Extreme event risk mitigation in short-term energy trading by operational meteorological assessment

Stephan Späth
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2

Extreme Event Example: March 22nd, 2025

High wind / high solar situation, Sahara dust present over Germany, weekend, solar installed capacity not exactly known

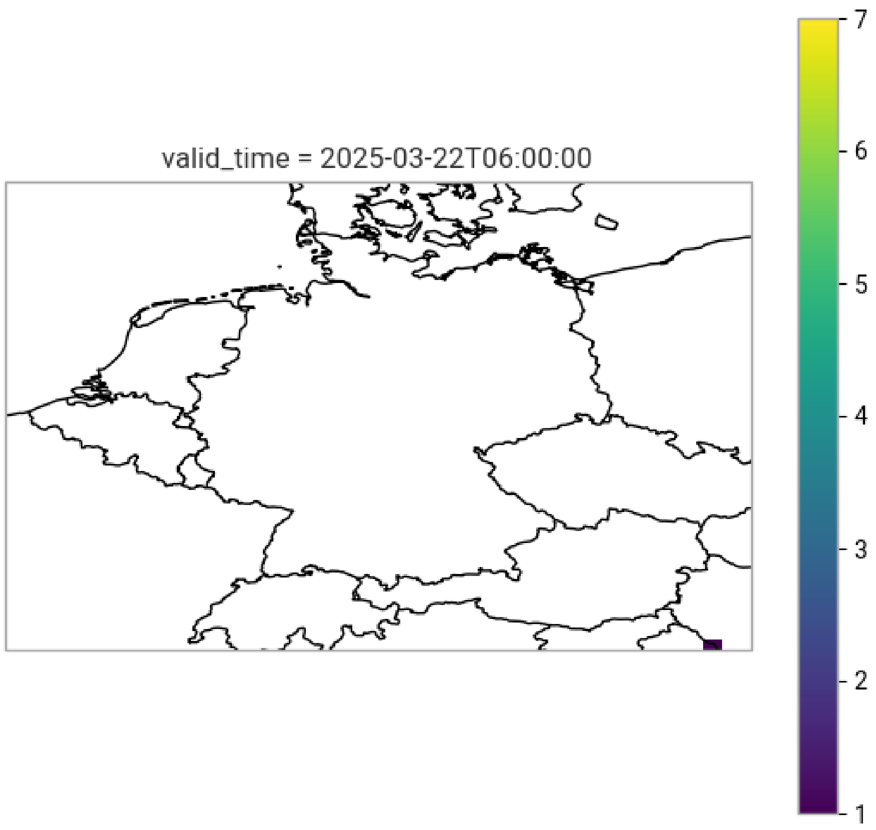
➔ Multiple critical situations at once

What's the impact of Sahara dust? Will it lead to development of opaque clouds? What do others (traders, meteorologists) think of this?

Assessment of a meteorologist:

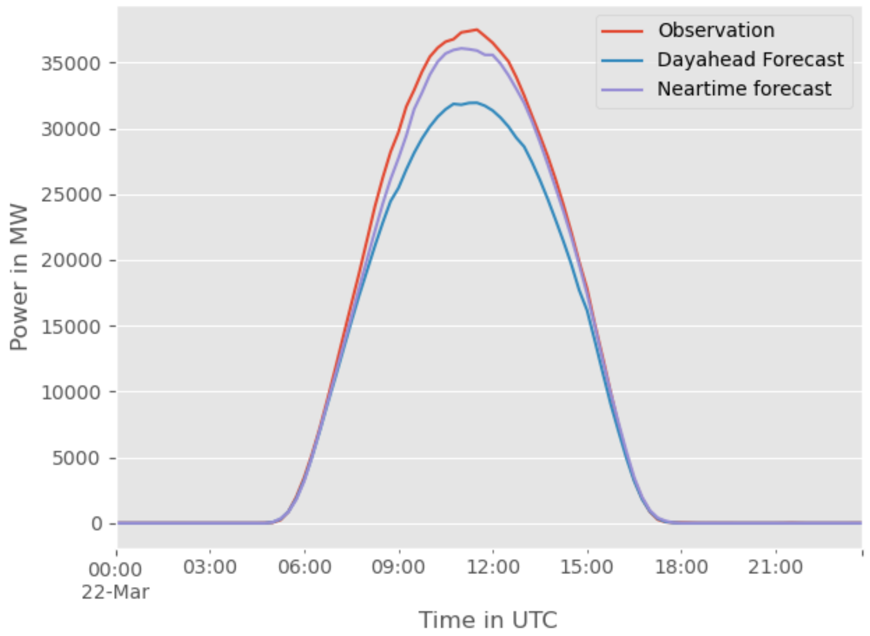
- General forecast error
- What's the impact of this particular Sahara dust outbreak? Will it impact our local market? What's the impact on solar forecasts?
- Impact of curtailments ?

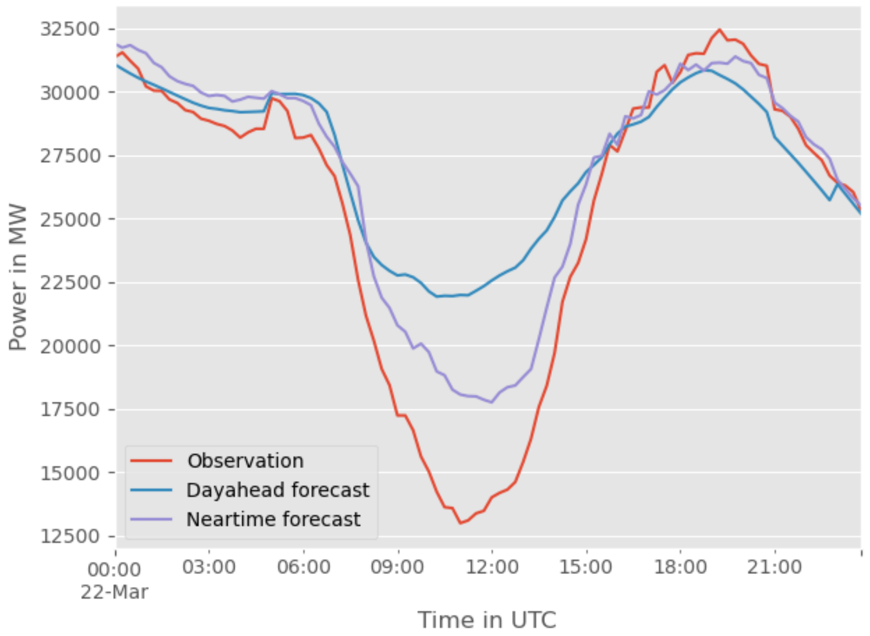
In-house Sahara dust cloud impact model showed no Sahara dust impact



3 What happened?

> March 22nd, 2025. German renewable output and forecasts (source: Entso-E)





More solar instead of less solar, no impact of Sahara dust at all, no export capacity

Huge wind curtailments (30 GW would have been possible all day).

➔ Balancing energy price of -3,300 €/MWh (7:30-7:45 UTC)

4 What is an extreme event in short-term power trading?

- Usually, renewable energy generation is sold in the dayahead market.
- Trading companies are responsible to balance the power generation.
- Whenever we have a perfect dayahead forecast, we have no problem and no risks.
- **For us, extreme events are always related to forecast errors that can cost a lot of money (price and volume risk).**

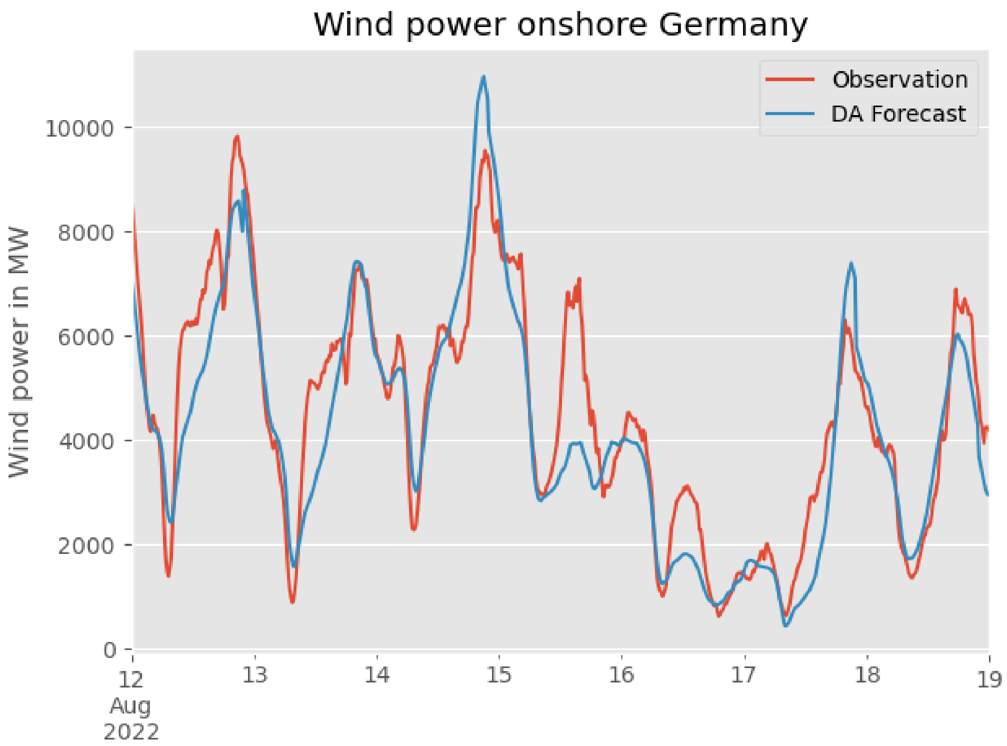
5 How to manage forecast errors and changes

- With updated model runs, the production volumes of our assets are steadily changing.

- Many market participants trade these changes fully automated and only have human supervision.

- Systematic errors in wind and solar power forecasts:
  - Icing
  - Fog
  - Sahara dust
  - Atmospheric boundary layer regimes and their diurnal cycles
  - Fronts, thunderstorms
  - Grid operator curtailments
  - ….

- Errors often happen during rare or unique events that cannot be ‚learned' by statistical methods.

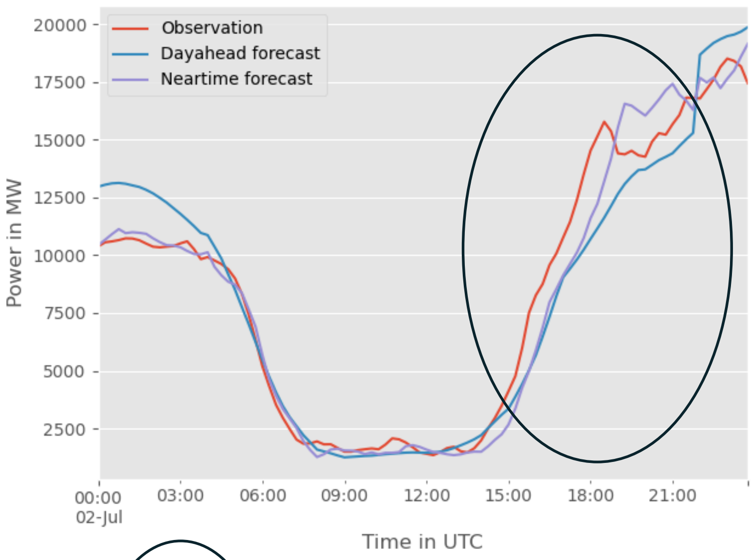


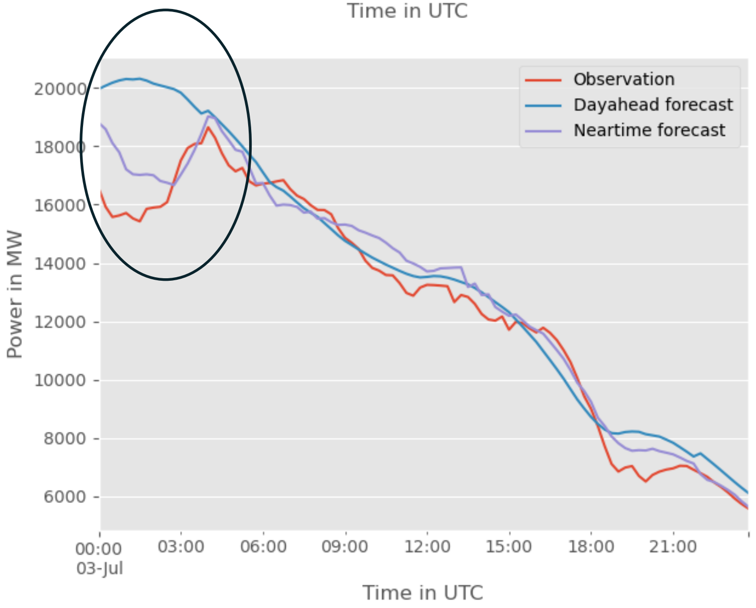
6 How can meteorologists help to manage risks?

- Many traders just look at prices and renewable forecast updates but have no clue of the current weather situation (e.g. satellite pictures, other maps) or have no meteorological advice

- Task of a meteorologist:
  - Forecasting the forecast error
  - communicate confidence of forecasts
  - identify risks
  - raise awareness

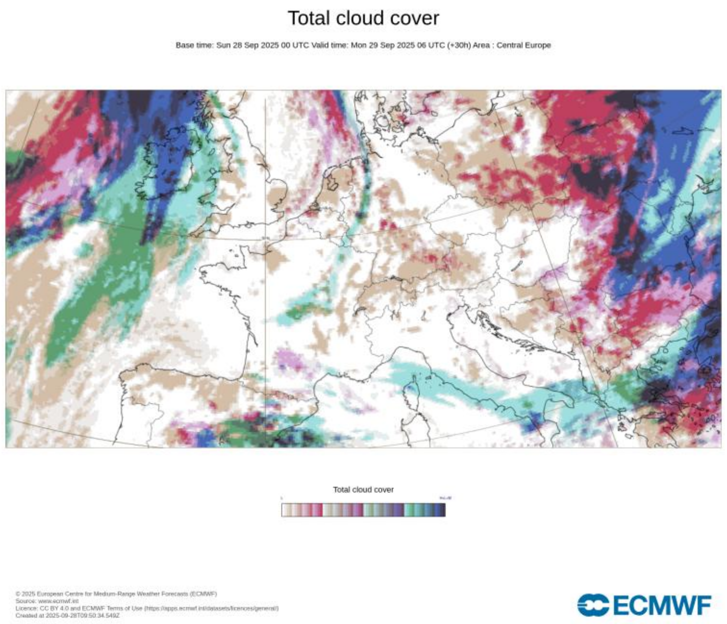
- Required knowledge:
  - Typical power forecasting problems
  - Energy markets
  - Synoptic Meteorology
  - Cloud Physics
  - Boundary Layer Meteorology

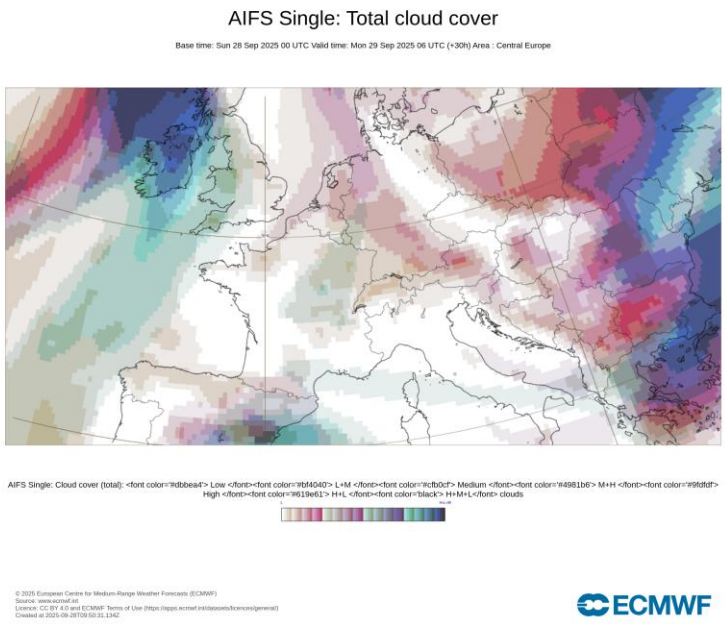


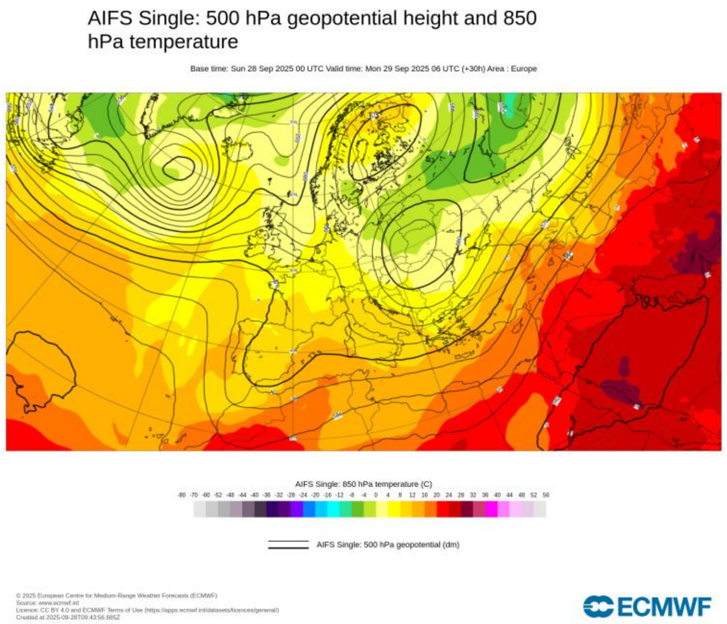


7 Regular forecast assessment

- Looking at standard synoptic maps
- Screening for special weather situations with known errors
- Checking and interpreting model differences

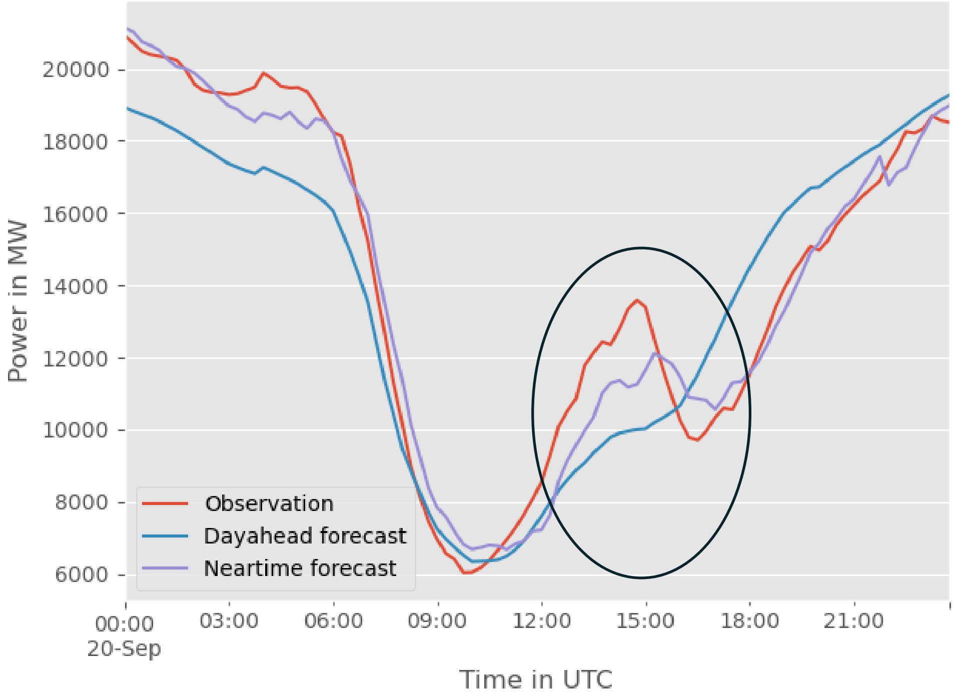


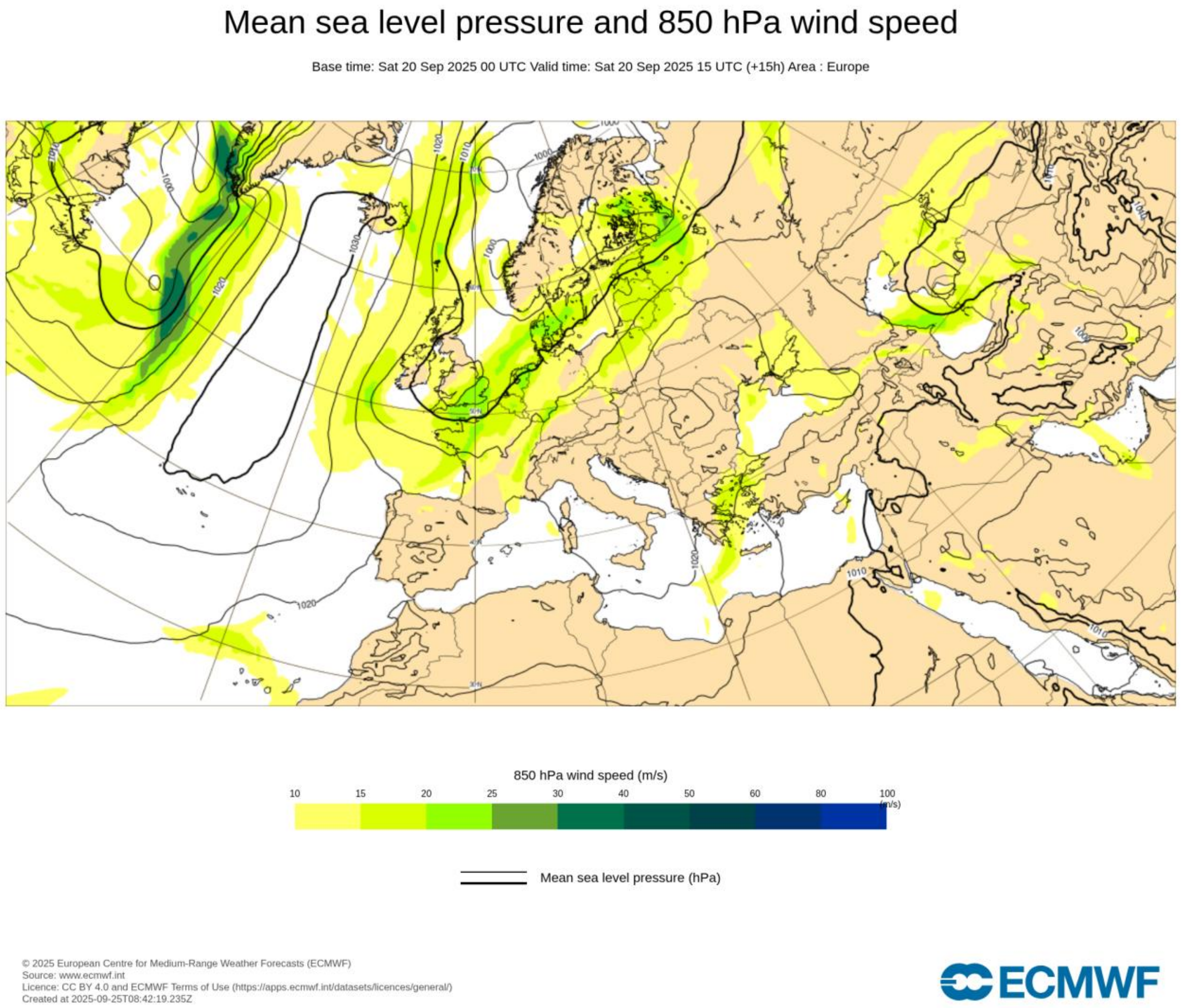




8 Recent example: September 20th

- Low-pressure influence in Northern Europe connected with high wind speeds over Northern Germany
- Wind power forecasting error

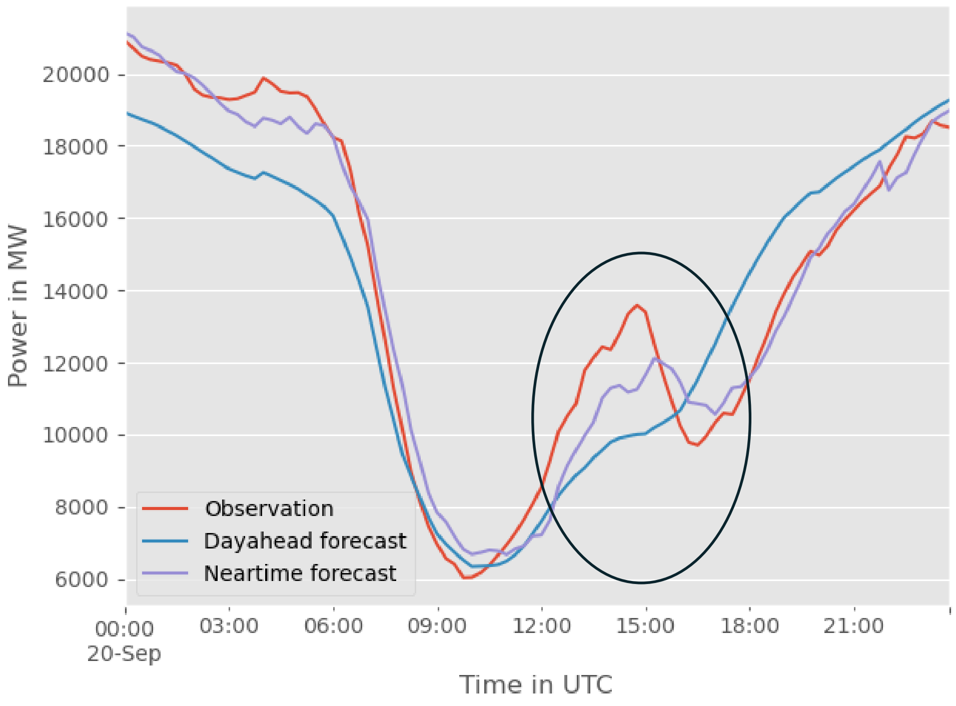




9 Recent example: September 20th

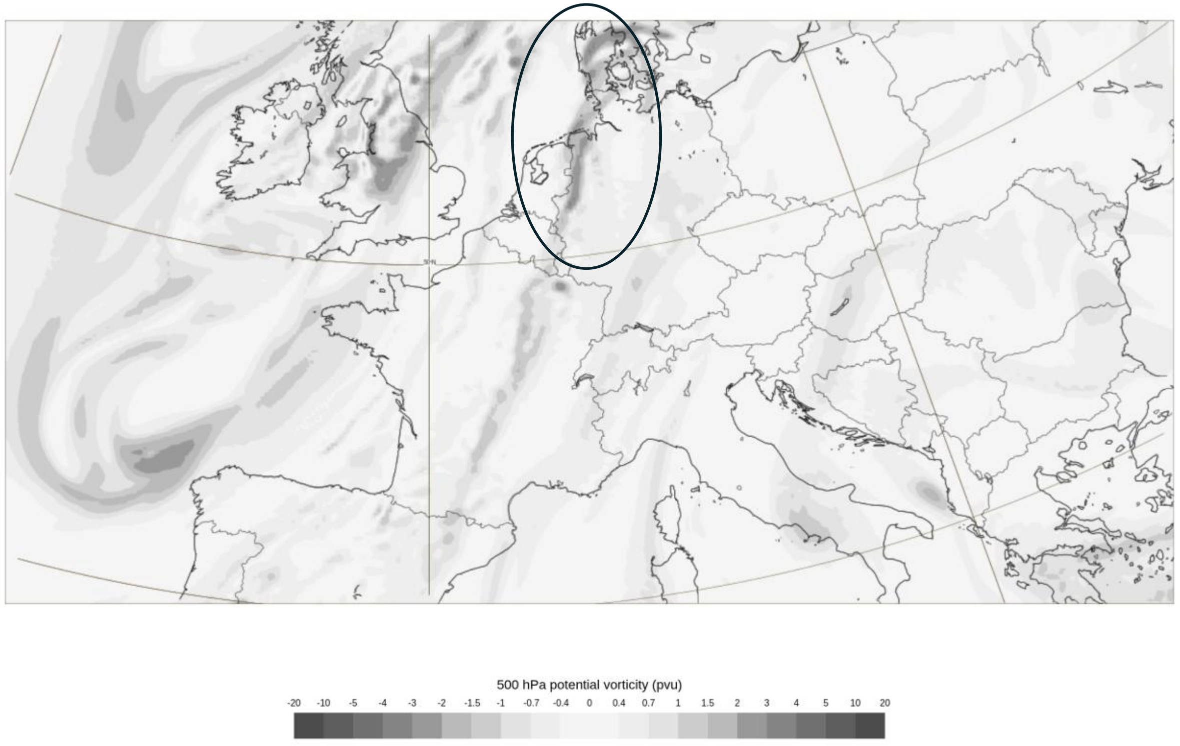
> Potential Vorticity analysis shows an anomaly over Northwestern Germany with rapid temporal changes

→ Low-level diabiatic processes in low pressure system



Potential vorticity at various pressure levels

Base time: Sat 20 Sep 2025 00 UTC Valid time: Sat 20 Sep 2025 18 UTC (+18h) Area : Central Europe Parameters : 500 hPa



10 Conclusion and Outlook

- Every forecast error can lead to extreme situations if other aspects are present (grid or power plant maintainance, cross-border capacities etc.).
- Routine meteorological assessment is necessary to understand the current situation and raise awareness
- Meteorological knowledge can give competitive advantage

- Financial risks will be more extreme in the future. With bigger volumes and more automisation, extreme events will have more impact.

Disclaimer: Power forecasts and observations were taken from ENTSO-E Transparency and all weather maps were taken from ECMWF Charts.

ANE GmbH & Co. KG

Stephan Späth,
Energy Meteorologist

Otto-Hahn-Straße 12-16
25813 Husum

E stephan.spaeth@ane.energy

www.ane.energy