Bend the wind!
Capstone

Predict imbalance energy prices

Our Team

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M.A. Empirical Democracy Research
3 years experience in market research

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B.Sc. Geography
>10 years Recruiting
Consulting, Automotive, Energy

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M.Sc. Mechanical Engineering
Product Manager
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7 years experience as postdoctoral researcher

Agenda

01 | Introduction

02 | Data Analysis

03 | Models

04 | Conclusion & Outlook

01

Introduction

Timeline & used tools

Week 1

Research
Data Analysis

Week 2

Data Analysis
Plots

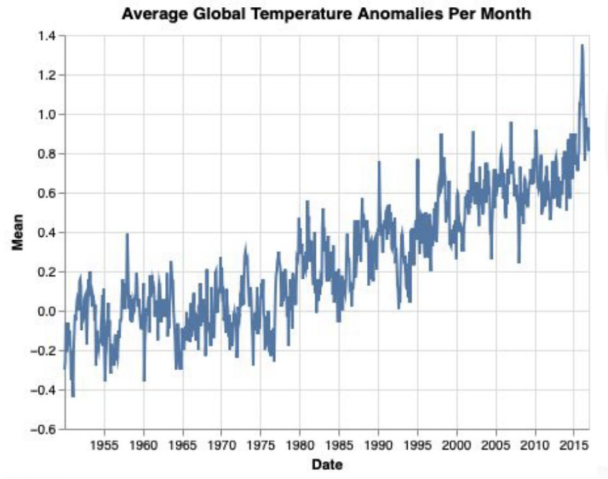
Week 3

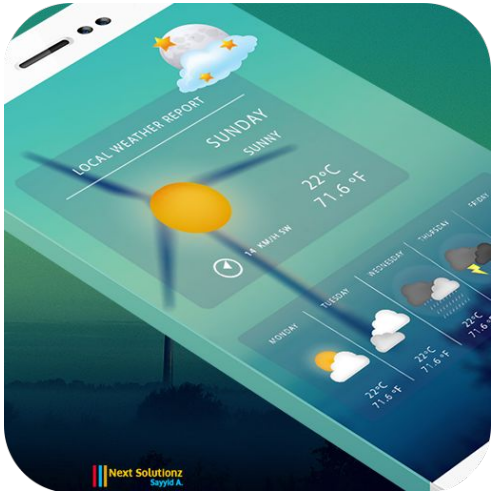
Model
Dashboard

Week 4

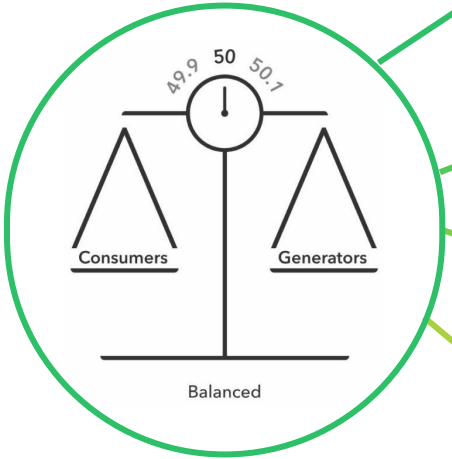
Model
Fine Tuning

Forecast


Average Global Temperature Anomalies Per Month
Mean
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015
Date


LOCAL WEATHER REPORT
SUNDAY
SUNNY
22°C
71.6 °F
Next Solutionz
Sayyid A.

Energy market



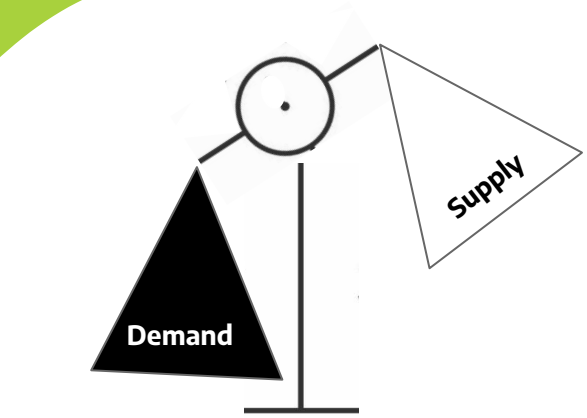
01 Demand and supply have to be balanced

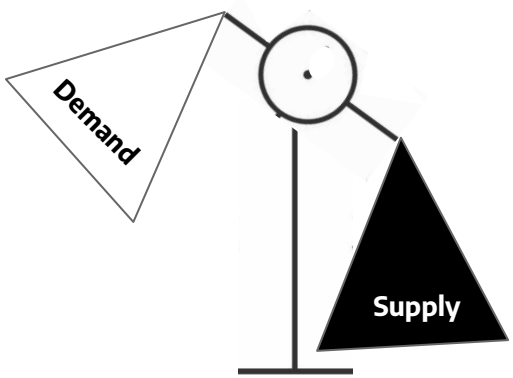
02 Companies need to place bids in advance

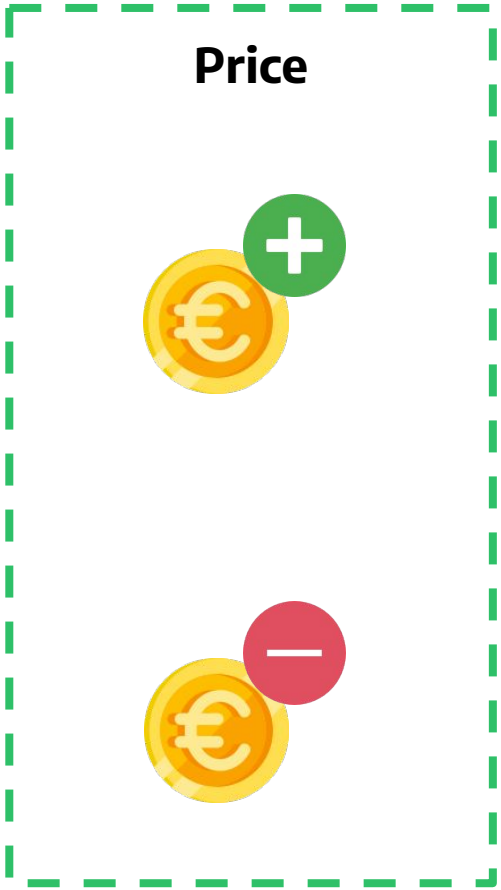
03 Limited ability to store electricity

04 Imbalance? Grid instability!

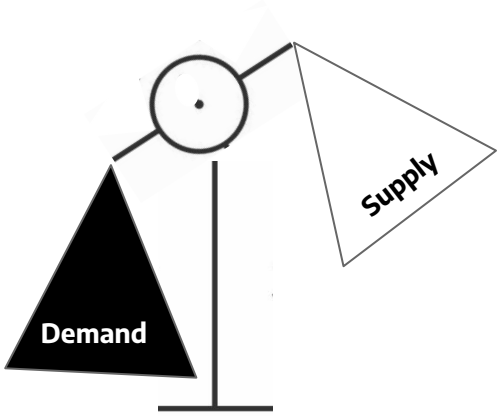
Imbalance Energy Price

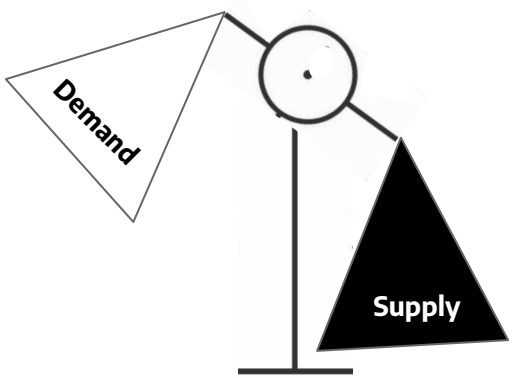






Imbalance Energy Price





Price

Strategy for placing bids

Sell

Buy

Why forecast the imbalance energy price?

- Imbalance energy price calculated every 15 min BUT published in following month

- Know in advance to make BUY / SALE decisions

02

Data Analysis

Data Overview

15%

Wind speed Forecast

16%

Offshore Forecast

Imbalance Price

2019-2021

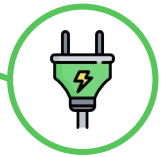
1 hour timesteps

18%

Onshore Forecast

36%

Day Ahead Price



29%

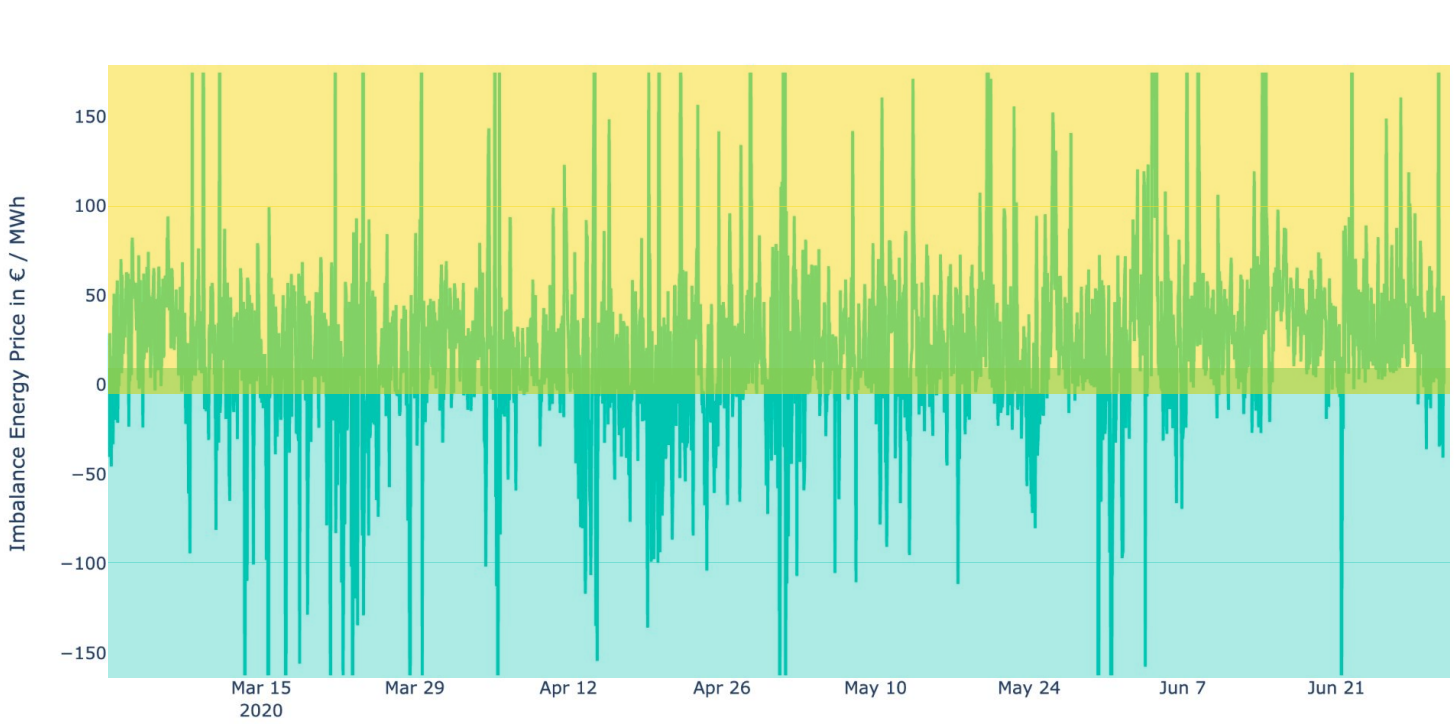
Load Forecast

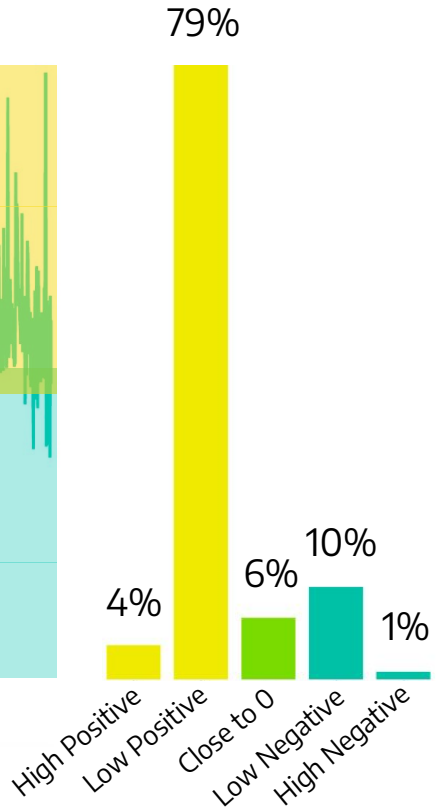
Imbalance Energy Price

Price range (in € / MWh)

24.500 €

Imbalance Energy - Distribution





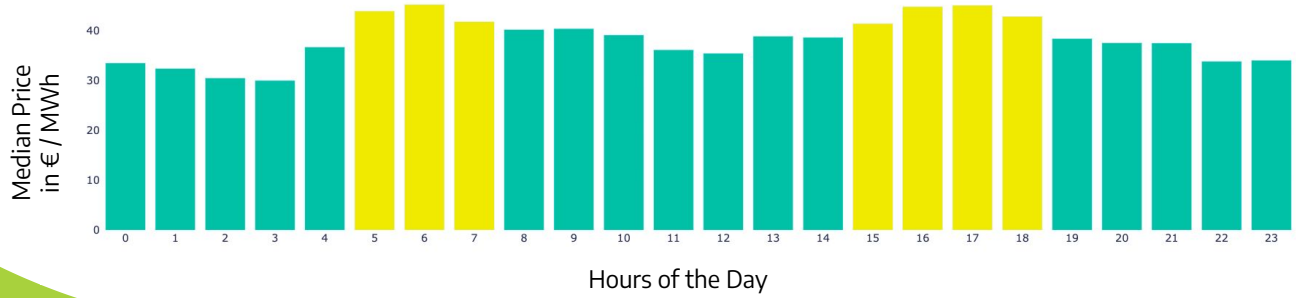
Trend & Seasonality

Trend:

- Stationary process (no trend)

Seasonality:

- Minor seasonalities



03
Models

Overview

Models:

- Baseline
- SARIMA
- Prophet

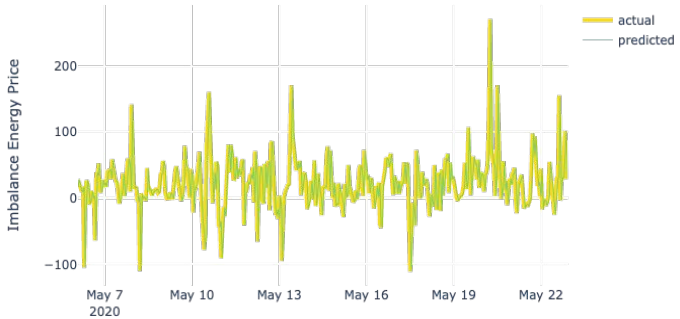
Univariate (1 Feature)

Multivariate (6 features)

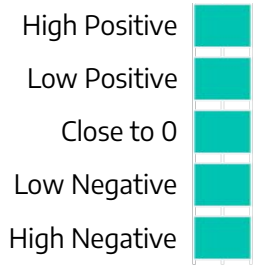
Forecast horizon:

- 1h
- 6h
- 12h

Approach :



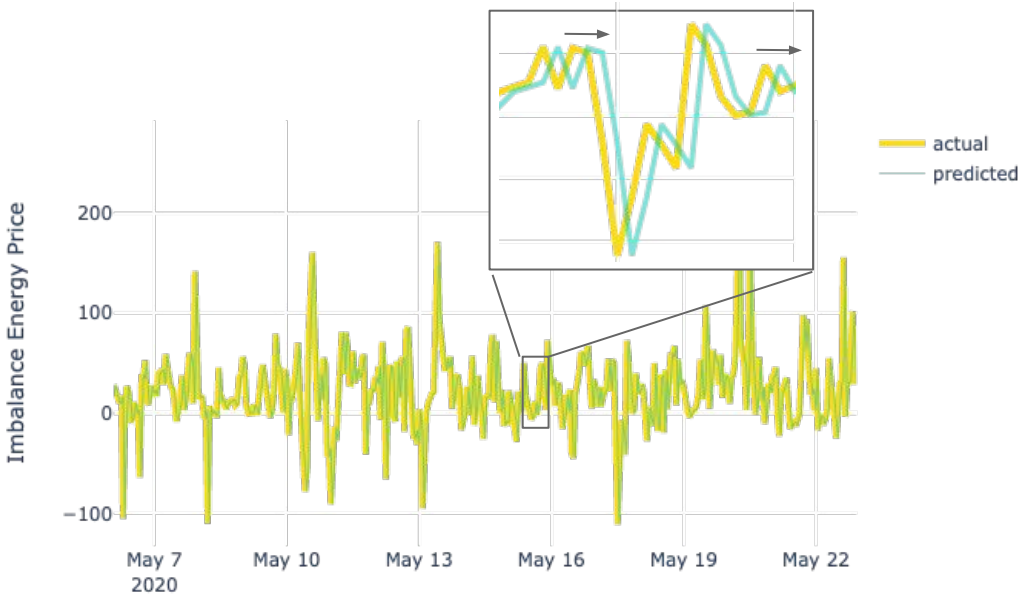
Regression

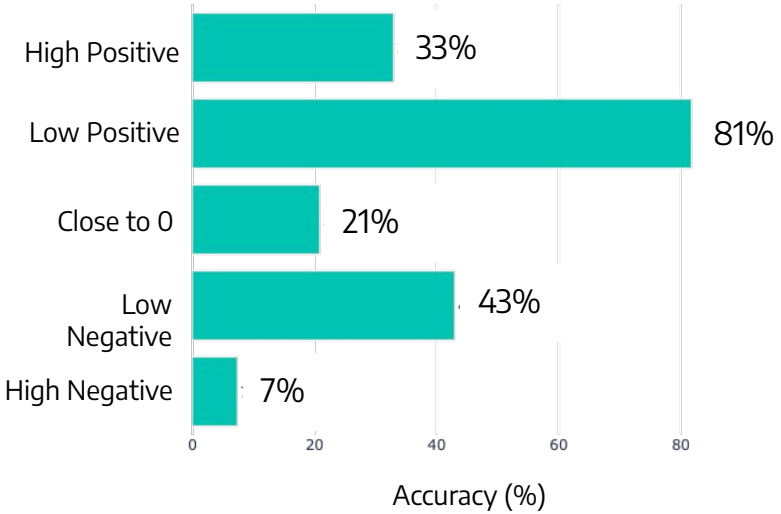


Classification

Baseline Model

- 1 hour shift to forecast price



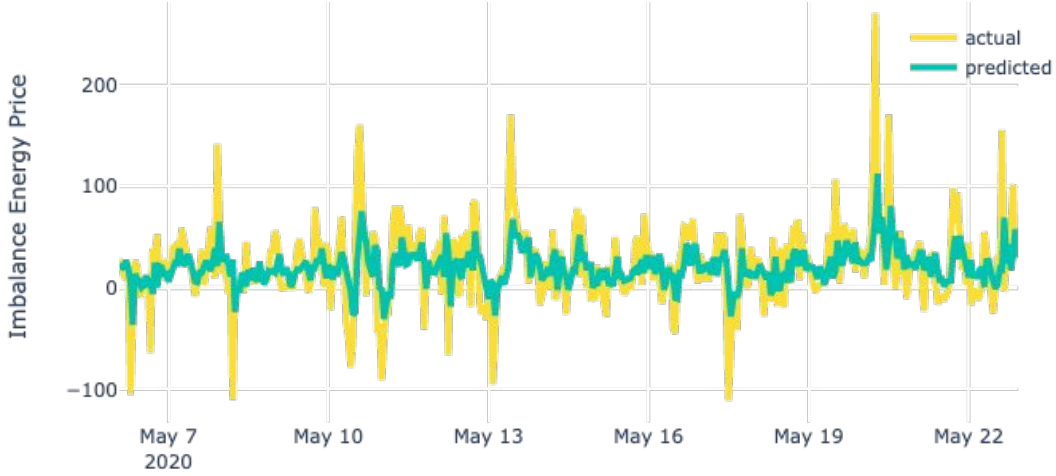


Error: ±60 € / MWh

Accuracy: 37%

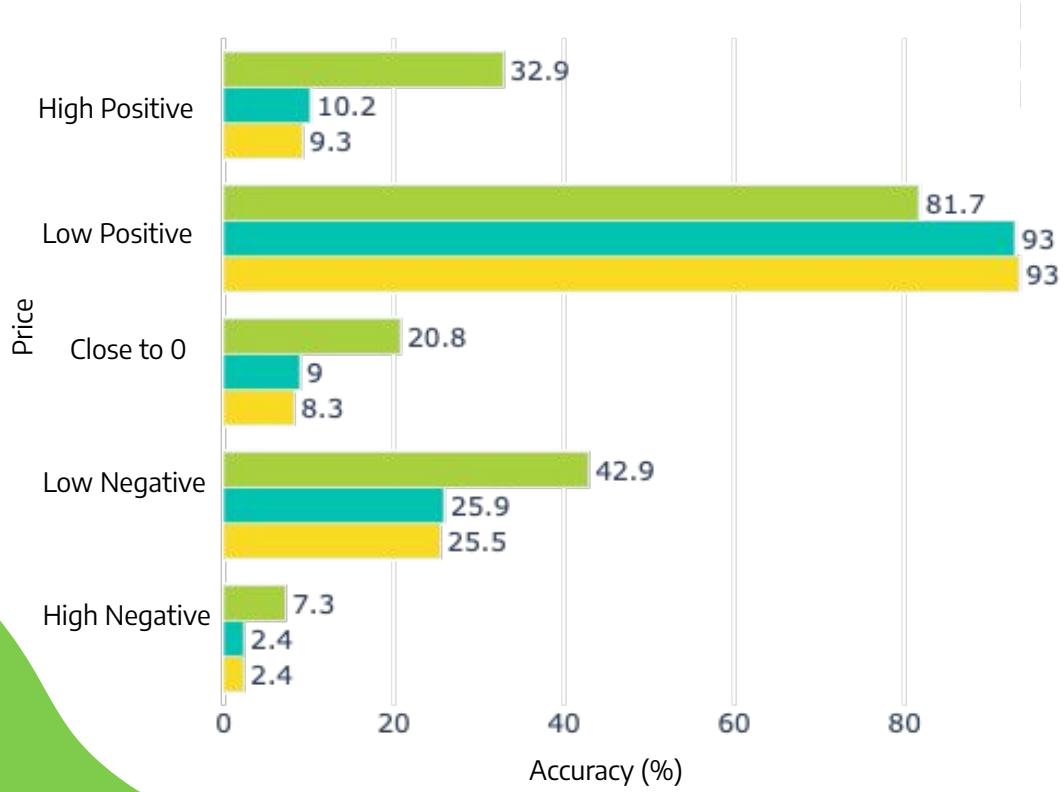
Final (SARIMA) Model :

Univariate : 1 Hour Forecast



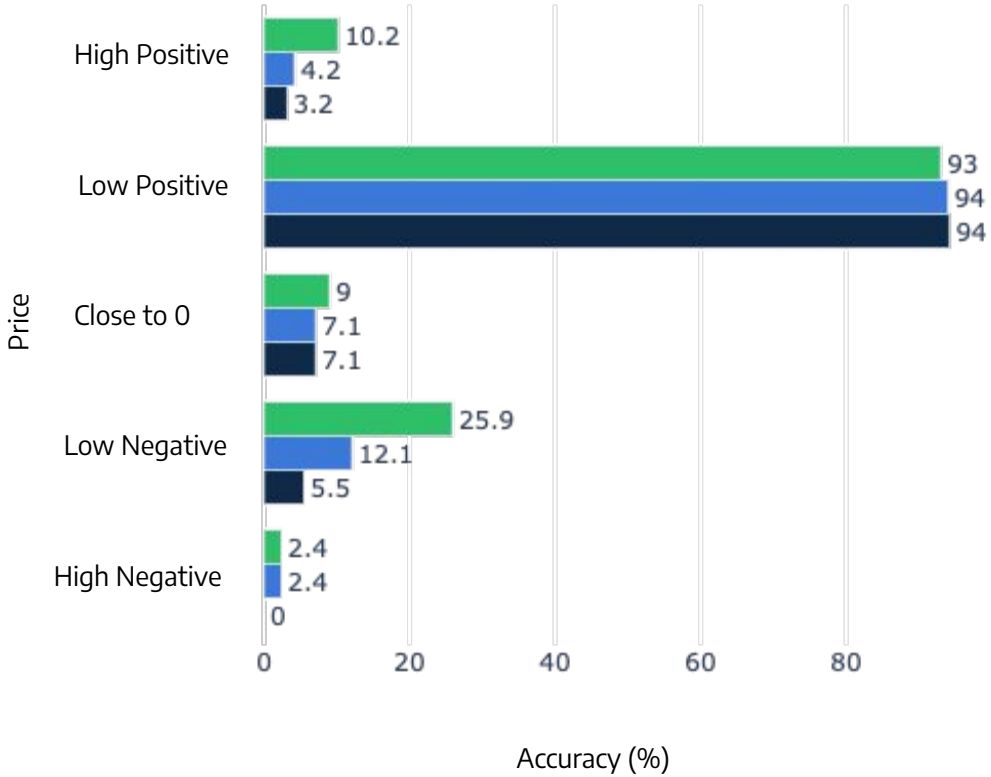
	Error (€/MWh)
Baseline	±60
Univariate	±50
Multivariate	±50

Comparison: 1 Hour Forecast



	Accuracy (%)
Baseline	37
Univariate	28
Multivariate	28

Model comparison over several time horizons



	Accuracy (%)
1 Hour	28
6 Hour	24
12 Hour	22

04
Conclusions & Outlook

Conclusions

- Complex problem
- Simple models already good for forecasting
- More advanced models: better performance at lower positive prices
- Comparable accuracy for longer time horizons
- Forecasting can be done quickly

Outlook

Use more complex algorithms (e.g. neural networks)

Further investigation on additional features

Tuning for other price segments

Thank you for your attention!

Aaron Holstein

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