

Operational wind & solar power forecasting

Physical Wind Power Predictions

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International Workshop on
“Current practices in Wind and Solar Forecasting”



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



Wind energy Consulting

Assessments

System and Software Development

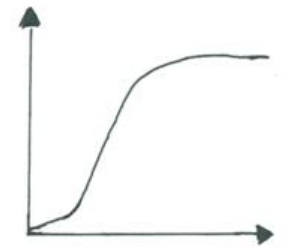
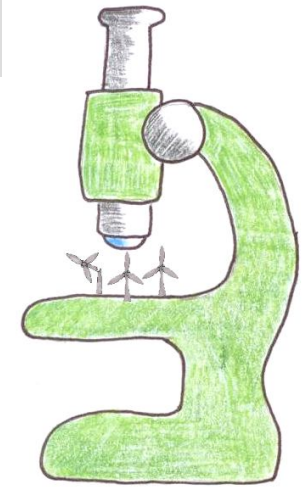
Wind and Solar Power Predictions

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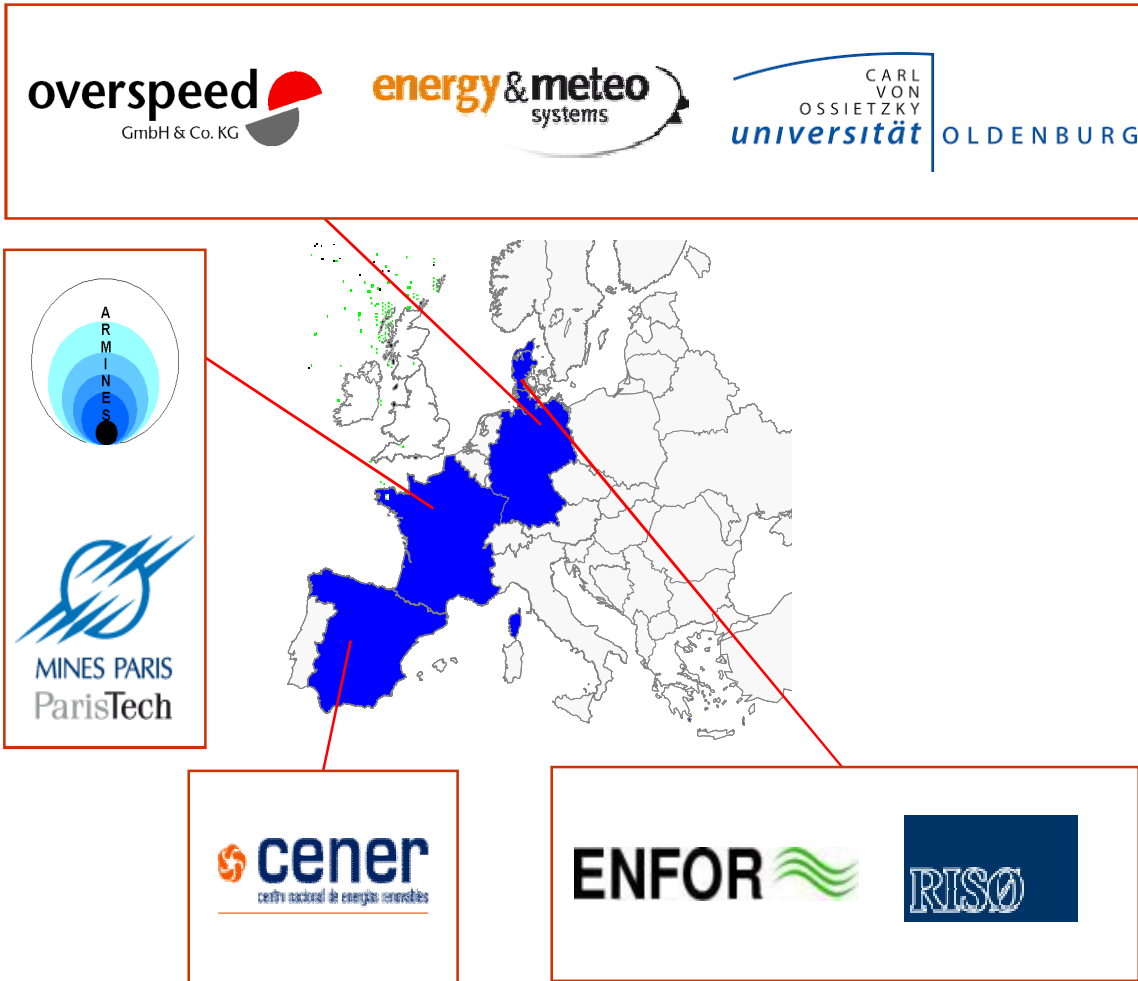


Anemos predictions: What is Anemos?

- Leading edge research and development
since 1994
- Prediction models and modules
since 1996
- Wind and Solar Power Prediction System
- Commercial wind & solar predictions *since 1997*



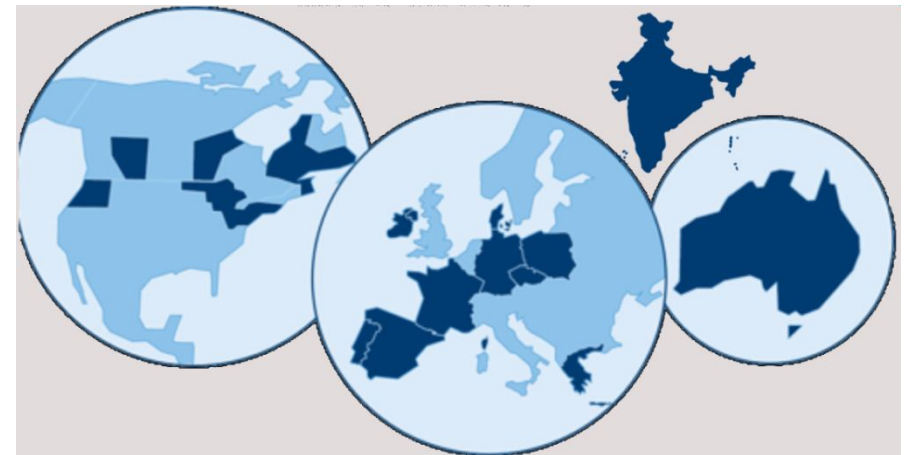
Anemos Wind/Solar Power Predictions: Partners



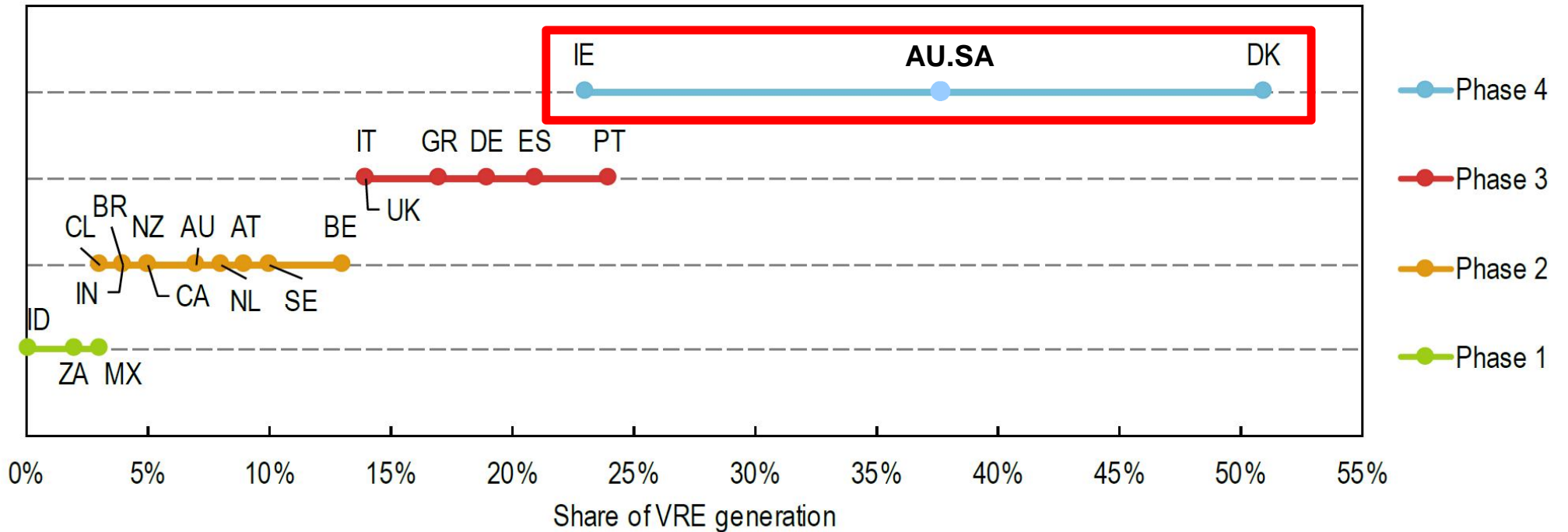
Anemos predictions: What is Anemos?

- Leading edge research and development
- Prediction models and modules
- Wind and Solar Power Prediction System
- Commercial wind & solar predictions

- World-wide around 100 GW



Anemos predictions: High penetration countries



Source: Adapted from IEA (2016d), *Medium-Term Renewable Energy Market Report 2016*



Wind power predictions: Principles

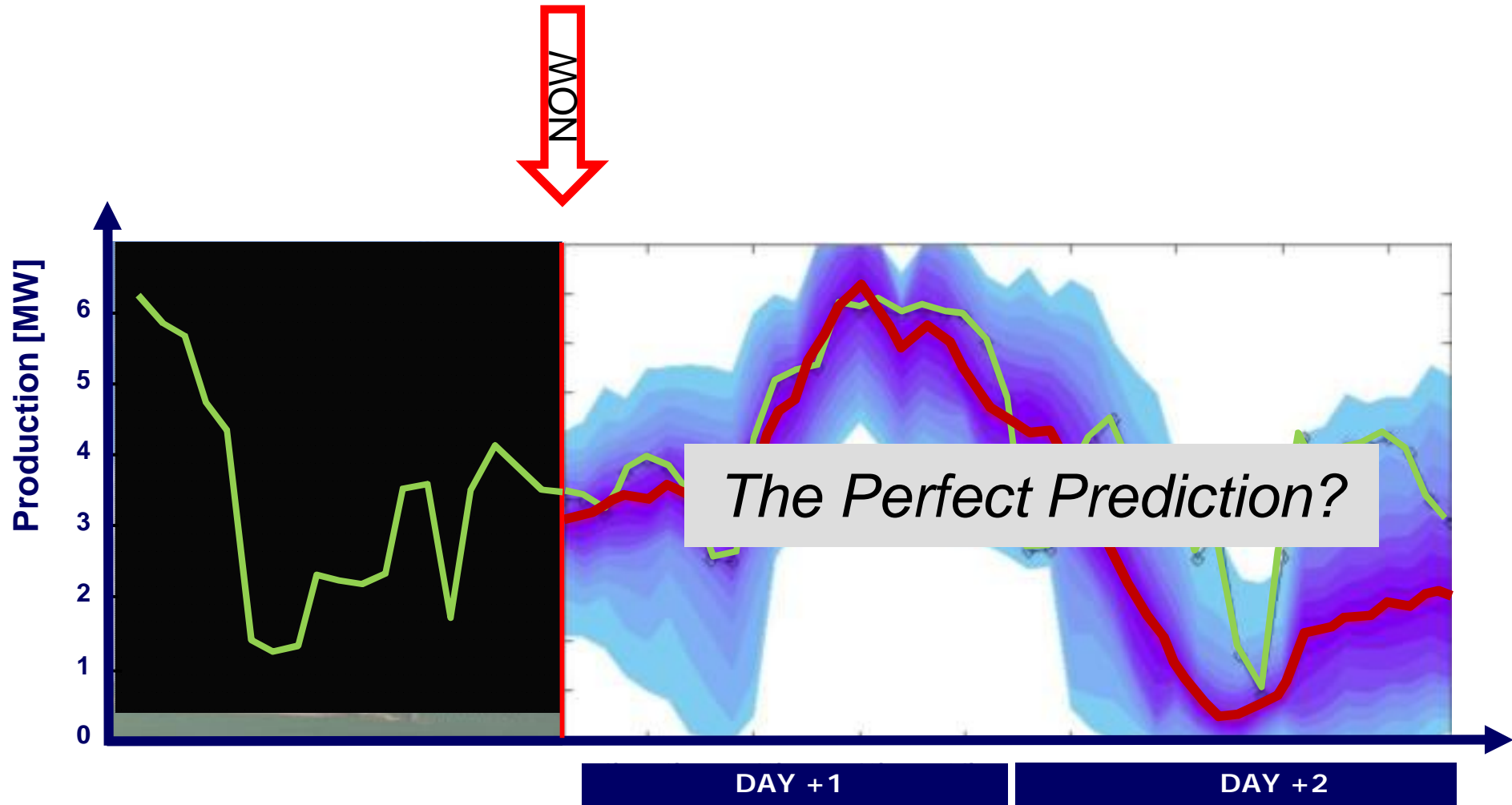
The Perfect Prediction: Models

The Perfect Prediction: Power data

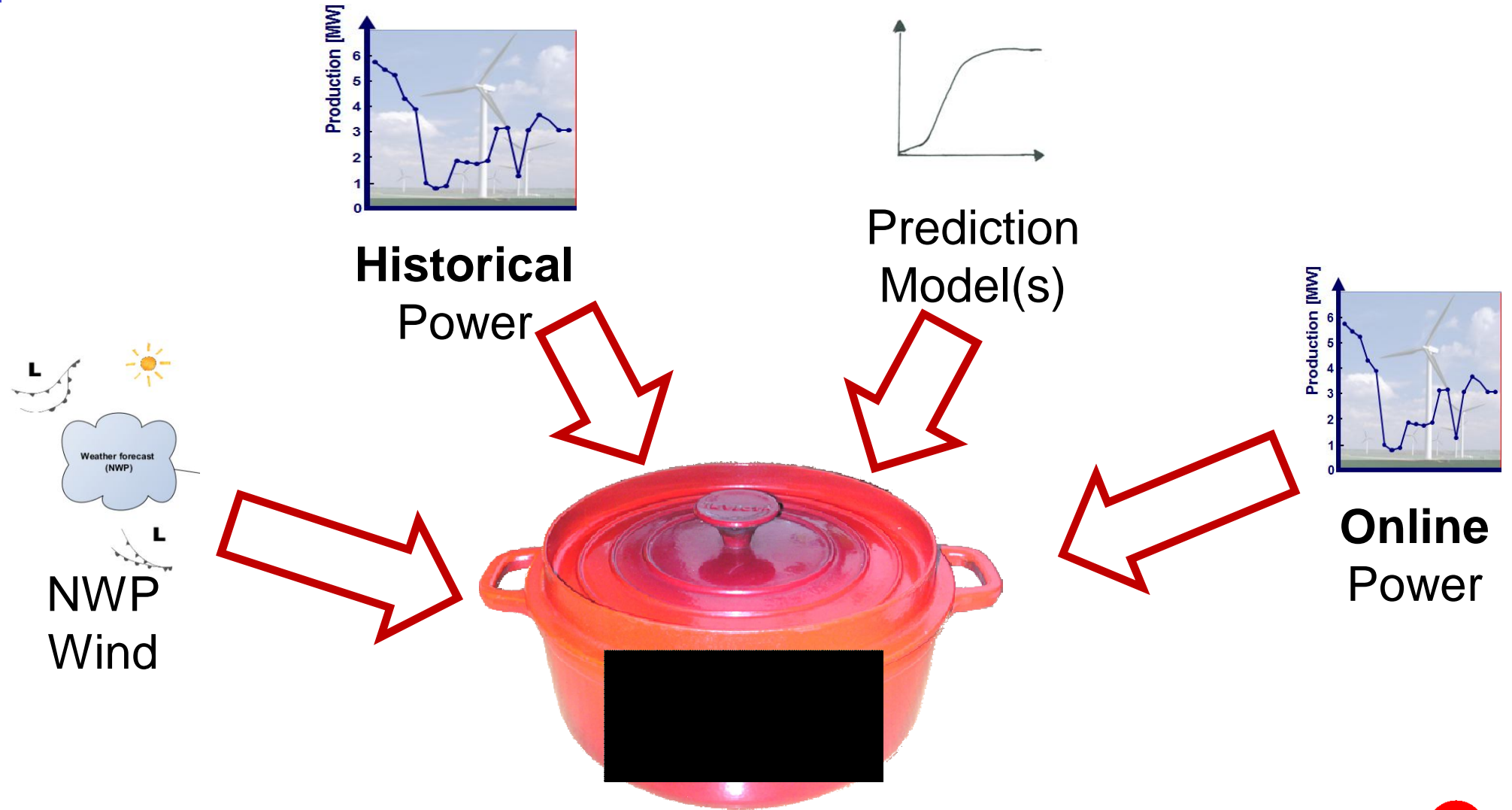
Summary



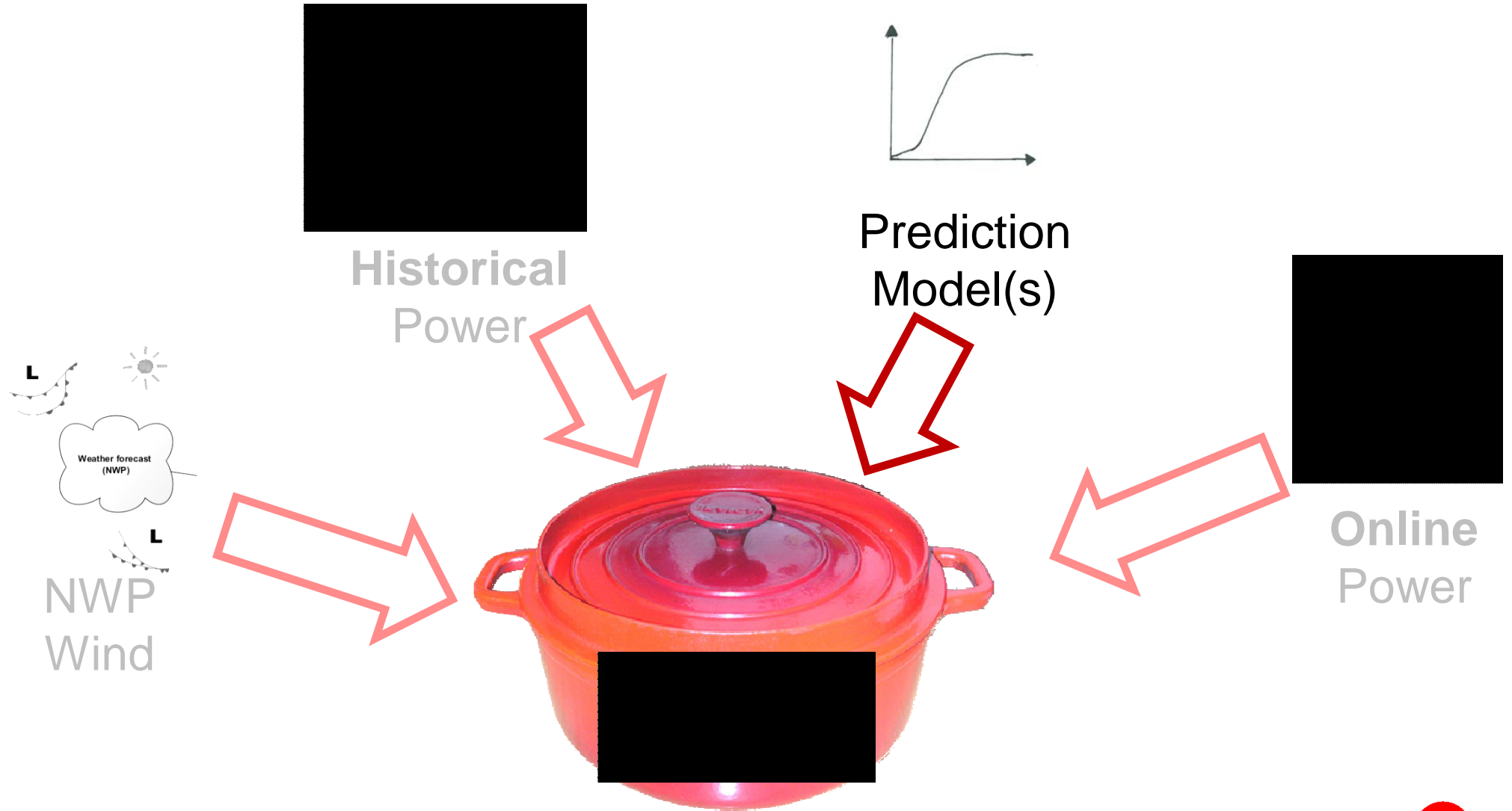
Wind power predictions: Principles



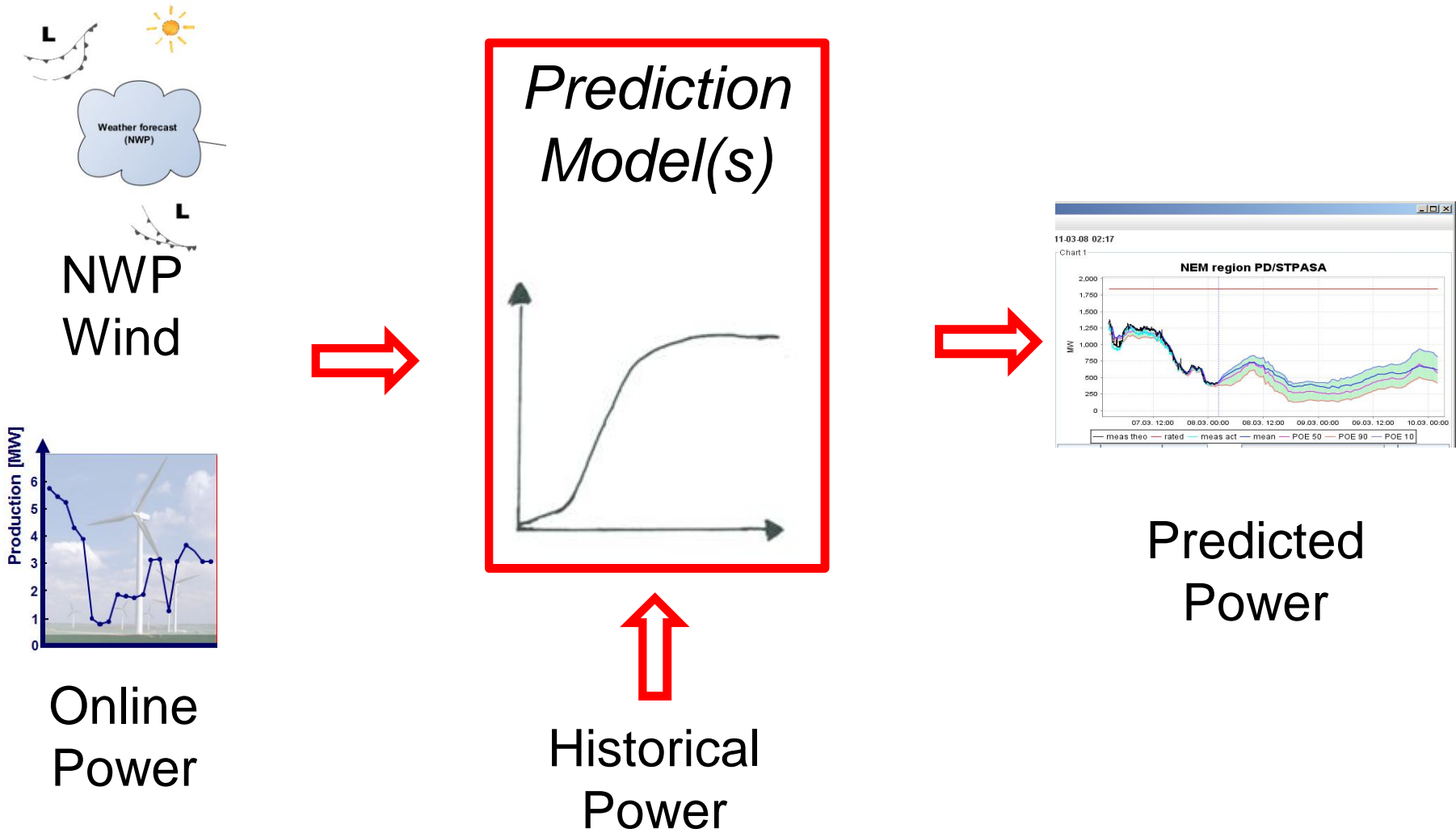
The Perfect Prediction: Ingredients



The Perfect Prediction: Models

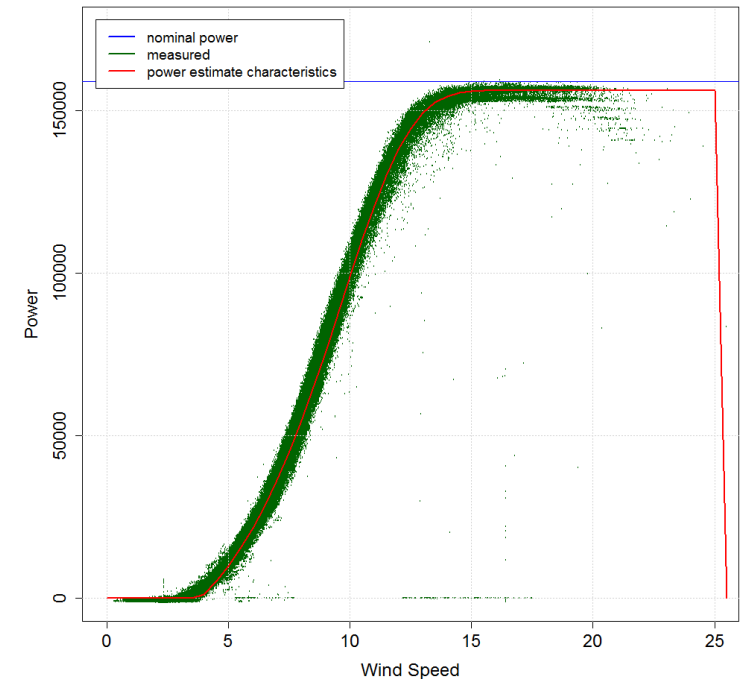


The Perfect Prediction: Ingredients



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



Physical modelling

Weather Forecast

Local influences

Local Wind

Local Wind

Turbine characteristics

Power

Power

Wind farm effects

Theoretical
Farm Power

Theoretical
Farm Power

Post processing

Real
Farm Power



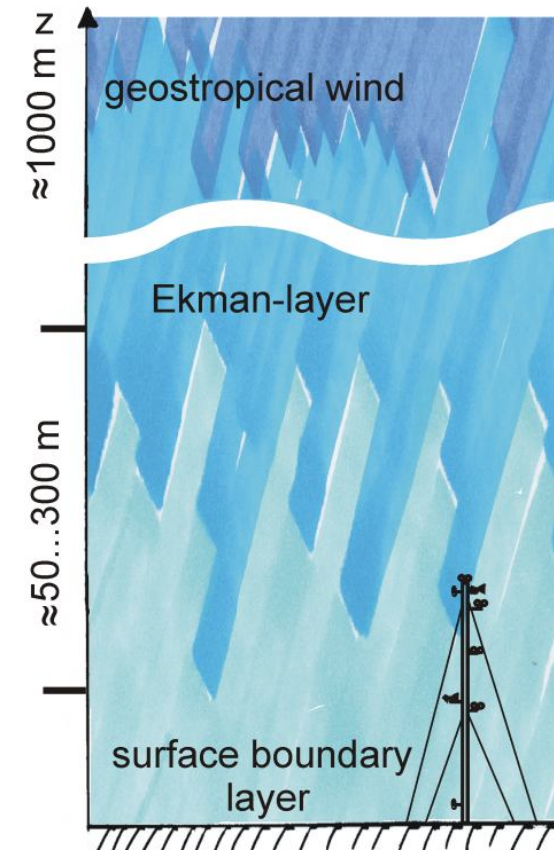
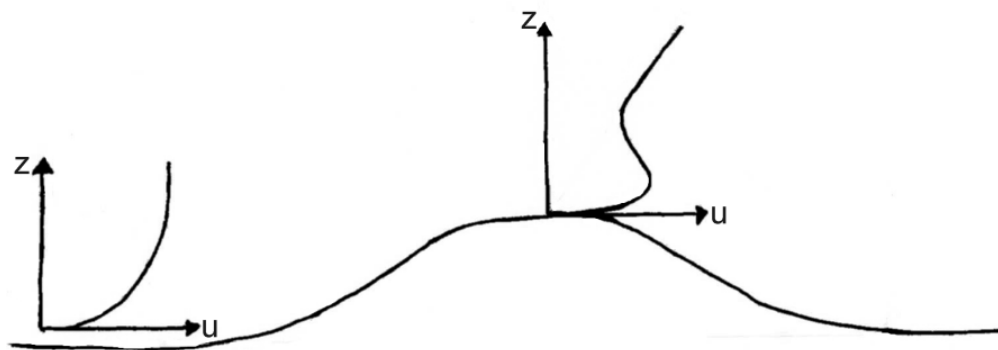
Physical modelling: Local wind

Weather Forecast

Local influences

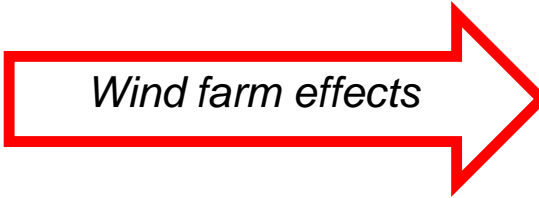
Local Wind

- Orography
- Roughness
- Daily patterns

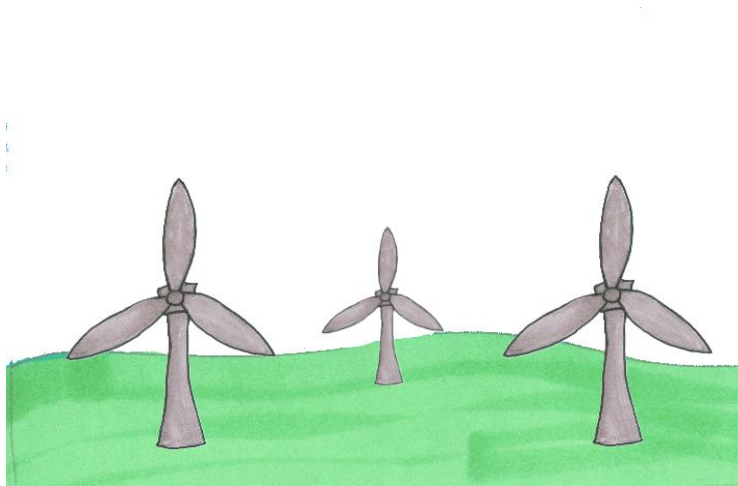


Physical modelling: Wind farm effects

Power



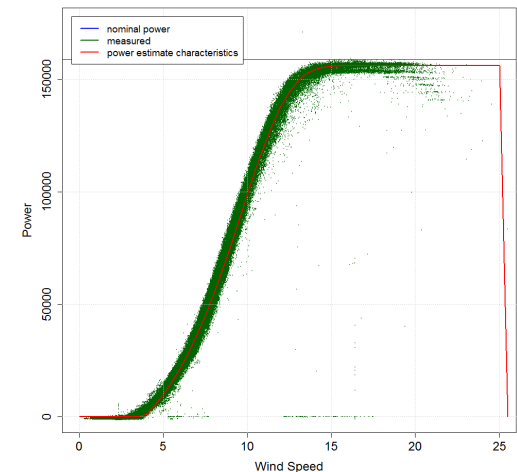
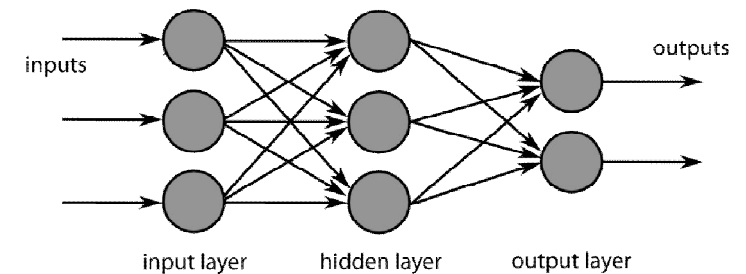
Theoretical
Farm Power



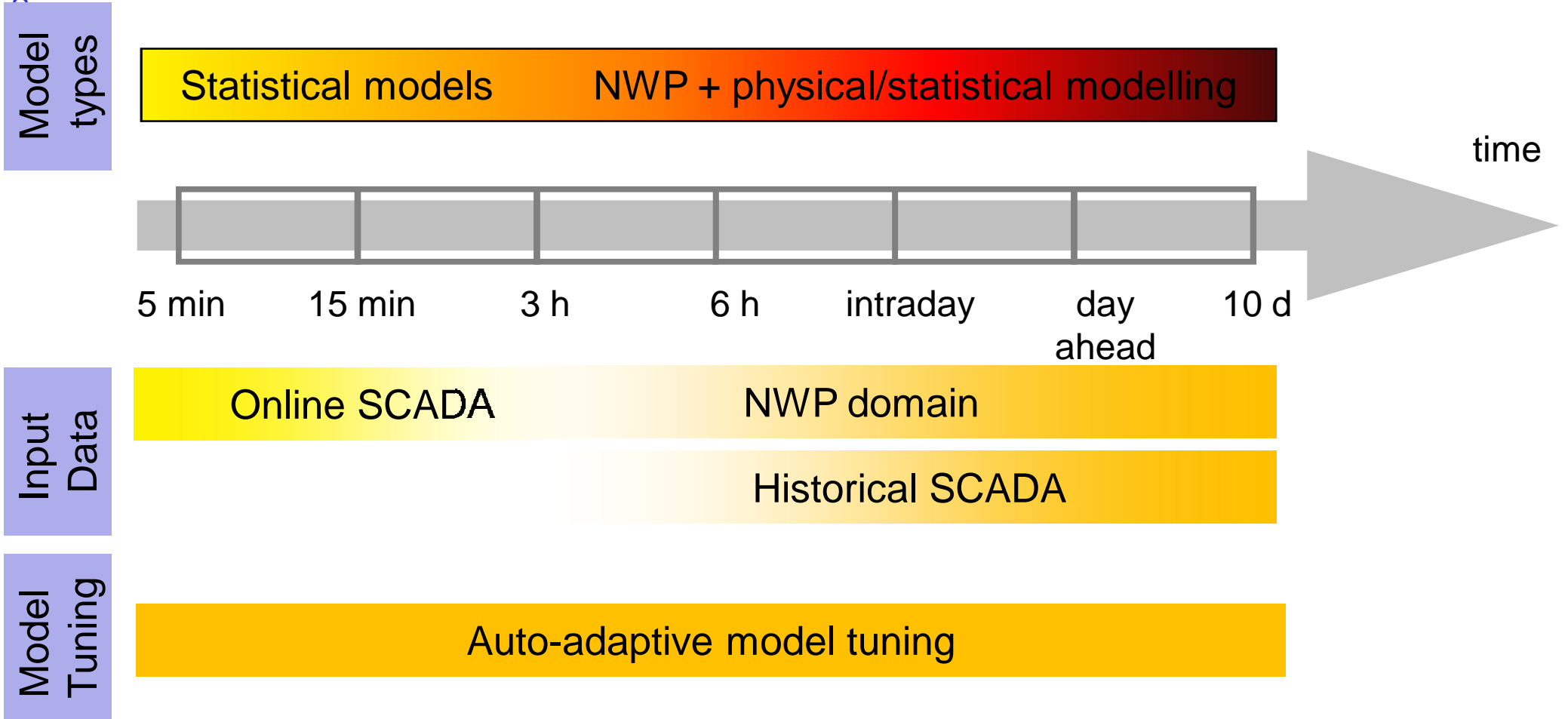
A note on “Machine Learning”

“Machine learning” methods based on power production

- Could be a great asset for some applications
- Needs big data volumes
- Depends on excellent data quality
- Issue: Not available in most applications
- Robustness is limited
- Risk: Modelling of extremes may be completely wrong



Prediction Principles: Time domains

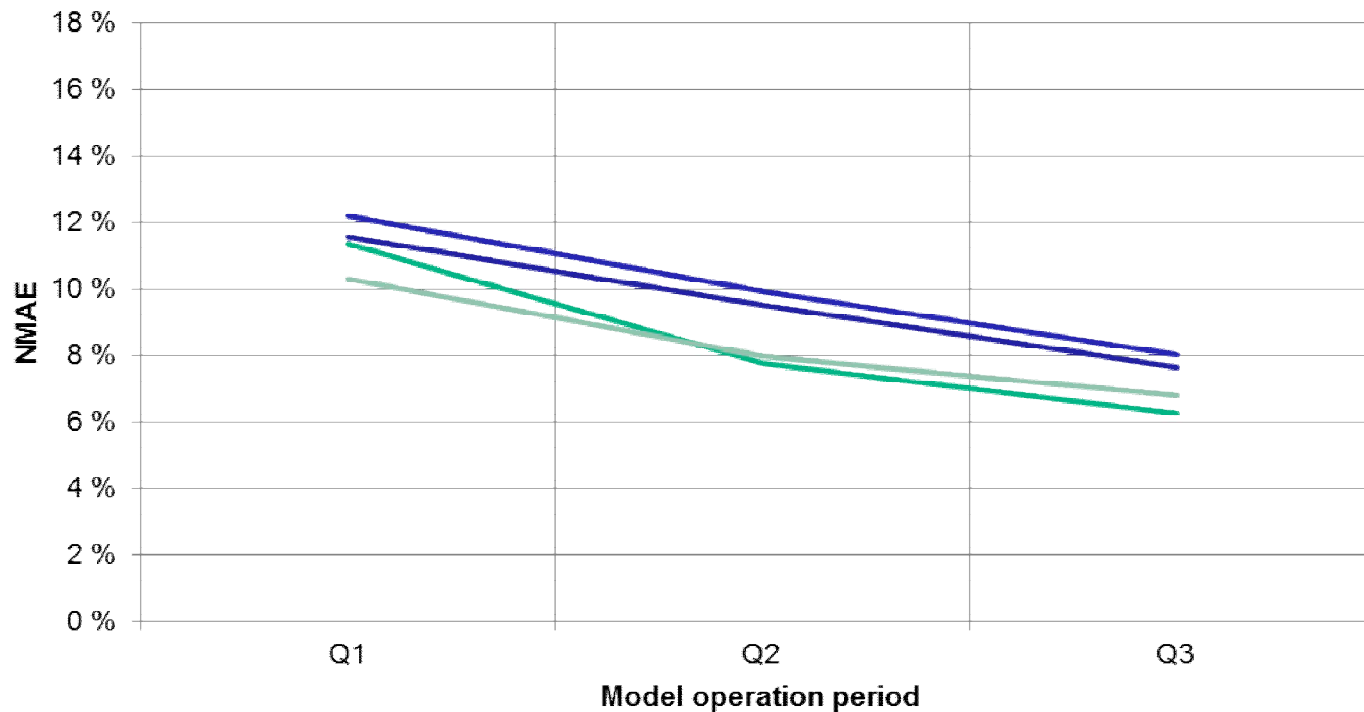


Auto-adaptive model improvement

Theoretical
Farm Power



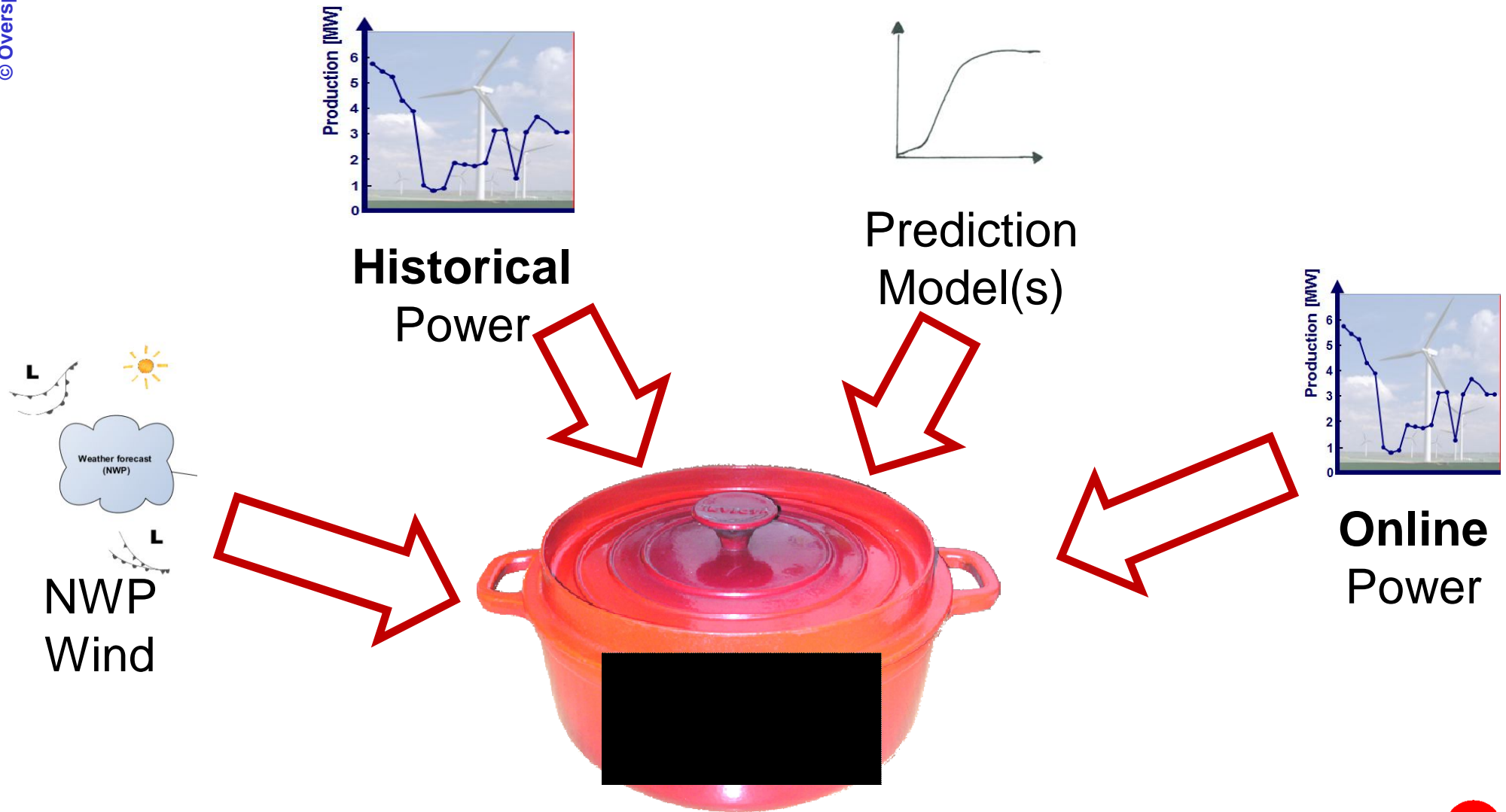
Real
Farm Power



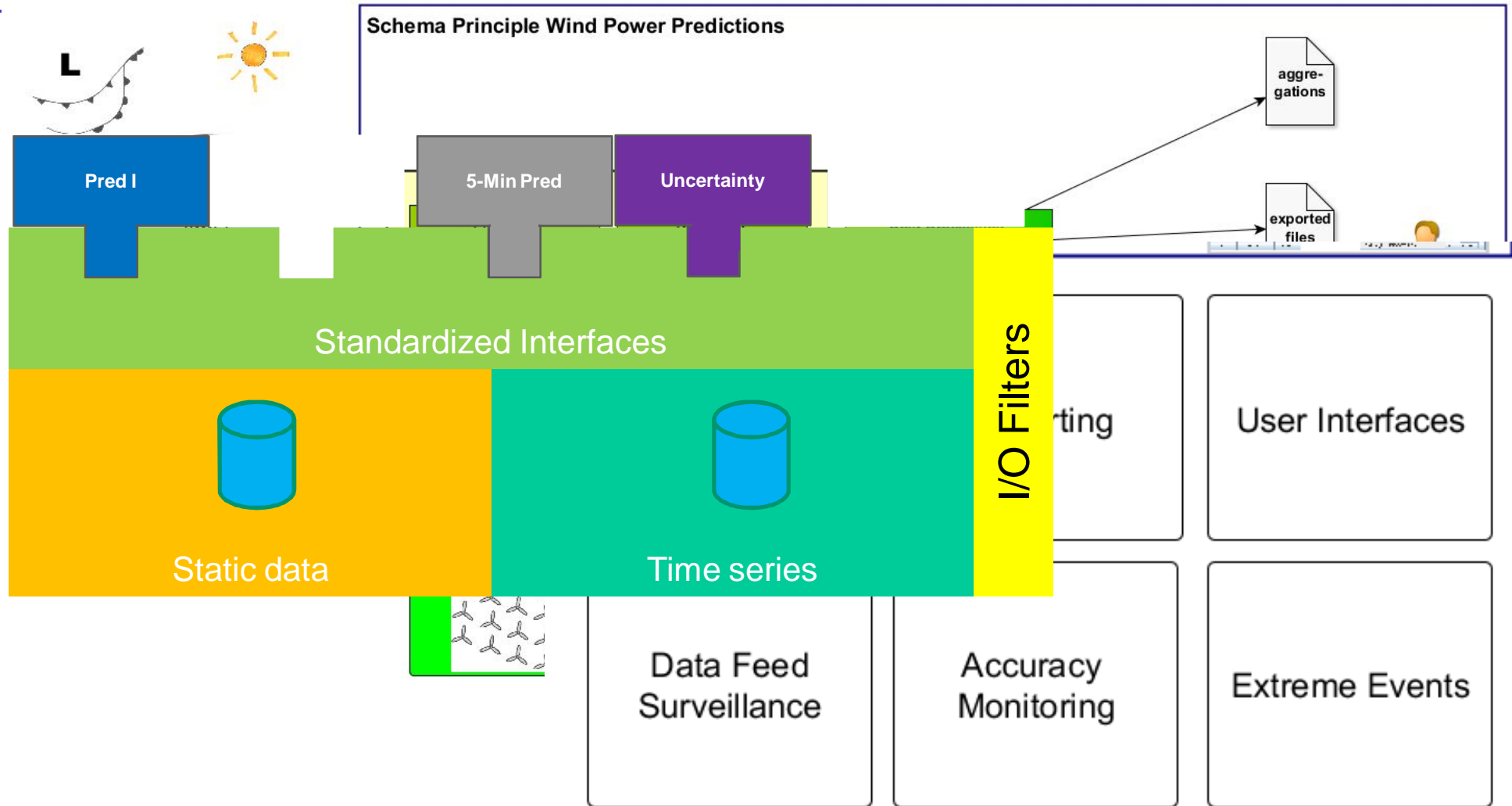
Model error improvement over 6 month, different NWP



Summary



Typical prediction system: "Anemos"



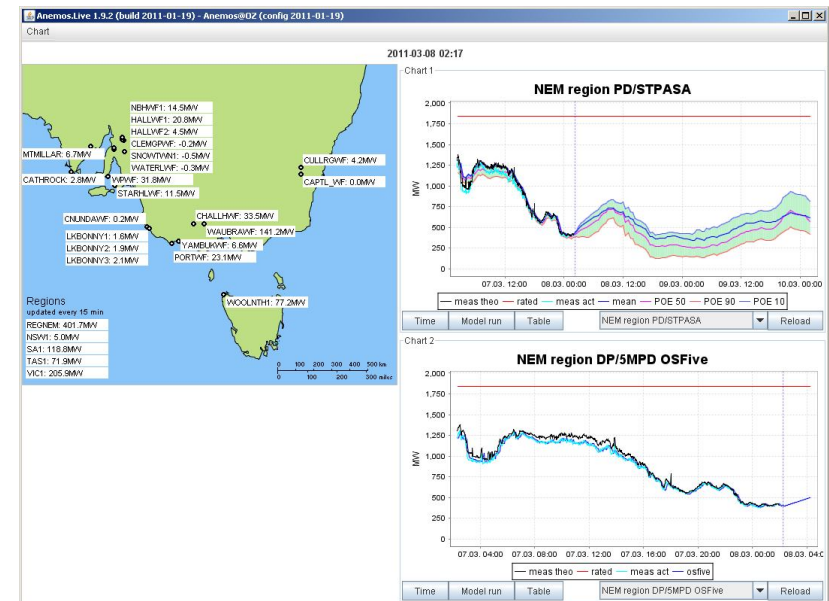
Resilience and high accuracy

Prediction systems must be robust and flexible

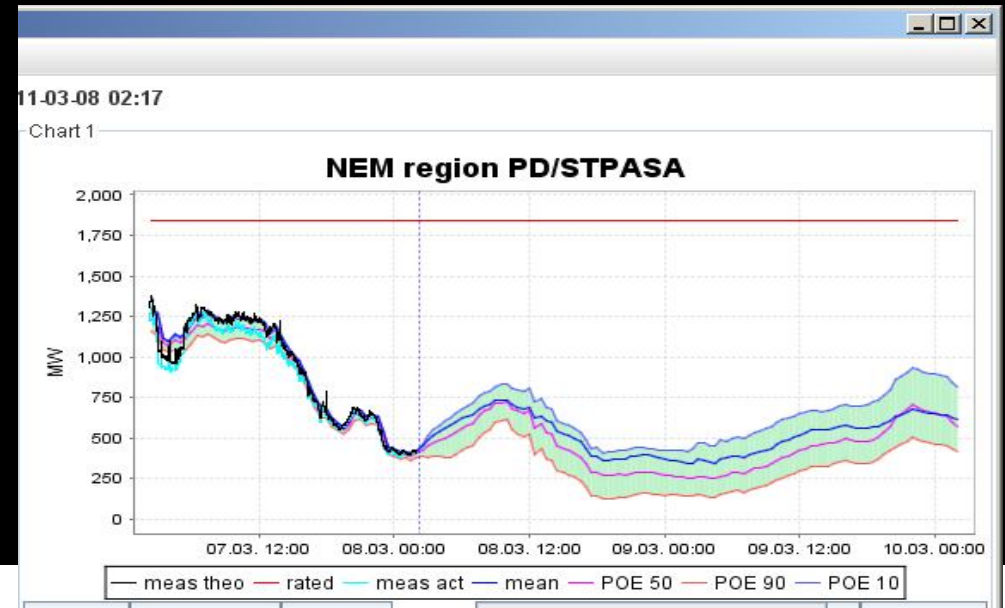
- Anemos platform for own and third-party models
- 100 % availability for 10 years

Models must be robust and flexible

- Physical modelling: higher resilience
- Post-processing improves accuracy
- Data quality management is essential



Perfect predictions?



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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The Perfect Ingredients?: Chili Peppers

**The
Perfect
Curry Meal**

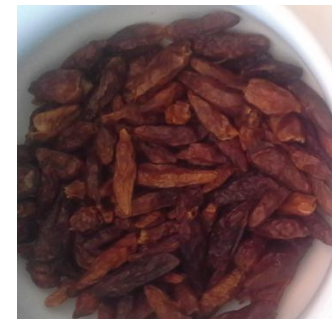
India



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

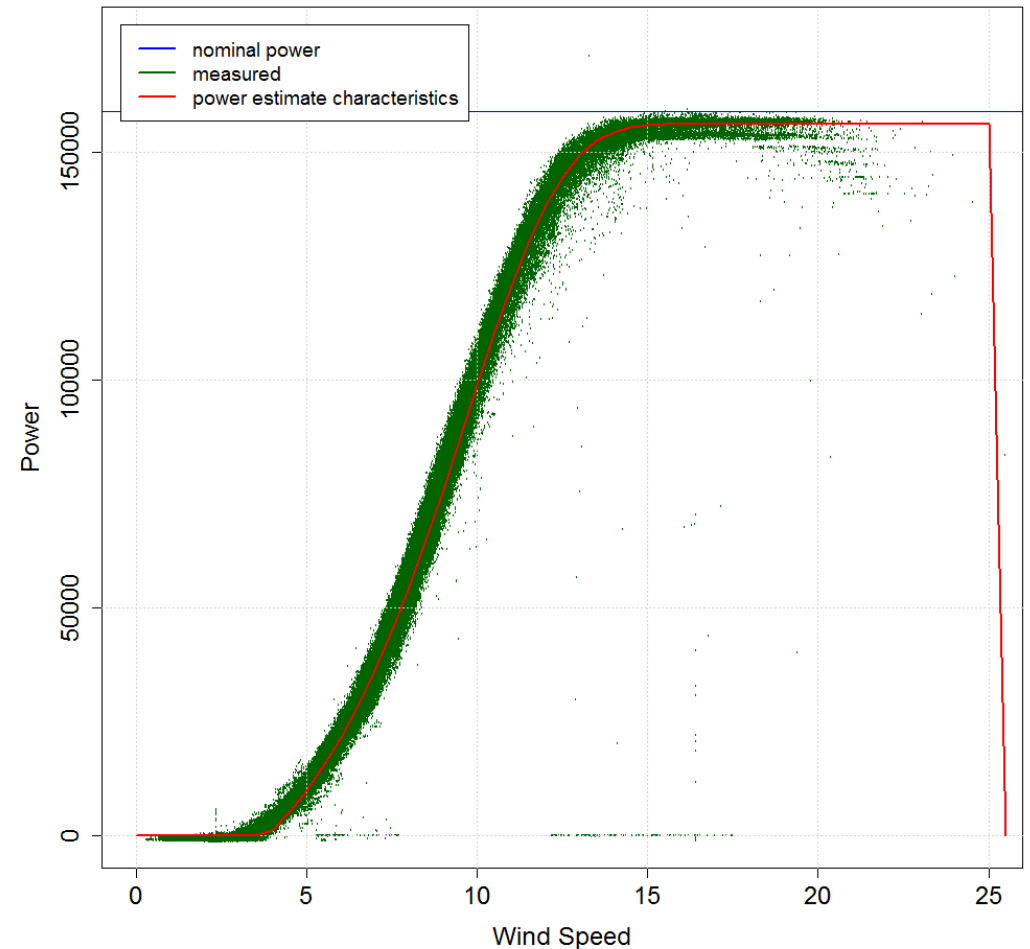


Rules and regulations!



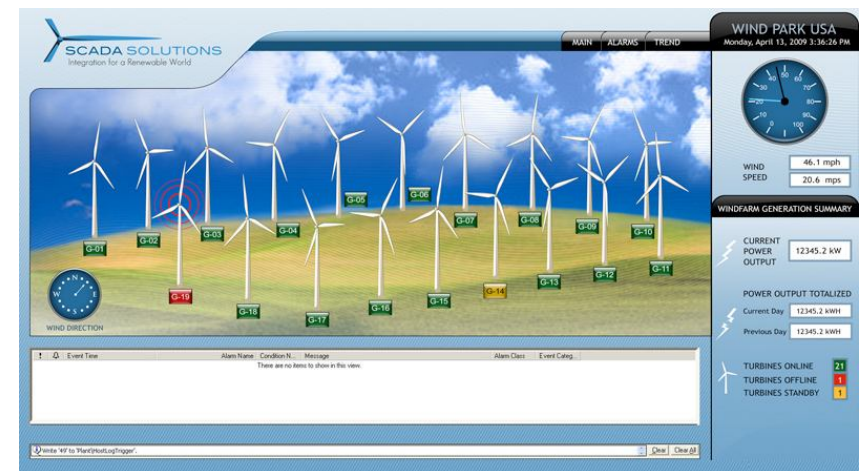
Upscaling for curtailed wind farms

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

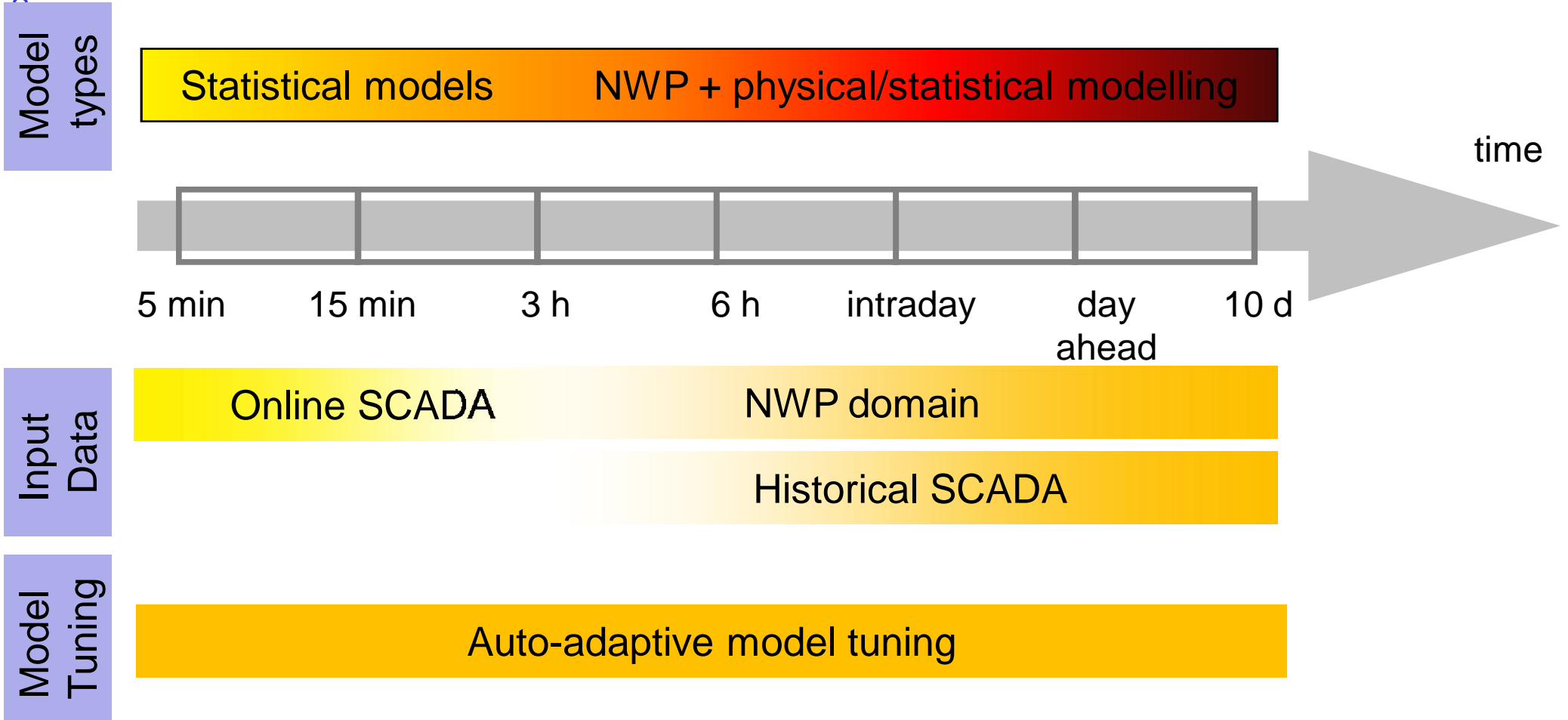


Data channels: Power, and?

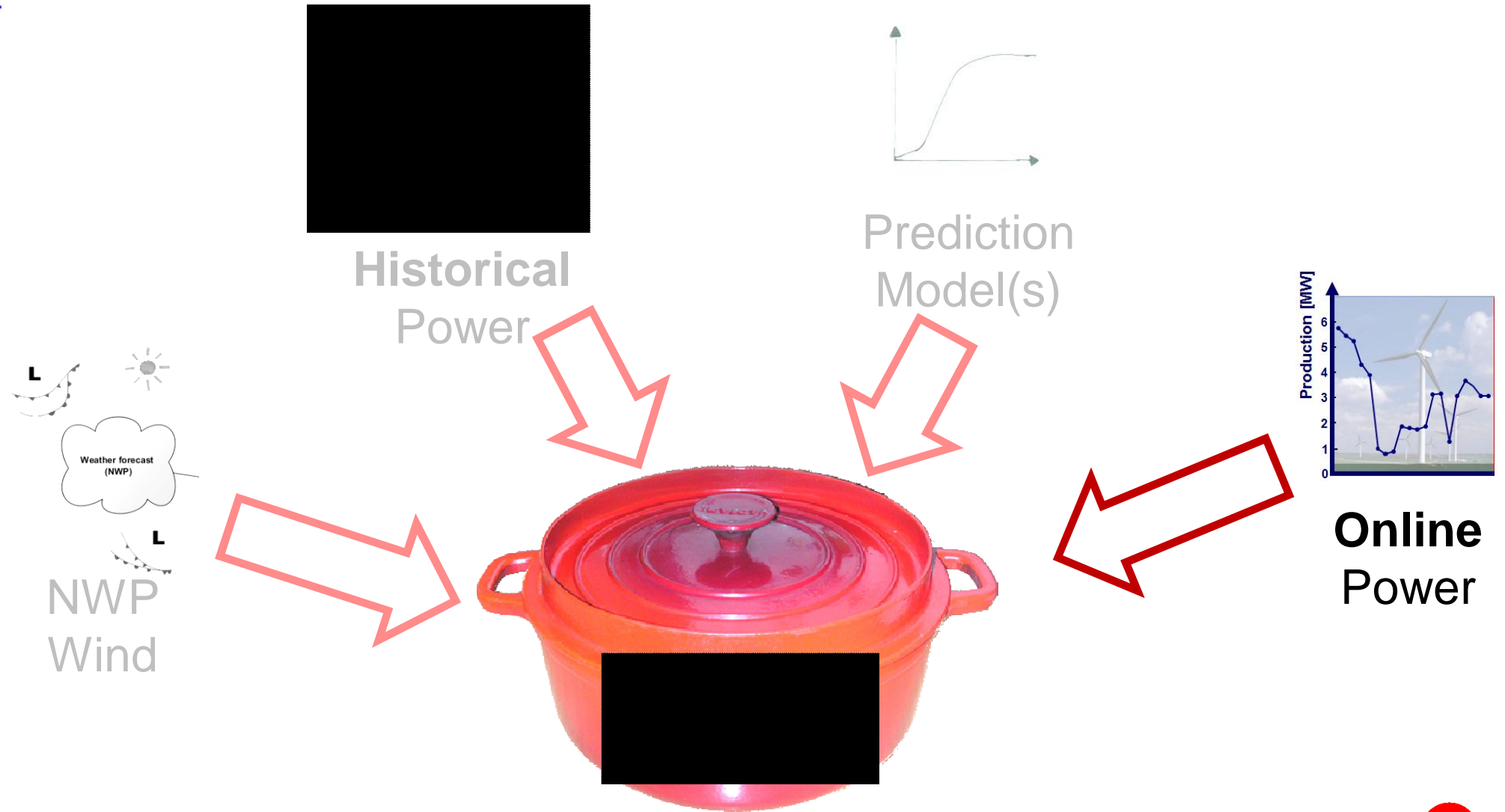
- Current power production *per farm if possible*.
 - Current turbine availability
 - Set-points for curtailment, ...
 - Data quality!
-
- Wind speed measurements for upscaling



Prediction Principles: Time domains

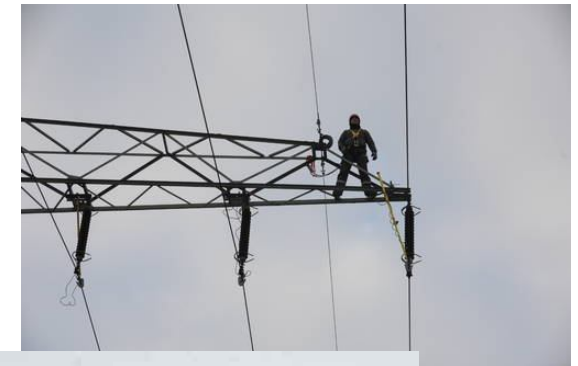


The Perfect Prediction: Power data



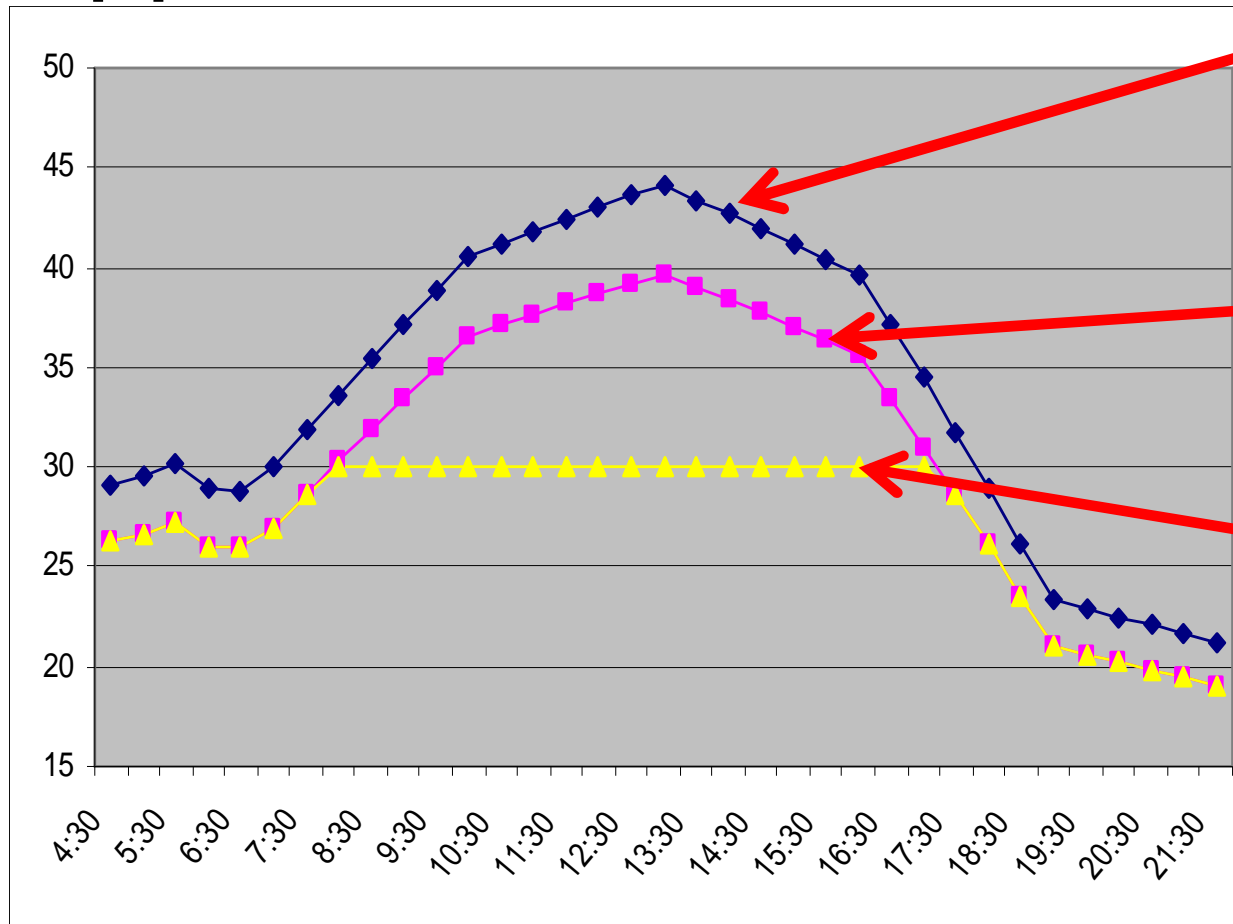
Power data should be as ideal as possible, but ...

- 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

Power [%]



Unconstrained wind farm production

Limited turbine availability

Grid curtailment

Time [hours]

