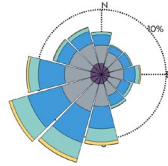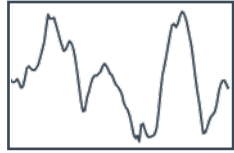# Time -series-based AEP calculations

Cutting out the middle man
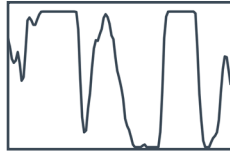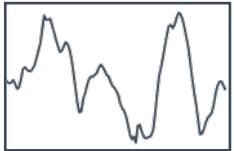
 → → Long-term AEP

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Örsted

Cutting out the middle man
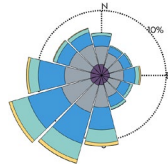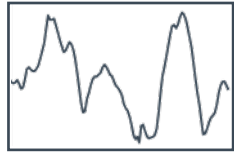
Long-term AEP

Long-term AEP
Revenue forecast
Commercial risk management
Model benchmarking
…
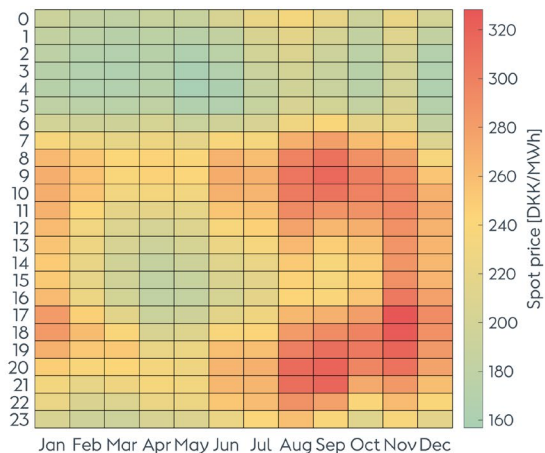
Örsted

Time (series) is money

Benjamin Franklin

From production forecast to revenue forecast
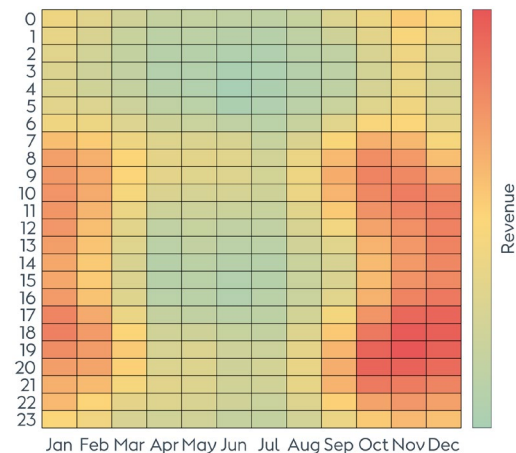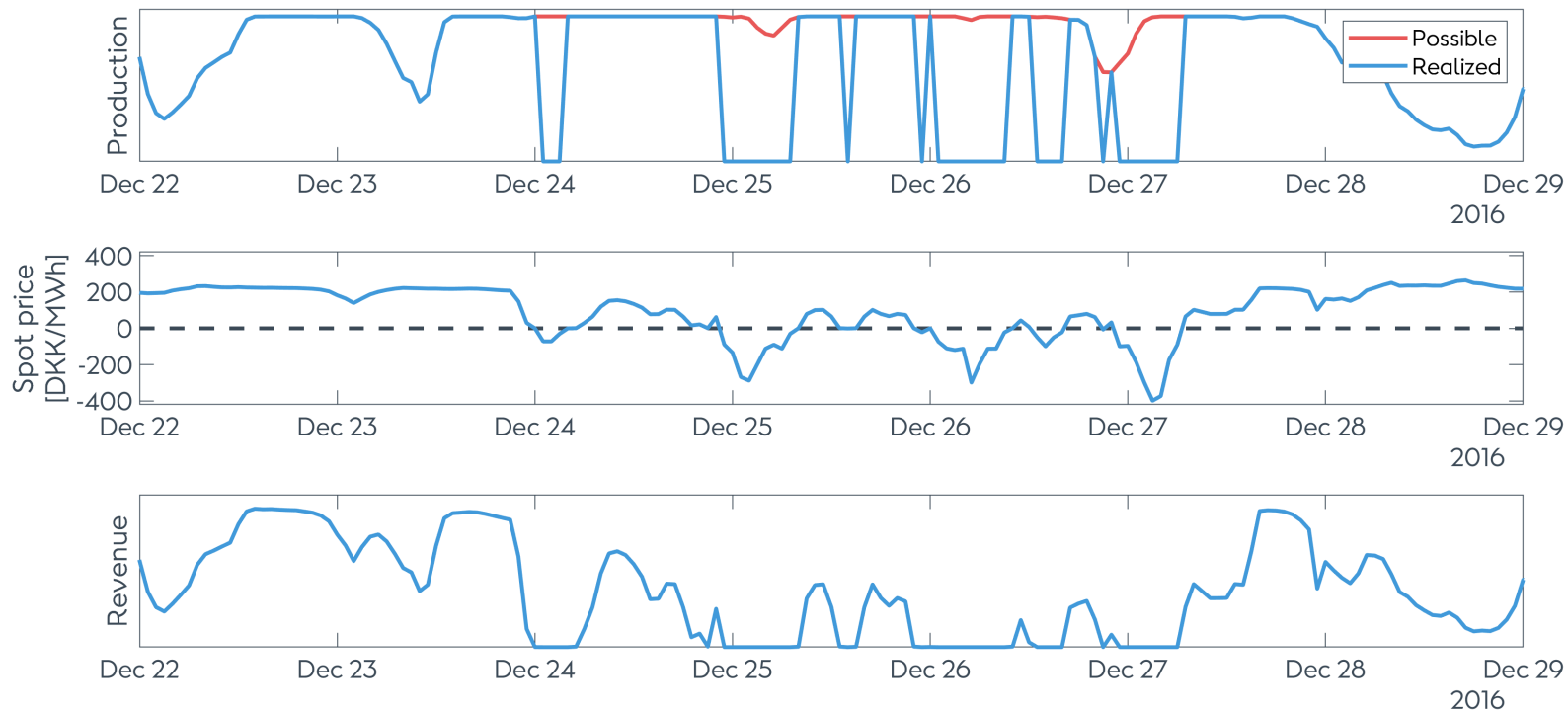

Mean production
hour x month

X

Mean electricity price
hour x month

=

Mean merchant revenue
hour x month

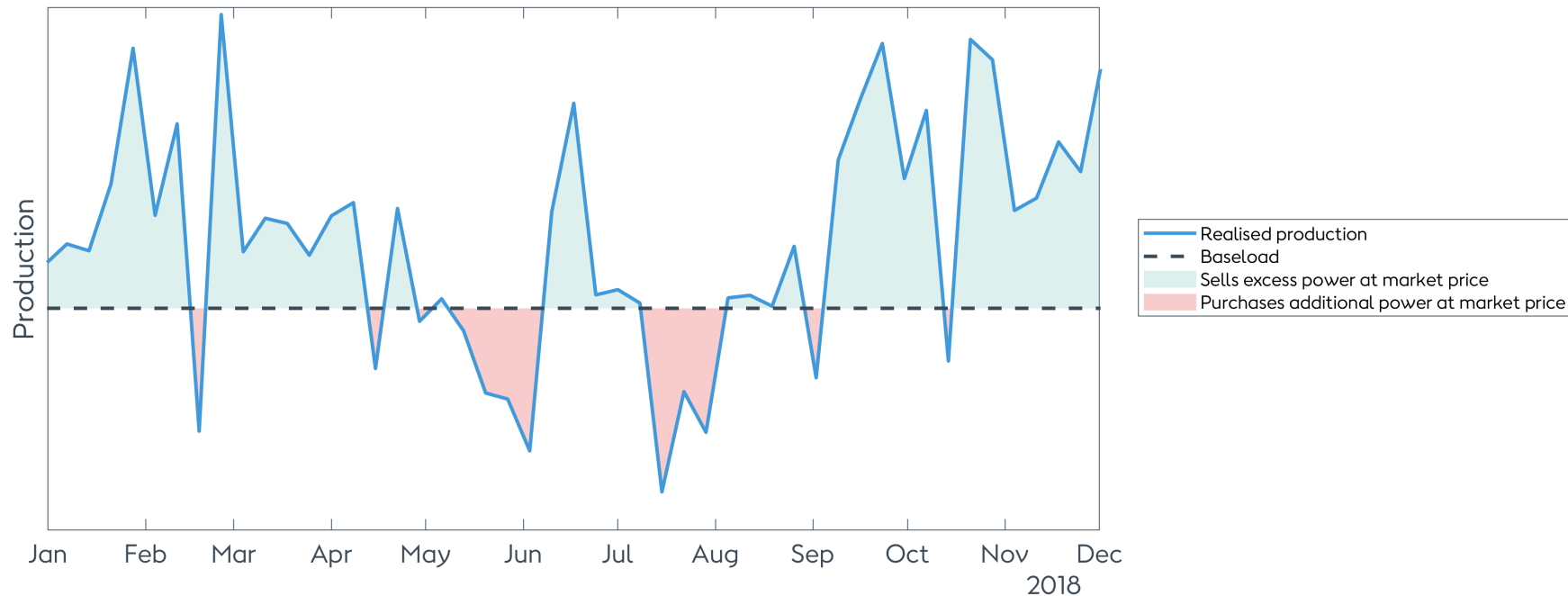Ørsted

Negative prices
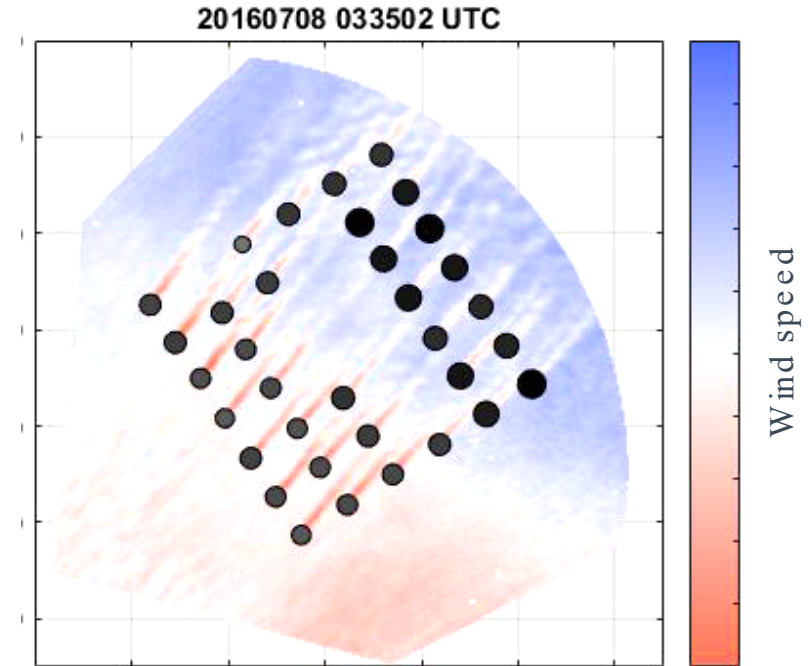
Corporate Power Purchase Agreements

Time (series) is the wisest counsellor of all

Pericles

The wind is dynamic

- Time series can capture the complex nature of the wind

- Meet increasing demand for granularity in business decisions and reporting

- Limited by level of details in
  - Modelling
  - Available model inputs

20160708 033502 UTC

Wind speed

Include more granularity

- Include additional physics

- Include time-dependence of air density, shear, turbulence, stability, …

- Accounts explicitly for correlations between variables
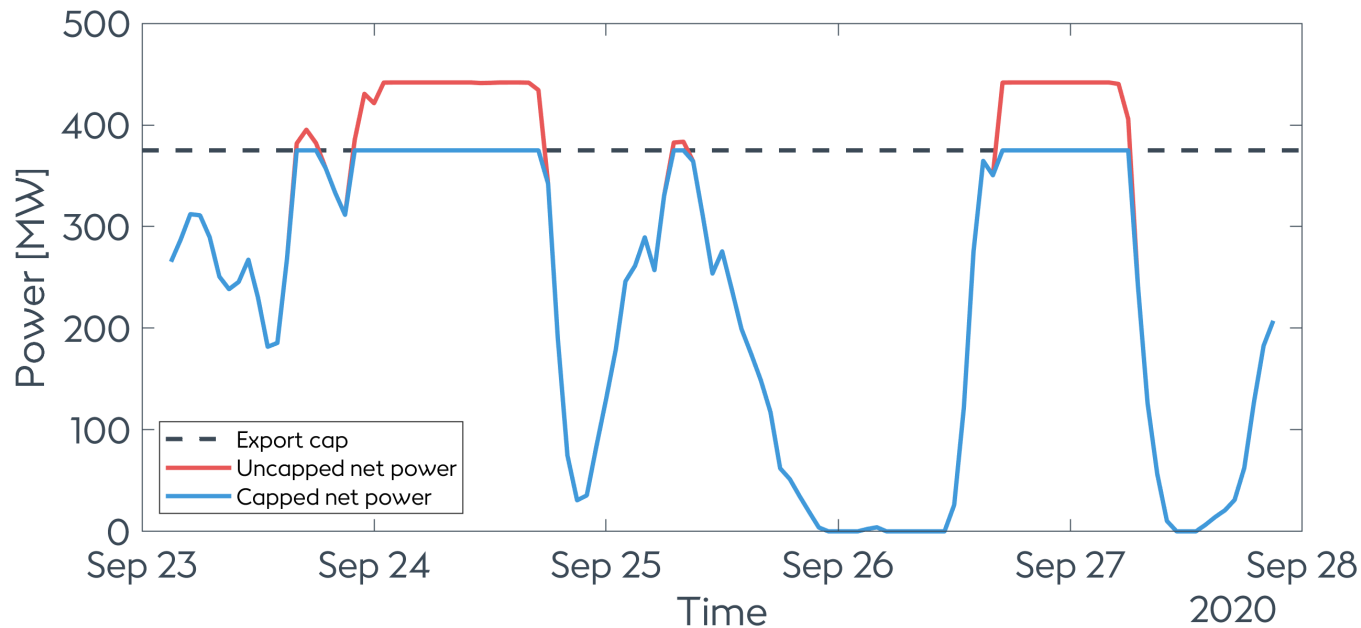
Ørsted
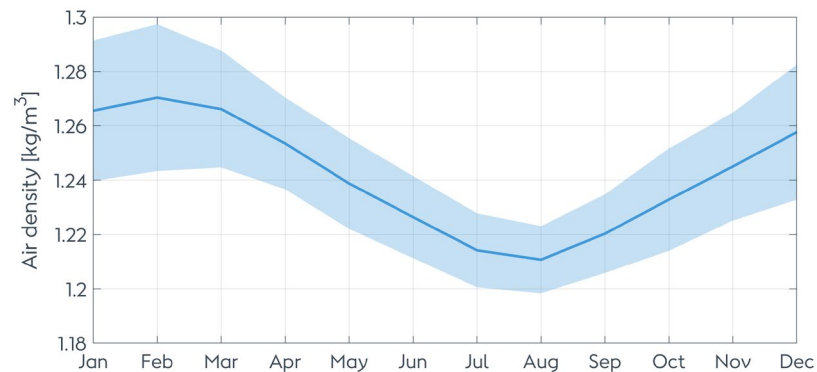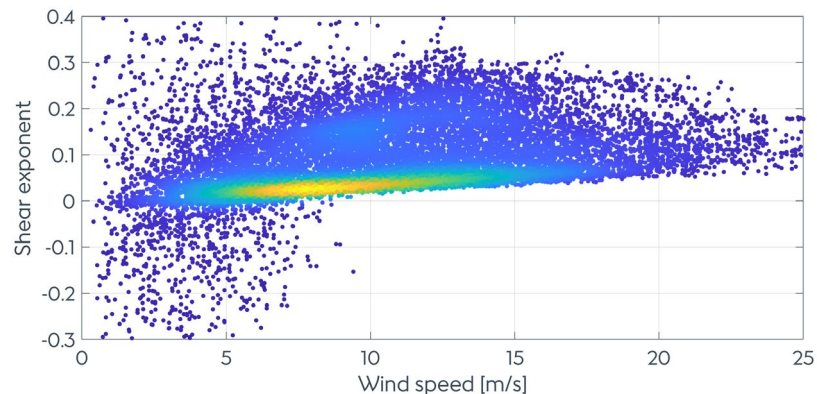
Seasonality in measured power curve

- Power performance measured continuously

- Density correction applied

- Power curves created in moving time window

- AEP variation using fixed wind speed distribution

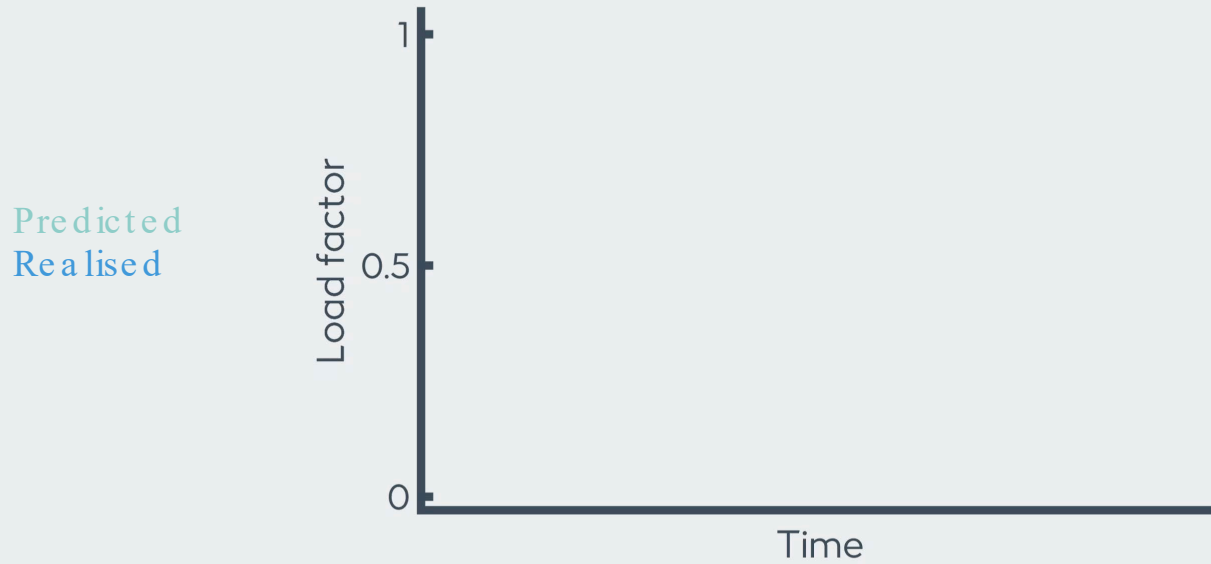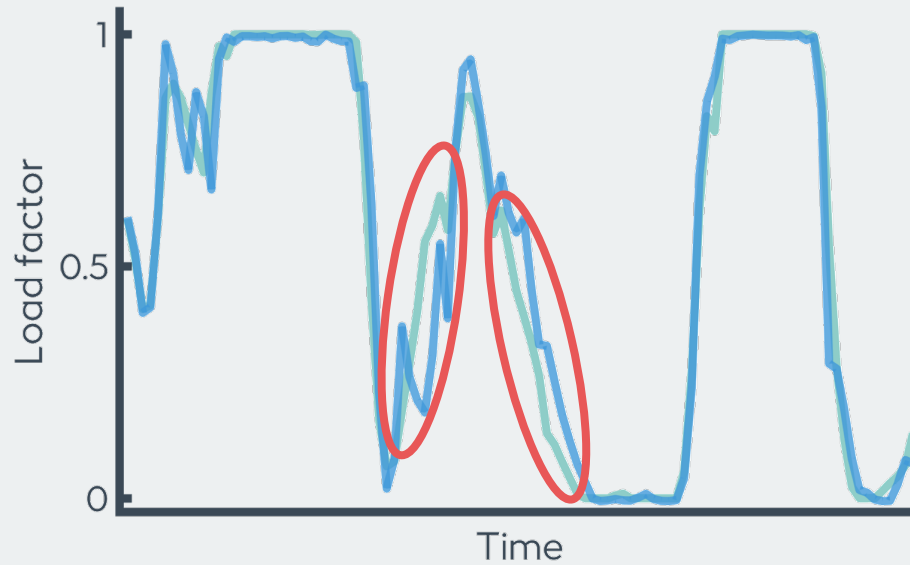**Seasonal Variation in AEP**
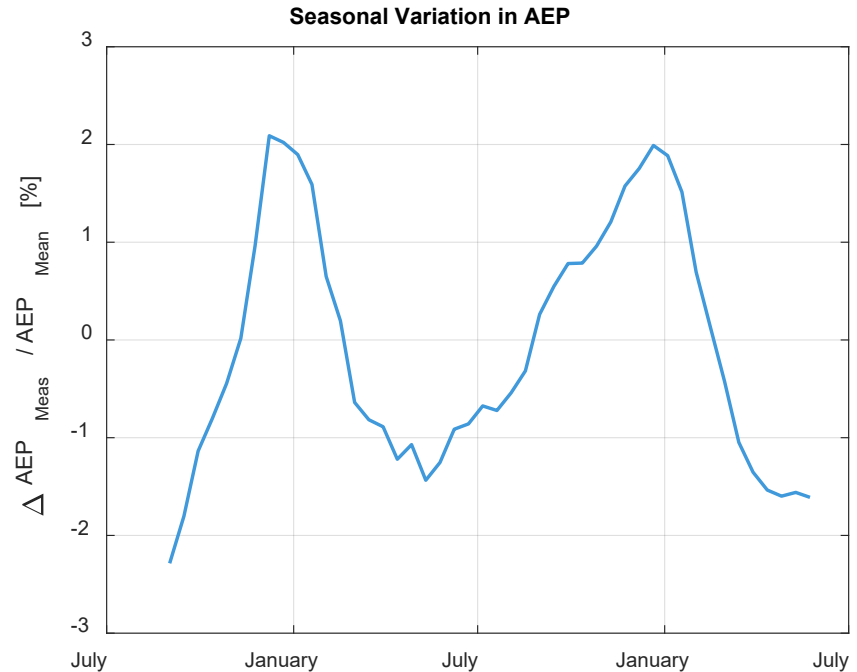
Handling curtailments

- **Export capacity curtailment**

- Hierarchy of curtailments

- Dynamic cable rating

Ørsted
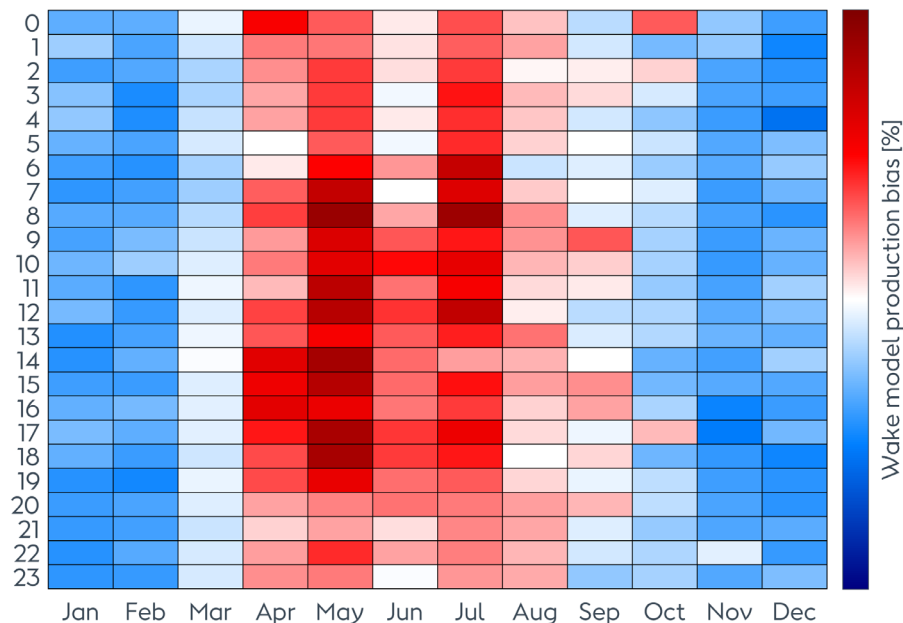
Comparing predictions with realised production

Predicted
Realised

Load factor

Time

Comparing predictions with realised production

Predicted
Realised

Load factor

1

0.5

0

Time

Understand details of model over- and underestimation

Seasonal model bias

For illustration purposes only

- Comparing modelled and measured waked power

- Model overestimates power in the spring/summer

- Model underestimates power in the fall/winter

- Understanding the seasonal pattern can help improve the model and reduce the bias
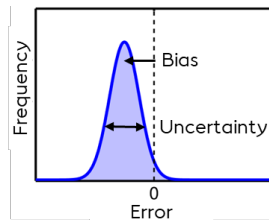
Örsted

Time (series) waits for no one

Folklore

Production uncertainty (illustrative)

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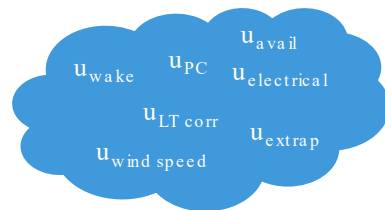
Ørsted
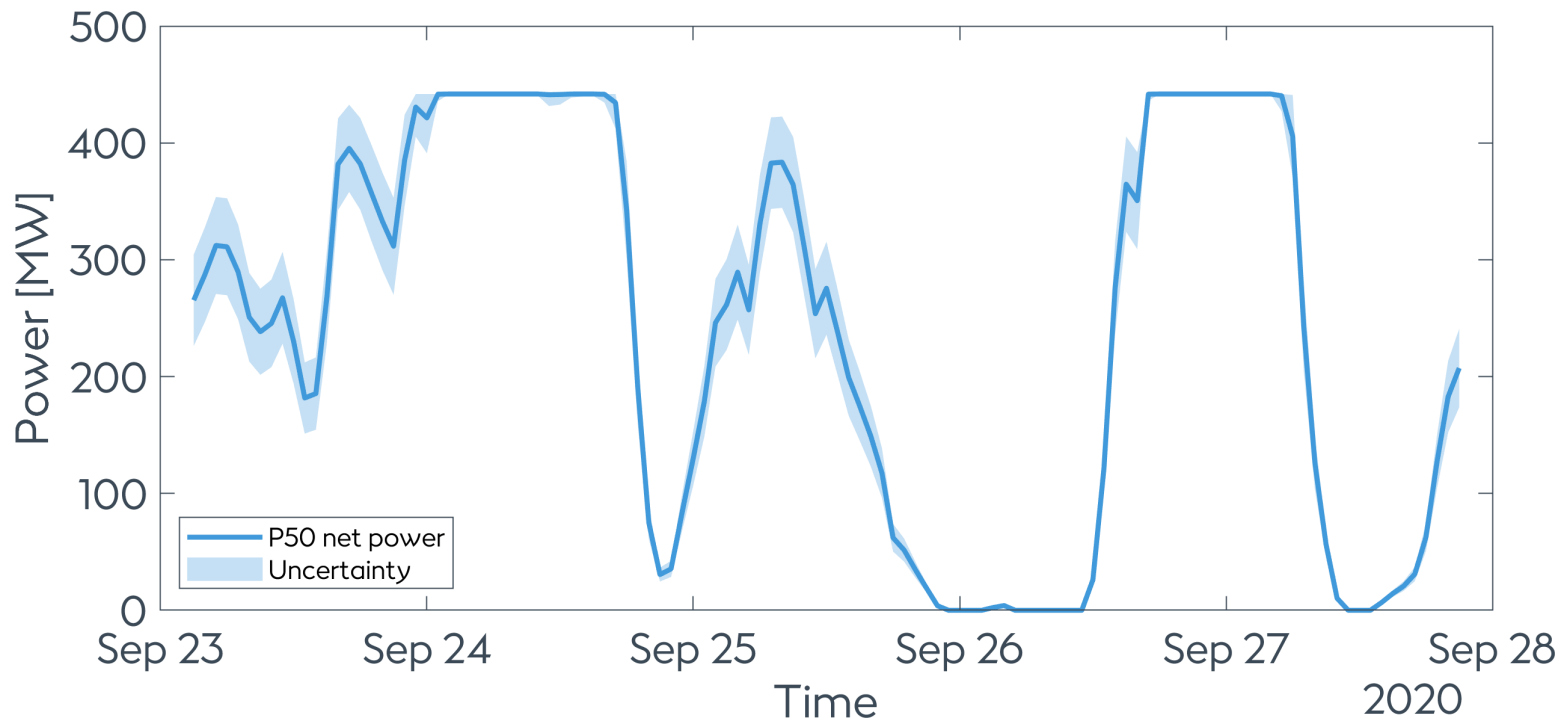
Production uncertainty issues

Assessing model uncertainty

- Distribution of model errors
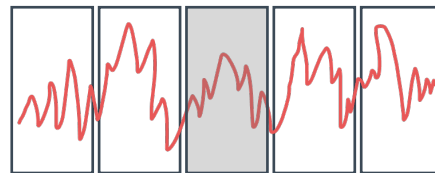- Binned on power?
- Assessed for each model component?

Finding the uncertainty at each time step (each turbine?)

- Accounting for uncertainty of inflow parameters
- Accounting for model uncertainties

Aggregating the uncertainty across time series

- Accounting for time series auto-correlation

Other production time series issues to solve

Dynamic losses

- Site-specific power curve corrections
- Availabilities
- Electrical losses

Mesoscale

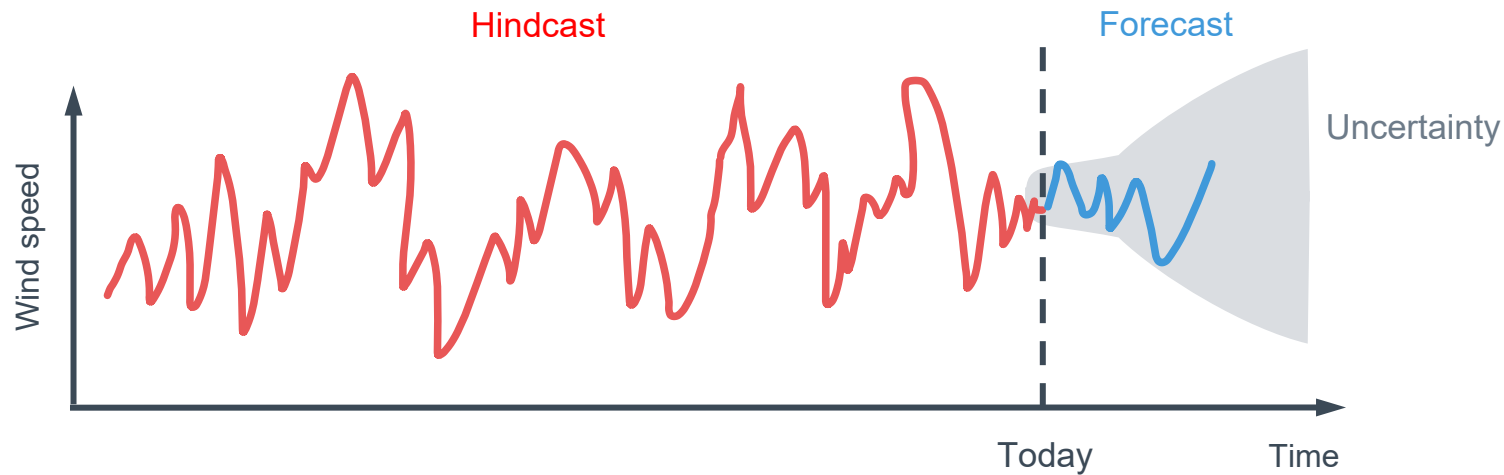- Capturing full wind speed variability
- Correcting phase errors

Long-term time series

- Representativity
- Consistency

Örsted

All we have to do is decide what to do with the time (series) that is given us

Gandalf the Grey

Seamless time series

Same production model produces hindcast, forecast and long   -term AEP

Ørsted