

Statistical Downscaling for Seasonal Wind Power Forecasts – A Case Study in India



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enercast power forecast products



- **enercast standard** product

The short- and medium-range wind/solar energy forecasts



7-day forecast
~10 updates per day



30-day forecast
2 updates per week

- **enercast seasonal** product – Pilot project wind power/ energy generation forecast for the upcoming 6 months



6-month forecast
monthly updates

Demand for seasonal energy forecasts

- Reliable budgeting
- Operational optimization
- Financial risk mitigation
- Statistical analysis based on historical data from the last few years is insufficient for projecting the next year.



Seasonal forecast from climate models

- Energy Forecasts Unavailable
- Lack of Wind Speed Data at Turbine Hub Height
- Coarse Spatial Resolution
- Systematic Errors Across Timescales



Converting Wind Speed Forecasts into Site-Specific Power Output

Data level:

- Tried several seasonal forecast resources
- Incorporating wind speed forecasts from surface and pressure Levels
- Utilizing monthly forecast anomalies
- Site data collection and cleansing

Method level:

- Various machine learning methods

In addition:

- Assessing forecast skill of the indian monsoon*



Data Quality Issues and Data Cleansing

■ Data Quality Issues:

Wind Plant Shutdowns

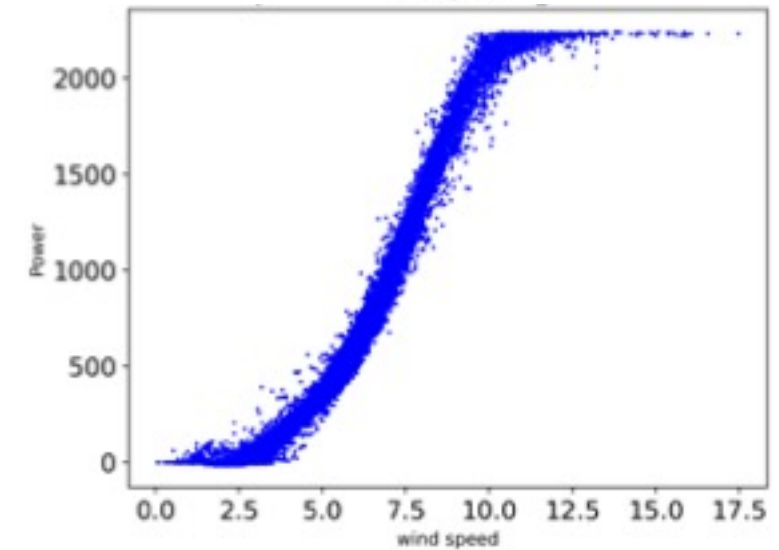
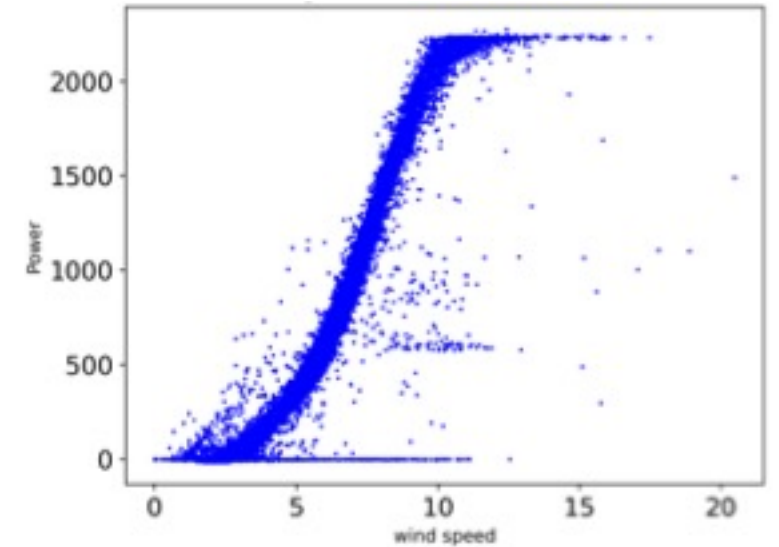
Incorrect Data Logging

Grid Issues and Operational Situations

■ Data Cleansing Approach:

Enercast's In-House Data Cleansing Automation

Individual Handling and Cleansing of +800 Wind Turbines



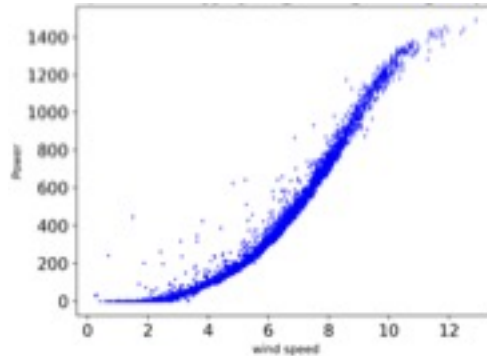
Data Sources and Methodology

Seasonal
forecast

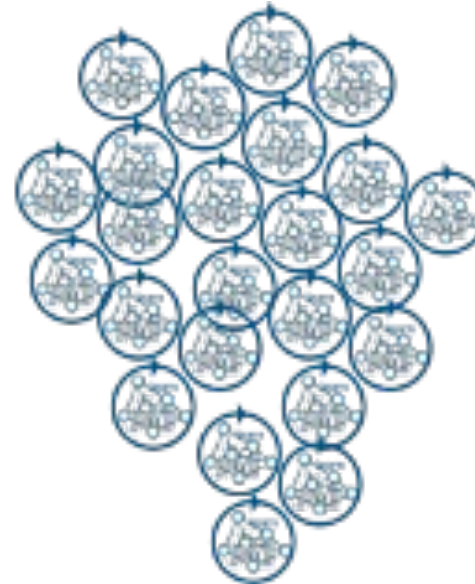
Reanalysis
data



Historical site data



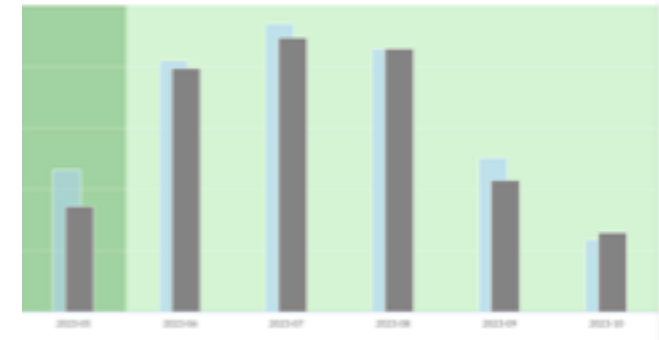
Machine Learning



Site-specific forecast

Forecast Delivery Timeline:

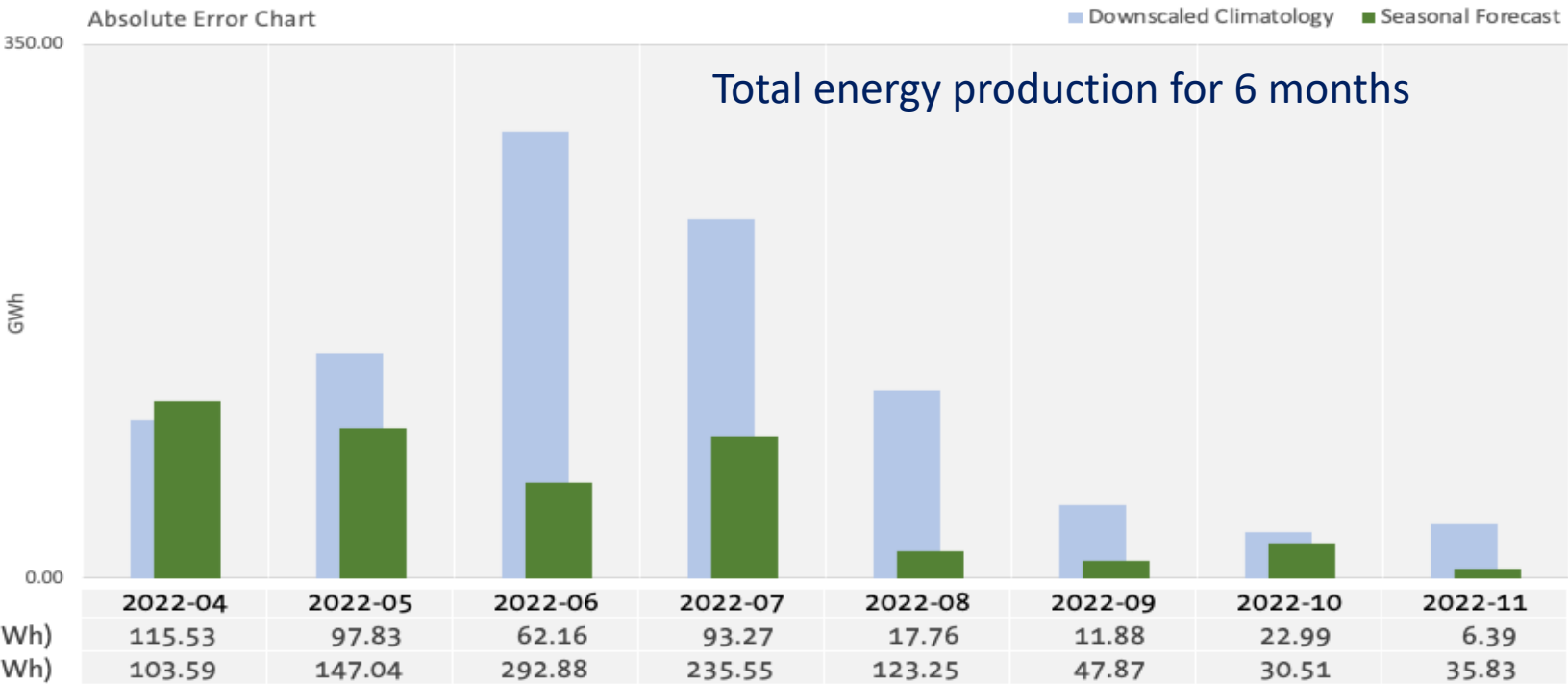
- Since April 2022
- Monthly Updates
- Covering the Upcoming 6 Months



Evaluations-1



- Country-Level Wind Portfolio:
Capacity: 1000 MW *
- Evaluation Metrics:
Energy Forecast vs. Actuals
Baseline: Climatological Energy Production**



*Capacity is slightly scaled down from the original portfolio capacity for the evaluation purpose
**Synthetic historical wind speed and power data is generated as a baseline for method evaluation

$Absolute\ Forecast\ Error\ (GWh) = |Forecast - Actuals|$

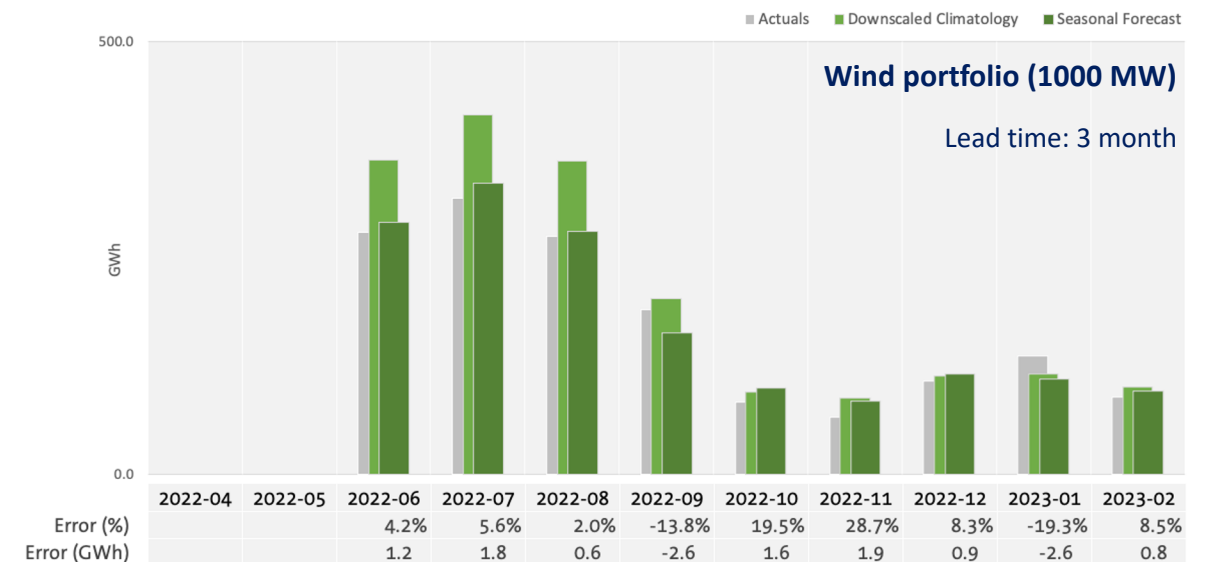
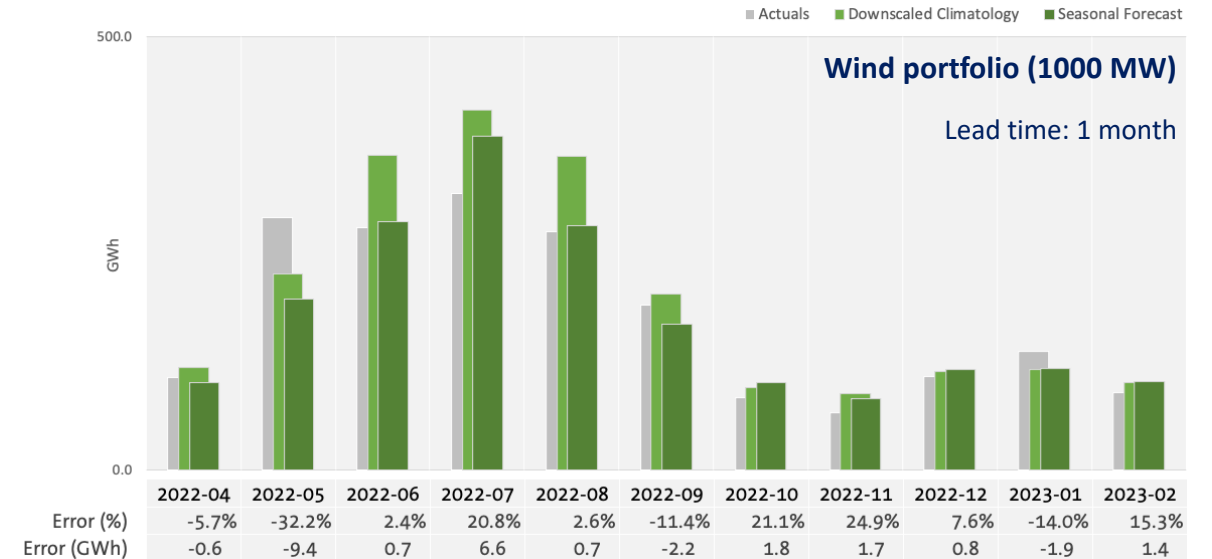
Evaluations-2

Lead Time: 1 Month

- Seasonal Forecasts captured the trend direction correctly in 7 out of 11 months.
- Seasonal Forecasts outperformed climatology in most months, particularly during the monsoon season.

Lead Time: 3 Months

- Seasonal Forecasts captured the trend direction correctly in 6 out of 9 months.
- Seasonal Forecasts outperformed climatology in most months, especially during the monsoon season.



$Error (\%) = (Forecast - Meter) / Meter$ | $Error (GWh) = (Forecast - Meter)$

Summary and Outlook



Seasonal Energy Forecasts Outperform Climatology:

- Lead times ranging from 1 to 6 months
- Excels climatology in most months, particularly during the high-wind season

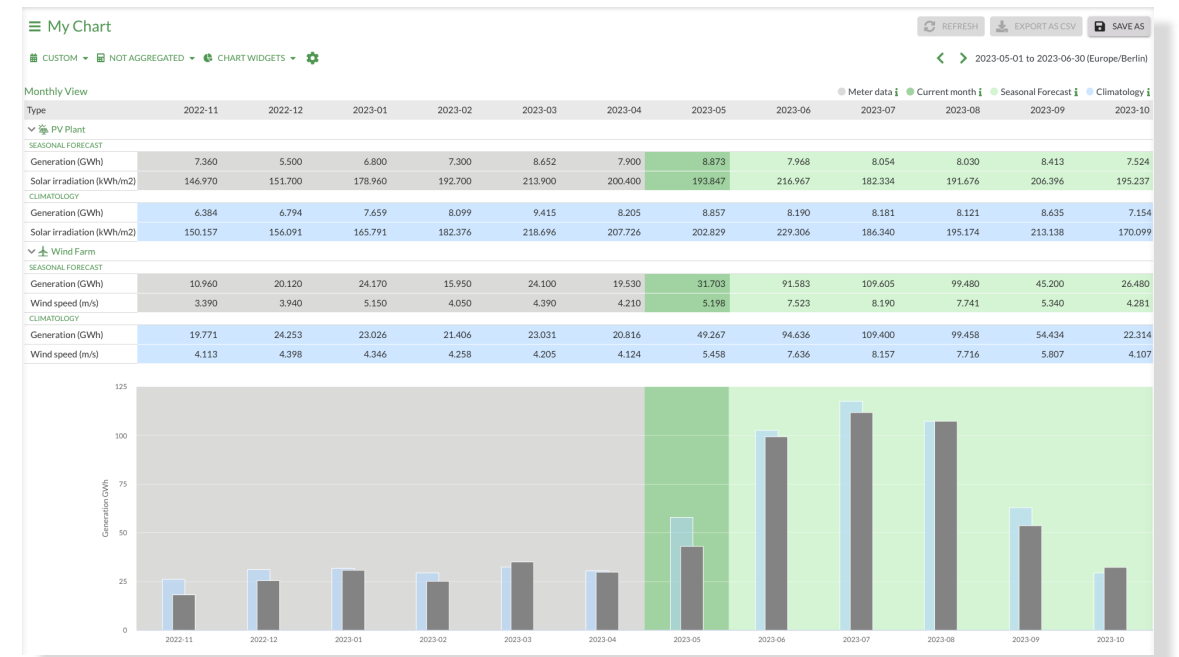
Seasonal Forecasts significantly enhance 6-month production estimates, which benefits for yearly budgeting and financial planning processes.

Next Steps:

Evaluate Extended Horizons

Pilot Projects in Additional Regions

Providing Uncertainty Range of Forecasts



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