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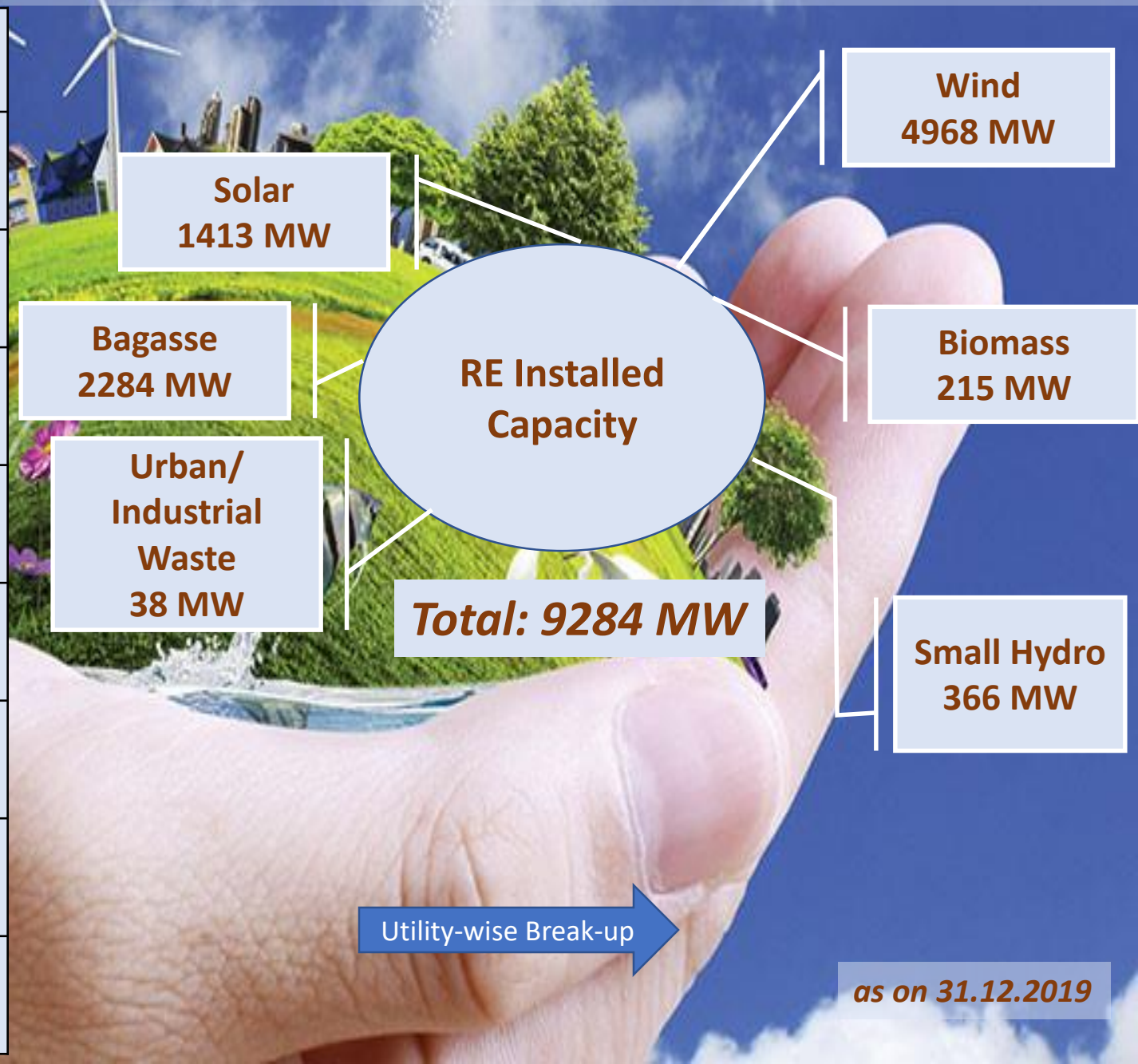
Maharashtra State Electricity Transmission Co. Ltd.

Challenges & developments in today's system operation and power transmission in Maharashtra

18.02.2020

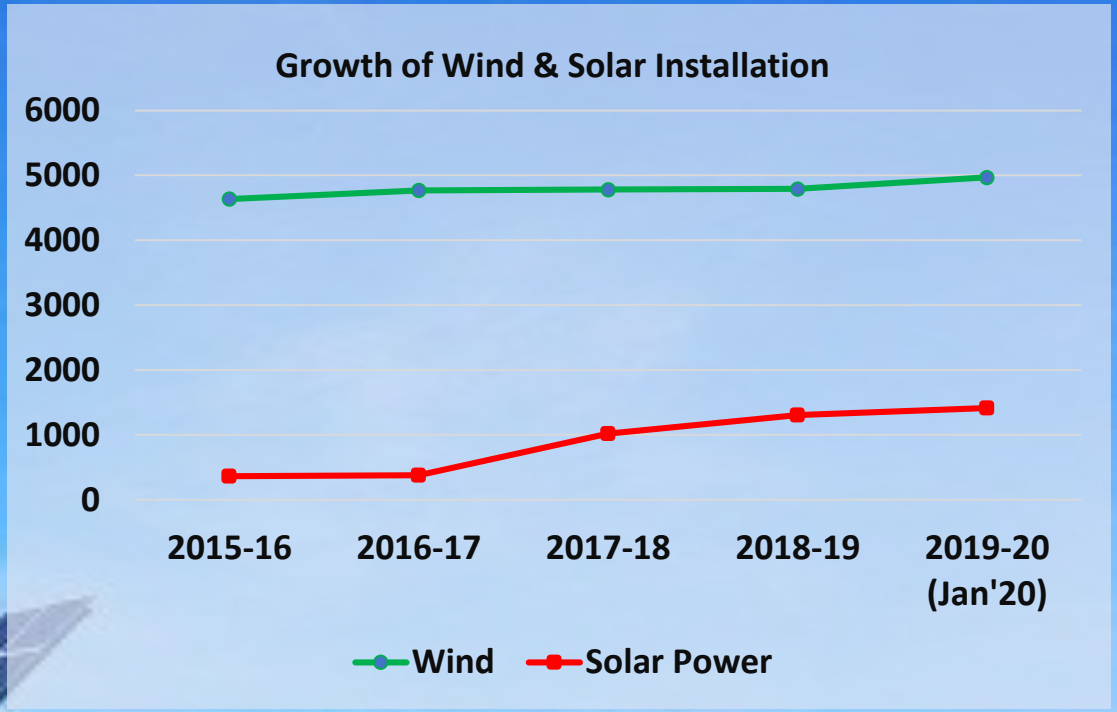
Total Intra State Generation Installed Capacity of Maharashtra

Type of Generation	Capacity (MW)	Percentage of Total
Thermal	20560	60 %
Hydro	2941	9 %
Gas	1240	4 %
Nuclear	0	0 %
Wind	4968	15 %
Solar	1413	4 %
Other RE	2903	9 %
Total	**34025**	



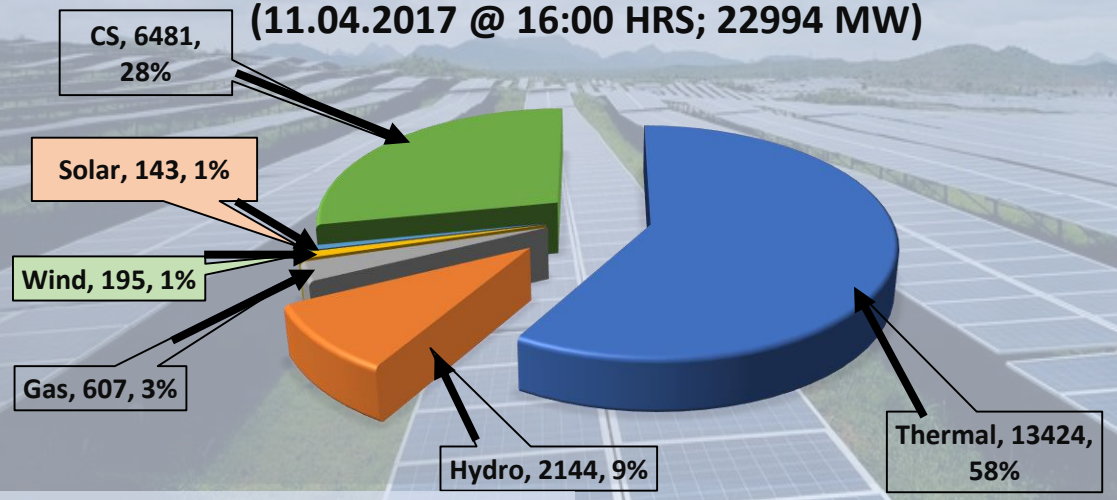
Growth of RE Installed Capacity in Maharashtra

Type of RE	2015-16	2016-17	2017-18	2018-19	2019-20 (Jan'20)
Wind	4636	4769	4782	4792	4968
Small Hydro	284	300	336	366	366
Bio-Mass	200	215	215	215	215
Bagasse Co-Gen	1415	1849	1954	2284	2284
Urban Waste	3	3	3	3	3
Solar PV	360	376	1017	1305	1413
Industrial Waste	34	35	35	35	35
Total (MW)	**6932**	**7547**	**8341**	**9000**	**9284**



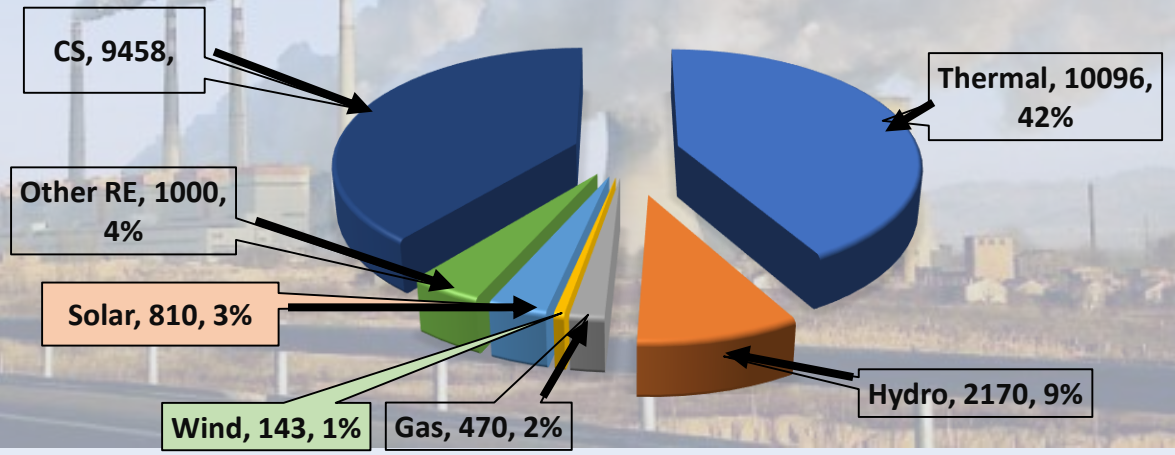
Resources for meeting Catered Peak Demand of Maharashtra for past 3 years

PEAK DEMAND MET (2017-18)
(11.04.2017 @ 16:00 HRS; 22994 MW)

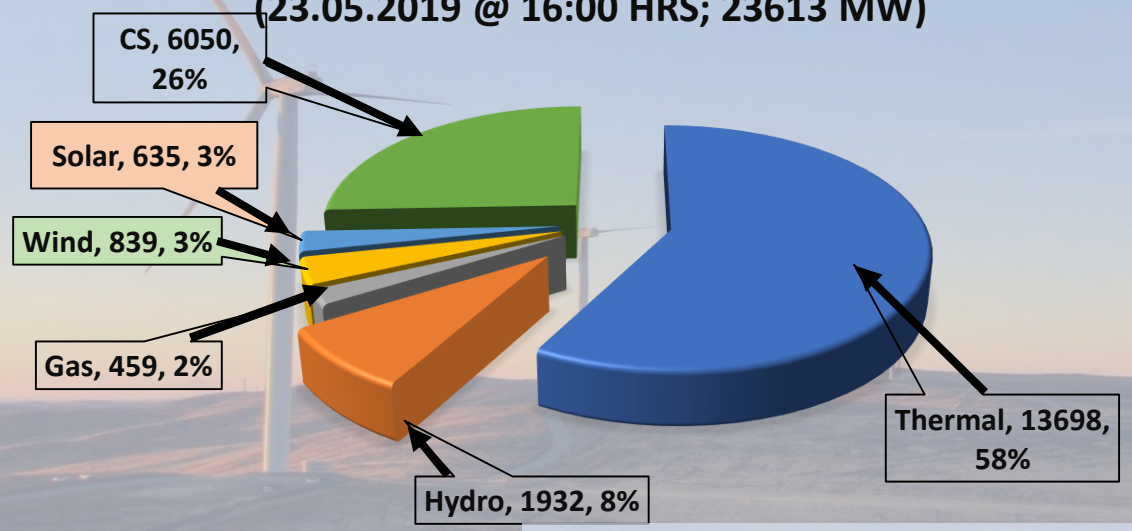


Contribution of other RE is around 0.5 %

PEAK DEMAND MET (2018-19)
(22.10.2018 @ 12:00 HRS; 24146 MW)



PEAK DEMAND MET (2019-20)
(23.05.2019 @ 16:00 HRS; 23613 MW)



Contribution of other RE is around 0.5 %

The Contribution of Wind & Solar Generation in mitigating State Peak Demand is around 3 - 6 %

Demand scenario during Peak Wind Penetration for past 3 years

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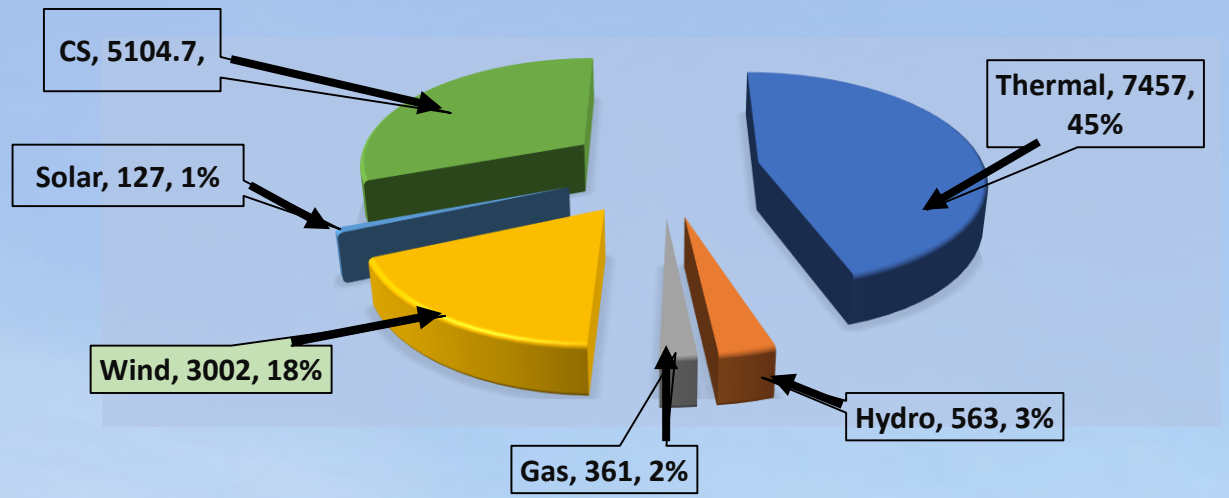
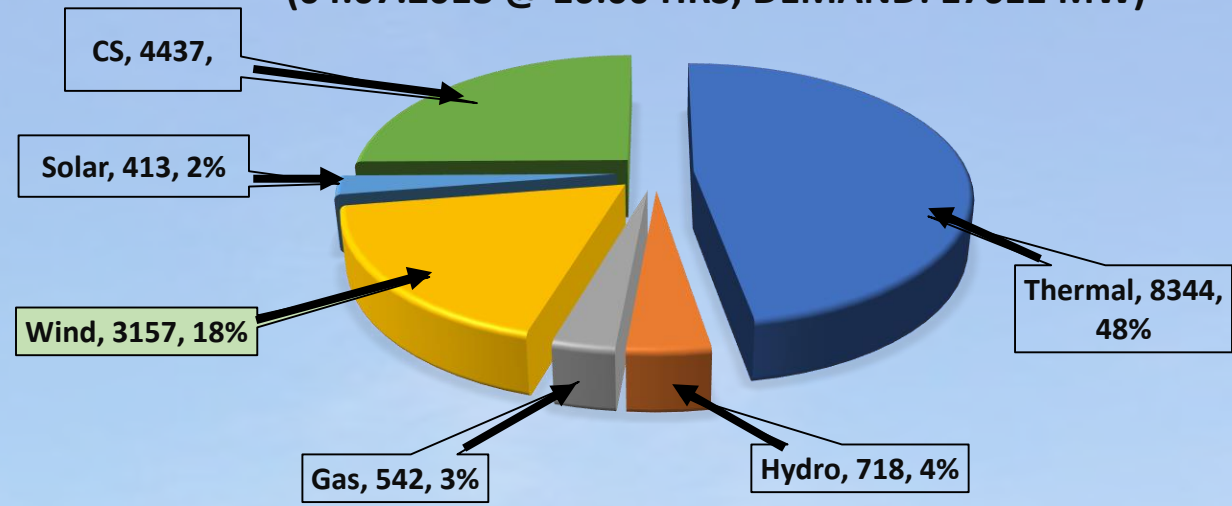
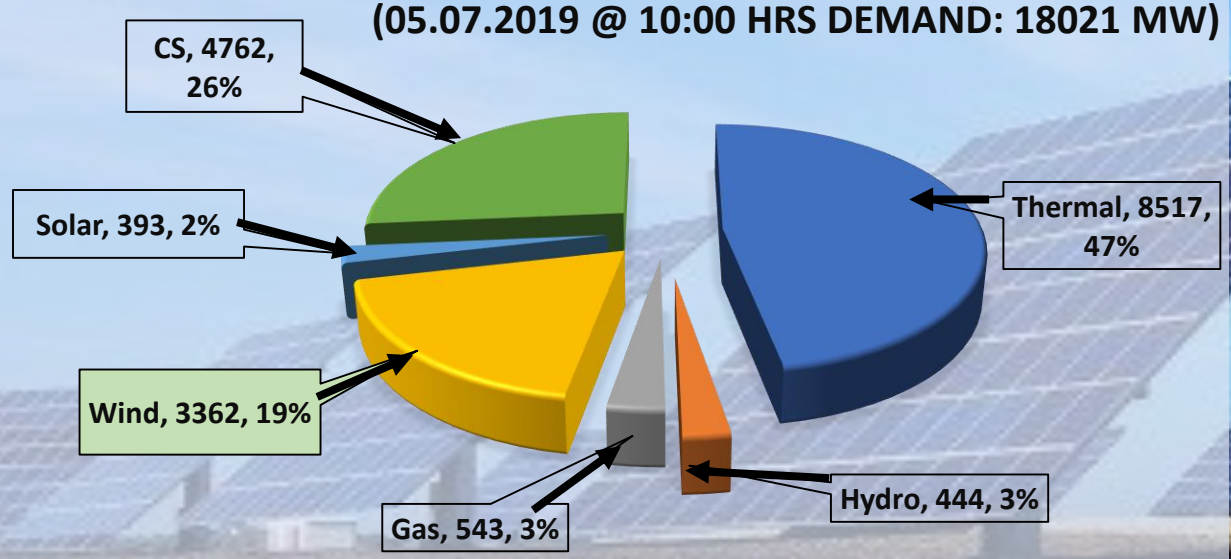
MAX. WIND INJECTION (2017-18)
(24.07.2017 @ 12:00 HRS; DEMAND: 16614 MW)



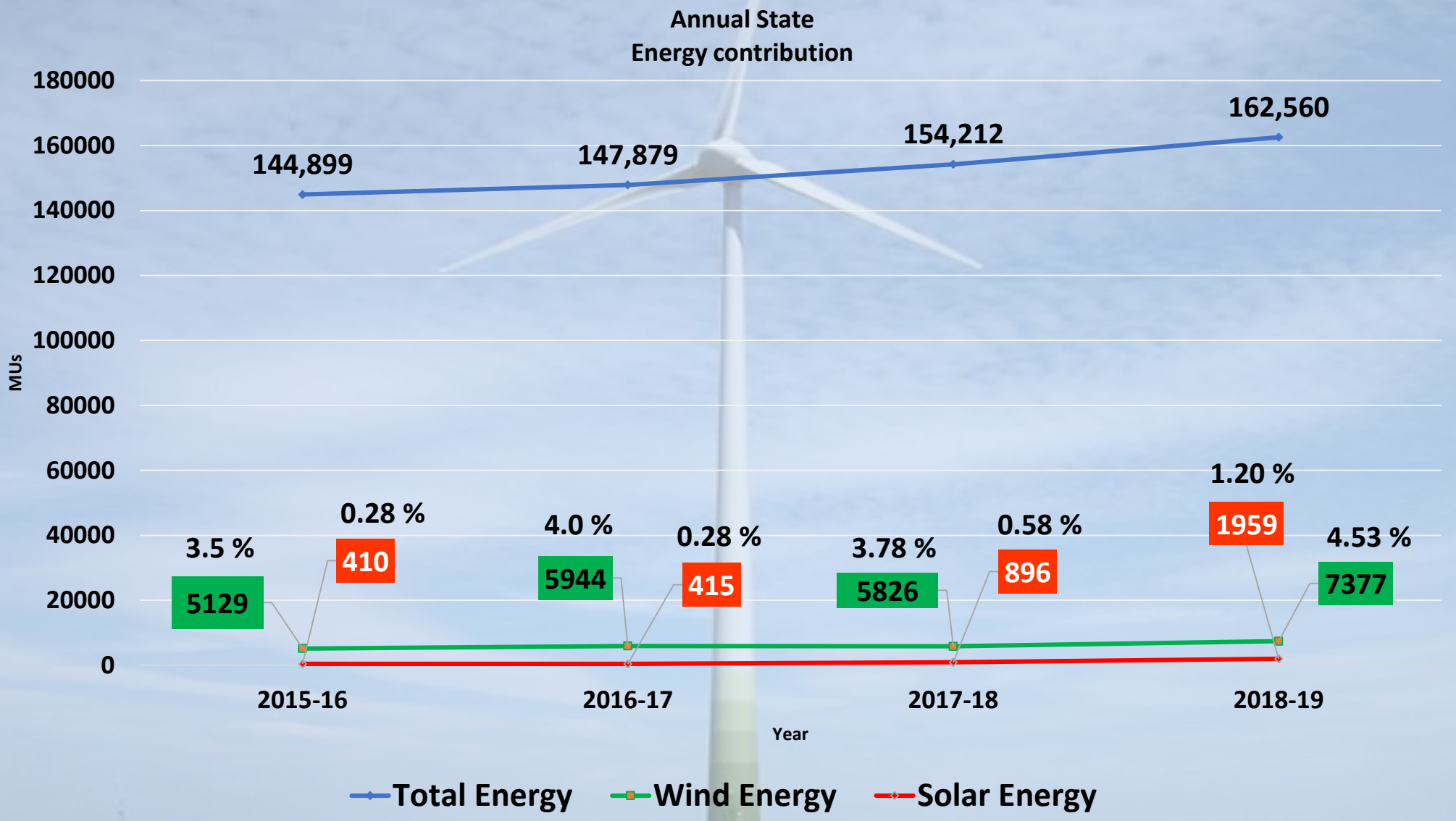
MAX. WIND INJECTION (2018-19)
(04.07.2018 @ 16:00 HRS; DEMAND: 17611 MW)



MAX. WIND INJECTION (2019-20)
(05.07.2019 @ 10:00 HRS DEMAND: 18021 MW)



Contribution of RE Sources in State Demand in MUs:



Renewable Energy Purchase Obligation (RPO) for State (2021-22 to 2024-25) as per MYT regulation.

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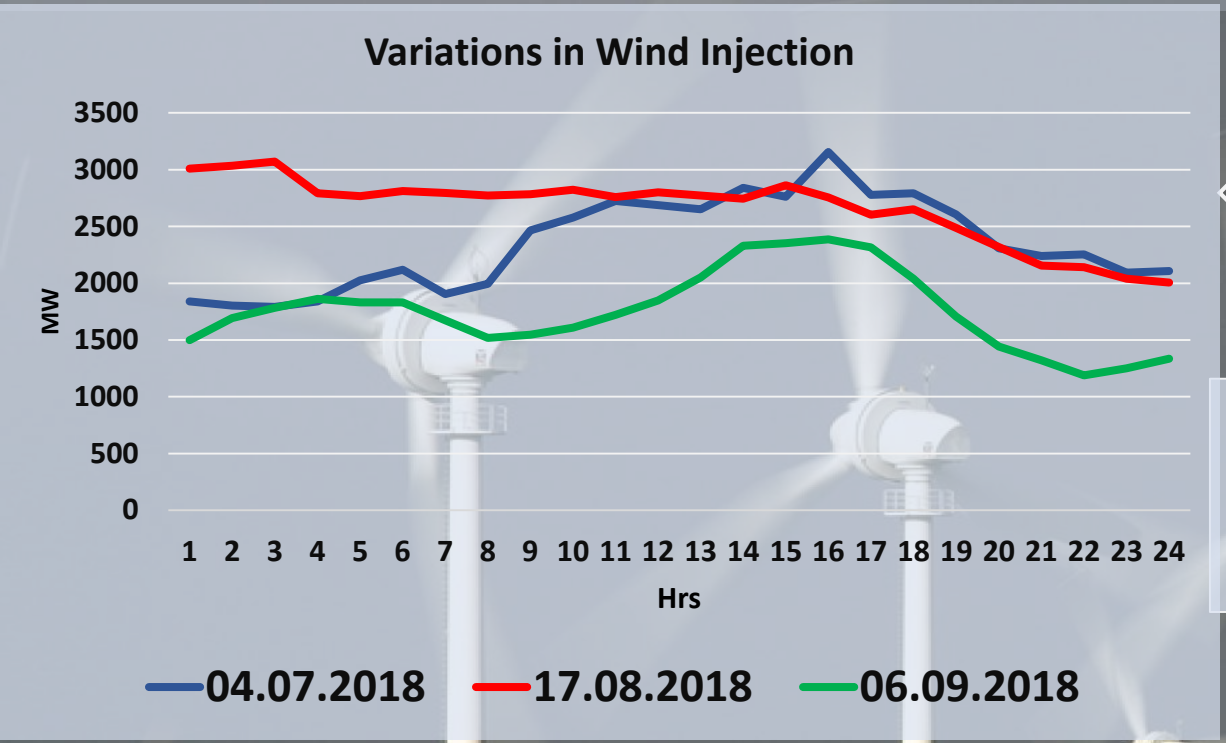
Year	Target Quantum of Purchase (in %) from RE Sources (in terms of energy equivalent in kWh)		
	Solar	Non-Solar	Total
2020-21	4.50	11.50	16.00
2021-22	6.00	11.50	17.50
2022-23	8.00	11.50	19.50
2023-24	10.50	11.50	22.00
2024-25	13.50	11.50	25.00

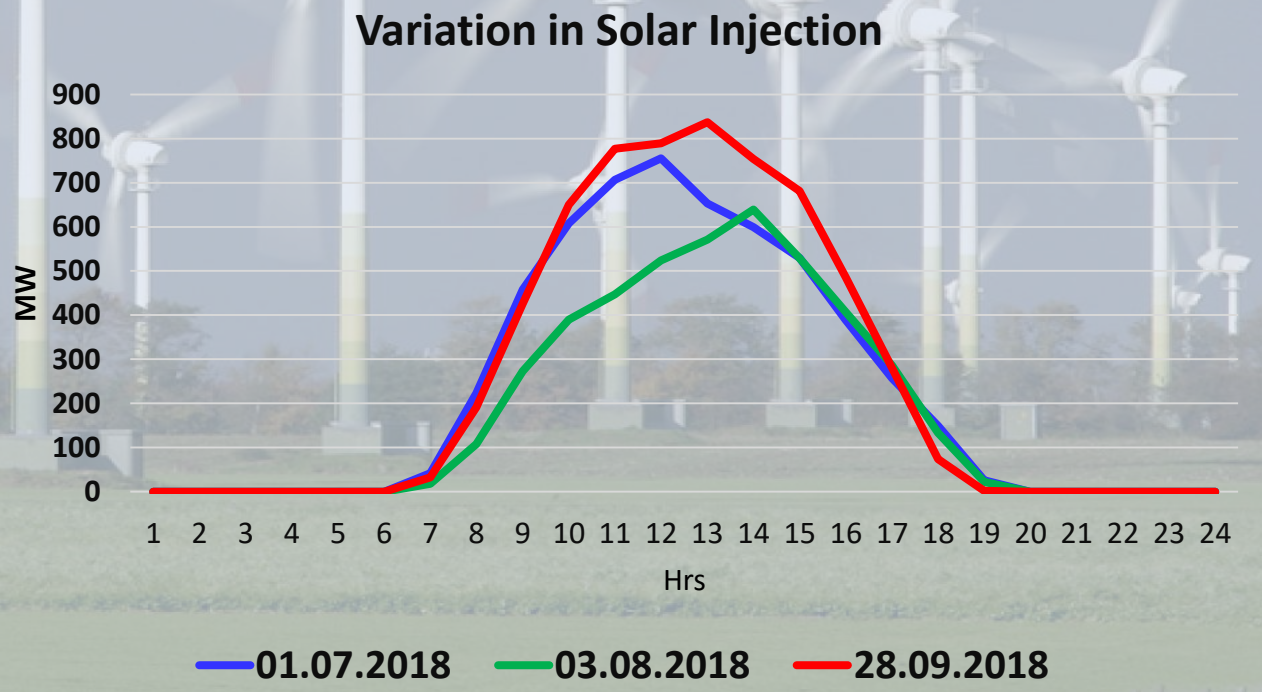
RPO for the State		
Year	Solar (MUs)	Non-Solar (MUs)
2020-21	7816	15400
2021-22	10976	16457
2022-23	16217	17635
2023-24	20457	17672
2024-25	23705	17712

Variations during Peak Seasons:



Daily Wind Power variations in July, Aug, Sept-2018.
State Demand was minimum (13000-15000 MW)

Solar Injection is more firm than Wind Injection



Daily Solar Power variations in July, August, Sept-2018.

Key Issues in Real time Grid Operations due to RE Generations:

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- Intermittent & Infirm
- Low Accuracy in Wind & Solar Generation Forecasting.
- Minimal contribution of Wind Generation during Peak Demand Periods
- Solar Generation contributes during Peak Demand periods, however, less reliable in view of weather conditions
- Conventional Generators are ramped up/down frequently due to continuous variation in RE Penetration.
- Difficulties in ramping of Conventional Generators with increase/decrease of RE Generation.
- Technical minimum capacity of 70 % of Thermal generators results in difficulty in managing RE variations.
- Sudden variation in the RE Penetration results in to:
  - Overloading of Transmission lines
  - Violation of System Parameters (Voltage, Frequency)
  - Violation of Deviation volume (± 250 MW) at state periphery resulting in to penalties
  - Difficulties in 'Sign Reversal' of Deviation in the event of unprecedented RE Penetration

Remedial measures to address RE Generation integration issues:

- Supply Side management:
  - Requirement of Flexible Generation such as:
    - Battery Storage in RE rich area
    - Hydro
    - Pumped Storage
  - Operation of all the Thermal Plants at Technical minimum of 55 %.
  - Accuracy of RE Generation Forecasting.
  - Ancillary Services to be in place.

- Demand Side Management:
  - Distributed Battery Storage
  - Accurate Demand Forecasting

Implementation of the MERC (F, S & DSM for Solar & Wind Generation) Regulations, 2018

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- Renewable Energy Management Centre (REMC) established at MSLDC, Airoli in April, 2019.
- Features of REMC:
  - Modelling of each Wind Turbine/Solar Module installed in State.
  - Week ahead, Day ahead & Intra Day Forecasting of Wind & Solar Generation by three agencies viz.
    - M/s. REConnect
    - M/s. Aleasoft
    - M/s. Enercast
  - Pooling Sub-Station-wise scheduling by QCAs/Generators.
  - Provisions of submission of 16 revisions in schedules per day.
  - Integration of Schedules of REMC with State Scheduling for calculation of total availability.

Forecast V/s Actual Generation (Wind + Solar)

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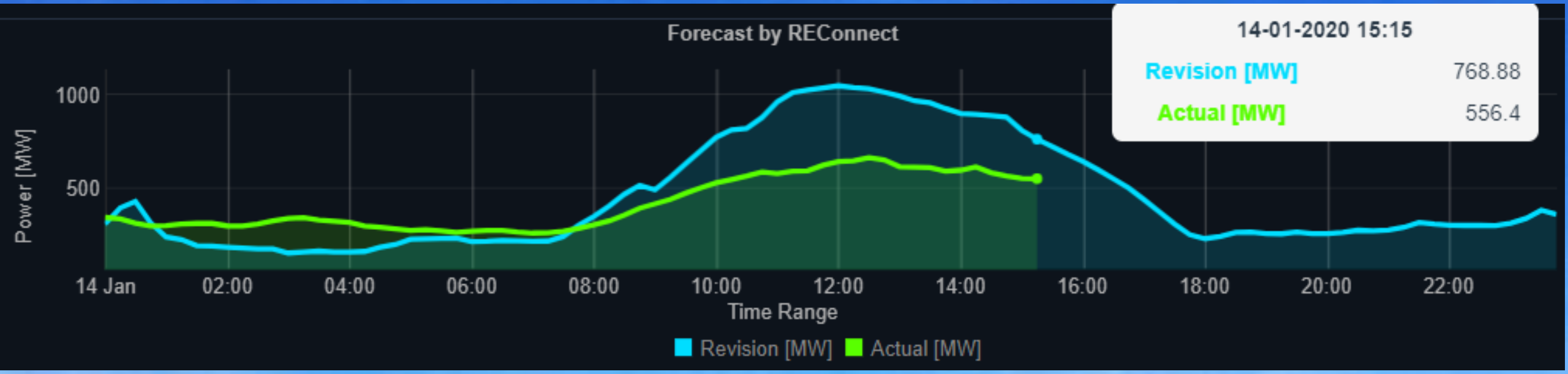
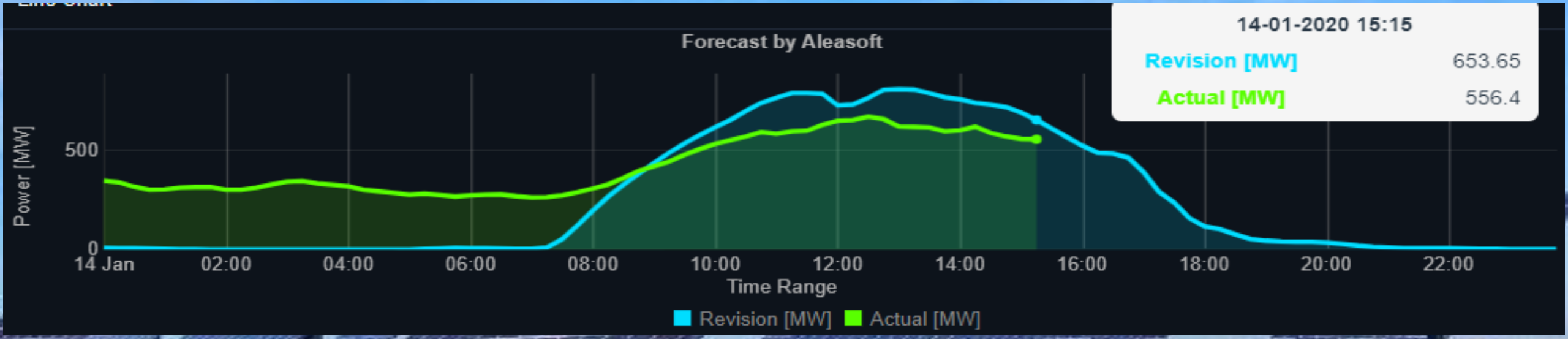
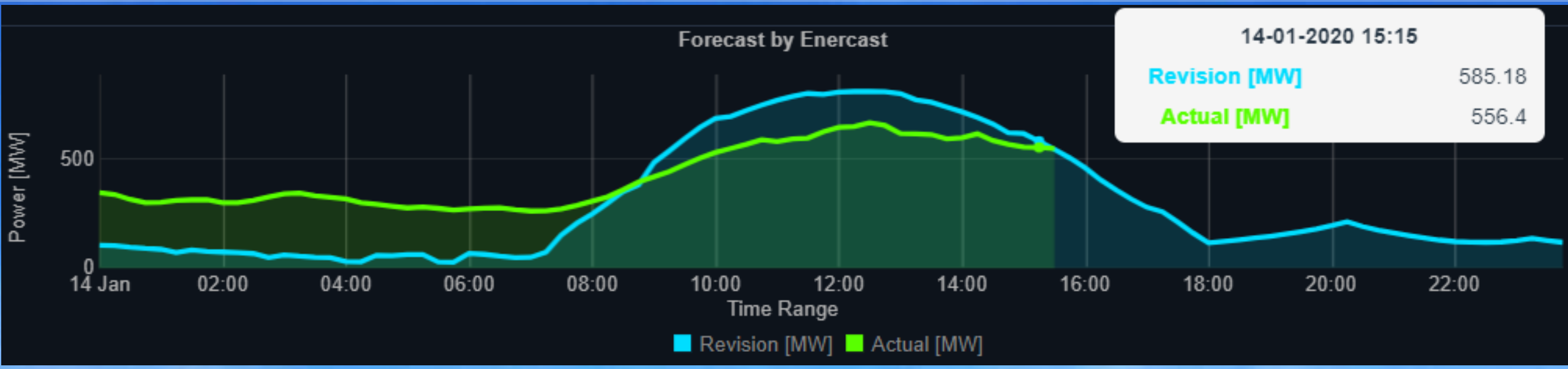




Screenshots of Forecast V/s Actual Generation (Wind + Solar)



Key Issues in Transmission Planning for RE Generations:

- RE Power project sites are far away from Load Centers.
- Uncertainty about the realization of anticipated RE projects.
- Non availability of Sufficient study inputs informing area wise realizable RE potential within the state
- Un availability of studies for operation of combination of conventional & Non-conventional power projects which is likely to impacts line loading patterns.
- Concentration of RE projects in particular areas based on land availability, available potential etc.
- Possibility of transmission infra remaining stranded due to non realization of RE power projects.
- Time period for development of transmission infra element is large compared to time required for completion of Solar & Wind power projects.

Key Issues in Transmission Planning for RE Generations:

- Approaches for Transmission Planning

  a) Pro-active Approach

  b) Responsive Approach

- In Pro-active approach network development done in advance in anticipation of upcoming RE
- power projects in certain areas.

Advantages:

- In advance Identification of potential RE power project areas and plan accordingly.
- Timely completion and readiness of transmission network.
- Encouragement to RE project developers to set up projects assuring timely evacuation.
- Low cost burden to RE project developer for development of evacuation infra.
- Ease of power transmission from RE projects to Load Centers.

Key Issues in Transmission Planning for RE Generations:

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Disadvantages:

- Creation of stranded assets in case of non-development of RE projects in the vicinity
- Cost for development may burden consumer in case of developed network becomes stranded.
- Additional financial provisions required for developing assets which will be put to use in future.

Key Issues in Transmission Planning for RE Generations:

B) Responsive Approach: The network is developed in response to demands raised by RE projects

Advantages:

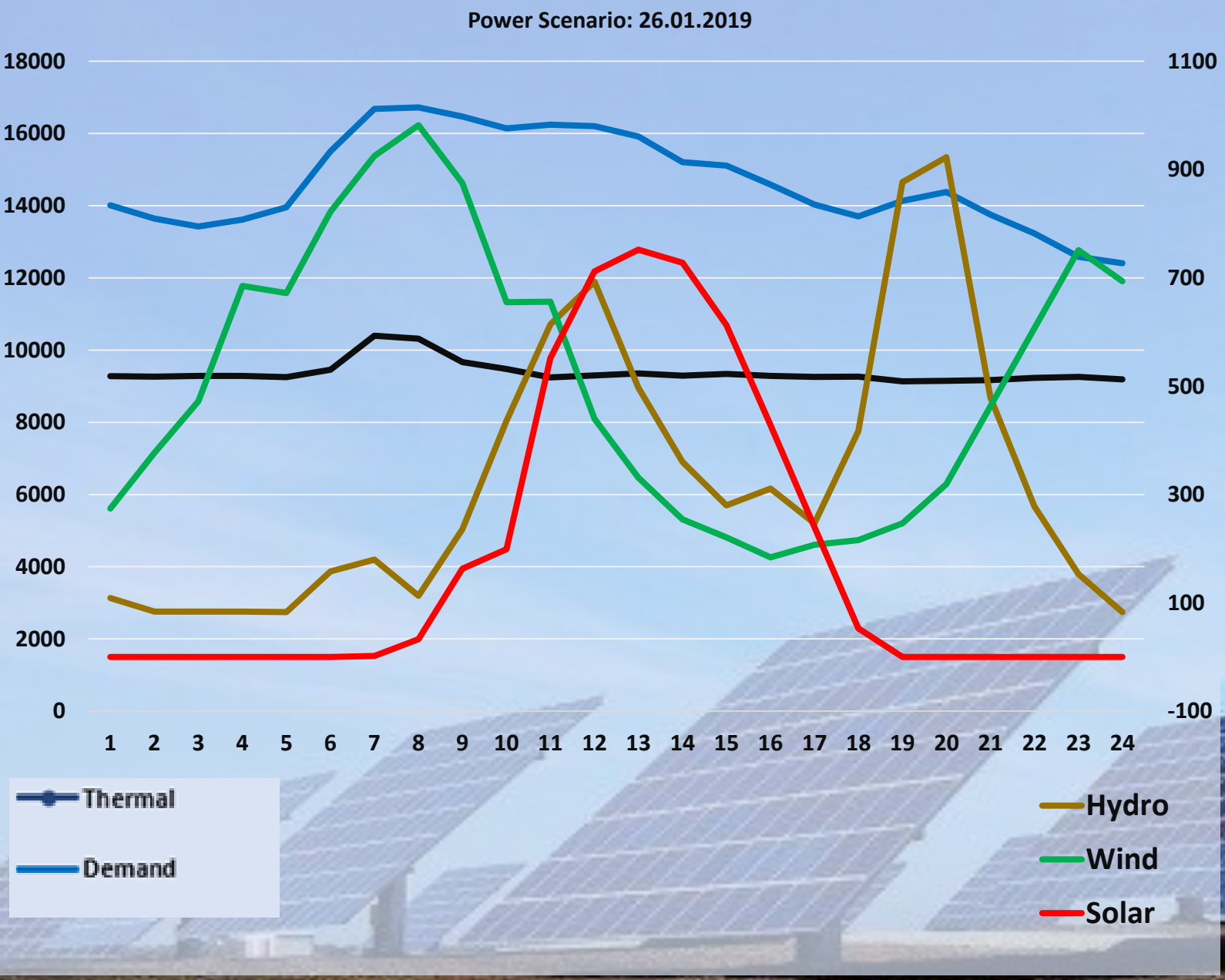
- Assurance of proper utilization of developed network.
- Development of stranded assets avoided.
- Disadvantages:
- Mismatch in transmission network development & RE power project development time period.
- Non-availability of network for evacuation of power from RE project
- Additional cost burden on RE project developer on evacuation arrangement to available far away network point.

Thank
YOU

Utility-wise Generation Installed Capacity Break-up

Name of Utility	Hydro	Thermal	Gas	Nuclear	Wind	Solar	Other RE	Total
MSPGCL	2450	10170	672	0	0	180	0	**13472**
TPCL	447	750	180	0	0	205	0	**1582**
AEML	0	500	0	0	0	0	0	**500**
IPP / CPP / Private	44	9140	388	0	4968	1028	2903	**18471**
Total	**2941**	**20560**	**1240**	**0**	**4968**	**1413**	**2903**	**34025**

Operational Observations: 26.01.2019 (Low Demand)

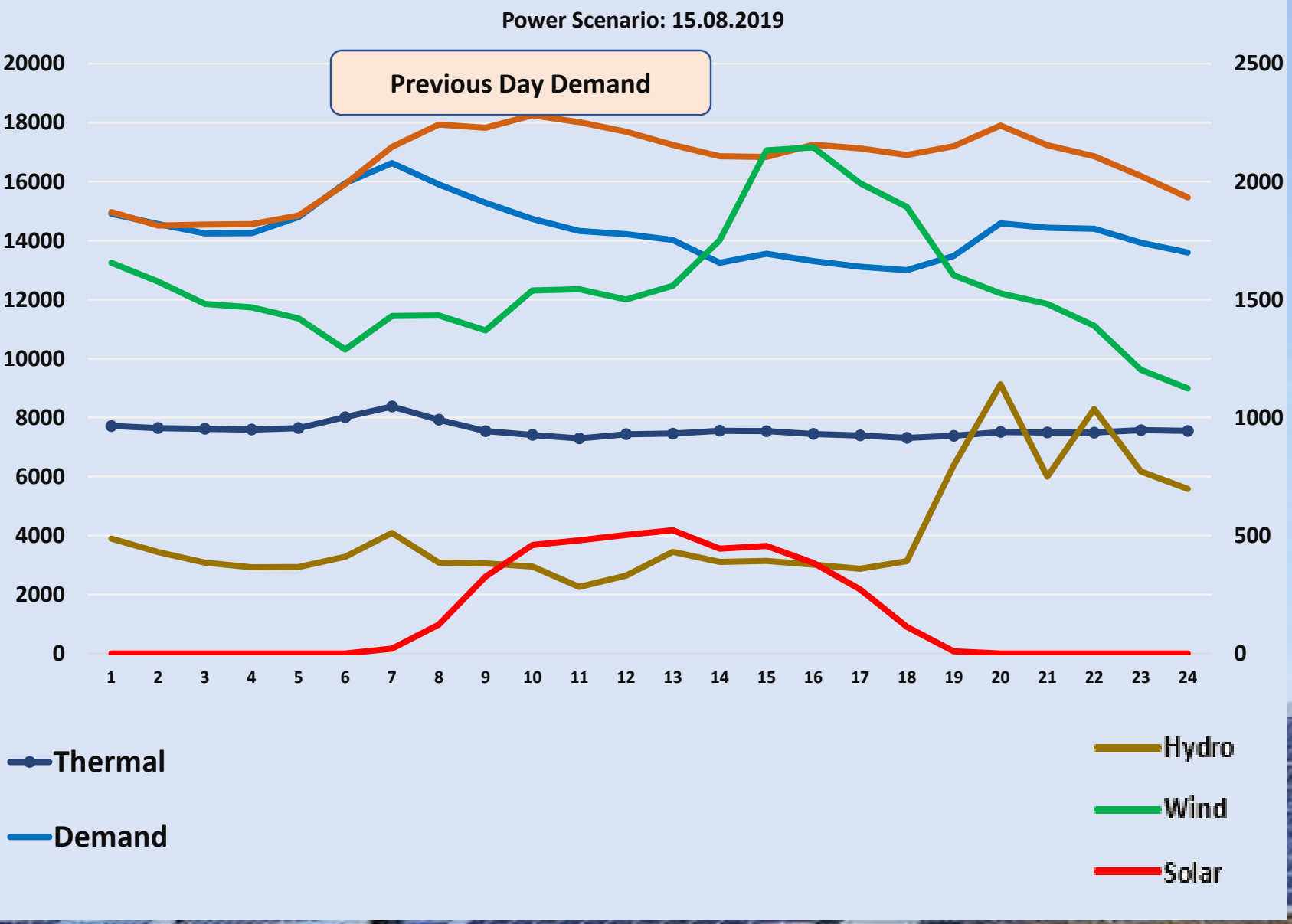


- Demand started decreasing from 08:00 Hrs.
- Wind Generation drastically decreased from 08:00 Hrs.
- Ramping down of Wind Generation was mitigated by Hydro Generation.

- Solar Generation started decreasing from 14:00 Hrs.
- Ramping down of Solar Generation was mitigated by Hydro Generation.

- Since such scenario was anticipated in advance, RE Generation variation was successfully mitigated using Hydro Generation.

Case Study: 15.08.2019 (Demand crash & High Wind injection)



- Demand crash by 4000 MW on 15.08.2019 from previous day.
- At 07:00 Hrs. considering increase in Wind Generation Thermal Generation was ramped down.
- At 19:00 Hrs Wind Generation ramped down and demand started increasing.
- To mitigate demand, hydro generation was peaked-up.
- Since such scenario was anticipated, schedules from Central Sector Generation was reduced.

Price Vector as per 4th Amendment of CERC DSM Regulations

Average Frequency of the time block (Hz)		Charges for Deviation (Paise/kWh)
Below	Not Below	
	50.05	0.00
50.05	50.04	**1xP/5**
50.04	50.03	**2xP/5**
50.03	50.02	**3xP/5**
50.02	50.01	**4xP/5**
50.01	50.00	**P**
50.00	49.99	**50.00+15xP/16**
49.99	49.98	**100.00+14xP/16**
49.98	49.97	**150.00+13xP/16**
49.97	49.96	**200.00+12xP/16**
49.96	49.95	**250.00+11xP/16**
49.95	49.94	**300.00+10xP/16**
49.94	49.93	**350.00+9xP/16**
49.93	49.92	**400.00+8xP/16**
49.92	49.91	**450.00+7xP/16**
49.91	49.90	**500.00+6xP/16**
49.90	49.89	**550.00+5xP/16**
49.89	49.88	**600.00+4xP/16**
49.88	49.87	**650.00+3xP/16**
49.87	49.86	**700.00+2xP/16**
49.86	49.85	**750.00+1xP/16**
49.85		800.00

Where '**P**' is **Average Area Clearing Price** in paisa / kWh

Implementation of the MERC (F, S & DSM for Solar & Wind Generation) Regulations, 2018

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- Regulations notified on 20.07.2018.
- Applicability: Wind and Solar Generators with capacity 5 MW & above.
- All the Qualified Co-ordinating Agencies (QCA) appointed by Generators are forecasting Day Ahead & Intra-Day Generation.
- Registration details of Pooling Sub-Stations (as on 11.02.2020):

Sr. No.	Particulars	Wind		Solar		Total	
		No	MW	No	MW	No	MW
1	Total No. of Pooling Sub-Stations	81	4953	34	1388	**115**	**6341**
2	Approved	80	4945	33	1378	**113**	**6323**
3	Applications yet to receive from QCA/Generators	1	8	1	10	**2**	**18**

- Regulations implemented commercially in the State w.e.f. 00:00 Hrs. of 06.01.2020.
- Wind & Solar forecasting for MSLDC is provided by 3 external agencies:
  - M/s. REConnect
  - M/s. Aleasoft
  - M/s. Enercast

Benefits of Implementation of F&S Regulations in Real time Grid Operations:

- Considering commercial impact, accurate forecasting by Generators/QCAs.
- Availability of Day Ahead & Intra-Day Schedules for Pooling Sub-Station/State aggregation.
- 16 Nos. of Intra-Day revisions at an interval of 1:30 Hrs are supporting more correct schedules and sufficient time for arranging conventional resources.

Rate of Penalty for Deviations in case of Intra-State Transactions

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Sr. No.	Absolute Error in %age terms in 15-minute time block	Deviation Charge payable to Pool Account for Wind/Solar Generation
1	< = 15%	None #
2	>15% but <=25%	At Rs. 0.50 per unit for the shortfall or excess beyond 15% and up to 25%
3	>25% but <=35%	At Rs. 0.50 per unit for the shortfall or excess beyond 15% and Up to 25% + Rs. 1.00 per unit for the balance energy beyond 25% and Up to 35%
4	>35%	At Rs. 0.50 per unit for the shortfall or excess beyond 15% and Up to 25% + Rs. 1.00 per unit for the shortfall or excess beyond 25% and Up to 35% + Rs. 1.50 per unit for the balance energy beyond 35%

Rate of Penalty for Deviations in case of Inter-State Transactions

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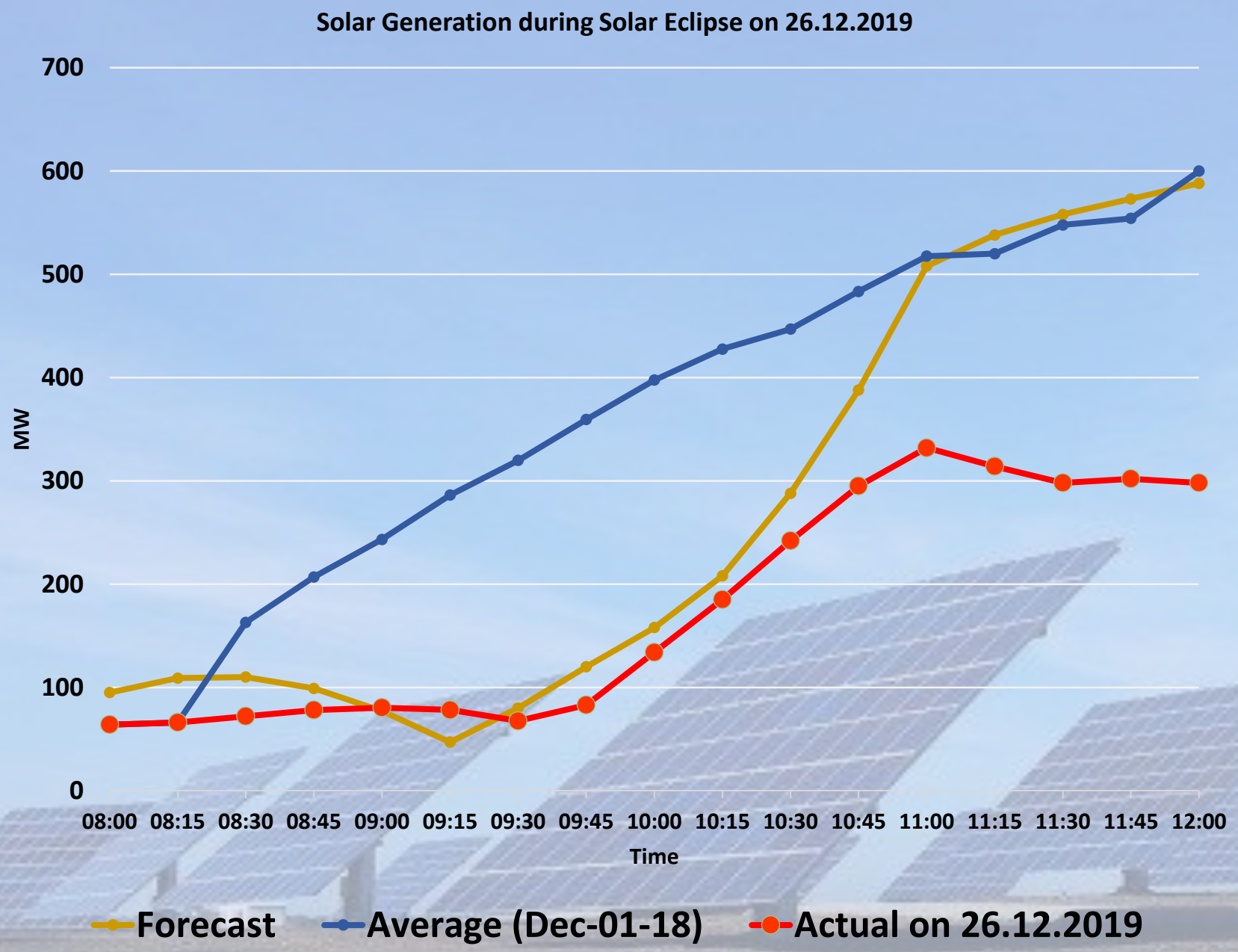
Sr. No.	Absolute Error in %age terms in 15-minute time block	Deviation Charges payable to State DSM Pool Account
1	< = 15%	At the fixed rate for the shortfall in energy for Absolute Error up to 15%
2	>15% but <=25%	At the fixed rate for the shortfall in energy for Absolute Error up to 15% (+) 110% of the fixed rate for the balance energy beyond 15% and up to 25%
3	>25% but <=35%	At the fixed rate for the shortfall in energy for Absolute Error up to 15% (+) 110% of the fixed rate for the balance energy beyond 15%, and up to 25% (+) 120% of the fixed rate for the balance energy beyond 25% and up to 35%
4	>35%	At the fixed rate for the shortfall in energy for Absolute Error up to 15% (+) 110% of the fixed rate for the balance energy beyond 15% and up to 25% (+) 120% of the fixed rate for balance energy beyond 25% and up to 35% (+) 130% of the fixed rate for the balance energy beyond 35%

Impact of Annular Solar Eclipse dated 26.12.2019 (Period: 08:04 to 10:55 hrs)



- At 09:15 – 09:30 Hrs. during Peak obscuration, net difference between past trend & actual injection observed was 208 MW.
- During Eclipse period, difference was managed by Hydro Generation.
- Solar generation not ramped up due to cloudy weather post eclipse period.