Operational wind & solar power forecasting

The Perfect Wind Power Prediction

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Large-scale Grid Integration of Renewables in India
Overspeed: 25plus Years of Experience

- Core: Consulting for investors, banks, project developers
- R&D as background
- System development
- Main areas:

Dr. Hans-Peter Waldl

Thomas Pahlke
Anemos predictions: What is Anemos?

- Leading edge research and development
- Prediction models and modules
- Wind and Solar Power Prediction System
- Commercial wind & solar predictions
Anemos Wind/Solar Power Predictions: Partners
Anemos predictions: What is Anemos?

- Leading edge research and development

Wind power predictions: Principles

The Perfect Prediction: Models

The Perfect Prediction: Power data

Summary
Wind power predictions: Principles

The Perfect Prediction?
The Perfect Prediction: Ingredients

- Historical Power
- Prediction Model(s)
- Online Power
- NWP Wind

Prediction System
The Perfect Ingredients?: Chili Peppers

The Perfect Curry Meal

India
Me
Tamil Nadu
Perfect for …? -- Applications

Grid and system operations
- Power plant dispatching
- Reserve planning
- Congestion management
- Extreme event handling

Other applications
- Energy trading
- Load predictions
- O&M optimisation

Rules and regulations!
The Perfect Prediction: Models

Online Power Prediction Model(s)

Historical Power

NWP Wind

Prediction System

Weather forecast (NWP)
The Perfect Prediction: Ingredients

- NWP
- Wind
- Online Power
- Historical Power
- Model(s)

Predicted Power
Modelling approaches

- Commitment of **physical or statistical models** strongly depends on purpose
- From experience: Combination of physical and statistical modelling leads to best results
- Use **all** knowledge you have about wind and wind power
A note on “Machine Learning”

“Machine learning” methods based on power production

• Could be a great asset for some applications

• Needs big data volumes

• Issue: Not available in most applications

• Risk: Modelling of extremes may be completely wrong
Prediction Principles: Time domains

- **5 min**
- **15 min**
- **3 h**
- **6 h**
- **intraday**
- **day ahead**
- **10 d**

**Model types**

- Statistical models
- NWP + physical/statistical modelling

**Input Data**

- Online SCADA
- NWP domain
- Historical SCADA

**Model Tuning**

- Auto-adaptive model tuning
Auto-adaptive model improvement

Model error improvement over 6 month, different NWPs
The Perfect Prediction: Power data

Historical Power

Prediction Model(s)

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Prediction System

Online Power
Power data should be as ideal as possible, but …

- Turbine failure
- Turbine availability is limited

- Missing SCADA data from wind farms
- Missing data connection to wind farms

- Substation availability

- Grid availability
- Grid congestions
- System services

- Issues with access to wind farm SCADA
Data with turbine availability and curtailment

Unconstrained wind farm production
Limited turbine availability
Grid curtailment

Power [%]

Time [hours]
Upscaling for curtailed wind farms

- Upscaling for curtailed wind farms
- Based on local wind speed measurements
- Automatic detection of curtailment
- Plus excellent data

Quality Management
Data channels: Power, and?

- Current power production *per farm if possible*.
- Current turbine availability
- Set-points for curtailment, …
- Data quality!

- Wind speed measurements for upscaling
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Input Data

Model Tuning

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- time
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Prediction System

Workshop Large-scale Grid Integration of Renewables in India, Delhi Sep. 2017
Typical prediction system: “Anemos”
Summary 1: Resilience

Prediction systems must be robust and flexible
• Communication and IT infrastructure is important!

Models must be robust and flexible
• Data quality management is essential

Well designed regulations and rules for wind/solar farms help the prediction business!
Perfect predictions?

In order to get an optimal prediction:

- Use more than one NWP; consider local models
- Get the best measurement data you can get
- Regulations: Make good power data quality a must

- Excellent predictions need good models and excellent data sources
Activities in India

- REMC advice
- Wind and solar power predictions
- Training for NIWE team (giz): Indigenous solar power prediction system for India

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