Operational wind & solar power forecasting

*Optimized Wind and Solar Power Forecasts for India*

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Overspeed: 30 Years of Experience

• Core: Consulting for investors, banks, project developers

• R&D as background

• System development

• Main areas:
Wind energy Consulting

Assessments

System and Software Development

Wind and Solar Power Predictions

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Anemos predictions: What is Anemos?

- Leading edge research and development

Offshore wind farm development Sandbank 24

Nordsee: Offshore-Windparks
Underground storage for hydrogen: Salt dome
Hydrogen (P2X) long-term storage
Activities in India

- REMC advice
- Wind and solar power predictions
- Satellite-based very short-term predictions
- Training for NIWE team (GIZ): Indigenous solar power prediction system for India
- Training for REMC operators (GIZ)
High/low Wind Seasons and Model Tuning

Daily patterns and the atmosphere

Curtailment and unavailability

Solar power: Soiling of PV panels

Solar power: Sat-based forecasting methods
High/low Wind Seasons and Model Tuning
Tuning affected by high/low wind period
Models and adaptive tuning

- Adaptive model tuning improves forecasts over time
- Includes some „forgetting factor“

![Graph showing model error over time](image_url)
Auto-adaptive model improvement

Model error improvement over 6 month
Tuning affected by high/low wind period
Models and adaptive tuning

- Adaptive model tuning improves forecasts over time
- Includes some „forgetting factor“

- Discarding of old observations from the process must take into account seasonality
Thermal status of the atmosphere
Strong thermal influences

That's a wind farm, not solar!

Strong daily pattern.
Vertical wind speed profile

- Geostrophic wind
- Ekman-layer
- Surface boundary layer

Regular and high irradiation regions

Graph showing wind speed (u(z)) vs. height (z)
Wind farm with strong thermal influences

Appropriate modelling of the atmosphere is crucial
Power Data: Curtailment and unavailability
Curtailment and unavailability

Auto-detection helps for better tuning and forecasts
Solar power: Seasons
PV Power Production, clear sky
PV Power Production, broken clouds

As for wind: Model tuning algorithms must be optimised
Solar power: Soiling of PV panels
Losses due to soiling

- Soiling could reduce the PV output up to 15% or more
- Cleaning routine in place in most farms
- Rain has high impact on the effect
- Local measurements help
Soiling experiment

NIWE/overspeed/Uni Oldenburg:

First long-term soiling experiment in India
(Sahana L., this conference)
Solar power: Sat-based forecasting methods
Prediction Principles: Short-term

Model types:
- Statistical models
- NWP + physical/statistical modelling

Input Data:
- Online SCADA
- NWP domain
- Historical SCADA

Time:
- 5 min
- 15 min
- 3 h
- 6 h
- Intraday
- Day ahead
- 10 d
Big cloud field over south-east Australia
Prediction Principles: Short-term

Model types:
- Statistical models
- NWP + physical/statistical modelling

Input Data:
- Online SCADA
- NWP domain
- Sat images
- Historical SCADA

Time:
- 5 min
- 15 min
- 3 h
- 6 h
- intraday
- day ahead
- 10 d
Consecutive satellite images

Motion Vector Field

Cloud prediction → Irradiation
Example roof-top, NWP-based, Brisbane

**subregion41 (QLD): forecasts and actuals 2015-12-03**

- **Actual Production**
- **Weather data based prediction**
Example roof-top, sat-based, 1 hour ahead

subregion41 (QLD): forecasts and actuals 2015-12-03

sat based prediction
Prediction Principles: Extreme Short-term

Model types

- Statistical models
- NWP + physical/statistical modelling

Input Data

- Online SCADA
- NWP
- Sky cams
- Sat images
- Historical

Workshop Large-scale Grid Integration of Renewables in India, Delhi Sep. 2019
India is a challenging environment!

- Strong seasonal effects
- Strong thermal influences
- SCADA data influenced by no-availability
- Aerosoles and humidity play a big role
- Soiling has to be taken into account
India is a challenging environment!

- Very short-term forecasting with Indian satellite
- Fine tuning of models and processes improves predictions significantly

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