Maharashtra Power System Transformation Workshop 2020

Mumbai, 18 Feb 2020

Role of Grid Network flexibility in Western region and National context

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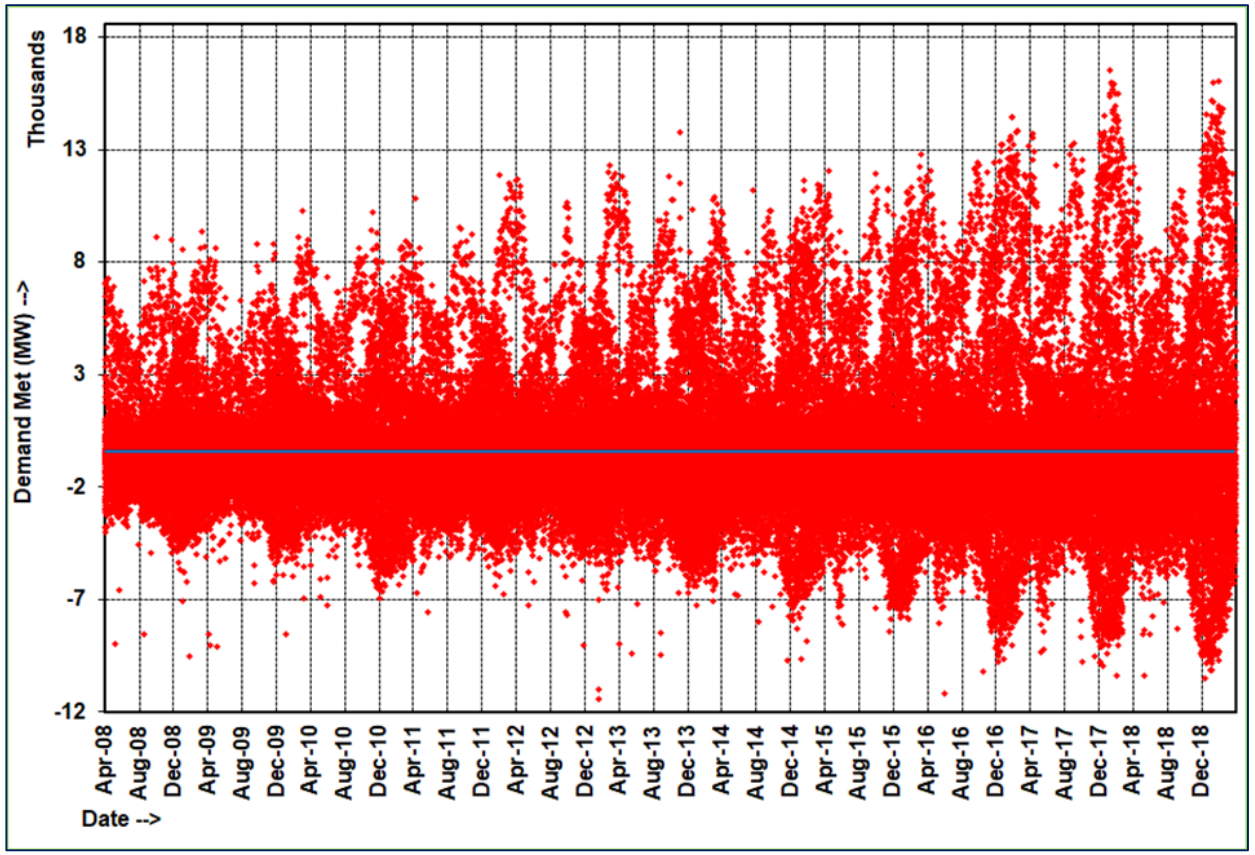
Outline

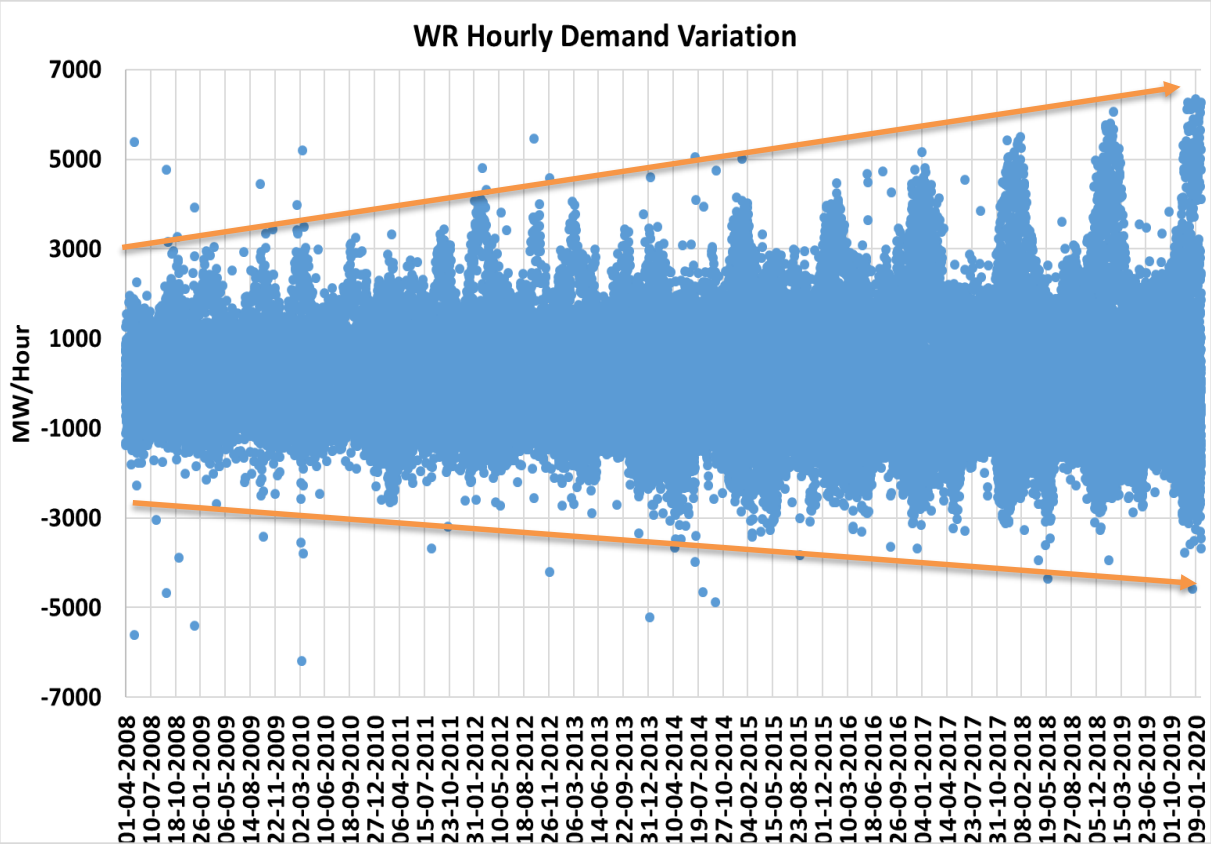
- Unfolding paradigm
- Flexibility is the only choice
- Way ahead

Wind and Solar Penetration Levels

State	Annual RE generation as % of Annual Energy consumption (2018-19)	Max Daily RE generation as % of daily energy consumption	Max Instantaneous RE generation as % of demand met	VRE Integration Phase
Karnataka	23 %	56 %	90 %	[3]
Tamil Nadu	13 %	38 %	48 %	[2]
Andhra Pradesh	21 %	51 %	71 %	[3]
Gujarat	11.6 %	33.2 %	39.5 %	[2]
Maharashtra	5.7 %	18 %	23 %	[2]
Madhya Pradesh	8.7 %	30 %	42 %	[2]
Rajasthan	14.2 %	34 %	50 %	[2]
Western Region	8.3 %	20 %	24.2 %	[2]
Southern Region	15 %	30 %	47 %	[3]
All India	**8 %**	**15.1 %**	**19.4 %**	[2]

Demand variability (hourly)

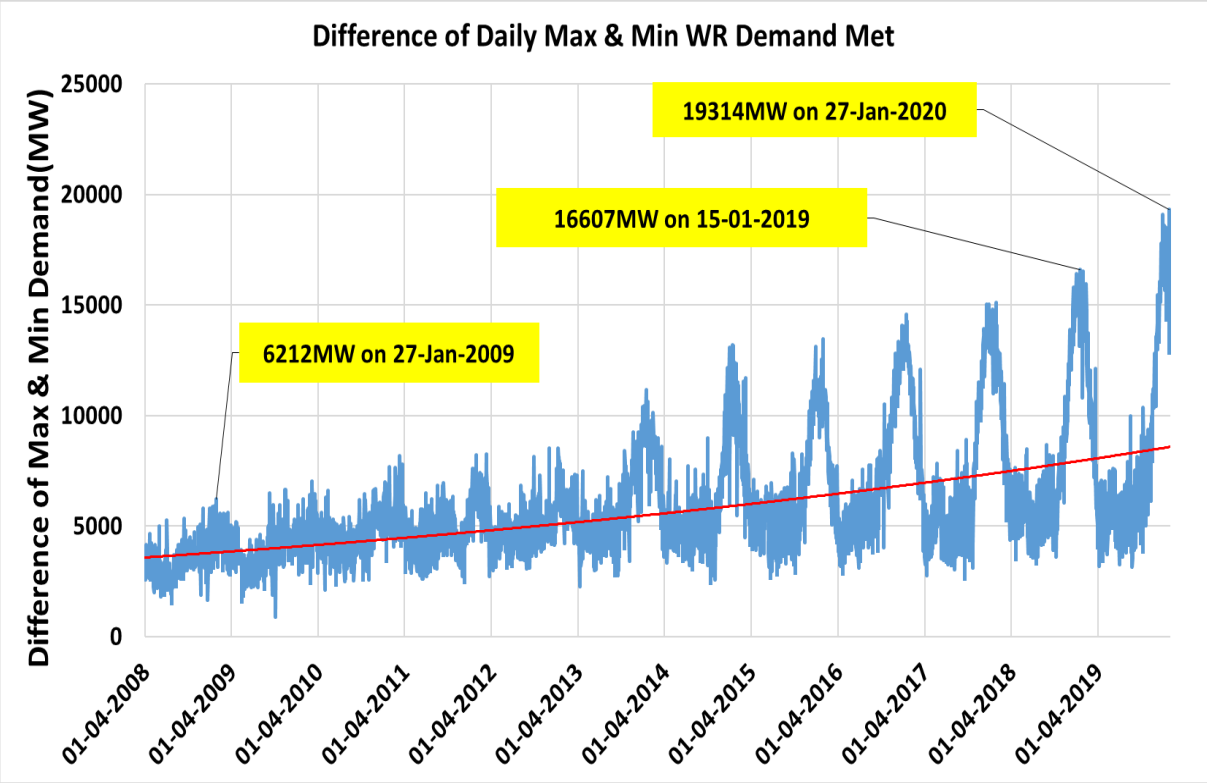


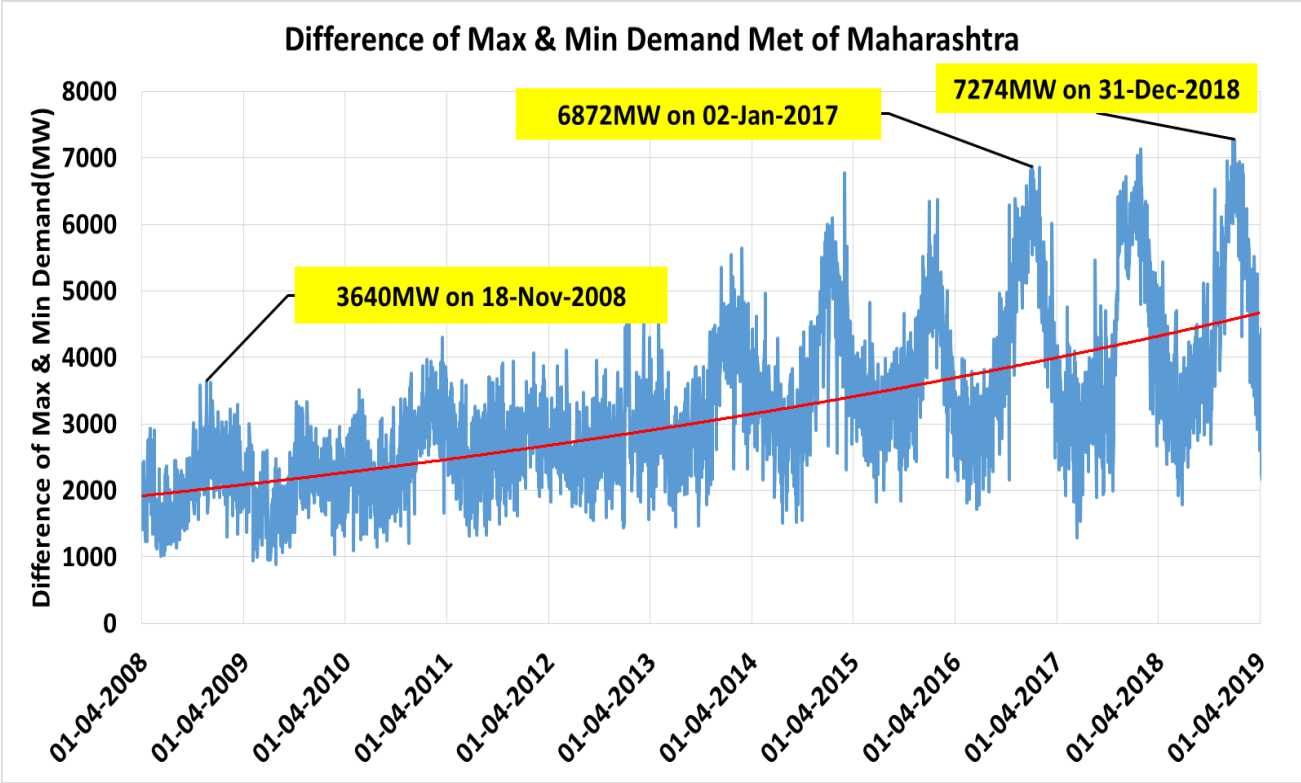


All India: -10 GW to + 14 GW

WR: -4 GW to + 6 GW

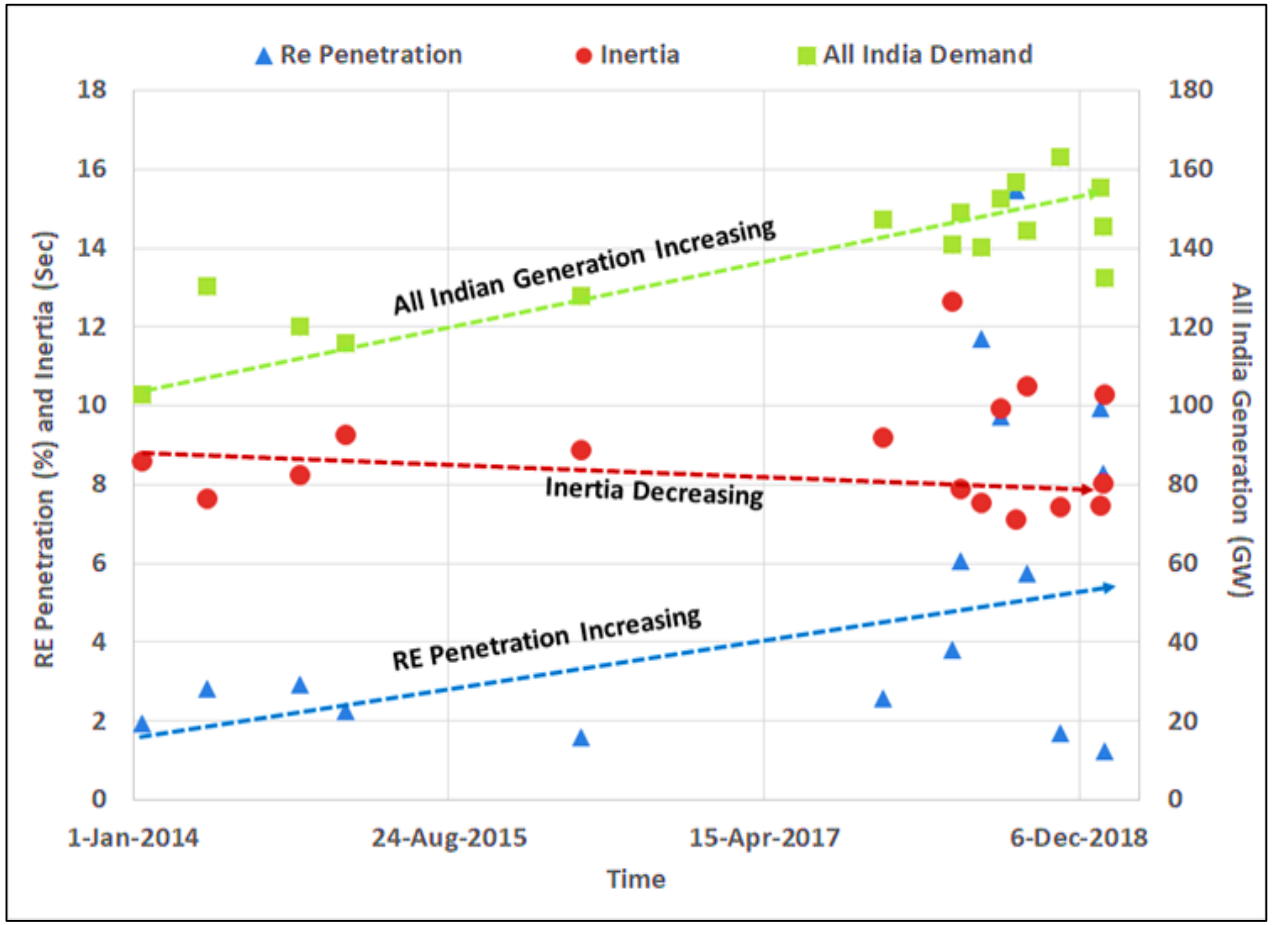
Increasing Diurnal variation in Net load

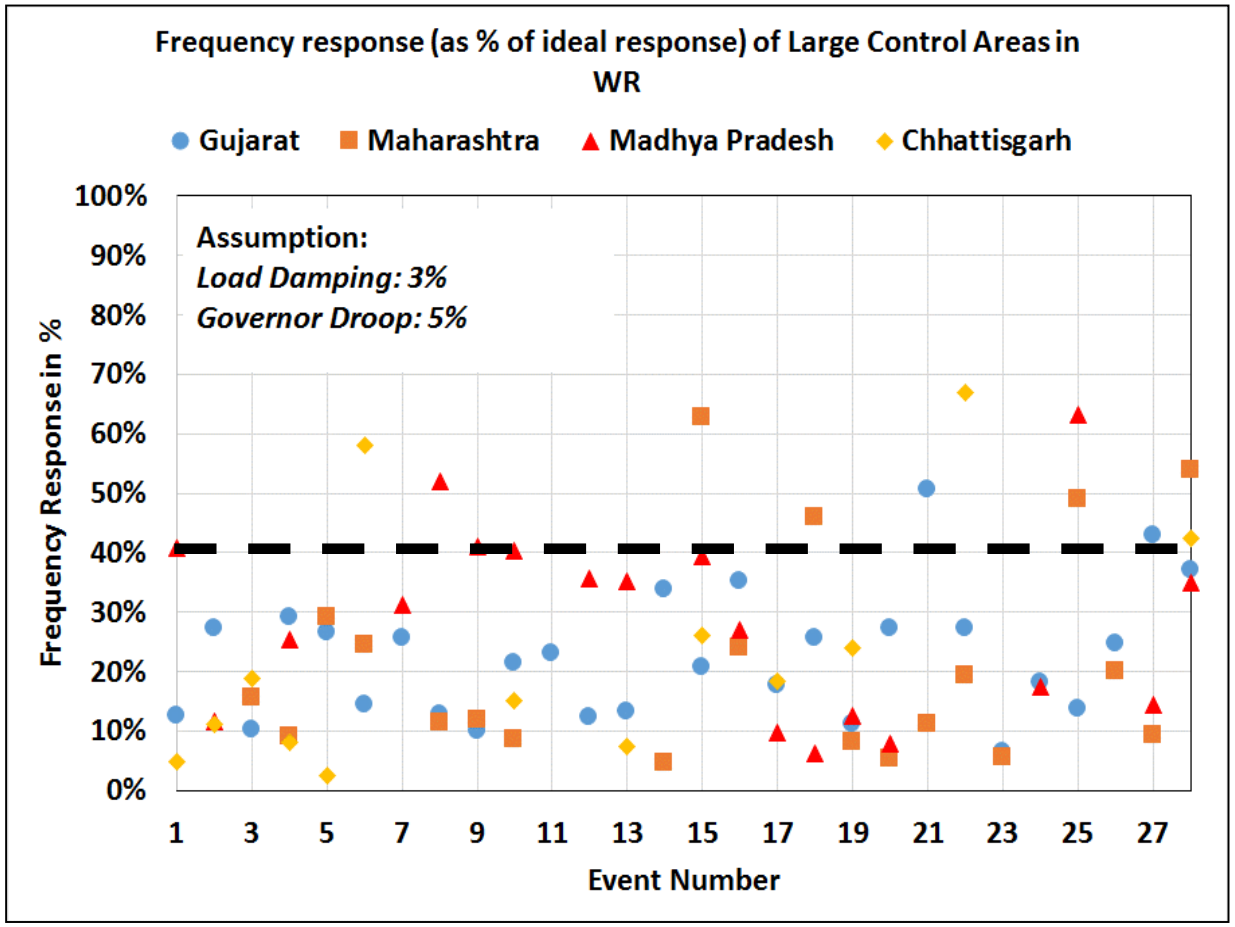




Flexibilization of conventional coal-fired is inevitable

Decreasing System Inertia with RE penetration

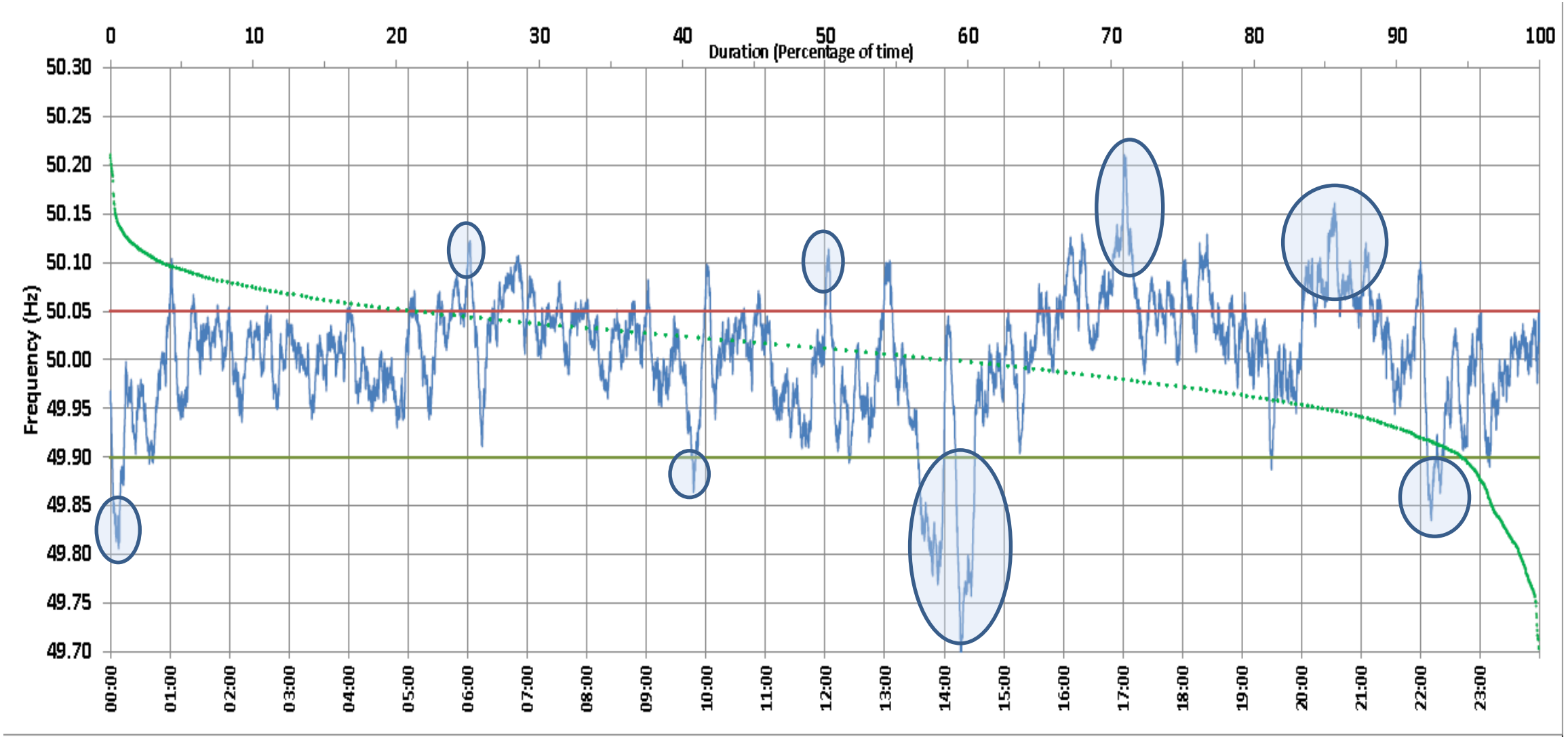




Gujarat:	870 MW/Hz
Maharashtra:	540 MW/Hz
Madhya Pradesh:	290 MW/Hz
Chhattisgarh:	15 MW/Hz

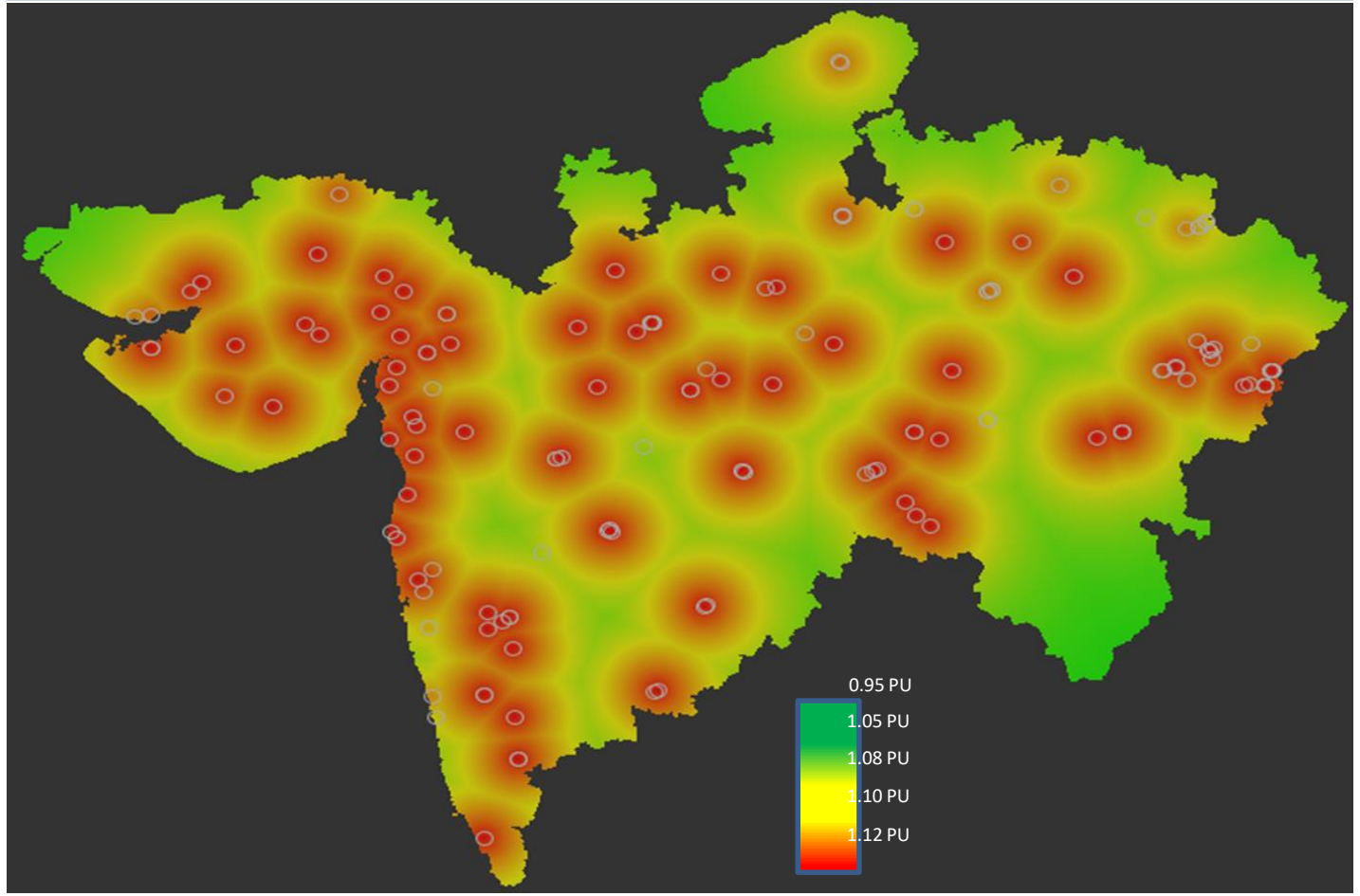
Median FRC for 28 Events

Schedule leaps - frequency excursions



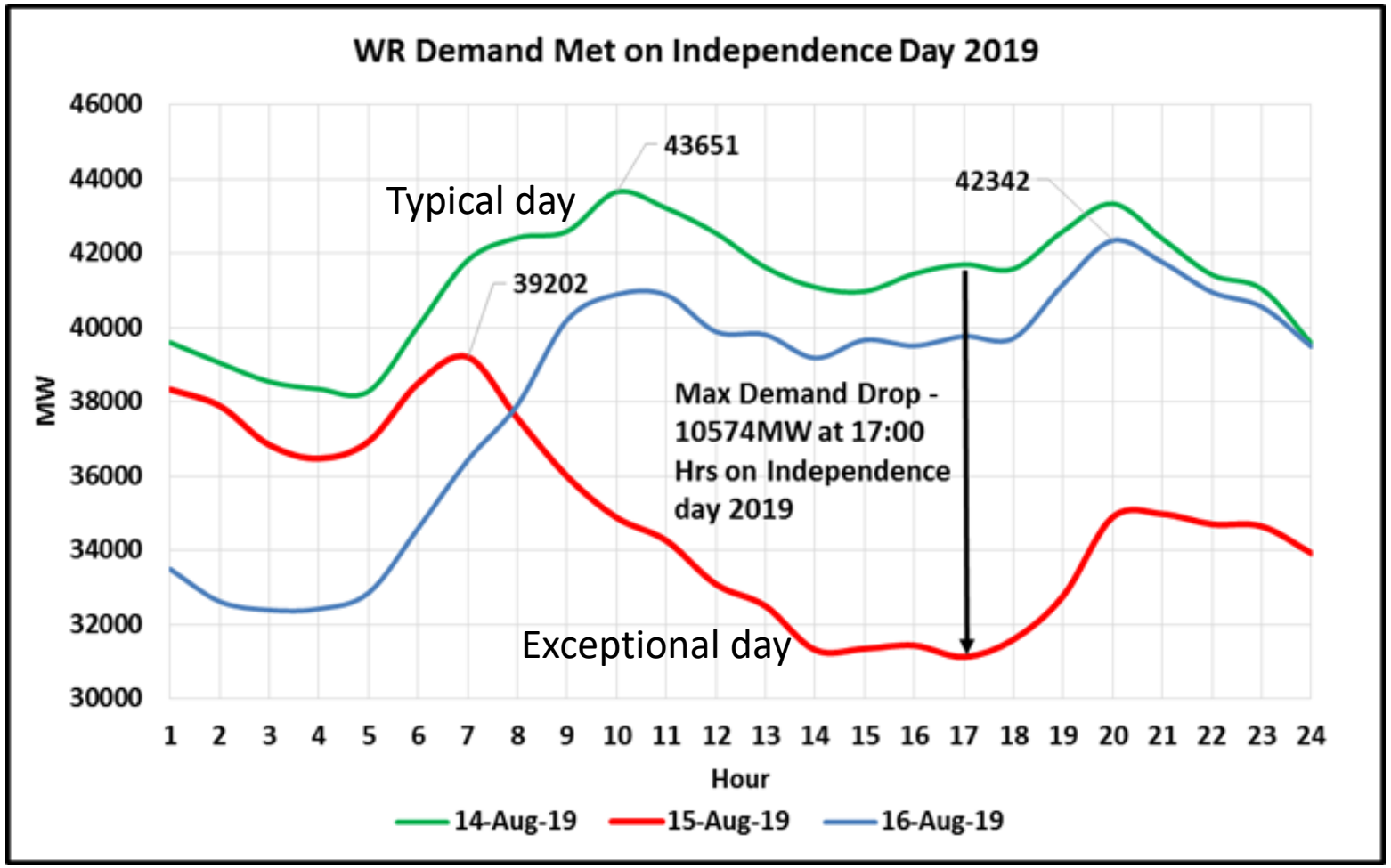
Voltage profile

Western Regional Grid of India



- **Low demand during night hours**
- **Lightly loaded lines**
- **Persistent high voltage in grid**

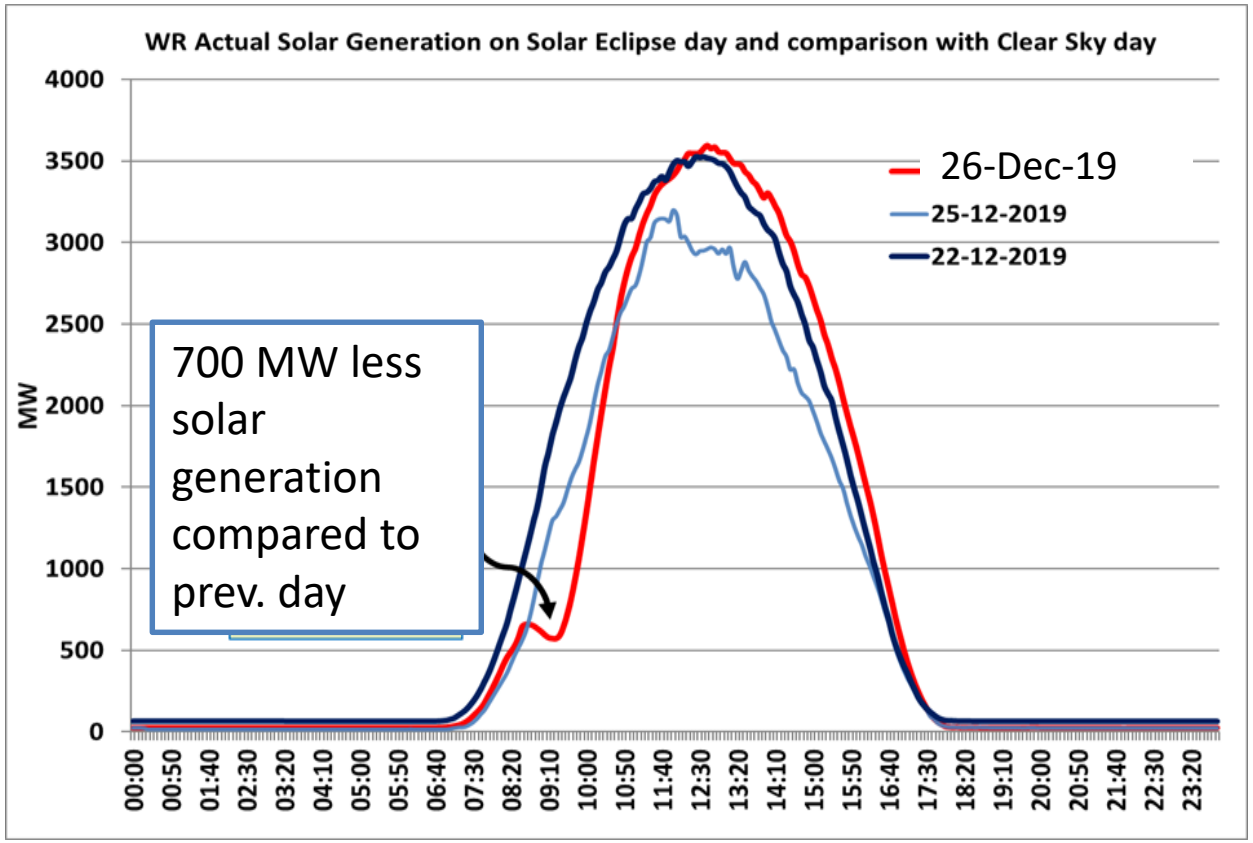
Low probability high impact events: Demand crash

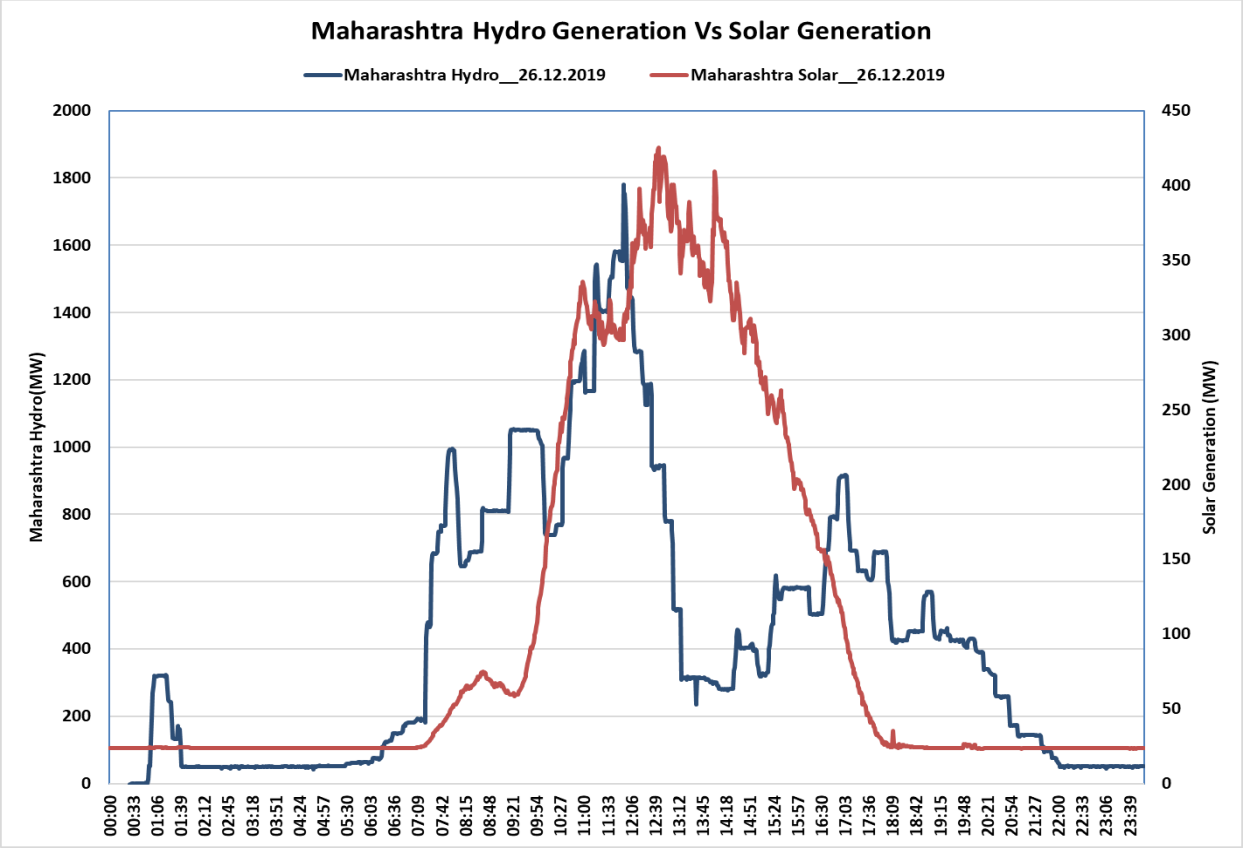


Actions taken to ensure 100% RE absorption

- **8 GW Gen back down**
- **Nuclear Gen reduction**
- **All reactors put back to service**
- **Max MVAR absorption by Generators**
- **34 EHV lines opened on voltage regulation**

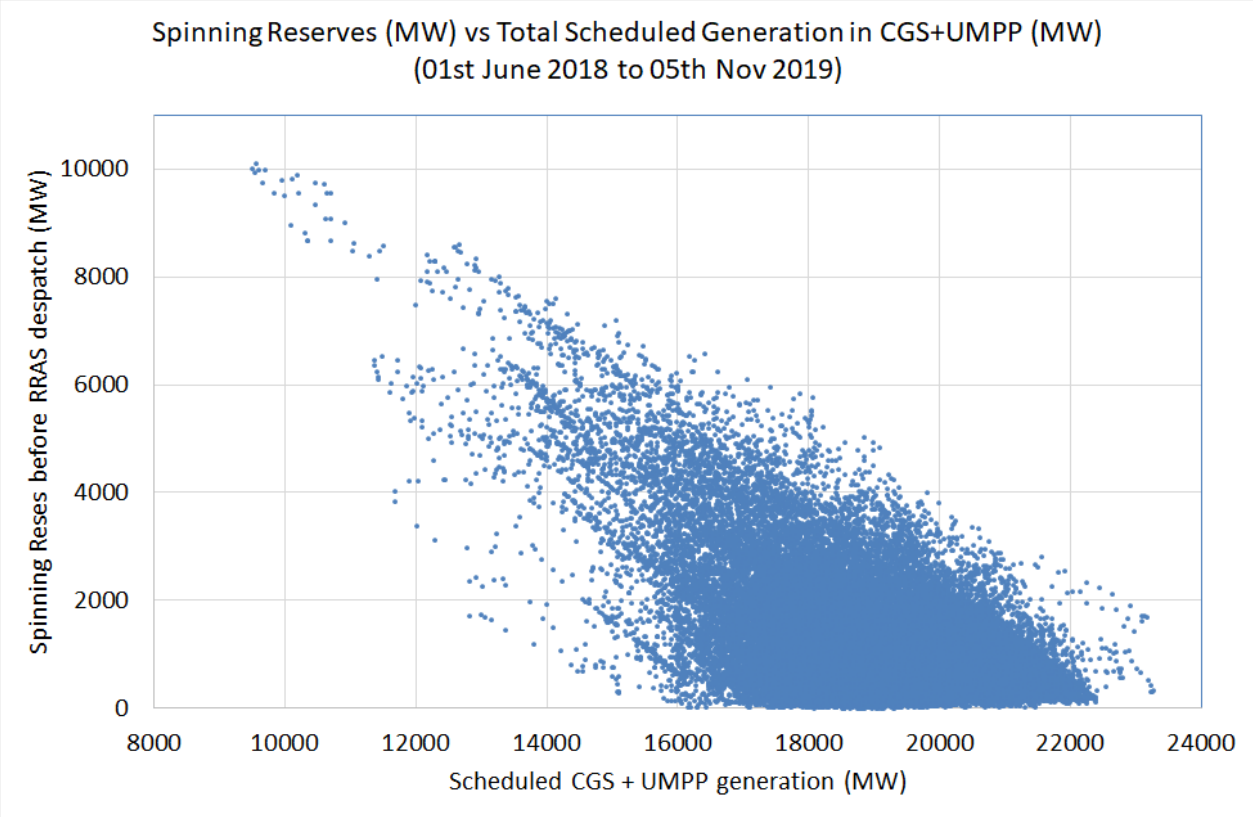
Low probability high impact events: Solar Eclipse

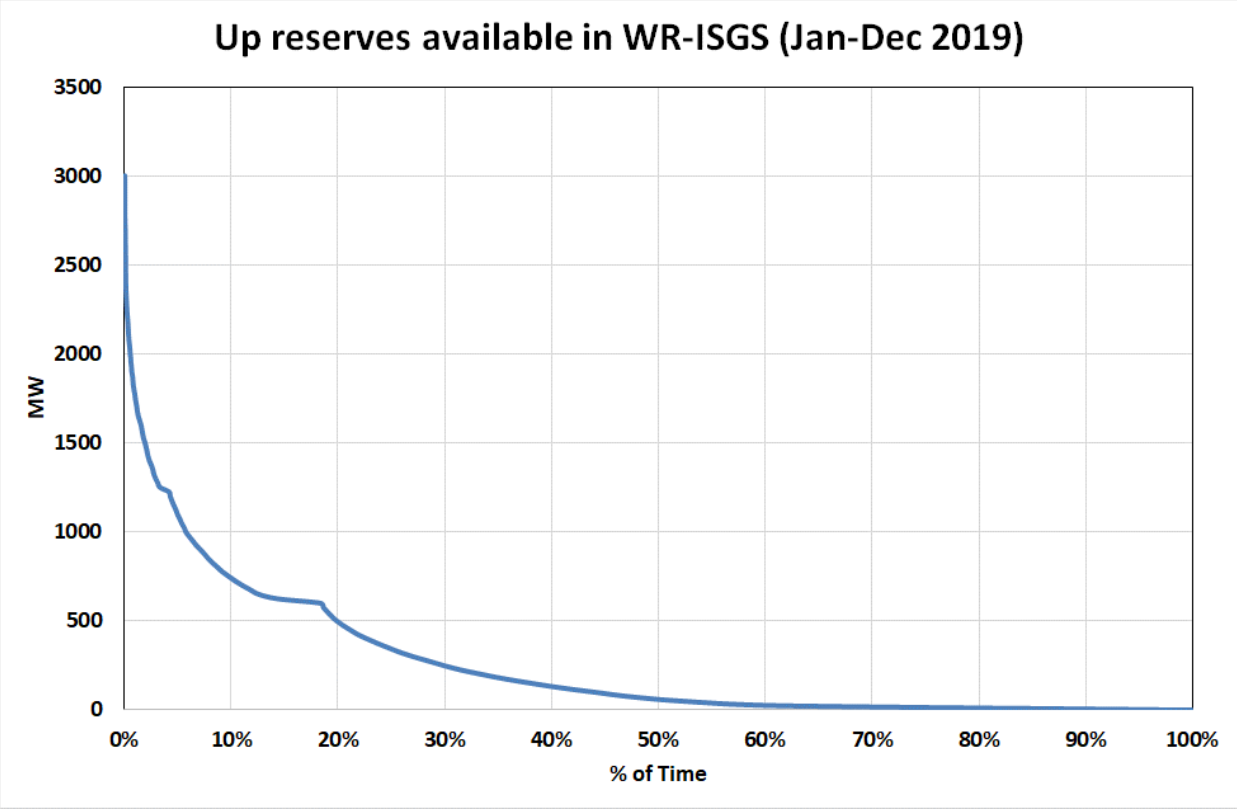




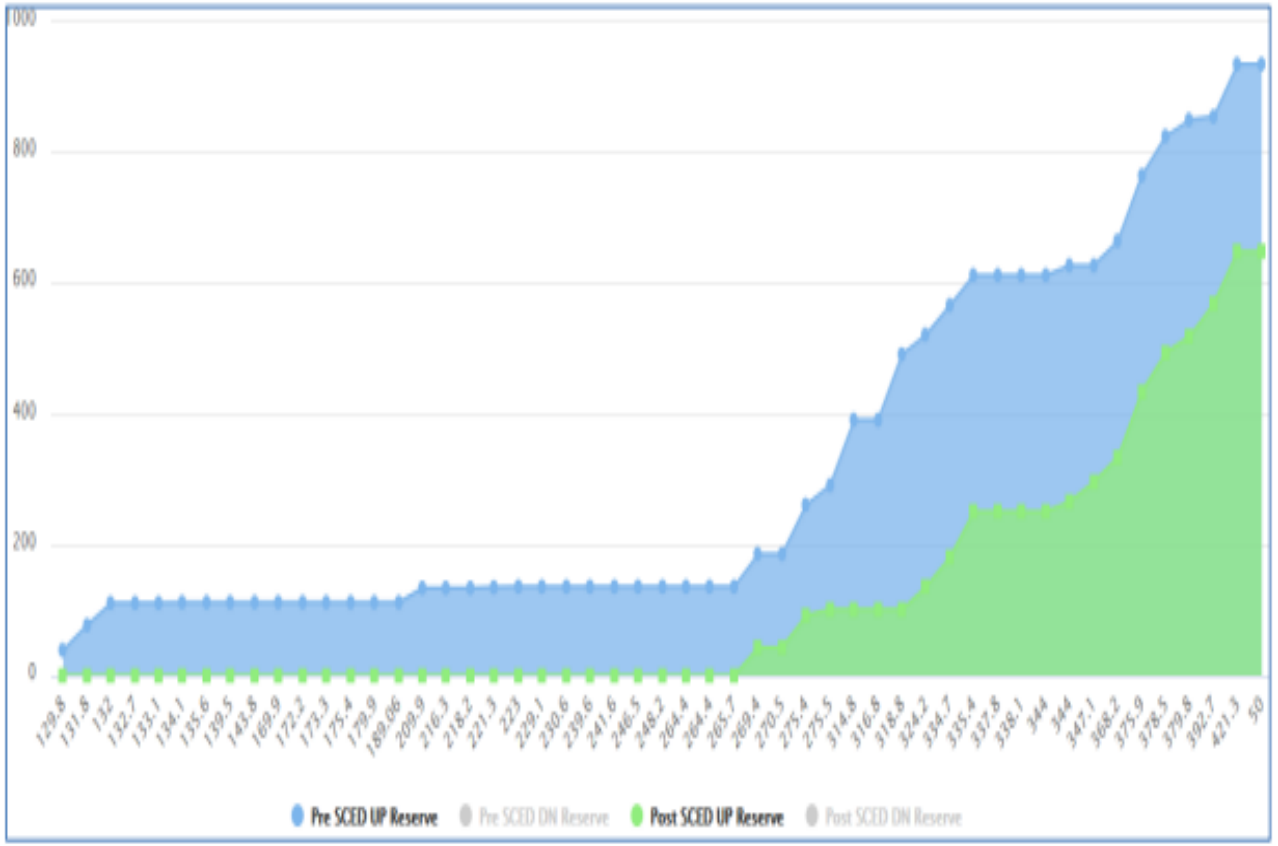
- Forecast closely matched with actual
- 1.8 GW Load drop during solar eclipse
- Load increased post eclipse

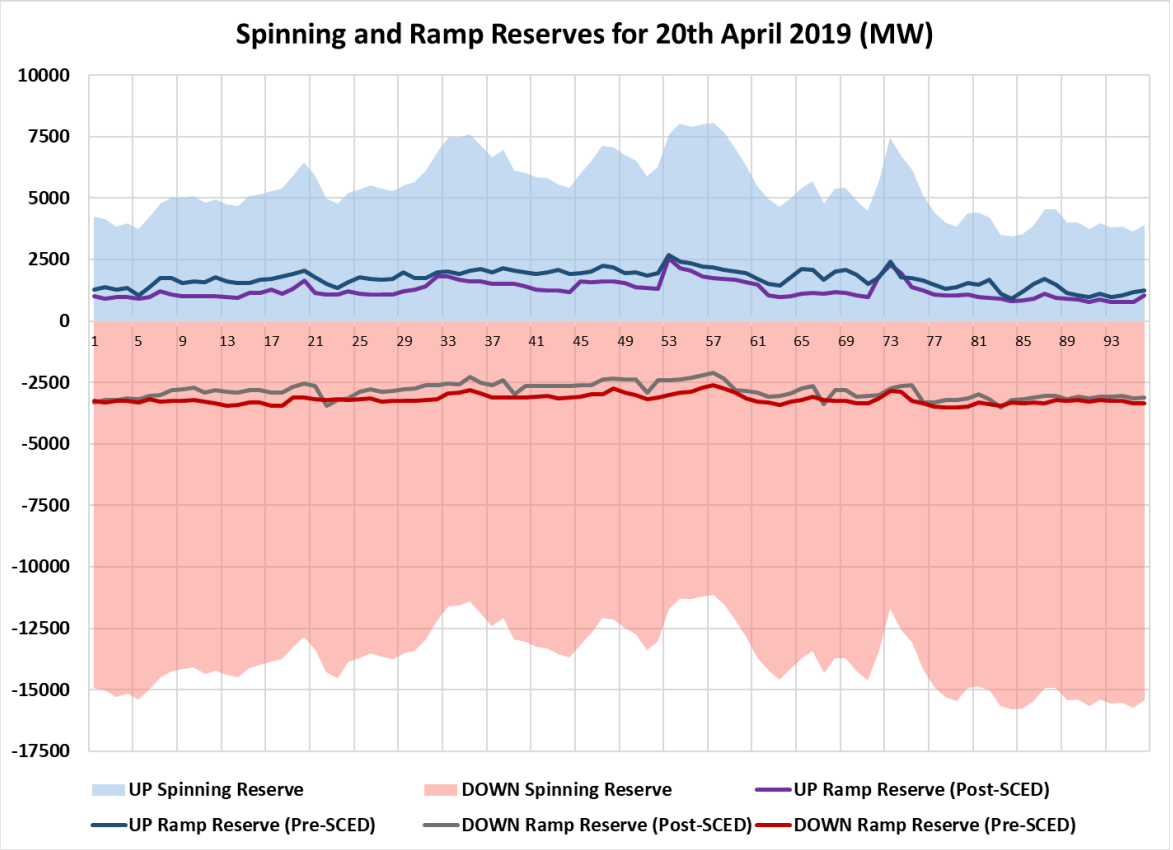
Spinning reserves



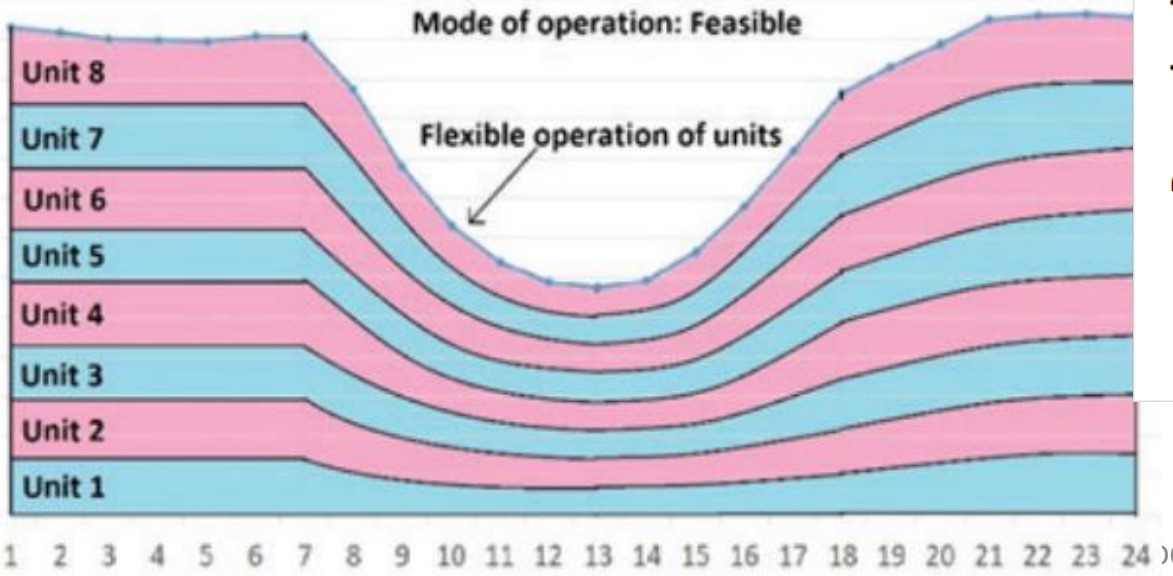


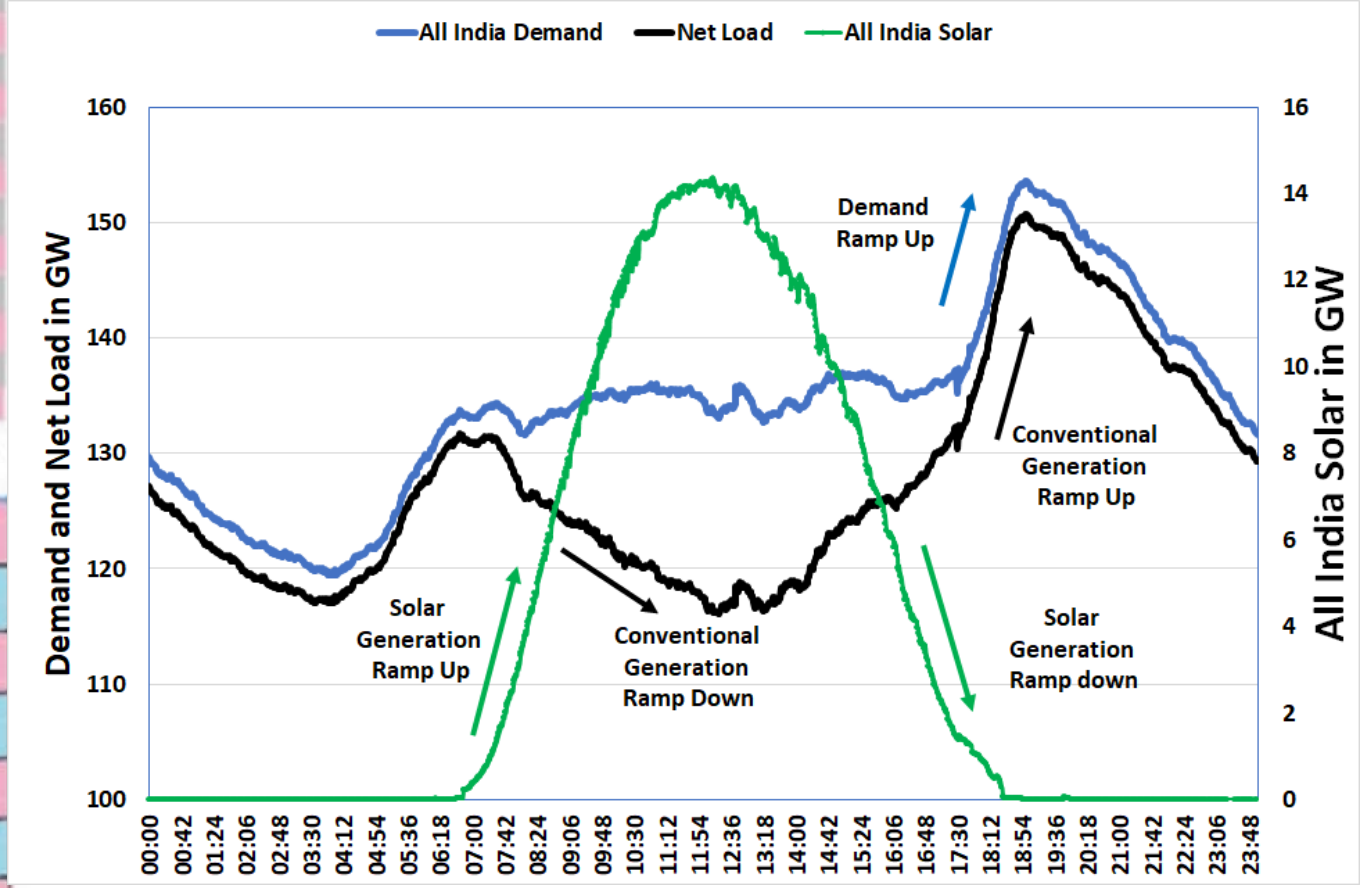
Optimization – Ramping constraints



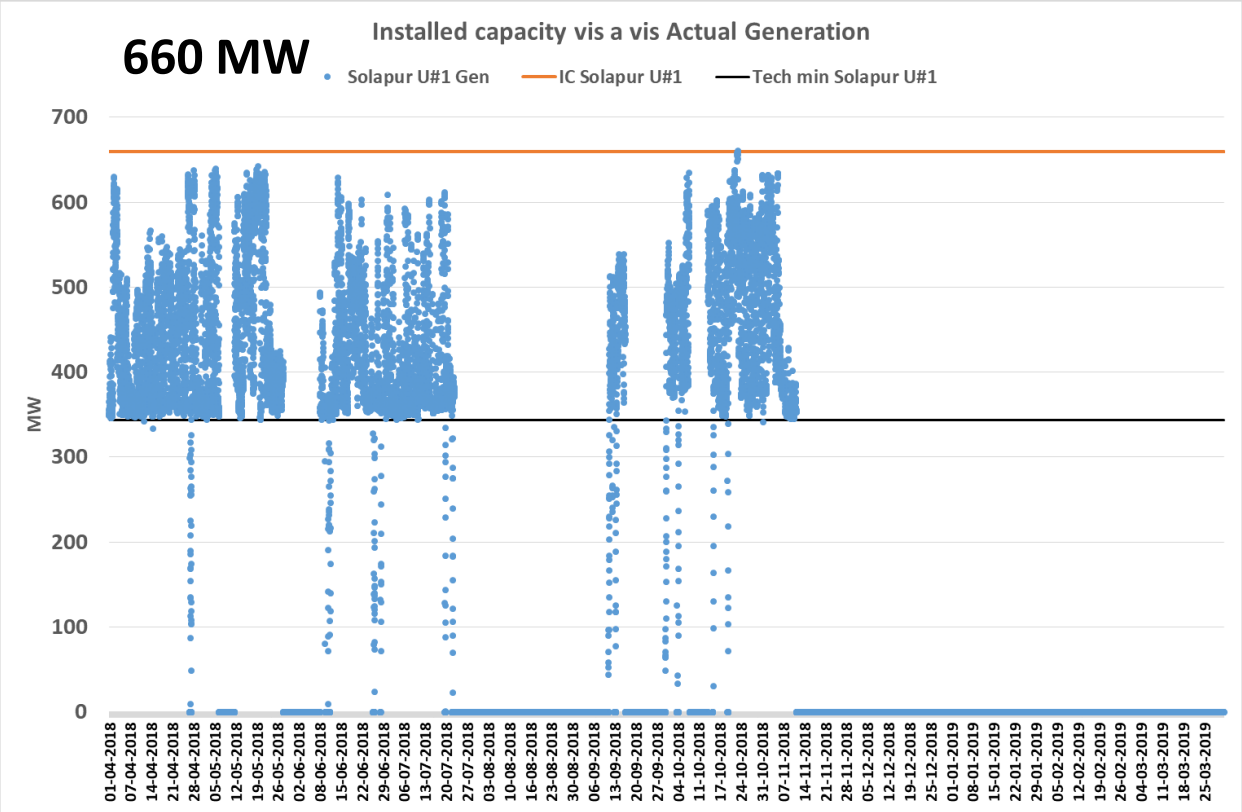


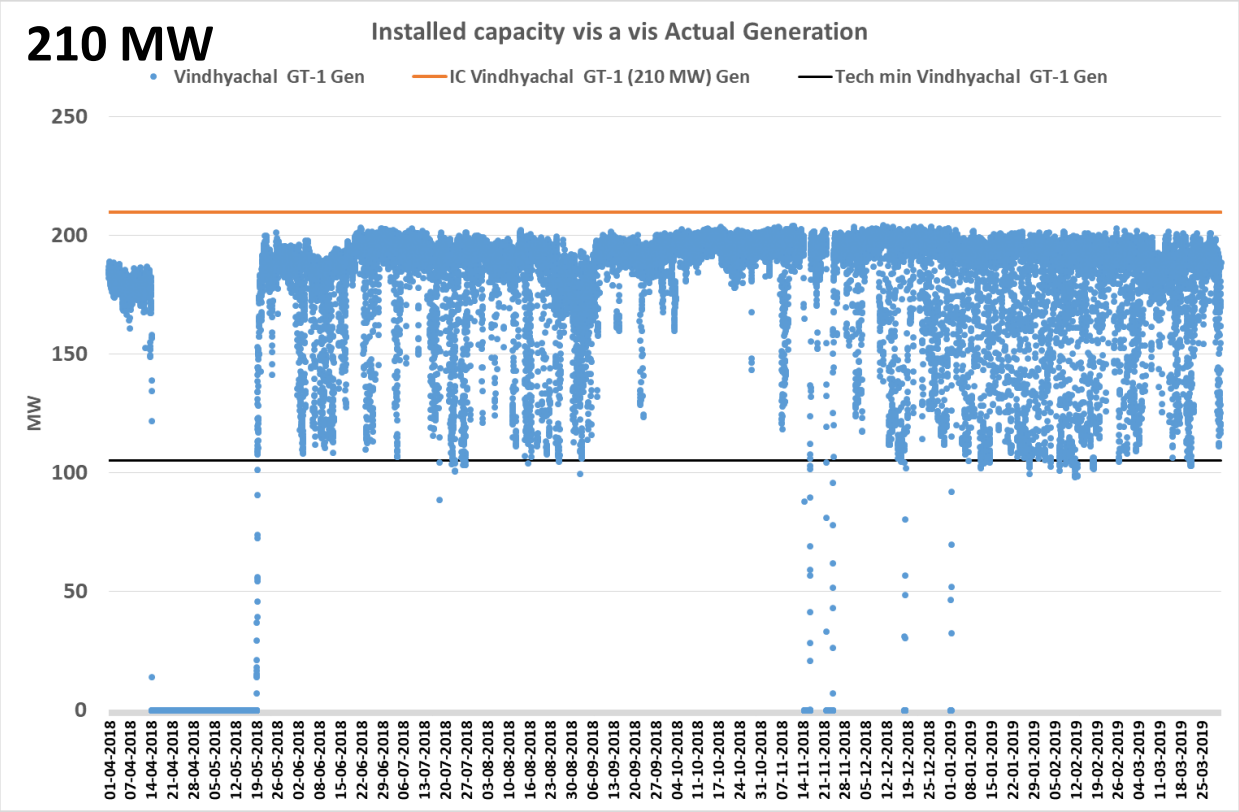
The choice before coal-fired stations



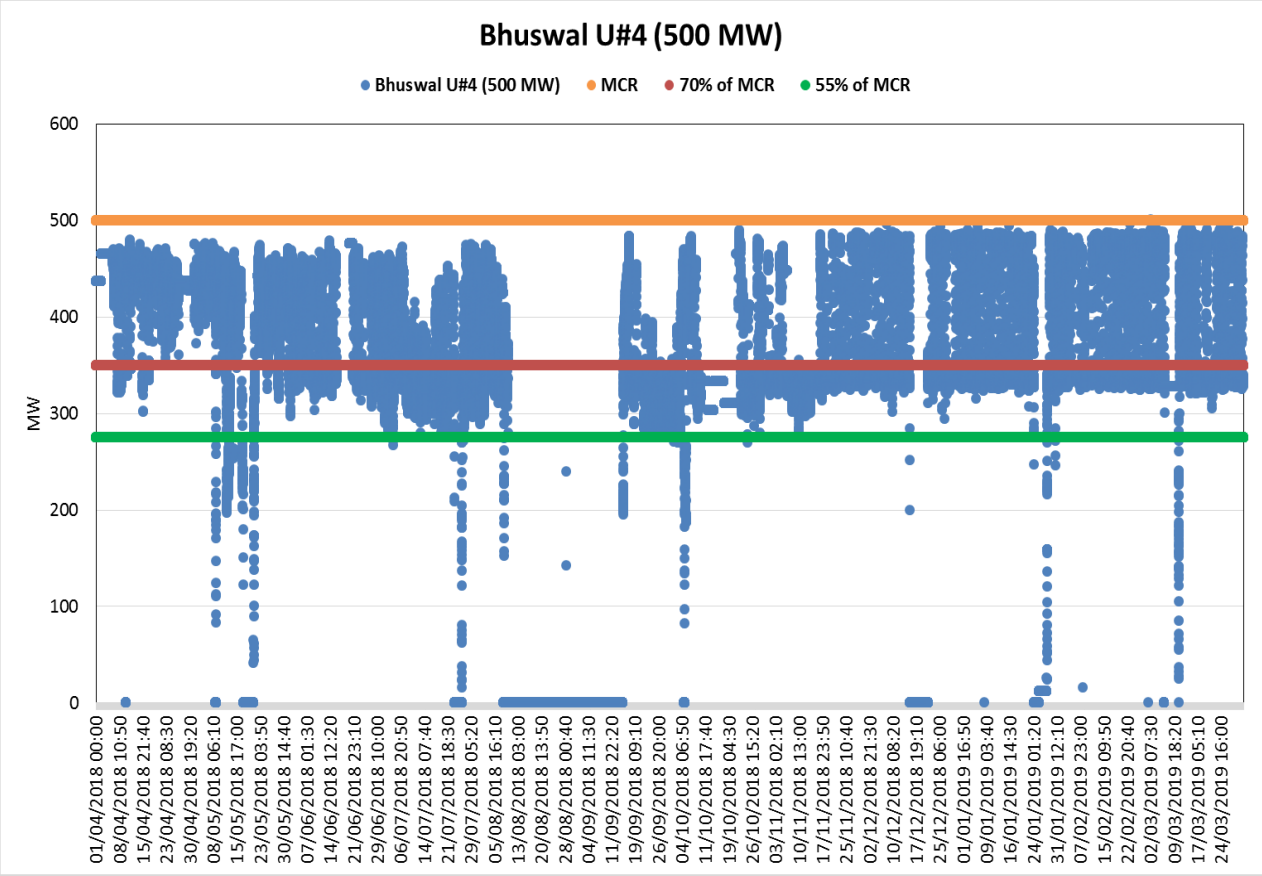


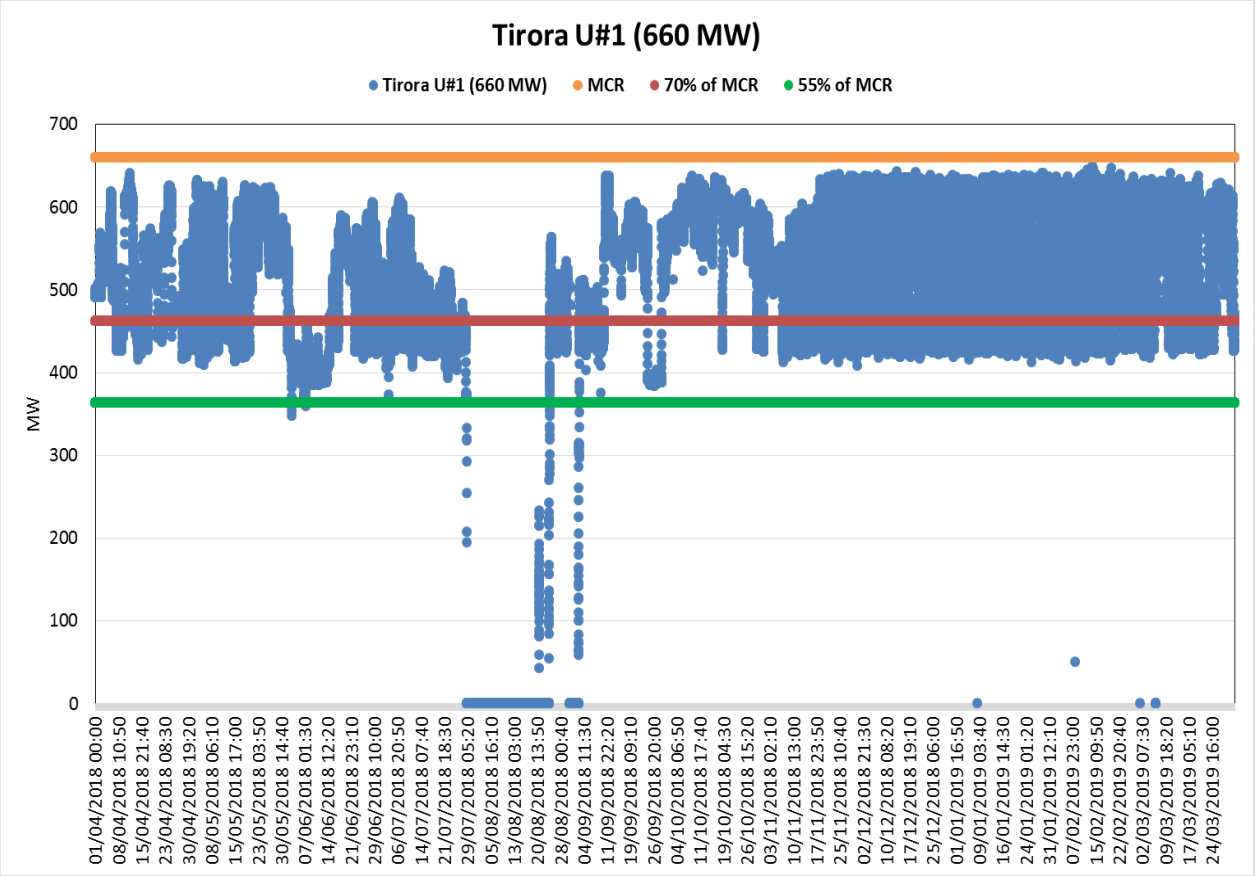
Turn down level: typical ISGS



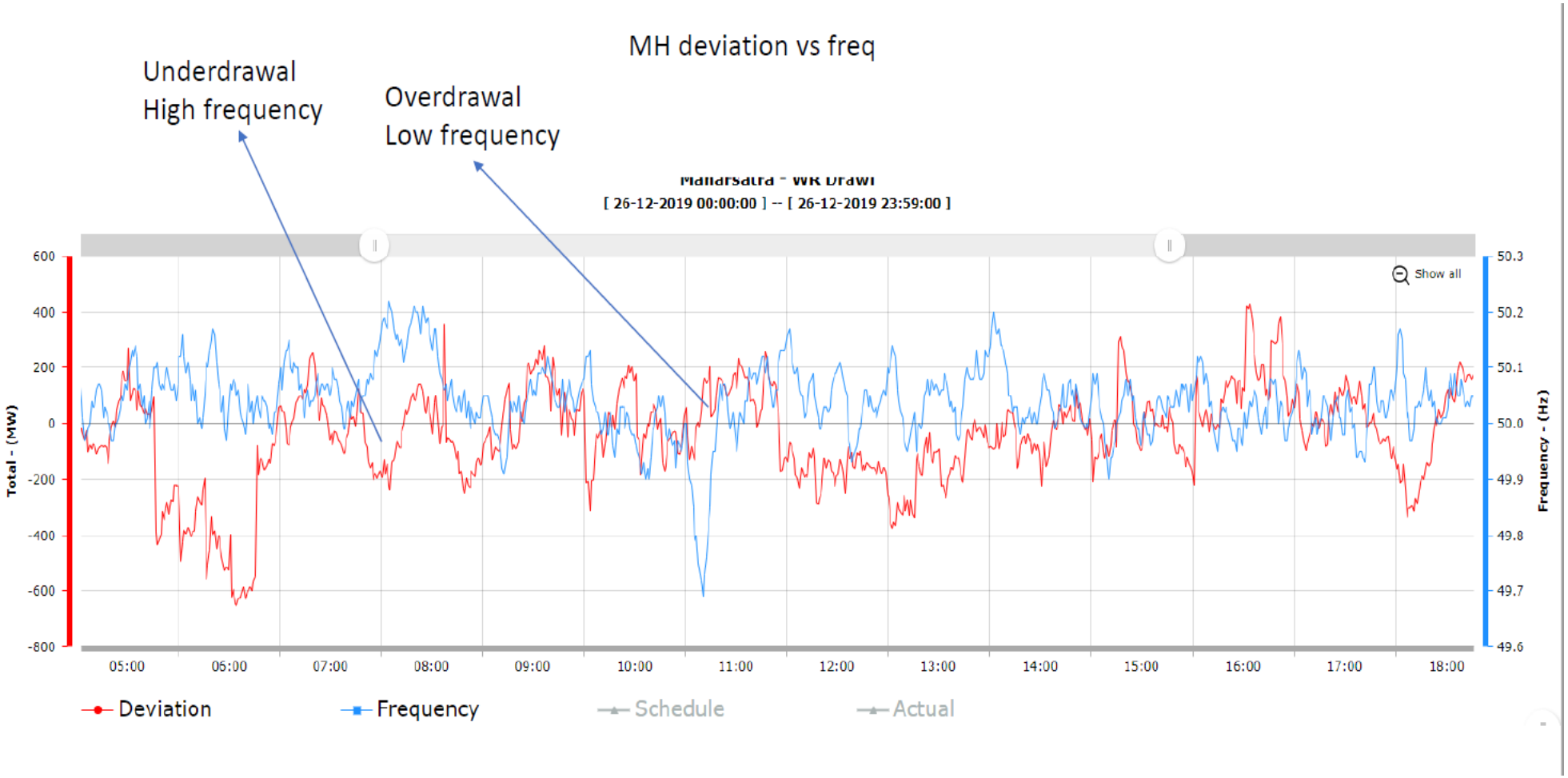


Turn down levels – Maharashtra units



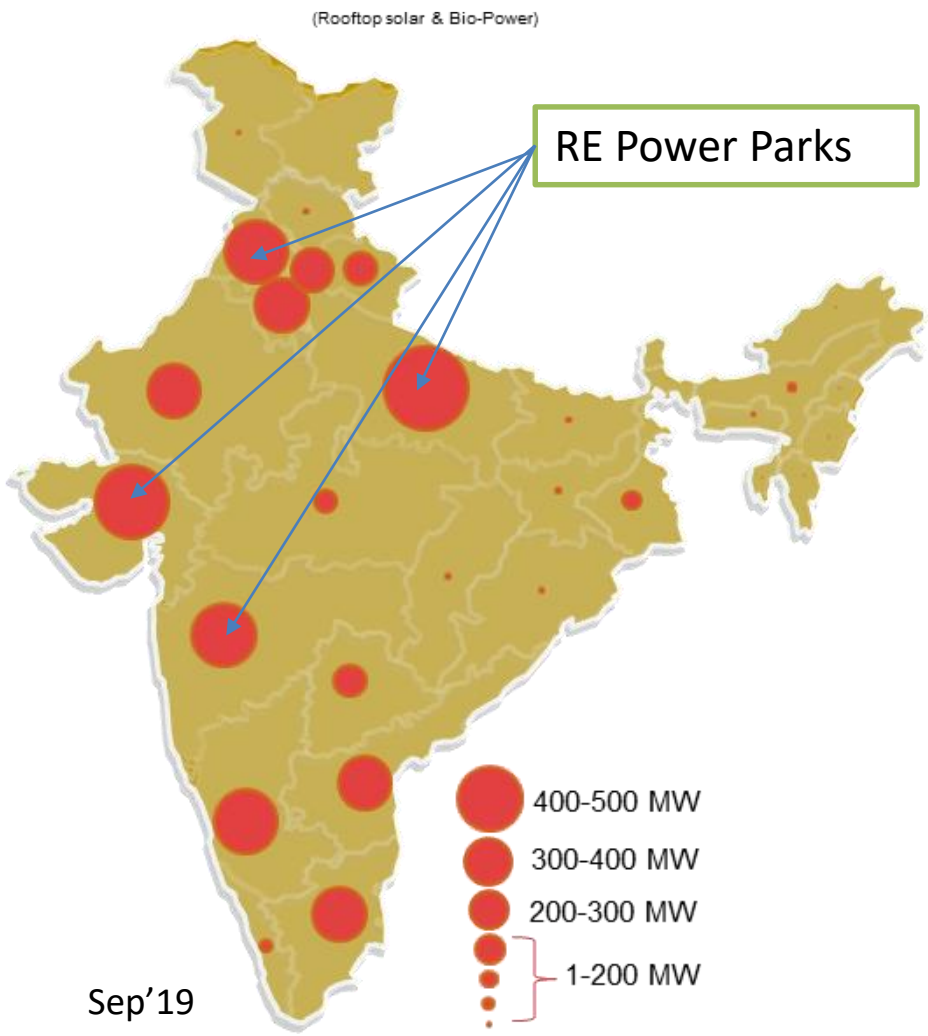


Flexible reserves essential for regulating the Area control Error

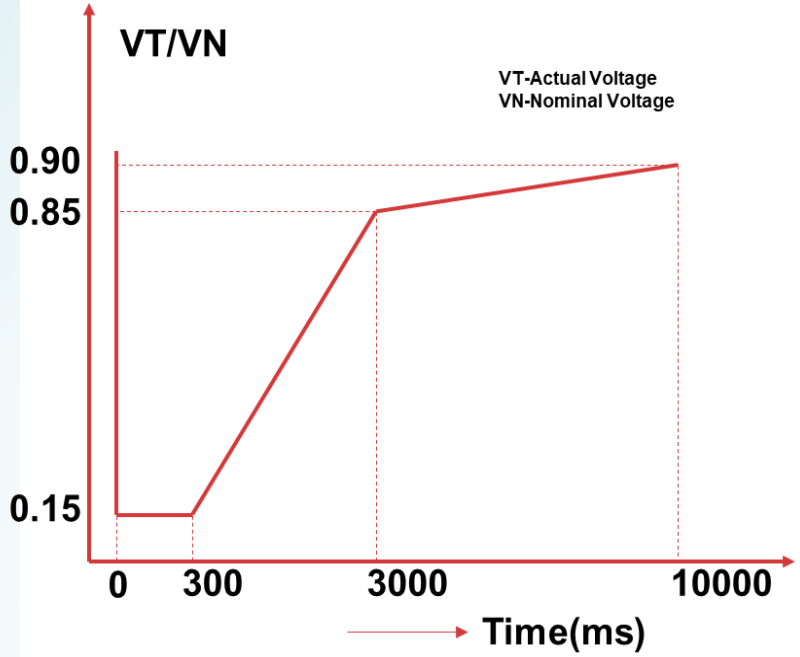


Way Ahead for the RE rich states

Observability and Reliability

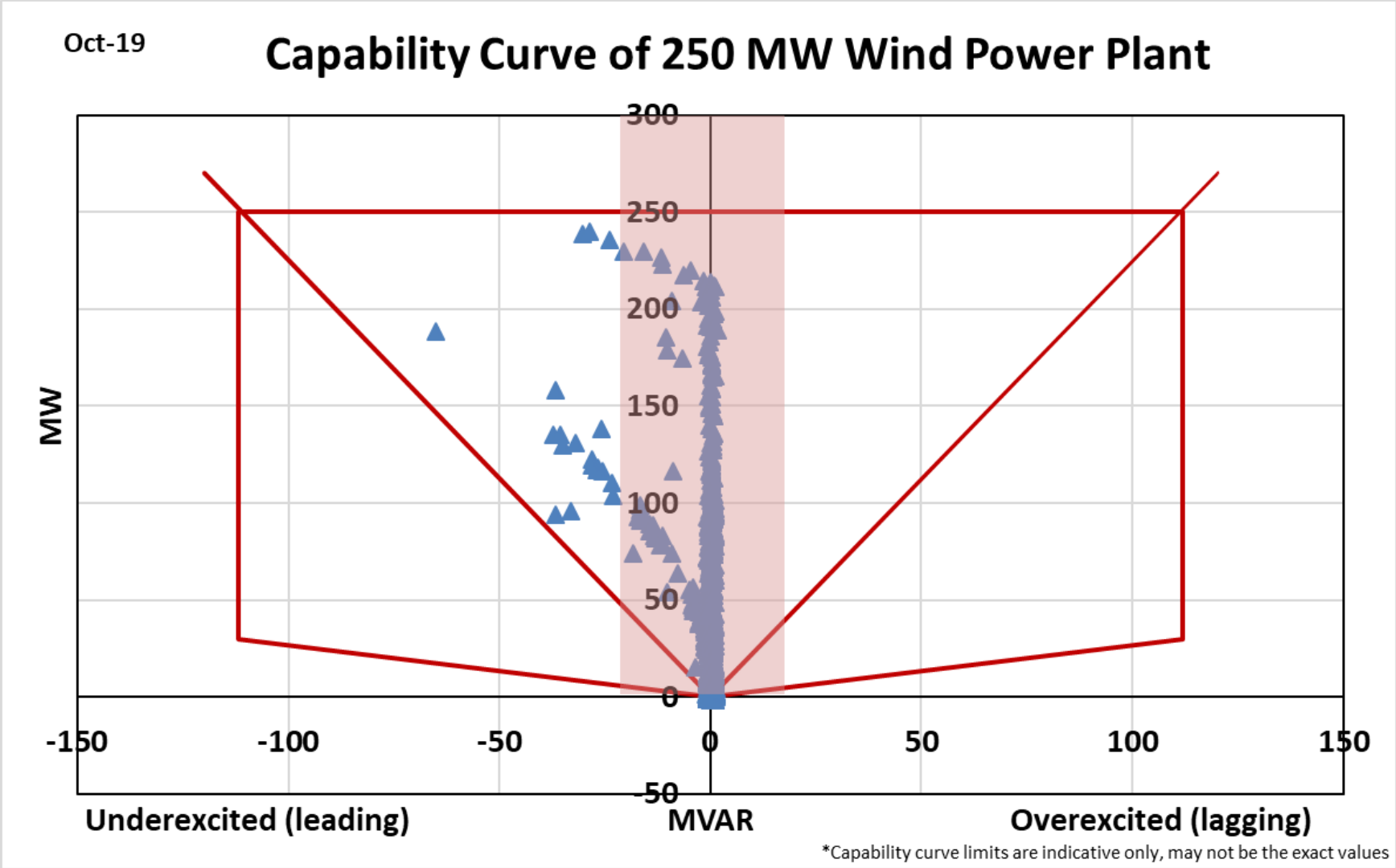


- **Reliability concerns associated with VRE-UMPP evacuated through pooling stations**
- **Field testing of LVRT, HVRT and compliance monitoring mechanism evolving**
- **Observability of DERs (40 GW roof top solar by 2022) to be tackled**



LVRT

Reactive support from VRE



Balancing paradigms in the Indian context

Chronic shortage Load follow generation	Harnessing diversity	Enhance market access, liquidity	Surplus Capacity Generation follow load Optimization
Enlarging footprints of Synchronous balancing area	Narrowing frequency band	Passive balancing through imbalance price signals	Active balancing through reserves and ancillary services
Floating frequency	Mandated primary response	Rescheduling Coupling DSM rate with day-ahead market	RRAS 50 Hz as ref. frequency Pilots FRAS, AGC, SCED

RE-rich States ACE data analysis (2018-19)

State	99 percentile	99 percentile
	Positive ACE (MW)	Negative ACE (MW)
Maharashtra	640	538
Gujarat	576	625
Madhya Pradesh	636	582
Andhra Pradesh	672	560
Telangana	620	595
Karnataka	638	768
Tamil Nadu	720	630
Rajasthan	718	788

Active balancing

Determine capacity

Acquire capacity

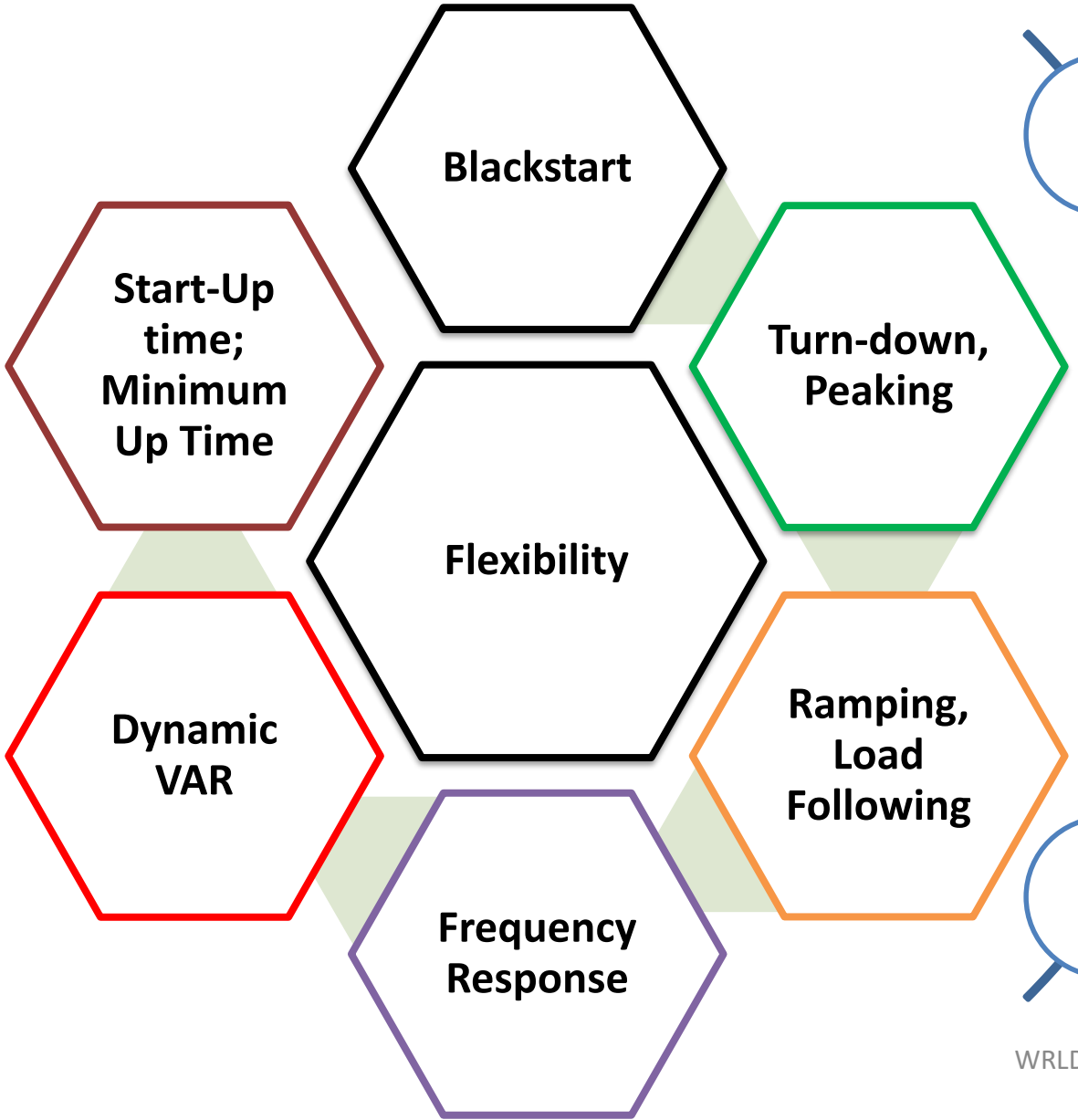
Activate balancing power

Financial clearing & Settlement

Deterministic or Stochastic

Regulated or competitive

Summary



- Compliance of standards
- Reactive ancillary services
- Real-time market
- Reserves & Active balancing
- Fast scheduling (5 min)

Thank you for your kind attention !

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