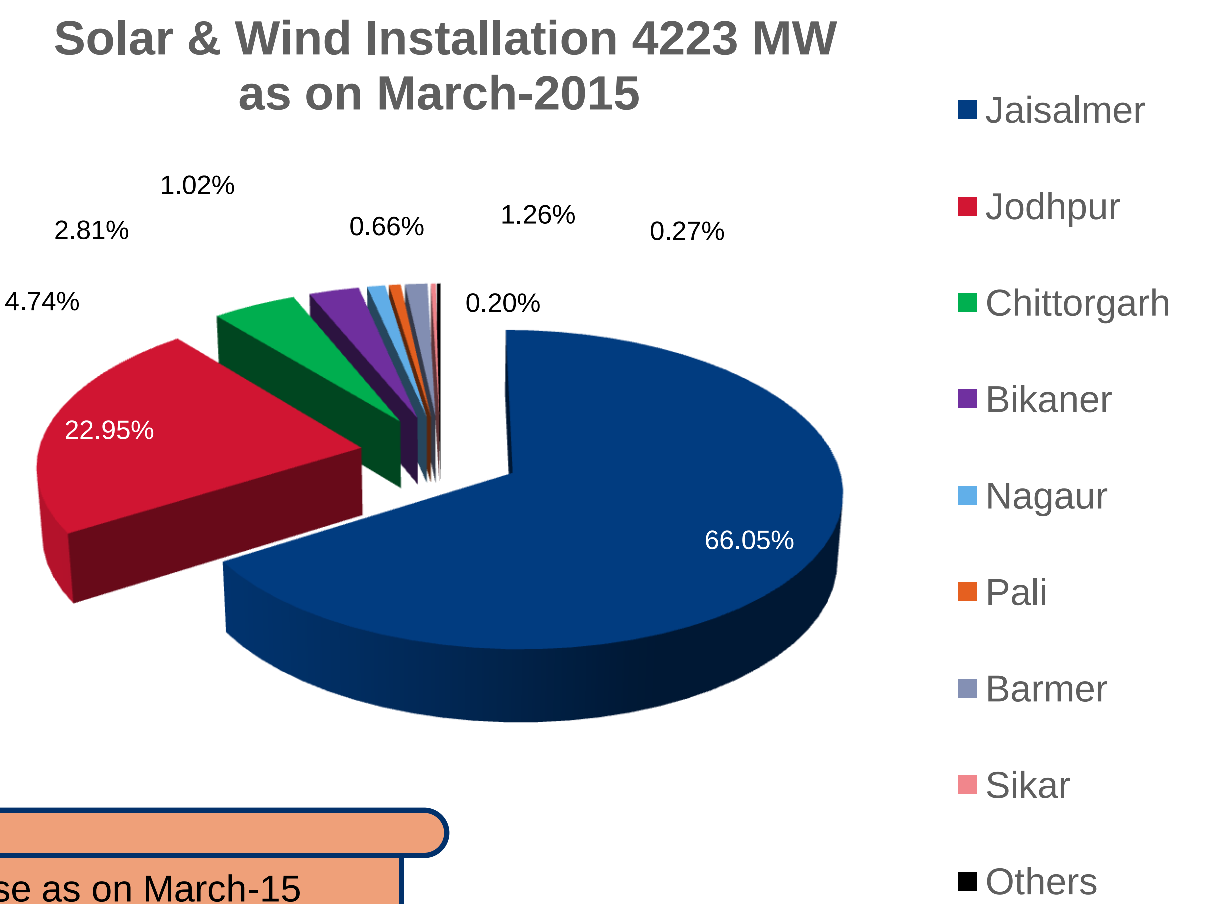
S. No.	Name of 400 kV GSS
A	**For Evacuation of power from conventional power plants**
1	**Ajmer (2x315 MVA)**
2	**Babai (2x315 MVA)**
3	**Chittorgarh (2x315 MVA)**
4	**Jodhpur (New) (2x315 MVA)**
5	**Udaipur (2x315 MVA) (PPP Mode)**
6	**Jaipur (North) (2x315 MVA) (PPP Mode)**
B	**For Evacuation of RE power**
1	**Jaisalmer-II (2x500 MVA)**
2	**Ramgarh (3x500 MVA)**
3	**Bhadla (3x500 MVA)**
4	**Banswara (2x500 MVA)**

RE Potential in Rajasthan

- Rajasthan has very huge potential of Renewable Energy Sources in western part which includes Jaisalmer, Barmer, Jodhpur & Bikaner districts .
- Wind Potential is also in Banswara & Pratapgarh districts of Rajasthan
- Source-wise potential envisaged :

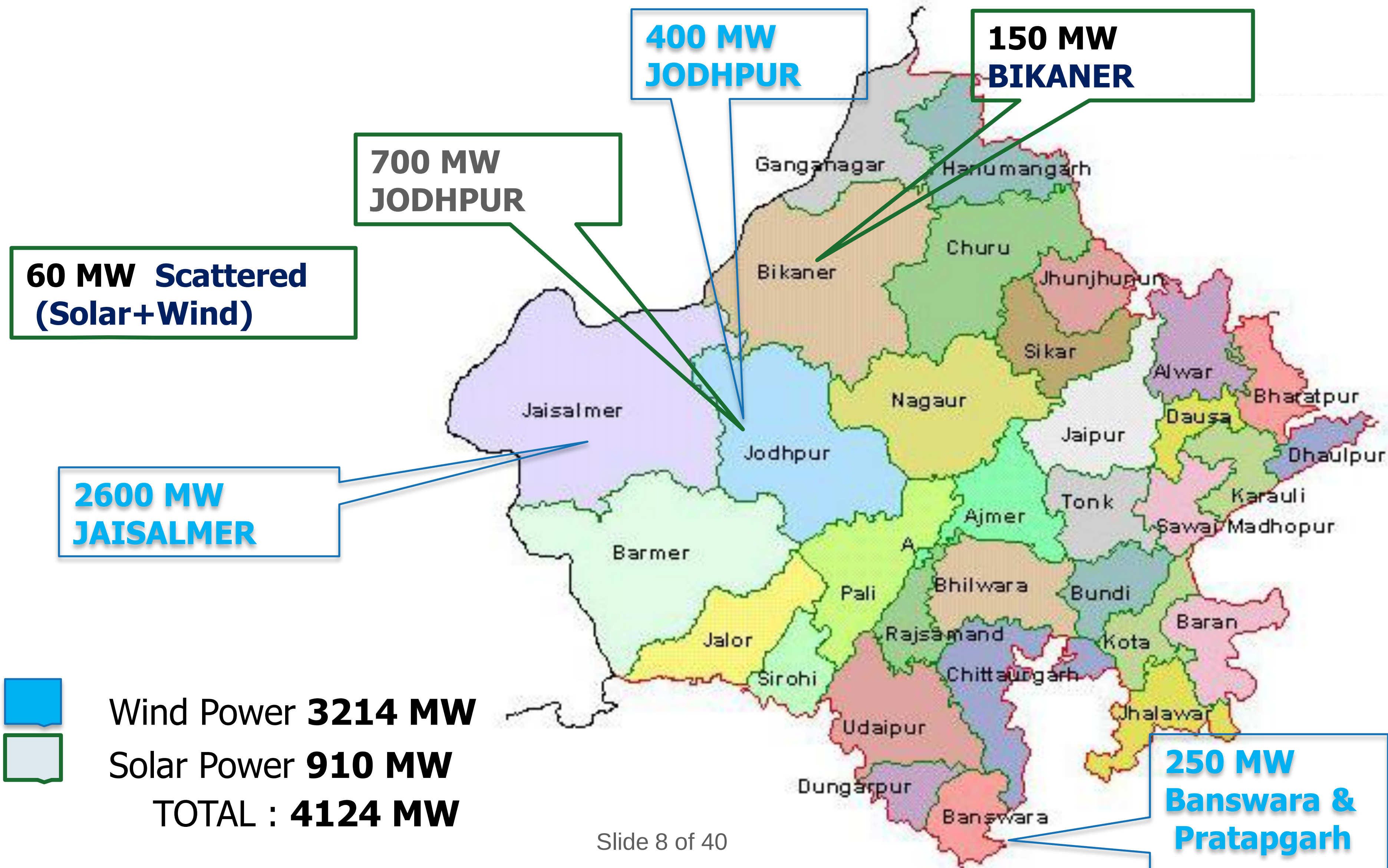
Sources	Total Potential (MW)
Wind	9000-10000
Solar	>100000

Wind & Solar Generation Districtwise



- ~4.2 GW Installed Base as on March-15
- Wind/Solar/Biomass comprise ~6% of total gen as on 31st Mar 2015
- Jaisalmer & Jodhpur together account for 89% of Solar & Wind capacity
- Chittorgarh adds another 2.81% from Wind

Locations of Existing Wind and Solar Projects in Rajasthan (As on 31st March 2015)



Wind Power **3214 MW**

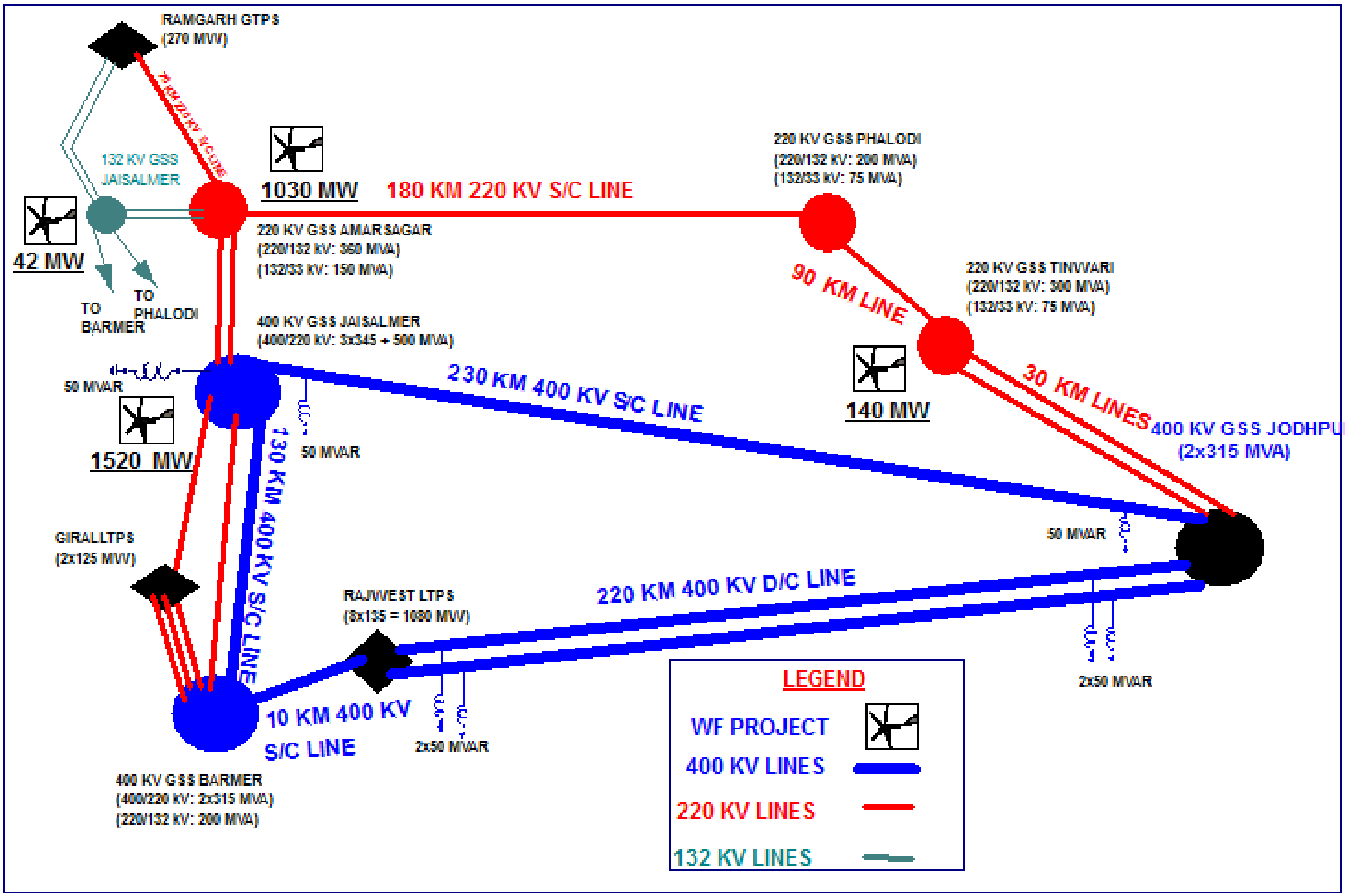
Solar Power **910 MW**

TOTAL : **4124 MW**

Existing Transmission System available for Evacuation of Wind / Solar Projects in Jaisalmer/Barmer Districts

Voltage Level	GSS No./MVA	Associated Tr. Lines Ckt kms
400/220 kV GSS (Jaisalmer, Barmer)	2/2075	360
220/132 kV GSS	10/960	700
132/33 kV GSS (Scattered)	23/1001	358

EXISTING WIND FARM EVACUATION SYSTEM FROM THE JAISALMER (March '2015)



Wind and Solar Power Projects addition target in Rajasthan (Upto FY 2021-22)

RREC has set the following yearly targets for addition of Wind and Solar Power Projects (MW) in Rajasthan upto 2021-22

Year	Wind	Solar	Total
Installed Capacity as on 31st March'2015	3321	910	4231
Taget for Addition upto end of XII plan	1000	3000	4000
Taget for Addition upto end of XIII plan	4000	15000	19000
Total	**8321**	**18910**	**27231**
RVPN will develop transmission system for evacuation of 13000 MW RE power **PGCIL will develop ISTS for evacuation of balance 14000 MW RE power which would be exported out side of state**			

Existing Transmission System available for Evacuation of Wind / Solar Projects in Jaisalmer/Barmer Districts

Voltage Level	GSS No./MVA	Associated Tr. Lines Ckt kms
400/220 kV GSS (Jaisalmer, Barmer)	2/2075	360
220/132 kV GSS	10/960	700
132/33 kV GSS (Scattered)	23/1001	358

Development of Solar Parks in Rajasthan

Govt. of Rajasthan has signed Joint Venture Agreements/ MOUs for development of 32000 MW capacity Solar Parks and Solar Power Projects in Rajasthan

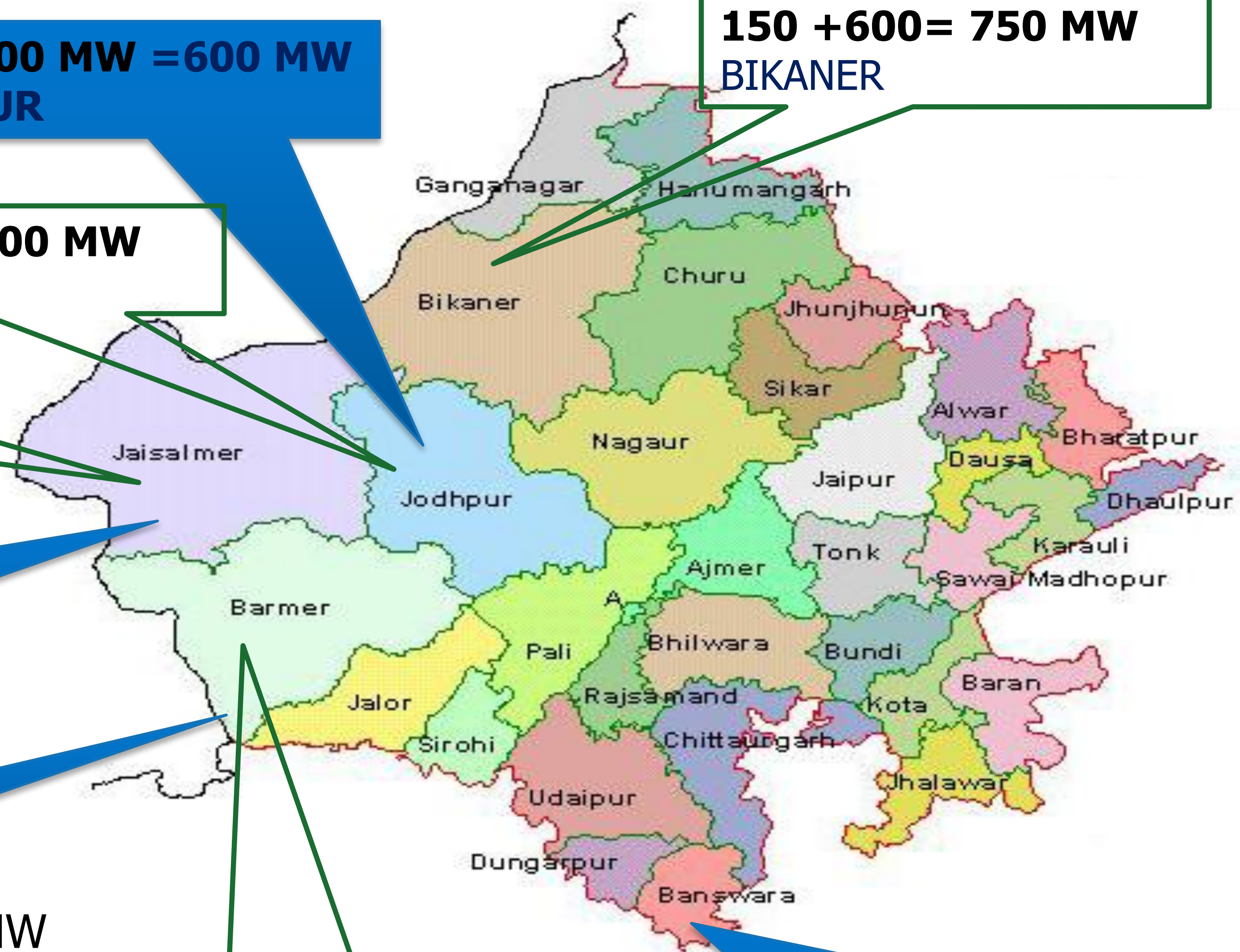
S. No.	Name of Firm	Capacity (MW)
1	M/s IL&FS Energy Ltd.	5000
2	M/s Sun Edison Solar Power India Ltd.	5000
3	M/s Azure Power Ltd.	1000
4	M/s Essel Infraproejcts Ltd.,	5000
5	M/a Adani Enterprises Ltd.(AEL)	10000
6	M/s Reliance Power Ltd. (RPOWER)	6000
	Total	**32000**

Development of Solar Parks in Rajasthan

Solar parks to be setup upto FY 2021-22

S. No.	District	Area in hectare (Approx.)	Capacity of Solar Park (MW)
1	Jodhpur	1600 2500	700 1000
2	Jaisalmer (Tehsil Jaisalmer)	12000	5000
3	Jaisalmer (Tehsil Fatehgarh)	6500	3000
4	Jaisalmer (Tehsil Pokaran)	2700	1000
5	Bikaner (Tehsil Pugal)	7000	3000
		Total (MW)	**13700 MW**

Tentative locations of 13000 MW RE Projects



400 +200 MW =600 MW
JODHPUR

150 +600= 750 MW
BIKANER

700 + 1700 =2400 MW
JODHPUR

50+1100 =1100 MW
JAISALMER

2600+3500 = 6100 MW
JAISALMER

50+650 =700 MW
BARMER

0 + 200 MW BARMER

250+ 750 MW =1000 MW
Banswara & Pratapgarh

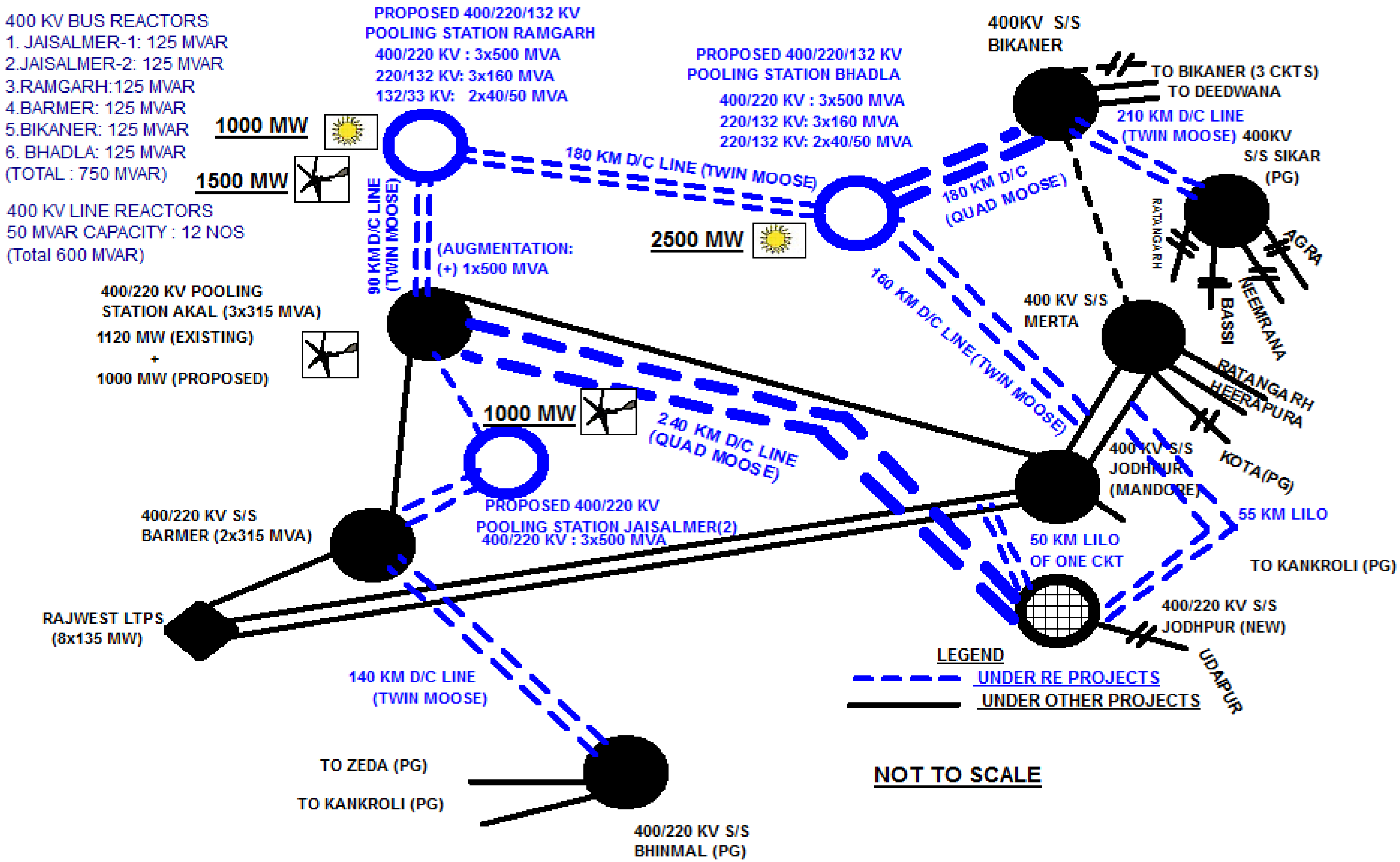
Wind Power: 8300 MW

Solar Power: 4700 MW

Details of Approved Evacuation System

Voltage Level	GSS No./MVA	Associated Tr. Lines Ckt kms
400 kV GSS (Ramgarh, Bhadla, Jaisamer2-, Banswara)	**4/5000**	**3150**
220 kV GSS	**8/1860**	**714**

Details of Approved Evacuation System



MAP

Under Planning Intra State Transmission System

S. No.	Transmission System
1	765/400 kV GSS Jodhpur
2	400/220 kV GSS Pokaran
3	400/220 kV GSS Kolayat

Details of Approved Evacuation System (Inter State Transmission System)

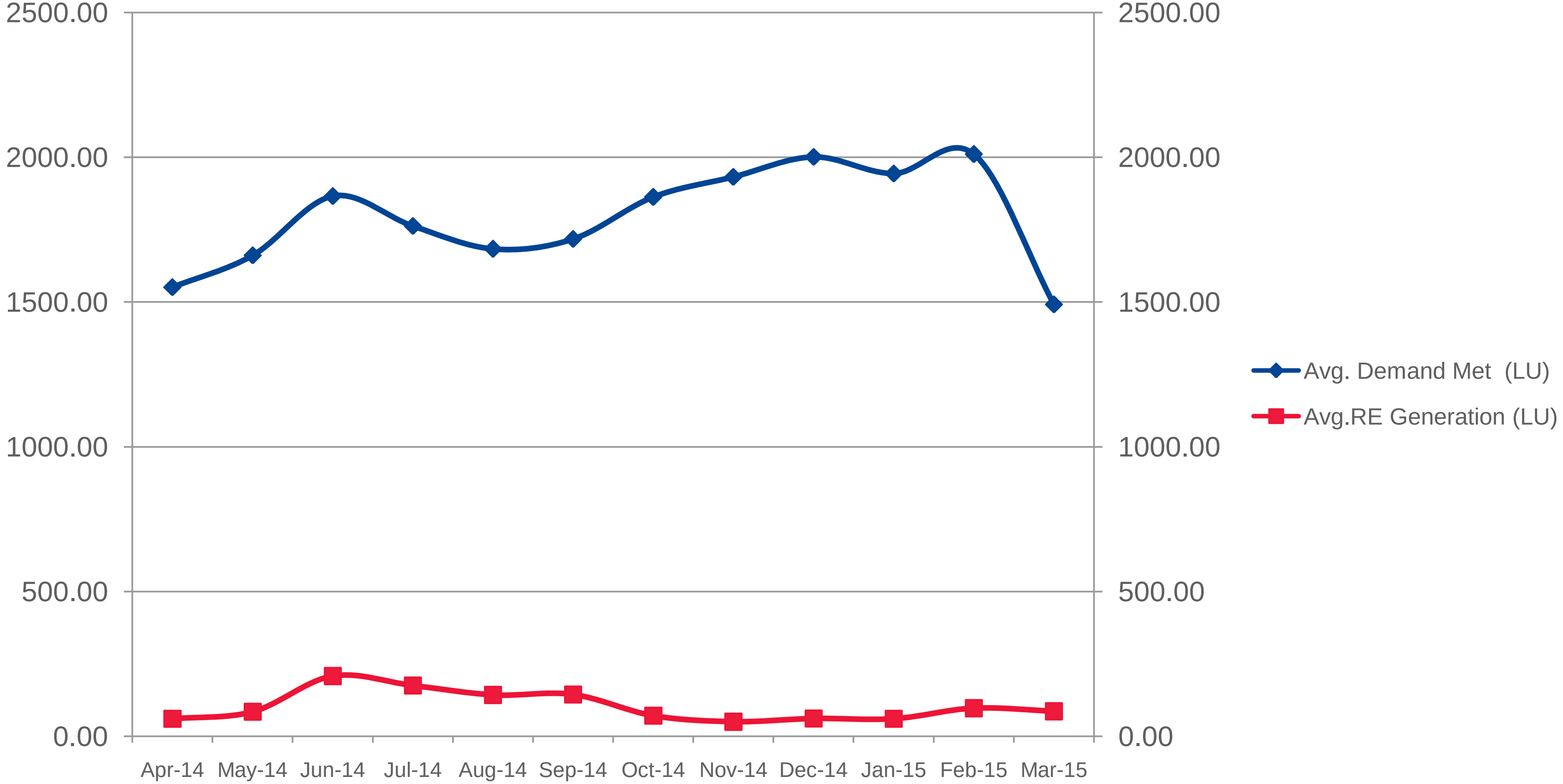
S. No.	Transmission System
A	Under Execution
1	765/400 kV GSS Chittorgarh
2	765/400 kV GSS Ajmer
3	765/400 kV GSS Suratgarh / Bikaner
B	Recently approved
1	765/400/220 kV GSS Parewar (Jaisalmer)
2	765/400/220 kV GSS Fatehgarh (Jaisalmer)
3	765/400/220 kV GSS Bhadla (Jodhpur)

Power Supply Scenario

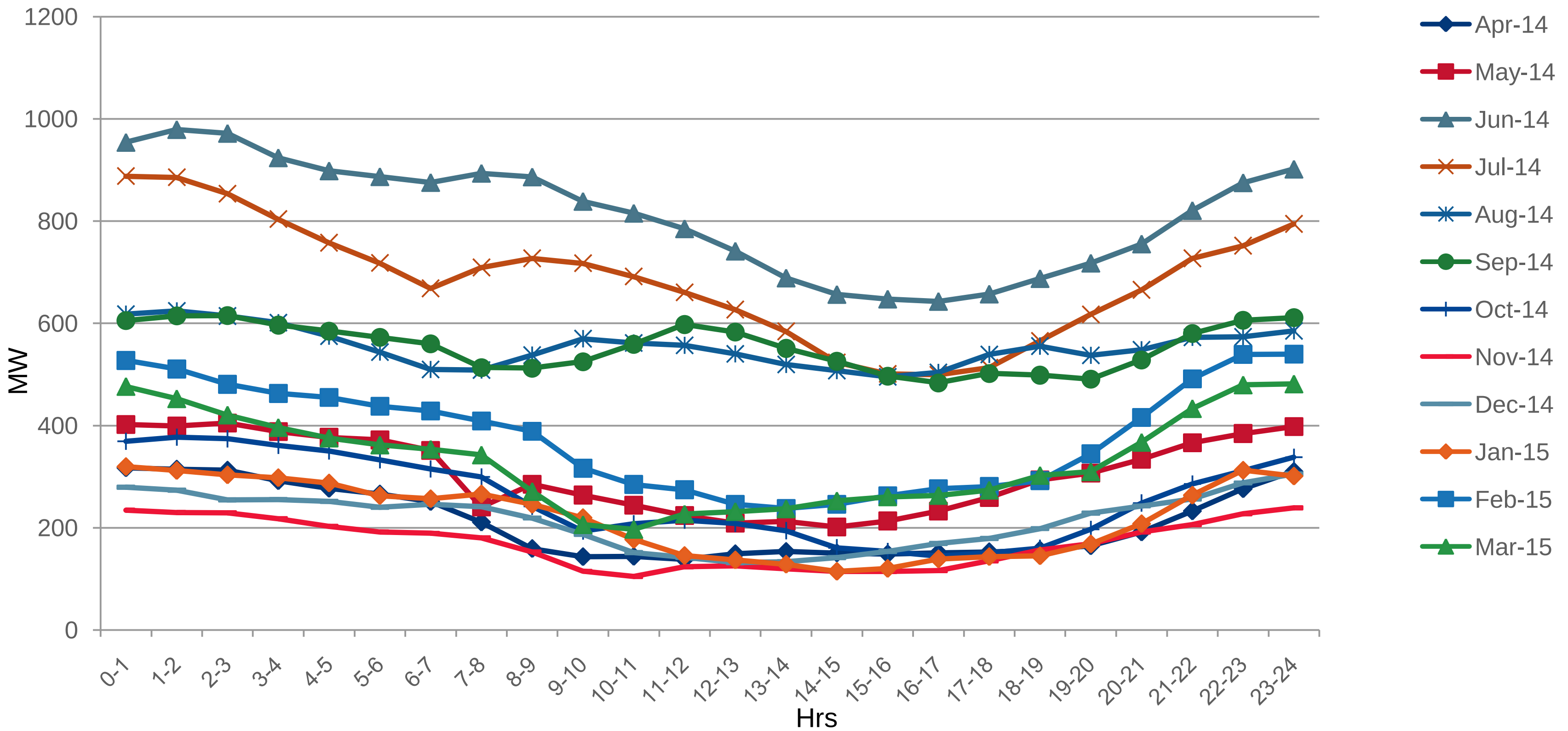
Power Position from April 2014 to March 2015

Month	Avg. Demand Met (LU/Day)	Maximum Demand (MW)	Avg.RE Generation (LU/Day)	Demand met by RE (%)
Apr-14	1551.66	7951	60.61	3.91
May-14	1661.59	8727	85.44	5.14
Jun-14	1866.48	9131	208.37	11.16
Jul-14	1762.68	9403	175.73	9.97
Aug-14	1683.71	10077	143.03	8.50
Sep-14	1717.86	9474	144.80	8.43
Oct-14	1862.79	9339	71.77	3.85
Nov-14	1932.77	9525	50.64	2.62
Dec-14	2001.52	10642	61.51	3.07
Jan-15	1944.20	10179	60.78	3.13
Feb-15	2010.82	10095	97.32	4.84
Mar-15	1492.42	8199	86.72	5.81

Avg. Demand Met v/s Avg. RE Generation (Monthly)



TYPICAL WIND GENERATION PATTERN 2014-15

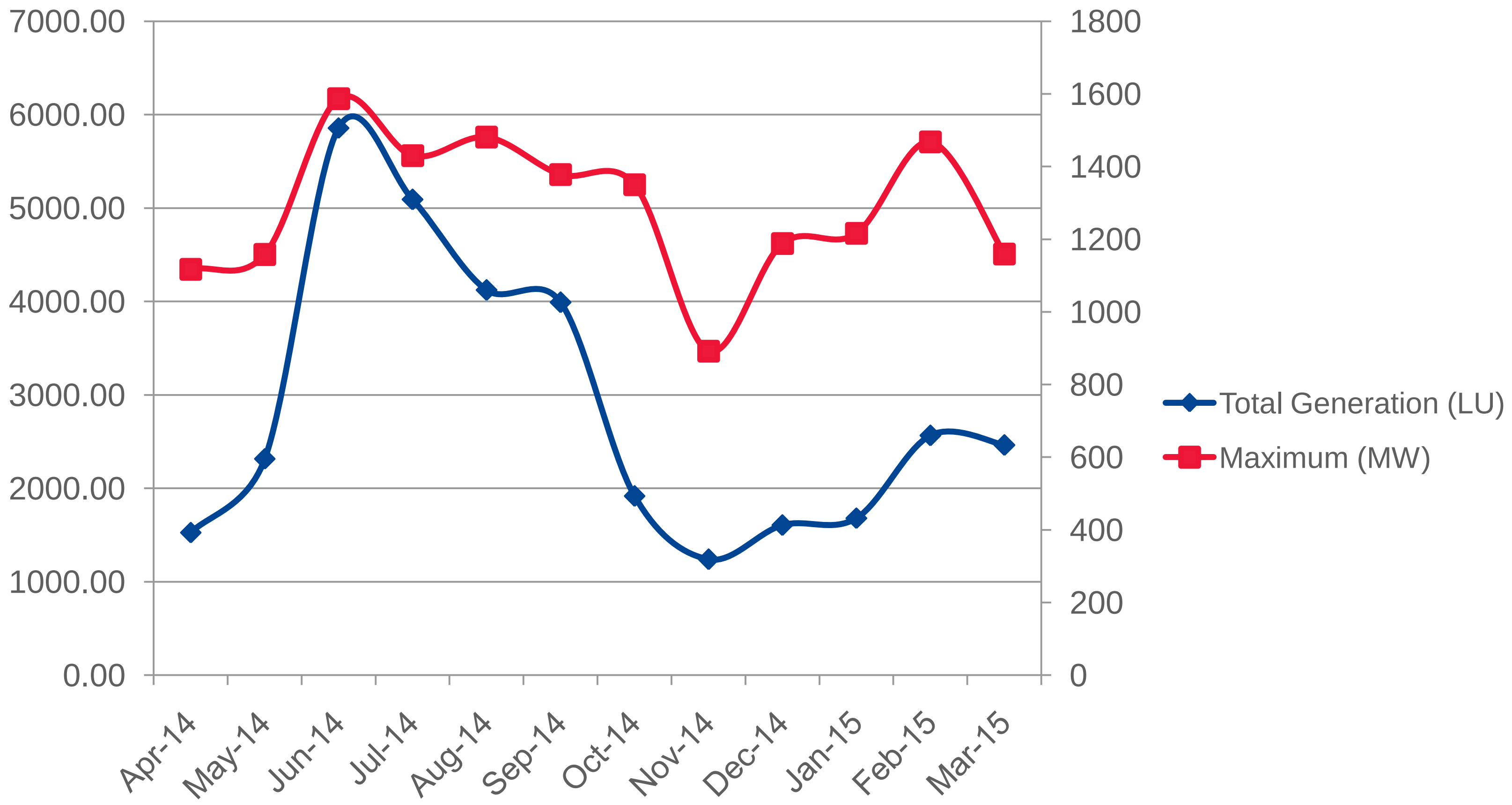


- Rajasthan Wind Generation starts to peak at 18 Hrs

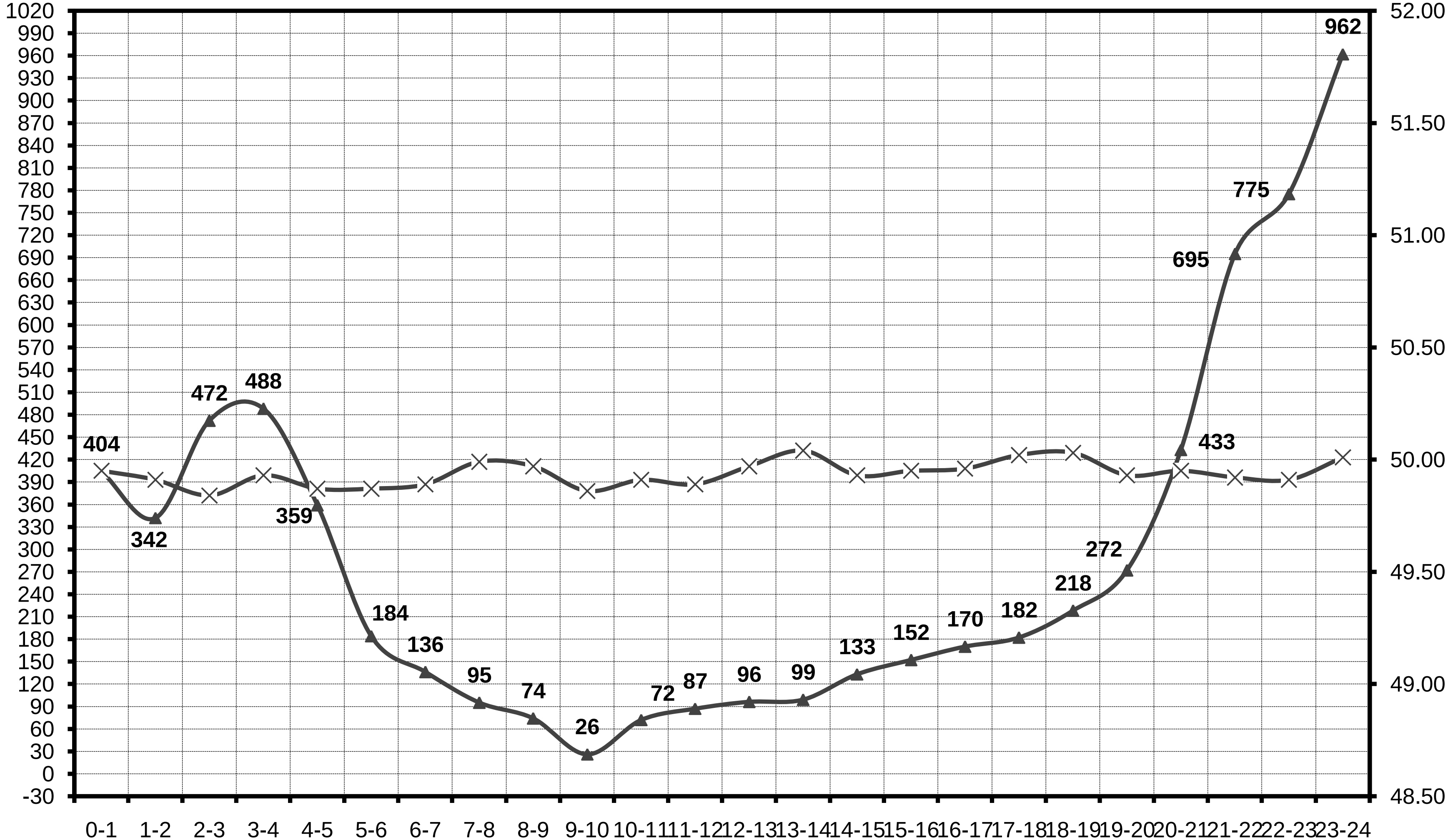
Details of Wind Generation (Month wise)

Month	Total Generation (LU)	Maximum (MW)	Maximum on Date
Apr-14	1526.30	1117	12-Apr-14
May-14	2316.42	1158	31-May-14
Jun-14	5857.42	1587	29-Jun-14
Jul-14	5090.44	1430	2-Jul-14
Aug-14	4122.08	1481	14-Aug-14
Sep-14	3990.83	1378	2-Sep-14
Oct-14	1915.77	1350	4-Oct-14
Nov-14	1239.06	892	13-Nov-14
Dec-14	1605.92	1188	12-Dec-14
Jan-15	1680.68	1216	1-Jan-15
Feb-15	2565.52	1468	14-Feb-15
Mar-15	2461.51	1159	10-Mar-15

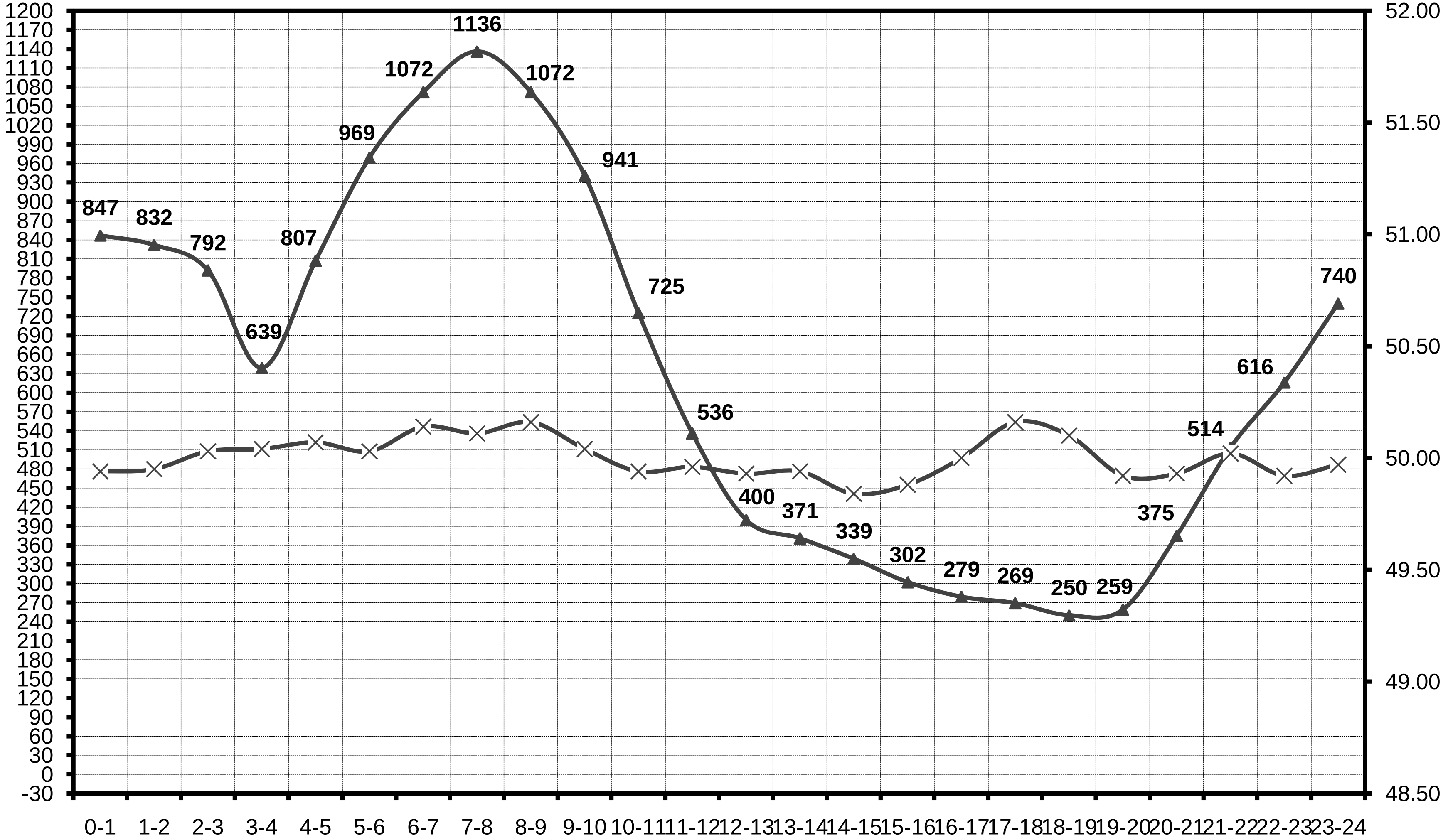
Wind Gen Pattern in (LU) and Maximum wind Gen in MW During the Month (2014-15)



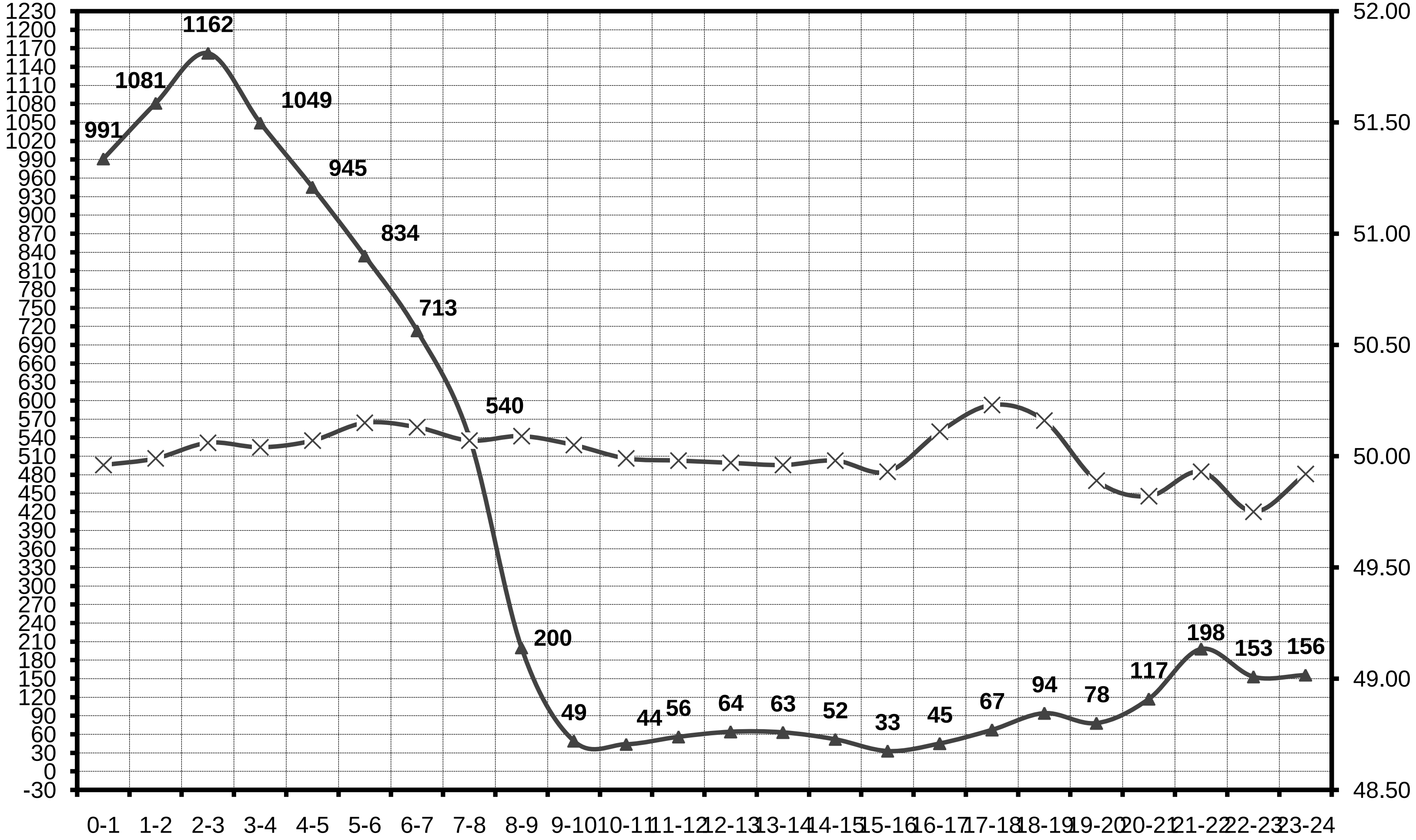
Wind Curve of 1st April 2014



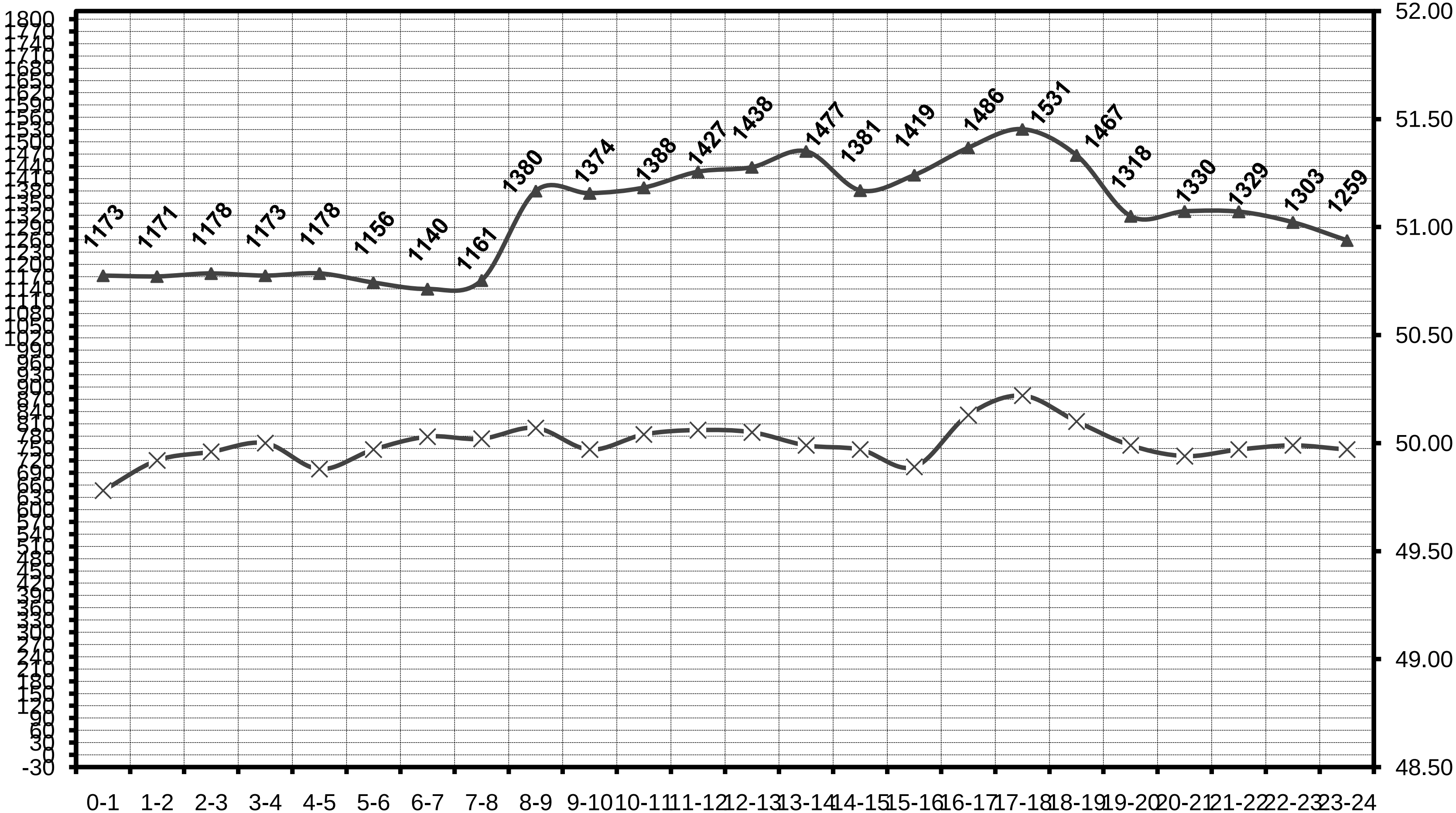
Wind Curve of 31st May 2014



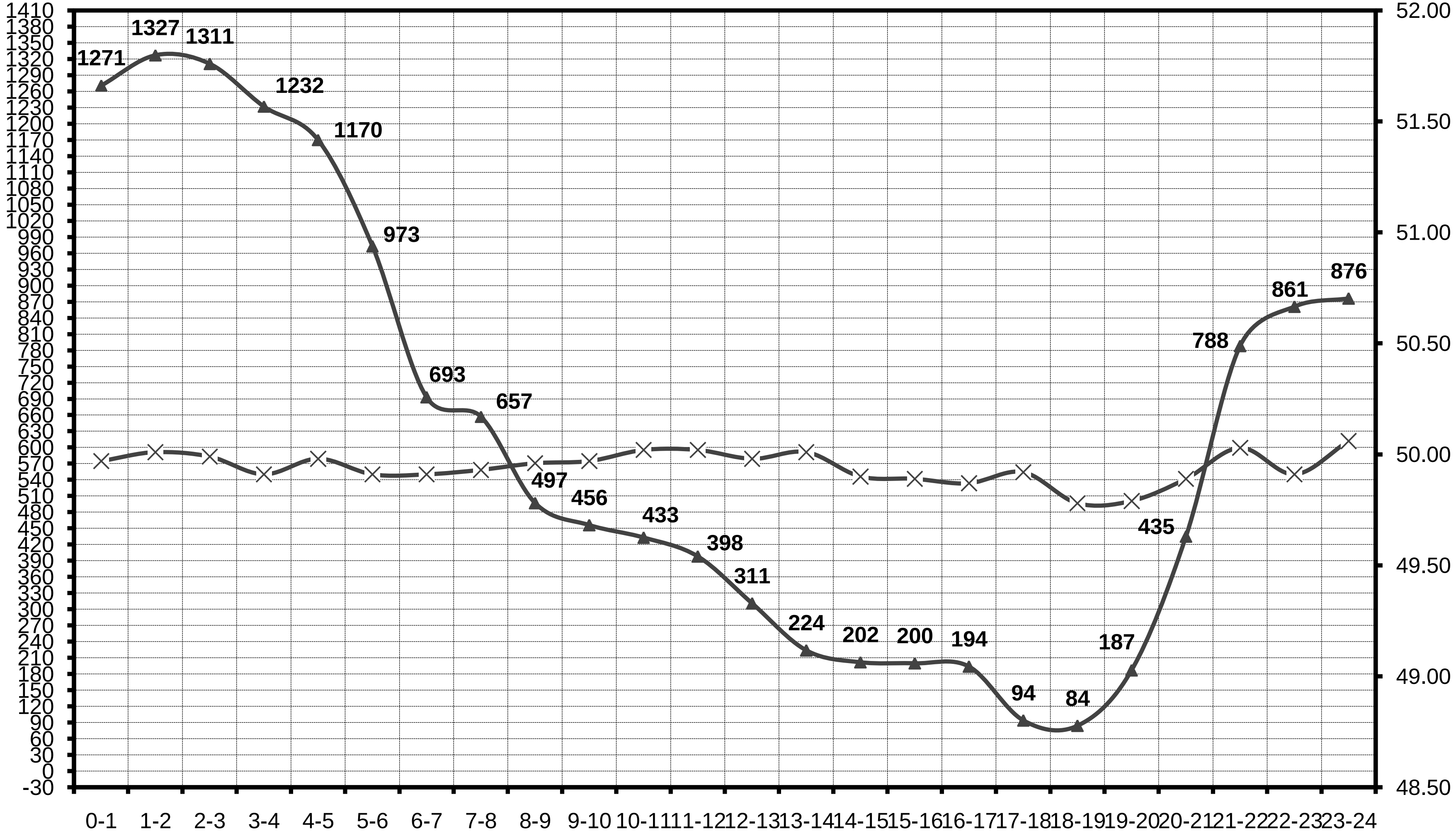
Wind Curve of 1st June 2014



Wind Curve of 29th June 2014



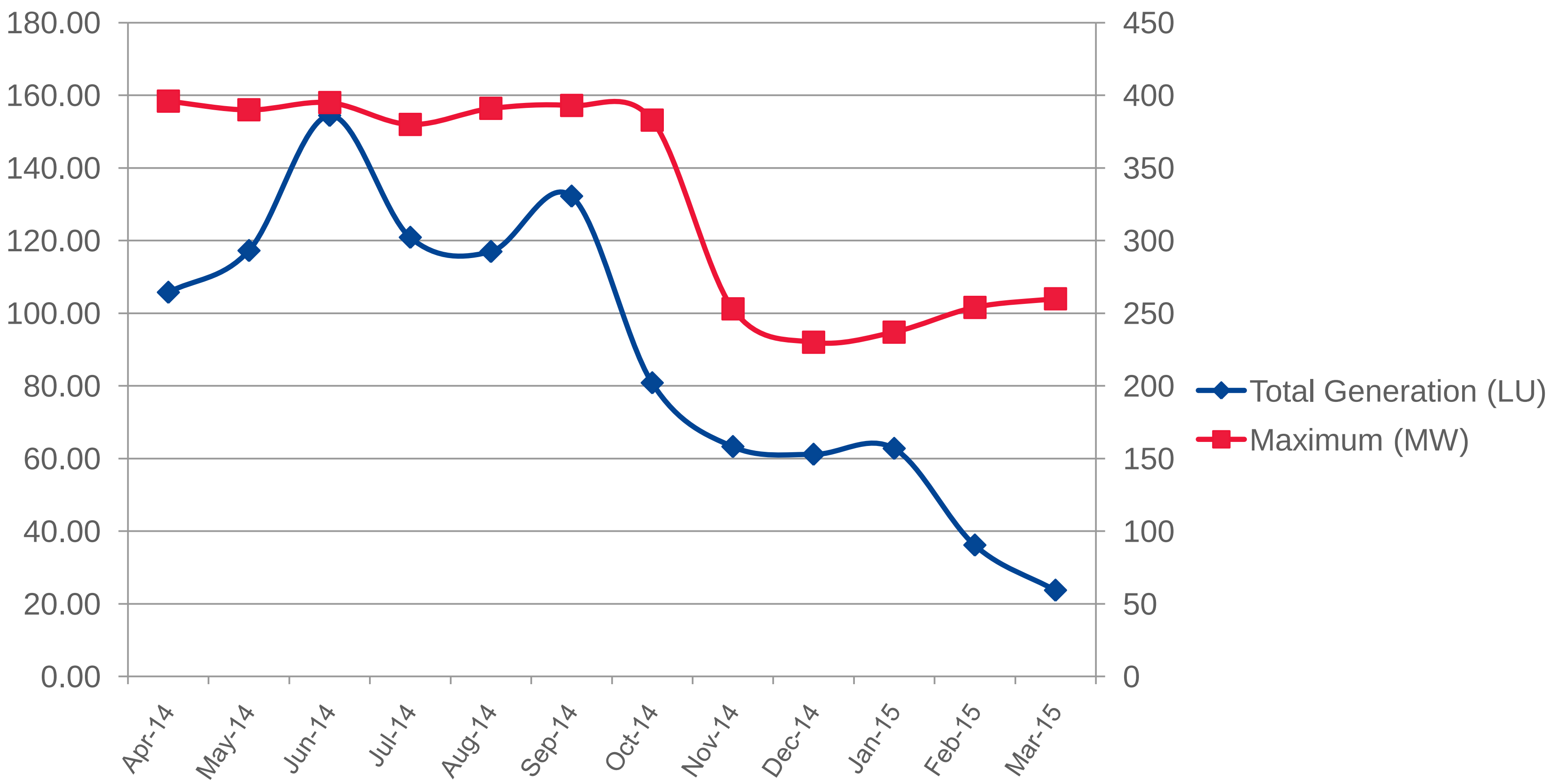
Wind Curve of 23rd July 2014



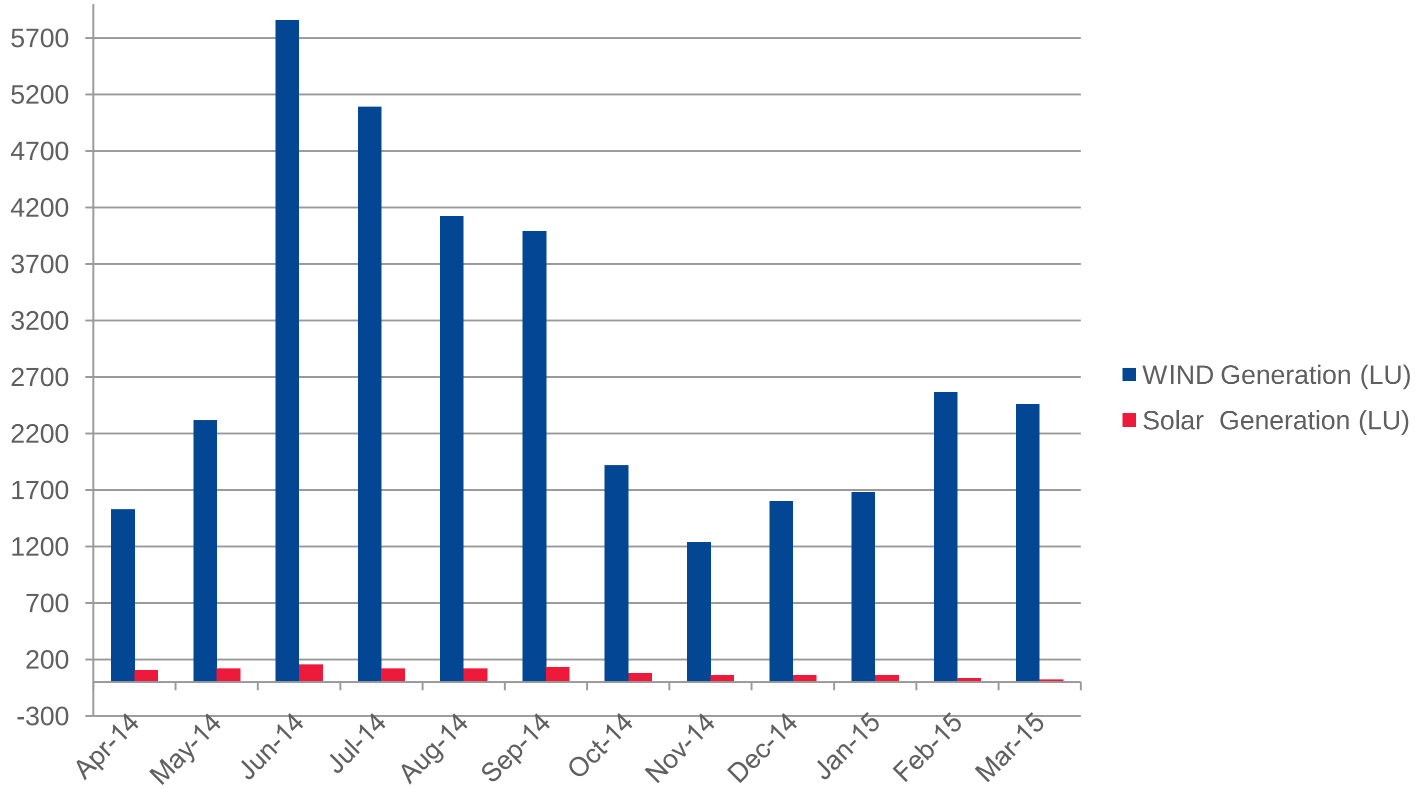
Details of Solar Generation (Month wise)

Month	Total Generation (LU)	Maximum (MW)	Maximum on Date
Apr-14	105.77	396	13-Apr-14
May-14	117.26	390	18-May-14
Jun-14	154.45	395	15-Jun-14
Jul-14	120.90	380	16-Jul-14
Aug-14	116.99	391	23-Aug-14
Sep-14	132.25	393	22-Sep-14
Oct-14	80.85	383	19-Oct-14
Nov-14	63.29	253	12-Nov-14
Dec-14	61.17	230	7-Dec-14
Jan-15	62.78	237	31-Jan-15
Feb-15	36.17	254	27-Feb-15
Mar-15	23.74	260	31-Mar-15

Solar Gen Pattern in (LU) and Maximum Solar Gen in MW During the Month (2014-15)



Monthwise Consumption Pattern Wind and Solar (2014-15)



CHALLENGES / BOTTLENECK IN PLANNING THE TRANSMISSION SYSTEM FOR RE PROJECTS

- The development period of Wind / Solar PP is low (3 to 4 months), whereas the time for construction of the transmission system is large (3 to 5 years for a 400 kV GSS).
- RoW constraint for construction of high capacity EHV lines
- Till the planned transmission system is commissioned, evacuation constraint is envisaged.
- Variation in envisaged RE Capacity and actual achievement.
- Low Capacity Utilization Factor (CUF).
- Potential far away from load centers – huge investment required for creating transmission infrastructure for evacuation

Renewable Energy Integration challenges in Rajasthan

- RE is variable, uncertain and geographically concentrated in western part of state
- RE Generation in SCADA system for smooth grid operation
- Forecasting and Scheduling
- Balancing mechanism
- Need for establishing Renewable Energy Management Centre (REMC)
- Grid codes and regulatory aspects of Grid management

DIFFICULTY FACED IN RESTRICTING OVER DRAWL/UNDER DRAWL DUE TO WIND GENERATION

- This huge variation in availability of wind generation makes it difficult to assess the day ahead drawl from Grid.

- When the RE generation increases in large quantum then it is difficult to back down conventional generation in order to keep the drawl within schedule i.e. to avoid under drawl condition

- When the RE generation dip is large then it is difficult to shed off large quantum of load in order to keep the drawl within schedule i.e. to avoid over drawl condition.

- This un-scheduled load shedding adversely affects the quality of supply

Outage Of Transmission Elements

- During Low wind Generation, state observe
  - Over-voltage problems causes over-fluxing in transformers resulting in its tripping
  - Over-voltage causes tripping of transmission lines

Voltage Control Issues

- Mostly Wind generation is concentrated in western part of Rajasthan
- Lack of load in Western Rajasthan
- Large variation of loading on long 400 kV & 220 kV transmission lines eminating from Western Rajasthan due to huge variation in RE power from 200 to 1000 MW.
- Wind Generators do not provide the required VAR support
- Lack of dynamic reactive power support

Grid Integration of Renewable Energy: Our Experience

- Due to high wind generation, frequently backing down/ box up of thermal units of higher rating (i.e. KTPS, STPS, Chabra, Kalisindh , Adani etc.) are carried out.
- Due to uncertainty of RE Generation we are facing difficulty for assessment of state demand and management for Deficit/Surplus power and forced to impose Load-shedding or Overdrawl from Grid.
- Due to large scale variation (200 MW-1000 MW) in RE Gen. frequent grid violations occurred
- Coal & Lignite based plants used for balancing. Challenges in minimising oil support for steady flame in boilers
- Issues are encountered due to frequent starting & stopping of thermal units for different intervals during high wind generation scenario
- Due to higher wind generation, the backing down of conventional or cheaper generation may have to be done and sometimes, wind generation may also have to be backed down to ensure grid security .
- Due to seasonal availability of wind generation & day-time availability of solar generation with very low PLF, the transmission network created for RE remains sub-optimally utilized.

Grid Integration of Renewable Energy: Our Experience

- Proper Forecasting and Scheduling mechanism is not available with Rajasthan SLDC.
- Appropriate Balancing mechanism is required
- SCADA data is not available for RE sources.
- Need for establishing Renewable Energy Management Centre (REMC).
- Future planning for transmission and distribution network required for Congestion/ grid management.
- Lack of VAR support from Wind Generators leading to over fluxing and tripping of transformers and lines.
- Grid codes and regulatory aspects of Grid management
- Special relaxations in Regulations for RE rich states i.e. provision in DSM for OD/UD restricted within 12%

THANK YOU

Grid Integration of Renewable Energy
State Experience - Gujarat

FOR Meeting

27^{th} July, 2015

Gujarat Energy Transmission Corporation Limited

[An ISO 9001 : 2008 Company]

www.getcogujarat.com

Presentation Outline

- RE Capacity in Gujarat State – Existing and Planned
- RE – Characteristics and Grid integration issues
- RE – Grid Integration Issues : Impacts
- Way forward and solutions

Existing RE capacity in Gujarat state (June-2015)

Sr. No.	District	Wind Power (MW)	Solar Power (MW)	Total RE Capacity (MW)
1	Kutch	1569	130	1699
2	Jamnagar	1228	25	1253
3	Porbandar	176	50	226
4	Rajkot	224	0	224
5	Morbi	198	0	198
6	Amreli	67	10	77
7	Bhavnagar	22	0	22
8	Junagadh	49	65	114
9	Surandranagar	65	187	252
10	Patan	4	442	446
11	Banaskantha	24	45	69
12	Central Gujarat	0	35	35
13	South Gujarat	0	6	6
	Total…	3626	995	4621

Nearly 20 % of conventional generation capacity

RE capacity addition – Perspective Plan for Gujarat state

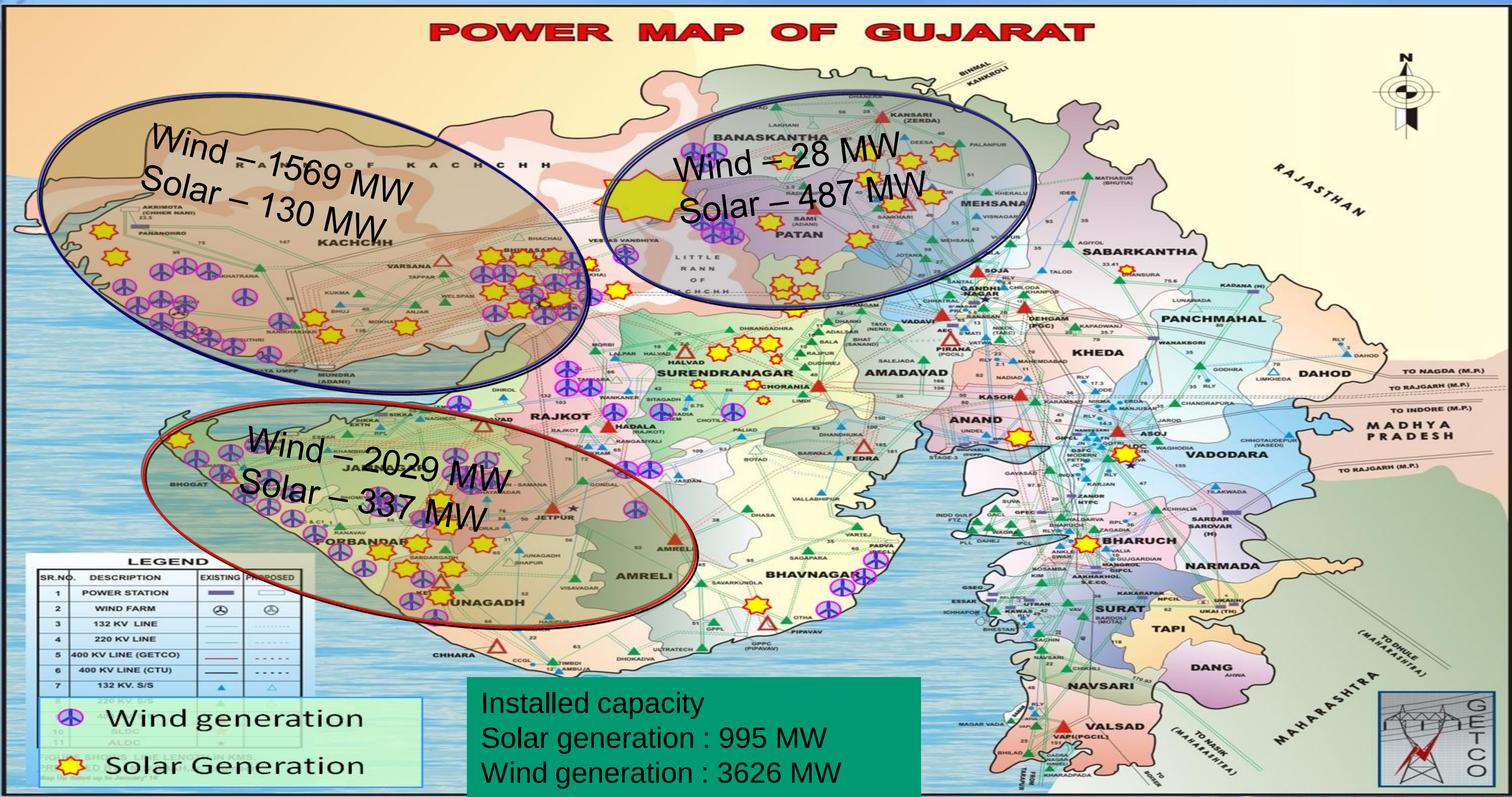
Sr. No.	Year	RE Source (in MW)		Grand Total at the end of year (in MW)
		Wind	Solar	
1	2014-15 (Actual)	3626	995	4621
Addition during 2015-16 to 2021-22				
2	2015-16	895	45	5561
3	2016-17	682	45	6288
4	2017-18	750	661	7699
5	2018-19	824	686	9209
6	2019-20	903	762	10874
7	2020-21	425	1060	12359
8	2021-22	451	1176	13986
Total Addition…		4930	4435	
Grand Total by 2021-22		8556	5430	13986

Likely to be 35 to 40 % of conventional generation Capacity

RE – Charactristics & Grid integration issues :

- **Geographical locations:**

  RE resources are remotely located – considerable distance from load centres, such infrastructure does not fit into cost benefit analysis having low demand locally .



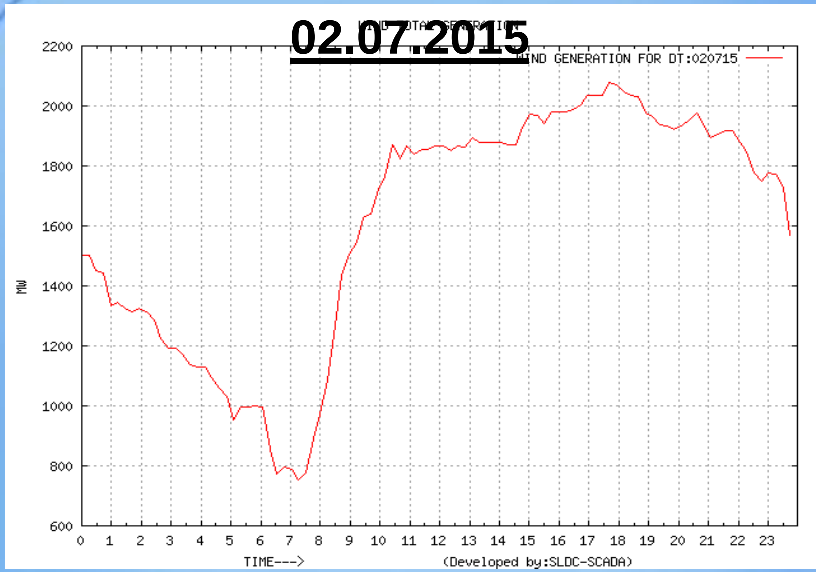
RE – Characteristics and Grid integration issues

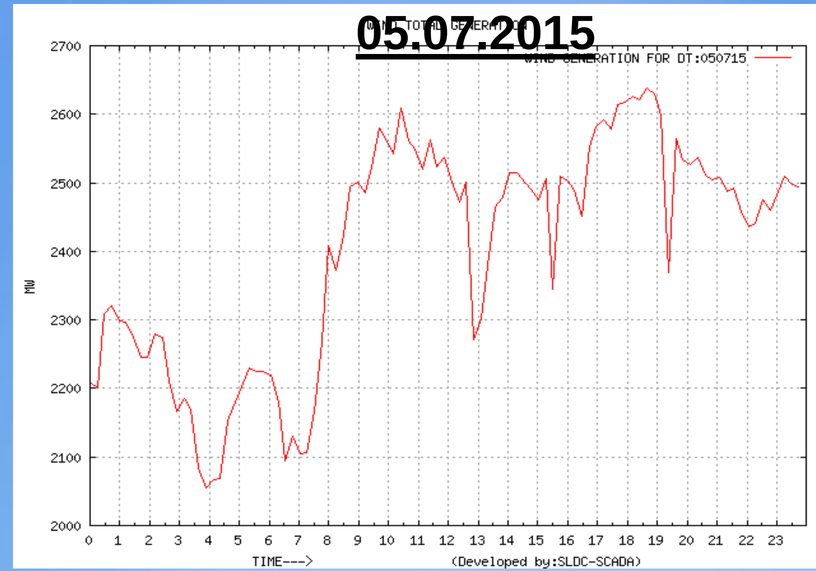
RE – Characteristics & Grid integration issues :

- **Uncertainty, Variability and Intermittency: Day wise**

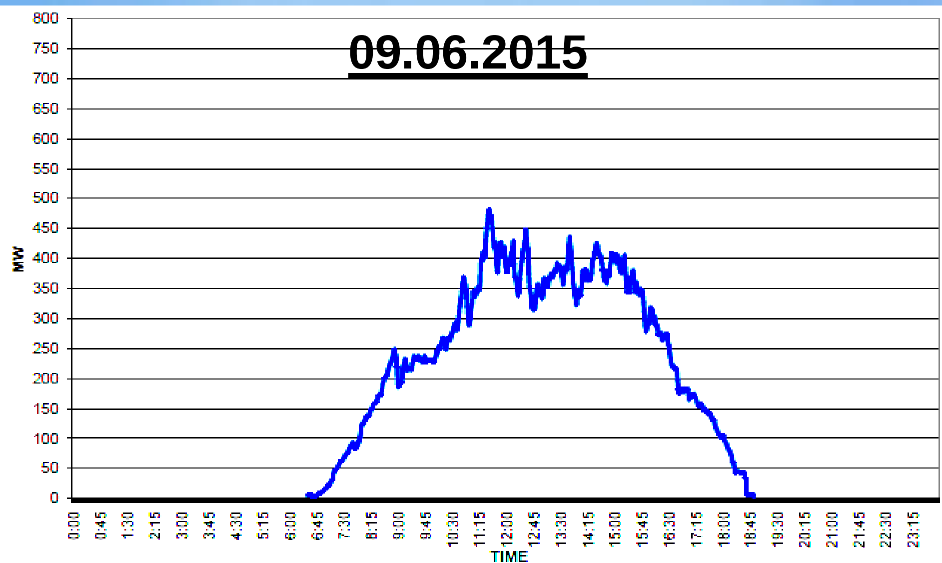
The generation of RE resources are weather dependent – output is variable

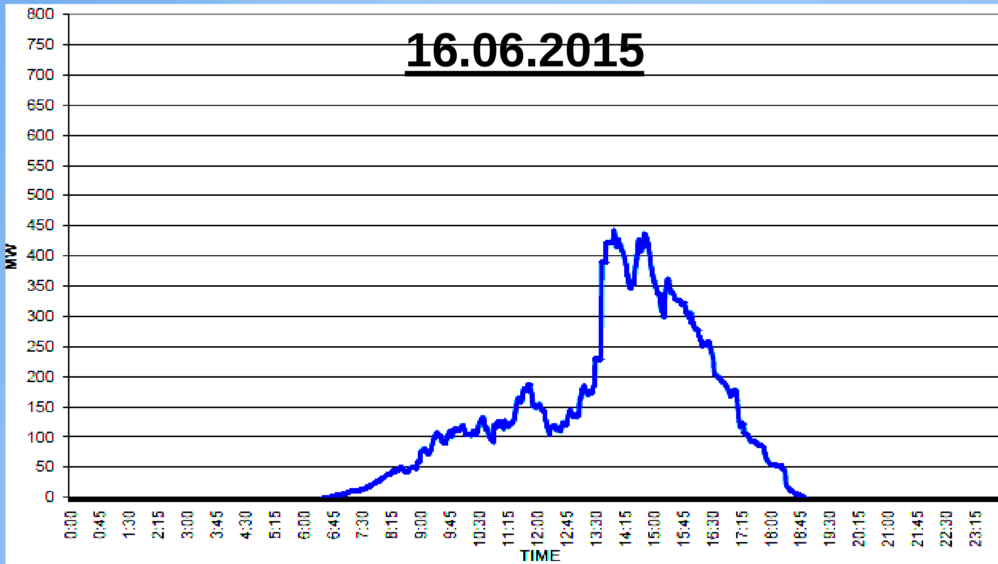
Wind





Solar

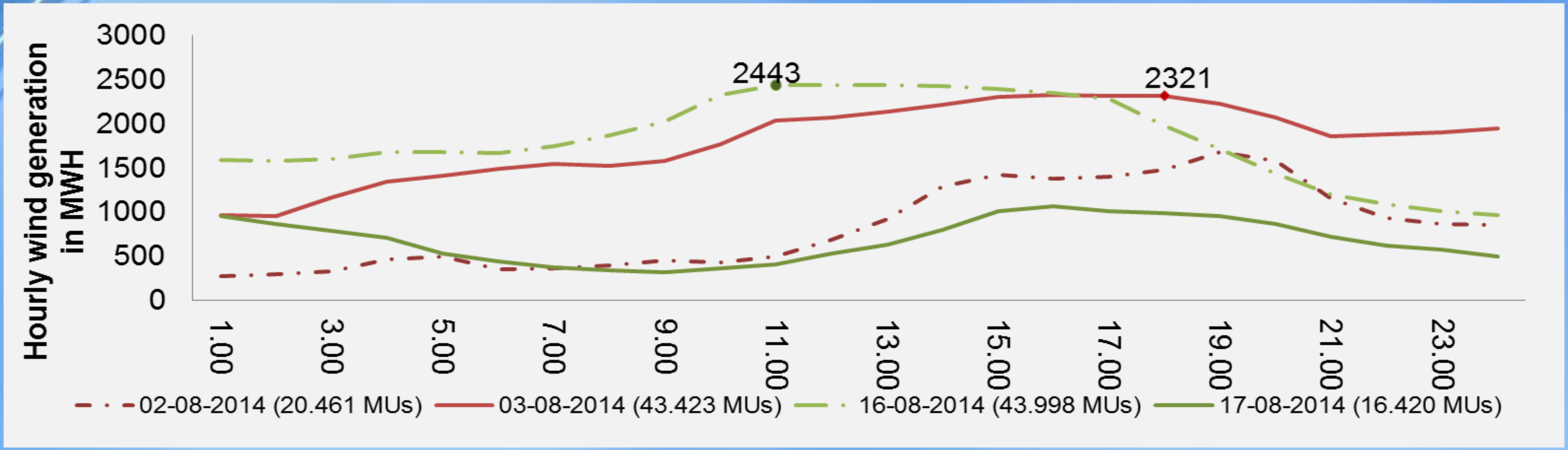




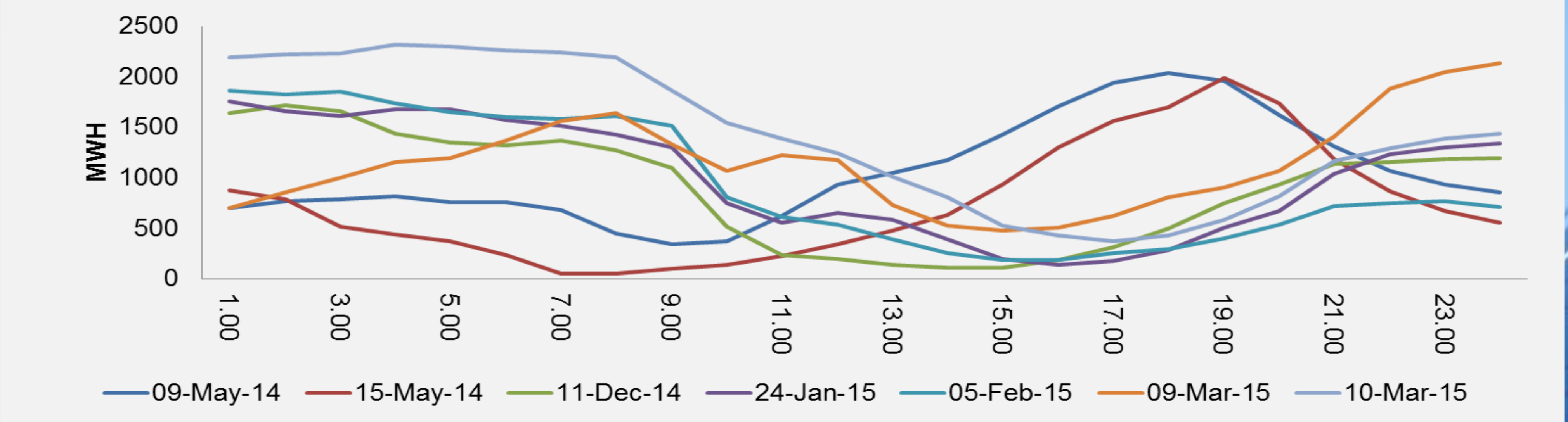
RE – Characteristics & Grid integration issues :

- **Uncertainty, Variability and Intermittency: Day wise**

Maximum variation in wind energy generation in MUs on two consecutive days:



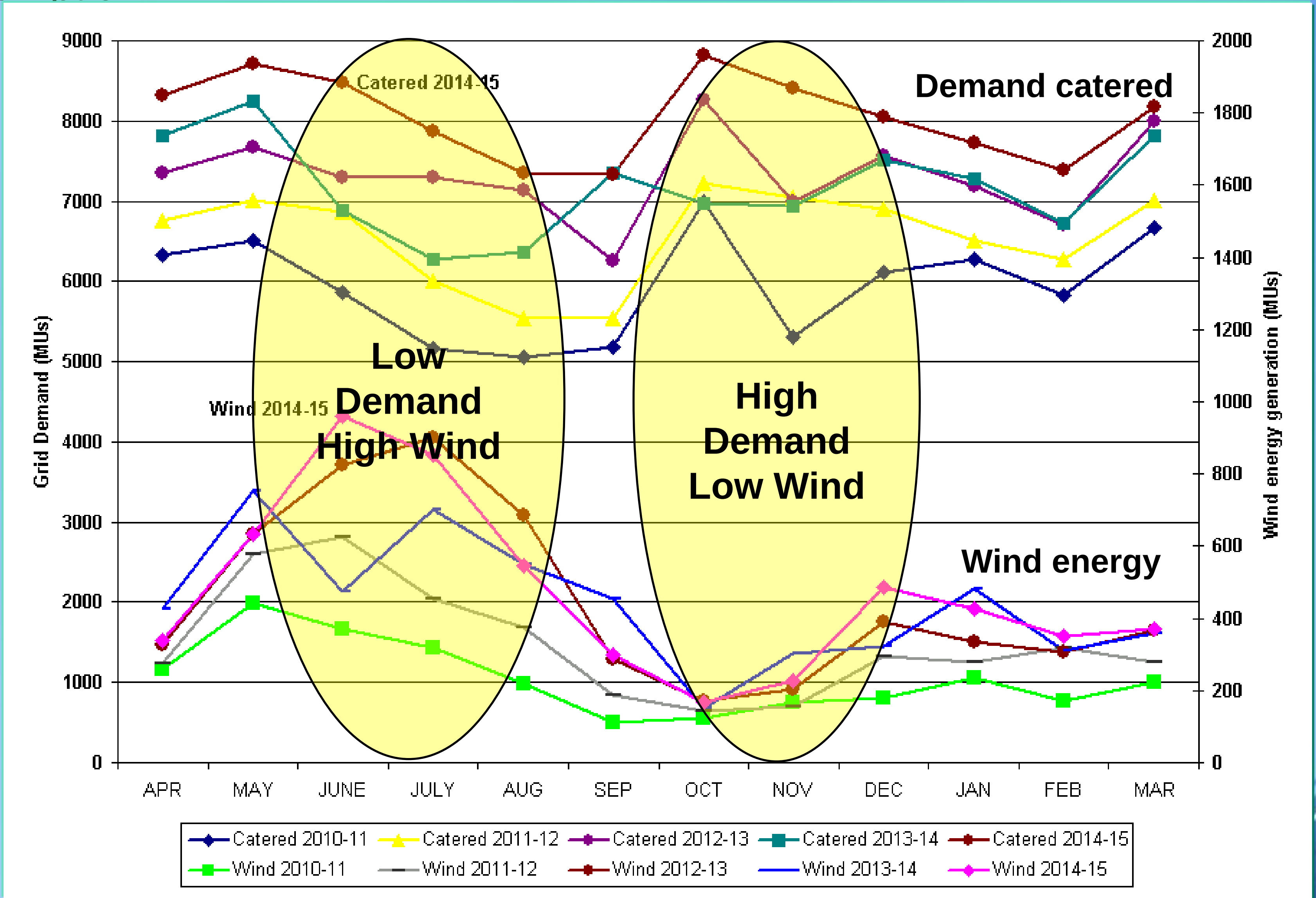
More than 1600 MW Wind variation in a day



RE – Charactristics & Grid integration issues :

- **Seasonal availability: Month wise**

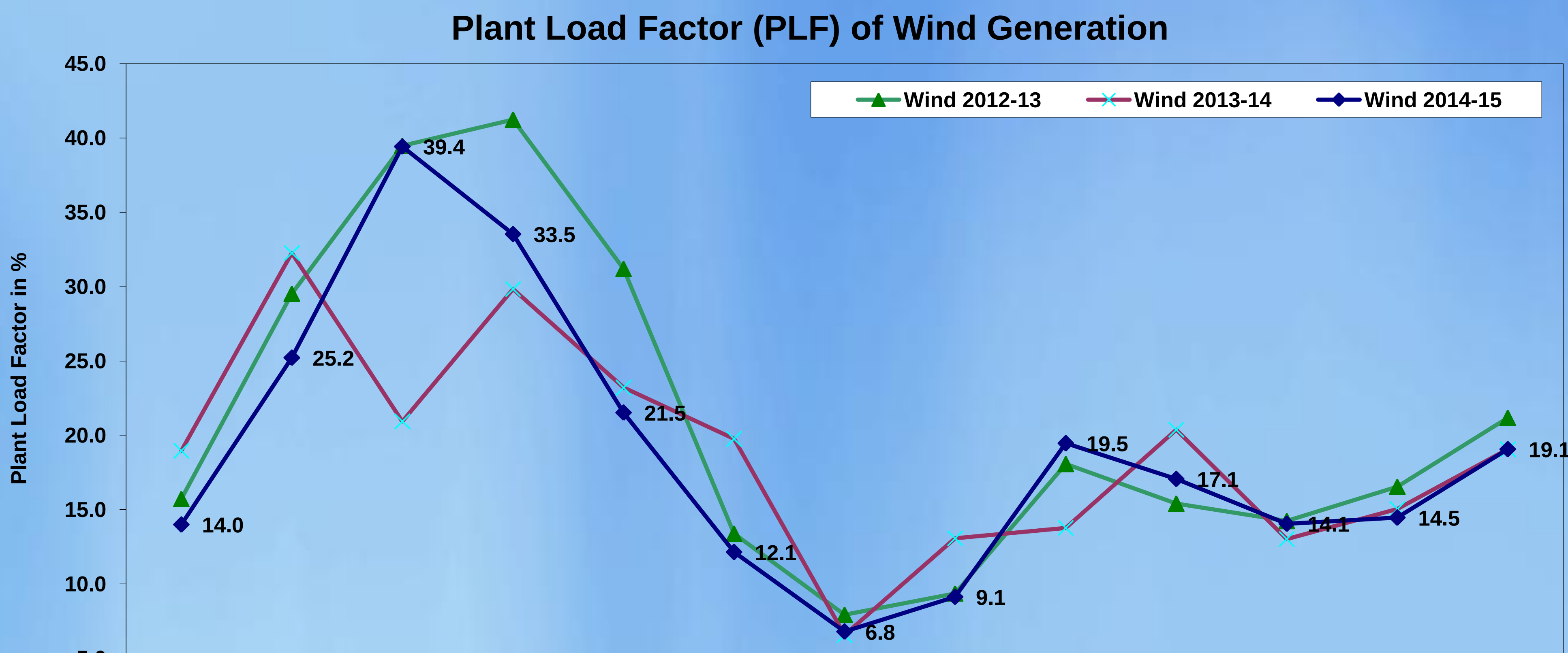
High wind availability in monsoon period – low domestic and agriculture consumption



RE – Charactristics & Grid integration issues :

- **Network utilization:**

  low PLF does not justifies transmission infrastructure cost.

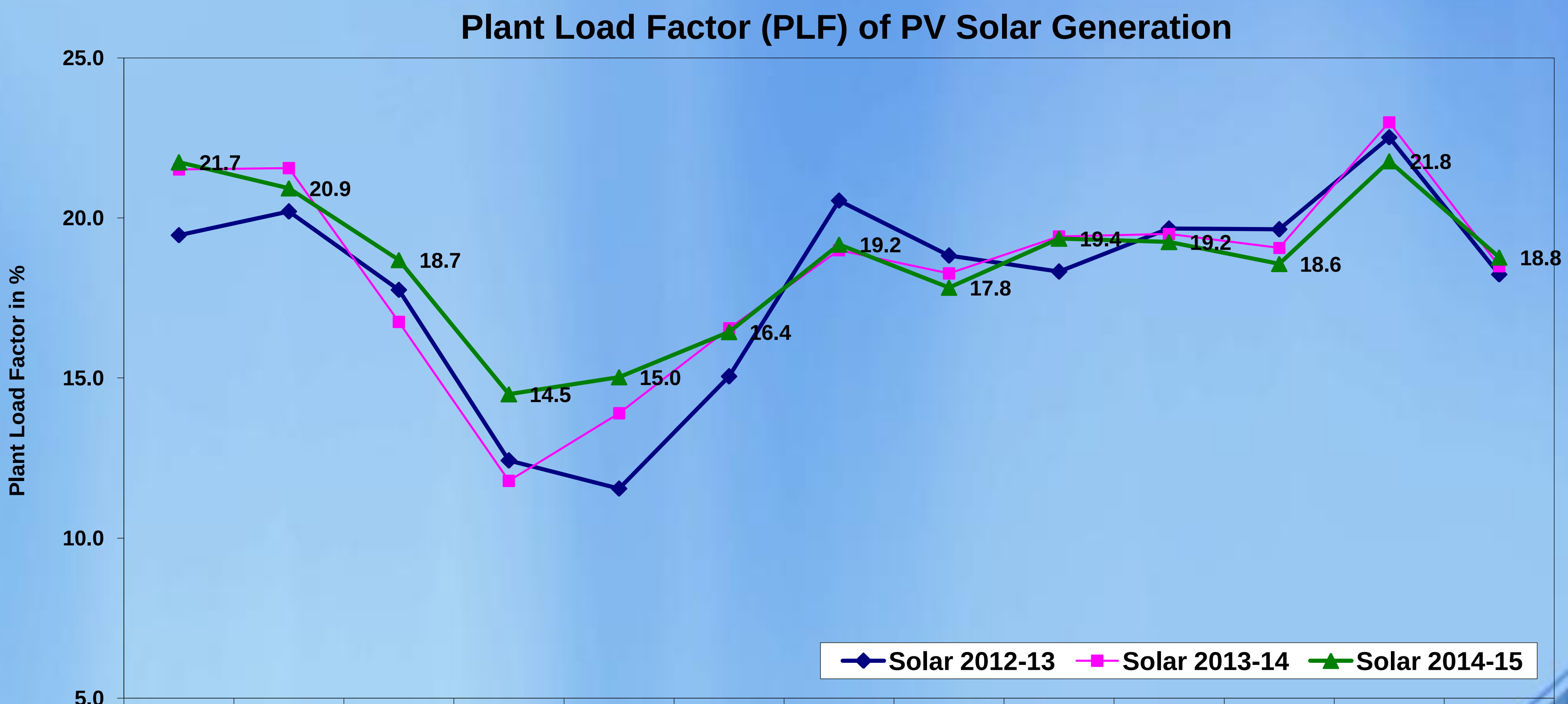


	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Overall
Wind 2012-13	15.7	29.5	39.5	41.2	31.2	13.4	7.9	9.4	18.1	15.4	14.2	16.5	21.2
Wind 2013-14	19.0	32.3	20.9	29.8	23.2	19.8	6.6	13.1	13.8	20.4	13.0	15.0	19.1
Wind 2014-15	14.0	25.2	39.4	33.5	21.5	12.1	6.8	9.1	19.5	17.1	14.1	14.5	19.1

RE – Charactristics & Grid integration issues :

- **Network utilization:**

  low PLF does not justifies transmission infrastructure cost.



	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Overall
Solar 2012-13	19.5	20.2	17.8	12.4	11.5	15.0	20.5	18.8	18.3	19.7	19.6	22.5	18.2
Solar 2013-14	21.5	21.6	16.7	11.8	13.9	16.6	19.0	18.3	19.4	19.5	19.1	23.0	18.5
Solar 2014-15	21.7	20.9	18.7	14.5	15.0	16.4	19.2	17.8	19.4	19.2	18.6	21.8	18.8

RE – Grid Integration Issues : Impacts

RE – Grid integration issues : Impact

- **Grid operation constraints:**
  - High voltage scenario during less RE injection – under utilization of EHV network
  - Reactive power management
  - "Must Run" status – State generating plants to account for RE variability and not the Interstate Generation Station (ISGS)
  - Over drawl (OD) / Under drawl (UD) within 150 MW of ISGS schedule to be adhered to for grid discipline compliances under Deviation Settlement Mechanism (DSM)
  -

Out of 365 days

Variation in wind generation in MW	No of Days 2012-13	No of Days 2013-14	No of Days 2014-15
More than 1000 MW	60	82	94
More than 500 MW	252	267	257

RE – Grid integration issues : Impact

Commercial impact under Deviation Settlement Mechanism (DSM):

Impossible to restrict OD / UD within 150 MW, when RE variation is more than 1500 MW in a day.

- The data recorded for OD and UD more than 150 MW for wind generation variation as high as 1500 MW in a day.

Date	Wind variation between Maximum & Minimum wind injection in a day	No. of blocks when deviation beyond ± 150 MW (out of 96 blocks)
01-04-2015	1579	60
11-04-2015	1661	66
23-06-2015	1749	59
16-04-2015	481	29
25-05-2015	646	44
18-06-2015	498	44

- Evident that deviation is comparatively lesser when wind variation band is limited (maximum and minimum in a day).
- Data recorded proves direct relation of wind variation with OD / UD deviation.

RE – Grid integration issues : Impact

On conventional generation- Backing down of cheaper generation

[1] inefficient / Uneconomical operation – Technical minimum operation

[2] Frequent back down / ramp up to honor “Must Run” status –
Higher Heat rates and emission from fossil fuel generators

[3 To restrict OD / UD within 150 MW , cheaper generation is backed down to
honor “Must Run” status,

RE – Grid integration issues : Impact

Data on typical peak wind scenario recently – July'15

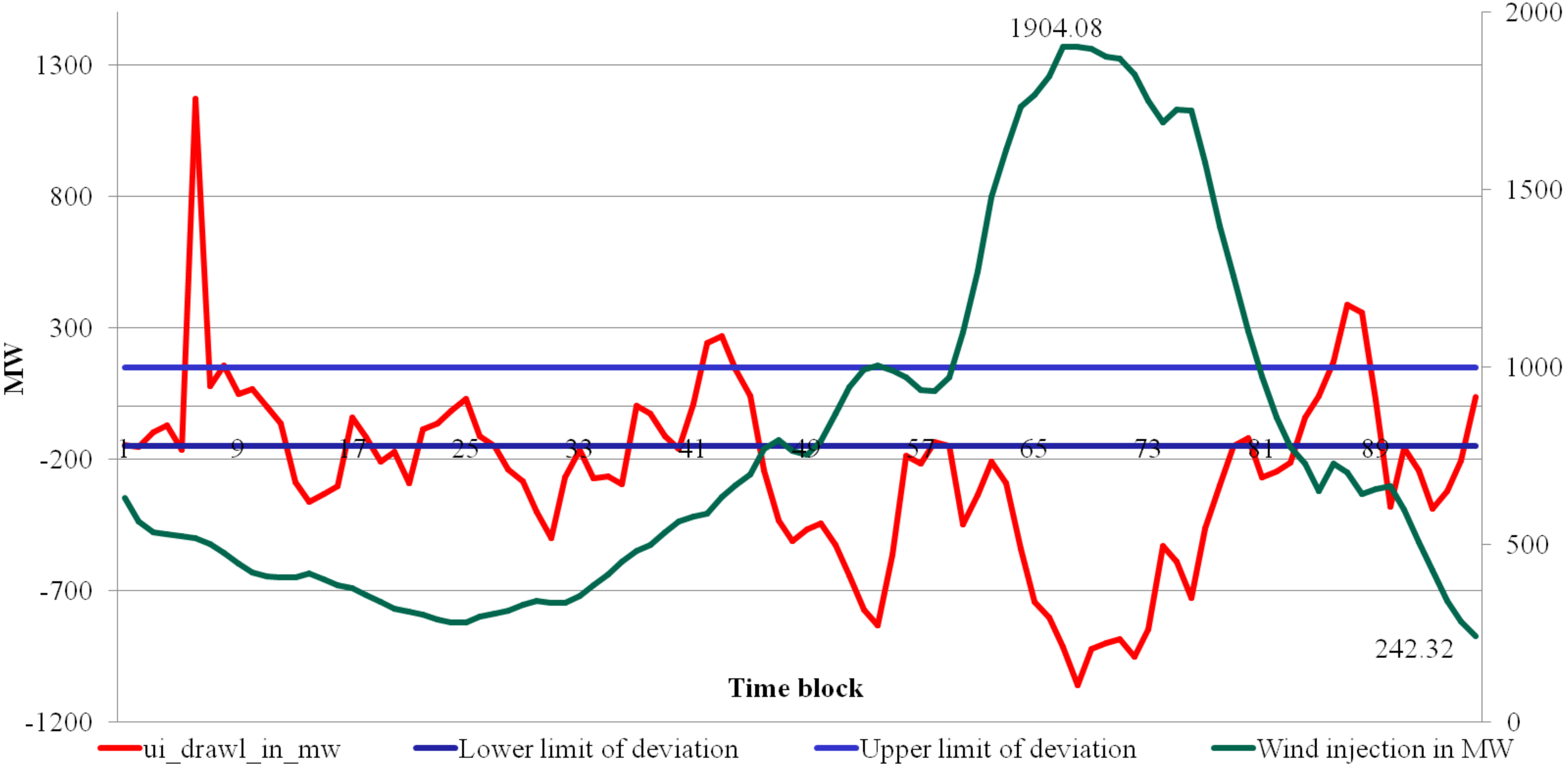
Date	Max. Wind Gen	Min. Wind Gen	Average Conventional Gen backed down	Lowest rate of baking down (Rs./ Unit)	Nos. of block DSM Violation (Out of 96 blocks)
01.07.15	2282	1553	963	1.55	24
02.07.15	2107	823	1573	1.55	50
03.07.15	2435	1513	844	1.55	40
04.07.15	2643	1850	1102	1.38	46
05.07.15	2726	2162	1276	1.38	38

RE – Grid integration issues : Impact

On Grid discipline compliances

Over drawl / Under drawl within 150 MW is inevitable under "Must Run" status

Deviation on 11.04.15 at State periphery (Difference between maximum and minimum wind injection was 1661 MW and for 66 Nos. of block when deviation beyond ± 150 MW).

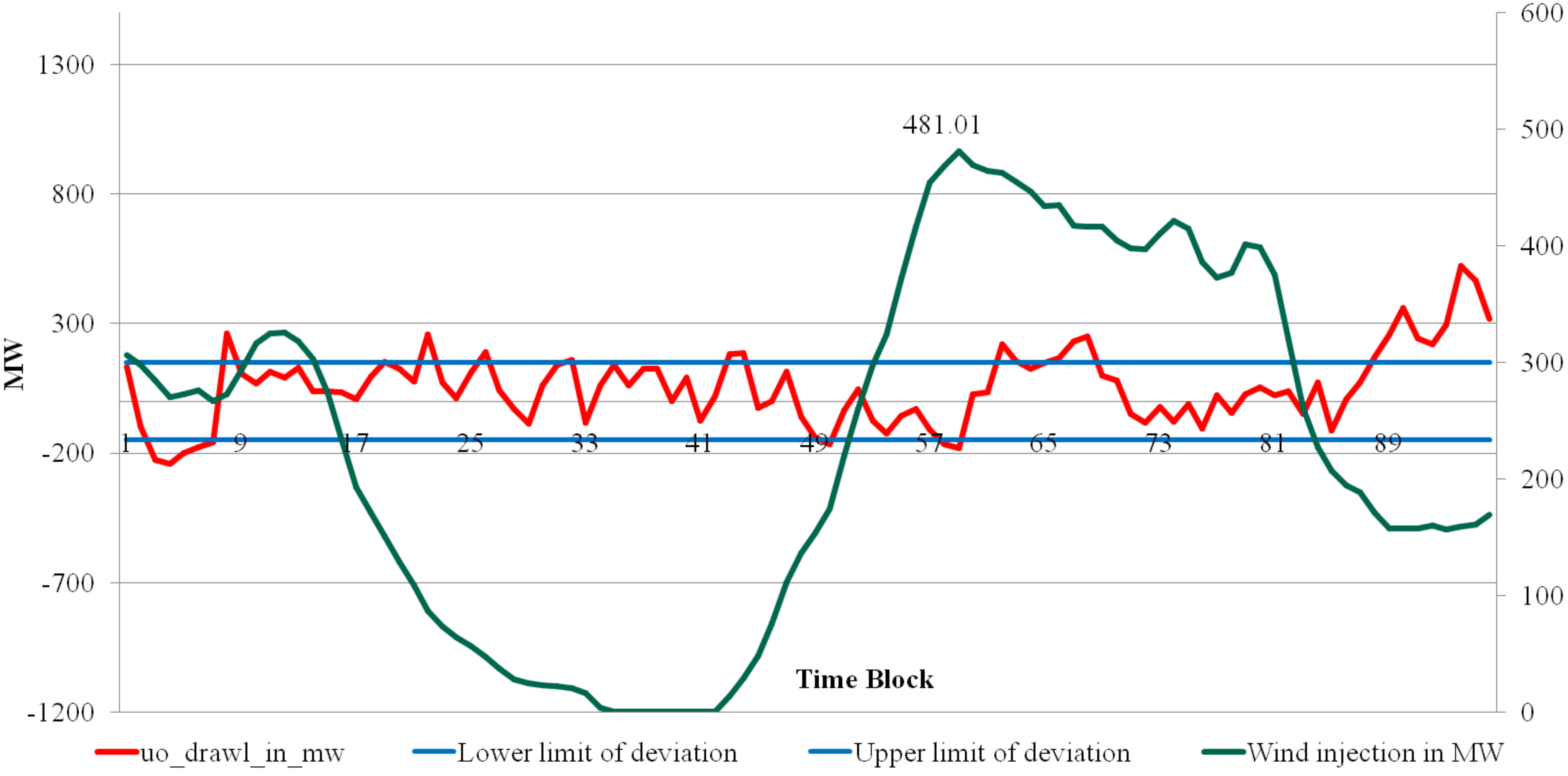


RE – Grid integration issues : Impact

On Grid discipline compliances

Over drawl / Under drawl within 150 MW is inevitable under "Must Run" status

Deviation on 16.04.15 at State periphery (Difference between maximum and minimum wind injection was 481 MW and for 29 Nos. of block when deviation beyond ± 150 MW).



Presentation Outline

Way forward and solutions

Way forward and solutions

[1] Renewable Energy Management Center (REMC) – Forecasting of RE

Following functionalities are required under REMC

- Forecasting of RE generation (day ahead and intra-day, ramp prediction etc)
- Online geospatial monitoring of RE Generation – at the transmission grid boundaries & at RE pooling Stations (through direct Data Acquisition OR through interface with RE Developer monitoring Systems)
- Responsible for quality and reliability of RE data
- Propagate RE related data to its partner SLDC, Forecasting, scheduling and balancing systems.
- Coordinating with SLDC for dispatching and balancing RE power
- Central Repository for RE generation data for MIS and commercial settlement purposes
- Coordination agency on behalf of SLDC for interacting with RE Developers
- Training and Skill building for RE integration into the grid.

Way forward and solutions

[2] RRF mechanism

- To address RE variability and its impact forecasting mechanism along with Renewable Regulatory Fund (RRF) mechanism will have to be instated, which has been suspended for commercial purpose.

[3] Balancing mechanism

- Today costly gas based generation is being used to handle RE variations
- No ancillary service mechanism
- Pump storage system needs to be developed
- Pooling all RE resources as Nations Assets to achieve balancing through pooled Pump Storage
- Participation of ISGS generation
- Increase of cheaper gas allocation to RE rich state
- Increase the balancing area. i.e. regional balancing area
- Encourage Micro grid / Distribution generation / roof-top solar projects.
- To plan for Distribution System Operators (DSO)

Way forward and solutions

[4] Spinning Reserve

- It is essential to safe guard the life of plants and also address commercial loss.
- Identify quick ramp up plants like Hydro power plant with reservoir, pumped storage hydro plants and gas based power plants.
- Suitable regulatory mechanism / market design shall have to be developed to handle reserves for power balancing and flexibility to system operator.
- Storage system may be developed in country by pooling RE sources as national asset.

[5] Market mechanism

- Efficient market mechanism to export the power for regional balancing.
- RPO fulfillment even through REC shall be insisted

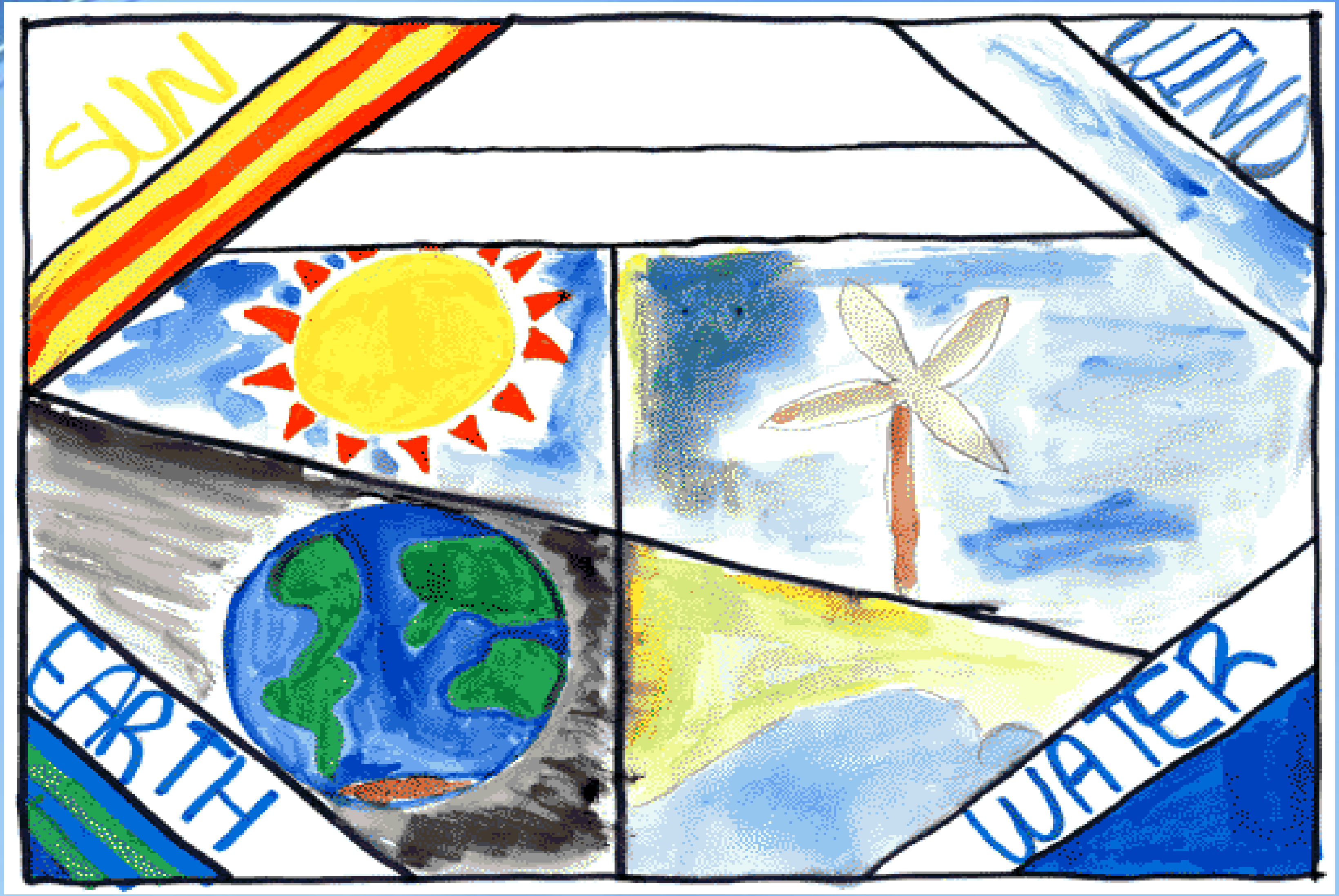
Way forward and solutions

[6] Grid Code

- The IEGC / State Grid Code covers very less about RE grid integration.
- Role and responsibility of all the stakeholders towards technology, compliance, certification and balancing mechanism etc. related to RE shall be specified in Grid Code.
- Brief technical standards / rules for RE connectivity with grid are issued by CEA in October-2013.

[7] Certification, testing labs and independent third party inspection

- Skill development, testing laboratories and field test apparatus to be available with the State Nodal Agency



Thank you !!!

Forum of Regulators Meeting

27th July, 2015, Ahmedabad, Gujarat

Grid Integration of Renewables

Power System Operation Corporation

Paradigm shift in operations

- Classical despatch
  - Forecast your load; generation fleet has to follow load
- Renewable Generation: the first game changer
  - Forecast load as well as RE; Load-RE or Net Load more important
  - Conventional generation has to follow net load
- Storage/Distributed Generation/Electric Vehicles
  - Is load forecastable?? Is generation despatchable?
  - From consumers to prosumers
- A flexible power system
  - but one that does not break.

Ecosystem for RE Integration…

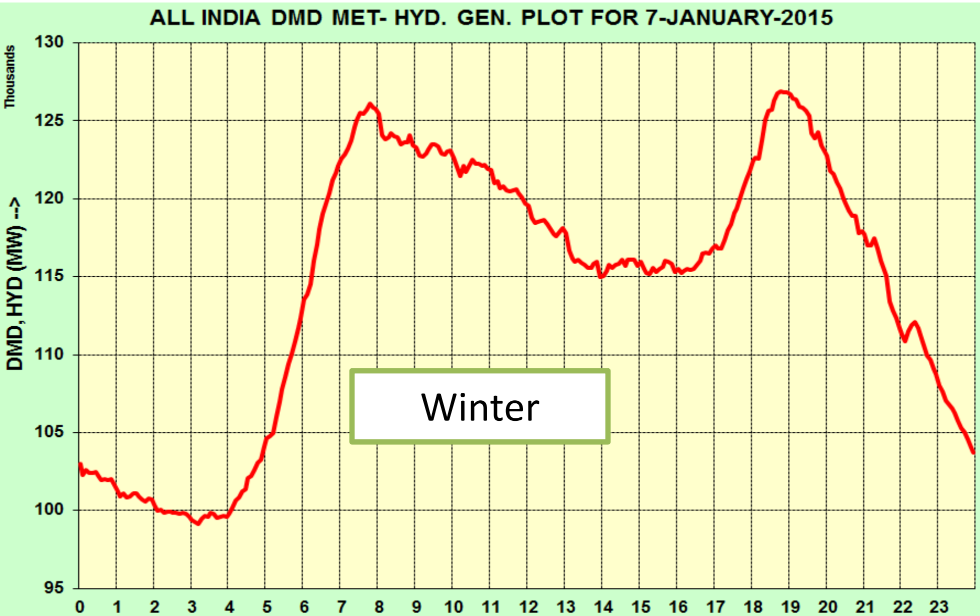
Existing Ecosystem

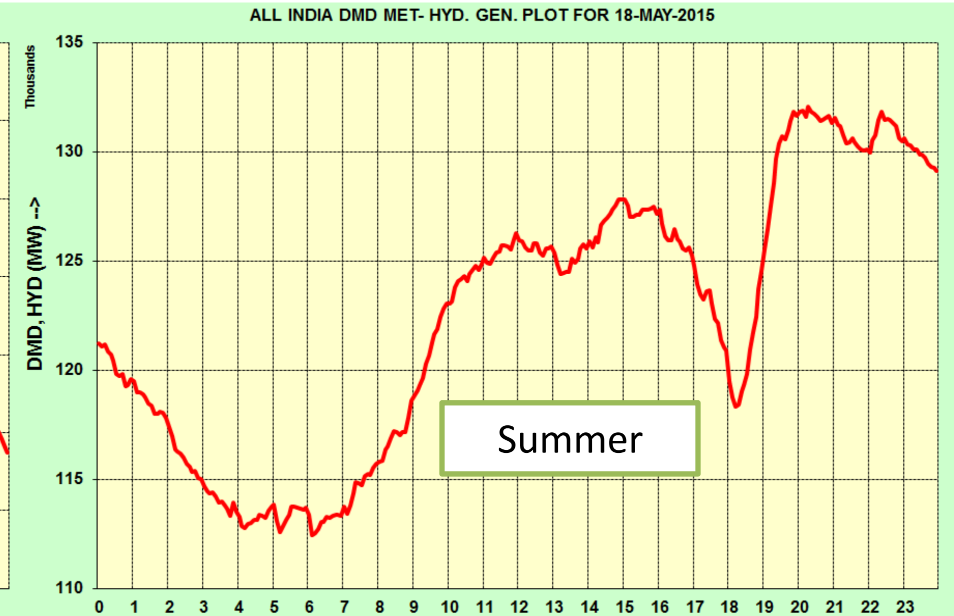
- Separate Carriage & Content in Transmission at inter-state level
- Multi-Part Tariff
- Non-Discriminatory Open Access
- Freedom & Choice
- Multi Buyer – Multi Seller
- Robust Imbalance Handling Framework at Inter-state level
- Dispute Free Settlement Systems
- Zonal Transmission Charges & Losses

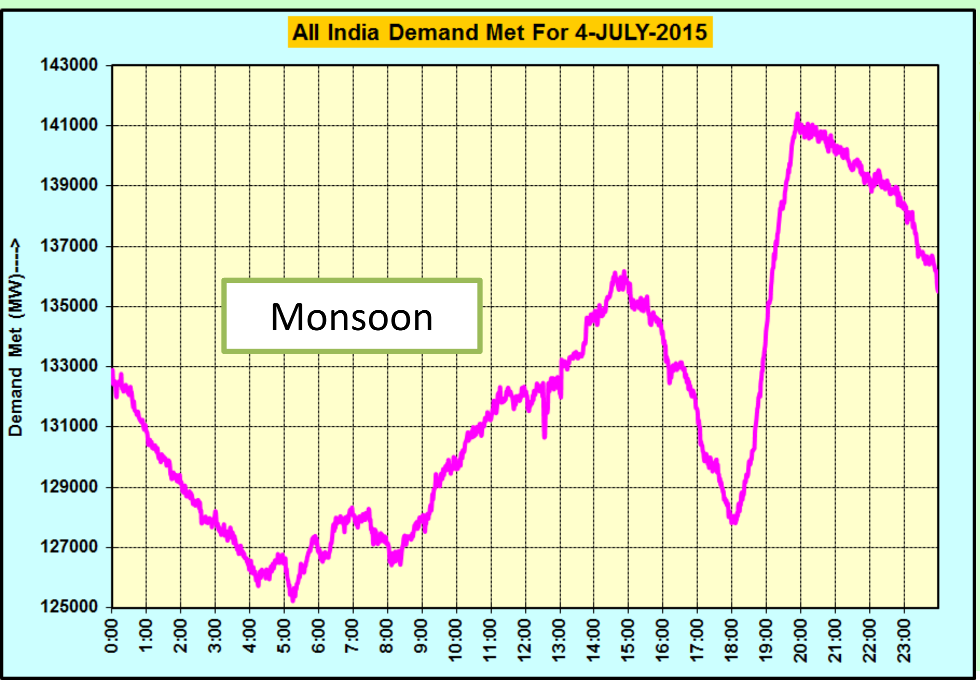
Further Ecosystem Requirements

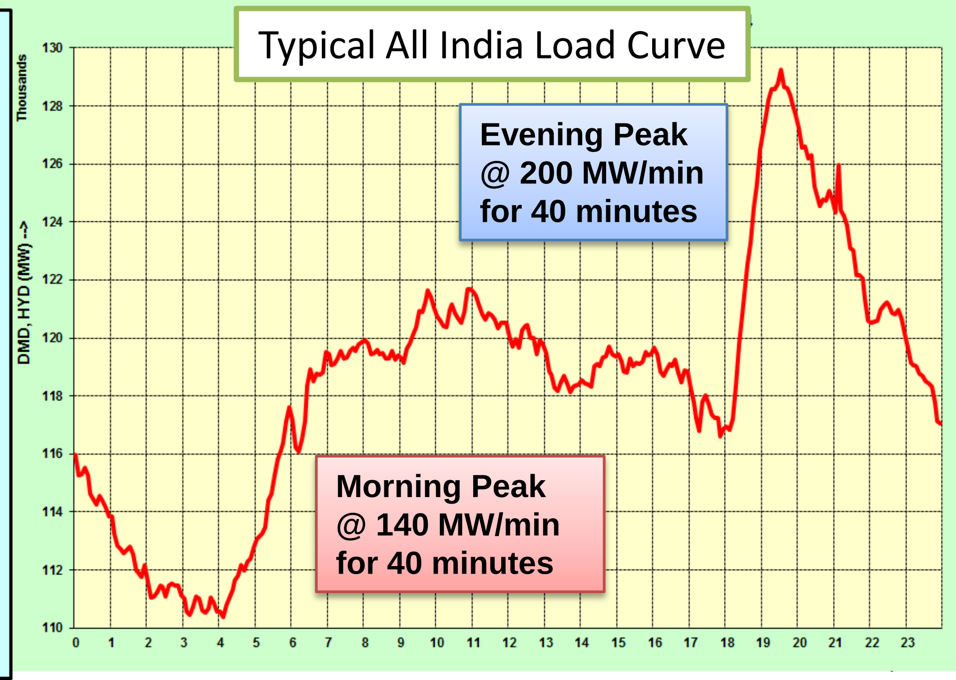
- Frequency Control (Primary, Secondary, Tertiary)
- Load Forecasting
- RE Generation Forecasting
- Balancing Resources
- Generation Reserves
- Flexible Generation
- Ancillary Services Market
- Real Time Markets
- Imbalance Handling Framework at Intra-state level in all states

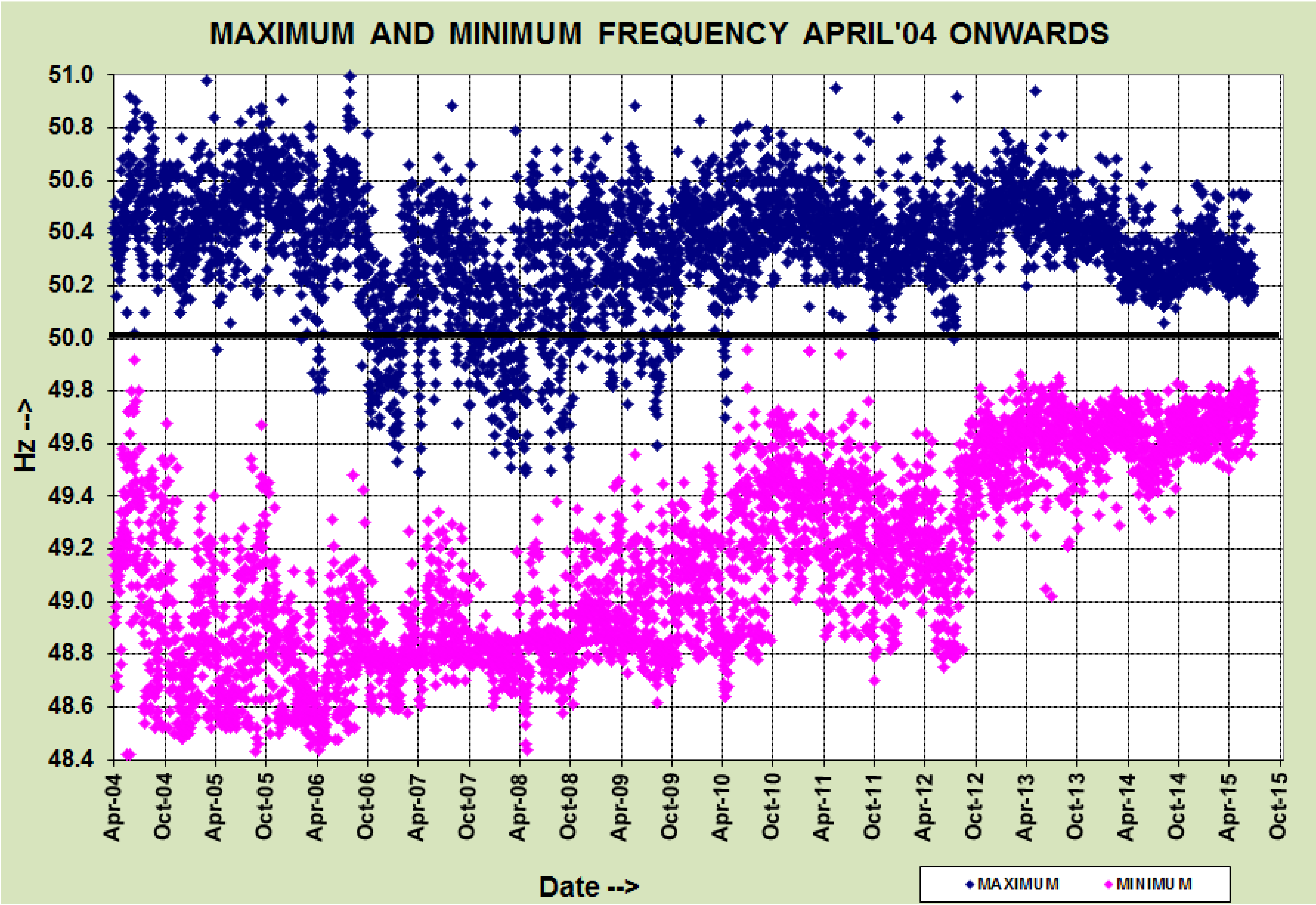
Typical Load Curves – Ramping Requirement

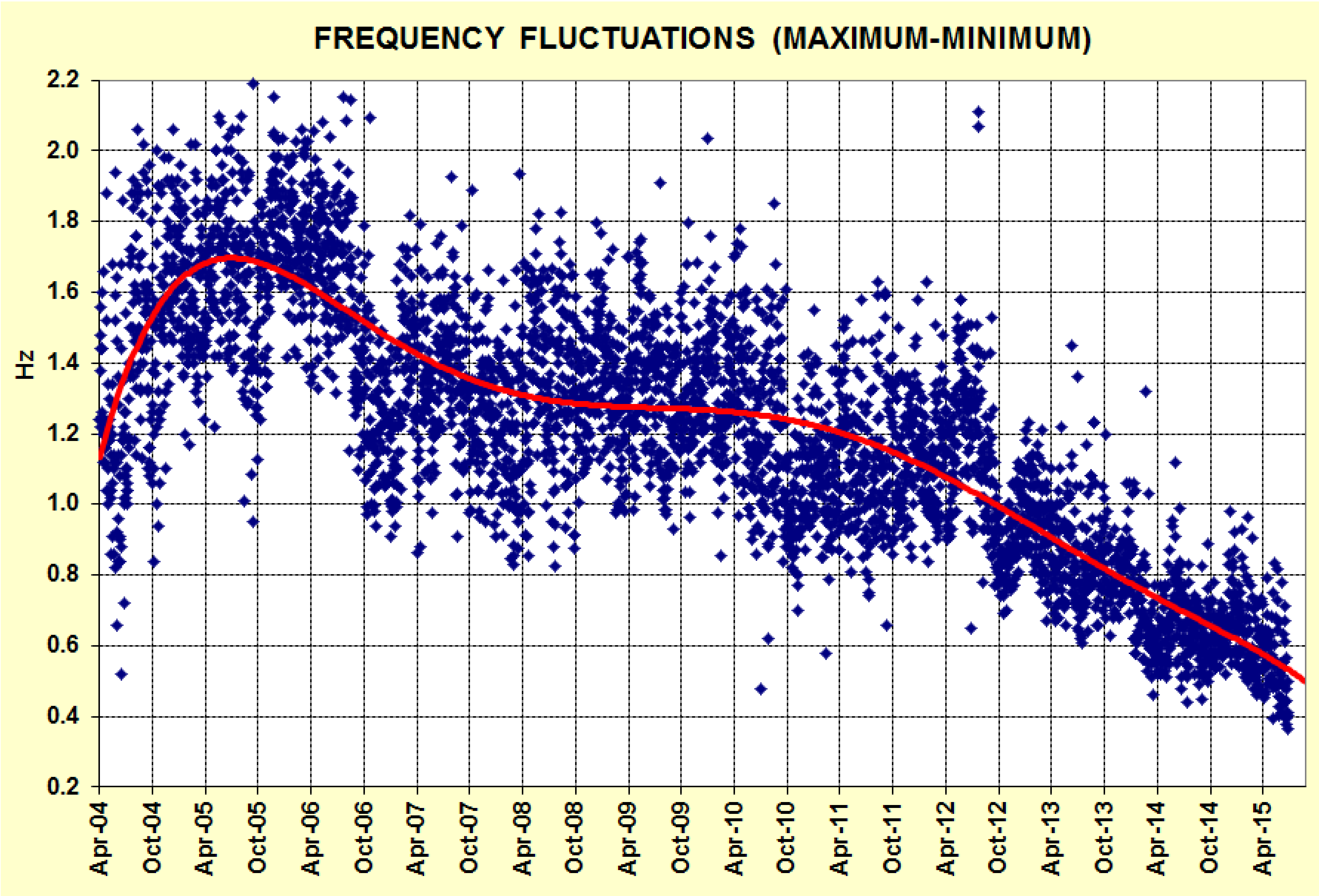


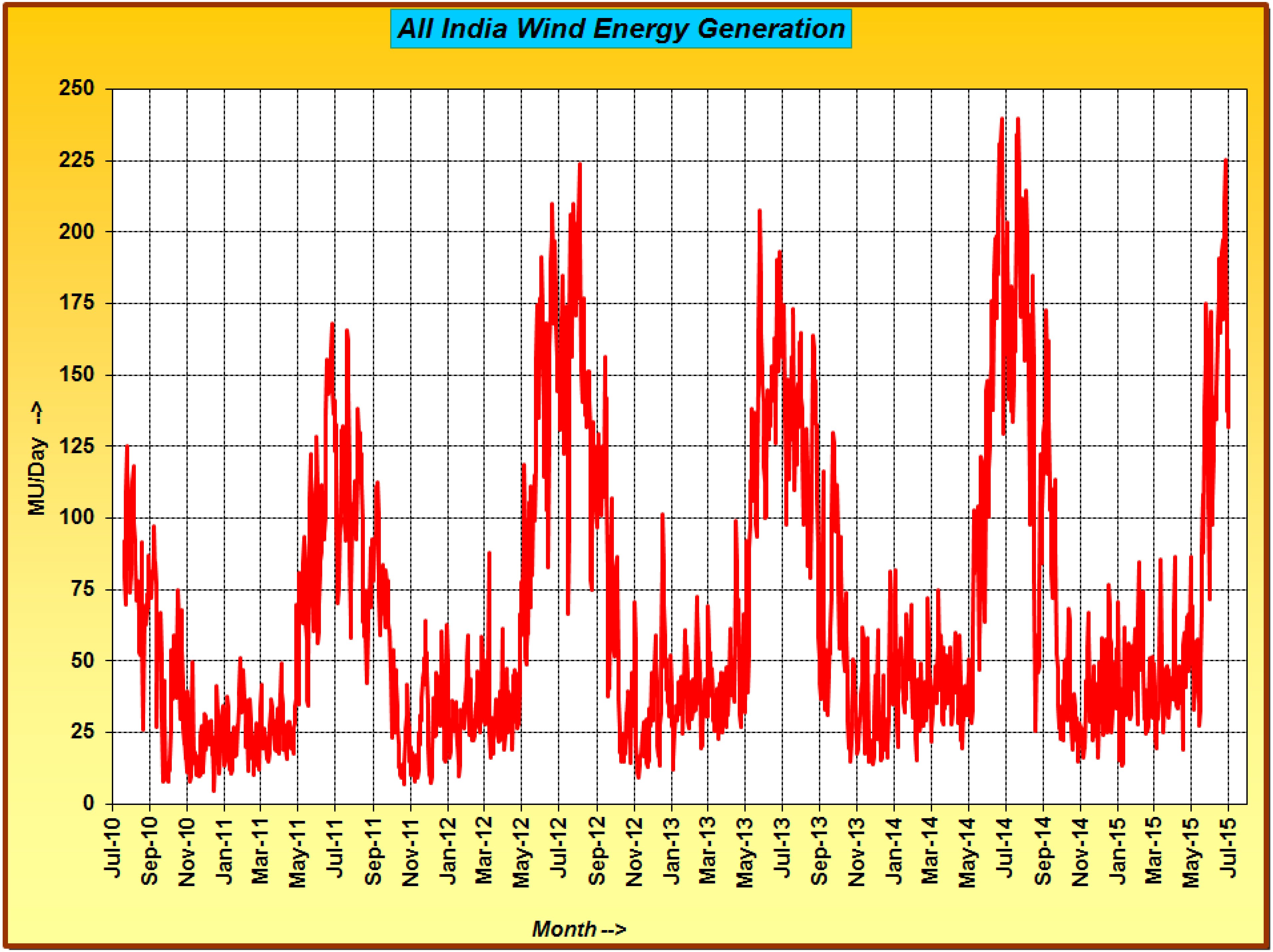




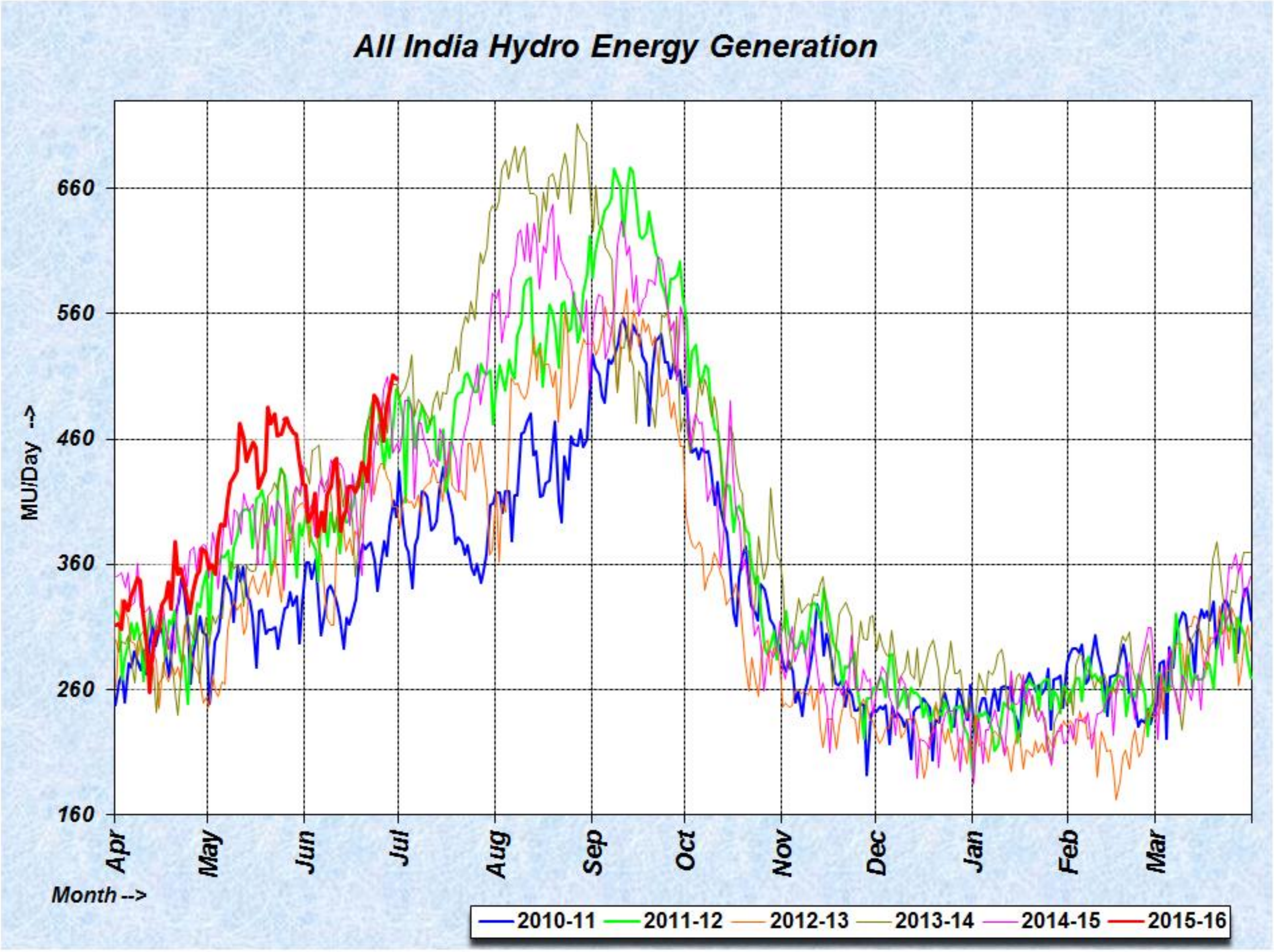


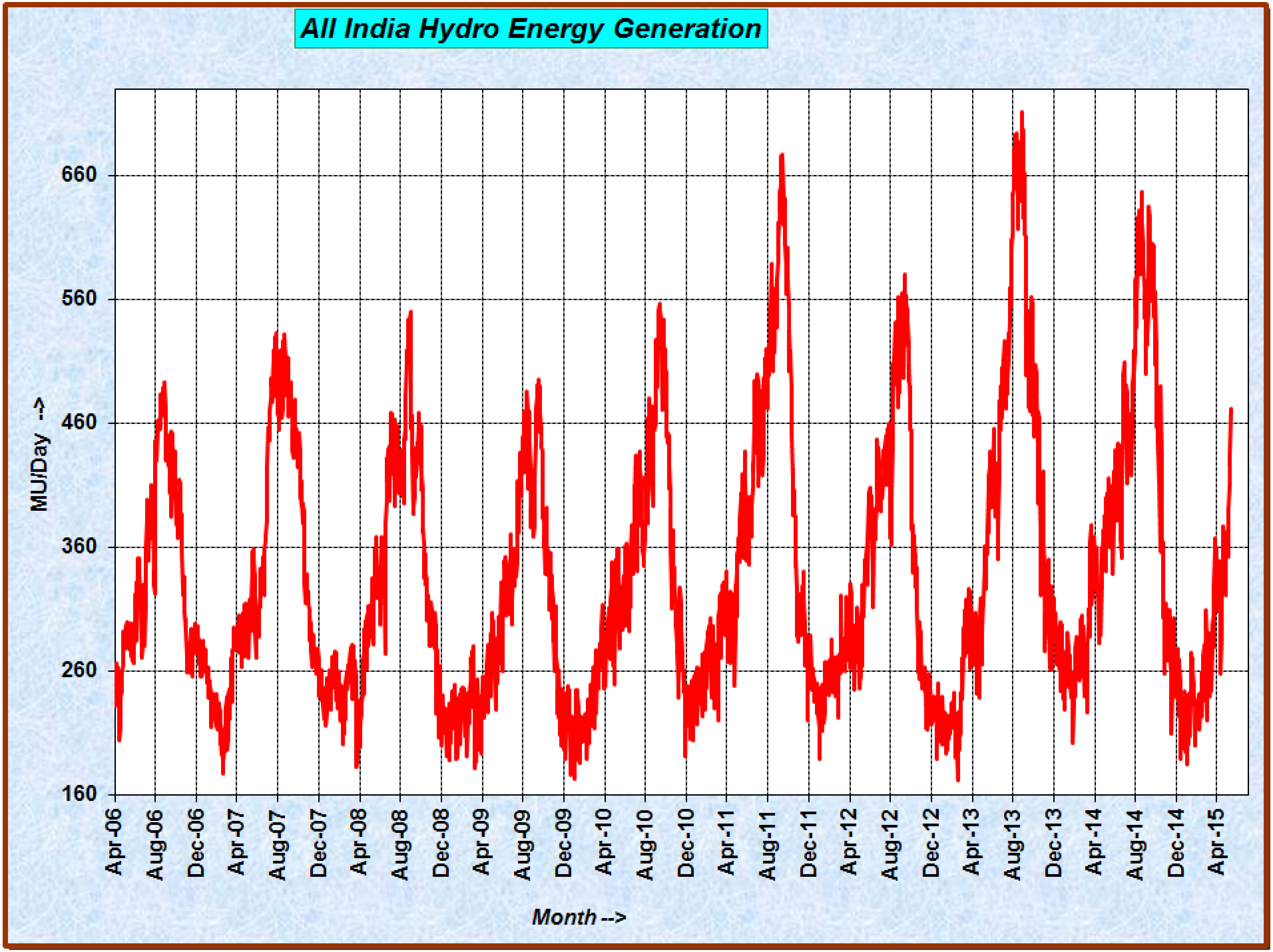

MAXIMUM AND MINIMUM FREQUENCY APRIL'04 ONWARDS
51.0
50.8
50.6
50.4
50.2
50.0
49.8
49.6
49.4
49.2
49.0
48.8
48.6
48.4
Hz -->
Apr-04
Oct-04
Apr-05
Oct-05
Apr-06
Oct-06
Apr-07
Oct-07
Apr-08
Oct-08
Apr-09
Oct-09
Apr-10
Oct-10
Apr-11
Oct-11
Apr-12
Oct-12
Apr-13
Oct-13
Apr-14
Oct-14
Apr-15
Oct-15
Date -->
MAXIMUM
MINIMUM


FREQUENCY FLUCTUATIONS (MAXIMUM-MINIMUM)
Hz
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
Apr-04
Oct-04
Apr-05
Oct-05
Apr-06
Oct-06
Apr-07
Oct-07
Apr-08
Oct-08
Apr-09
Oct-09
Apr-10
Oct-10
Apr-11
Oct-11
Apr-12
Oct-12
Apr-13
Oct-13
Apr-14
Oct-14
Apr-15



All India Wind Energy Generation
MU/Day -->
250
225
200
175
150
125
100
75
50
25
0
Jul-10
Sep-10
Nov-10
Jan-11
Mar-11
May-11
Jul-11
Sep-11
Nov-11
Jan-12
Mar-12
May-12
Jul-12
Sep-12
Nov-12
Jan-13
Mar-13
May-13
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Month -->


All India Hydro Energy Generation
MU/Day -->
660
560
460
360
260
160
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Month -->
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16

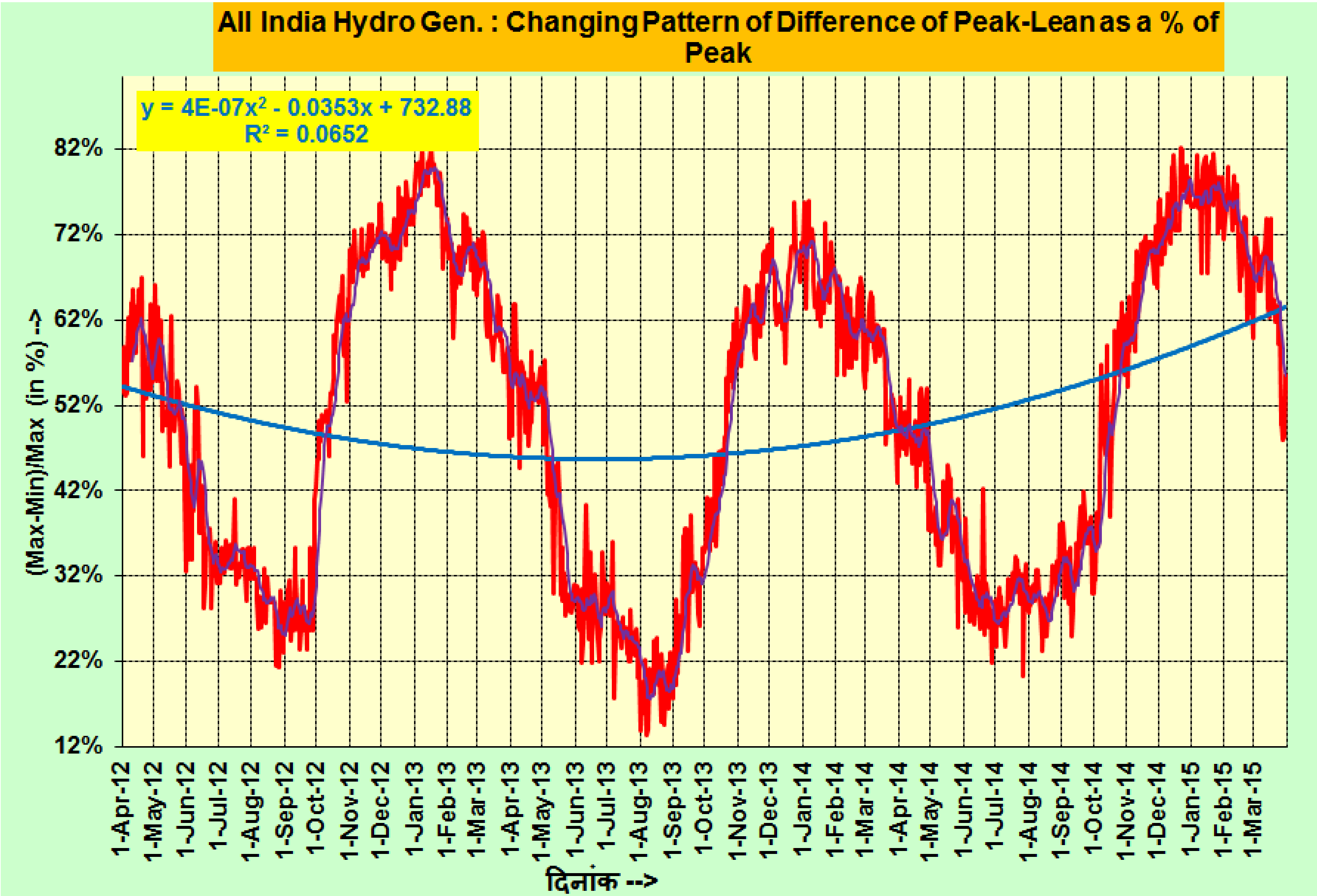


All India Hydro Energy Generation
MU/Day -->
660
560
460
360
260
160
Apr-06
Aug-06
Dec-06
Apr-07
Aug-07
Dec-07
Apr-08
Aug-08
Dec-08
Apr-09
Aug-09
Dec-09
Apr-10
Aug-10
Dec-10
Apr-11
Aug-11
Dec-11
Apr-12
Aug-12
Dec-12
Apr-13
Aug-13
Dec-13
Apr-14
Aug-14
Dec-14
Apr-15
Month -->

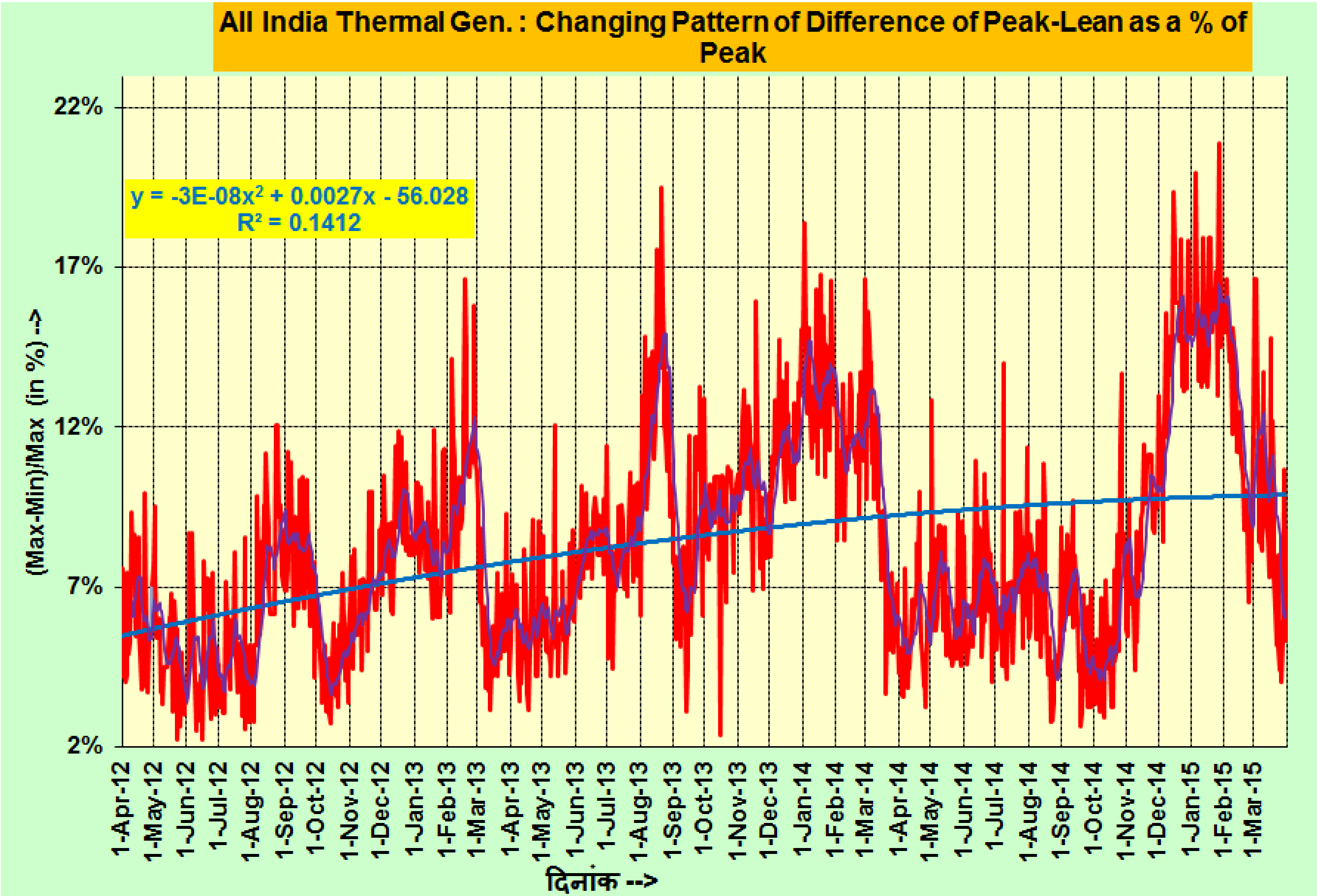
Need for Flexibility

- **CERC IEGC (4th Amendment) (Draft)**
- **Proposed Technical Minimum - 55%**
- **Proposed station heat rate degradation to be considered for the purpose of compensation:**

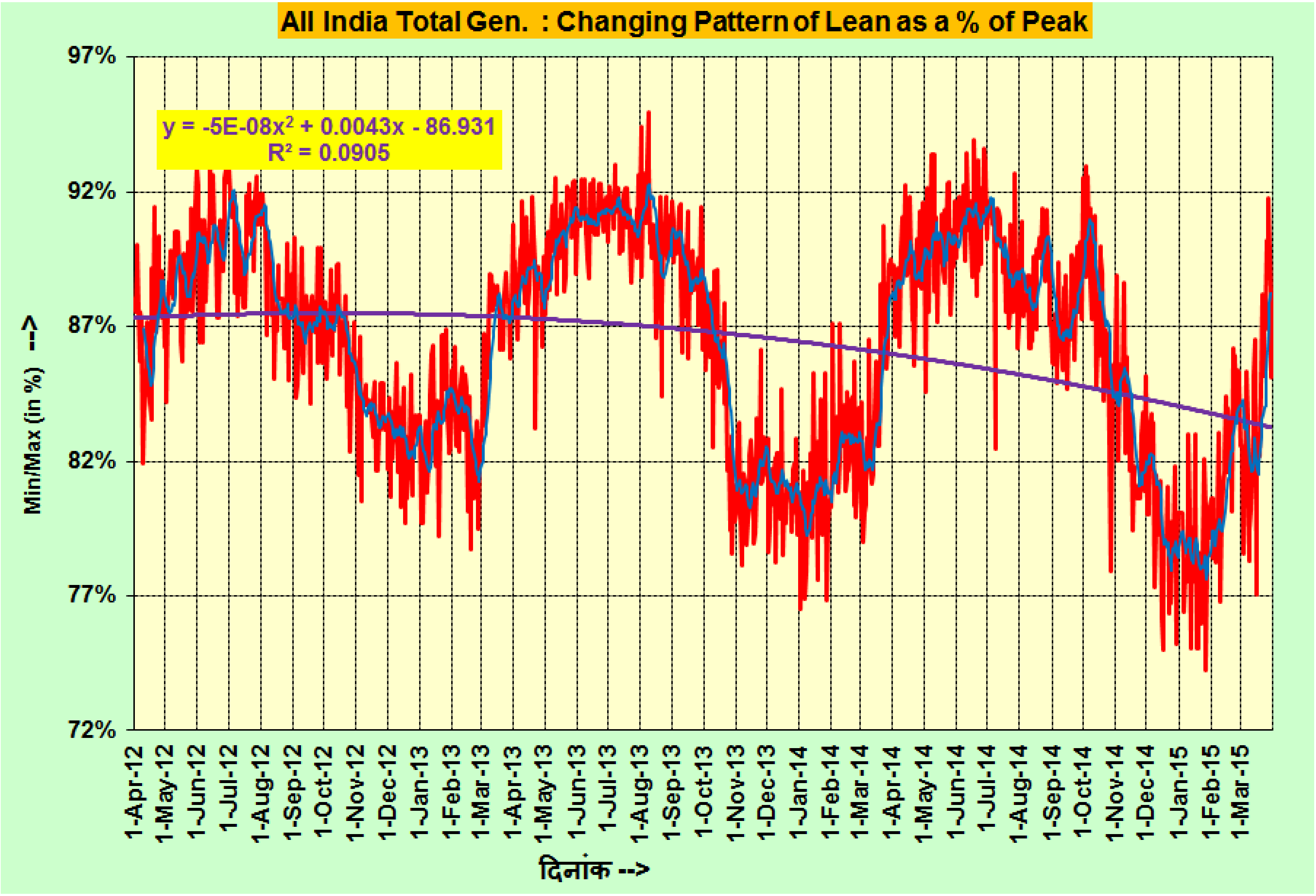
S.No.	Unit loading as a % of Installed Capacity of the Unit	Increase in SHR (for supercritical units) (%)	Increase in SHR (for sub-critical units) (%)
1	85-100	Nil	Nil
2	75-84.99	1.25	2.25
3	65-74.99	2	4
4	55-64.99	3	6



All India Hydro Gen. : Changing Pattern of Difference of Peak-Lean as a % of Peak
y = 4E-07x² - 0.0353x + 732.88
R² = 0.0652
82%
72%
62%
52%
42%
32%
22%
12%
(Max-Min)/Max (in %) -->
1-Apr-12
1-May-12
1-Jun-12
1-Jul-12
1-Aug-12
1-Sep-12
1-Oct-12
1-Nov-12
1-Dec-12
1-Jan-13
1-Feb-13
1-Mar-13
1-Apr-13
1-May-13
1-Jun-13
1-Jul-13
1-Aug-13
1-Sep-13
1-Oct-13
1-Nov-13
1-Dec-13
1-Jan-14
1-Feb-14
1-Mar-14
1-Apr-14
1-May-14
1-Jun-14
1-Jul-14
1-Aug-14
1-Sep-14
1-Oct-14
1-Nov-14
1-Dec-14
1-Jan-15
1-Feb-15
1-Mar-15
दिनांक -->

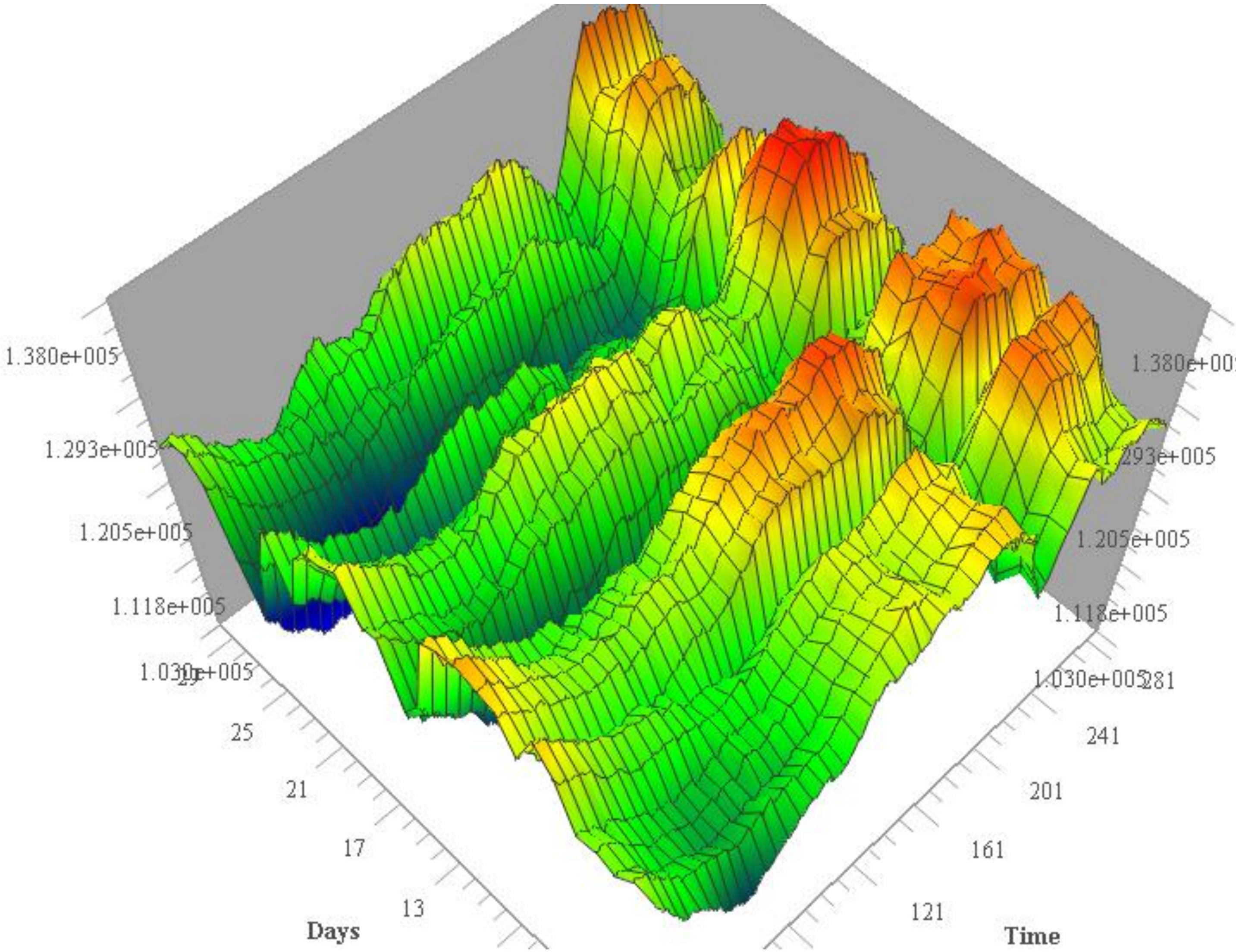


All India Thermal Gen. : Changing Pattern of Difference of Peak-Lean as a % of Peak
y = -3E-08x2 + 0.0027x - 56.028
R2 = 0.1412
22%
17%
12%
7%
2%
(Max-Min)/Max (in %) -->
1-Apr-12
1-May-12
1-Jun-12
1-Jul-12
1-Aug-12
1-Sep-12
1-Oct-12
1-Nov-12
1-Dec-12
1-Jan-13
1-Feb-13
1-Mar-13
1-Apr-13
1-May-13
1-Jun-13
1-Jul-13
1-Aug-13
1-Sep-13
1-Oct-13
1-Nov-13
1-Dec-13
1-Jan-14
1-Feb-14
1-Mar-14
1-Apr-14
1-May-14
1-Jun-14
1-Jul-14
1-Aug-14
1-Sep-14
1-Oct-14
1-Nov-14
1-Dec-14
1-Jan-15
1-Feb-15
1-Mar-15
दिनांक -->

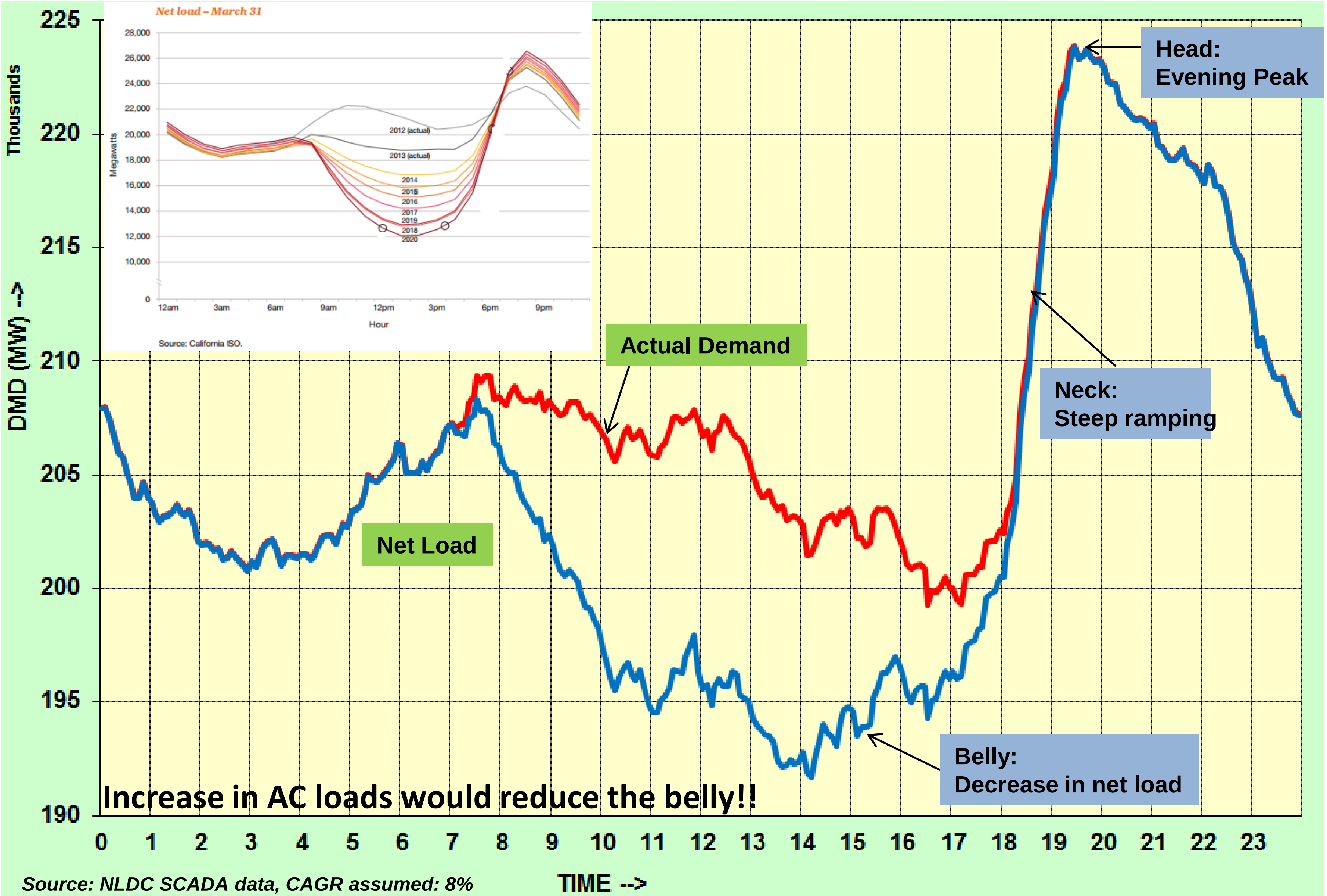


All India Total Gen. : Changing Pattern of Lean as a % of Peak
y = -5E-08x² + 0.0043x - 86.931
R² = 0.0905
97%
92%
87%
82%
77%
72%
Min/Max (in %) -->
1-Apr-12
1-May-12
1-Jun-12
1-Jul-12
1-Aug-12
1-Sep-12
1-Oct-12
1-Nov-12
1-Dec-12
1-Jan-13
1-Feb-13
1-Mar-13
1-Apr-13
1-May-13
1-Jun-13
1-Jul-13
1-Aug-13
1-Sep-13
1-Oct-13
1-Nov-13
1-Dec-13
1-Jan-14
1-Feb-14
1-Mar-14
1-Apr-14
1-May-14
1-Jun-14
1-Jul-14
1-Aug-14
1-Sep-14
1-Oct-14
1-Nov-14
1-Dec-14
1-Jan-15
1-Feb-15
1-Mar-15
दिनांक -->

All India Demand (June 2015)

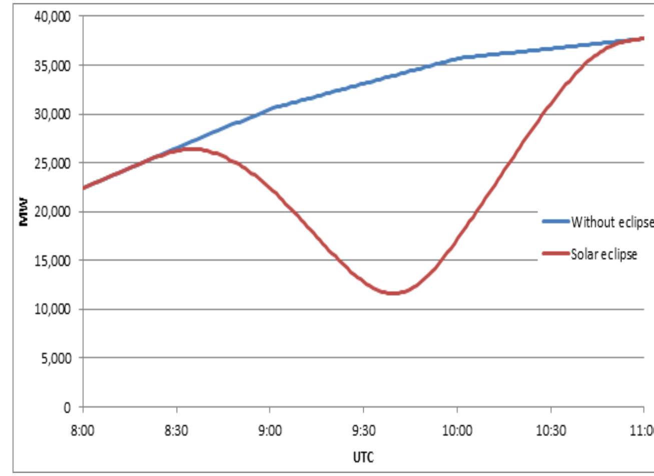


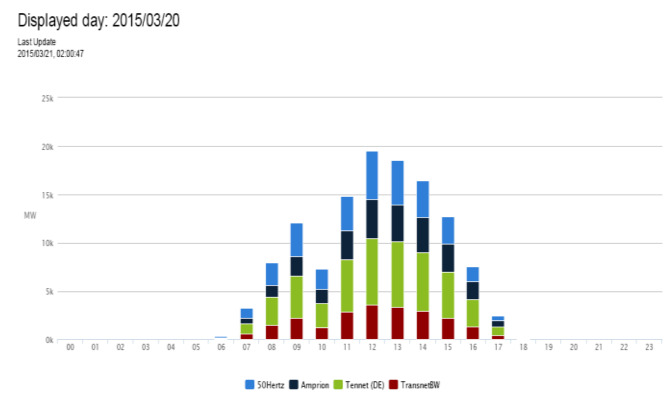
Expected All India Duck Curve
(Sample: 20000 MW of Solar Generation)



Solar eclipse 20th March 2015 affecting Europe

- Time: 8 a.m. to 11 a.m.(GMT) on Friday, 20th March, 2015
- 80 percent of the sun's light blocked between 10:45 – 11:15
- German solar output right before the eclipse totaled 21.7 GW, then dropped to a low point of 6.2 GW
- 15 GW – ramping down followed by ramp-up in one hour. Triple the usual rate.
- Italy lost 8 GW of solar production
- In Britain, solar output reduced by 850 megawatts.
- Frequency maintained in the band 50 ± 25 mHz.





India to prepare for 26th Dec 2019 and 21st June 2020 solar eclipse!!

Courtesy: ENTSOE

CERC DSM Regulations 2014

- **Limits as per DSM Regulations**
  - 12% or 150 MW whichever is lower
- **Concerns of smaller states addressed**
  - CERC order (Petition No. RP/06/2014 dtd. 20th Jan. 2015)
  - Relaxation to all the sellers/buyers whose schedule is less than 400 MW
  - Deviation limit of 48 MW across the board
- **Large states/renewable rich states continue to raise concerns about 150 MW limit**

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)

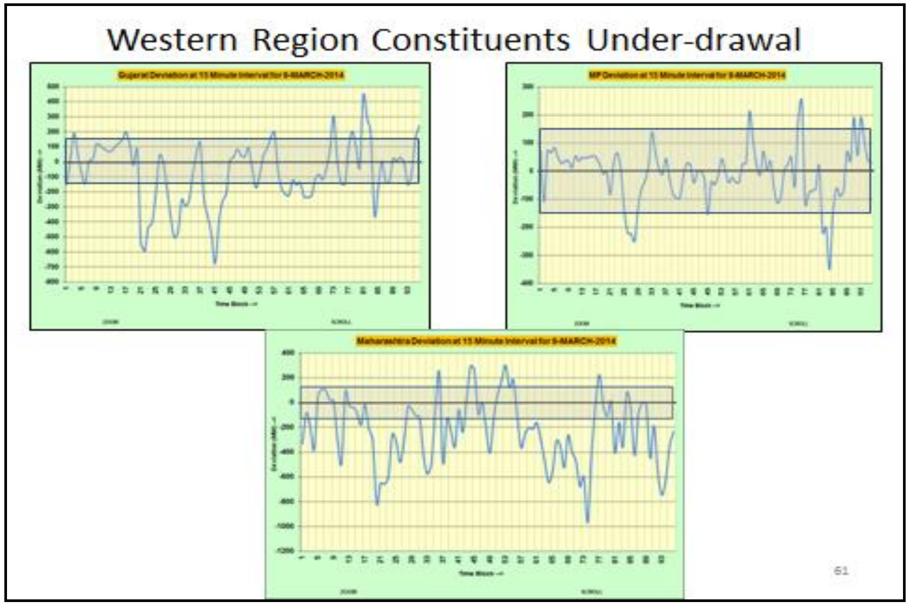
Analysis for Gujarat for 2013-14

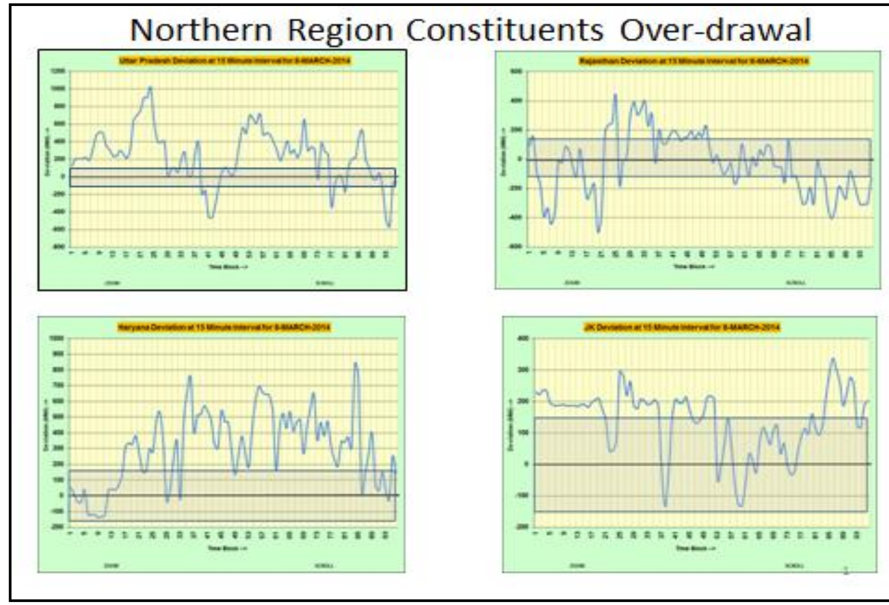
Month	Co-relation coefficient between		
	Deviation change with demand change	Deviation change with conventional generation change	Deviation change with wind generation change
April 2013	**0.68**	-0.16	-0.06
May 2013	**0.69**	-0.19	-0.04
June 2013	**0.53**	-0.15	-0.11
July 2013	0.42	-0.13	-0.09
Aug 2013	0.46	-0.13	-0.05
Sep 2013	**0.53**	-0.20	-0.03
Oct 2013	**0.52**	-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
Average	**0.51**	**-0.18**	**-0.05**

Analysis for Tamilnadu for 2013-14

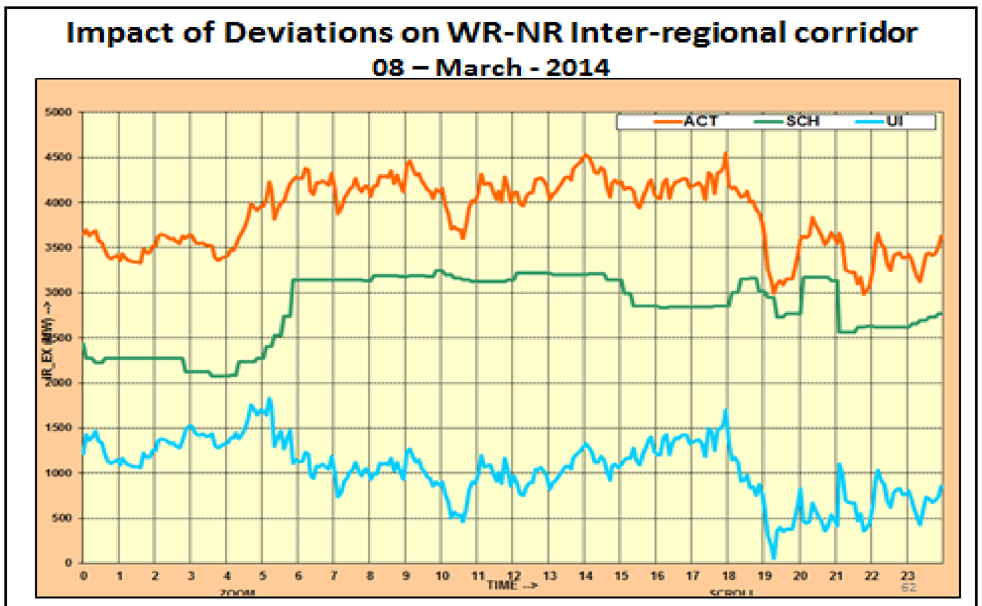
Month	Co-relation coefficient between		
	Deviation change with demand change	Deviation change with conventional generation change	Deviation change with wind generation change
April 2013	0.67	-0.15	0.01
May 2013	0.58	-0.17	-0.07
June 2013	0.52	-0.06	-0.10
July 2013	0.52	-0.12	-0.15
Aug 2013	0.33	-0.15	-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
Average	**0.56**	**-0.17**	**-0.06**

Extreme Scenario – All erring in one direction





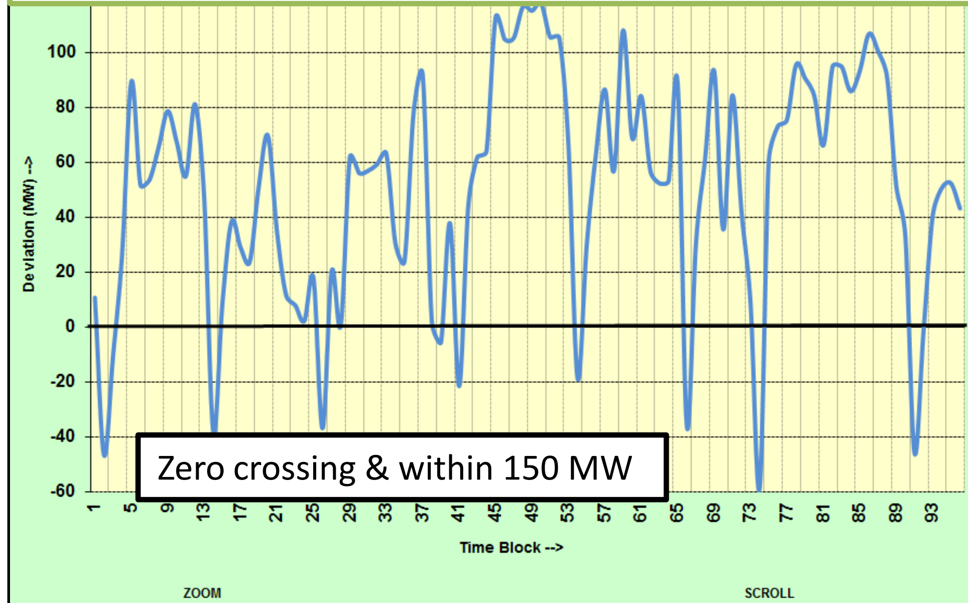
Skewed scenario stressed the IR tie lines flows leading to critical levels.



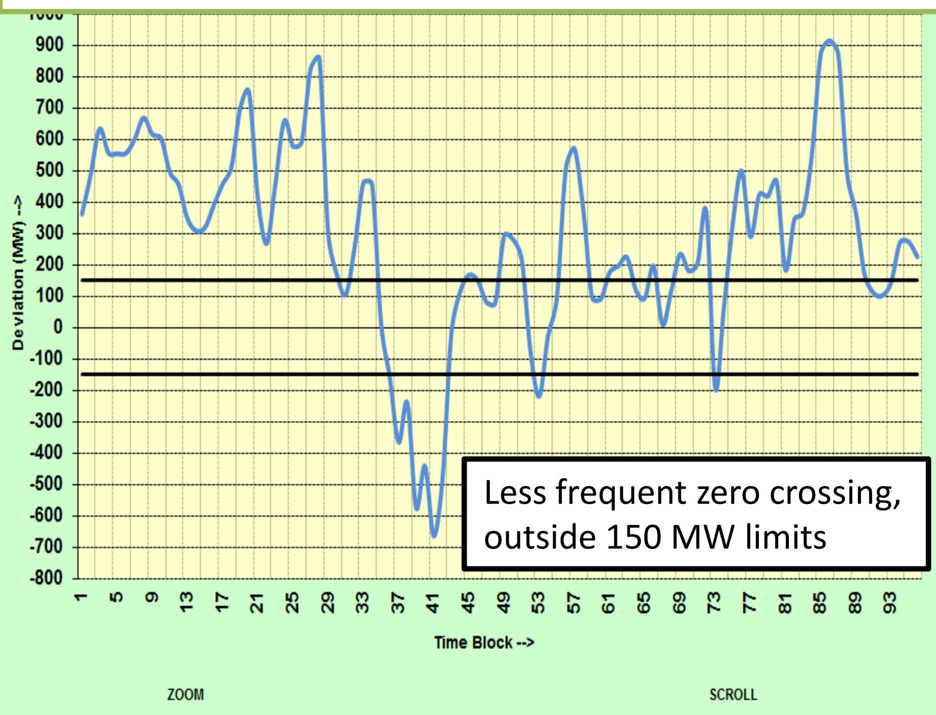
If utilities resort to persistent over-drawal / under-drawal, there is a threat of grid disturbance.

Zero Crossing in 3 Hours
(12 time blocks)
is essential

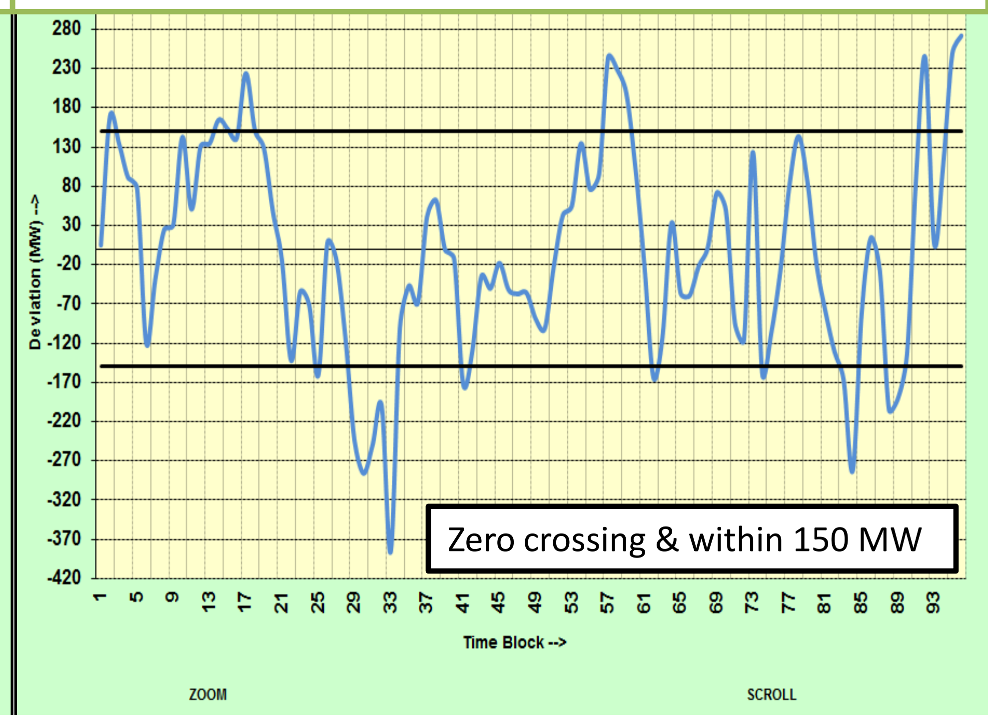
Kerala - Typical Day



Uttar Pradesh – Typical Day



Gujarat – Typical Day



Load Crash in WR on 28th Feb- 1st Mar 2015

- Rains in the Western region
- Load crash of 6000-13000 MW
- High frequency and high voltage
- Several lines were opened
- Several tripped on overvoltage
- Action Taken - Reduction in ISGS and State generation
- At 03:35 Hrs of 1st March 2015, the remaining 400 kV interconnection circuits tripped resulting in islanding of 400/220 kV New Koyna, Karad, Kolhapur, Jaigad and Mapusa and 220 kV stations in the area from the grid which collapsed immediately.
- Load loss - 950 MW (Southern Maharashtra and Goa)
- Generation loss of 415 MW (Jaigad and Koyna)
- Frequency rise by 0.0775 Hz.

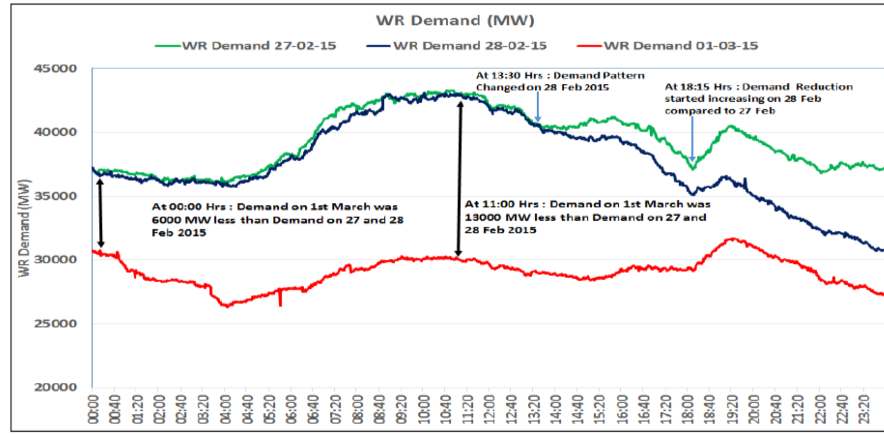


Figure 2: Western Region Demand on 27th & 28th February and 1st March 2015.

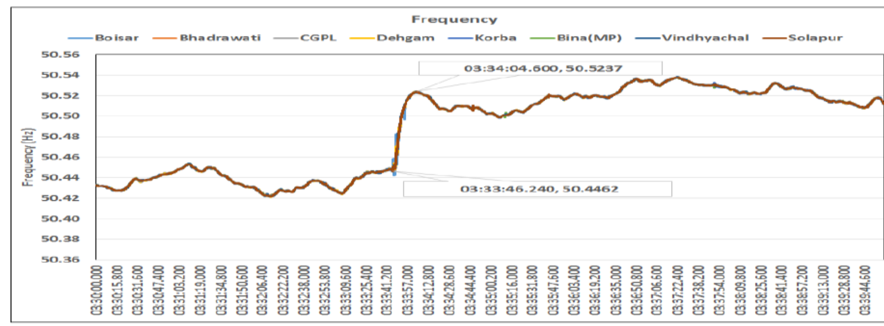


Figure 13: Frequency during tripping at 03:35 Hrs

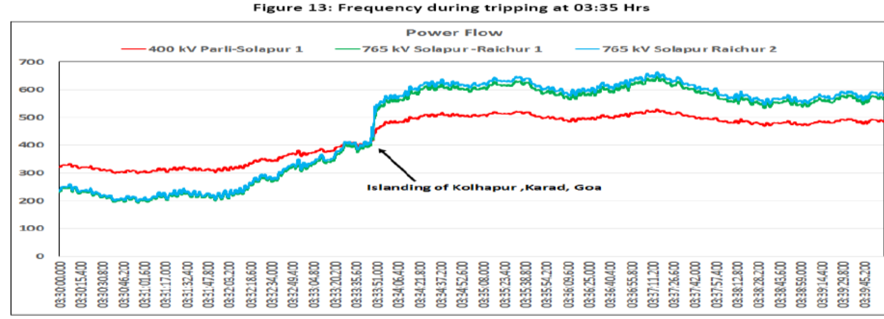
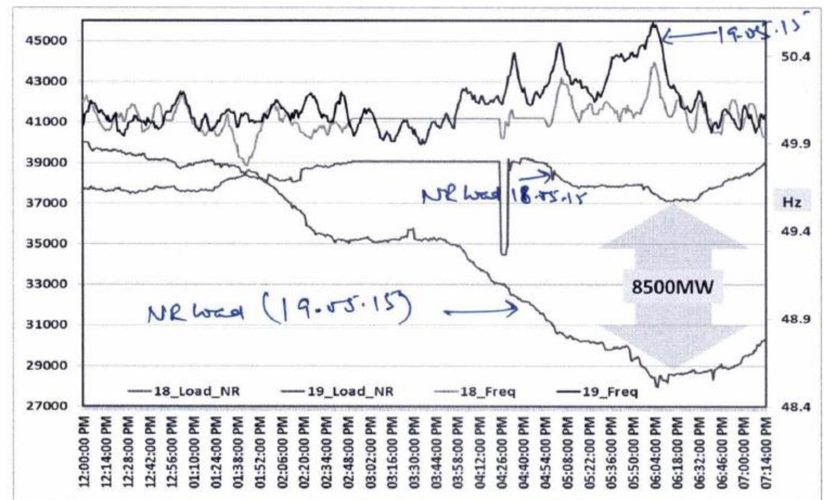


Figure 14: 765 kV Solapur-Raichur D/C and 400 kV Parli-Solapur 1 during the tripping at 03:35 Hrs

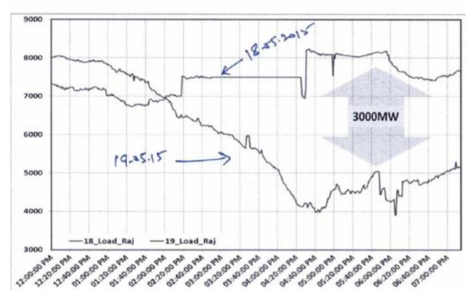
Load Crash in Northern Grid during from 13.30hrs to 20:00hrs of 19th May, 2015

- On 19th May'2015 NR experienced heavy demand crash due to thunder storm (8500 MW).
- NR demand started decreasing from the afternoon (13:30hrs). Regional demand touched a minimum of 27966 MW at around 18.06 Hrs.
- High frequency and widespread high voltages throughout the system.
- System frequency touched a high of 50.59 Hz at 18:03 hrs.
- 12 no. of EHV (400kV & above) lines were opened to control high voltages and 23 no. of EHV (400kV & above) lines also tripped on fault/over voltage.

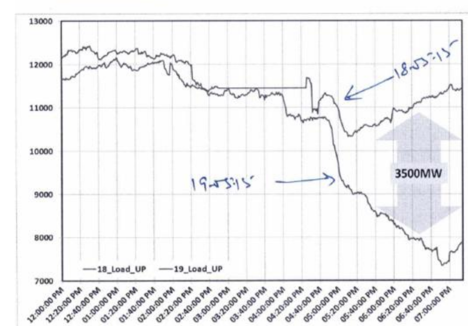
Load of NR for 18th & 19th May'15



Load of Rajasthan for 18th & 19th May'15

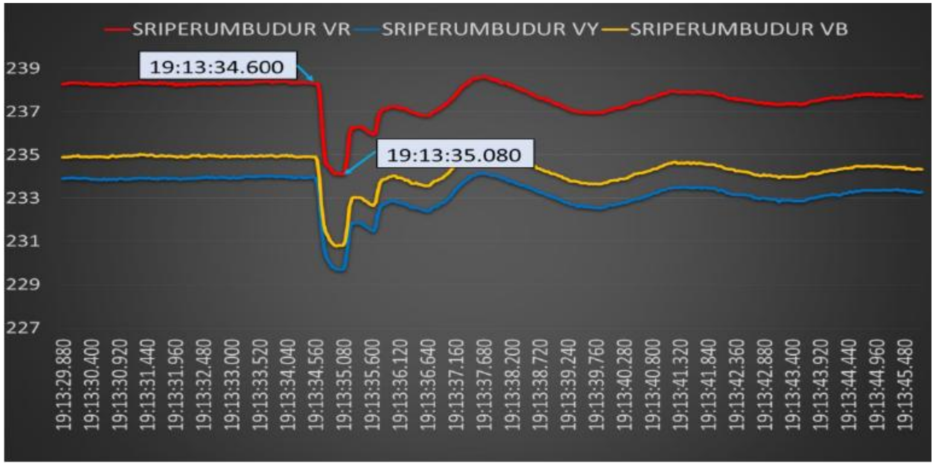


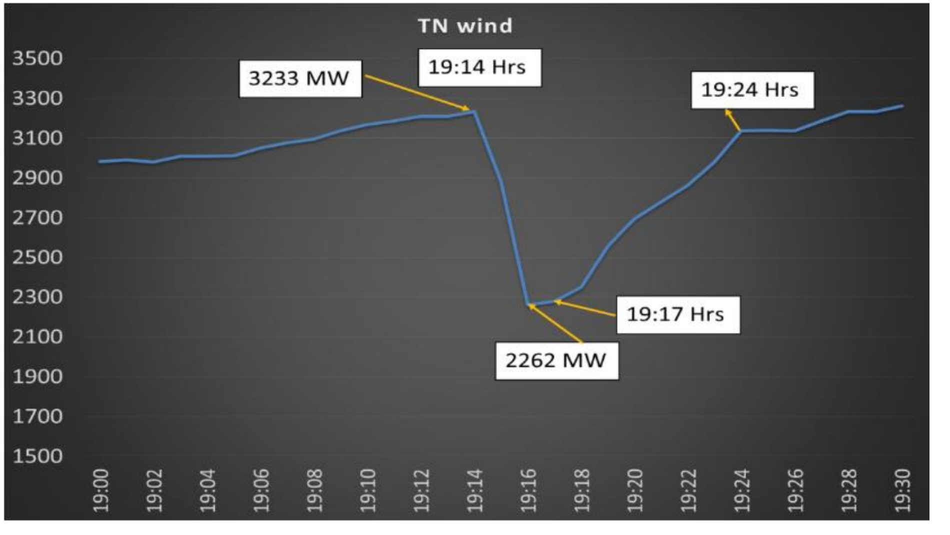
Load of UP for 18th & 19th May'15



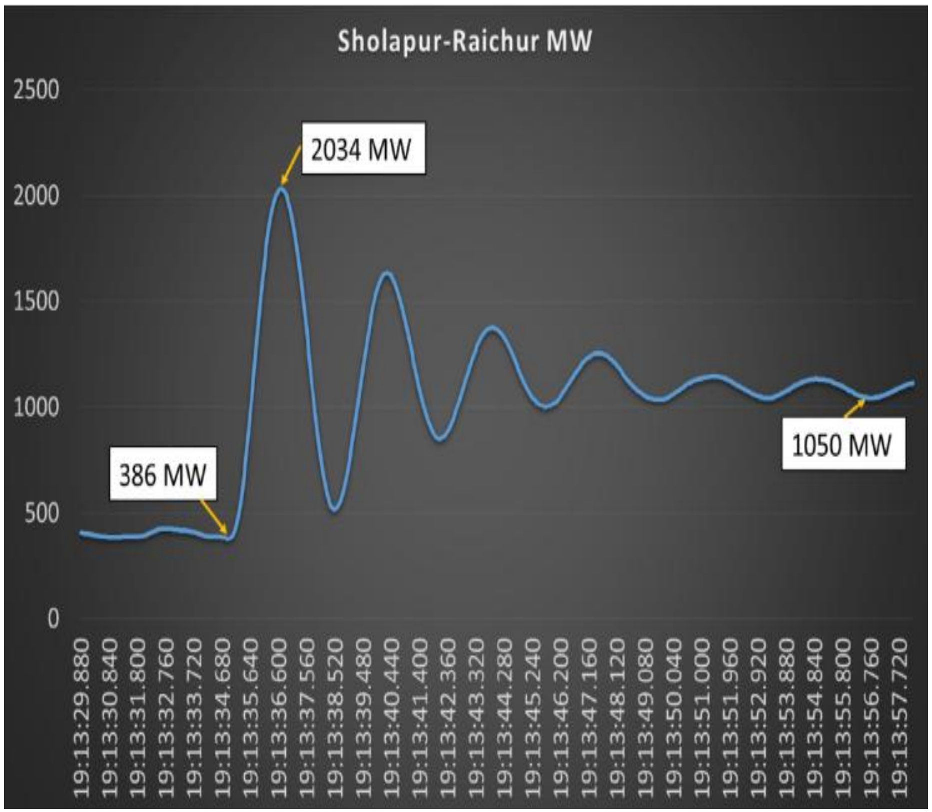
Wind power loss at Udumalpet area in Tamil Nadu at 19:13 hrs on 26th June 2015

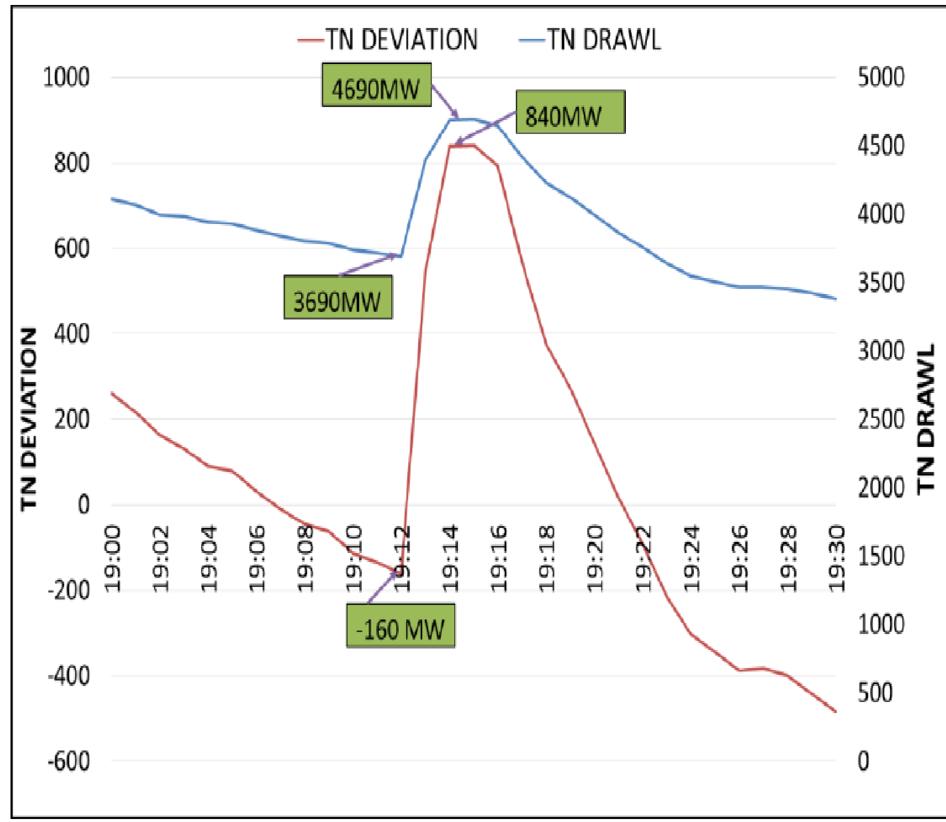
- Bus fault led to complete outage of 110kV Udumalpet station.
- Delayed clearance of fault in 480ms
- 970 MW of wind power loss in TN
- Increase of power flow on 765kV Solapur-Raichur lines-1&2
- From antecedent flow of 386MW to 1050 MW (cumulative flow).
- SPS-1 of Solapur-Raichur operated as power flow went upto 2034 MW during the first swing.





Wind power loss at Udumalpet area in Tamil Nadu at 19:13 hrs on 26th June 2015





Why Limits on Deviation

- Large deviations cause severe transmission constraints
- Endangers Grid Security
  - To control large deviations during contingency is difficult
- Manual action takes time to control drawal from grid and puts the grid to risk in case of contingencies.
- Volume limits incentivize stakeholders for implementing better controls
  - Load forecasting in all time horizons,
  - Frequency control through primary control (FGMO), Secondary control (AGC) and Tertiary controls.
  - Reserves

Effect of Deviation on Reliability Margin

- Reliability margins essential for secure operation
  - Transmission outages
  - Unit trippings
  - Deviations

- Skewed scenarios
  - All constituents erring on the same side
  - Example: Say 6 out of 9 Constituents of NR overdrawing by 150 MW each, hence total deviation 900 MW

- TRM also a deciding factor for open access

Responsibility & Resource Sharing

- Centralized Level
  - Secondary Control
  - Ancillary Services
  - Forecasting for Grid Security

- De-Centralized Level
  - Demand and RE Generation Forecasting
  - Scheduling of All Kinds of Generators
  - Assessment & Procurement of Balancing Resources

Aggregators

- **RE Ownership fragmented, many small investors.**
- **Scope for New Actors / Players**
  - Registered Generation Aggregator (RGA)
  - Qualified Scheduling Entity (QSE)
  - Solar Park developer
- **CERC recognized the need of nodal entity at connection point**
  - Responsible for coordinating with SLDC/RLDC on behalf of all the developers/generators.
- **Need for a separate Institutional Entity**
  - Recognized under regulatory framework
  - Qualified/certified/registered with System Operator
  - Undertake scheduling/commercial settlement/de-pooling/ communication/data management and co-ordination etc.
  - Suitable definition may be incorporated in the appropriate regulations including Grid Code.

Other Critical Requirements

- **Data Telemetry**
  - Need for providing data telemetry to the RLDCs by all RE generators
  - Communication infrastructure issues

- **Specification of Technical Characteristics of Solar generators**
  - Need for sharing information with the RLDCs
  - Essential input for facilitating forecasting by the Solar generators as well as the RLDCs

Adherence to Standards (1)

- **CEA Technical Standards for Connection of the Distributed Generation Resources**
  - *"…(e) "distributed generation resource" means a generating station feeding electricity into the electricity system at voltage level of below 33 kV;…"*
  - *"(6) Distributed generation resource operating in parallel with electricity system shall be equipped with the following protective functions…..*

*(a) over and under voltage trip functions, if voltage reaches **above 110% or below 80% respectively with a clearing time upto two seconds**; however, appropriate licensee may prescribe a narrower range of voltage for the purpose.*

*(b) over and under frequency trip functions, if frequency reaches **50.5 Hz and below 47.5 Hz with a clearing time upto 2 seconds**; however, appropriate licensee may prescribe a narrower range of frequency for the purpose…."*

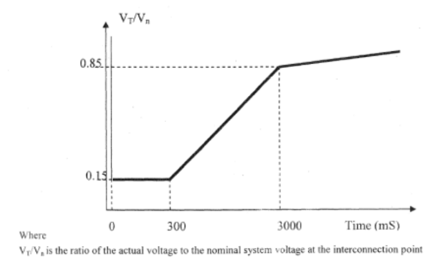
European Experience:

A large amount of PV installed capacity was initially tuned for automatic shedding at 50.2 Hz. A wide retrofitting campaign was performed since 2011 in order to avoid this technical specification, mainly on German and Italian areas. On German area 4 GW of PV installed capacity remains not retrofitted. For Italy the completion of retrofitting will be fulfilled in 2015

Source: Solar Eclipse March 2015: The successful stress test of Europe's power grid – more ahead ENTSO-E Policy Brief 15 July 2015

Adherence to Standards (2)

- **CEA (Technical Standards for Connectivity to the Grid) Amendment Regulations, 2013**
  - ***Power Factor Provisions*** - *B2(1) Power factor within the limits of 0.95 lagging to 0.95 leading."*
  - ***FRT / LVRT Provisions*** - *B2(3) Fault Ride Through provisions when voltage at the interconnection point on any or all phases dips up to the levels depicted*

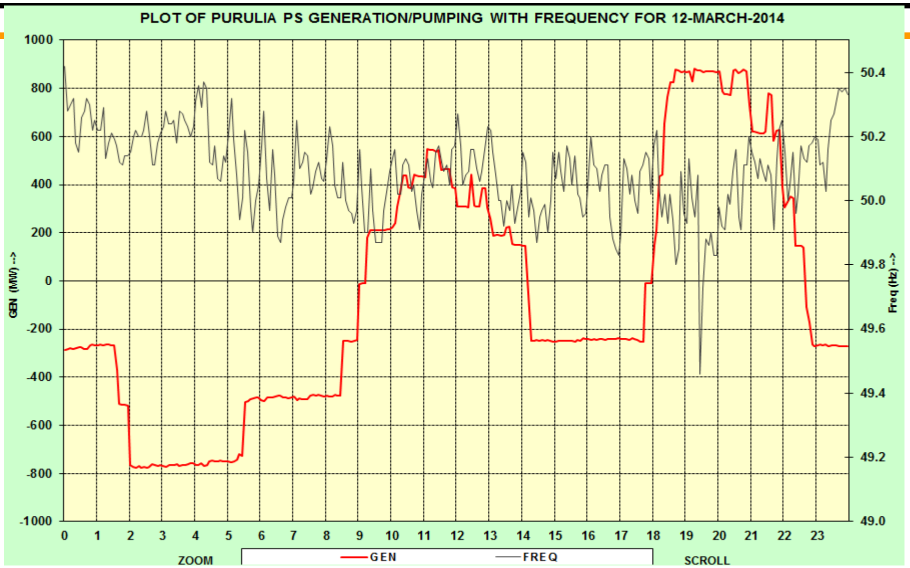


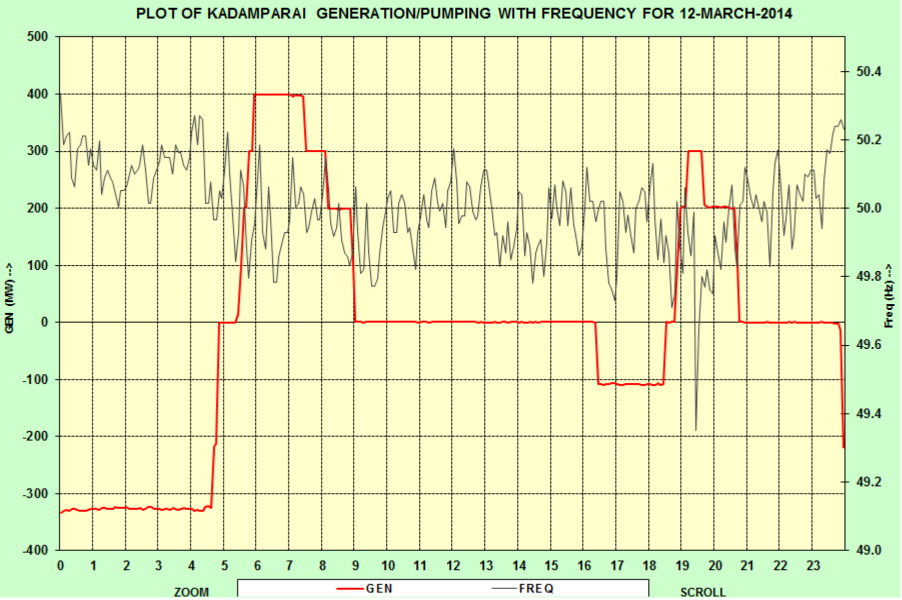
  - ***Active Power Injection Provisions*** - *B2(4) control active power injection in accordance with a set point, based on the directions of the appropriate Load Despatch Centre…"*

Amendments in Connectivity Standards are applicable only to the Wind generating stations and generating stations using inverters
Need for clarity on Connectivity Standards for Solar stations/parks

Pumped Storage Plants

- Pump Storage Plants:
  - **Purulia (4x225 MW)**
  - **Srisailam (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	Srisailam LBPH Andhra Pradsesh	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		

Way Forward for RE Integration

- Forecasting Load and RE
- Adequacy & Balanced Portfolio
- Framework for integrating RE
- Intra-state deviation handling mechanism in all States
- Aggregators – New market entities
- Reserves
- Ancillary Services
- Frequency Response
- Market opportunities : more frequent clearing
- Communication & data telemetry
- REMCs
- Compliance to Standards
- Flexibility in conventional generation
- Capacity building


Thank You!
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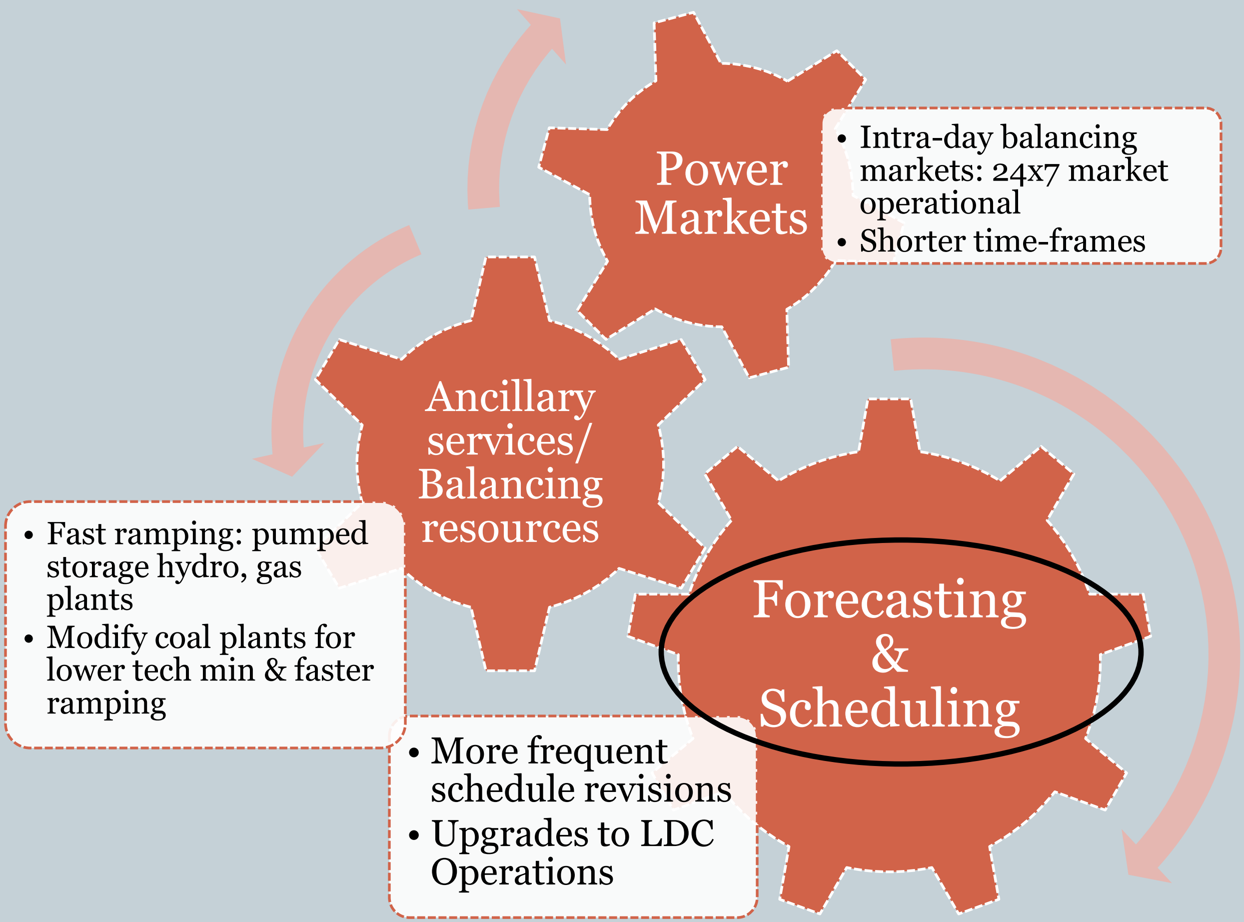
Forecasting, Scheduling & Deviation Settlement for RE

49TH FOR MEETING

JULY 27, 2015

CERC

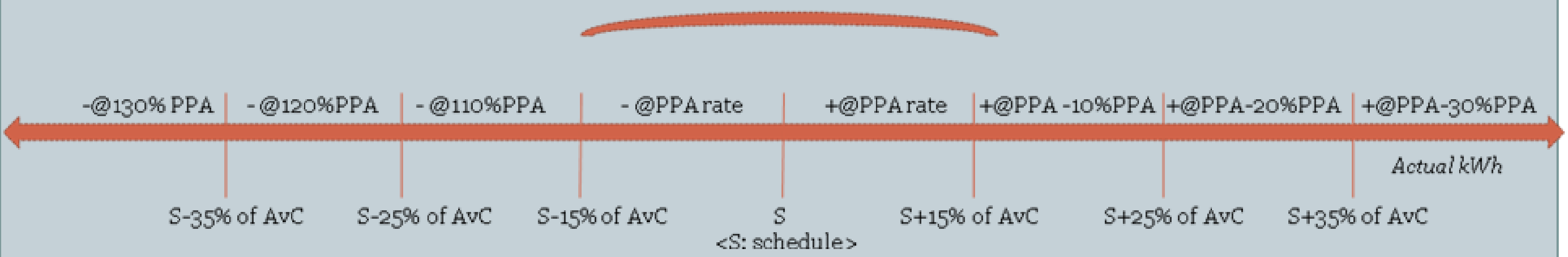
Integration of RE Sources into the Grid



CERC's Framework for Scheduling, Forecasting & Deviation Settlement for RE Sources (solar & wind)

- Forecasting and scheduling must be done for both solar and wind regional entities
  - Can be done by generator and/or RLDC
  - Larger geographical area results in better forecasting accuracy
- Due to the infirm nature of these sources, more flexibility provided w.r.t schedule
- Incentive to improve forecasting- deviation charges outside a tolerance band, which could be tightened over time.
- Integration with existing grid-framework for long term sustainability of RE sources on the grid

Deviation Settlement Framework for Regional Entities



- Error definition: [(Actual generation – Scheduled generation)/Available Capacity] x 100
- Payment as per schedule @PPA Rate
- Deviation Settlement within tolerance band (+/- 15%):
  - Receipt from/payment to pool @PPA rate (i.e. in effect, payment as per actuals)
- Beyond 15%, a gradient band for deviation charges is proposed as follows:

Abs Error (% of AvC)	*Deviation Charge*
15%-25%	10% of PPA rate
25%-35%	20% of PPA rate
>35%	30% of PPA rate

- 16 revisions allowed, one for every one-and-half-hour block, effective from 4th time-block.

Settlement of RPO under revised framework

- RPO deemed complied at scheduled generation
- In case of under-injection by RE generator, actual units to be balanced with RPO
  - Need for procurement of equivalent REC for shortfall in RE generation
- Similarly over-injection necessitates
  - crediting REC towards such excess generation

Instead of procuring or crediting REC for each case
  - all RE under/over-injections can be netted off (on monthly basis) for the entire pool first
- RE shortfall: RECs will be purchased from exchange and extinguished
- RE surplus: notional RECs will be credited to DSM Pool as carry forward for next cycle

- **Example:**

Total RE Over-injections in pool = 10,090 MWh; Total Shortfall = 10,195 MWh
Net= Over-injections – Shortfalls = 10,090 -10,195= - 105 MWh

Central Agency (on behalf of DSM pool) purchases 105 RECs from market for shortfall at end of month

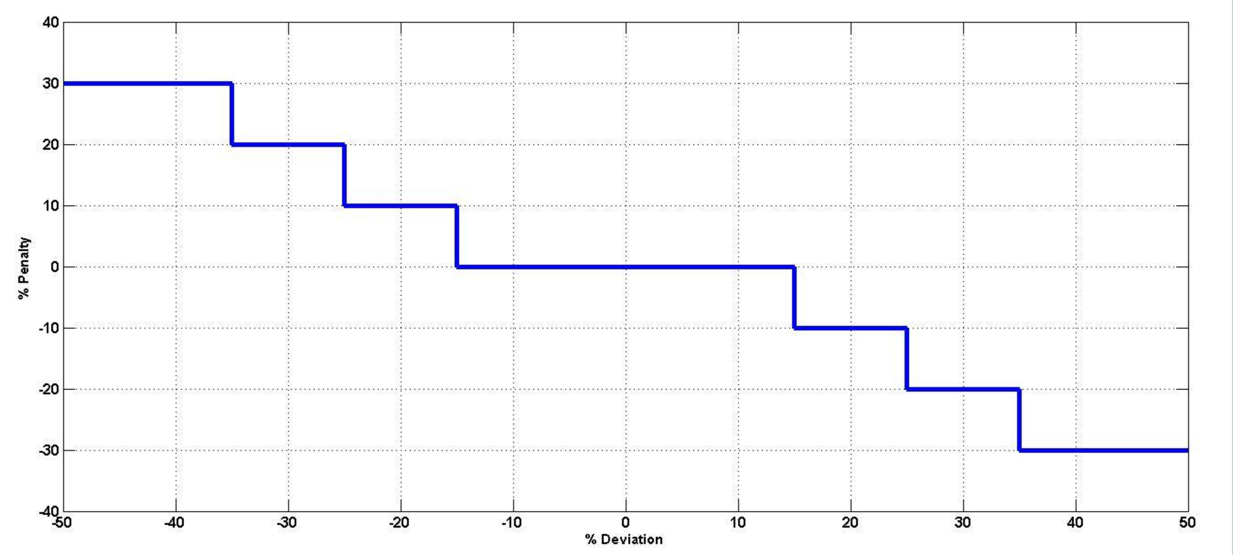
Settlement & Deviation Charges for Open Access and Captive Power Plants

- Settlement of OA and CPP poses challenge, particularly for CPP where there is no PPA rate
- Therefore a reference rate equal to APPC at National level that may be determined by CERC through order
- All deviations from schedule by these entities must be settled at APPC rates.

Example:
OA/CPP deviation from schedule = 20 MWh of shortfall; APPC = 3 Rs/kWh
OA/CPP pays = 20*3*1000 = Rs. 60,000 to DSM pool

Framework minimizes gaming

- <u>Reference rate to be the PPA rate</u>
  - deviation charges determined as a % of this rate
  - will ensure equitable burden for the same error among generators
- <u>Symmetrical deviation charge for under and over-injection</u>
  - ensures no perverse incentive to over-schedule or under-schedule vs forecast
  - charges for deviation symmetrical around zero



Advantages of the proposed framework

- In sync with conventional deviation and settlement framework
- Budgeting and matching easier
- Minimizes possibility of gaming
- Will give fillip to RPO compliance, while no risk of REC price on generator
- Risk shared between RE generator and buyer
- No impact on revenue for generators within the free & comfortable 15% band
- Band can be tightened later with more forecasting experience
- Will not result in windfall gain or loss to generators; generator equity

Scheduling & Deviation Settlement for States

Objectives of Model Framework

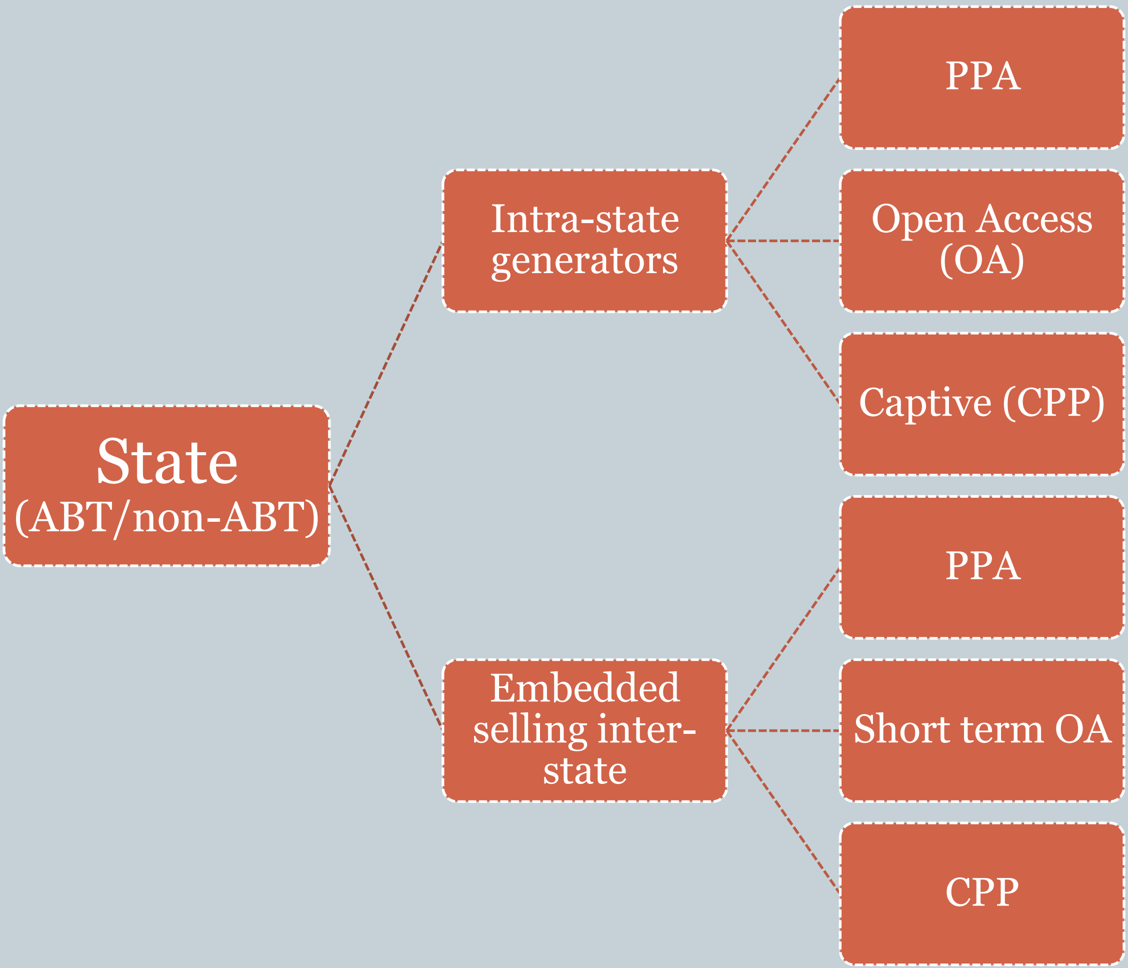
Objectives:

1) To roll out forecasting & scheduling for wind and solar generators so that Grid operators
   - have day-ahead and hour-ahead visibility into how much power is expected to be injected
   - can forecast 'net load' (load – RE power)
   - can plan for up and down ramps of net load
2) To enable a commercial framework where RE generators can seamlessly sell power across the country

Challenges

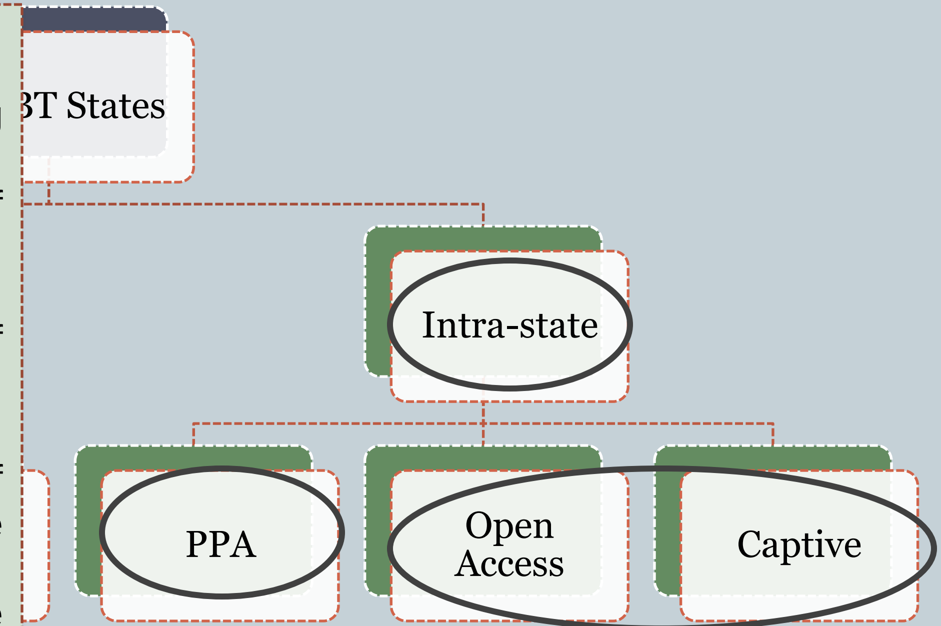
- Few states have implemented Availability Based Tariff (ABT) mechanism as stipulated in IEGC:
  - Chhattisgarh, Delhi, Gujarat, Maharashtra, MP, West Bengal
- Nearly all states have unique methodology of intra-state commercial settlement
- Generators of various categories are connected to the same pooling station, which is the commercial metering point in many cases

Objective: a solution that works for all permutations & combinations

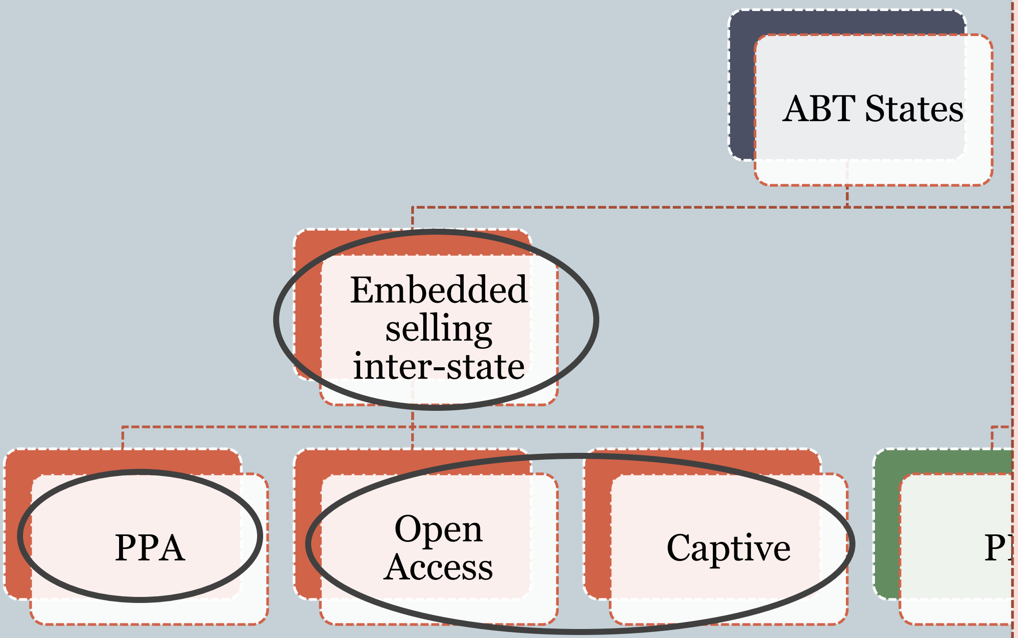


ABT States: intra-state generators

- **Schedule:**
  - schedule preparation at pooling station level
  - de-pool schedule on the basis of available capacity
- **Payment:**
  - payment as per current arrangement
- **Deviation Settlement:**
  - de-pool deviations on the basis of generated units (or available capacity if no turbine-level-meters)
  - deviation settlement with state DSM pool with **state APPC** as reference rate

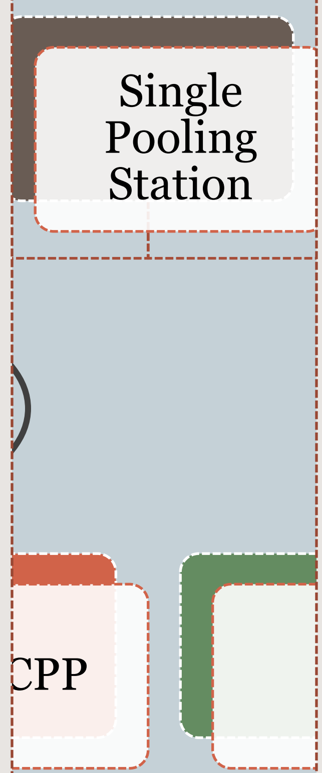


ABT States: embedded generators selling inter-state



- ***Schedule:***
  - schedule preparation at pooling station level
  - de-pool schedule on the basis of available capacity
- ***Payment:***
  - payment as per current arrangement
- ***Deviation Settlement:***
  - de-pool deviations on the basis of generated units (or available capacity if no turbine-level-meters)
  - deviation settlement with state DSM pool with **state APPC** as reference rate

ABT States: the hybrid pooling station case (generators selling both intra-state & inter-state connected to a single pooling station)



- ❑***Schedule:***
  - ▪schedule preparation at pooling station level
  - ▪ de-pool schedule on the basis of available capacity
- ❑***Payment:***
  - ▪payment by beneficiary on basis of schedule/current arrangement
- ❑***Deviation Settlement:***
  - ▪ de-pool deviations on the basis of generated units (or available capacity if no turbine-level-meters)
  - ▪ deviation settlement with state DSM pool with **PPA rate/APPC** as reference rate, as the case may be
- ❑***RPO Compliance***
  - ▪REC netting off by SLDC monthly, with state DSM pool (for PPA units)

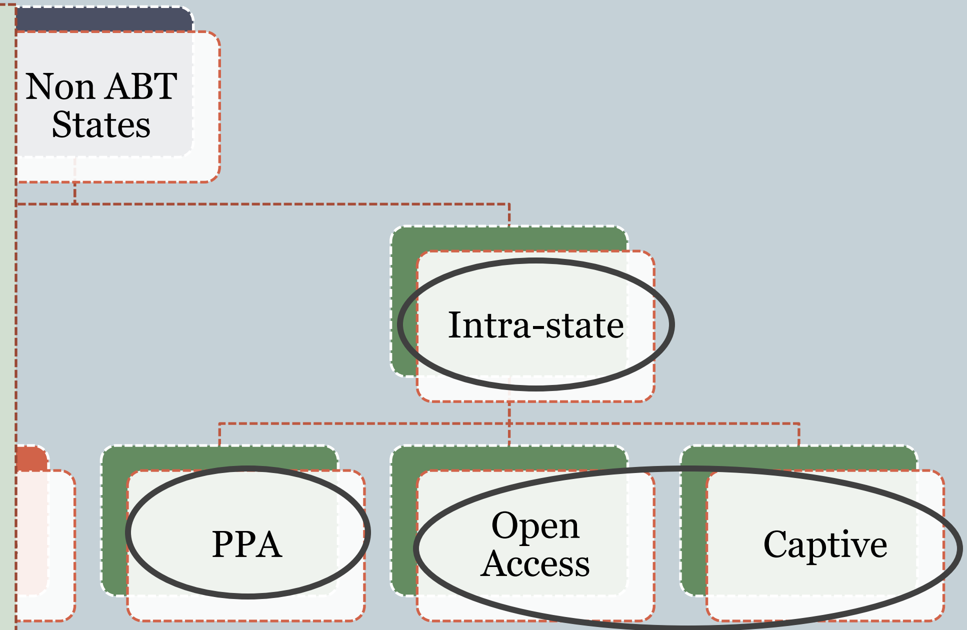
- ❑***Schedule:***
  - ▪schedule preparation at pooling station level
  - ▪ de-pool schedule on the basis of available capacity
- ❑***Payment:***
  - ▪payment by beneficiary on basis of schedule/current arrangement
- ❑***Deviation Settlement:***
  - ▪ de-pool deviations on the basis of generated units (or available capacity if no turbine-level-meters)
  - ▪ deviation settlement with state DSM pool with **PPA rate/APPC** as reference rate, as the case may be
- ❑***RPO Compliance***
  - ▪REC netting off by SLDC monthly, with state DSM pool (for PPA units)

For generators selling both intra-state & inter-state at different PPA rates: a weighted average PPA rate may be used

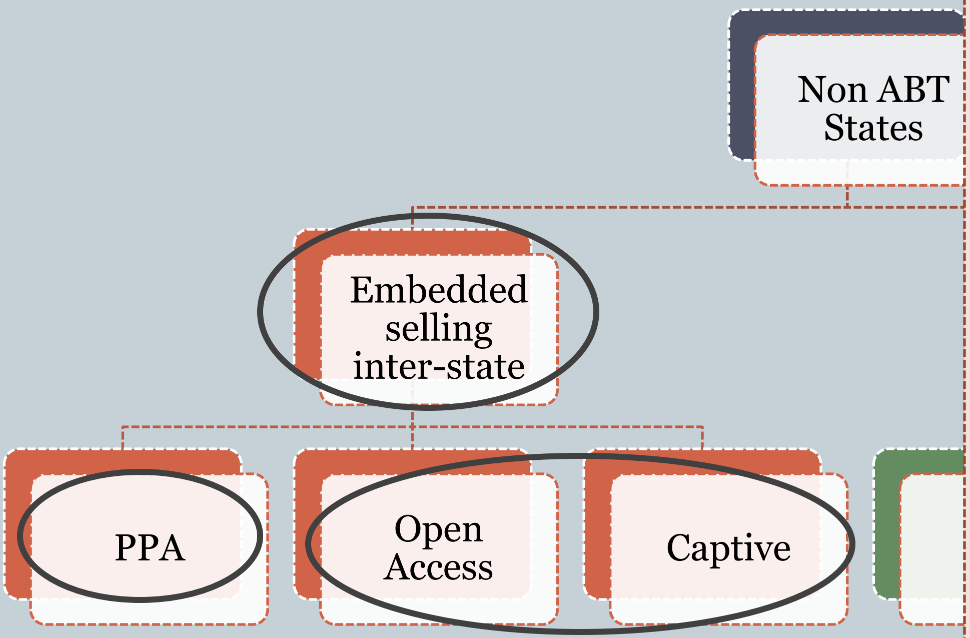
Non-ABT States: intra-state generators

Interim Framework until ABT implementation:

- ***Schedule:***
  - schedule preparation at pooling station level
  - de-pool schedule on the basis of available capacity
- ***Payment:***
  - payment as per current arrangement
- ***Deviation Settlement:***
  - de-pool deviations on the basis of generated units
  - deviation charges to be paid to the state with **state APPC** as reference rate



Non-ABT States: embedded inter-state generators



Interim Framework until ABT implementation:

❑ ***Schedule:***

- schedule preparation at pooling station level
- de-pool schedule on the basis of available capacity

❑ ***Payment:***

- payment as per current arrangement

❑ ***Deviation Settlement:***

- de-pool deviations on the basis of generated units (or available capacity if no turbine-level-meters)
- deviation settlement by SLDC with **state APPC** as reference rate

Non-ABT States: the hybrid pooling station case

Interim Framework until ABT implementation:

❑***Schedule:***

- schedule preparation at pooling station level
- de-pool schedule on the basis of available capacity

❑***Payment:***

- payment by beneficiary on basis of actuals/current arrangement

❑ ***Deviation Settlement:***

- de-pool deviations on the basis of generated units (or available capacity if no turbine-level-meters)
- deviation settlement with state SLDC with **PPA rate/APPC** as reference rate, as the case may be

❑***RPO Compliance***

- REC netting not required

Single Pooling Station

CPP

Interim Framework until ABT implementation:

❑***Schedule:***

- schedule preparation at pooling station level
- de-pool schedule on the basis of available capacity

❑***Payment:***

- payment by beneficiary on basis of schedule/current arrangement

❑ ***Deviation Settlement:***

- de-pool deviations on the basis of generated units (or available capacity if no turbine-level-meters)
- deviation settlement by SLDC with **PPA rate/APPC** as reference rate, as the case may be

❑***RPO Compliance***

- REC netting off by SLDC monthly (for PPA units)

The Building Blocks

- Load Forecasting at SLDC
- Implementation of ABT regime
- Data telemetry at RE stations
- Forecasting of wind & solar
  - Engage forecasting agencies
  - Pilots to record data, improve models, measure algorithm accuracy
- REMC at SLDC
  - Capacity building through CERC/POSOCO workshops
  - Software systems for data recording and schedule management

Load variability vs wind variability

- Net load variability is almost same as load variability
- can be handled if load forecasting and scheduling are implemented

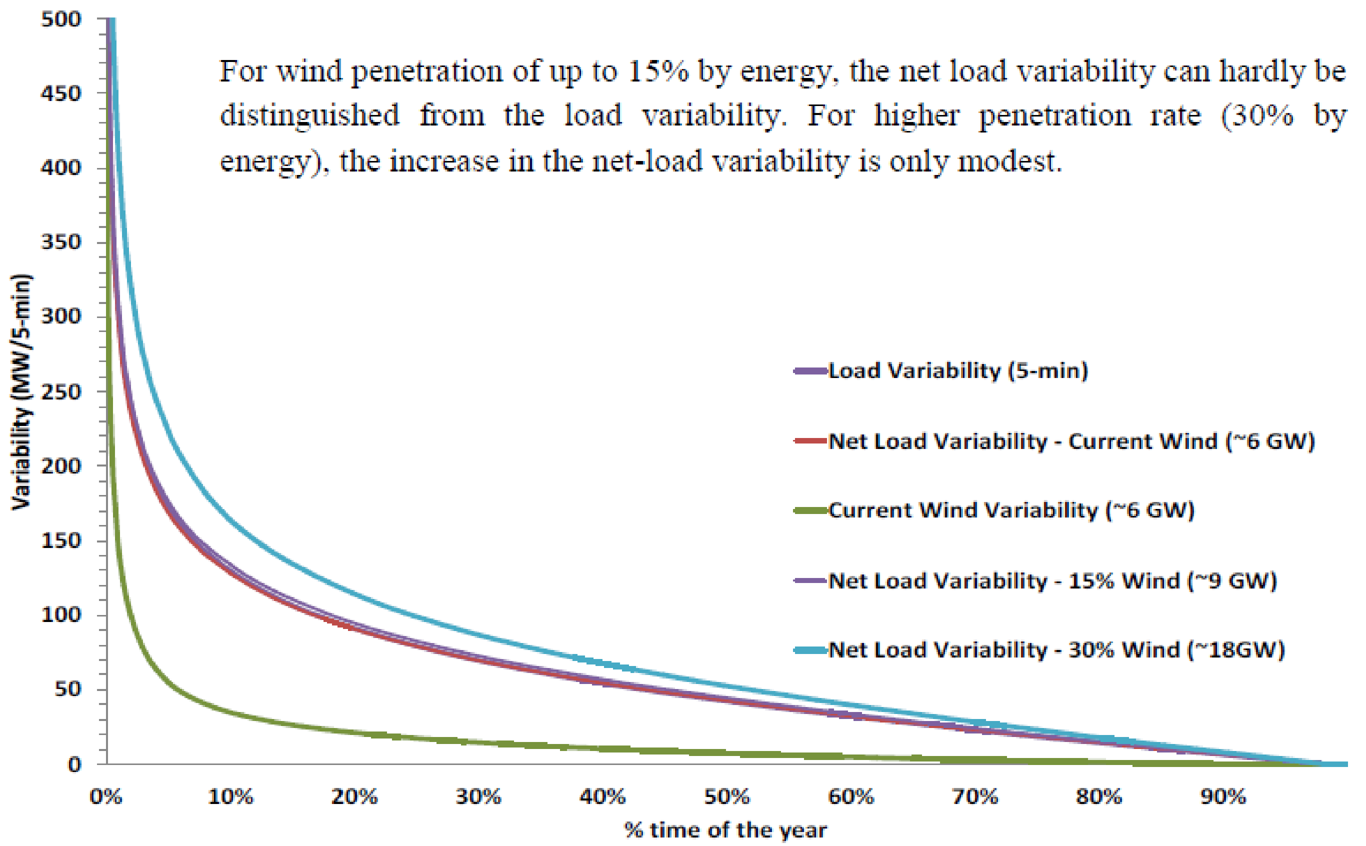
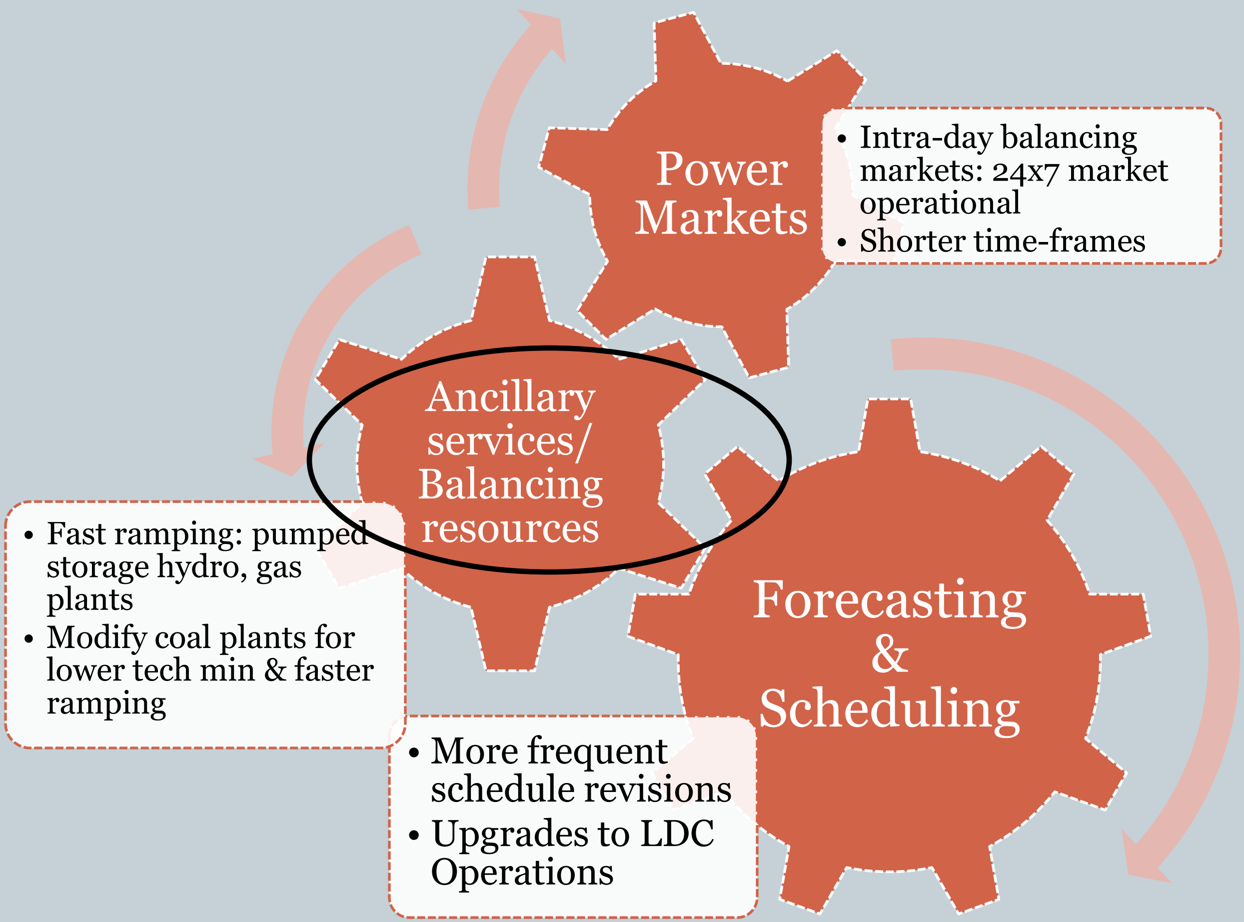


Figure ES-1: 5-min Load, Wind and Net Load Variability in Tamil Nadu (2011)

Source: LBNL Report "Empirical Analysis of the Variability of Wind Generation in India

Integration of RE Sources into the Grid- other components



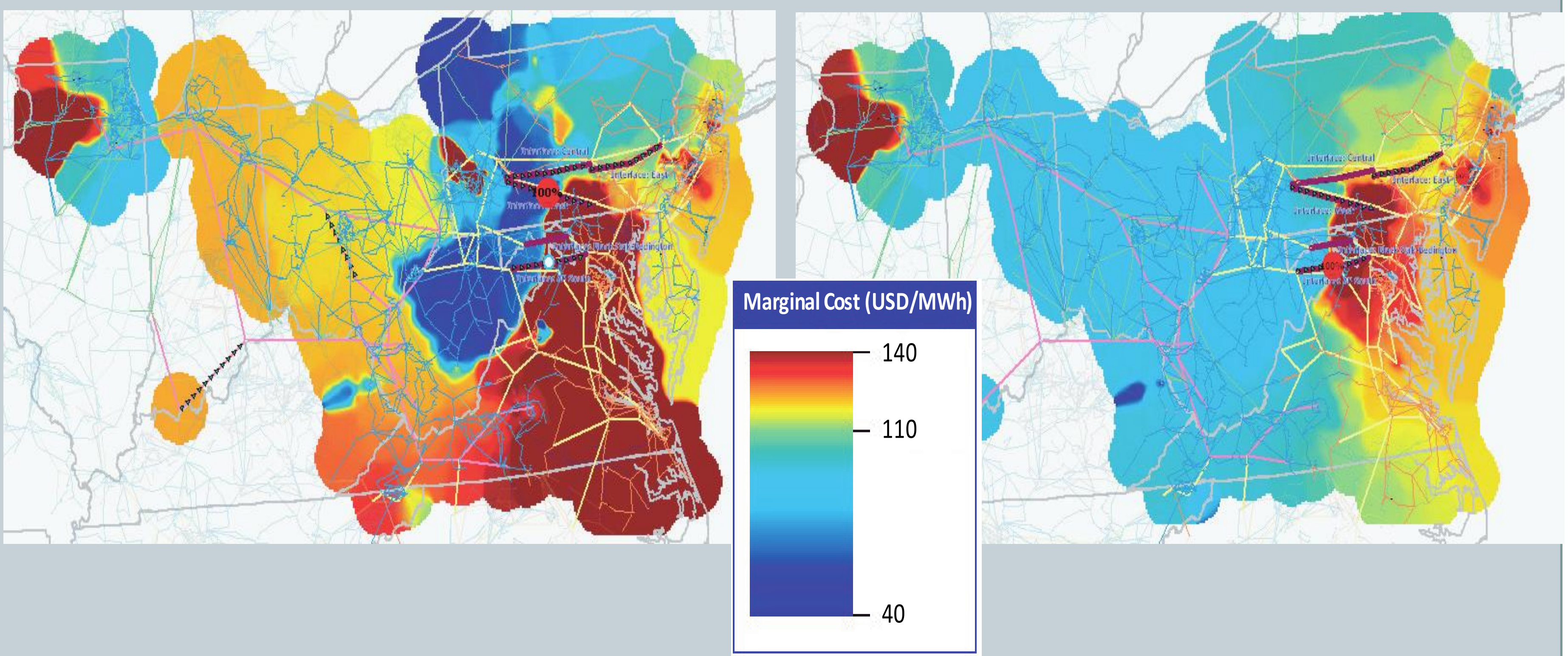
Balancing of RE in Germany

- Renewables now provide ~30% of Germany's power on an average basis. On some peak days in 2014, solar and wind supplied close to 80% of peak power demand at specific times of the day
- Balancing has been made possible through:
  - Flexible operation of coal and nuclear plants
  - Faster and more effective ancillary markets
  - Better system control software (allows higher ramp rates) and day-ahead forecasting at System Operators
  - Modest technical improvements to distribution grids
  - Export of power to EU

Example from the US: PJM

Figure 26 • LMP patterns before and after integration

Pre-integration price pattern (PJM)	Post-integration price pattern (PJM)

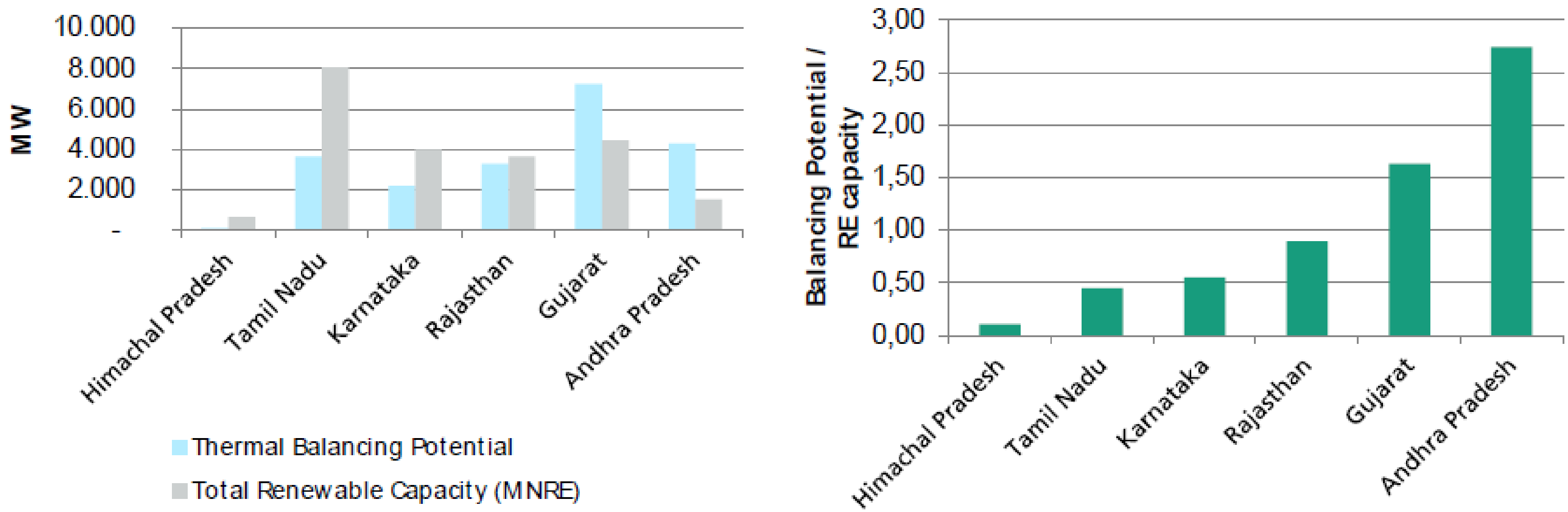


Balancing potential of Indian states

Theoretical balancing potential = Σ (1- min load of power plant)
maximum potential of reducing or increasing the actual generation (no shut-down or start-up of plants, all power plants on bar).

Figure 26: Total theoretical balancing potential for each state and comparison to installed RE capacity

Source: Fraunhofer IWES, data: CEA 2015

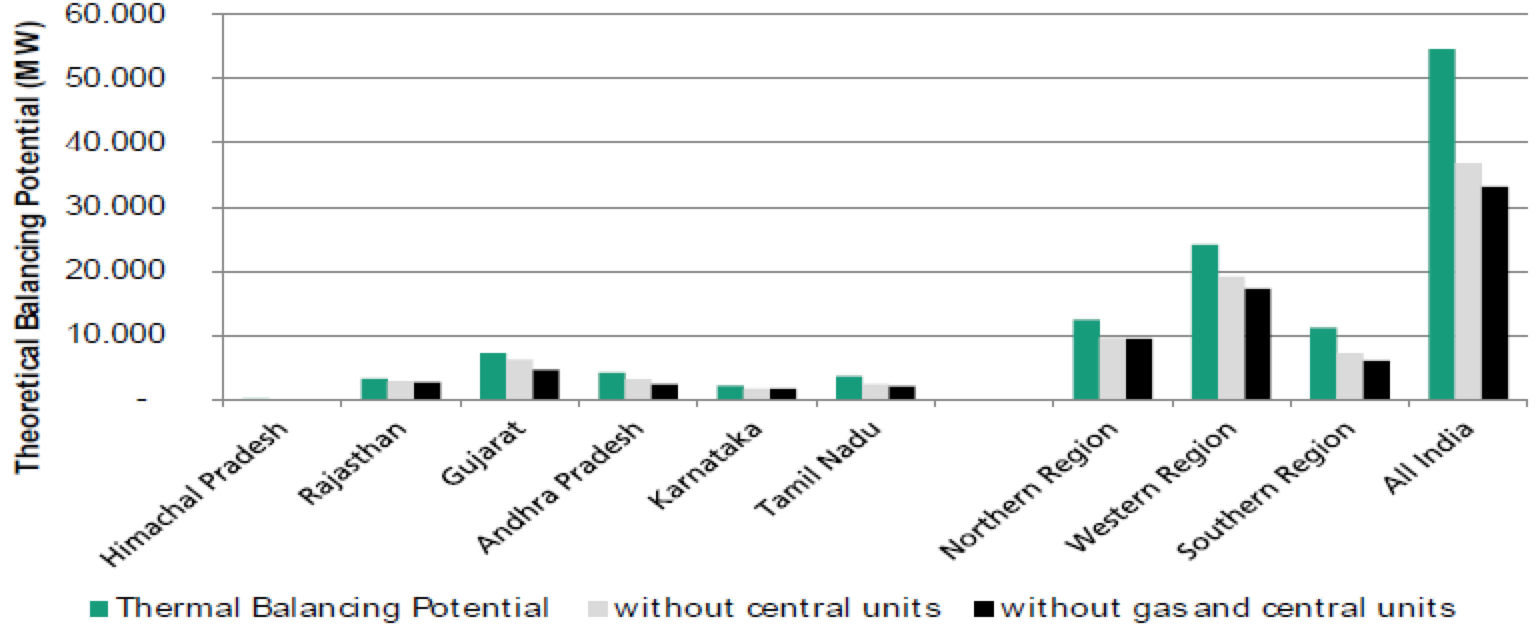


Source: GIZ Report on Forecasting, Concept of Renewable Energy Management Centres and Grid Balancing

Regional and all-India balancing potential

Regional balancing potential is very large compared to the states

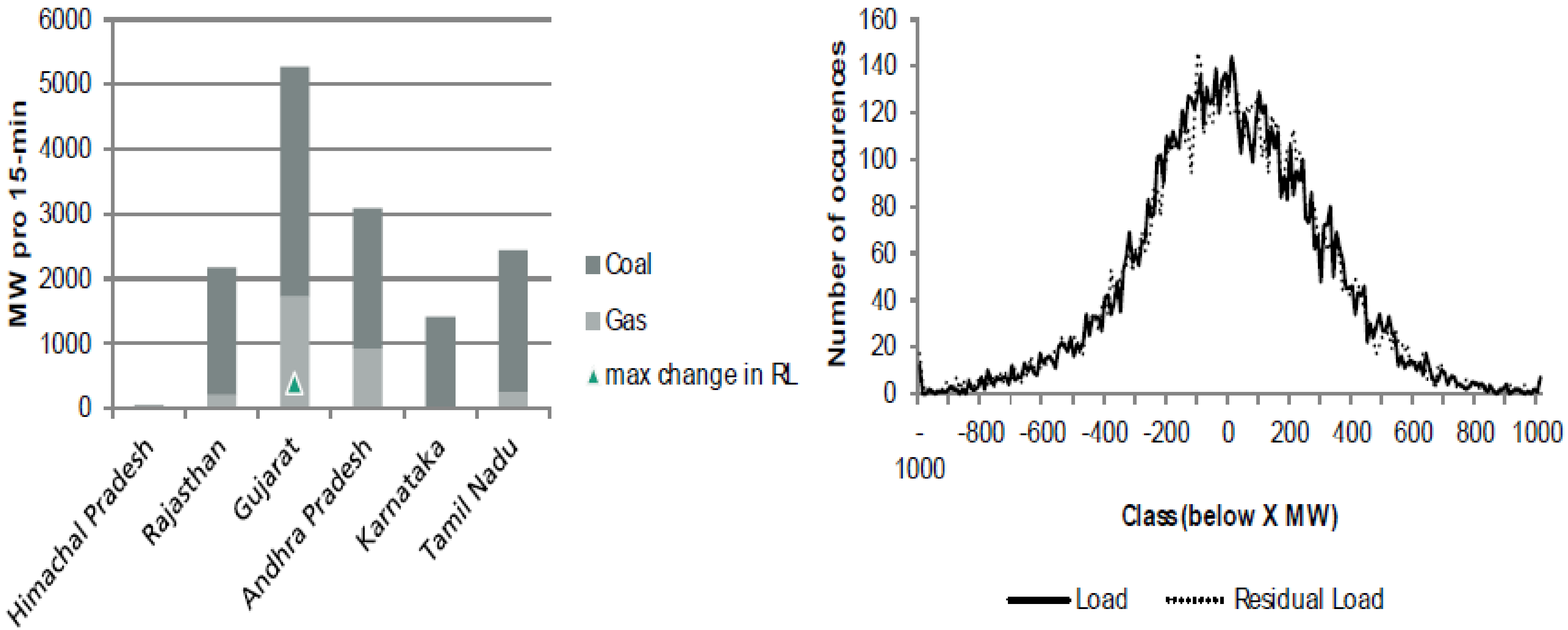
Figure 27: Theoretical thermal balancing potential in RE rich-states compared to the potential of regions and all India



Source: GIZ Report on Forecasting, Concept of Renewable Energy Management Centres and Grid Balancing

Ramping potential

Figure 28: Theoretical state wise ramping potential of all thermal power plants (left) and ramping demand in Gujarat (right)



Handling RE variation: the long term solution

- Load forecasting to be mandated
- Implementation of ABT mechanism
- Requirement of forecasting for RE as in the proposed framework
- Frequent intra-day revision of schedule for RE
- Presently steep load ramp up and down being managed; correlation between RE variation and resultant over/under-drawal not established
- Meeting net load (load-RE generation) variation through balancing…CERC coming up with Ancillary Services/Spinning Reserves Regulation
- States and regions to better/optimally utilise the reserves available in their respective states/region
- Use 24x7 extended power market for balancing
- Technical minimum limit for thermal power stations proposed at 55% by CERC (states to follow suit)

THANK YOU

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ANNEXURE

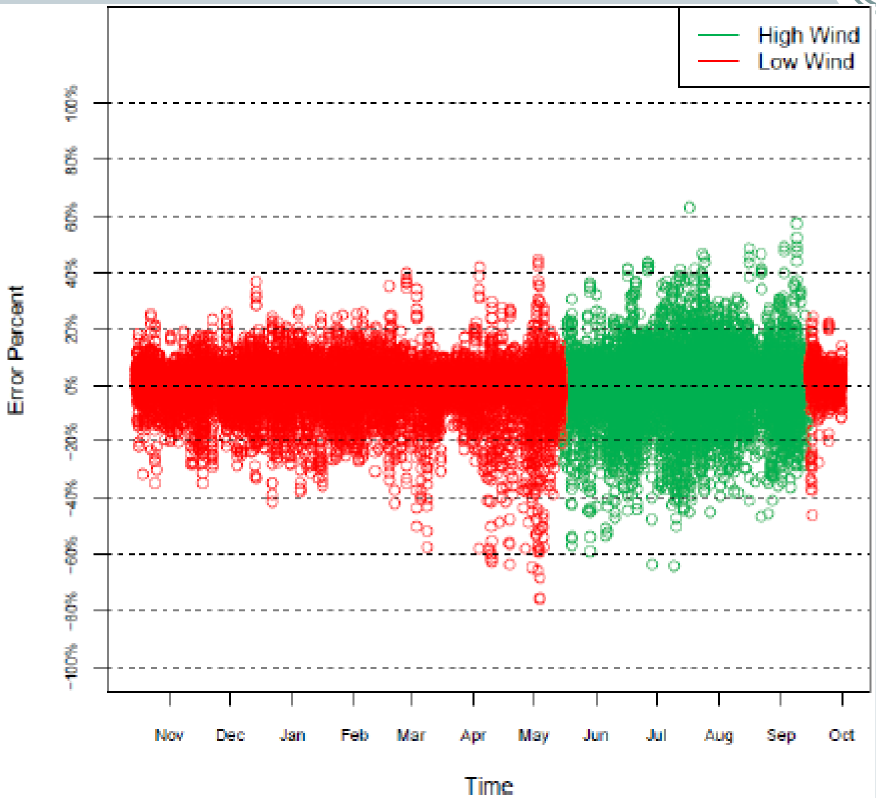
Example Calculation (within tolerance band)

Example 1:			
	Schedule (MWh)	100	
	PPA Tariff (Rs/Unit)	5	
	Available Capacity (MWh)	100	
	Scenario	**Scenario I: Within band of -15%**	**Scenario II: Within band of +15%**
	Actual Generation	90	110
	% Absolute Error	10%	10%
	Buyer Pays	**5*100*1000 = 500,000**	**5*100*1000 = 500,000**
	Seller Receives	500,000	500,000
Seller to DSM	**Add: Seller Receives from DSM Pool**	5*(90-100)*1000 =(50,000)	5*(110-100)*1000 =50,000
	Add: Deviation Charge @ 10% for Deviation Between 15%-25%	-	-
	Add: Deviation Charge @ 20% for Deviation Between 25%-35%	-	-
	Add: Deviation Charge @ 30% for Deviation Beyond 35%	-	-
	Total Receipt from/(payment to) Pool	**(50,000)**	**50,000**
	Net Revenue of Generator	**450,000**	**550,000**

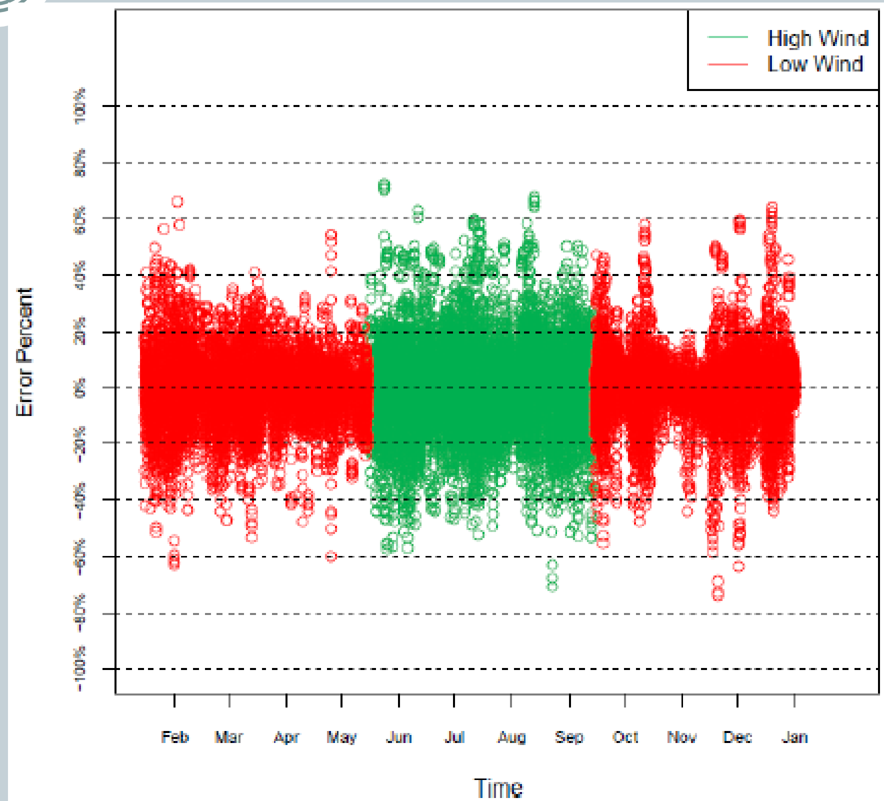
Example Calculation (Beyond 35% Deviation)

Example 3:			
	Schedule (MWh)	100	
	PPA Tariff (Rs/Unit)	5	
	Available Capacity (MWh)	100	
	Scenario	Scenario V: Outside band….beyond -35%	Scenario VI: Outside band….beyond +35%%
	Actual Generation	60	140
	% Absolute Error	40%	40%
	Buyer Pays	5*100*1000 = 500,000	5*100*1000 = 500,000
	Seller Receives	500,000	500,000
Seller to DSM	Add: Seller Receives from DSM Pool	5*(60-100)*1000 = (200,000)	5*(140-100)*1000 = 200,000
	Add: Deviation Charge @ 10% for Deviation Between 15%-25%	(5*10%)*10*1000 = (7500)	(5*10%)*10*1000 = (7500)
	Add: Deviation Charge @ 20% for Deviation Between 25%-35%	(5*20%)*10*1000 = (10000)	(5*20%)*10*1000 = (10000)
	Add: Deviation Charge @ 30% for Deviation Beyond 35%	(5*30%)*5*1000 = (7500)	(5*30%)*5*1000 = (7500)
	Total Receipt from/(payment to) Pool	**(225,000)**	**175,000**
	Net Revenue of Generator	**275,000**	**675,000**

Error normalized to capacity: simulation studies by GE



Period	MAE
Overall	6.21%
High Wind	8.22%
Low Wind	5.12%

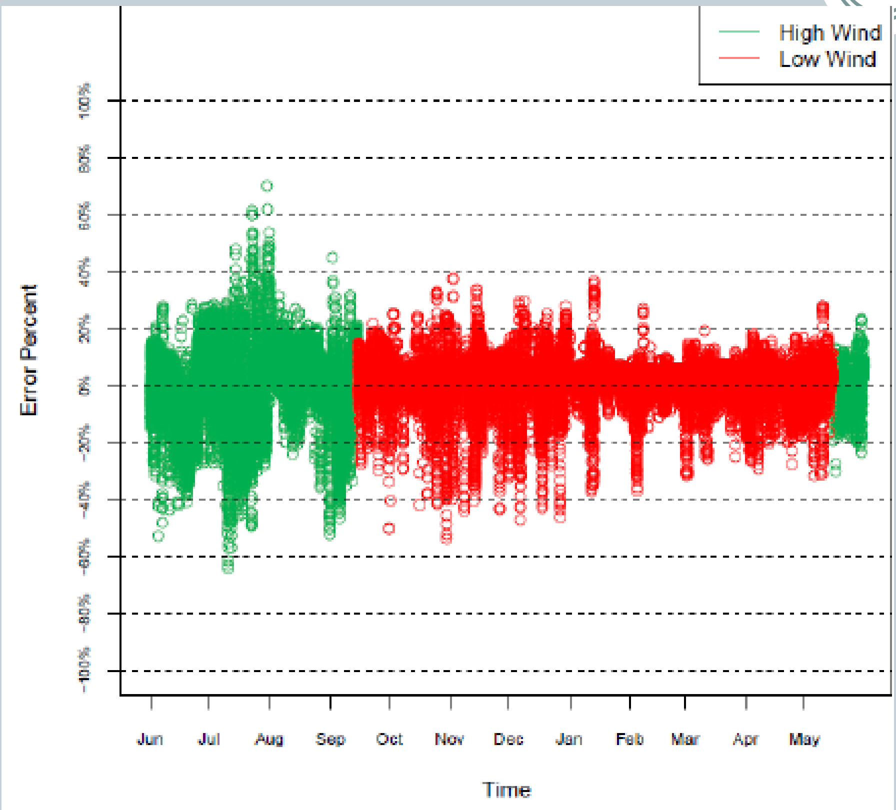


Period	MAE
Overall	8.62%
High Wind	10.84%
Low Wind	7.39%

Site A: 25.5 MW

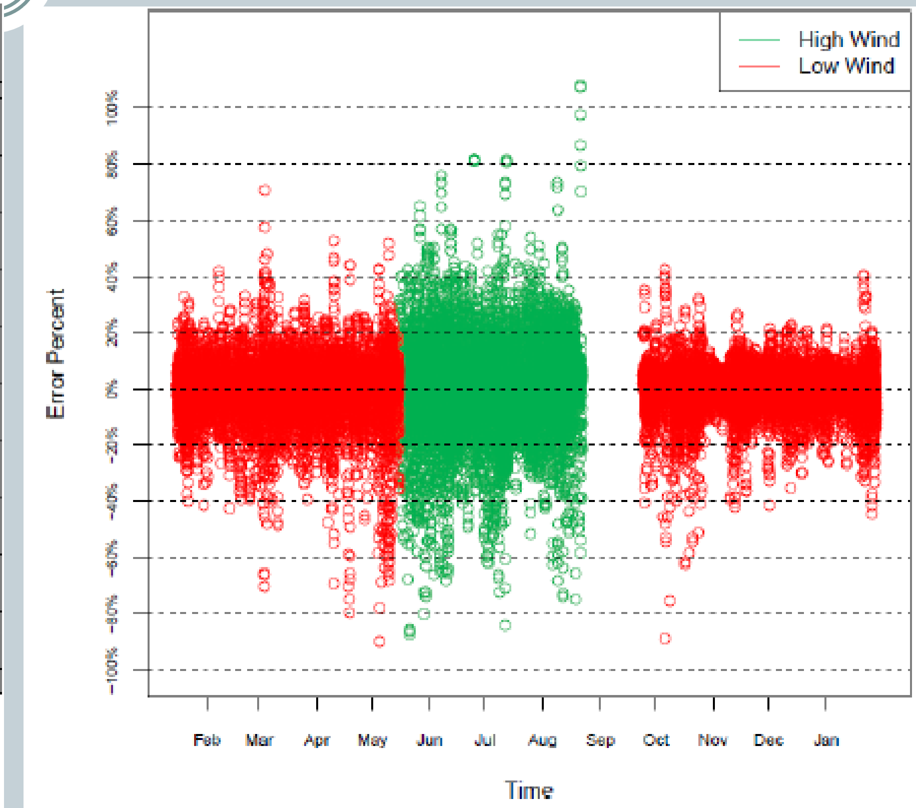
Site B: 24 MW

Error (normalized to capacity) distribution



Period	MAE
Overall	7.56%
High Wind	10.71%
Low Wind	5.97%

Site C: 72 MW

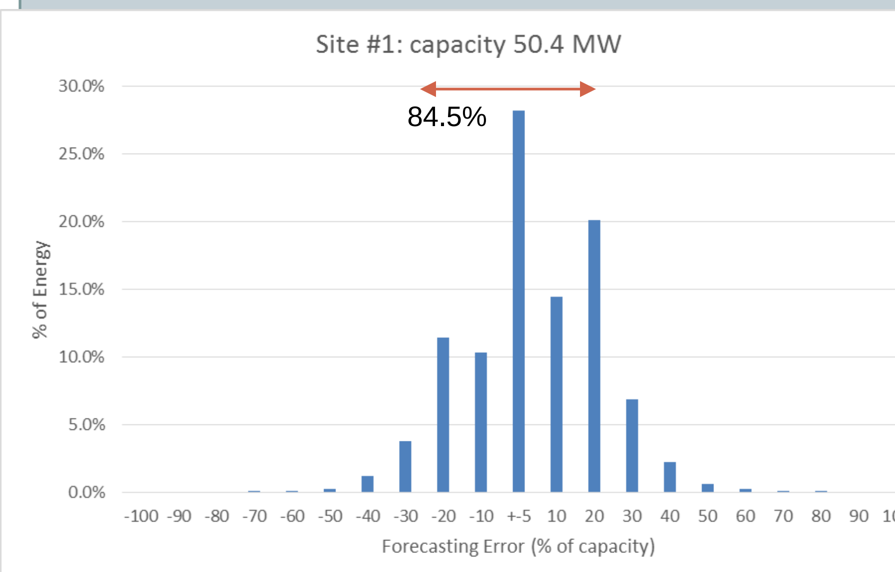


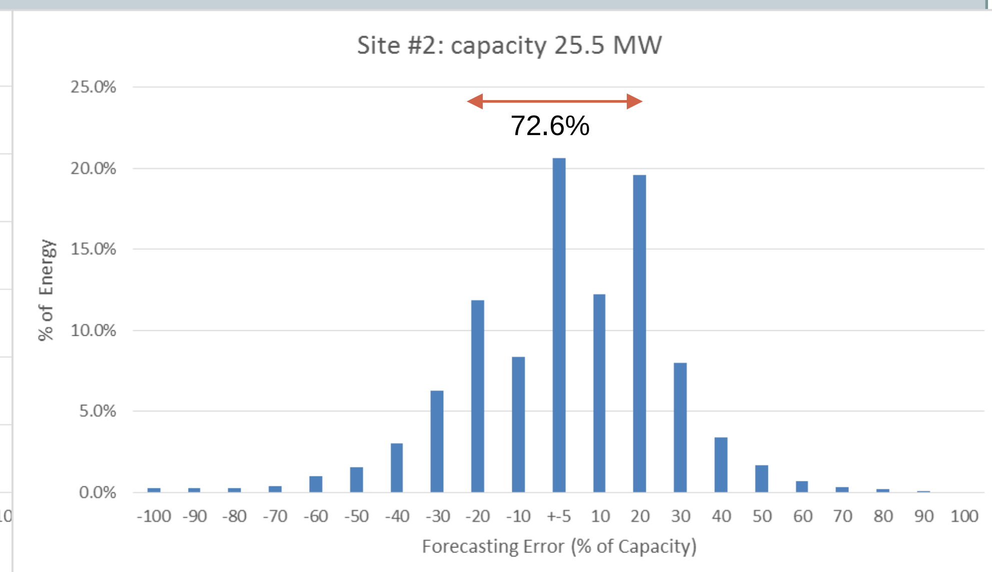
Period	MAE
Overall	7.78%
High Wind	12.12%
Low Wind	6.02%

Site D: 51.2 MW

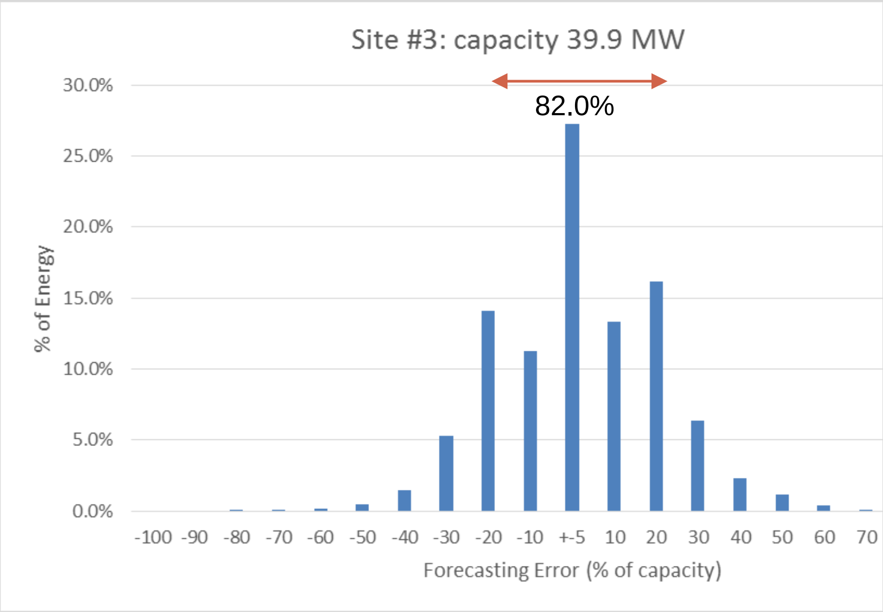
Forecasting Error analysis by Unilink

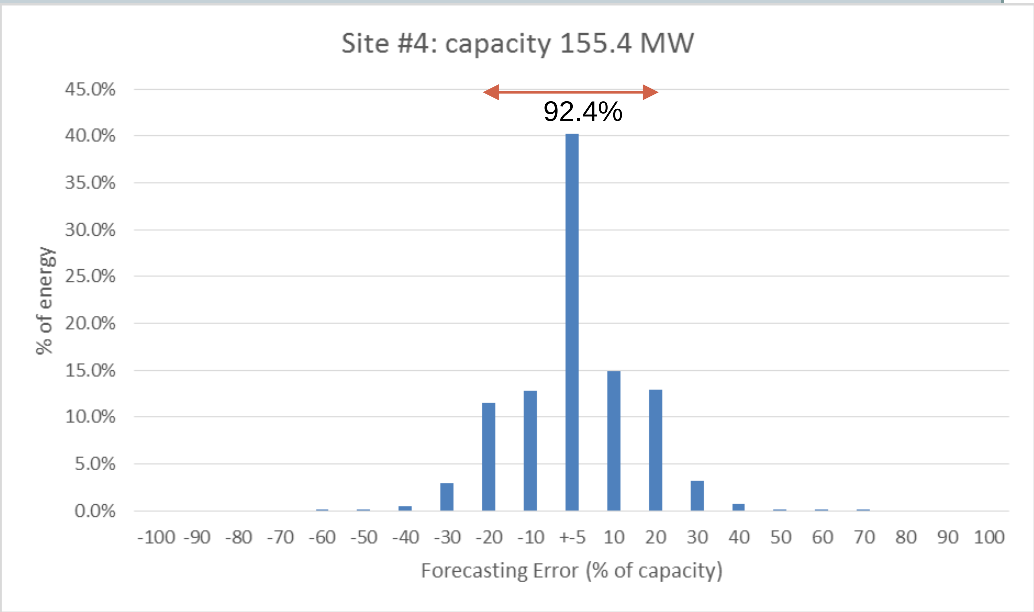
- Unilink Corp: aggregator & forecaster in Gujarat (covering 500 MW)
- Error observed based on actual data for year 2014
- Forecasting done with 8 revisions per day





Observations on new error definition (contd)





Cost of forecasting

As per Unilink Corp,

- One-time cost of 5 lacs per pooling station
- 2 to 3 paise per kWh
- Recurring cost of Rs 2000-2500 per MW of installed capacity per month

Accelerating Growth,
Creating Employment

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Anil Sardana
Chairman, CII National Committee on
Power & Managing Director, Tata Power
Company Ltd.

July 16, 2015

Dear Mr. Gireesh Pradhan,

Absence of Level Playing Field for Private Sector Companies in Power Plant Contracts by State Power Companies

The Electricity Act (EA), 2003, which forms the cornerstone of the power sector in India, encourages competition amongst players so as to ensure maximum benefits for the consumers of India. Contrary to this spirit imbibed in EA, 2003, it is learnt that around 6000MW EPC power plant contracts have been ordered in favour of PSUs on nomination basis by State Power Companies. In addition to these awards of contracts, MoUs are being signed with PSUs like BHEL by the governments of other states.

Confederation of Indian Industry (CII) wishes to express deep concern and apprehension about the growing number of instances of the private sector being deprived of an opportunity to bid for power generation contracts for upcoming power plants in India. We wish to bring to your notice the following points:

1. In line with the Hon. Prime Minister's initiative of **Make in India**, private sector has set up world class manufacturing facilities in India. Such instances of contract awards on nomination basis discourage investment in India due to such unfair actions by state power companies and may lead to reduction in jobs.

2. **Private Sector companies have proven credentials** of executing contracts of such nature at costs as or more competitive than those of PSUs. Infact, it is a private sector company which has the unique achievement of setting up India's first indigenously built supercritical power plant of 2 X 700MW in Rajpura, Punjab. In the past few tenders, private sector companies as well as PSUs have been awarded the EPC contracts on the basis of price competitiveness. This new and sudden development will spoil the reputation of India for fair business practices.

3. The Central Government has been a staunch advocate of private sector participation and encouraging competition. The auction of coal mines and spectrum is a landmark achievement of the Central Government. We feel this auction is also an indication for state governments to follow suit to ensure **transparency, provide level playing field** for all entities in India and thereby derive benefits of competition.

...2/-

4. The tariff for supply of power from the State power companies is determined on cost plus basis as per **Section 62** of EA, 2003 and not based on competitive price discovery mechanism under **Section 63**. By awarding the EPC contract on **negotiated basis**, the capital cost for determination of tariff gets fixed and thereafter the power consumers are completely **deprived of benefits of competition at all stages of the process**. This is against the spirit of EA, 2003.

It has come to our knowledge that more states intend to follow the practice of placement of orders on nomination basis after the award of 1x800 MW Kothagudem TPS Expansion (Oct '14), 4x270 MW Manuguru TPS (Mar '15), 5x800 MW Yadagiri TPS (June'15).

To protect the interests of the consumers of India, potential investors from across the globe and the private sector, CII requests **CERC to issue appropriate advisory to state governments, regulators and financing organizations to ensure International Competitive Bidding (ICB) guidelines with award based on lowest evaluated price is adopted for Power Plant EPC contracts.**

We are confident that you will ensure that fair processes are adopted in the larger interest of the country.

With regards,

Sincerely,

16.7.2015

Anil Sardana

Mr. Gireesh Pradhan
Chairperson
Central Electricity Regulatory Commission (CERC)
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Dr A. Didar Singh
Secretary General

July 16, 2015

Mr. Gireesh B. Pradhan
Chairperson & Chief Executive
Central Electricity Regulatory Commissior
New Delhi

Dear Mr. Pradhan,

Sub: Award of contracts for Power plants on nomination basis by State Govt. Utilities

FICCI appreciates the multi-pronged initiatives taken by your Ministry to make the energy sector more dynamic, competitive and progressive. The first signs of the sector turning round are visible. We would, however, like to bring to your notice a recent case, which may not be in the spirit of encouraging competition and market development.

We understand that, of late, a few State power utilities are contemplating to by-pass the tendering process and award power plant EPC contracts to CPSUs on nomination basis. Case in point is the recent MoU signed by Telangana Power Generation Corporation (TSGENCO) for Kothagudem (1x800 MW), Manuguru (4x270 MW) and Yadagiri (5x800 MW) thermal power stations.

FICCI's view is that placing such power plant orders on "nomination basis", without following the competitive bidding route, is clearly,

- restraint of trade;
- anti-competitive;
- Against Honorable PM's "Make in India" initiative as it violates the level playing field and leads to idling of indigenous manufacturing capacities.

Such preferential treatment restricts providing an equal opportunity to other competent EPC contractor(s), like Alstom Bharat Forge, Doosan India Ltd, Larsen & Toubro Limited, Toshiba JSW etc. These EPC contractors have invested in capital and resources by bringing in supercritical technology from OEMs, establishing factories in India under Ministry of Power's Phased Manufacturing Program (PMP) and producing supercritical sets indigenously.

It is also pertinent to note that the Central Government, in its constant endeavor to lend transparency and create a level playing field in contracting involving Central and State level bodies, has recently done away with duty benefits to Defence PSUs; a move to put the Indian private sector and PSUs at par.

Besides this, we understand that such arrangement with PSUs is also not in line with the Guidelines issued by the Central Vigilance Commission pertaining to works to be awarded on single nomination basis.

Since this matter is hurting the Industry and leading to severe underutilization of manufacturing capacities, FICCI requests Ministry of Power to step-in and put a halt to this unfair practice of awarding supercritical coal fired Power Plant contracts by State/ Central Power Utilities to PSU's on nomination basis.

We also request Central Electricity Regulatory Commission to advise State Power Utilities to invite bids on EPC basis under International Competitive Bidding (ICB) for upcoming projects. This will not only ensure a fair competitive environment, but the consumers of electricity also will ultimately stand to gain the most as inviting tenders through the ICB Process will encourage efficient pricing and provide greater choice to equipment buyers. This in true sense will be in line with Honorable PM's "Make in India" initiative.

We look forward to your prompt and fair actions in this regard.

With best regards,

Yours sincerely,

A Didar Singh