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A physical model for offshore wind power prediction

Melih Kurt
Fraunhofer IWES, Kassel, Germany

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Projektträger

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Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit

Projektträger Jülich Forschungszentrum Jülich

Fraunhofer IWES

Agenda

- Statement of problem
- Wind power forecasting methods
- Day-ahead forecast
  - Wake Adjusted Physical Power Model (WAPPM)
  - Optimization of the WAPPM with Model Output Statistics (MOS)
  - Artificial Neural Networks
  - Results
- Conclusions and Outlook

Statement of problem

- Wind power forecast is necessary for new installed wind farms
- No or limited power data available
- Which wind power forecasting method should be selected?
- How much historical data is needed for a reliable wind power forecast?

Wind power forecasting methods

- Physical model

  … uses physical considerations concerning the terrain information; models the shadowing effects of the wind farm

- Statistical model

  … describes the connection between the wind and the wind power directly through the statistical analysis of time series

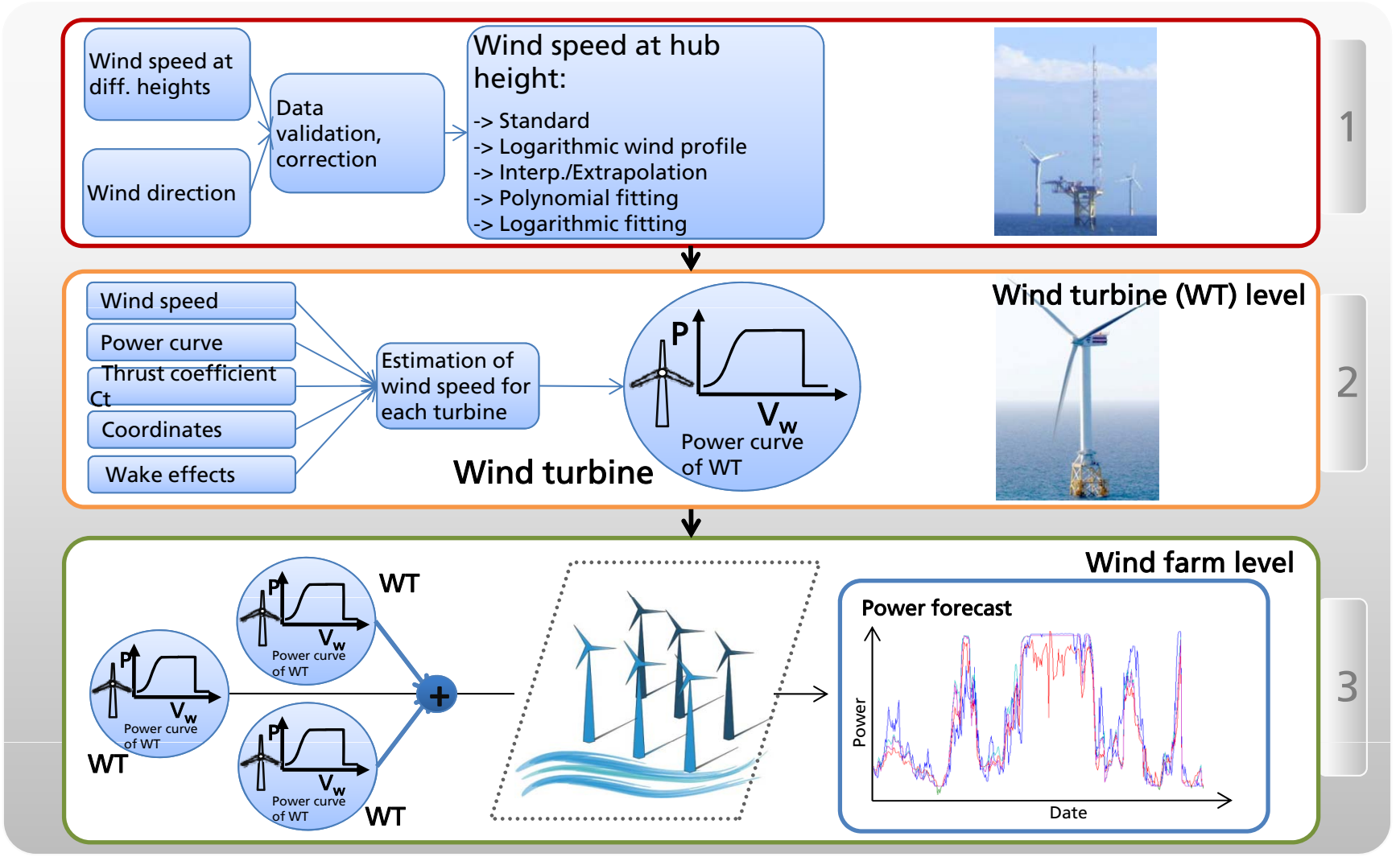
  – Learning approach

  … uses methods of Artificial Intelligence to learn relationship between Numerical Weather Prediction (NWP) and power data.

Day-Ahead Forecast

- Forecast of the expected power production for the next day (1-96h)
- Used for trading of electricity and power plant scheduling
- NWP parameters are the main input variables
- Three different models are investigated:
  - Wake Adjusted Physical Power Model (WAPPM)
  - Optimization of the WAPPM with MOS
  - Artificial Neural Networks

Wake Adjusted Physical Power Model (WAPPM)



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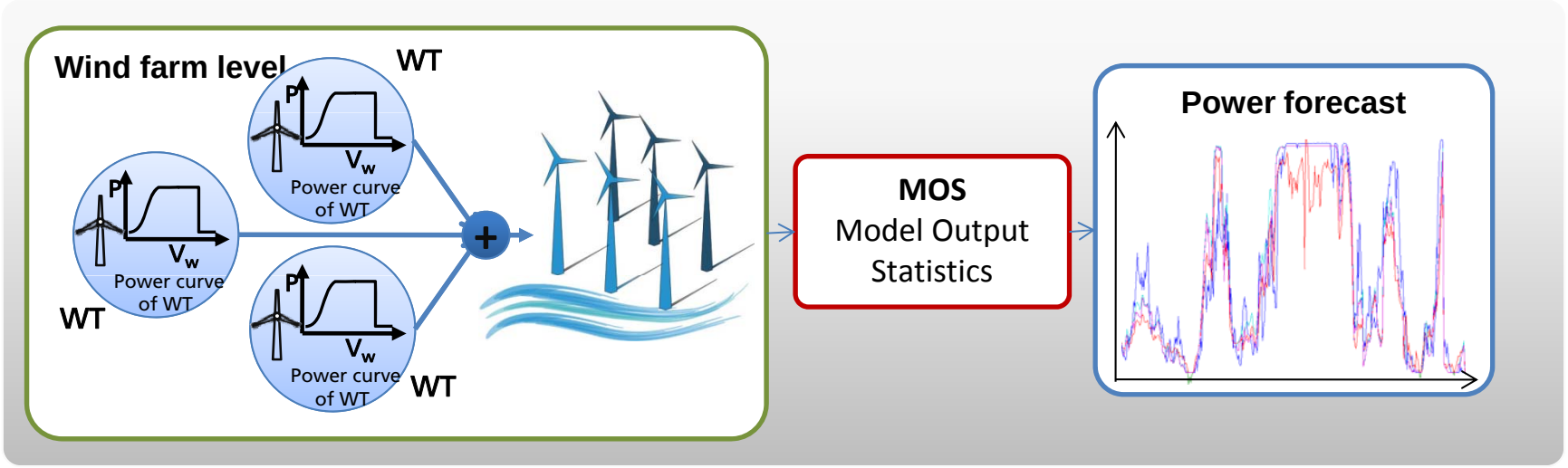
Optimization of the WAPPM with MOS



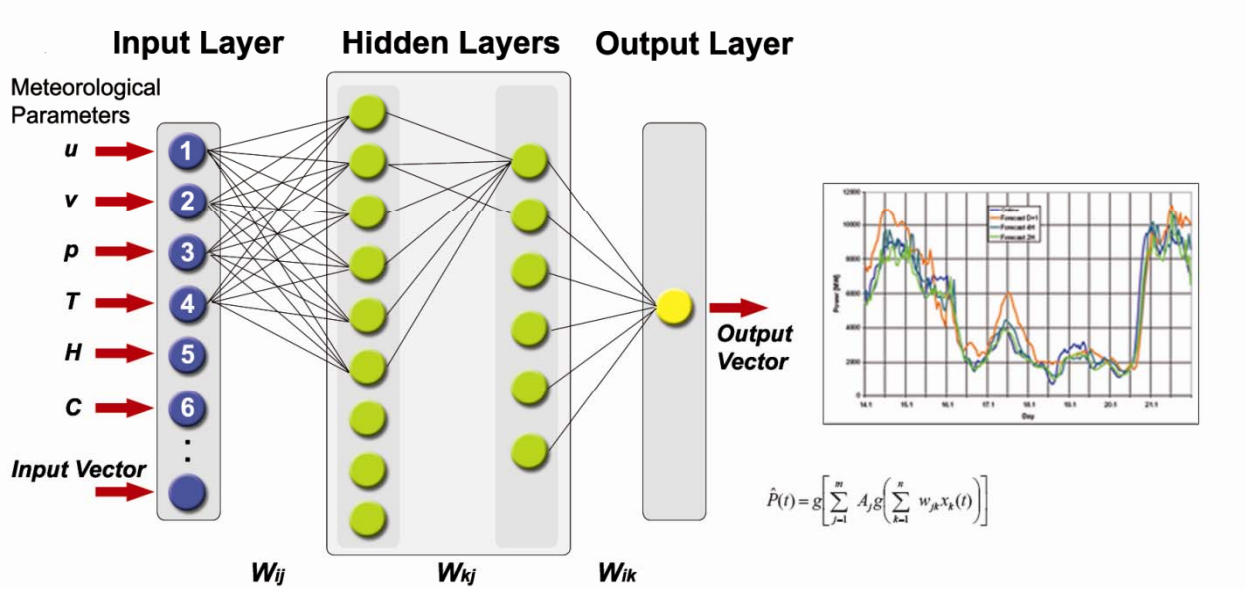
- MOS with Linear Regression

Linear regression method:

$$Y = \beta_0 + \beta_1 \cdot X_1$$

Development of an Artificial Neural Network Model

To learn the relationship between meteorological data and wind farm power output, the ANN needs to be trained with NWP and measured power values from the past.



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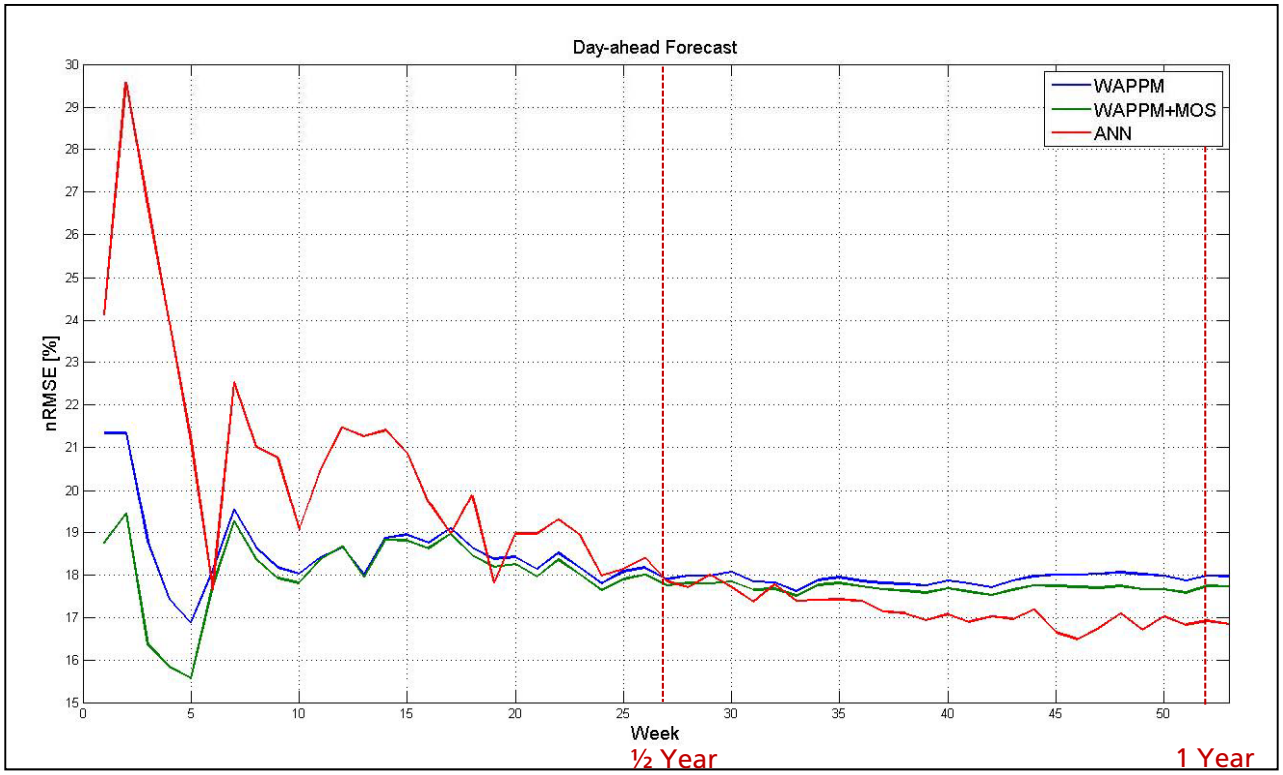
Results of different training intervals

To predict wind power production in the following day, WAPPM, WAPPM with MOS and ANN models are used.



Forecast error depends on amount of training time

Conclusions and Outlook

- The physical approach provides reasonable results with no training data
- The additional MOS leads to a slight improvement
- In the existence of large training time series (> ½ year) the Artificial Neural Network leads to best results.
- The historical measurements are very important to improve forecast quality

Training Data	Model
< ½ year	Physical Model + MOS
> ½ year	Artificial Neural Networks

Thank you for your attention

Melih Kurt
melih.kurt@iwes.fraunhofer.de

Fraunhofer IWES

Energy Meteorology & Wind Power Management
R&D Division Energy Economy and Grid Operation

Fraunhofer Institute for Wind Energy and Energy System Technology IWES
Königstor 59, 34119 Kassel