Improved intraday power forecasts of unmeasured wind plants with weather predictions and nearby online power measurements

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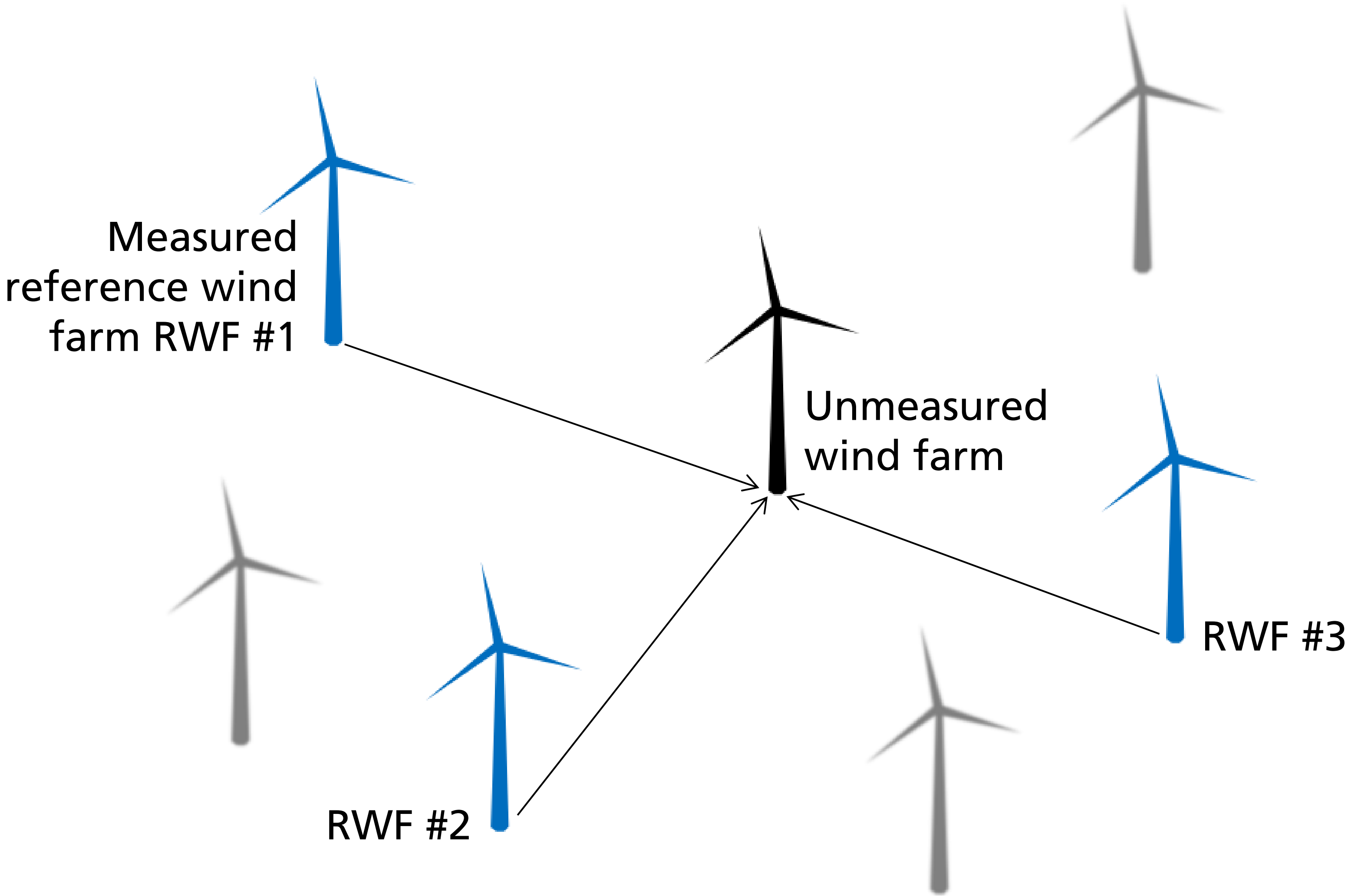
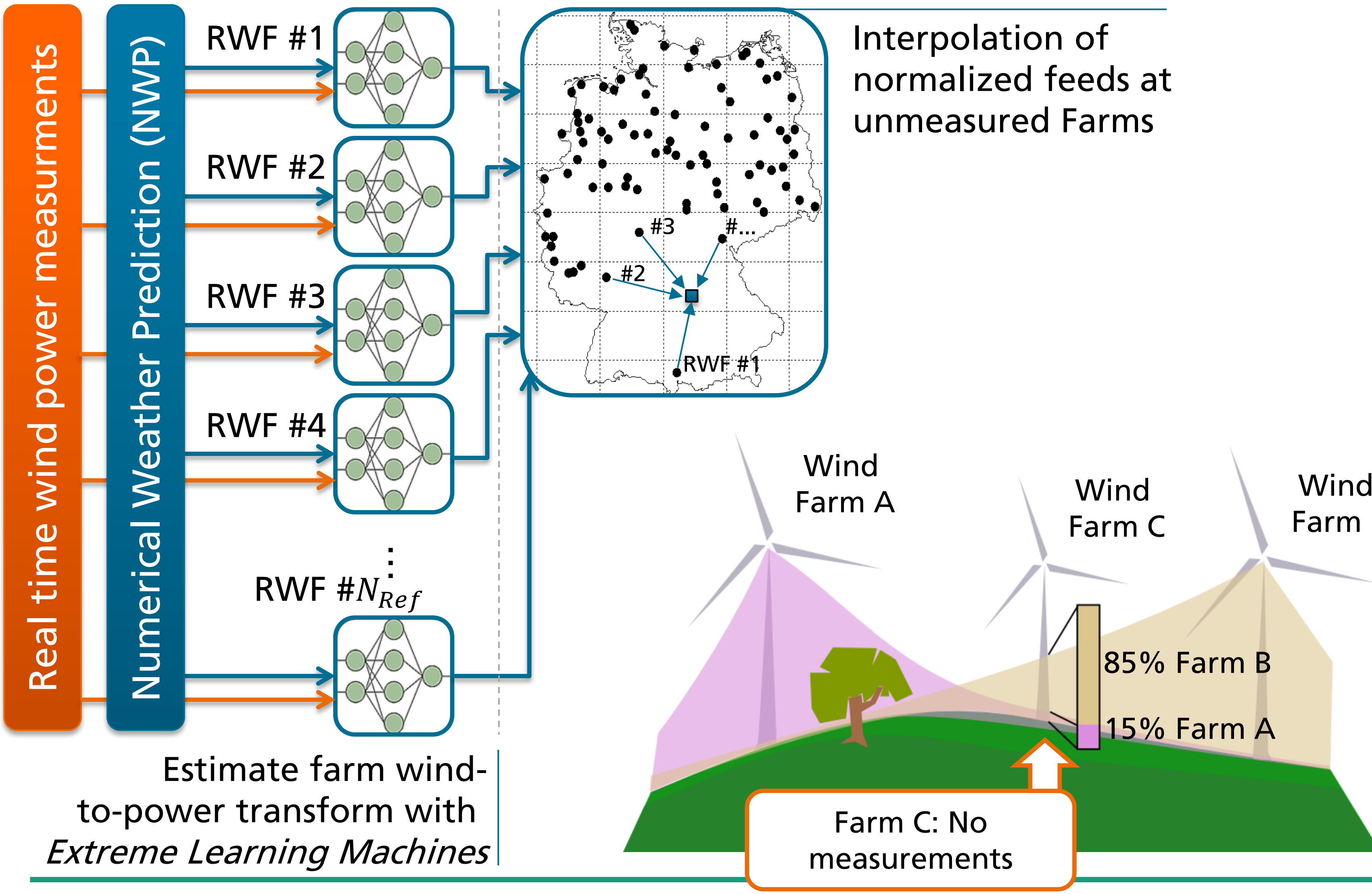
Introduction



Method #1 – Approximation with Reference Wind Farms (RWF)



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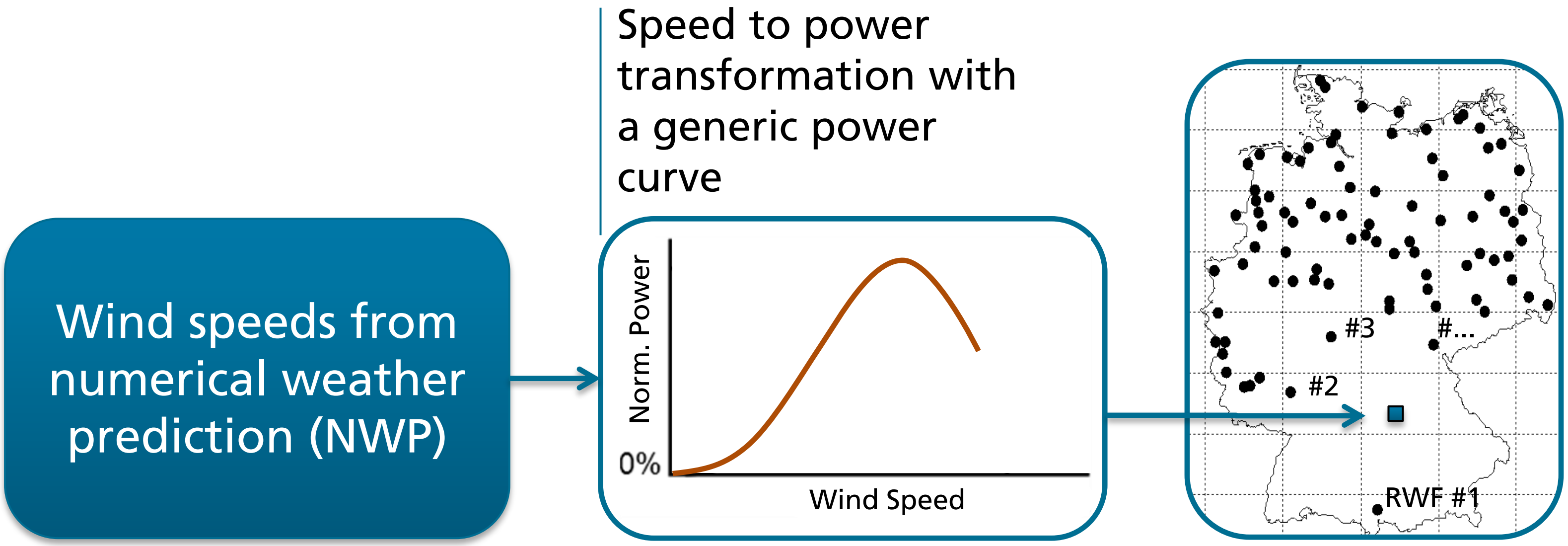
Method #2 – Generic Power Curve (PC)



Considers local NWP data

- **But:** Does not use any real time measurements

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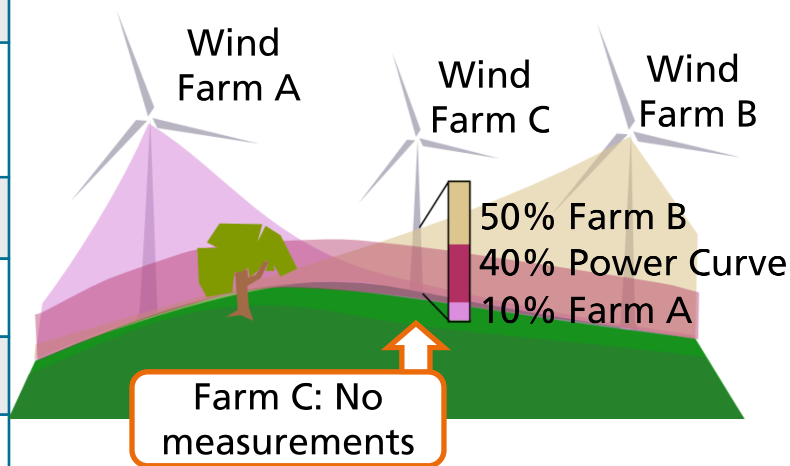
Method #3: Combination with Spatial Weights

$$p_{combined,j} = w_{PC}(\vec{x}_j) \cdot p_{PC,j} + \sum_{i=1}^{N_{RWF}} w_{RWF,i}(r_{i,j}) \cdot p_{RWF,i}$$

$$w_{PC}(\vec{x}_j) = \frac{\alpha}{\alpha + \sum_{i=1}^{N_{RWF}} \varphi_s(r_{i,j})}$$

$$w_{RWF,i}(r_{i,j}) = \frac{\varphi_s(r_{i,j})}{\alpha + \sum_{k=1}^{N_{RWF}} \varphi_s(r_{k,j})}$$

$p_{PC,j}$	Power curve (PC) forecast of unmeasured wind farm j
$p_{RWF,i}$	i-th ref. wind farm (RWF) forecast
$p_{combined,j}$	Combined power
w	Weight of the Methods
α	Influence factor of the PC
$\varphi_s(r_{i,j})$	Radial basis function where $r_{i,j} = \lVert\vec{x_i} - \vec{x_j}\rVert$



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Experiment Setup

12 previous 15min real time measurements of 58 wind farms, 96 x per day

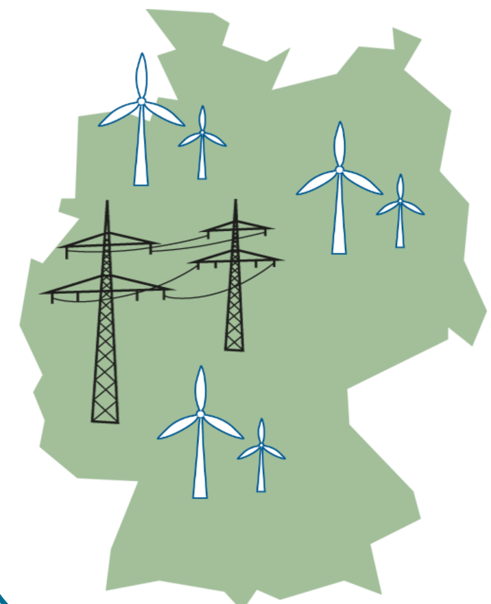
Last IFS (ECMWF) weather forecast 3h resolution, 6.25h delay, 2 x per day

→ Approximation with reference farms (Method #1)

→ Generic Power Curve (Method #2)

→ Combination with spatial weights

→ Comparison based on 82 reference farm measurements (Forecast Horizons: 15min, 30min, … 8h)



Partition	From	To
Training	01/01/2013	30/05/2014
Validation	30/05/2014	15/12/2014
Test	15/12/2014	30/06/2015

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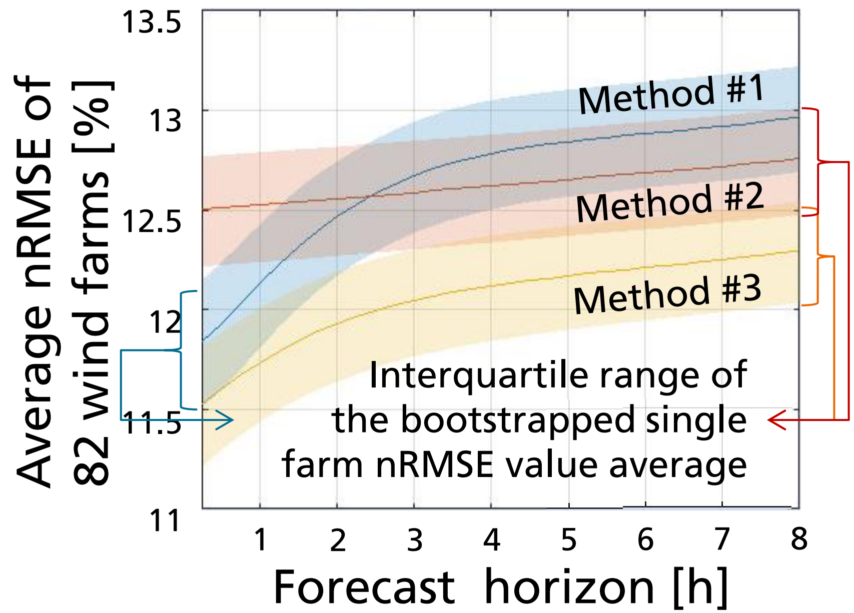
Results – Farm Errors

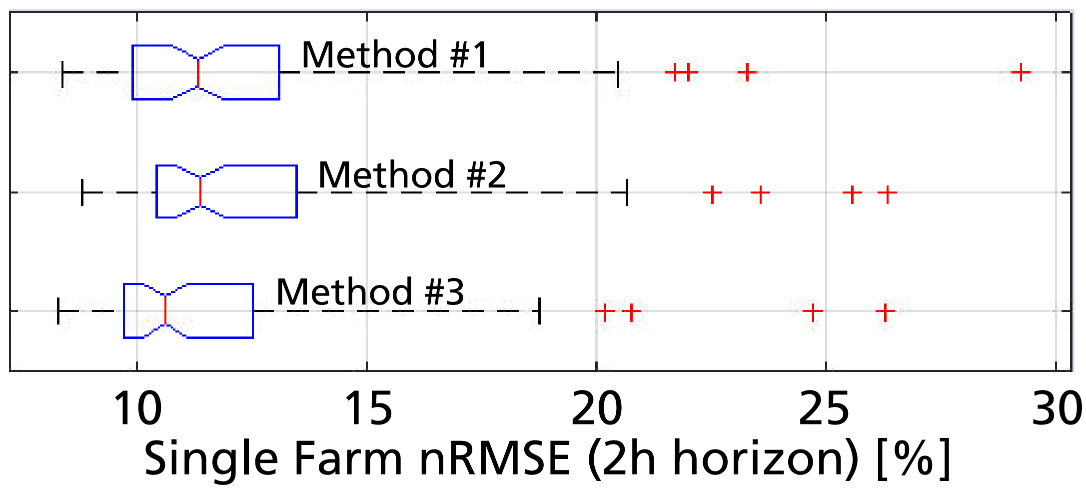
- **Real time measurements** → improve unmeasured farms in the first 3 to 4 hours
- Generic power curve does a surprisingly good job
- Best to combine real time supported reference farm forecasts with power curve, but **is it significantly** better?



Reference Farm Approximation

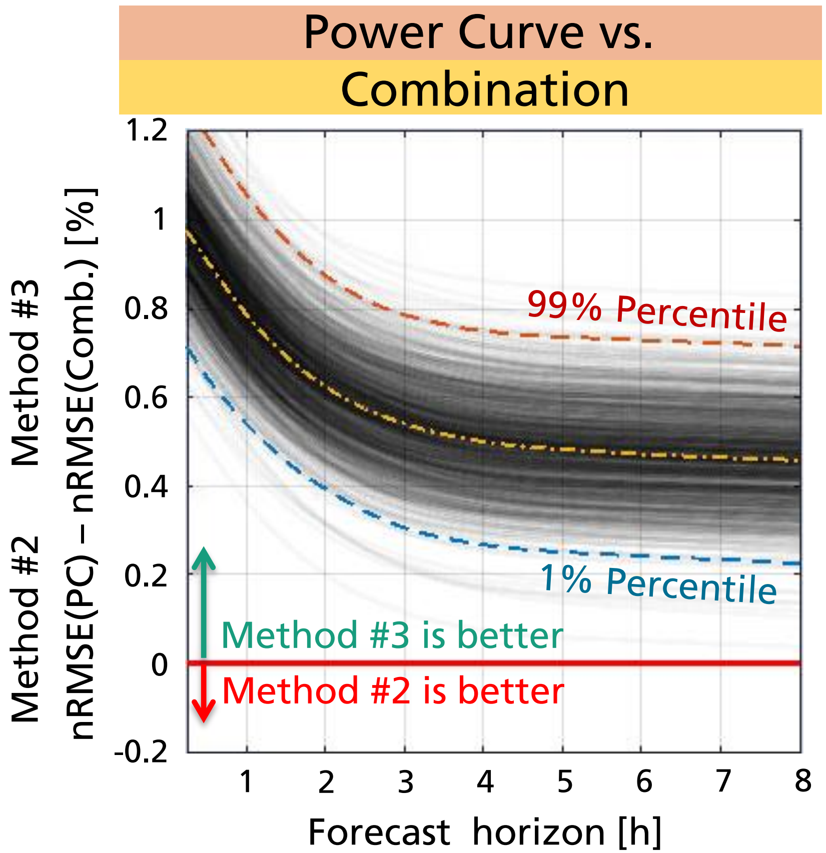
Generic Power Curve

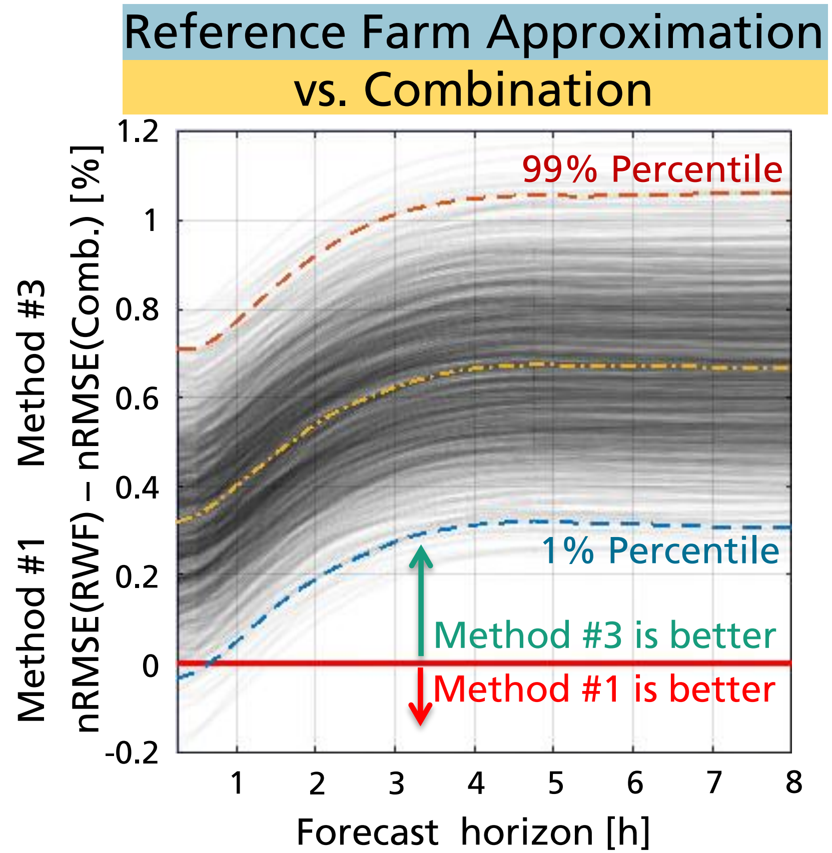
Combination



Significance of the Improvement

Improvement over all single Wind Farms with the average error of 1000 bootstrap sets with 82 single wind farm errors:





Conclusion

- 3 Methods forecast the production of unmeasured wind farms:
  - Reference farm method: Extrapolation of single farm forecasts to region
  - Generic Power Curve
  - Combination
- Methods compared: 2.5 years of NWP and 15min power measurements
- Generic power curve ≈ reference farms
- Combination (method #3) results in significant improvement

Acknowledgements

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