Prediction of Renewable Power Loss caused by Feed-In Management

Using Advanced Linear Models and Recurrent Neural Networks for Time Series Predictions

Capstone Presentation
26.November 2020
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BACKGROUND

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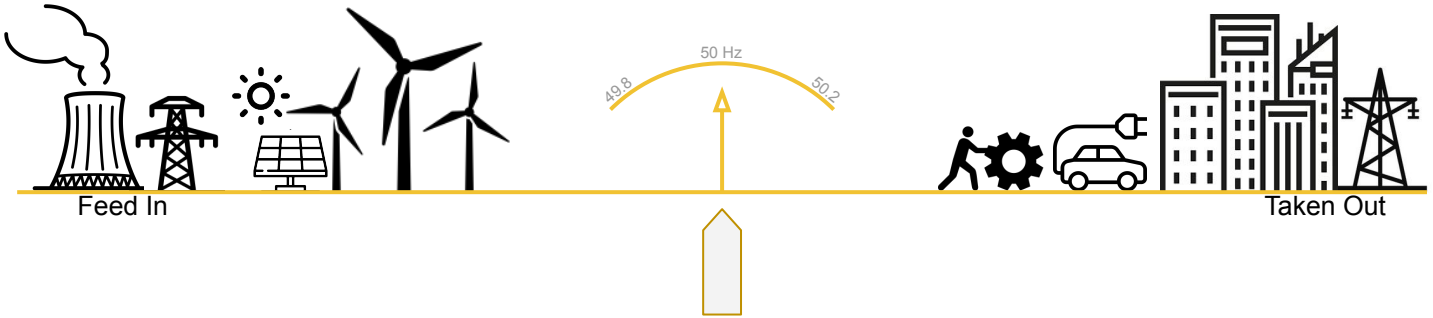
FUTURE WORK

Energy feet into the system needs to meet energy taken out of the system at all times. This was already difficult with conventional electricity generation. It is even more difficult with a combination of volatility renewable energy sources. For example, on a windy and sunny day in June, there is potentially a lot of excess wind energy. Feed-In Management describes the curtailment of energy to protect grid infrastructure of overloads.
What if we could instead use the excess energy?



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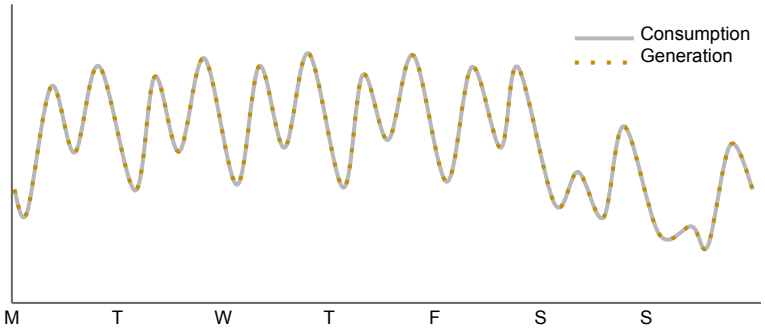
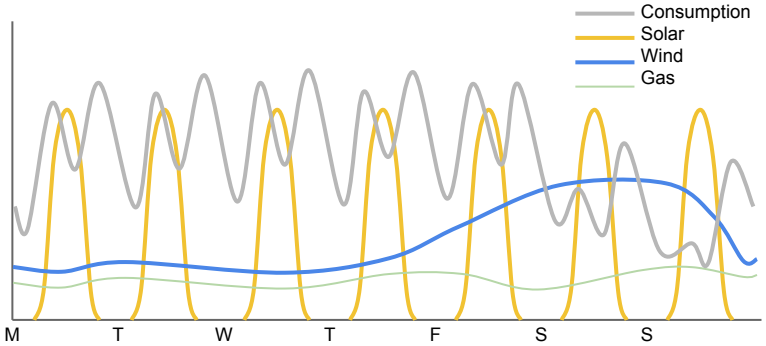


Renewable Electricity Grid



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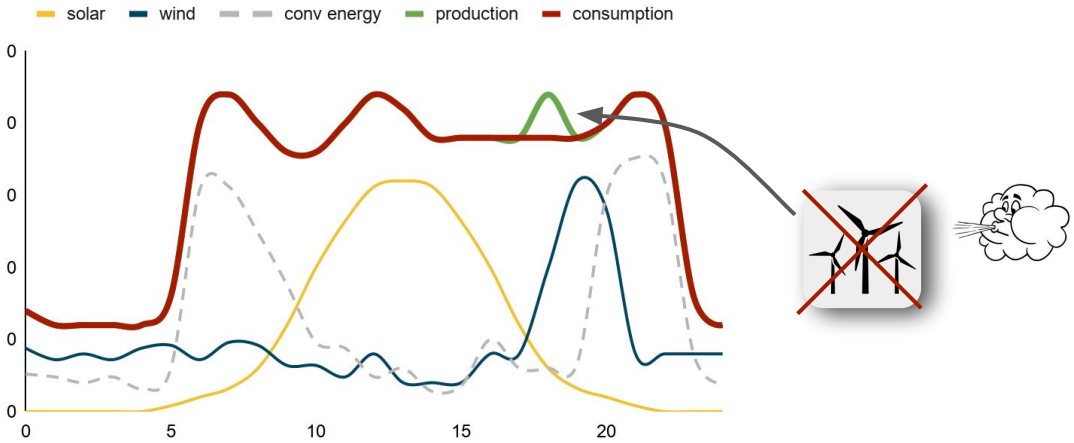

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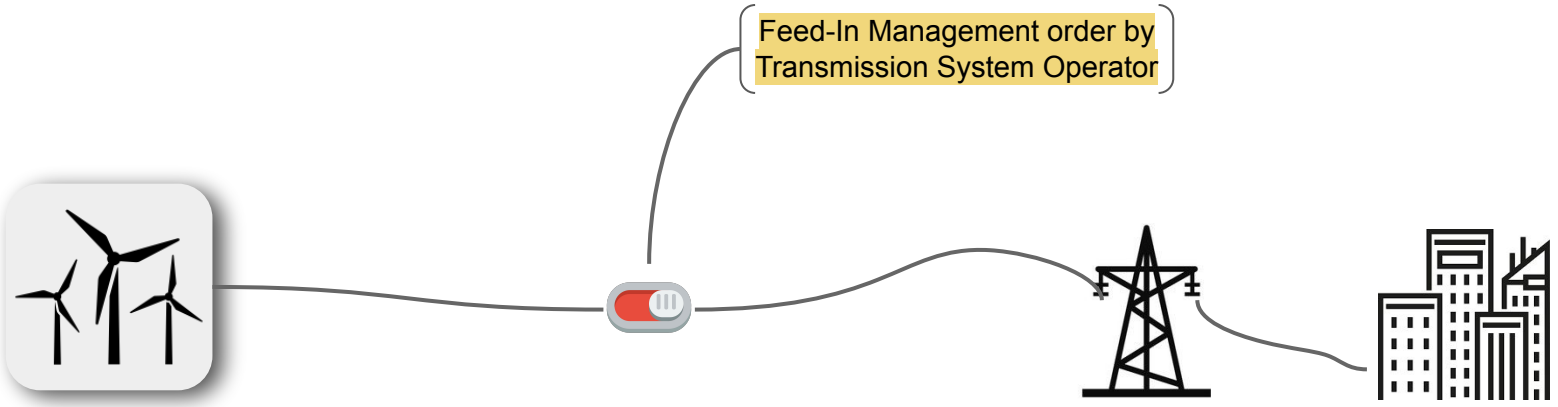

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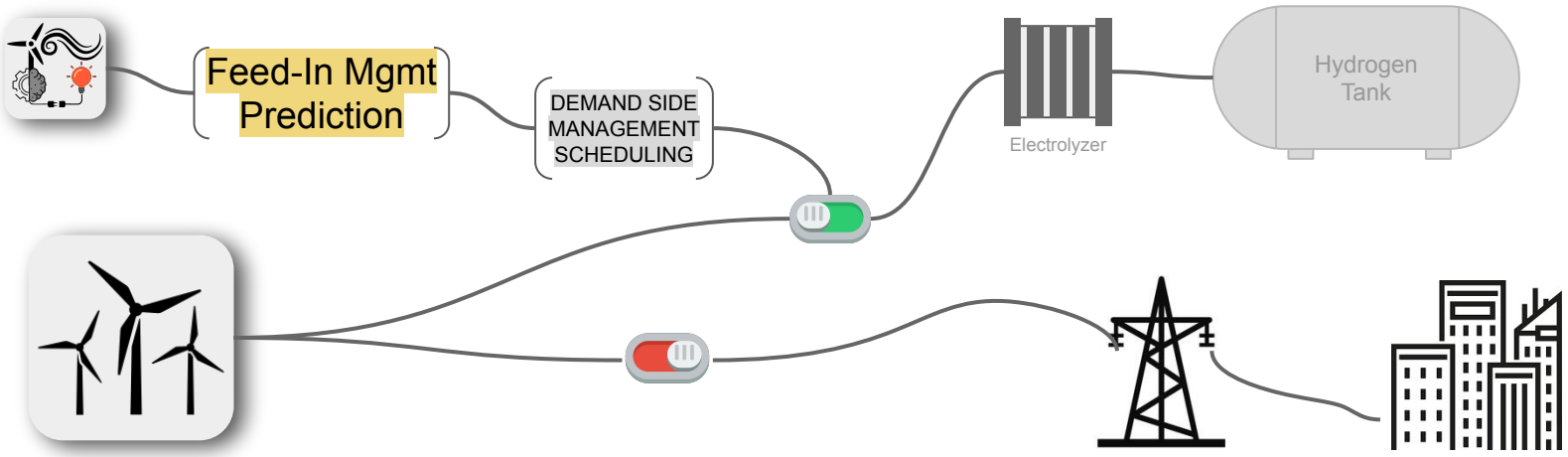
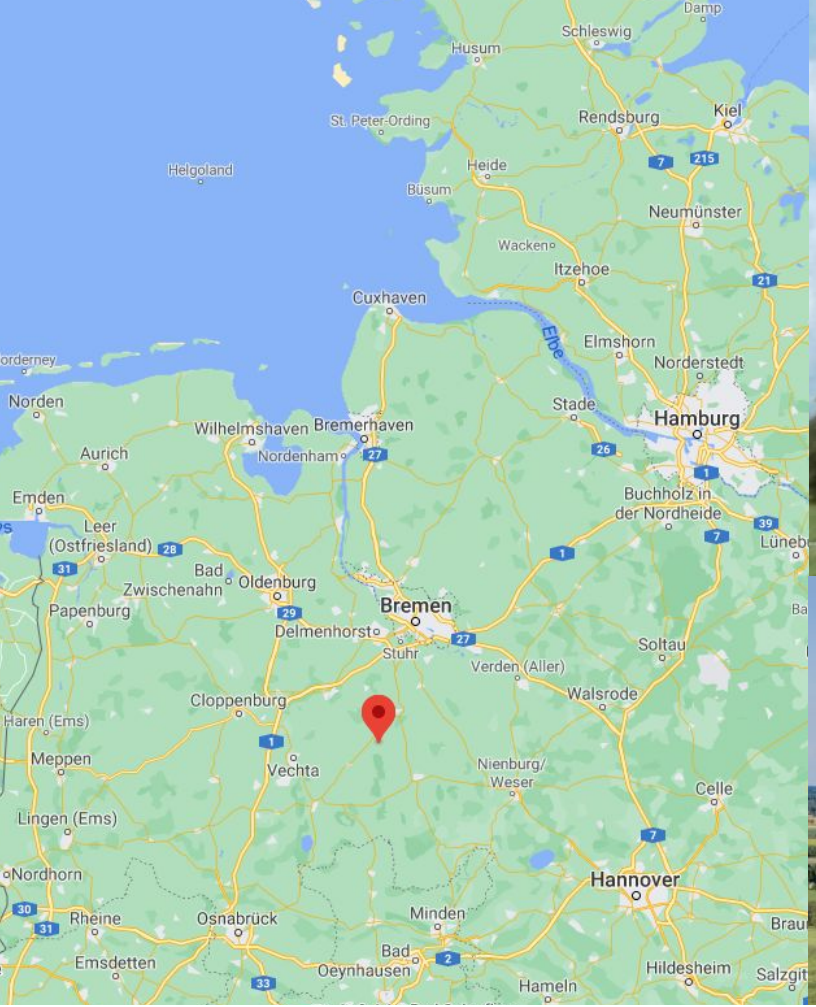


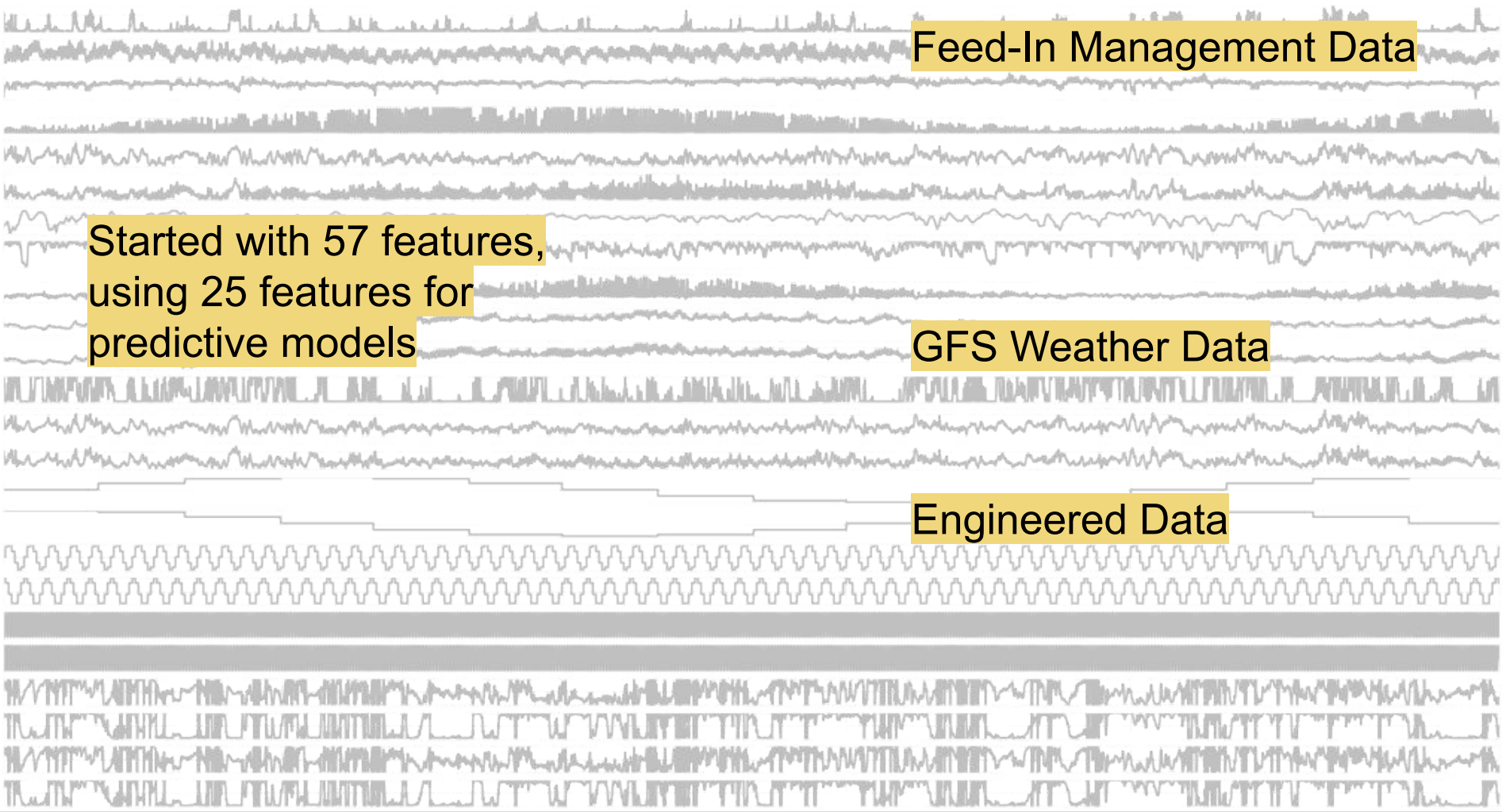
BACKGROUND

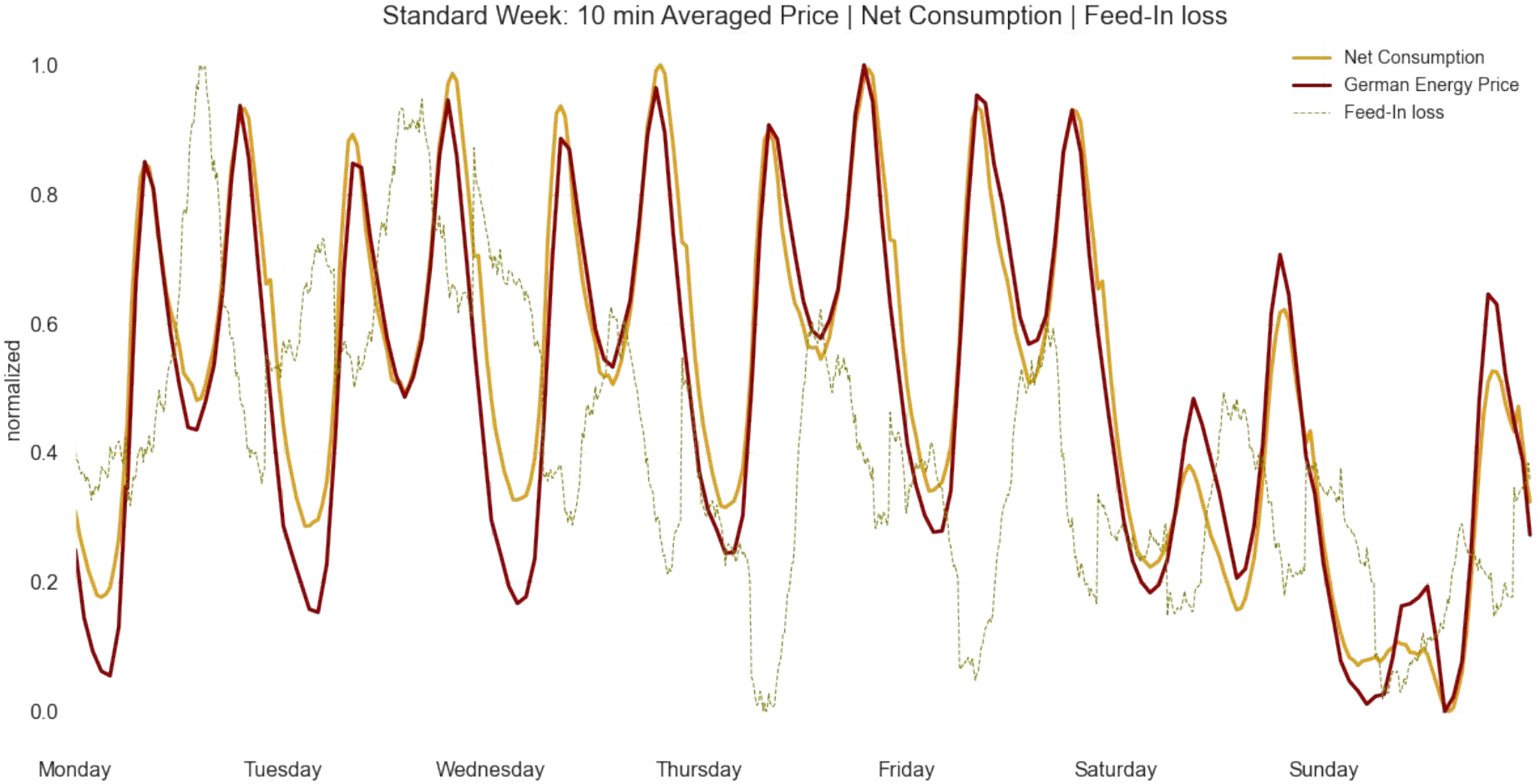
DATA ANALYSIS

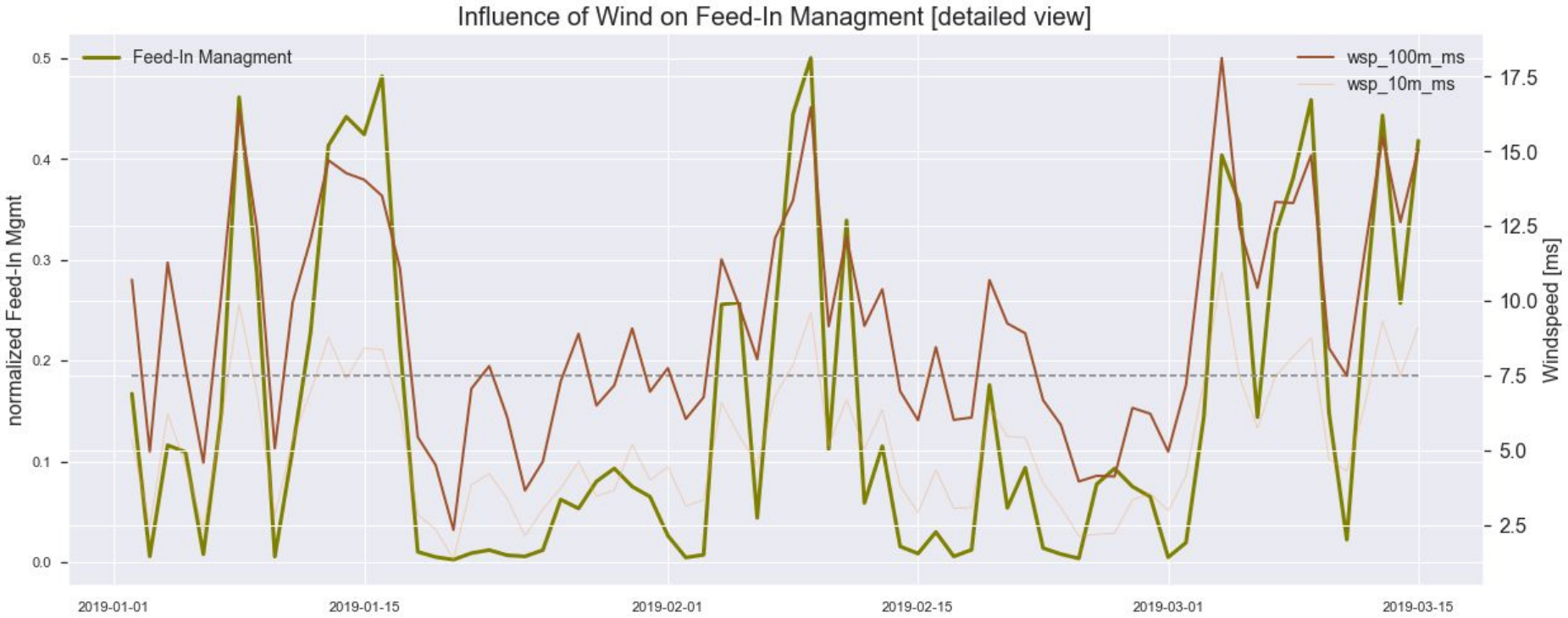
MODEL RESULTS

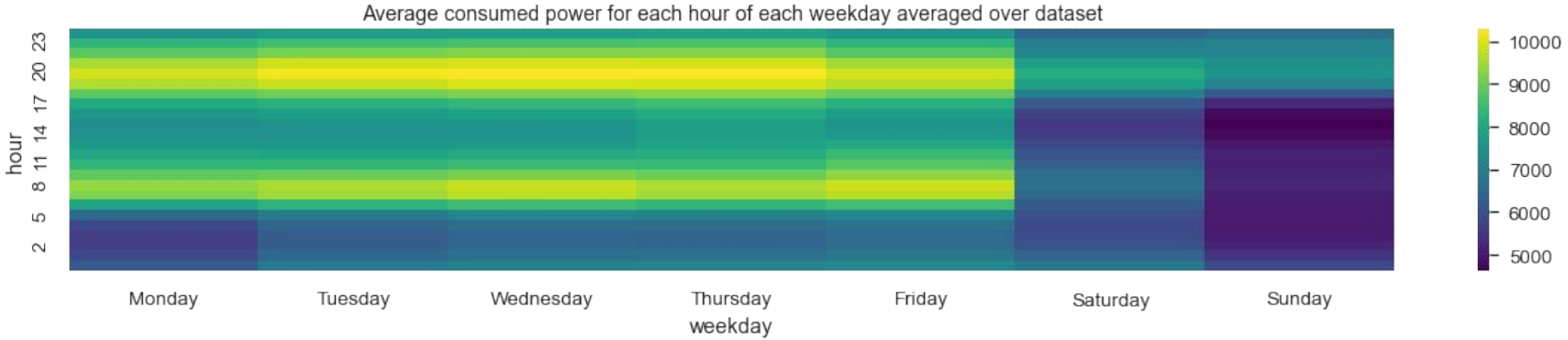
FUTURE WORK

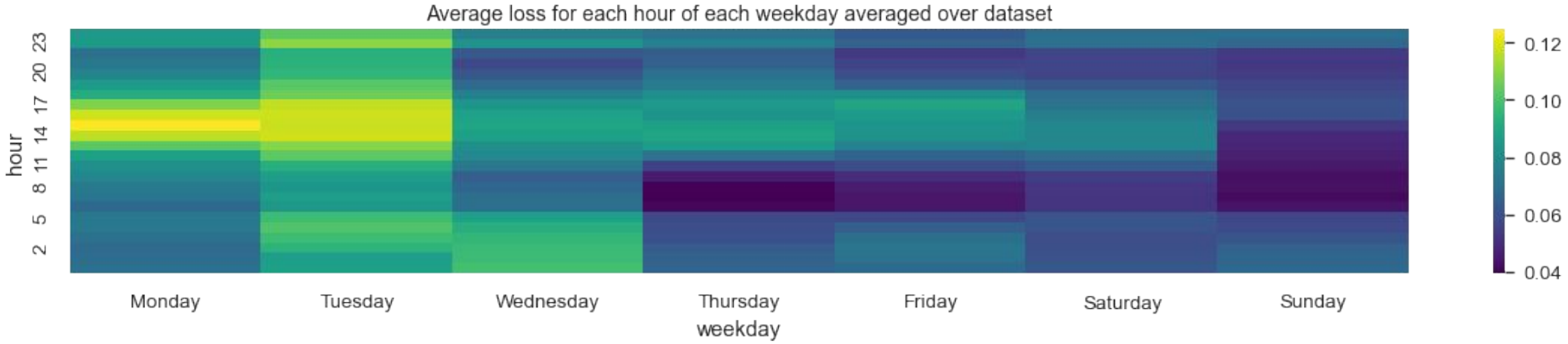

Damp
Schleswig
Husum
St. Peter-Ording
Rendsburg
Kiel
Helgoland
Heide
Büsum
Neumünster
Wacken
Itzehoe
Cuxhaven
Elbe
Elmshorn
Norderstedt
Norden
Stade
Hamburg
Wilhelmshaven
Bremerhaven
Aurich
Nordenham
Buchholz in der Nordheide
Emden
Leer (Ostfriesland)
Bad Zwischenahn
Oldenburg
Papenburg
Bremen
Delmenhorst
Stuhr
Verden (Aller)
Soltau
Walsrode
Cloppenburg
Haren (Ems)
Meppen
Vechta
Nienburg/ Weser
Celle
Lingen (Ems)
Nordhorn
Hannover
Rheine
Osnabrück
Minden
Emsdetten
Bad Oeynhausen
Hildesheim
Hameln

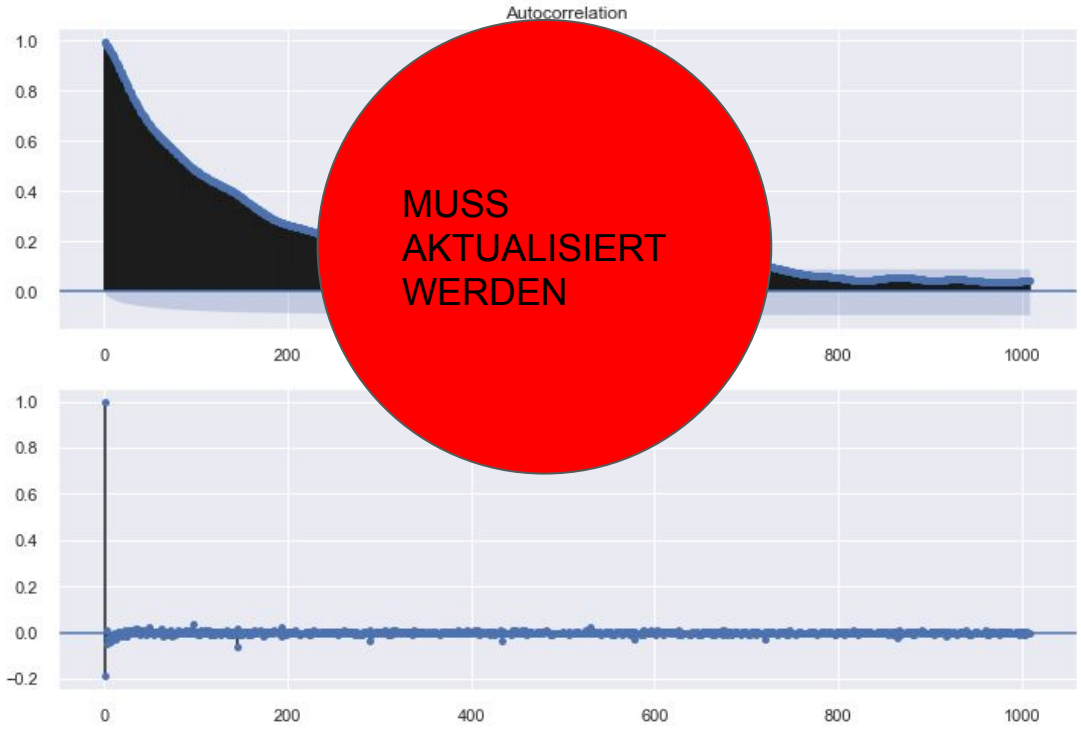

Feed-In Management Data
Started with 57 features,
using 25 features for
predictive models
GFS Weather Data
Engineered Data


Standard Week: 10 min Averaged Price | Net Consumption | Feed-In loss
Net Consumption
German Energy Price
Feed-In loss
normalized
1.0
0.8
0.6
0.4
0.2
0.0
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday

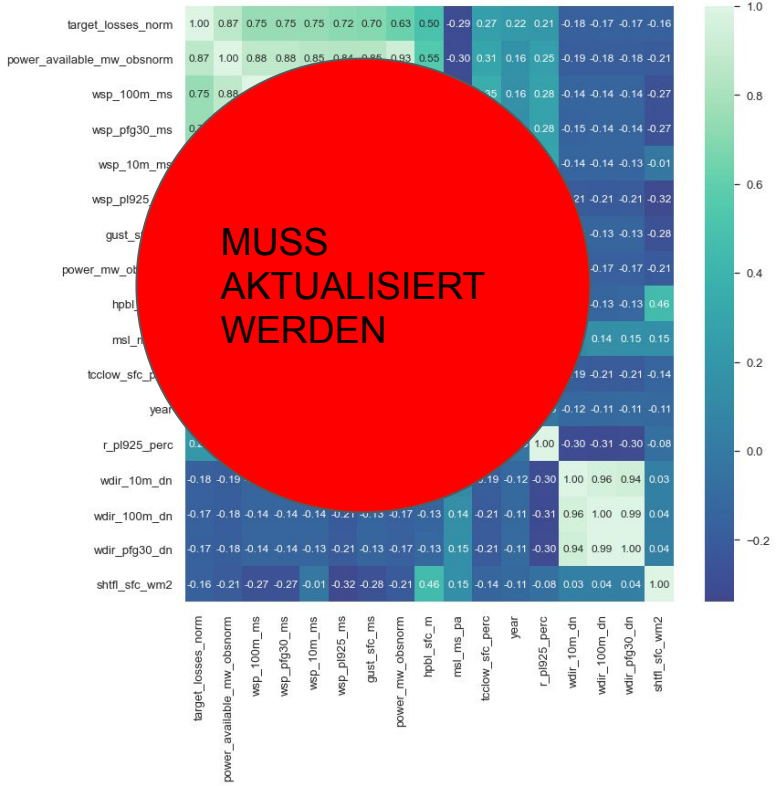

Influence of Wind on Feed-In Managment [detailed view]
Feed-In Managment
wsp_100m_ms
wsp_10m_ms
normalized Feed-In Mgmt
Windspeed [ms]
0.0
0.1
0.2
0.3
0.4
0.5
2.5
5.0
7.5
10.0
12.5
15.0
17.5
2019-01-01
2019-01-15
2019-02-01
2019-02-15
2019-03-01
2019-03-15


Average consumed power for each hour of each weekday averaged over dataset
hour
23
20
17
14
11
8
5
2
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday
weekday
10000
9000
8000
7000
6000
5000


Average loss for each hour of each weekday averaged over dataset
hour
23
20
17
14
11
8
5
2
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday
weekday
0.12
0.10
0.08
0.06
0.04



MUSS AKTUALISIERT WERDEN



MUSS AKTUALISIERT WERDEN

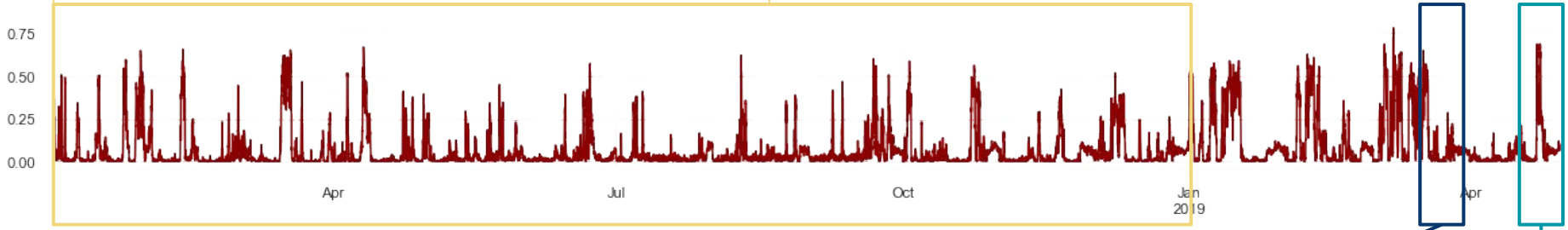
BACKGROUND

DATA ANALYSIS

MODEL RESULTS

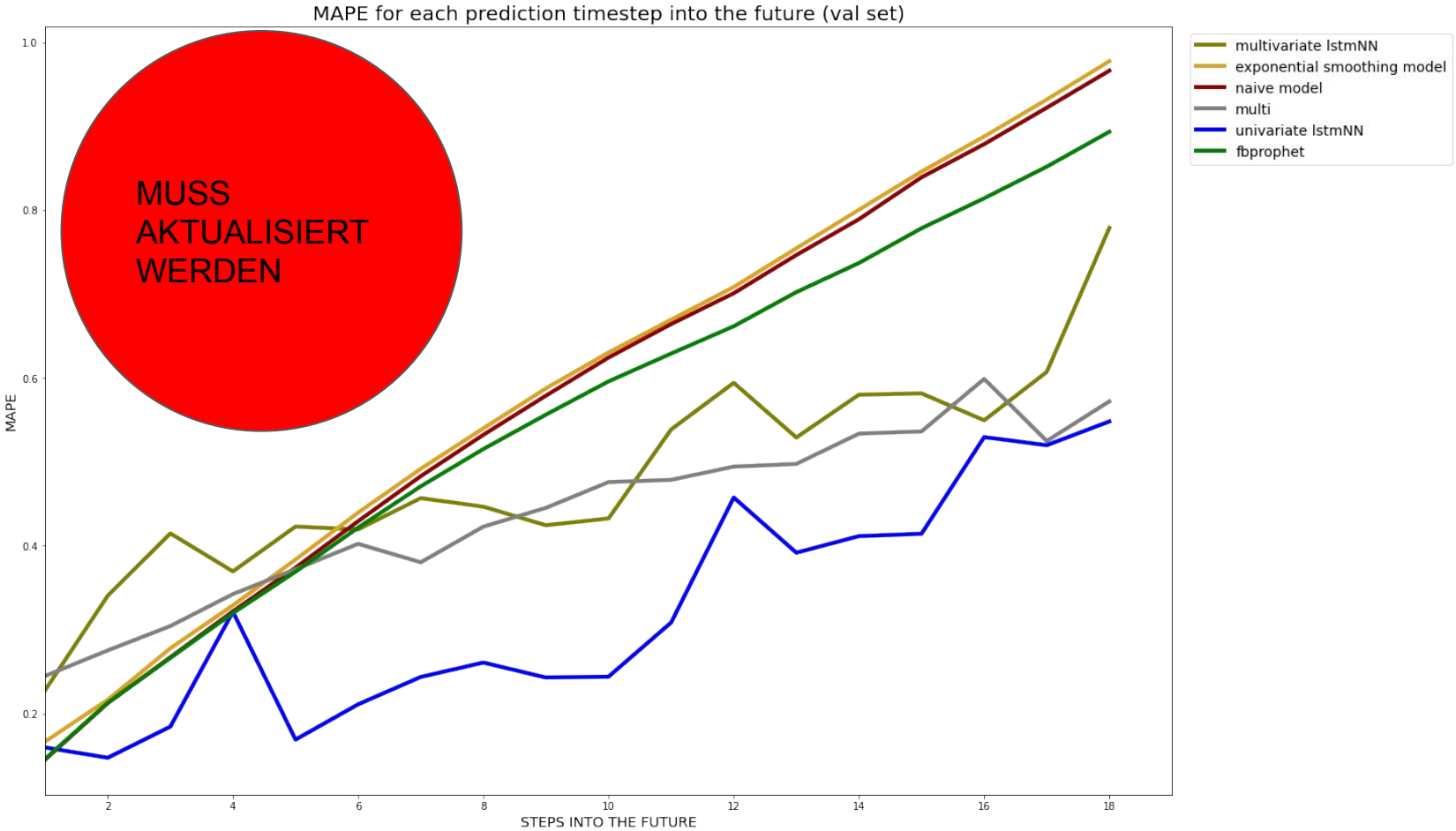
FUTURE WORK

Training
'01.01.2018 06:00:00' to '01.01.2019 06:00:00'



Validation
'17.03.2019 06:00:00' to '27.03.2019 06:00:00'

Test
'20.04.2019 06:00:00' to '30.04.2019 06:00:00'


MAPE for each prediction timestep into the future (val set)
MUSS
AKTUALISIERT
WERDEN
multivariate lstmNN
exponential smoothing model
naive model
multi
univariate lstmNN
fbprophet
MAPE
STEPS INTO THE FUTURE
1.0
0.8
0.6
0.4
0.2
2
4
6
8
10
12
14
16
18

BACKGROUND

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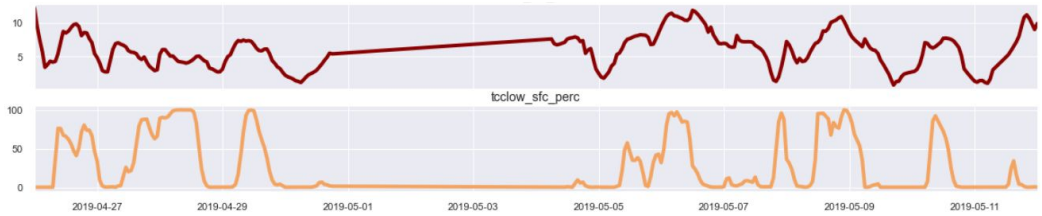


TensorBoard

SELECTED APIs — SELECTED MODEL — FEED-IN MANAGEMENT PREDICTIONS

Low Hanging

Extensiv Data Fixing: data after 1. May 2019 contained errors, could be fixed via its own seasonal model

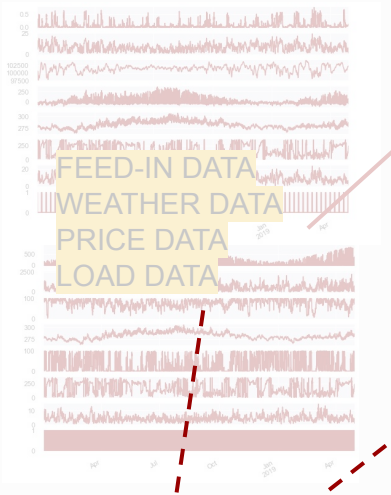
LSTM Tuning via TensorBoard

Forecast of GFS Data for Feed-In Mgmt predictions >1 timestep

High Hanging

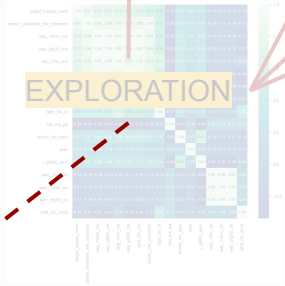
API: receiving data via an API for live predictions

[MODEL DESIGN]



FEED-IN DATA
WEATHER DATA
PRICE DATA
LOAD DATA

CLEANING



EXPLORATION

HOLD OUT TEST DATA

TRAINING DATA

VALIDATION DATA

MODEL OPTIMISATION

MODEL SELECTION

[USE CASE]

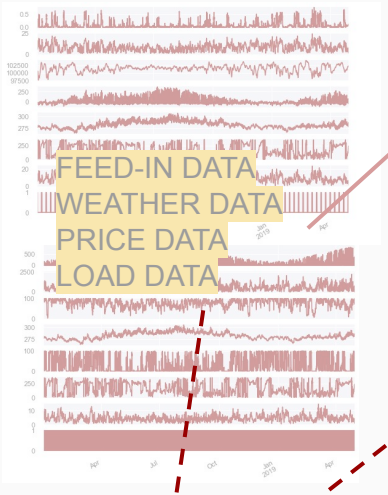
SELECTED APIs

SELECTED MODEL

FEED-IN MANAGEMENT PREDICTIONS

DEMAND SIDE MANAGEMENT SCHEDULING

[MODEL DESIGN]



FEED-IN DATA
WEATHER DATA
PRICE DATA
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[USE CASE]

SELECTED APIs

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DEMAND SIDE MANAGEMENT SCHEDULING

END