PREDICTING GRID MANAGEMENT EVENTS
FOR WIND POWER PRODUCTION

EINSMAN

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BACKGROUND: METEOROLOGIST

DATA SCIENCE SKILLS

Python, Pandas, NumPy, Scikit-learn, Keras

Matplotlib, Plotly, Bokeh, Folium

Unix, Git, Jupyter, SQL

Matlab, MS Office

PRESENTATION

OUTLINE OF TOPICS

Energy transition towards renewables

Grid management events (EinsMan)

Datasets

Predictions

Future plans

ENERGY TRANSITION TOWARDS RENEWABLES

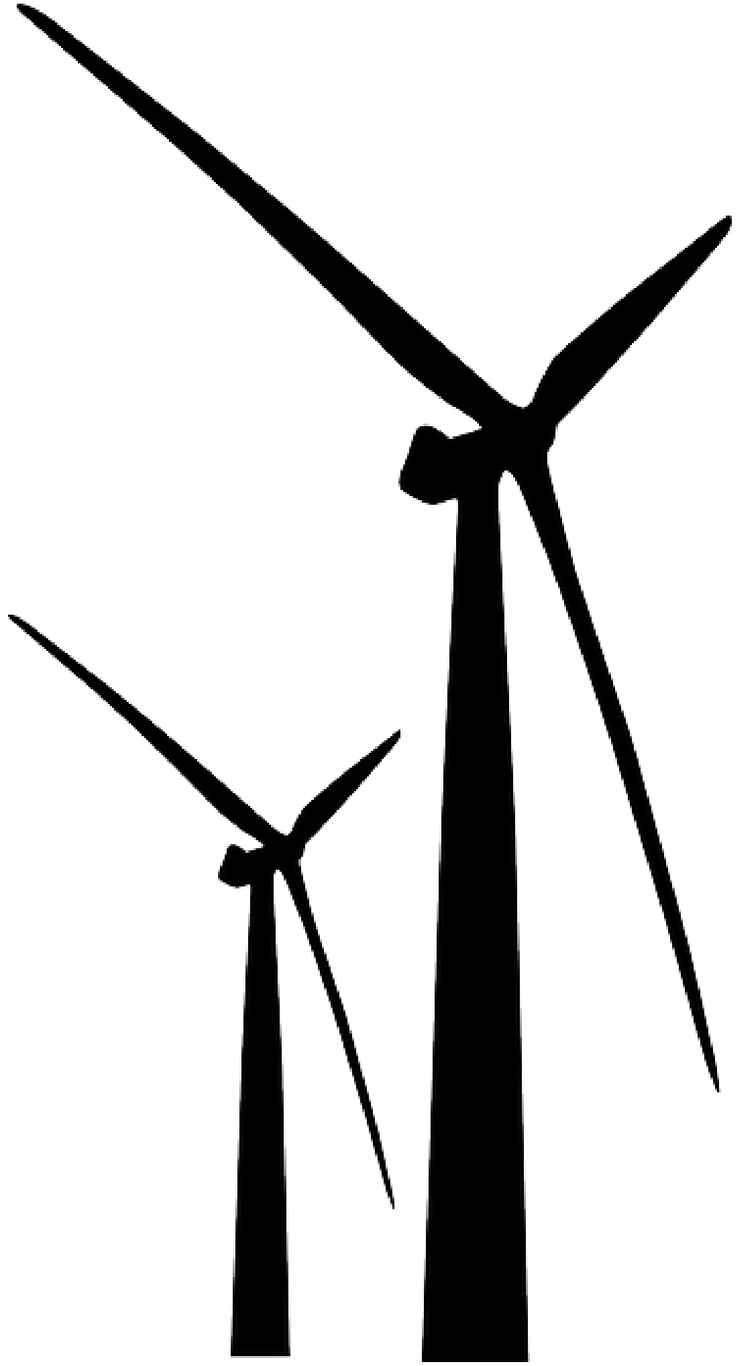
WIND POWER PRODUCTION IN GERMANY

2018:

17.5% or 95 TWh (onshore)
3.7% or 20 TWh (offshore)

2014:

10.1% or 53 TWh (onshore)
0.4% or 2 TWh (offshore)



EINSMAN

GRID MANAGEMENT EVENTS IN GERMANY

Energy grid not ready for distributing large volatile production

---> Local bottlenecks can occur and supply must be shut off by grid operators (stability)

---> Control mechanism is called **EinsMan** ("EinspeiseManagement")

EINSMAN VOLUME

IN GERMANY, 2014 AND 2018

2014

1.2 TWh
2.2 % of potential
power production

2018

5.4 TWh
4.7 % of potential
power production

IN SCHLESWIG-HOLSTEIN ALONE

53% of German EinsMan
300 Mio € compensation
payments

Source: bundesnetzagentur.de

DATASETS

I: EinsMan loss work and available power production

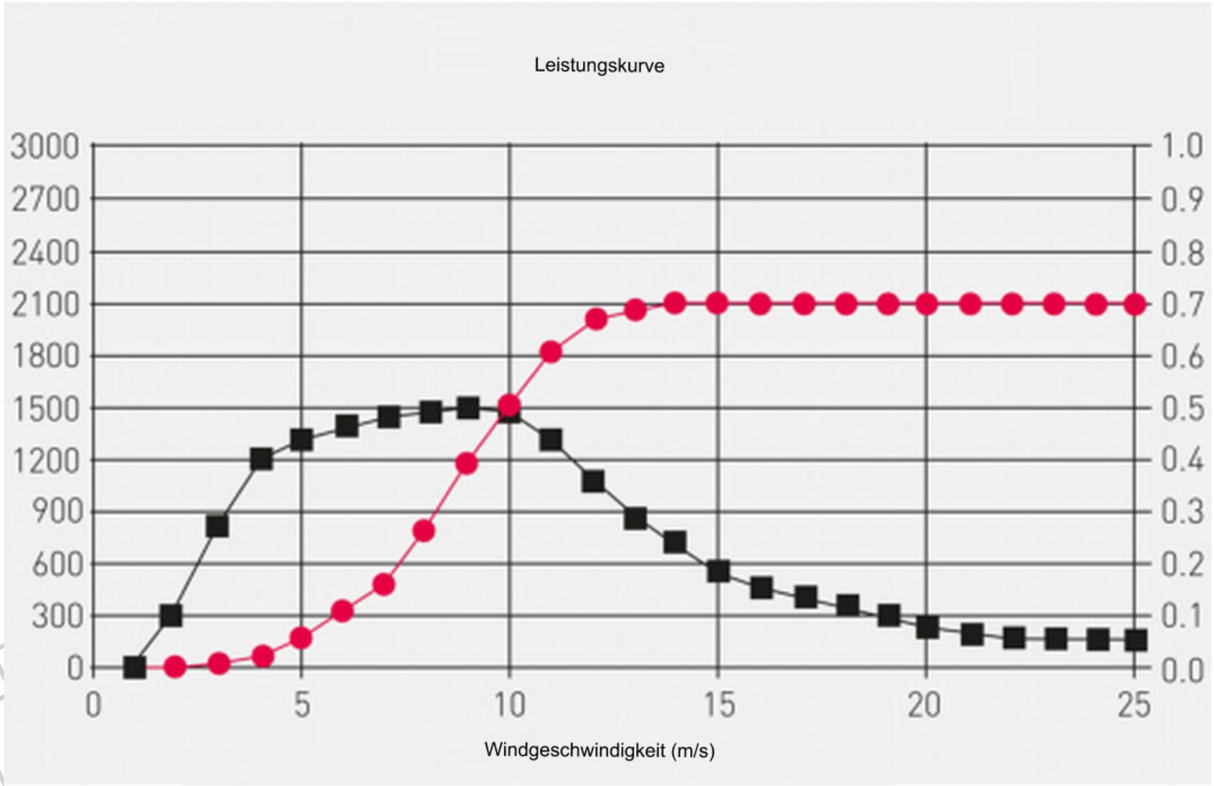
- Representing around 300 MW of installed wind power production in Schleswig-Holstein
- Time Period: 01/2018 - 10/2019

II: GFS weather forecasts for area of interest

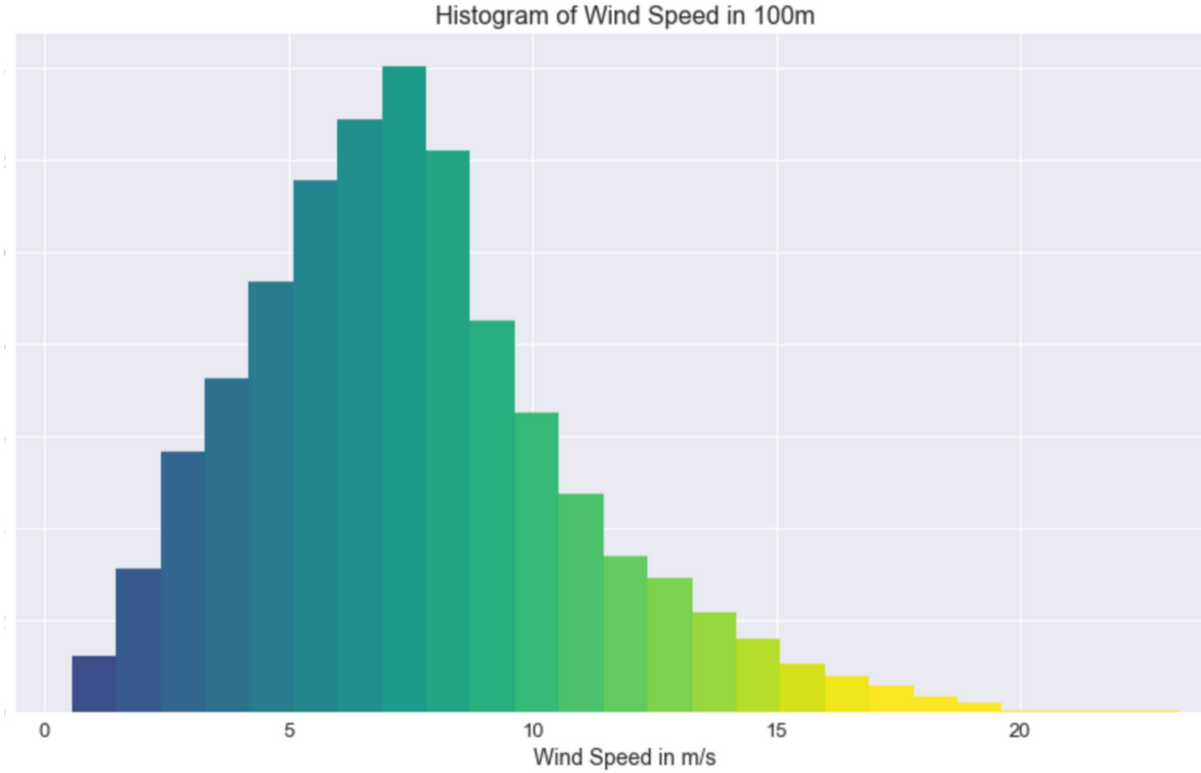
- Various parameters, from wind speed in different heights to humidity and cloud cover
- Time Period: 01/2018 - 08/2019

The datasets were provided by Quadra Energy

AVAILABLE POWER PRODUCTION



POWER CURVE



WIND CONDITIONS

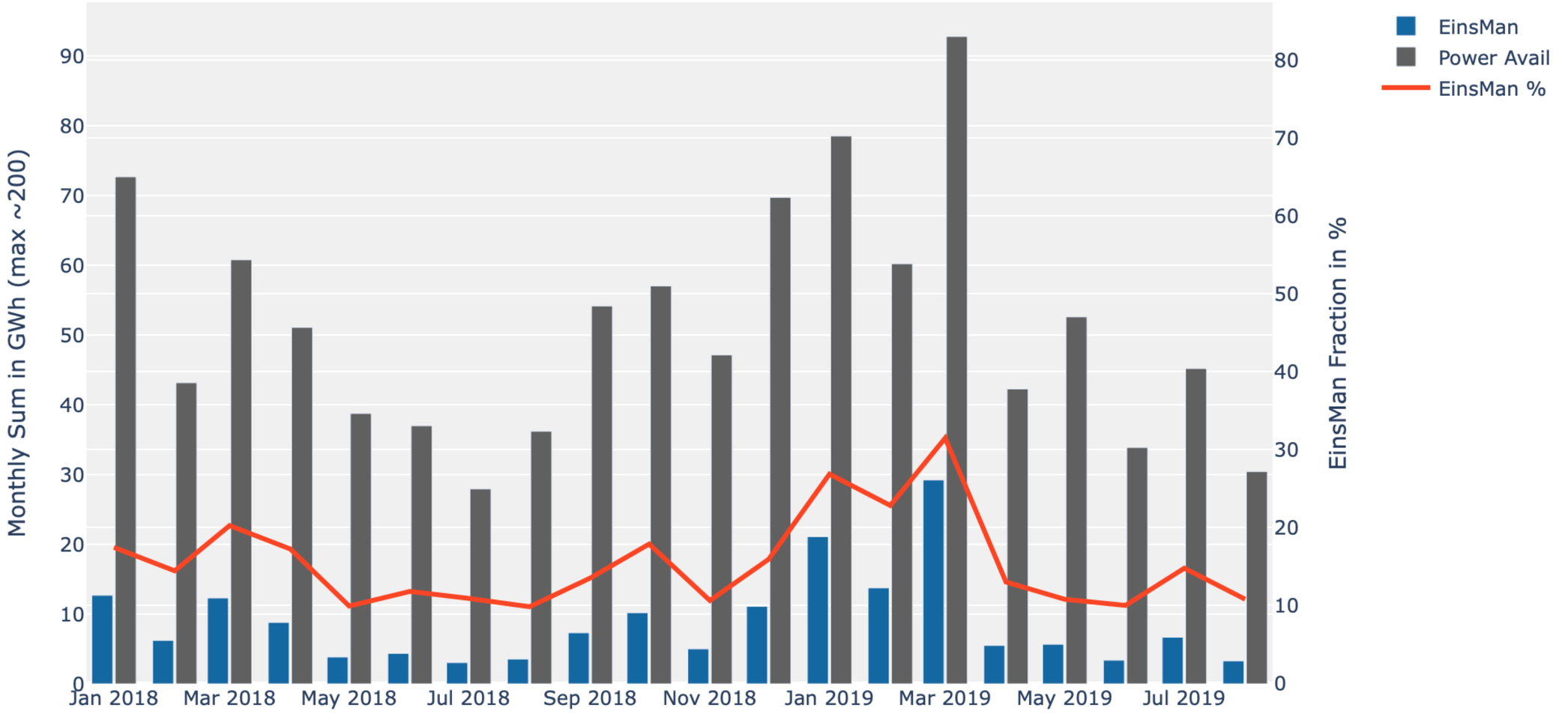
Source: enercon.de

EINSMAN S-H

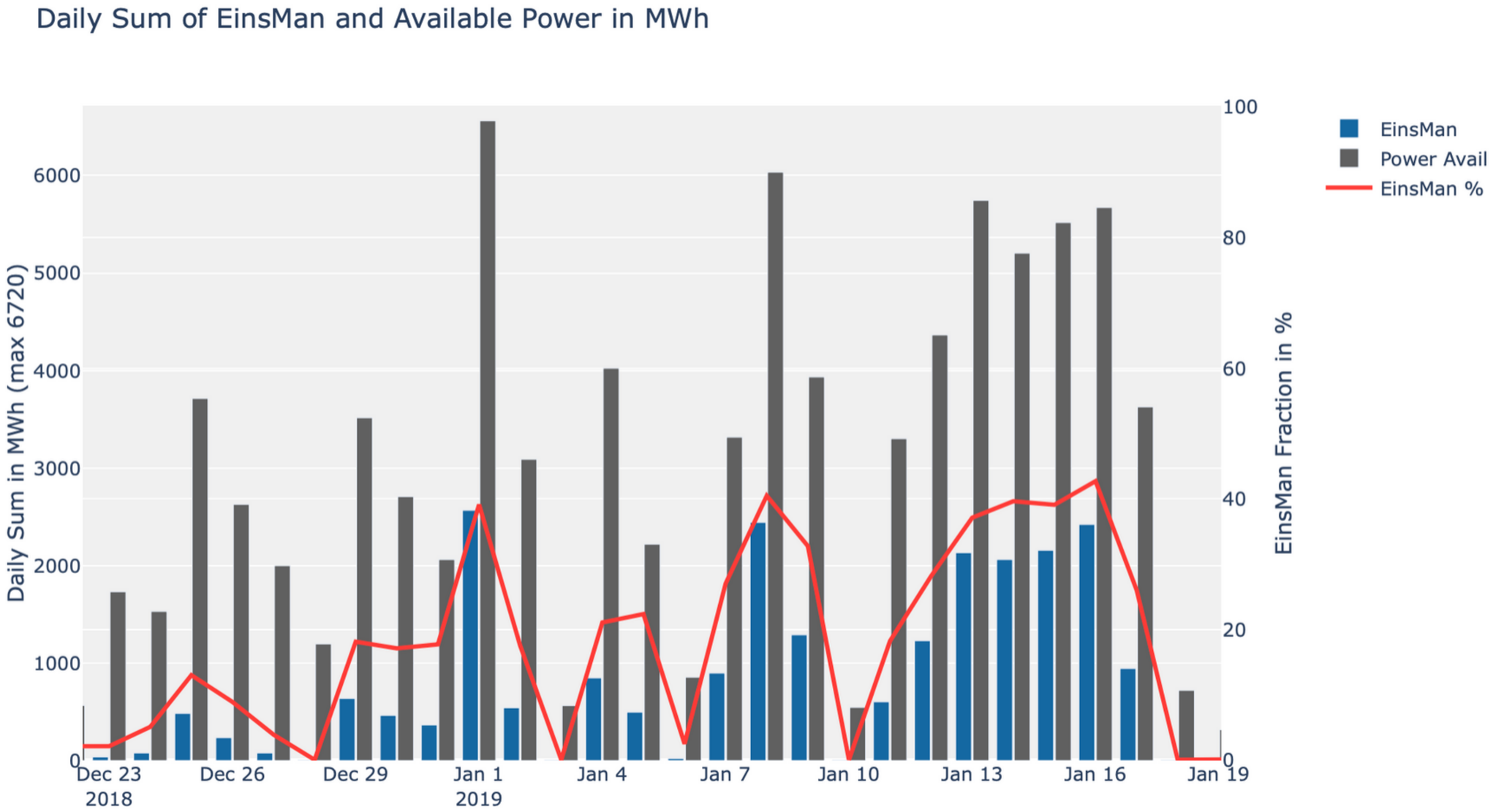

EinsMan Fraction and Windspeed in 100m
power_available_norm
0.0
40.0
80.0
120.0
EinsMan [% of installed power]
0
10
20
30
40
50
60
70
0
5
10
15
20
Windspeed in 100m [m/s]

EINSMAN S-H

Monthly Sum of EinsMan and Available Power in GWh



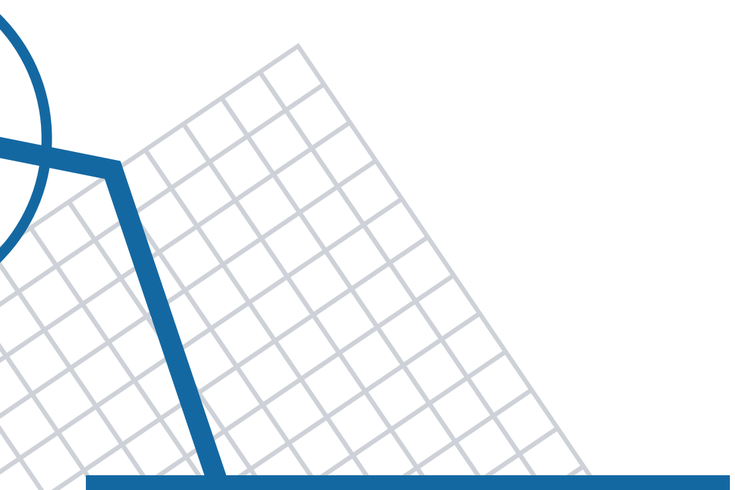
EINSMAN S-H


Daily Sum of EinsMan and Available Power in MWh
Daily Sum in MWh (max 6720)
EinsMan Fraction in %
EinsMan
Power Avail
EinsMan %
0
1000
2000
3000
4000
5000
6000
0
20
40
60
80
100
Dec 23
2018
Dec 26
Dec 29
Jan 1
2019
Jan 4
Jan 7
Jan 10
Jan 13
Jan 16
Jan 19

PREDICTIONS

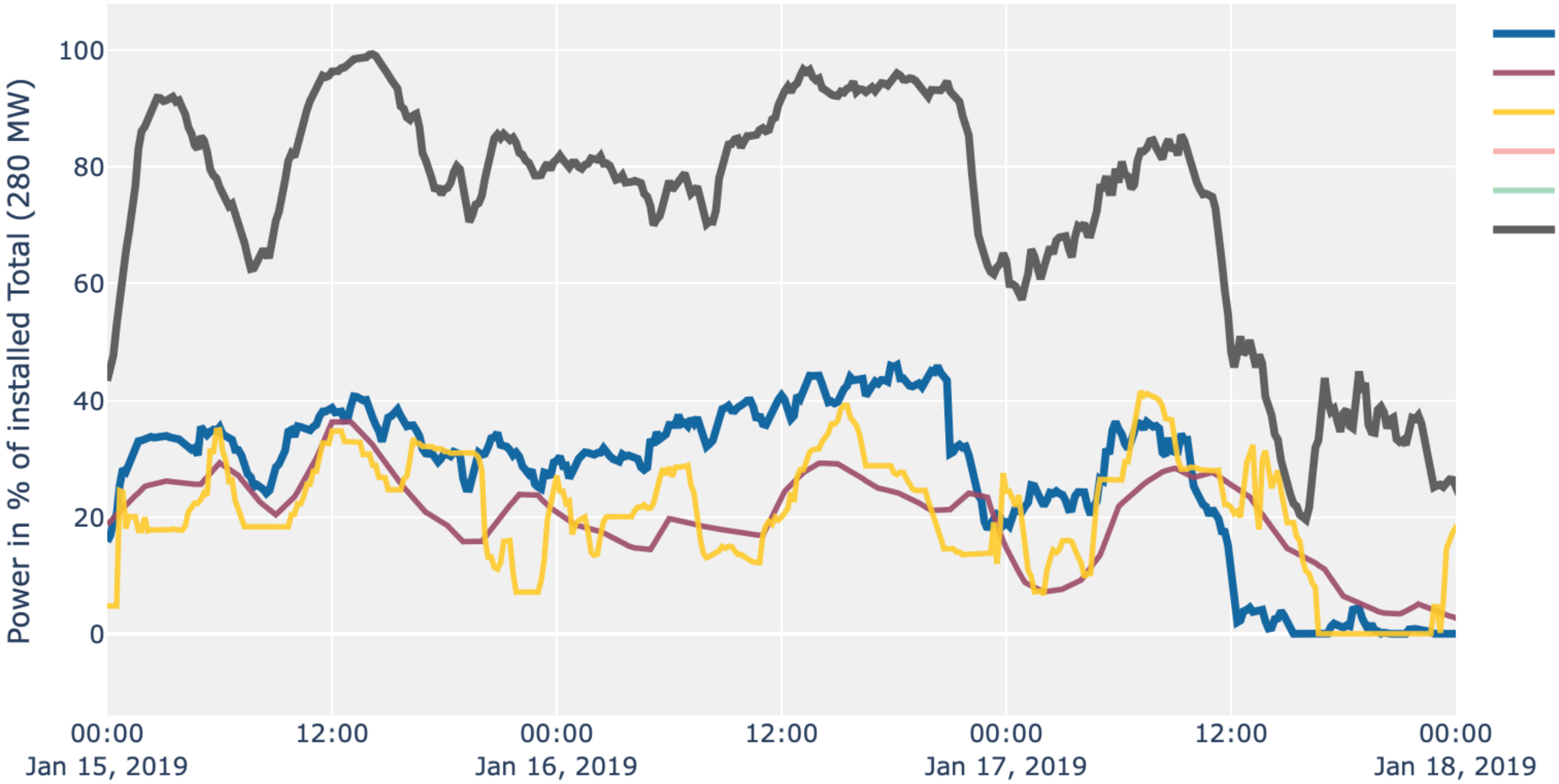
TRAINED MODELS

- lreg: Linear Regression
- knr: KNeighbors Regression
- rfr: RandomForest Regression
- xgbr: XtremeGradientBoosting Regression



PREDICTIONS

Time Series of EinsMan Events (all features)



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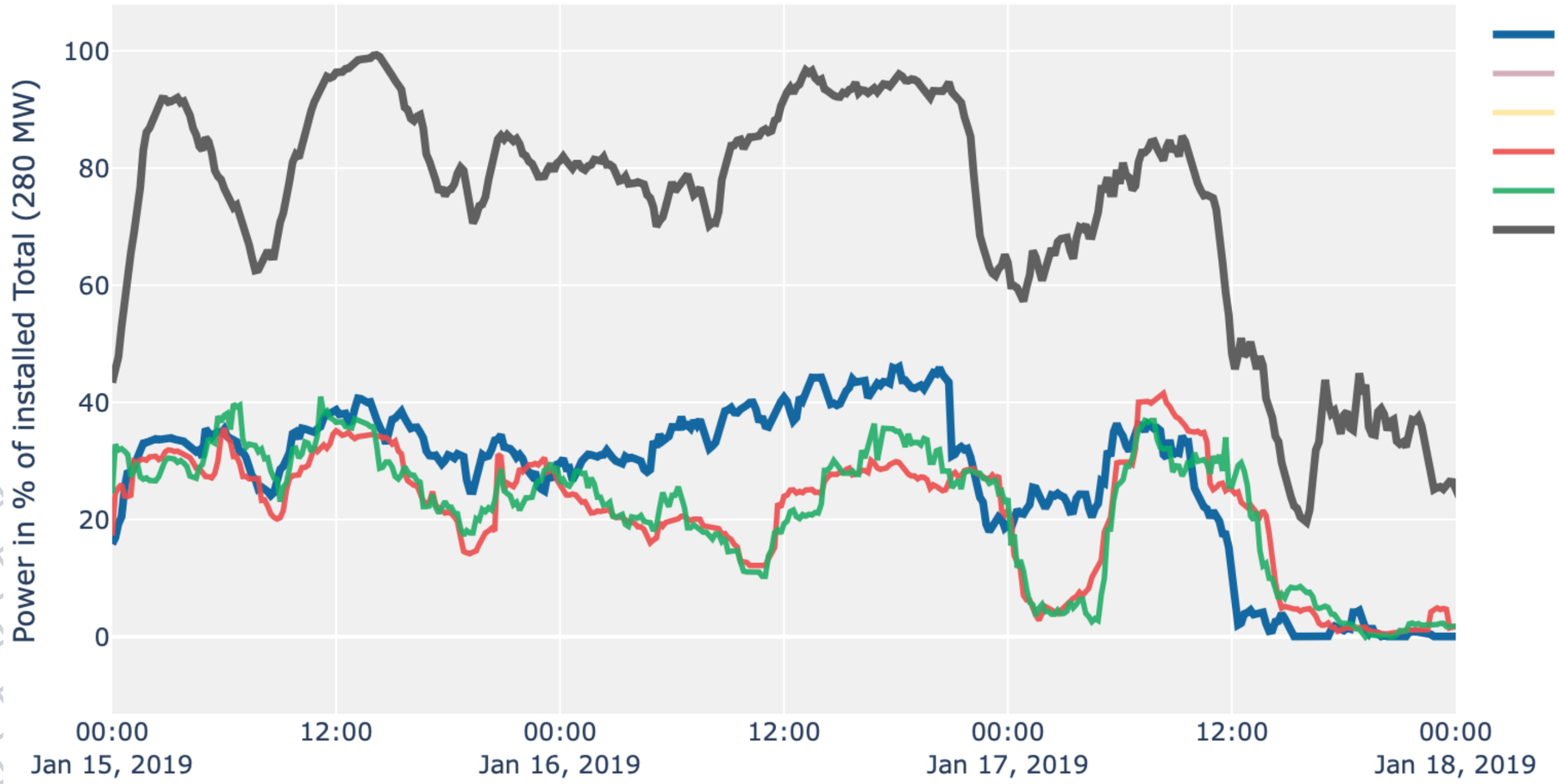

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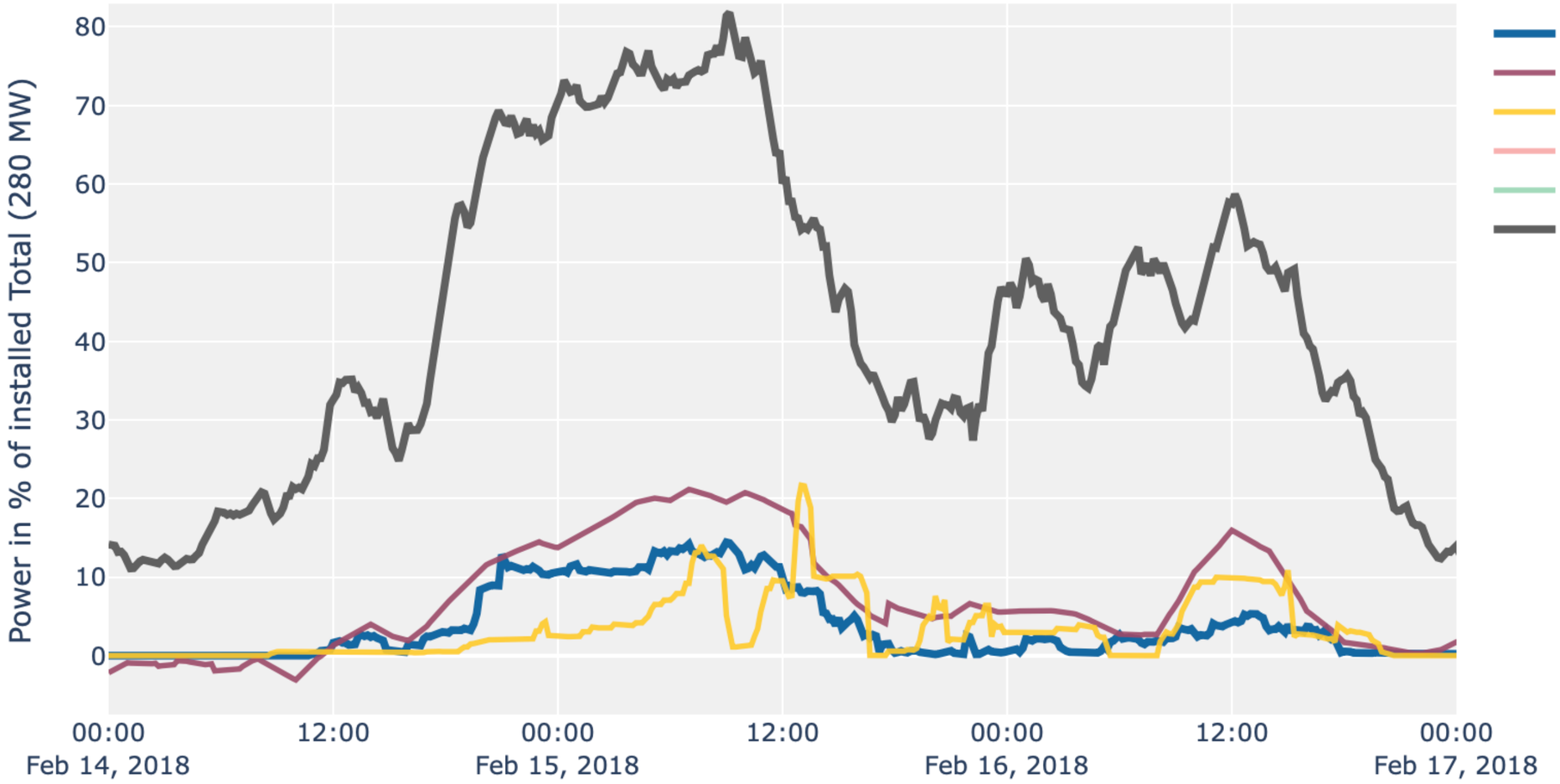

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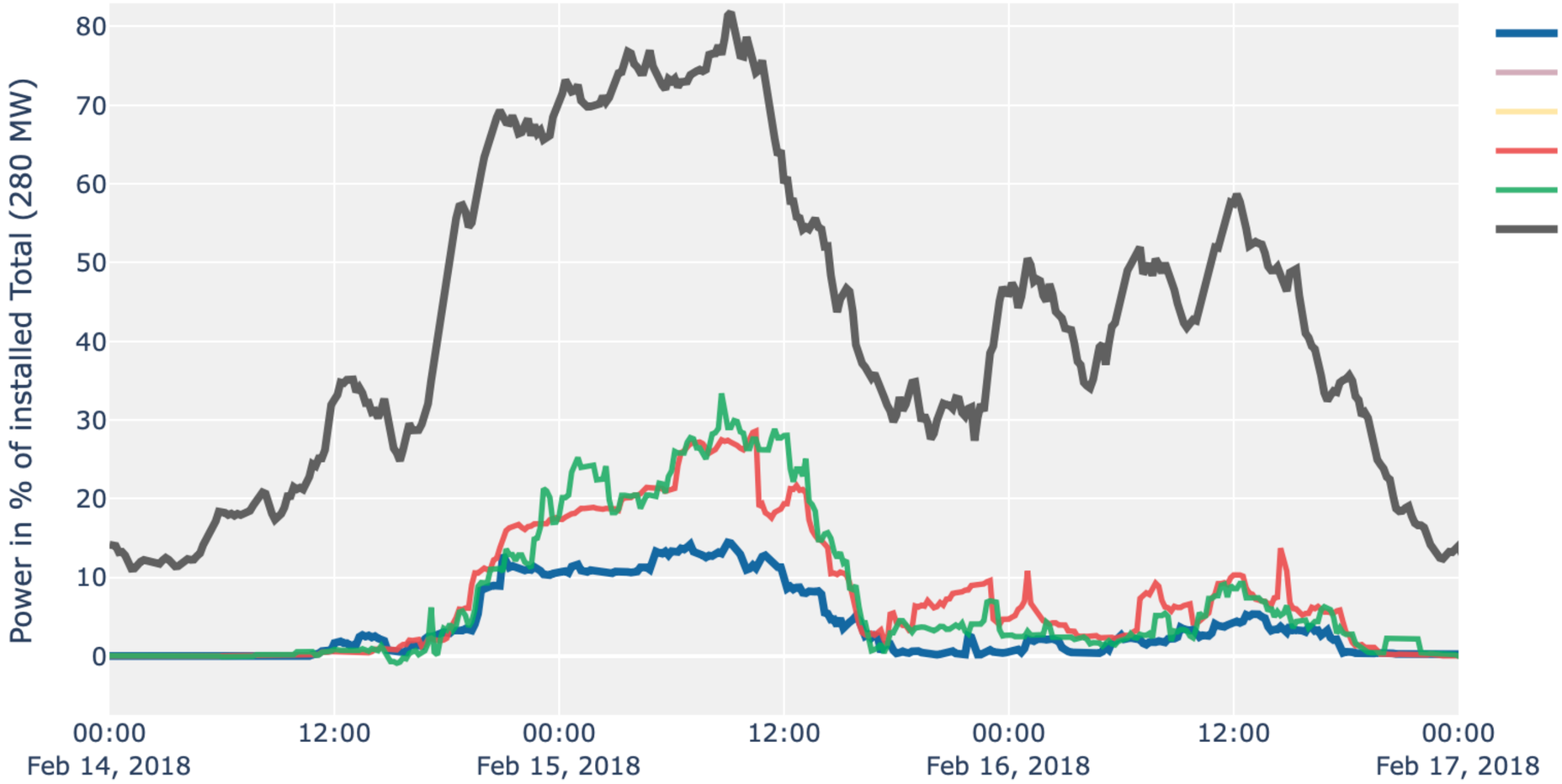
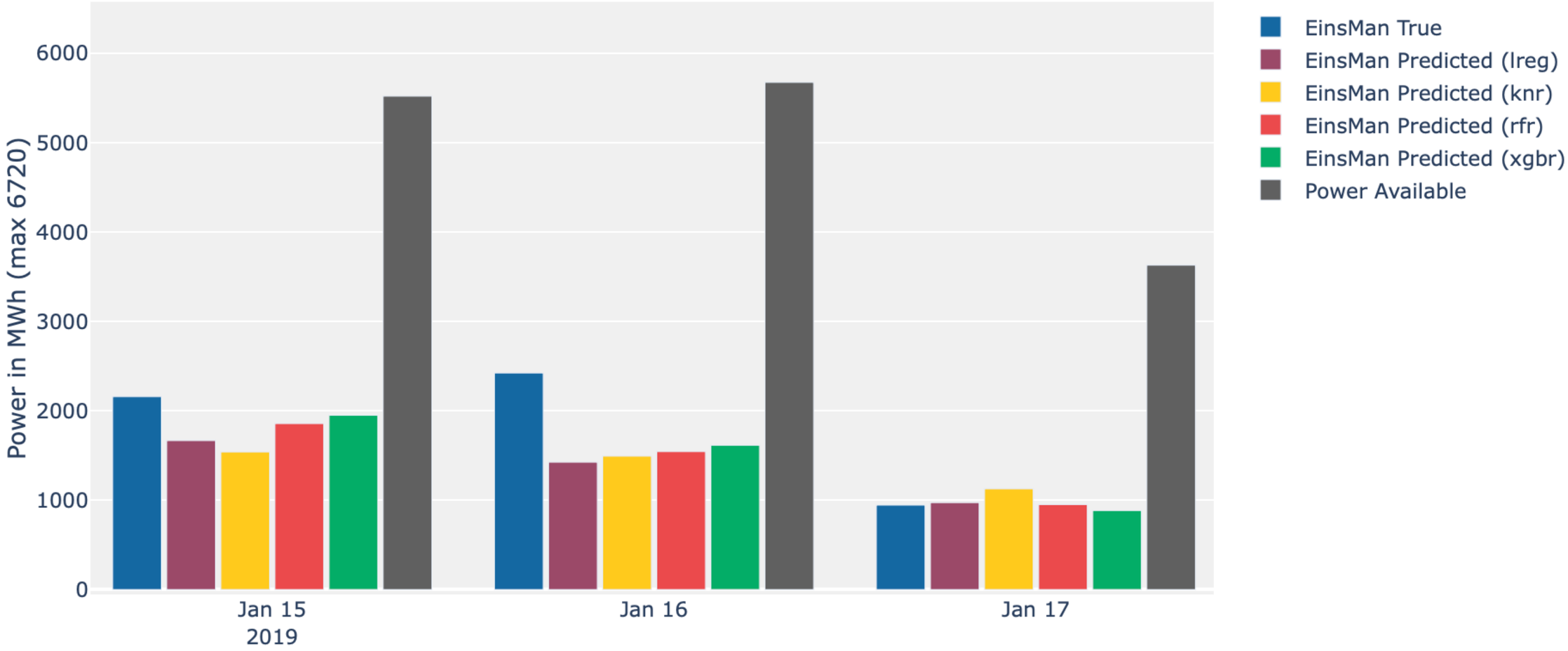


PREDICTIONS

Daily Sum of EinsMan Events in MWh (all features)



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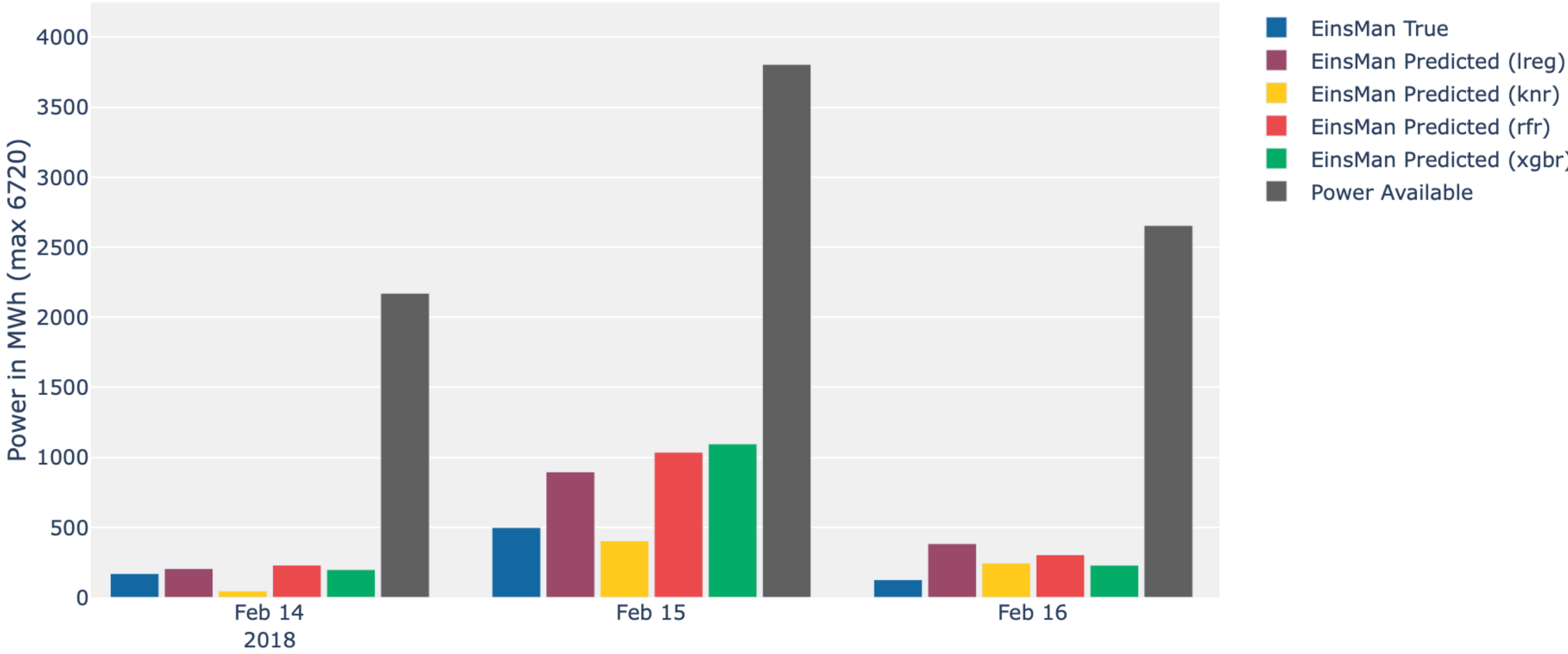

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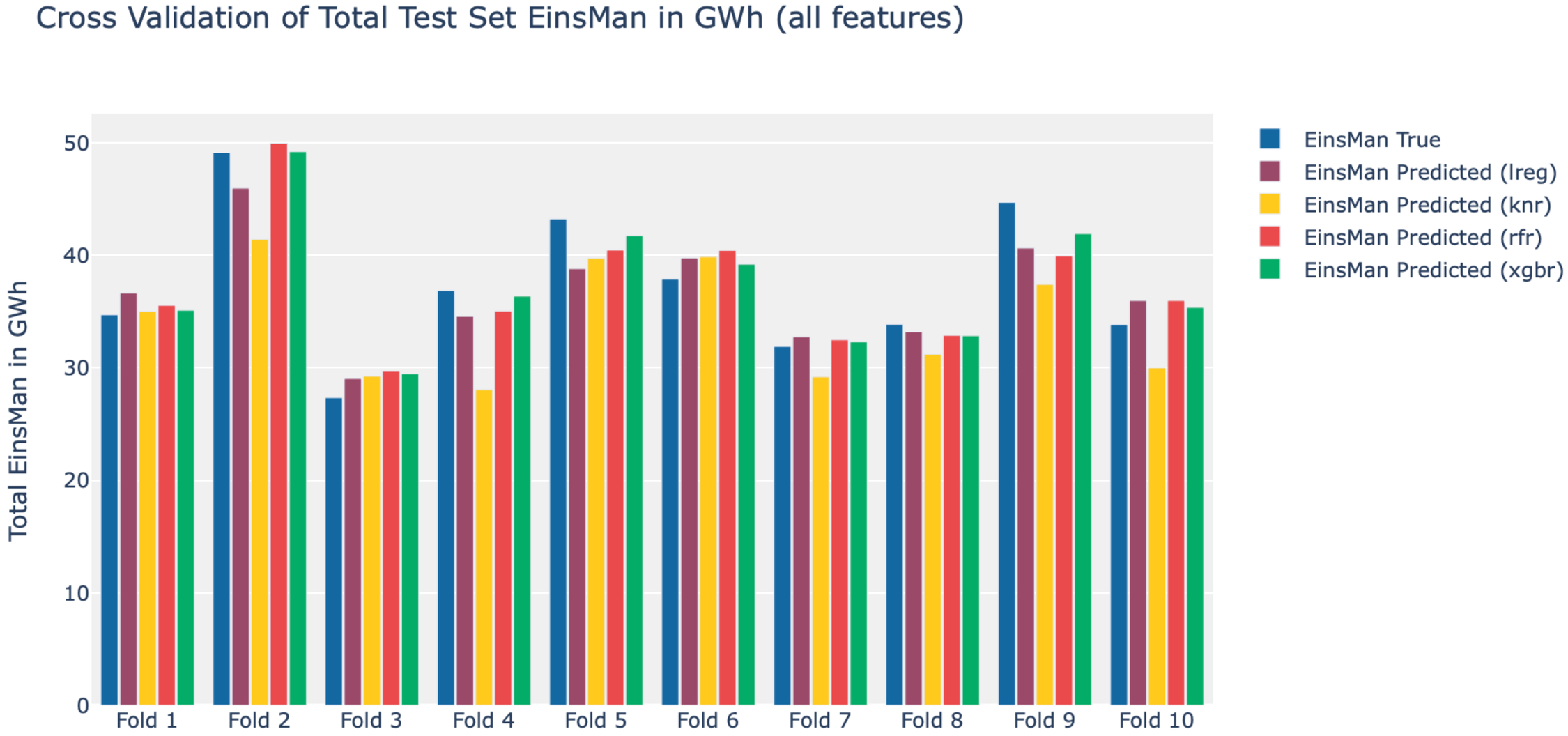

FUTURE PLANS

FURTHER DEVELOPMENTS

- Building meta estimators for balancing
    - BaggingRegressor
    - VotingRegressor
    - StackingRegressor

OTHER PREDICTIVE APPROACHES

- Autoregressive models
- Neural Networks (LSTM)

THANK YOU FOR YOUR INTEREST!