meteo control
Energy & Weather Services

How Monitoring Services of Distributed Solar PV Production Benefits from Machine Learning

PV Systems Symposium 2019, Albuquerque (NM)

Daniel Lassahn, Dr. Christian Kurz

DANIEL LASSAHN

- *Energymeteorologist since 2016 and 24/7 Meteorologist*
- *M. Sc., Physics of the Earth and Atmosphere*
- *Hobby: Stormchasing*
- *Get in contact:* *d.lassahn@meteocontrol.com*

Who we are?
leader for pv monitoring & solar power forecast‘s

- *First provider of online feed-in monitoring for grid operators worldwide*
- *More than 10 years of experience in grid forecasting*
- *Biggest data pool for the performance of PV systems worldwide*
- *> 46 000 pv systems worldwide equipped with meteocontrol‘s monitoring solutions*

MOTIVATION FOR ONLINE FEED-IN

AVAILABILITY

- *Measurements are only available with a time delay*

- *Only a small amount*

- *Not reliable because no quality control of provided data*

GRID STABILITY

- *More accurate grid management with high amount of renewable feed-in*

- *Curtailment management*

- *More renewable energy is feed-in to the grid*

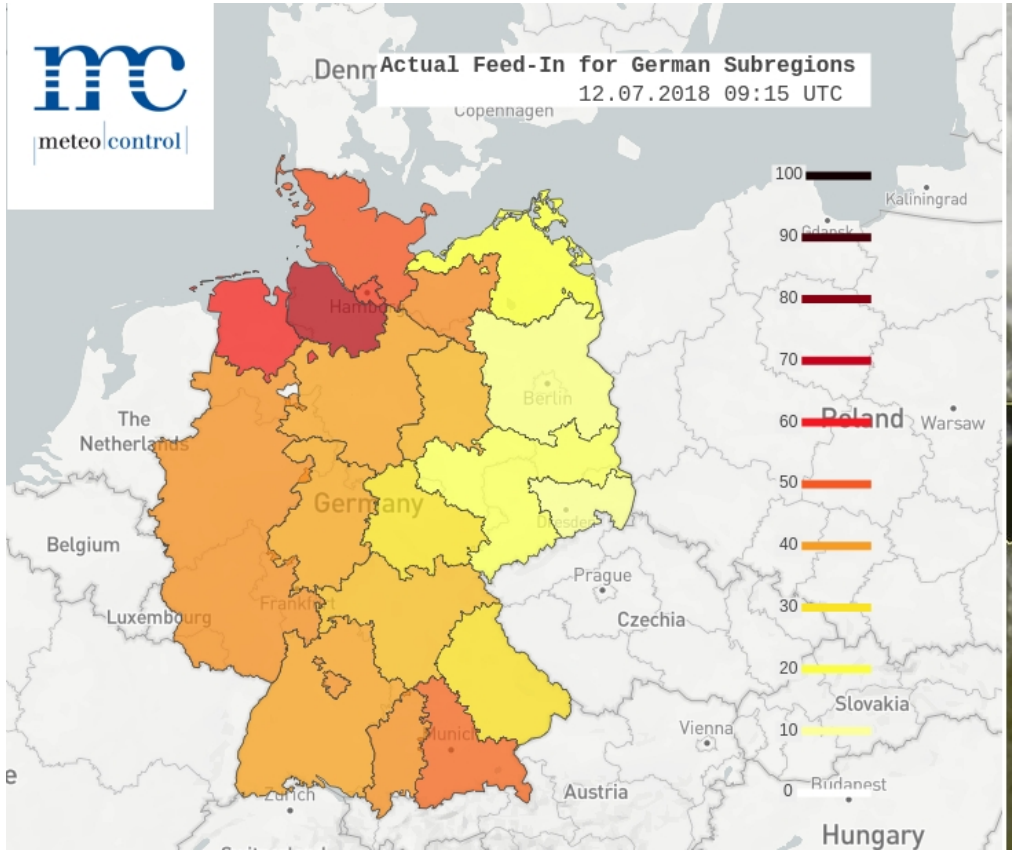
SETTLEMENTS REGULATION

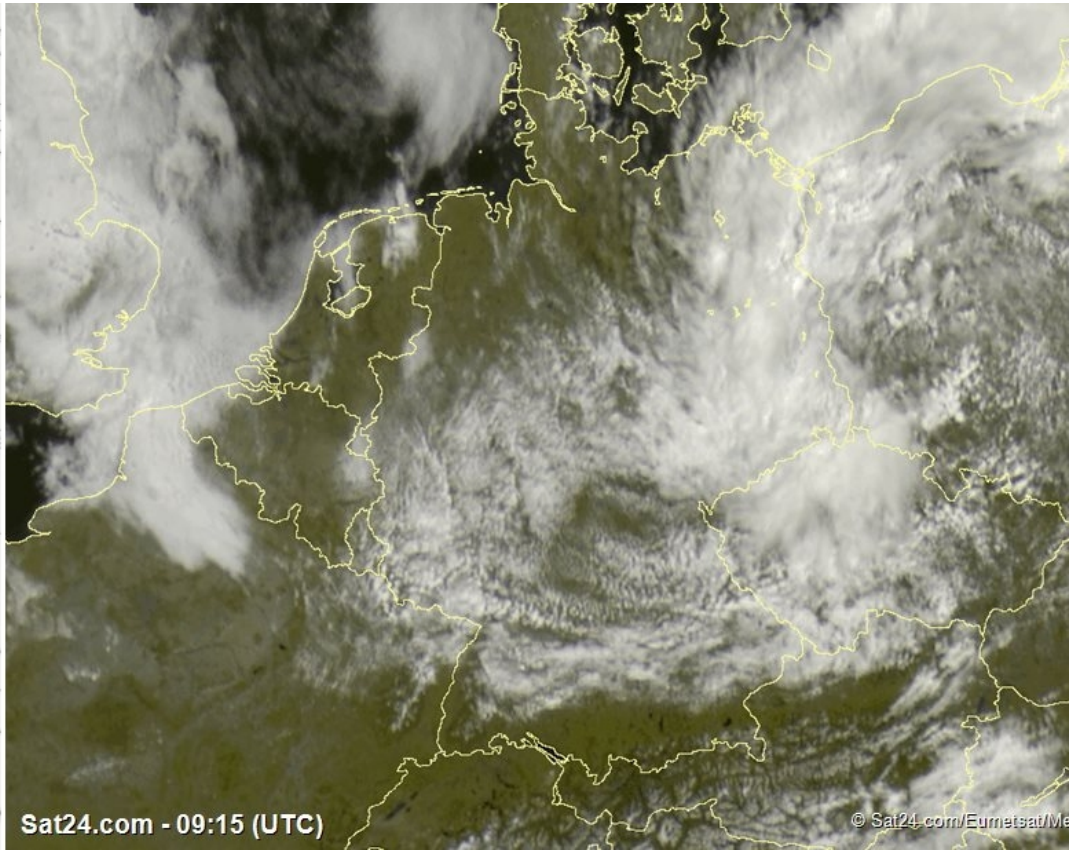
- *Reliable data for spot markets*

- *State allowances (like EEG in Germany)*

ONLINE FEED-IN ESTIMATION

MONITORING OF DISTRIBUTED SOLAR ENERGY GENERATION





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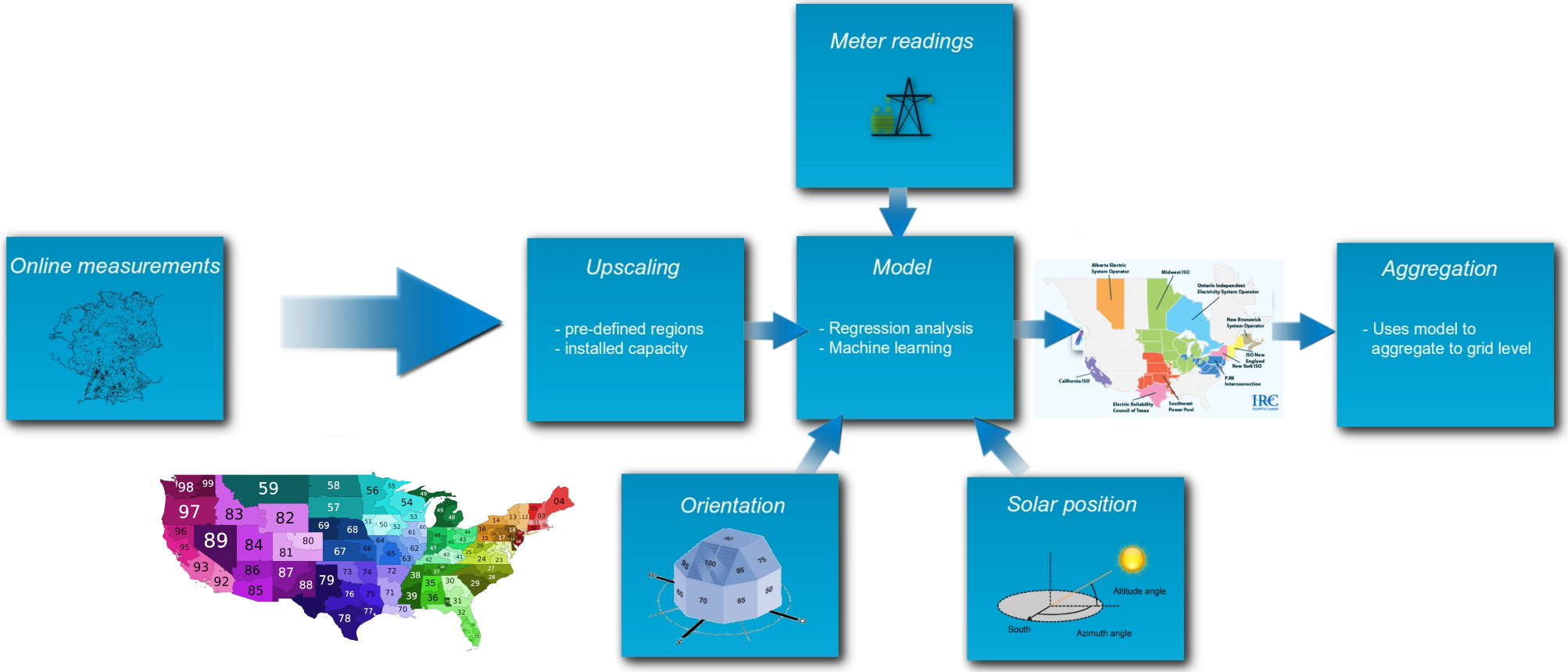
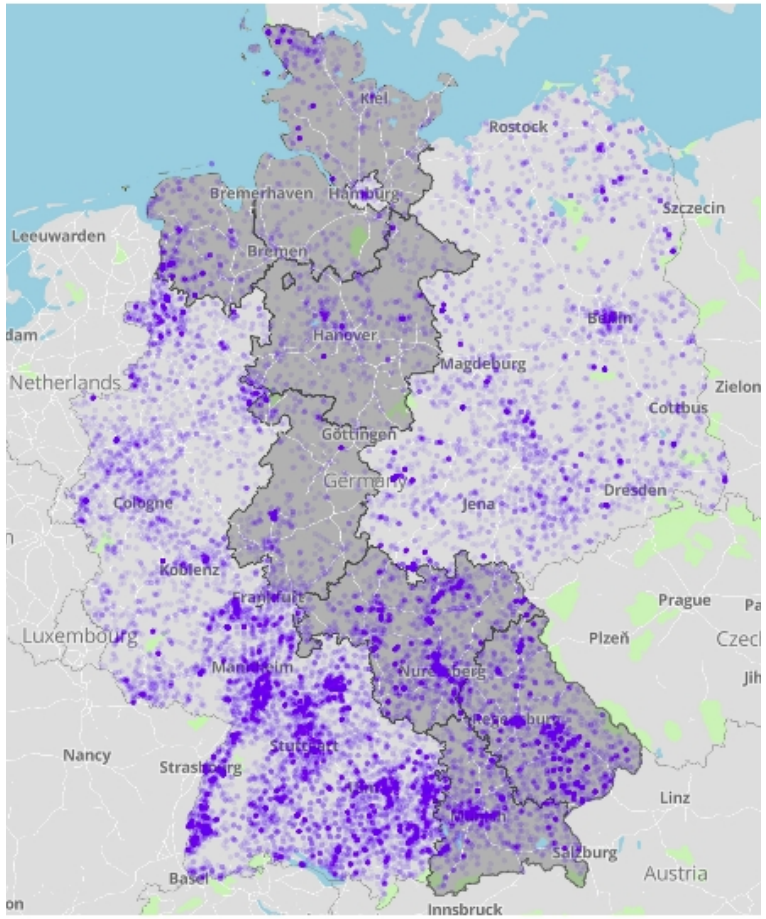


SYSTEMS IN MONITORING
case study: Germany



- *> 20 000 systems in monitoring*
- *Spatial representative measurement ensemble for germany*

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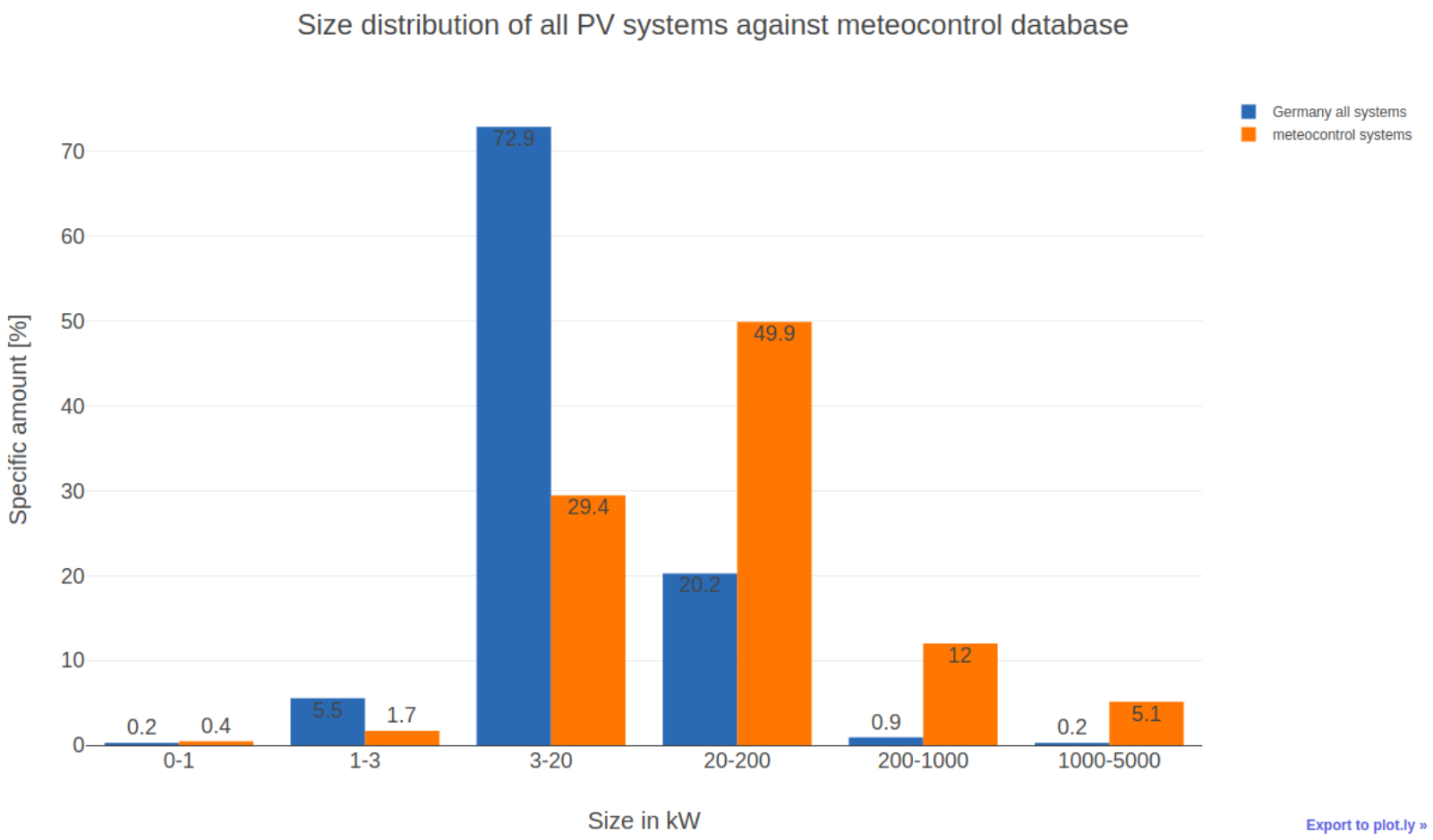

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- *Difficult to find representative system configuration in measurement ensemble*
- *1,5 Mio systems in germany*

~ 80 % < 20 kW

- *Btw.: Same for the USA dataset*

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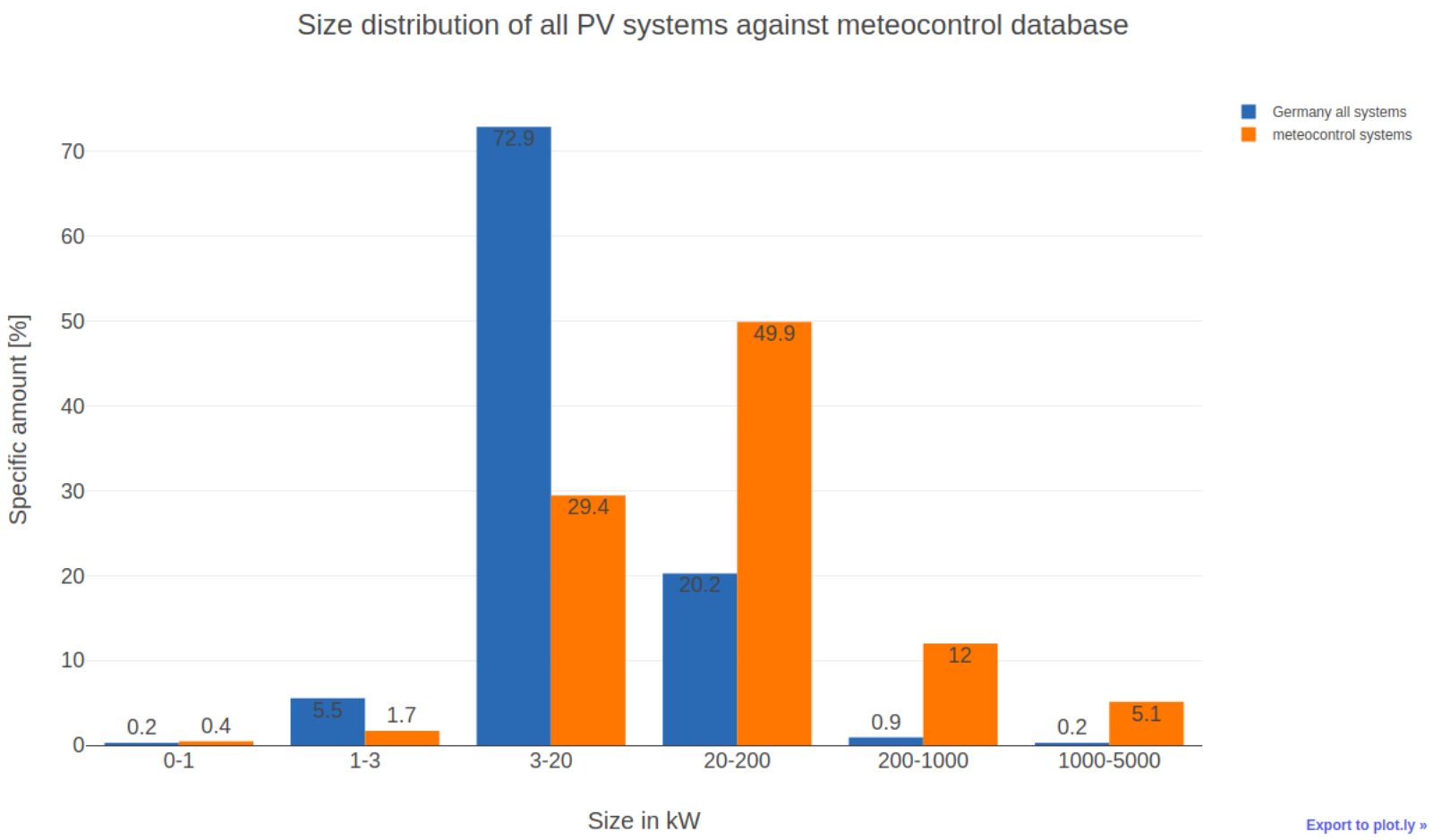

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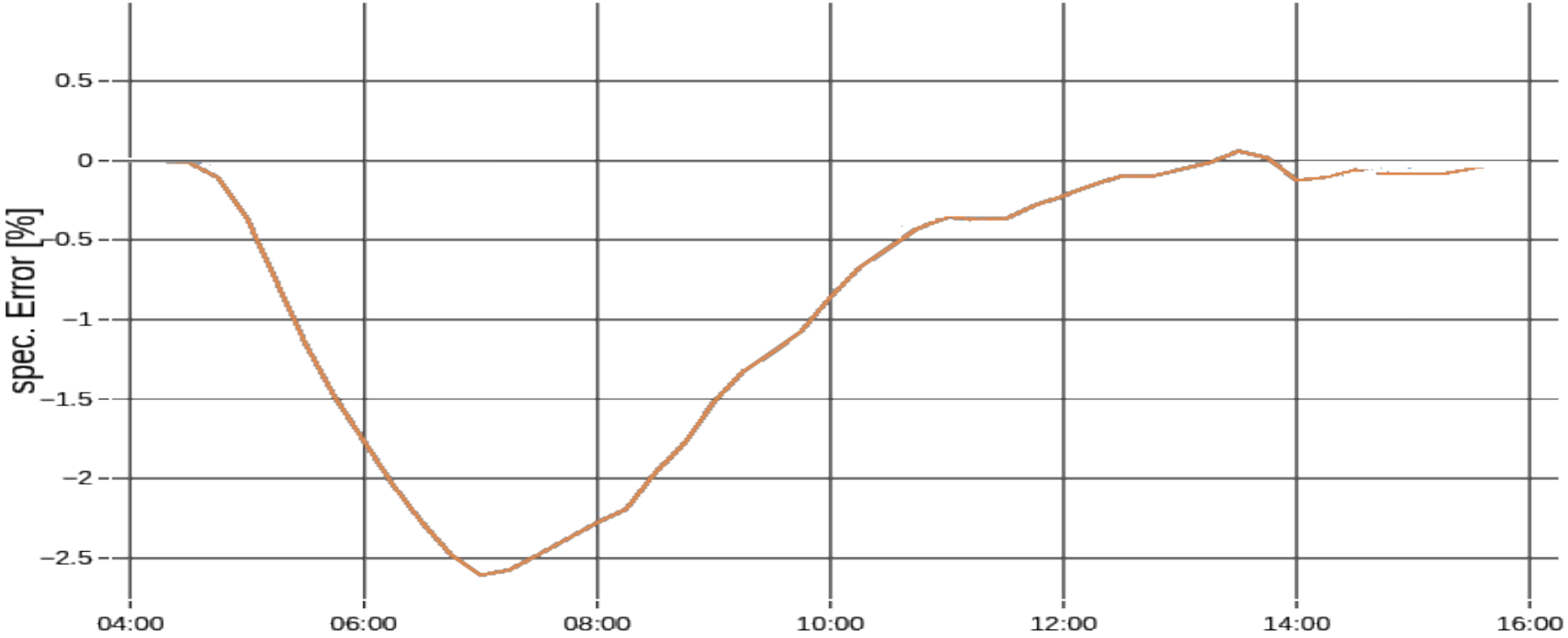
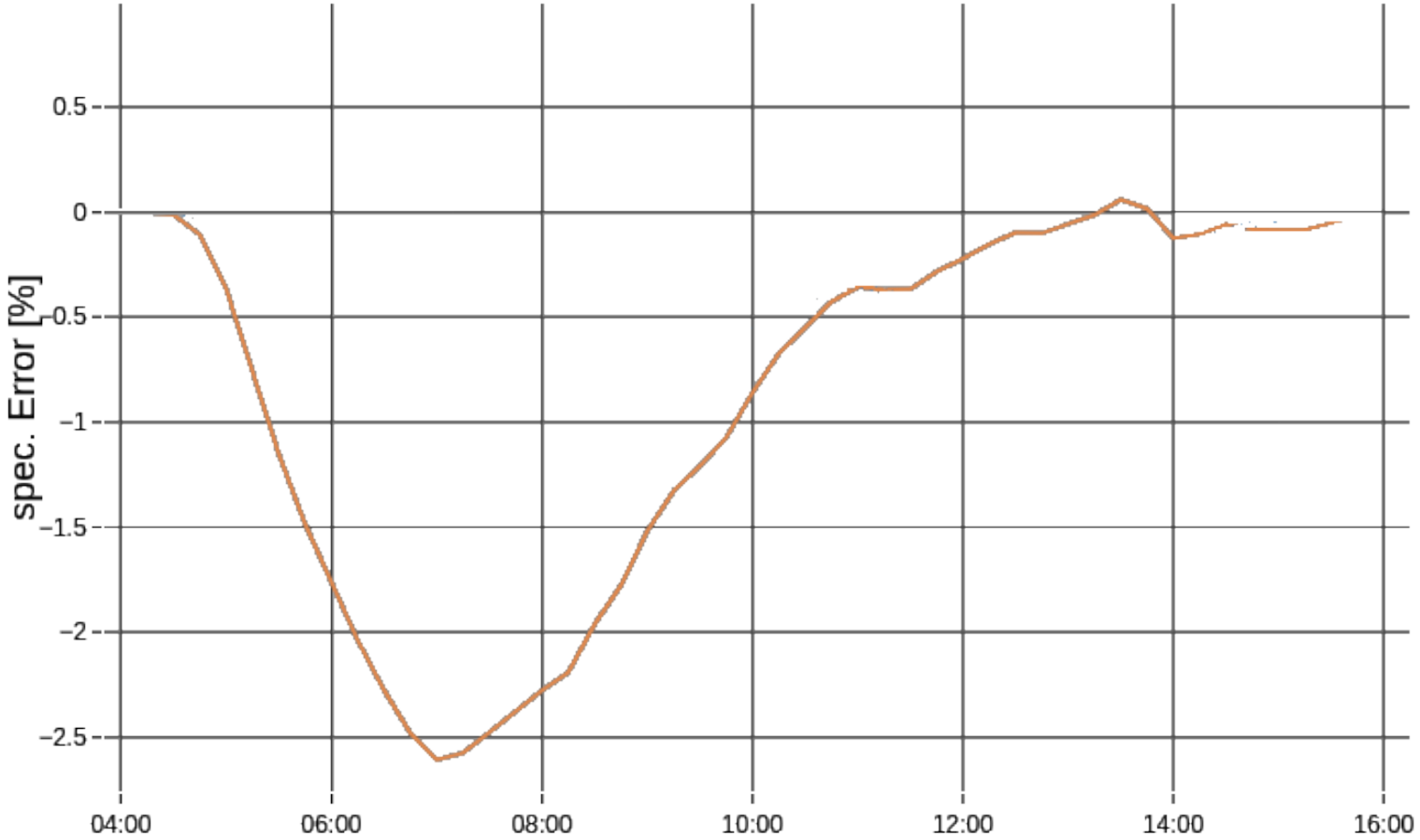
➔ ***Yields in non-linear and diurnal errors after the upscaling process of power output measurements***

BIAS BY TIME OF DAY OVER A MONTH



REQUIREMENTS TO THE ML MODEL



- *Diurnal Error of estimation against Feed-In*
- *Feed-In: Target values provided by Tennet TSO with a time delay of ~2 months*

➔ ***Optimisation tool that considered the time of day and the solar cycle***

ANALOG SAMPLING

$$||F_t, A_{t'}|| = \sum_{i=1}^{N_v} \frac{w_i}{\sigma_{f_i}} \sqrt{\sum_{j=-\tilde{t}}^{\tilde{t}} (F_{i,t+j} - A_{j,t'+j})^2}$$

- *Novell approach to pre sample the trainings dataset*
- *Based on Analog Ensemble metric*
- *Builds up a ranking for most similar datapoints with regards to the input feature Nv*
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Assumption:

- *n-nearest datapoints having the same error charateristics*

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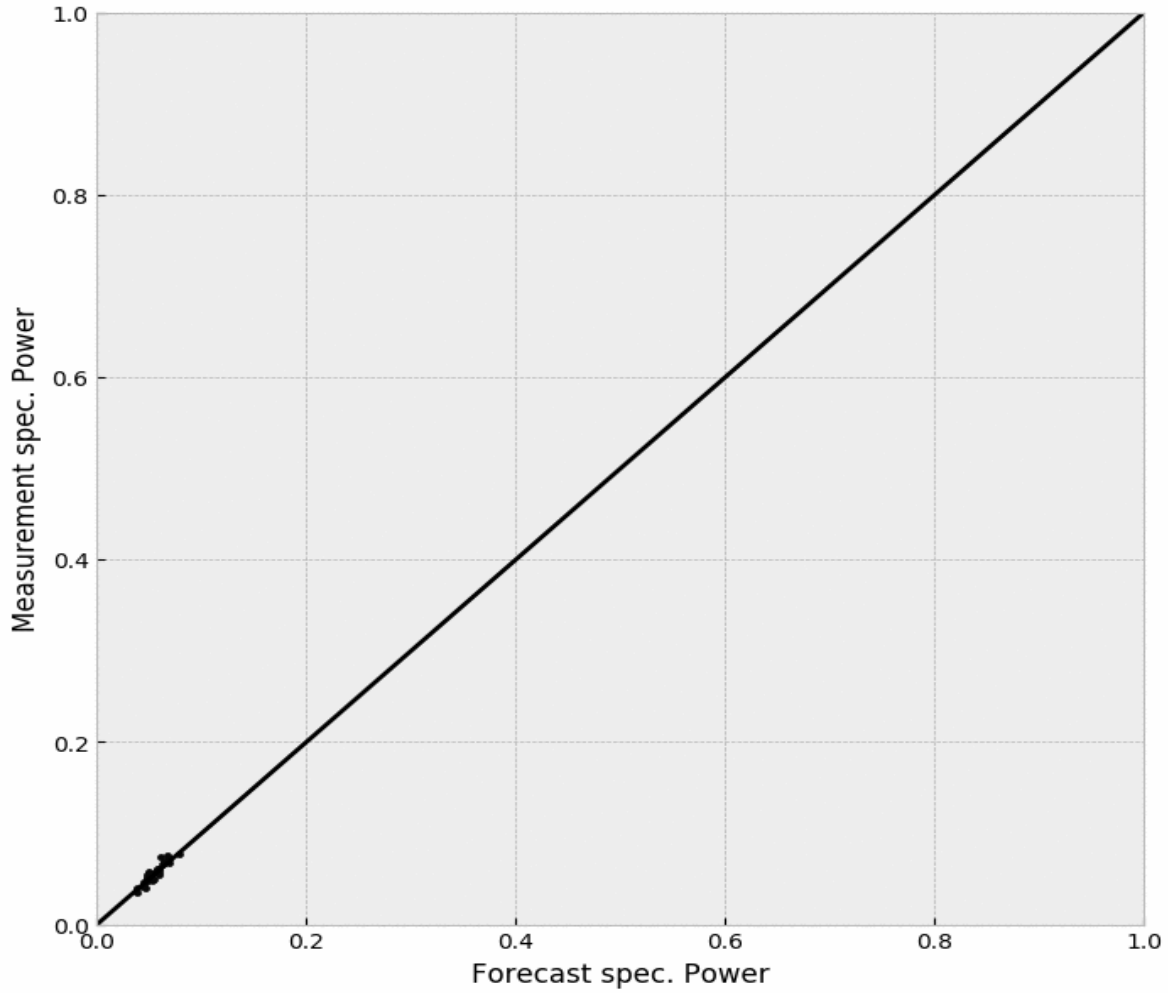

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- *Training: February 2018 – February 2019*
- *Evaluation: March 2019*
- *Power and Solar position as input feature*

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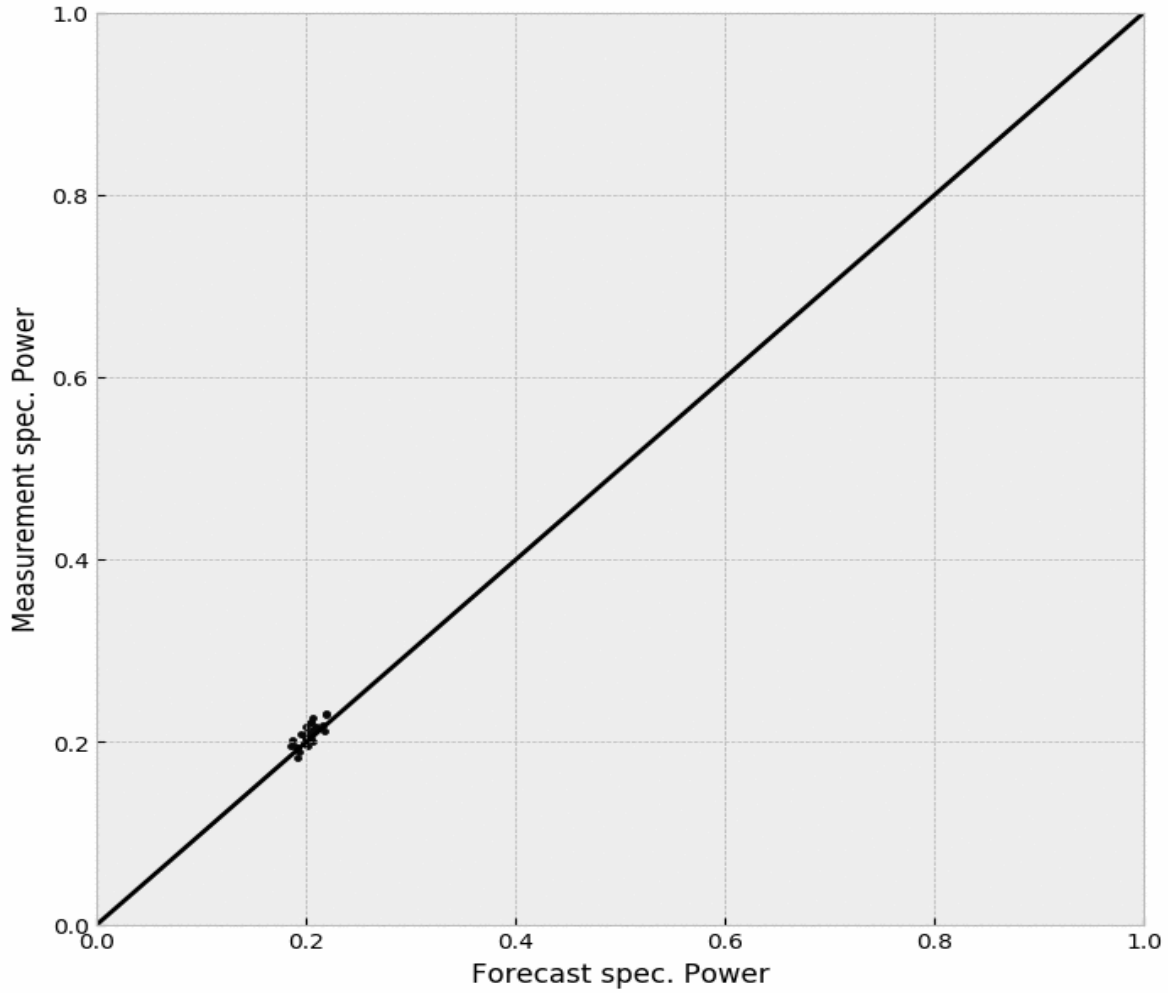

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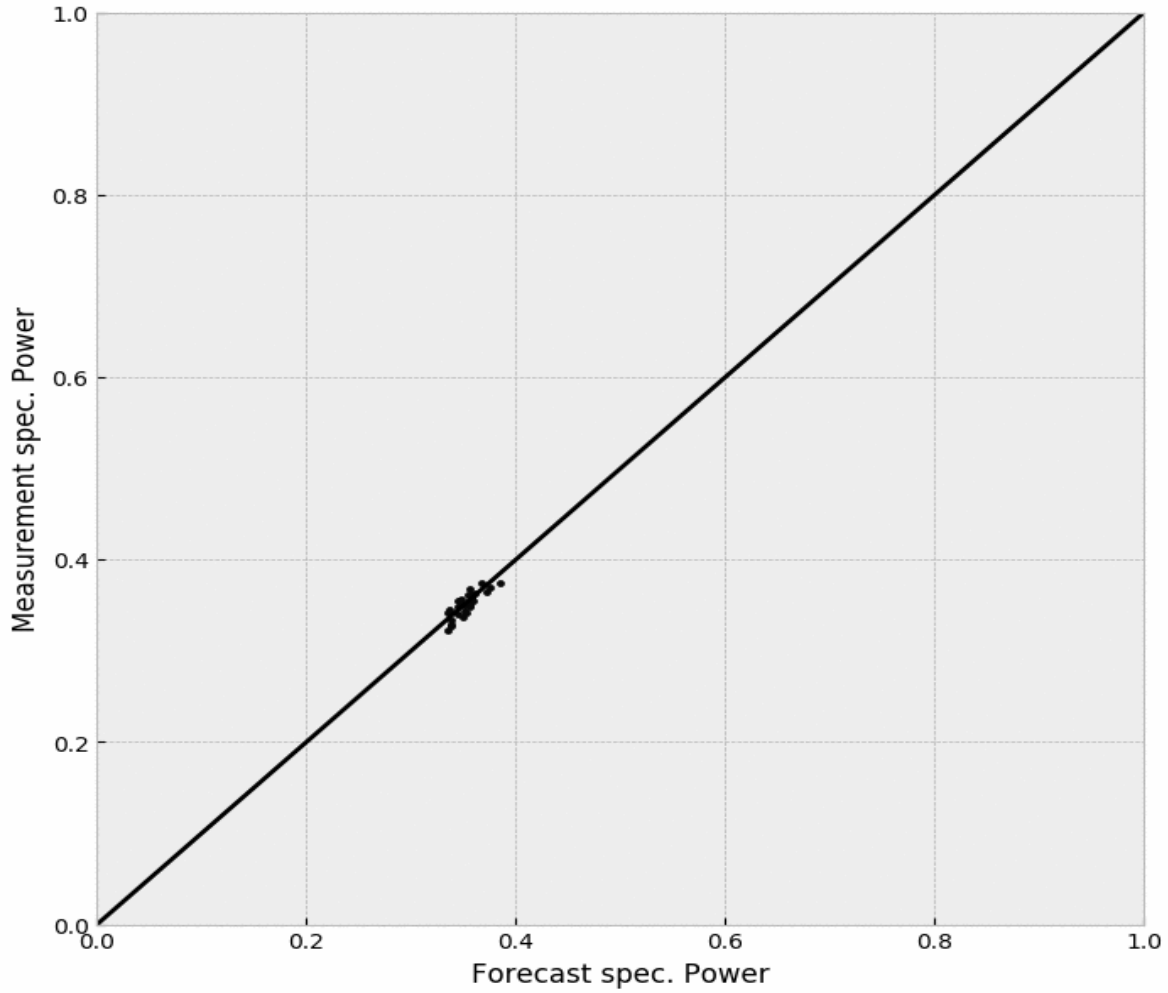

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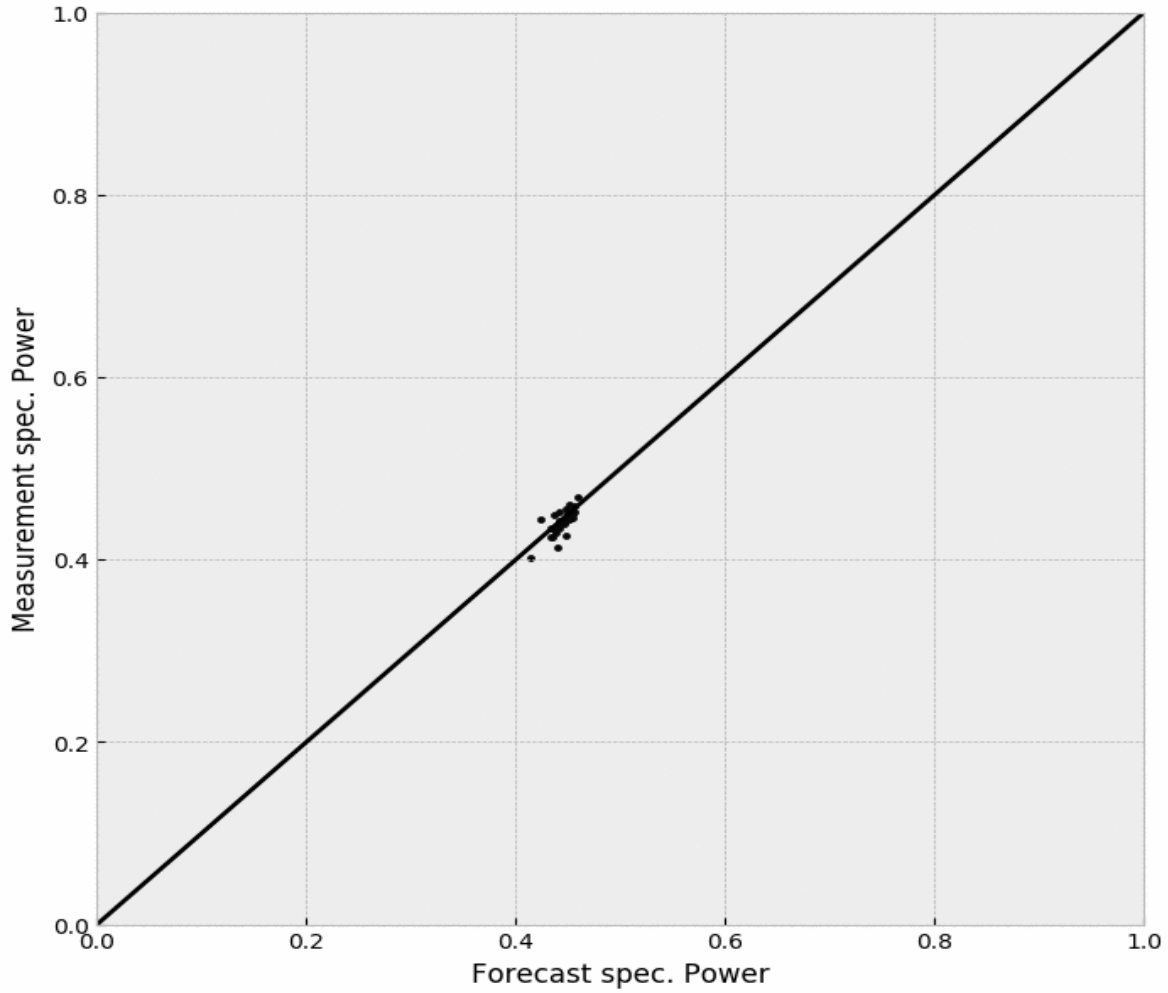

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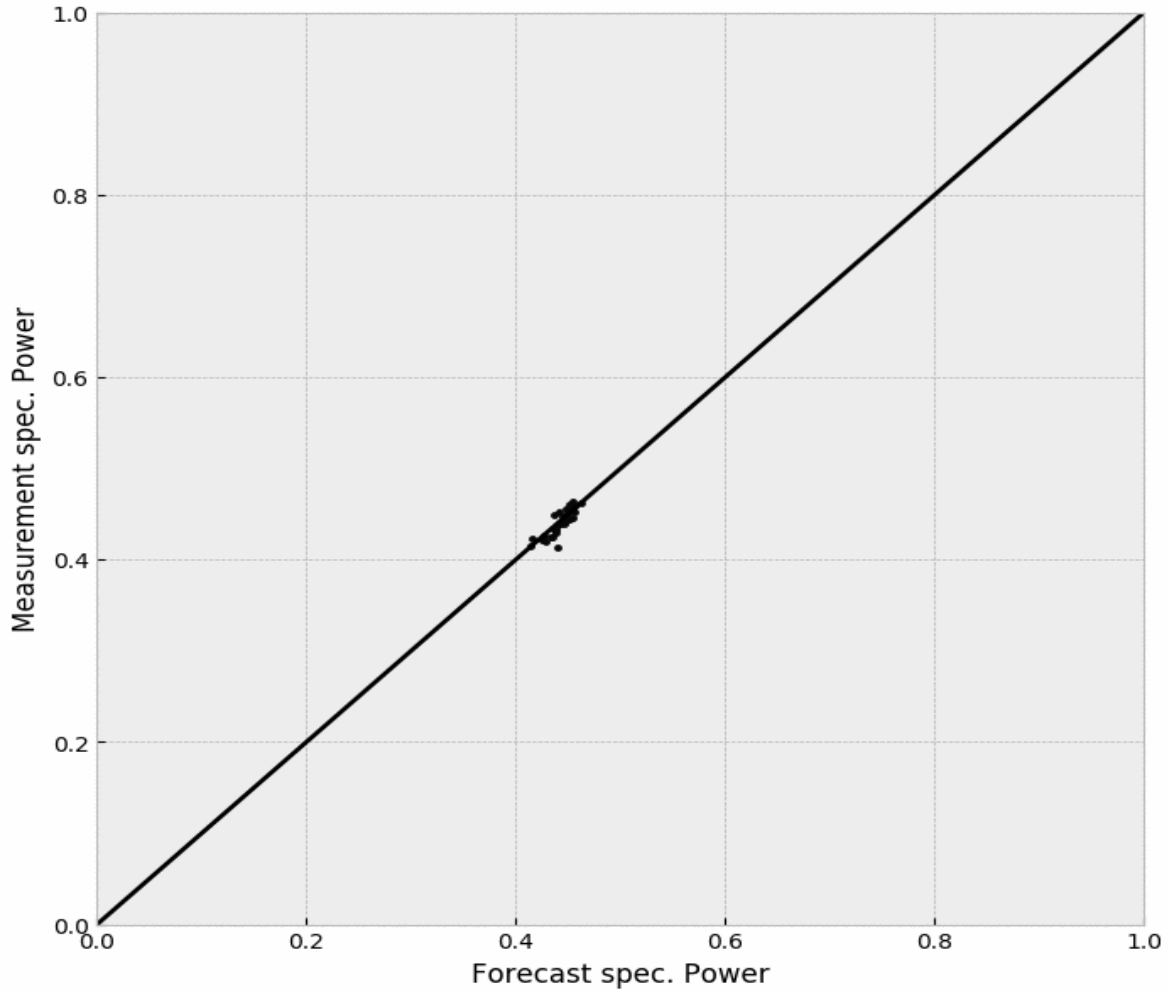

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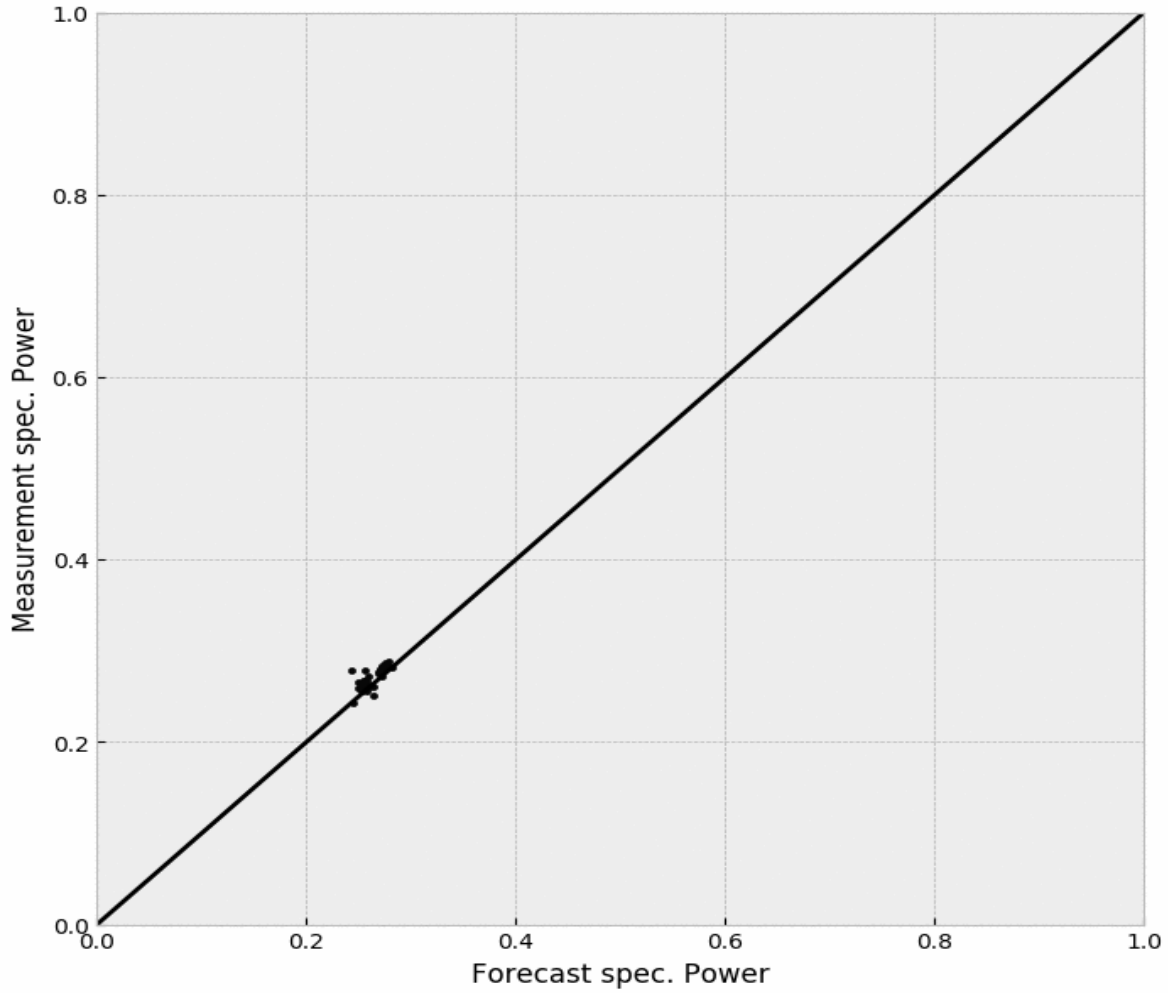

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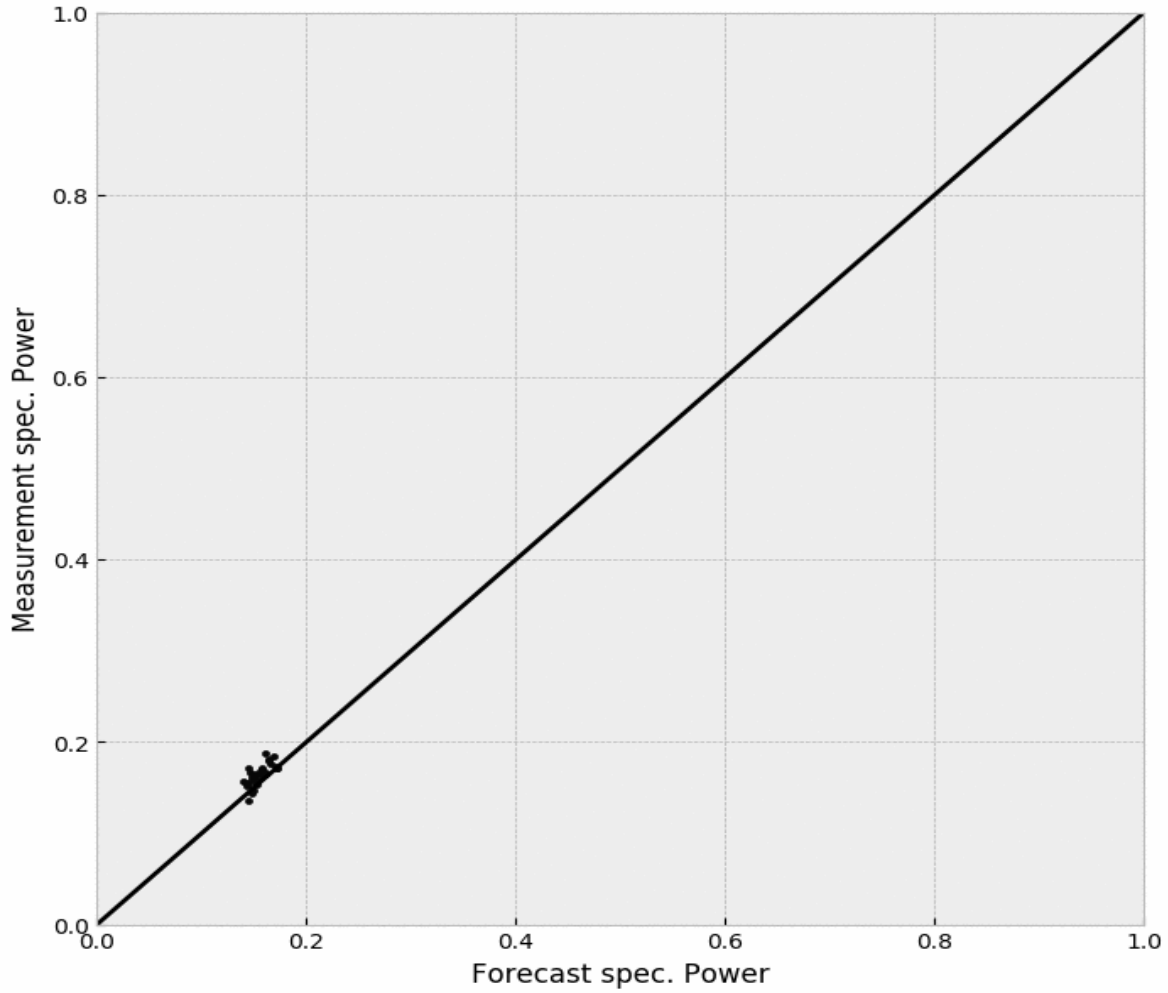

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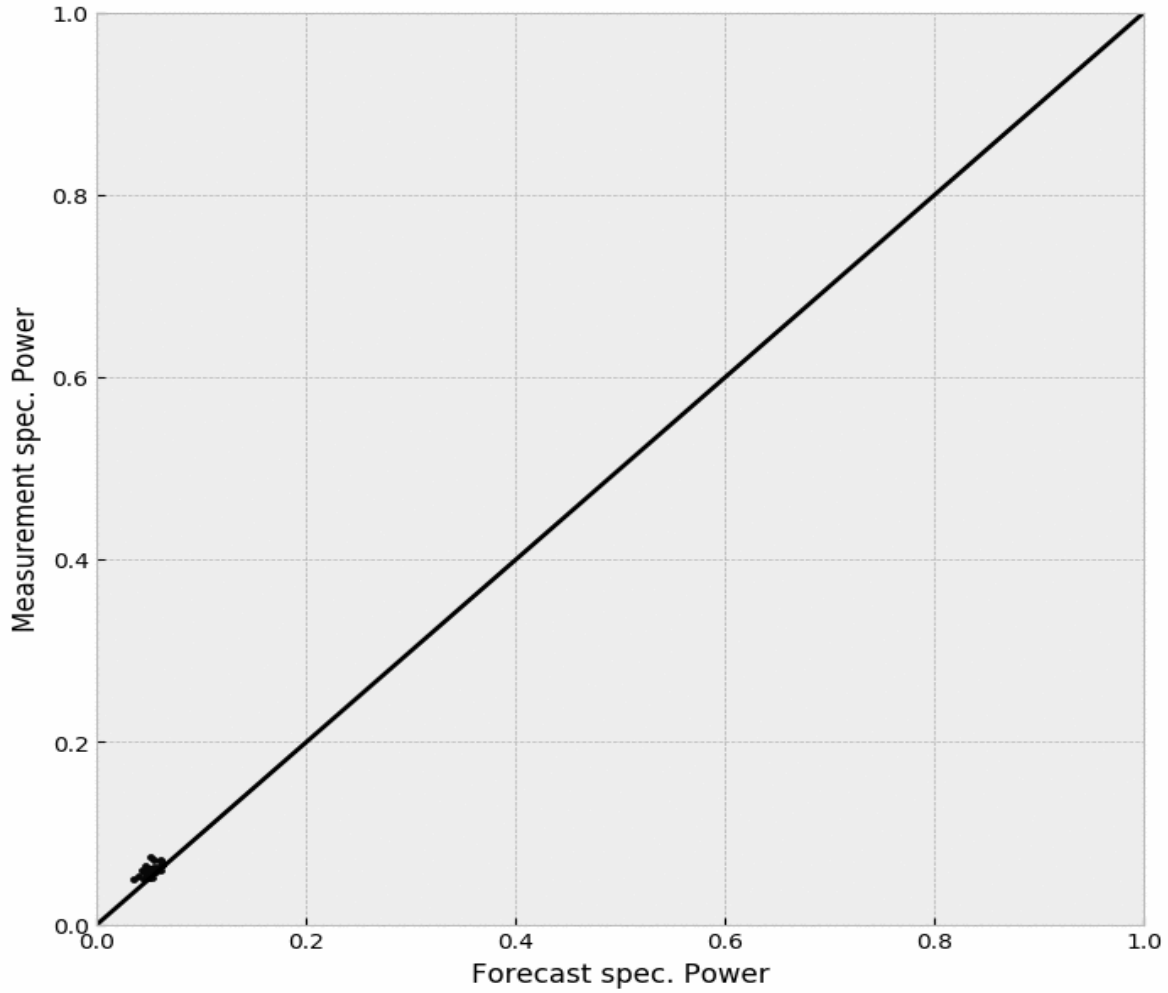

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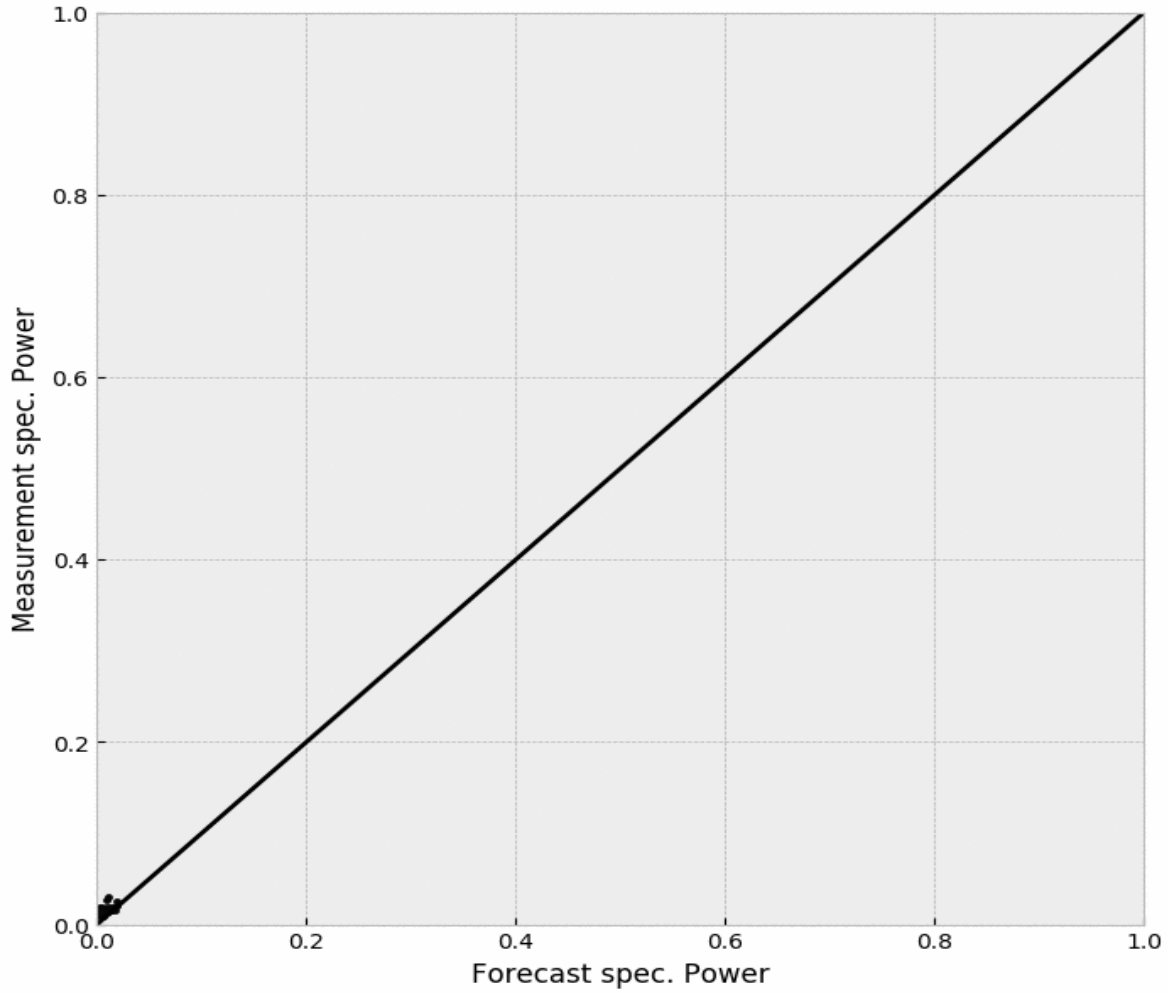

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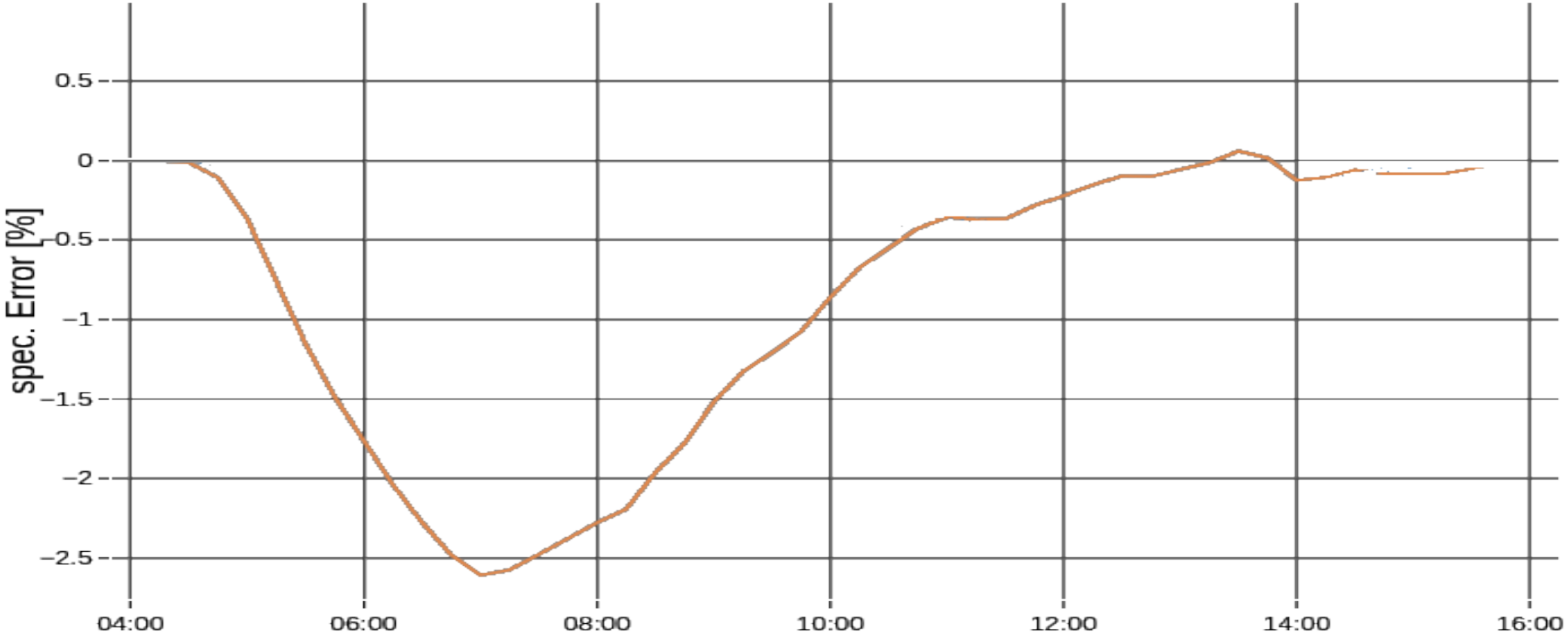

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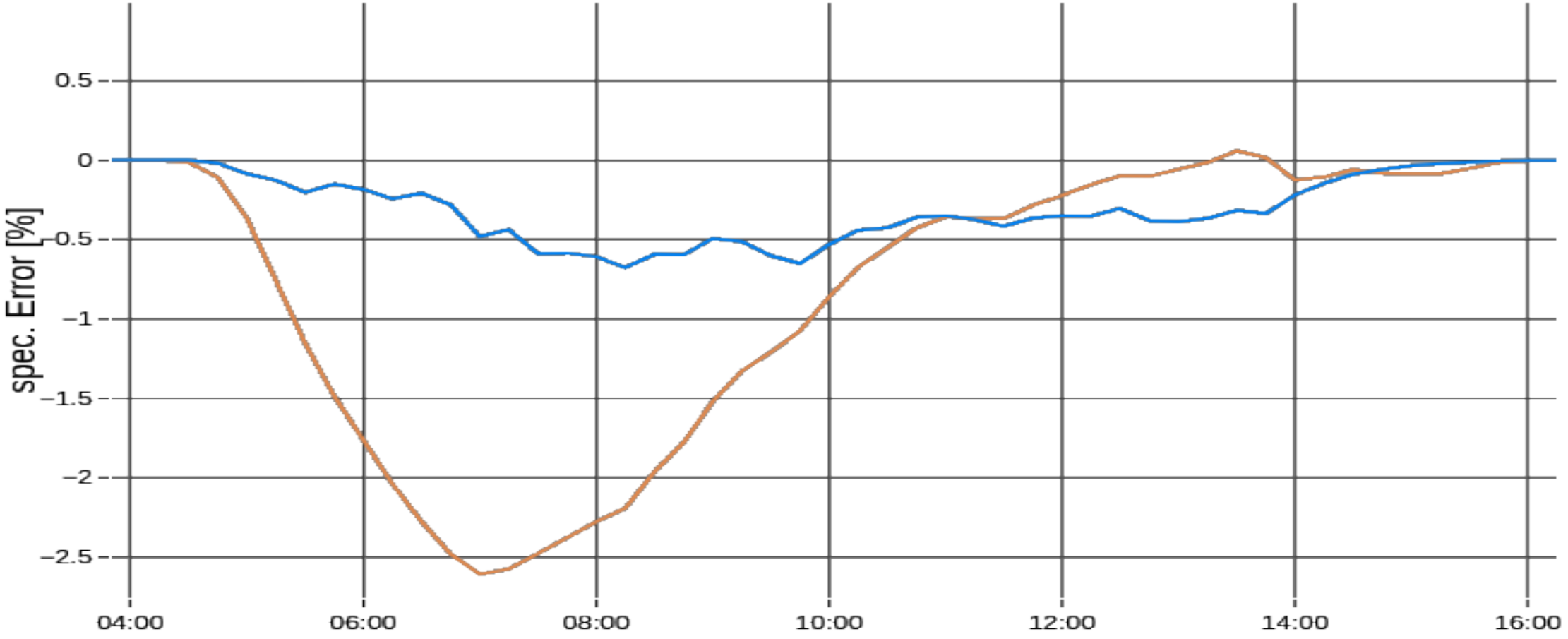

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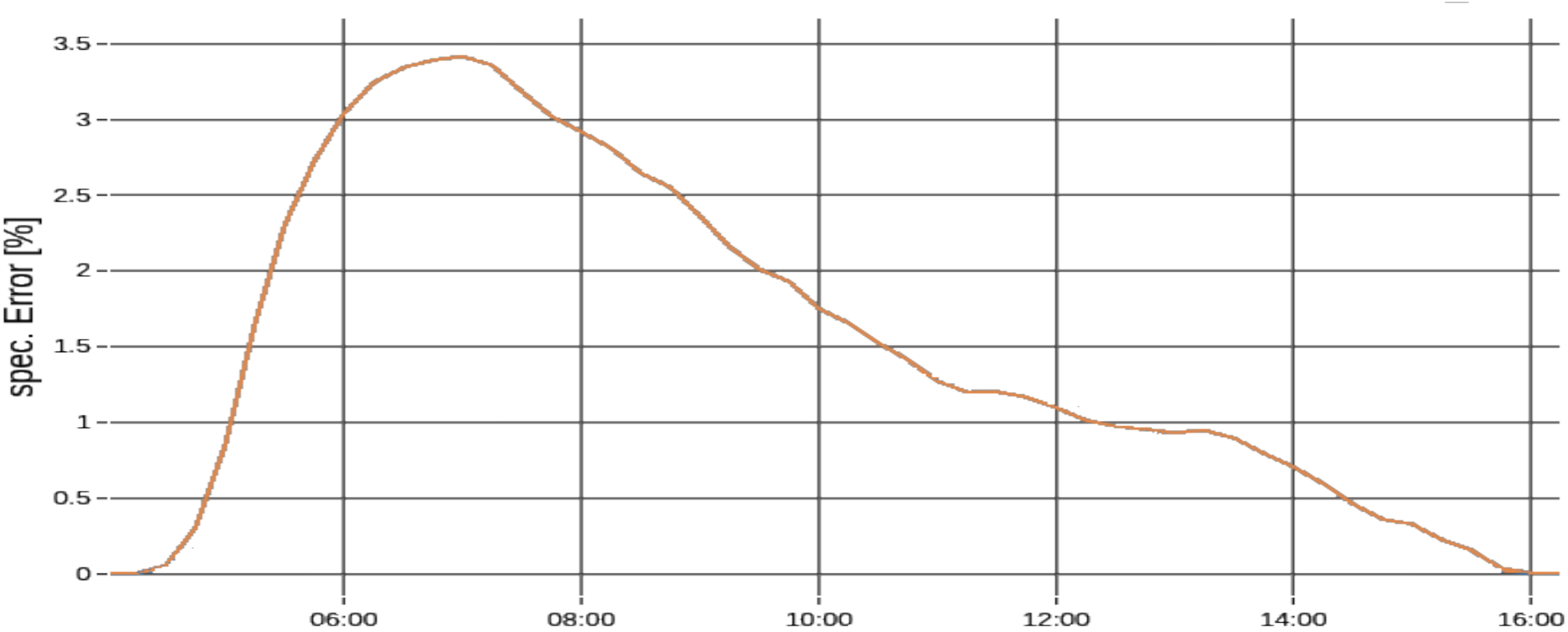

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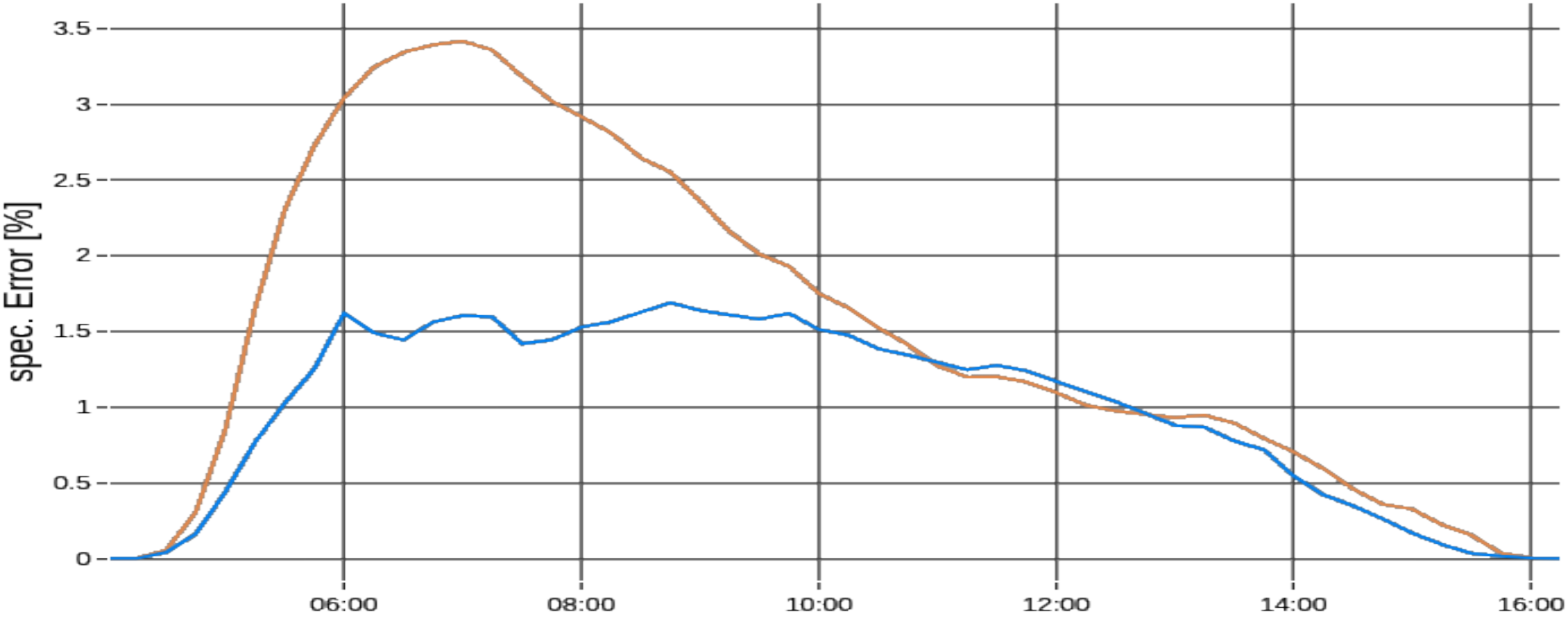

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HYBRID SOLAR POWER FORECAST MODEL

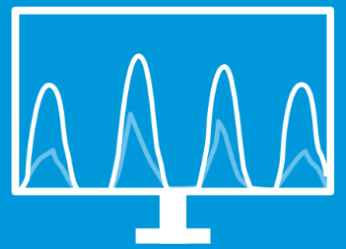
Satellite Images
→ Cloud-Motion

Several
Numerical Weather
Prediction
Model

PV Power
Measurement
→ Online Feed-In

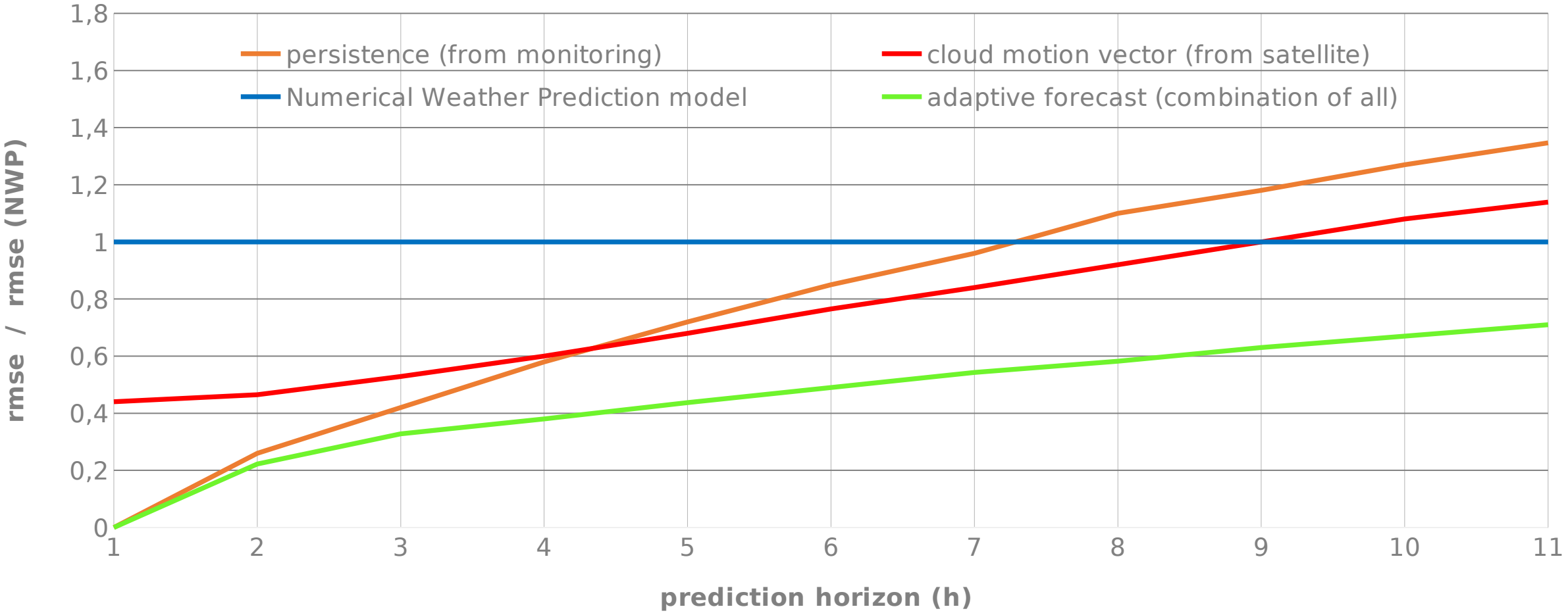
SPATIO-TEMPORAL COMBINATION REGARDS TO THE LOCAL WEATHER CONDITION

Forecast Optimization
- Regression
- Neural Network



OPTIMIZED SOLAR POWER FORECAST

RESULT OF THE COMBINATION MODEL



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meteocontrol GmbH
Spicherer Straße 48 | 86157 Augsburg
Telefon +49 (0)821 34666-0
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