Uncertainty of Energy Forecasts Conditioned on Grosswetterlage

Greta Denisenko[a], Detlef Siebert[b], Paul Seidler[b], Thomas Seidler[a], Dr. Markus Abel[a]

[a]4Cast GmbH & Co. KG, Potsdam; [b]SEtrade GmbH, Potsdam

Background/Motivation

4Cast performs short- and long term predictions for renewable energy (solar and wind). Customers of these forecasts need information about the uncertainty of forecasts to use it i.a. for trading and cost optimization.
Obtaining a quantitative measure for the uncertainty of forecasts for renewable energy has proven to be a challenging problem in the past.

Grosswetterlagen

As a measure for the general weather situation (Grosswetterlage) we use the objective weather situation classification of the German Weather Service (DWD). They sort into 40 weather situations based on

- Wind direction
- Cyclonality in 950 hPa and in 500 hPa
- Humidity of the atmosphere.

DWD offers the result of the classification over Germany daily, containing a 12-hourly forecast for the next three days and thereafter with daily resolution up to 7 days in the future.

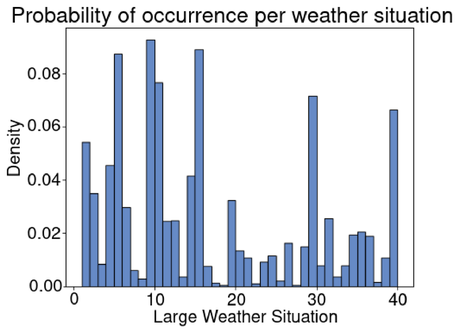

Figure 1:Histogram of the 40 Grosswetterlagen for the entire available timeseries since 1979.

Data

The following data is available from 1. May 2016 to 26. November 2020 for a solar park in Germany:

- Day-ahead energy forecast (15-min resolution)
- Actually produced energy (15-min resolution)
- Timeseries of weather classification (12-hourly resolution).

Methods and Results

We define five different metrics, derived from the difference between prediction and production. Those metrics are used as targets for machine learning (gradient boosting) with Grosswetterlage as the only feature. We obtain the following results:

- Measures for over- and underprediction conditioned on Großwetterlage
- Great variability of NMAE per Grosswetterlage
- Striking asymmetry of the error of under- and overestimation

Uncertainty depending on Grosswetterlage

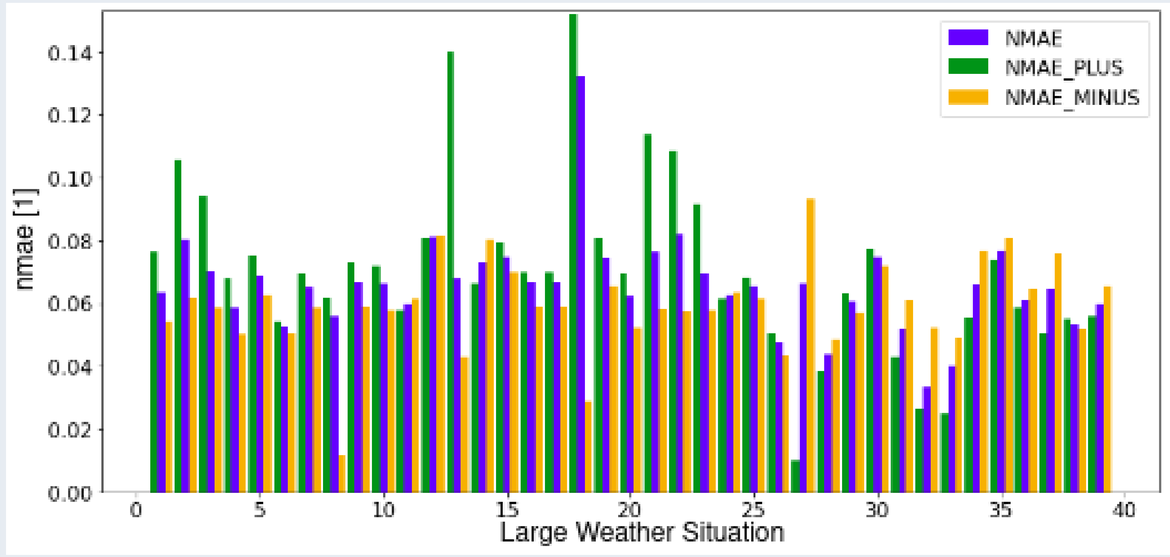

Figure 2:NMAE, $NMAE_{PLUS}$ (NMAE for overestimation) and $NMAE_{MINUS}$ (NMAE for underestimation) depending on the 40 weather situations.

Outlook/Coming soon

We consider this to be a very promising yet accessible approach to derive a quantitative measure for uncertainties based on the current, day-to-day weather situation. The uncertainty prediction could be further improved by:

- Adding more features like time of day, season and NAO index
- Rework the weather classification algorithm
- Consider Germany-wide forecasts to be able to draw conclusions about electricity trading prices.

Contact Information

- Web: https://4-cast.de/
- Email: greta.denisenko@4-cast.de
- Phone: +49 331 273 19 540

4cast SEtrade ENERGY REVOLUTION

Uncertainty of Energy Forecasts Conditioned on Grosswetterlage

Greta Denisenko[a], Detlef Siebert[b], Paul Seidler[b], Thomas Seidler[a], Dr. Markus Abel[a]

[a]4Cast GmbH & Co. KG, Potsdam; [b]SEtrade GmbH, Potsdam

Uncertainty depending on Grosswetterlage (part II)

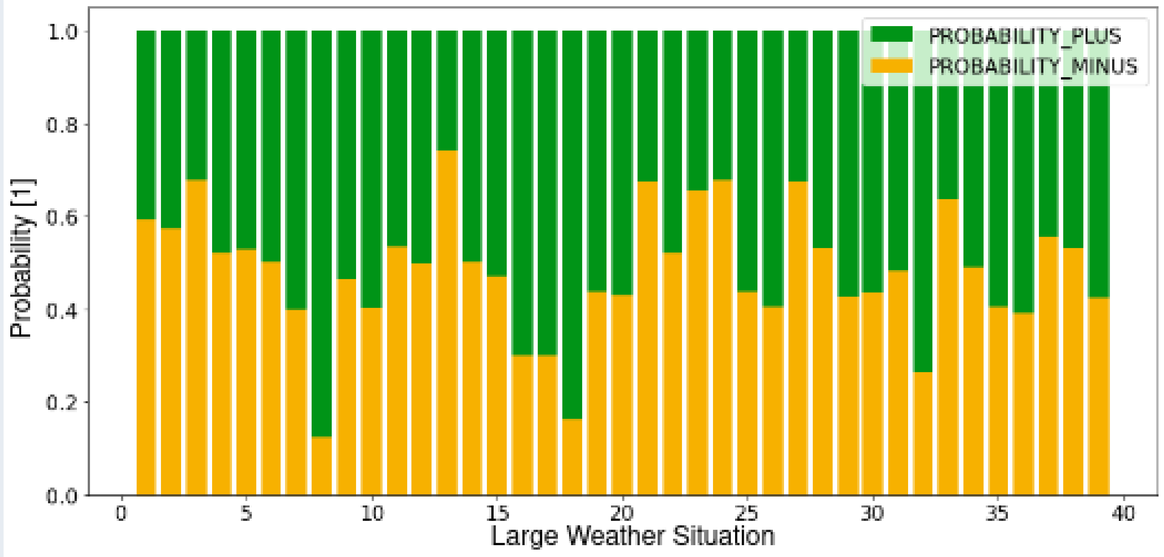

Figure 3:PROBABILITY$_{\text{PLUS}}$ (Probability for overestimation) and PROBABILITY$_{\text{MINUS}}$ (Probability for underestimation) depending on the 40 weather situations.

Prediction of Uncertainty

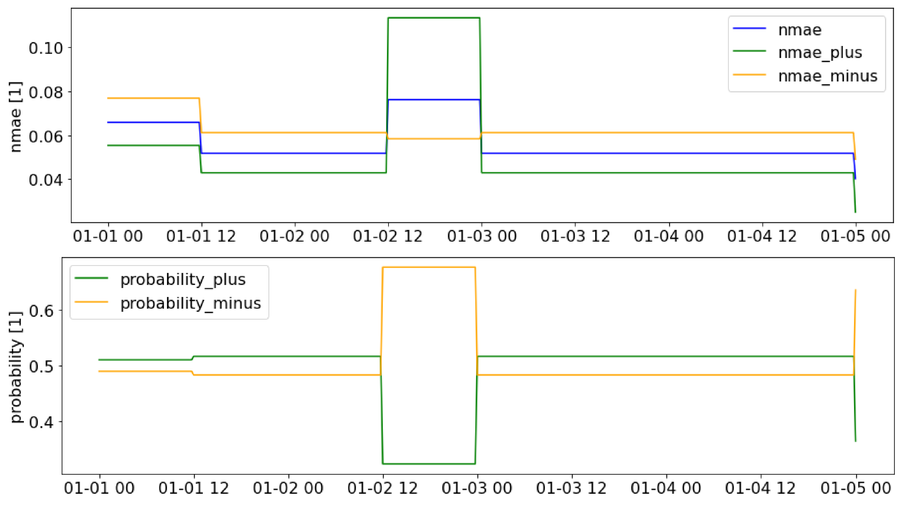

Figure 4:Exemplary prediction of the five error measures from 1.1.2021 to 5.1.2021. 12-hourly resolution becomes apparent.

Used Error Measures

1. NMAE: normalized mean absolute error
2. NMAE$_{\text{PLUS}}$: nmae for all times when the forecast overestimated production
3. NMAE$_{\text{MINUS}}$: nmae for all times when the forecast underestimated production
4. PROBABILITY$_{\text{PLUS}}$: frequency of times when the forecast overestimated production
5. PROBABILITY$_{\text{MINUS}}$: frequency of times when the forecast underestimated production

Transition Matrix

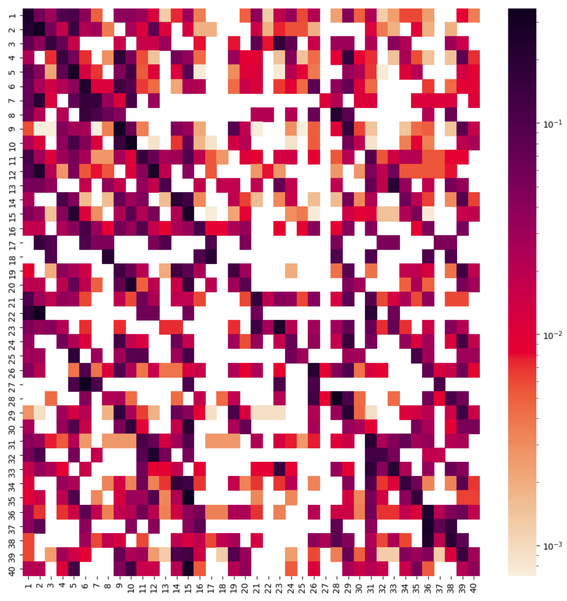

Figure 5:Matrix of transition probability between all 40 weather situations for the entire available timeseries since 1979.

The Transition of Grosswetterlagen to itself is probable. Many states have preferred predecessors and successors.