

ENERGY

Short-term power forecasting

Ayumu Suzuki

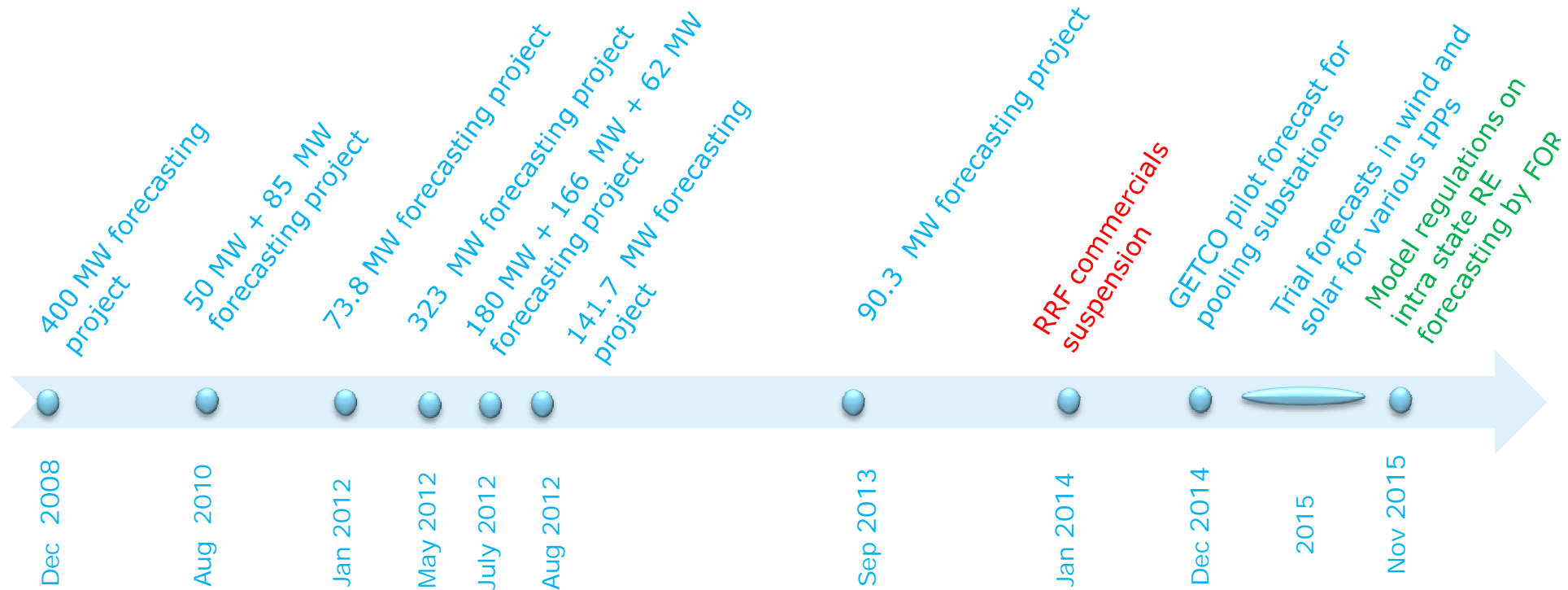
22nd January 2018

Agenda

- Current state of short term power forecasting
- Forecasting methodology
- Example forecast accuracies
- Audience questions



Implemented Project Summary



- Day-ahead and intra-day forecasting in India for over 3 GW
- Carried out a study for WIPPA on "Mechanism of Grid Integration of Wind Power: Scheduling & forecasting the Practical Way Forward for India". CERC regulation analysis
- Training SRPC on integrating renewables for grid management

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DNV GL's Short-Term Forecasting – A Summary



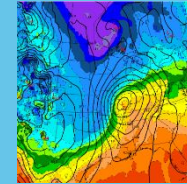
Wind, solar and power demand forecasts



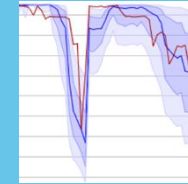
5 minutes to 15 days into the future



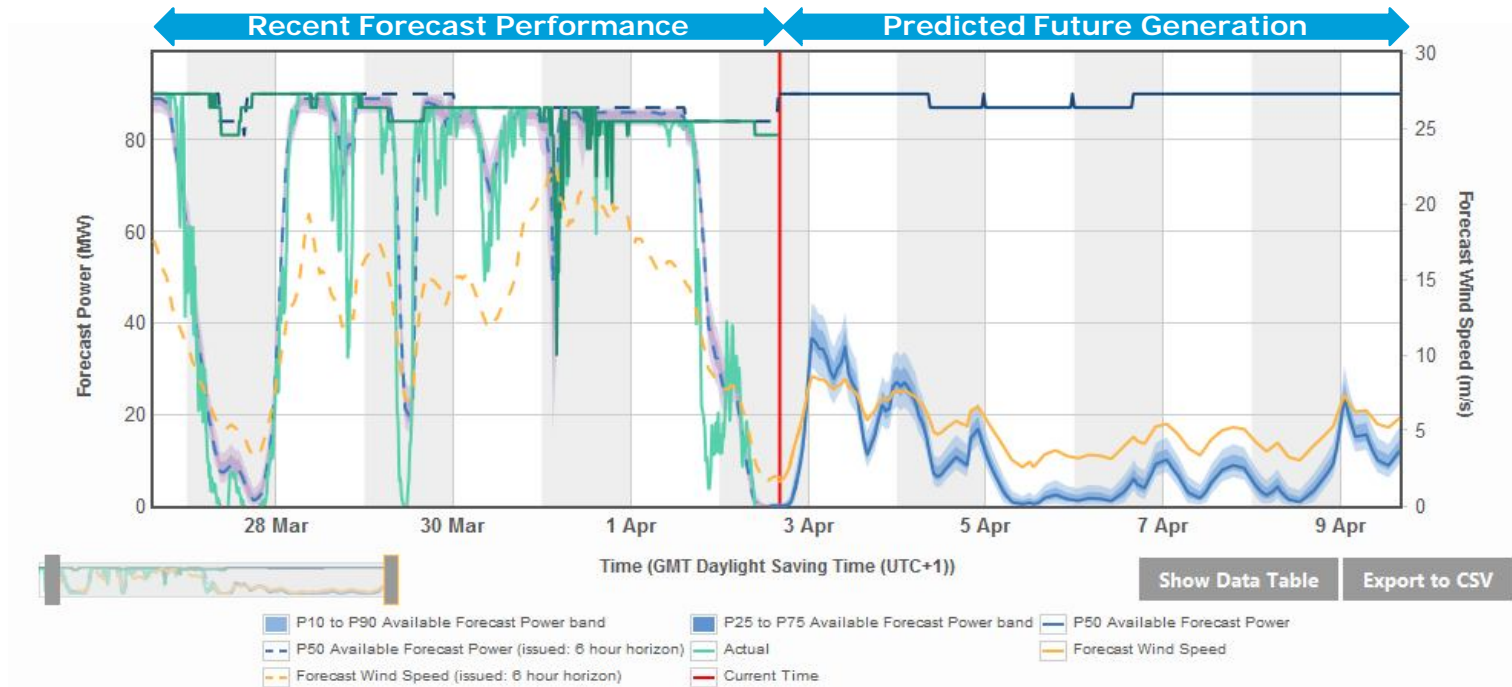
Global Experience > 50 GW capacity > 20 countries



Data from the World's best forecast models

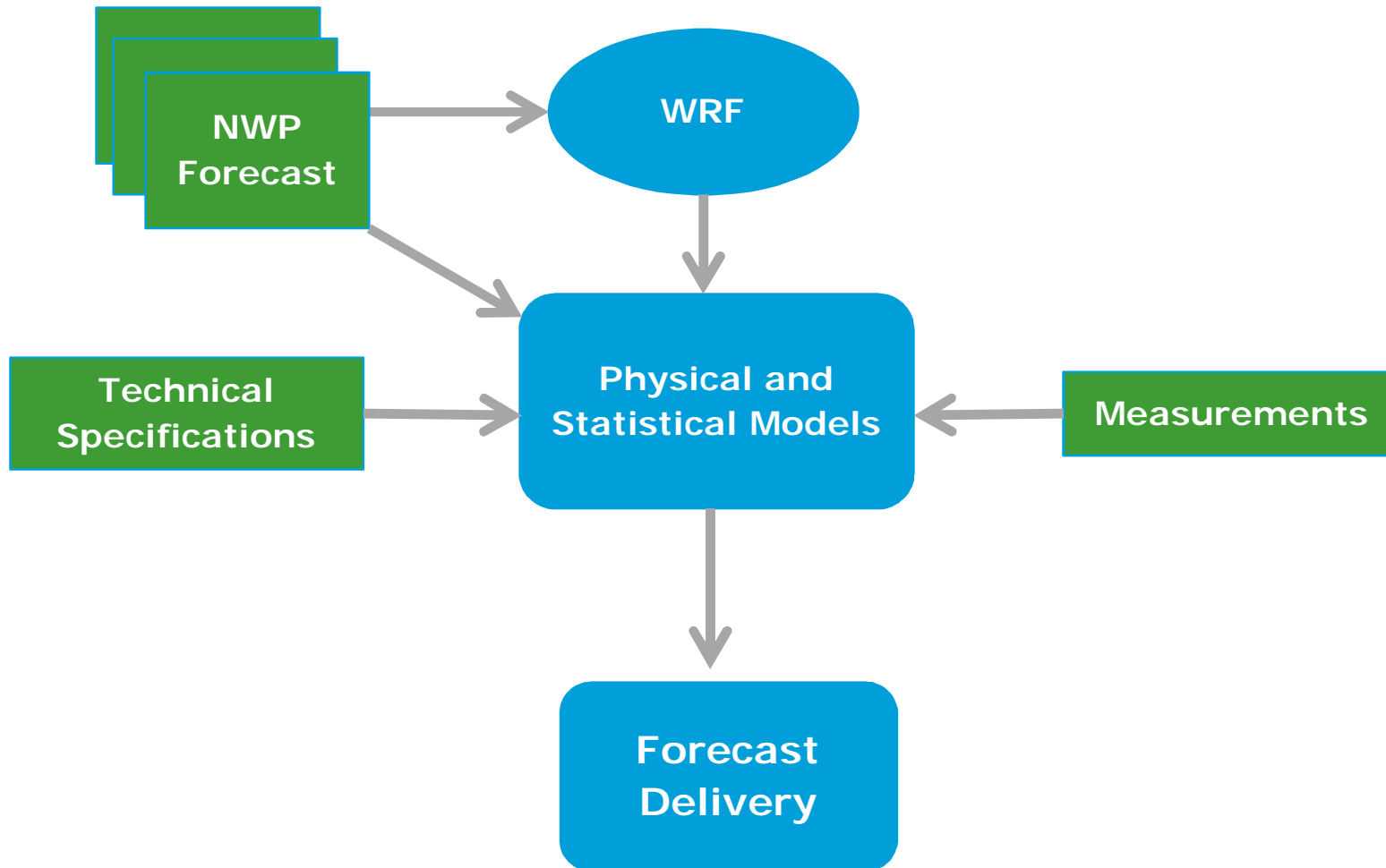


Accurate uncertainty data for risk evaluation



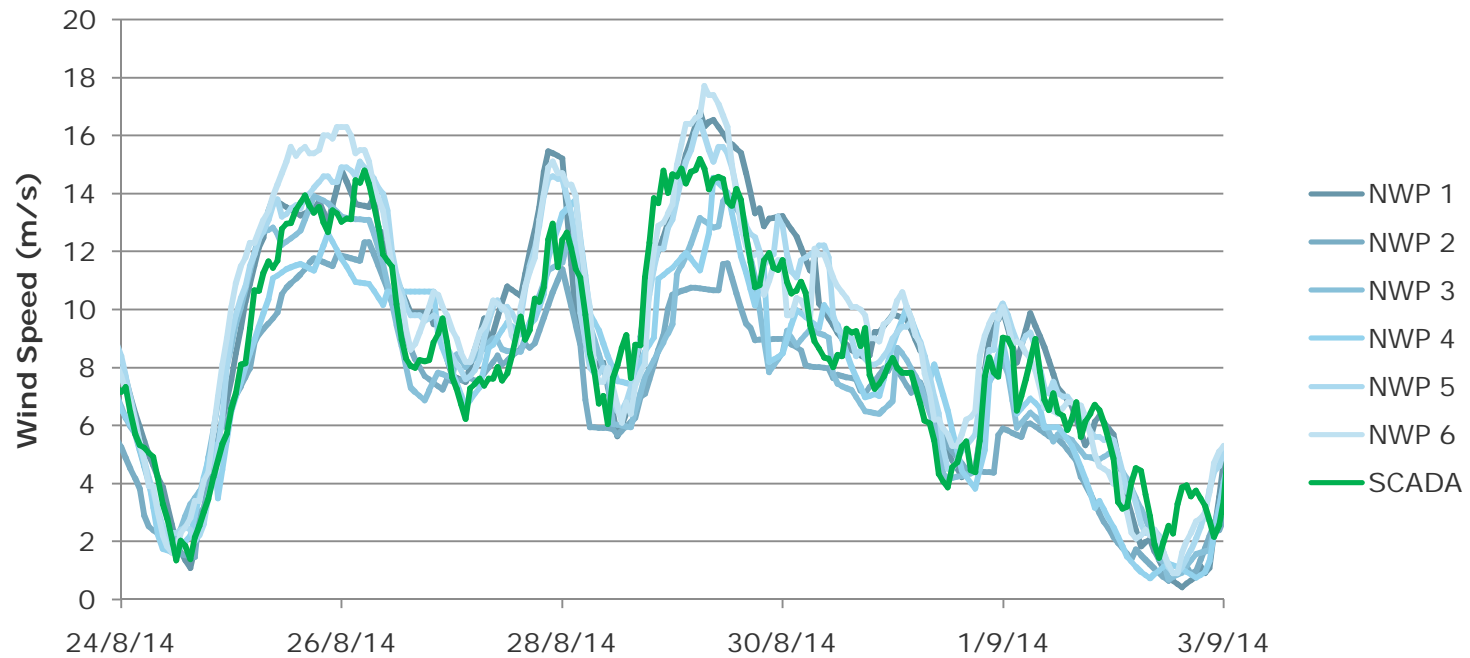
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Methodology – Wind Power Forecasting



Methodology – Wind Power Forecasting

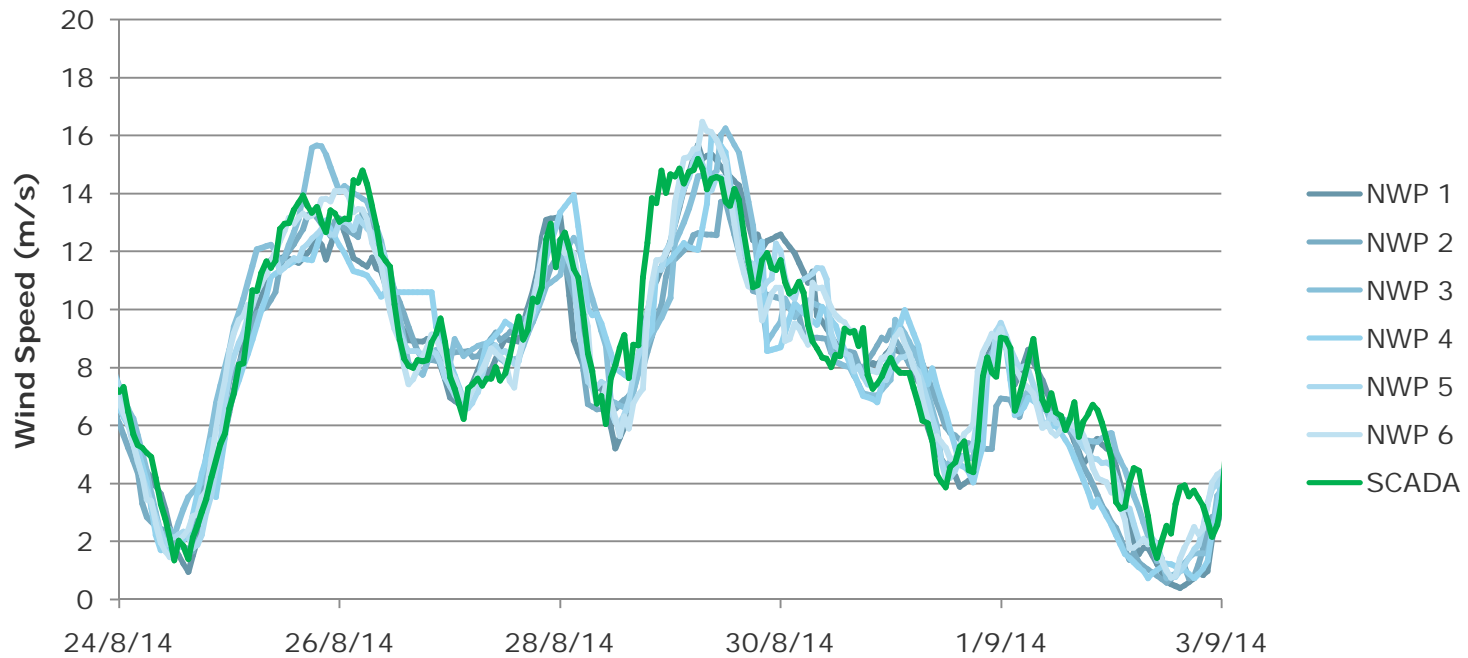
- Step 1: Source Numerical Weather Prediction (NWP) data



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Methodology – Wind Power Forecasting

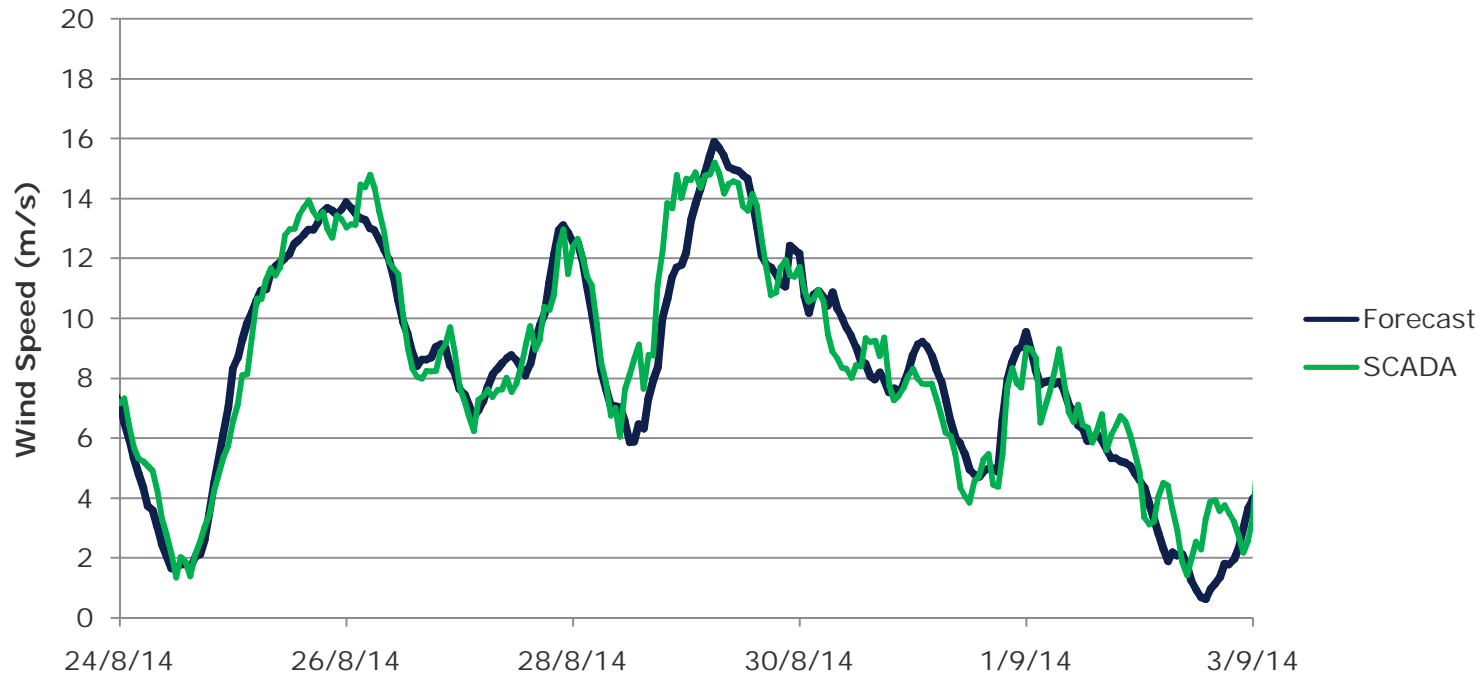
- Step 2: Site-specific refinement



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Methodology – Wind Power Forecasting

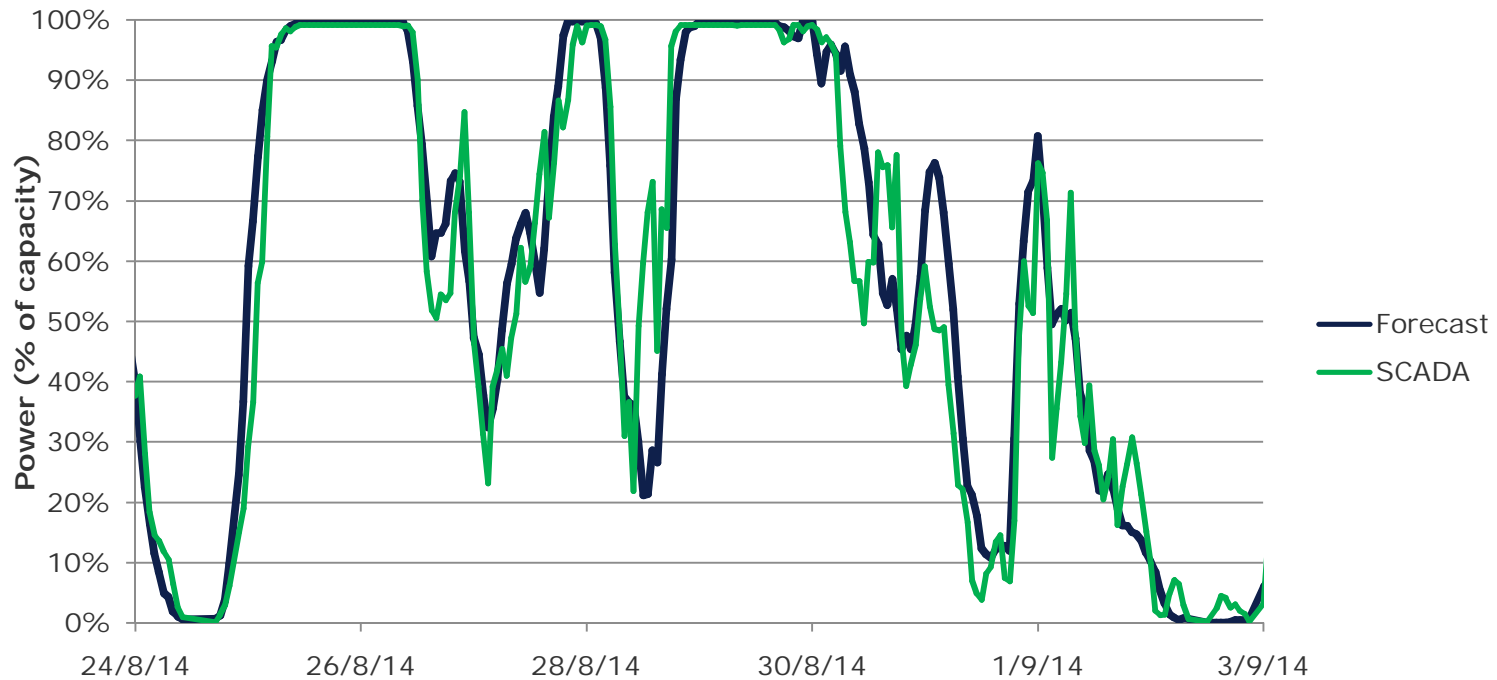
- Step 3: Model combination



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Methodology – Wind Power Forecasting

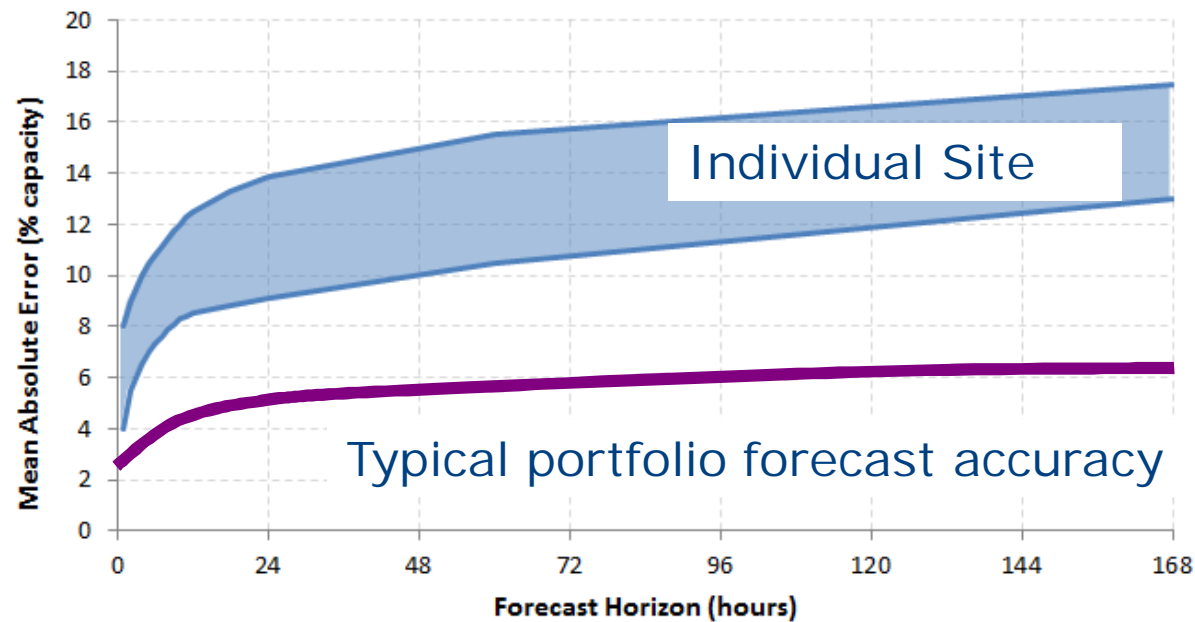
- Step 4: Power conversion



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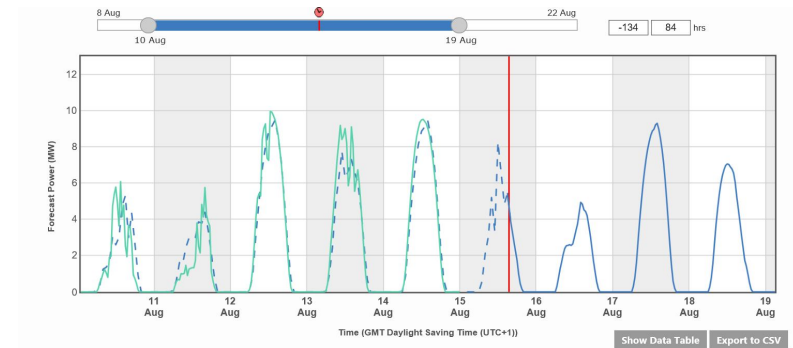
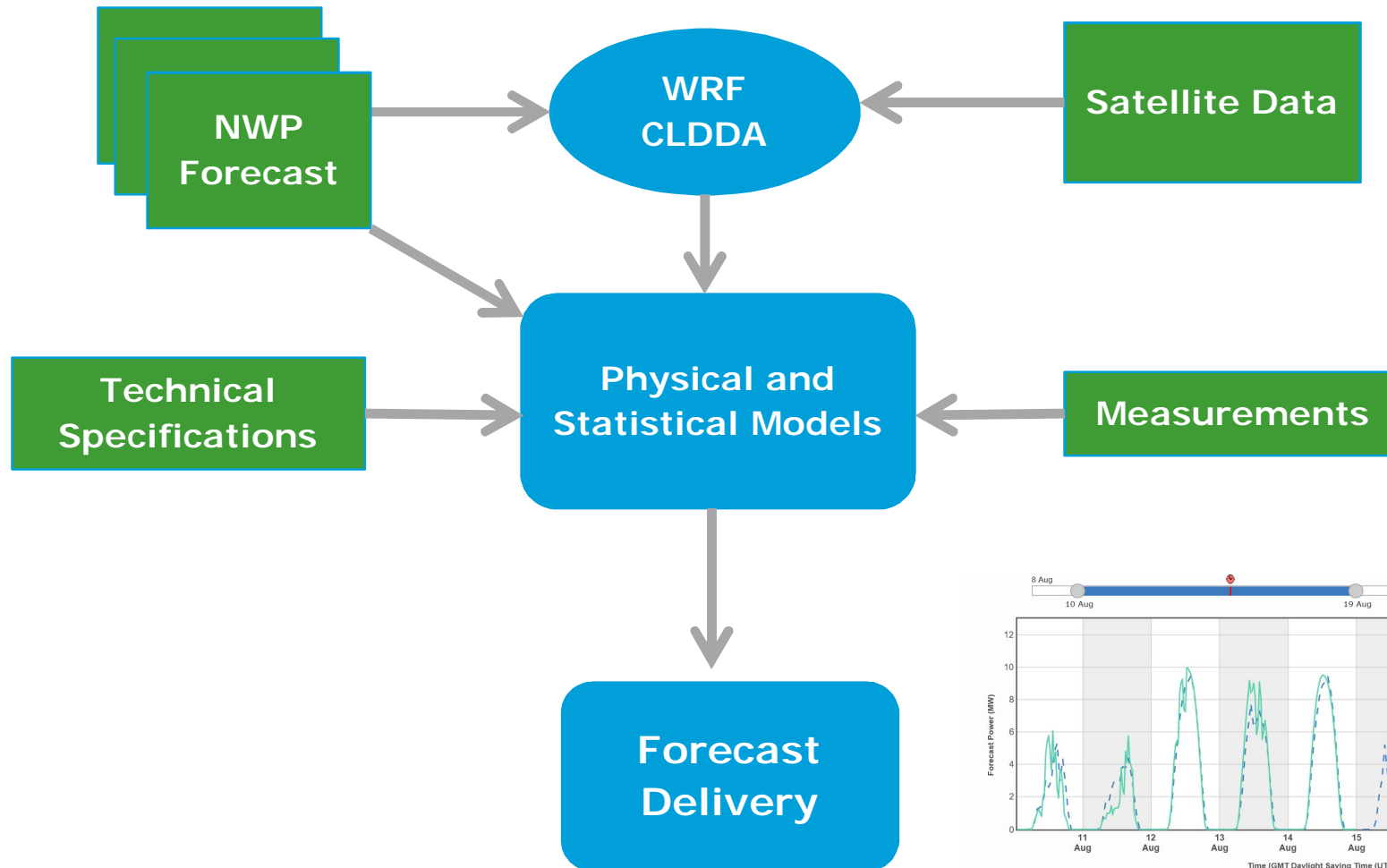
Methodology – Wind Power Forecasting

- **Step 5: Use of measurement data**
 - Forecast accuracy analysis
 - Statistical site-specific meteorology and power model refinements
 - Input for short-term learning model's intra-day improvements



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Solar Power Forecasting - Incorporation of Satellite Data



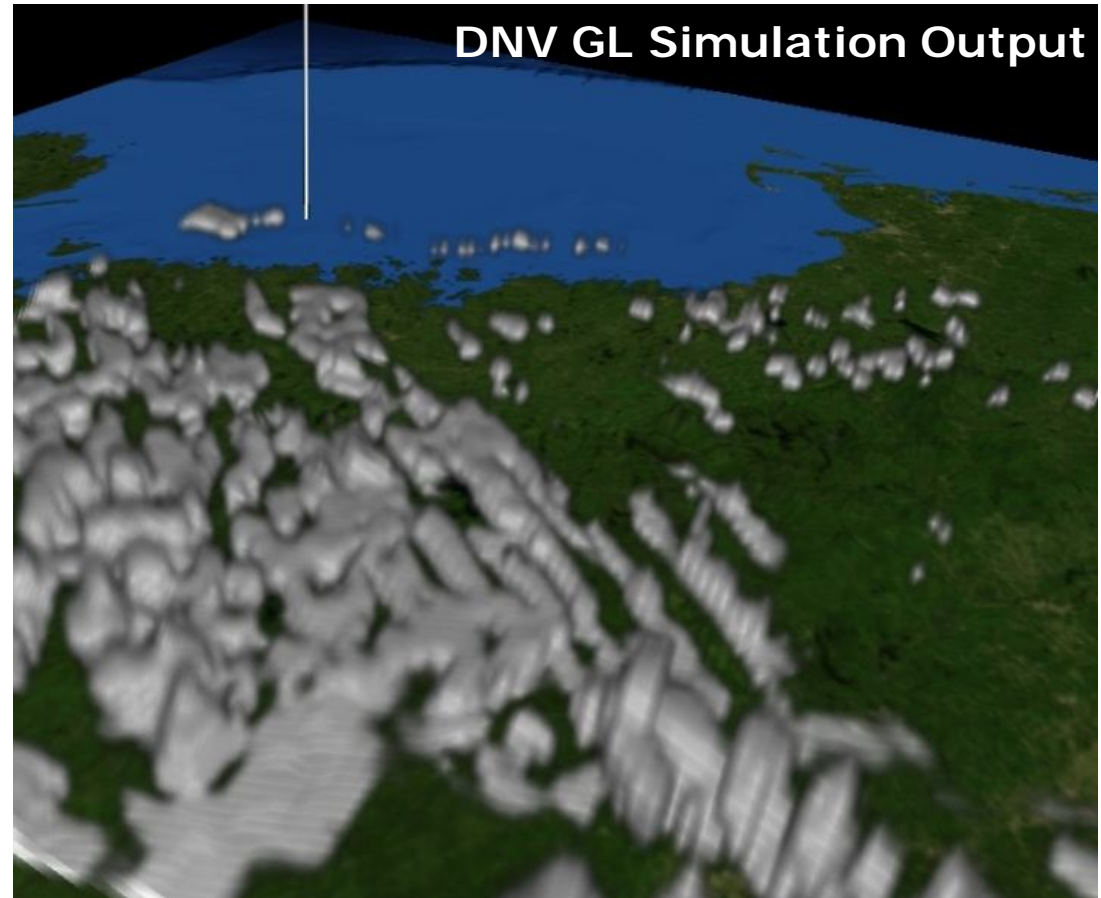
Solar Power Forecasting - Incorporation of Satellite Data

Solar Forecasting is Cloud Forecasting

- Power primarily dependent on clouds
- Resolved by Numerical Weather Prediction (NWP) models
- Specifically optimized for cloud cover

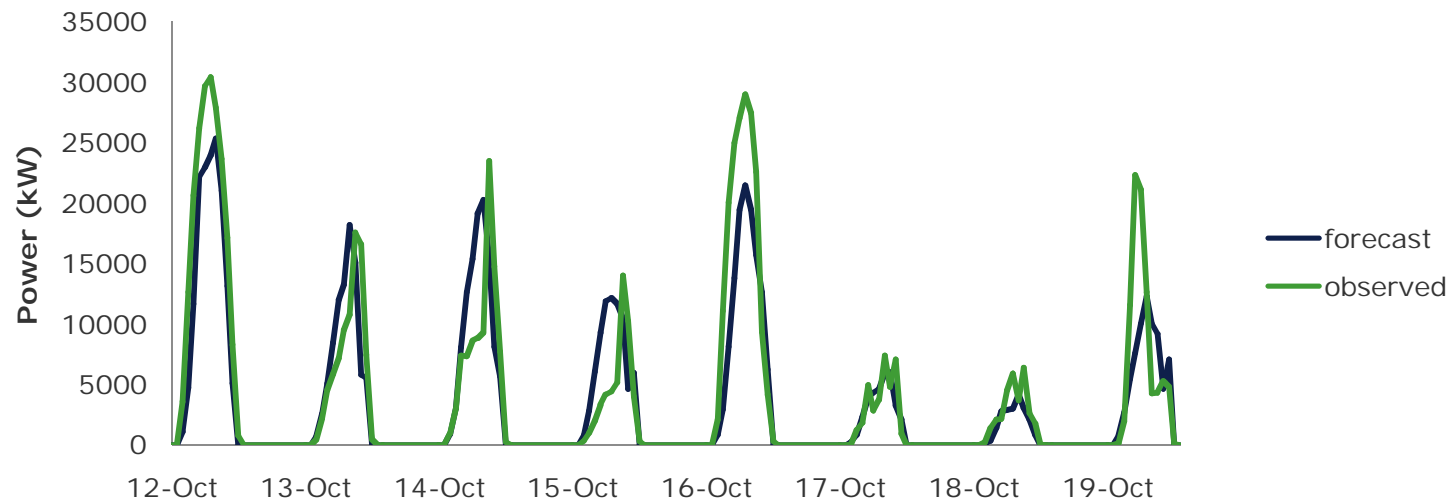
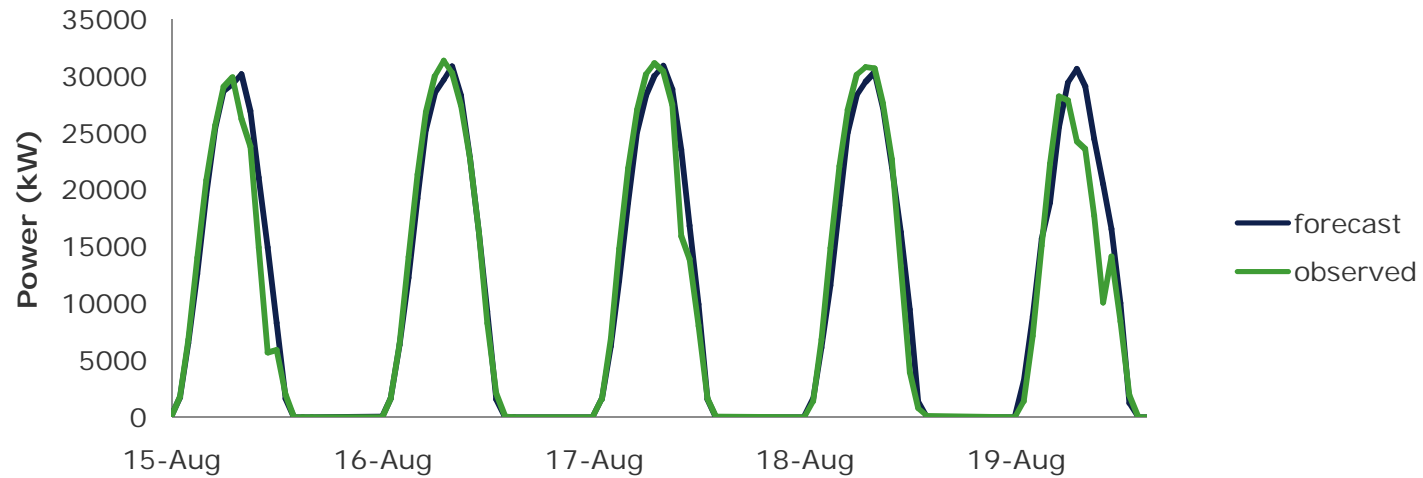
High Resolution

- 2 km
- Up to 15 min. output
- High vertical fidelity
 - Resolves convective processes



UCAR Vapor Visualization Software

Performance I: Example Forecasts, Day Ahead



Forecast examples in India

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A Look at Forecasting Regulatory Framework in India

- Forum of Regulators (FOR) constituted by representatives from SERCs and CERC formulated model regulations for intra-state forecasting in November 2015.

Table – I: Deviation Charges in case of under or over-injection, for sale of power within the State

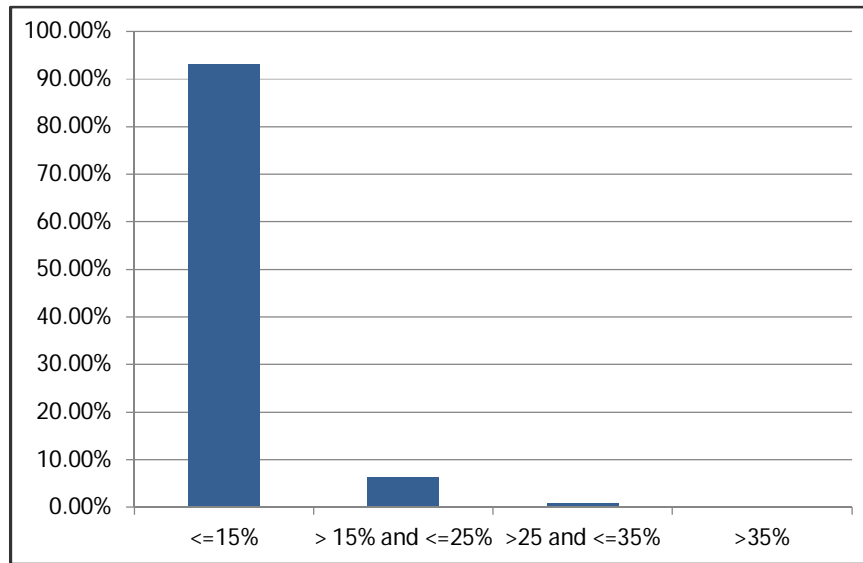
Sr. No.	Absolute Error in the 15-minute time block	Deviation Charges payable to State DSM Pool
1	<= 10%	None
2	>10% but <=20%	At Rs. 0.50 per unit for the shortfall or excess energy for absolute error beyond 10% and upto 20%
3	>20% but <=30%	At Rs. 0.50 per unit for the shortfall or excess energy beyond 10% and upto 20% + Rs. 1.0 per unit for balance energy beyond 20% and upto 30%
4	> 30%	At Rs. 0.50 per unit for the shortfall or excess energy beyond 10% and upto 20% + Rs. 1.0 per unit for shortfall or excess energy beyond 20% and upto 30% + Rs. 1.50 per unit for balance energy beyond 30%

Table – II: Deviation Charges in case of under or over-injection for wind or solar generators commissioned prior to the date of effect of these regulations, and selling power within the State:

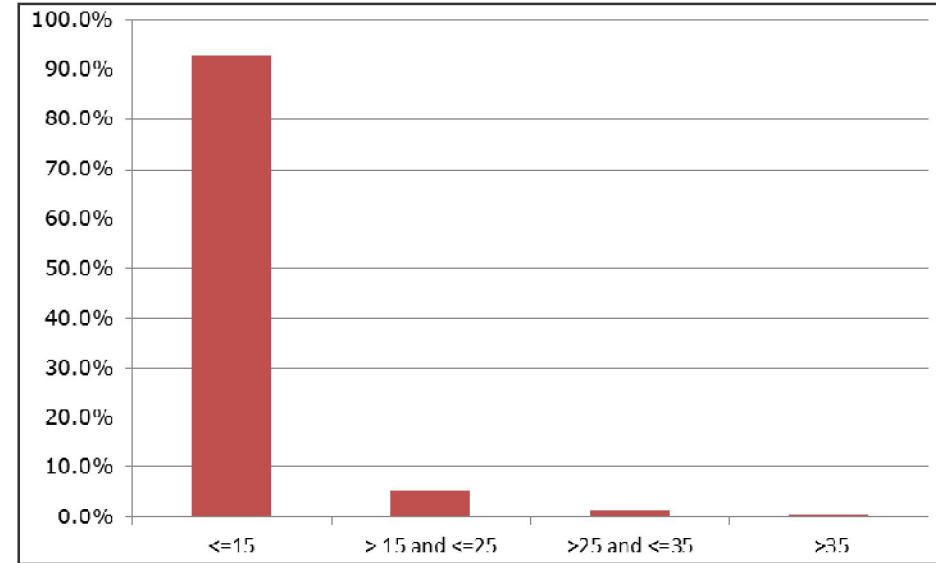
Sr. No.	Absolute Error in the 15-minute time block	Deviation Charges payable to State DSM Pool
1	<= 15%	None
2	>15% but <=25%	At Rs. 0.50 per unit for the shortfall or excess energy for absolute error beyond 15% and upto 25%
3	>25% but <=35%	At Rs. 0.50 per unit for the shortfall or excess energy beyond 15% and upto 25% + Rs. 1.0 per unit for balance energy beyond 25% and upto 35%
4	> 35%	At Rs. 0.50 per unit for the shortfall or excess energy beyond 15% and upto 25% + Rs. 1.0 per unit for shortfall or excess energy beyond 25% and upto 35% + Rs. 1.50 per unit for balance energy beyond 35%

- Madhya Pradesh, Rajasthan, Karnataka and Tamil Nadu have released draft regulations for intra-state forecasting for wind and solar

DNV GL Forecasting Performance



WIND



SOLAR

Percentage of 15-minute time blocks falling in various bands of deviation

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DNV GL Performance: Wind Farm Level Forecasting in India

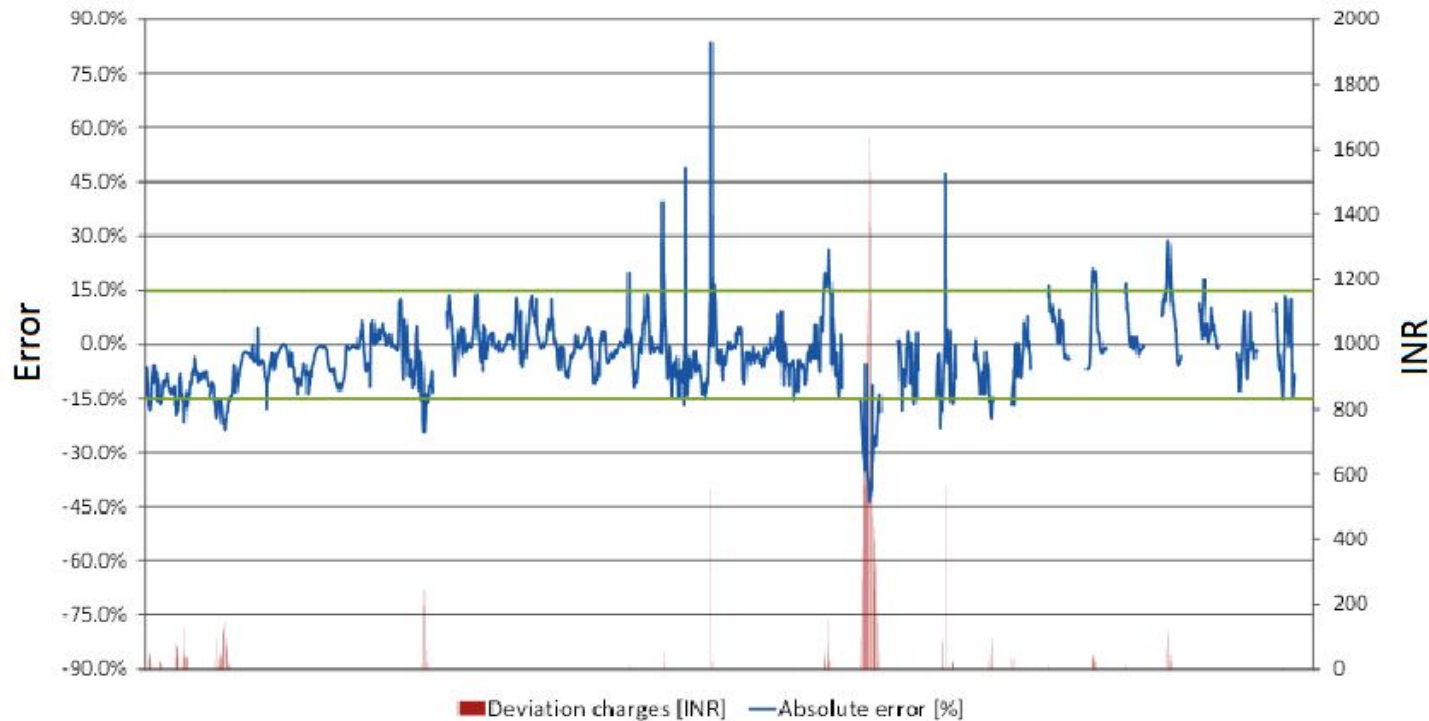


Fig. Graphs showing absolute error, +/- 15% band, and resulting deviation charges in compliance with model regulations

- Potential revenue losses as low as 0.1% established through accuracy analysis
- High data quality and transmission with minimum delay (~20 min.) along with the turbine availability data (incorporated in the live SCADA data indicating the turbine operational status on 10 min. basis) was helpful in achieving high accuracy levels.

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DNV GL Performance: Solar Farm Level Forecasting in India

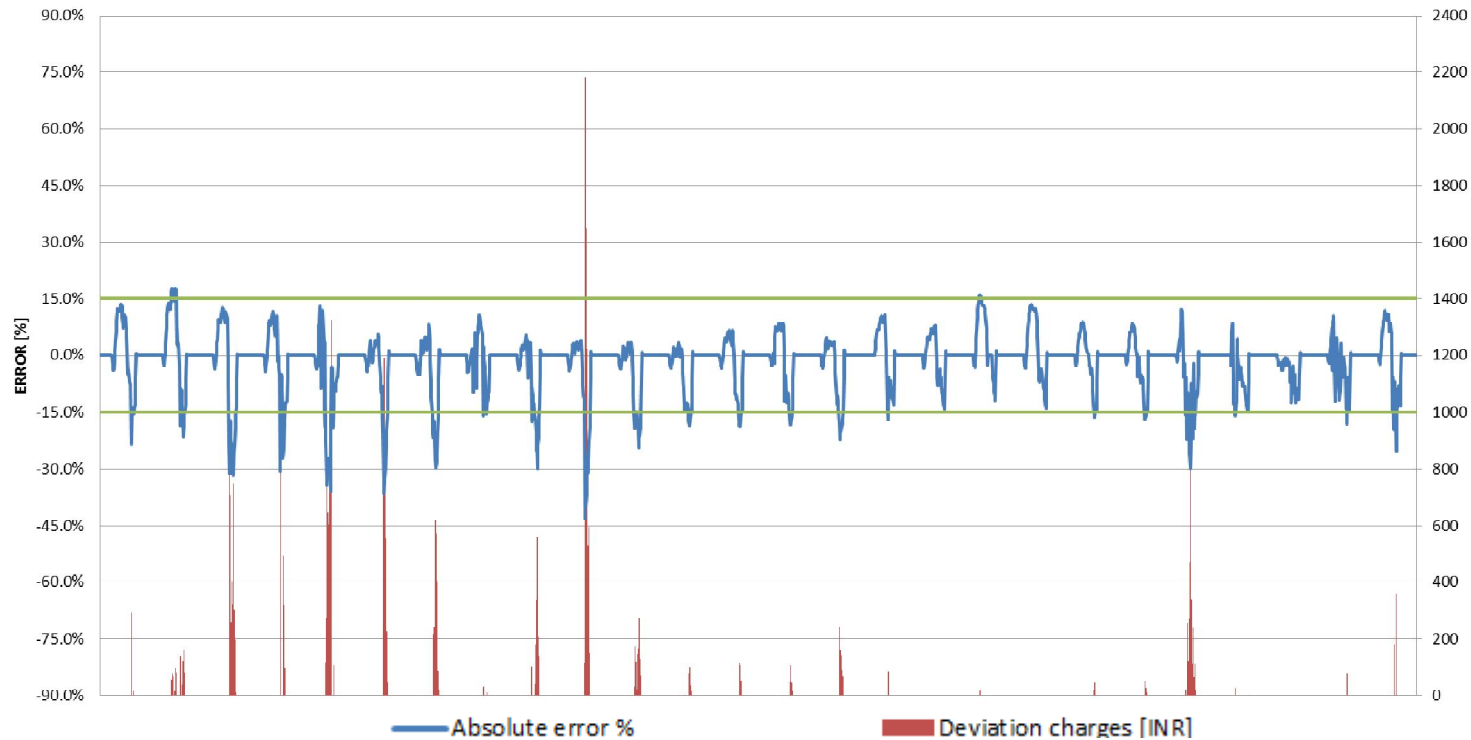
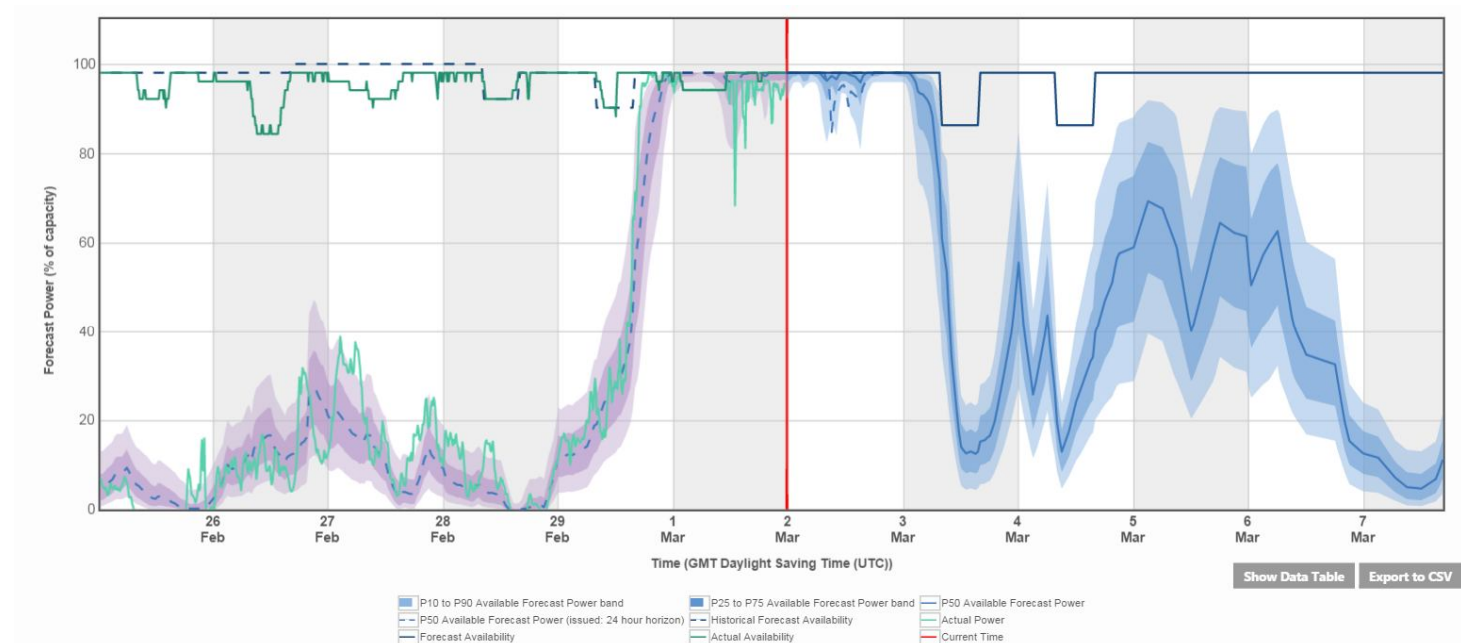


Fig. Graphs showing absolute error, +/- 15% band, and resulting deviation charges in compliance with model regulations

- Potential revenue losses of 0.4% established through accuracy analysis
- Improved revenue protection possible with improved data quality and transmission

Conclusion

- Detailed modelling can produce accurate short-term forecasts
- Fast & reliable measurement data feed essential for short horizon improvements



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