Benefits of Probabilistic Forecasting in Power Trading

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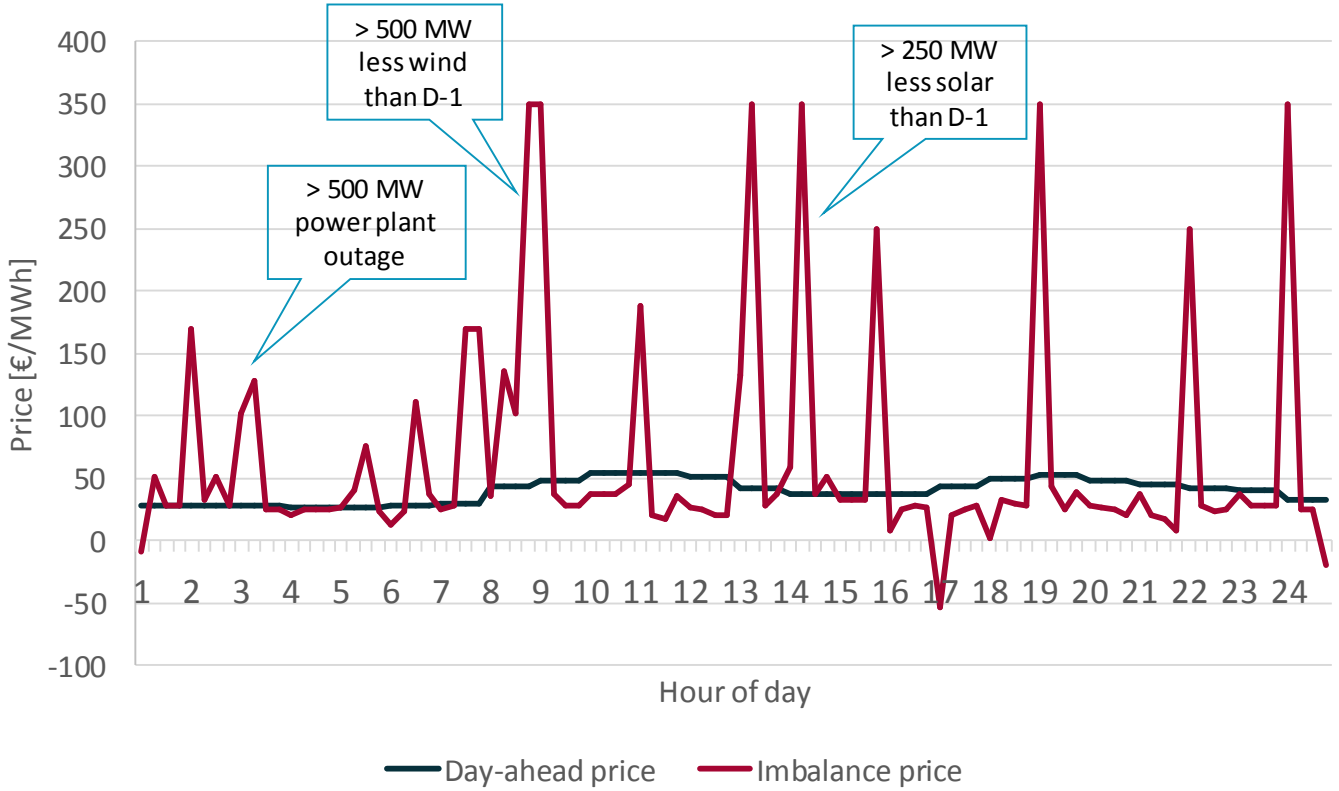
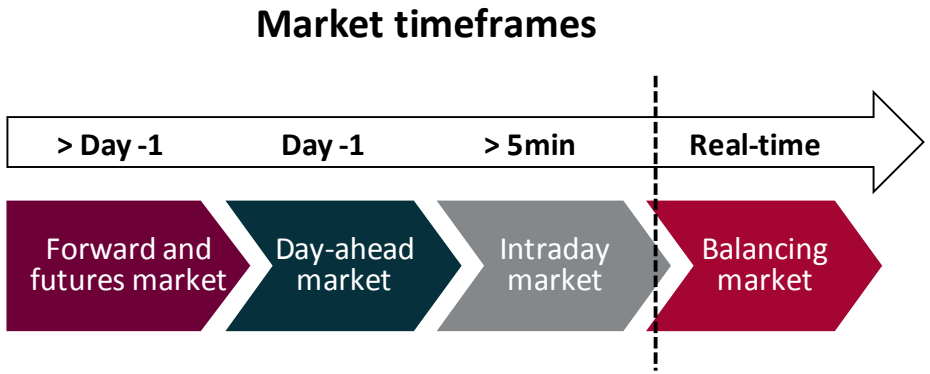
Day-ahead price vs. imbalance price

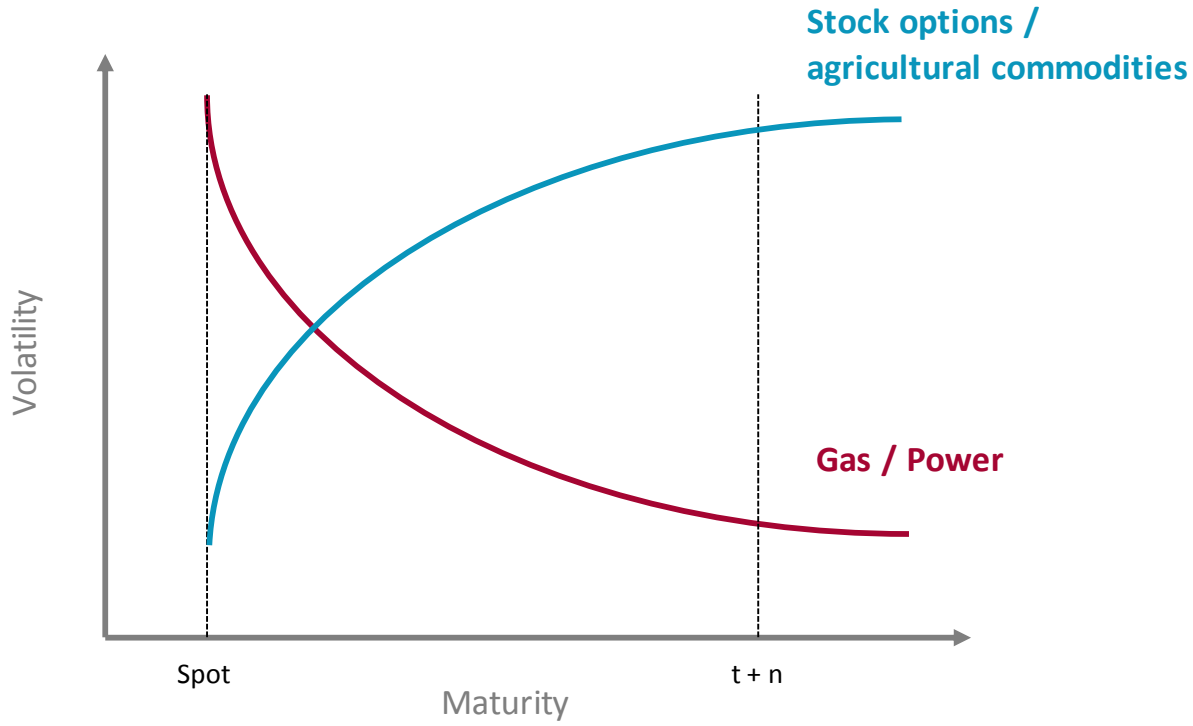
In The Netherlands on the 10th of January, 2020





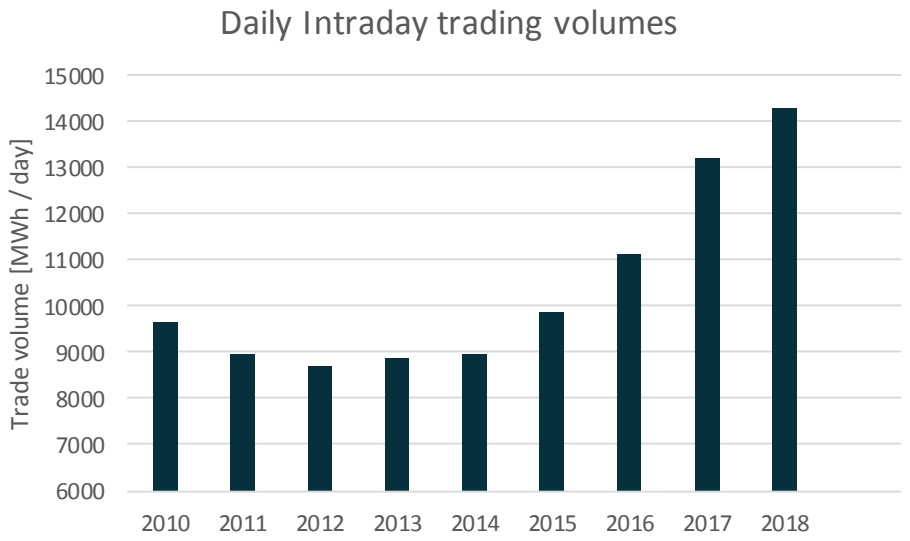
Price uncertainty in power markets

Volatility evolution



Developments in short-term energy markets

Intraday power market trends



Main findings (3/3)

Larger imbalance volumes and higher balancing capacity prices.

Intraday prices

In 2018: larger differences between DA and ID prices

Intraday trading volumes

Renewables growth and XBID go-live contributed to the further increase of intraday market volumes

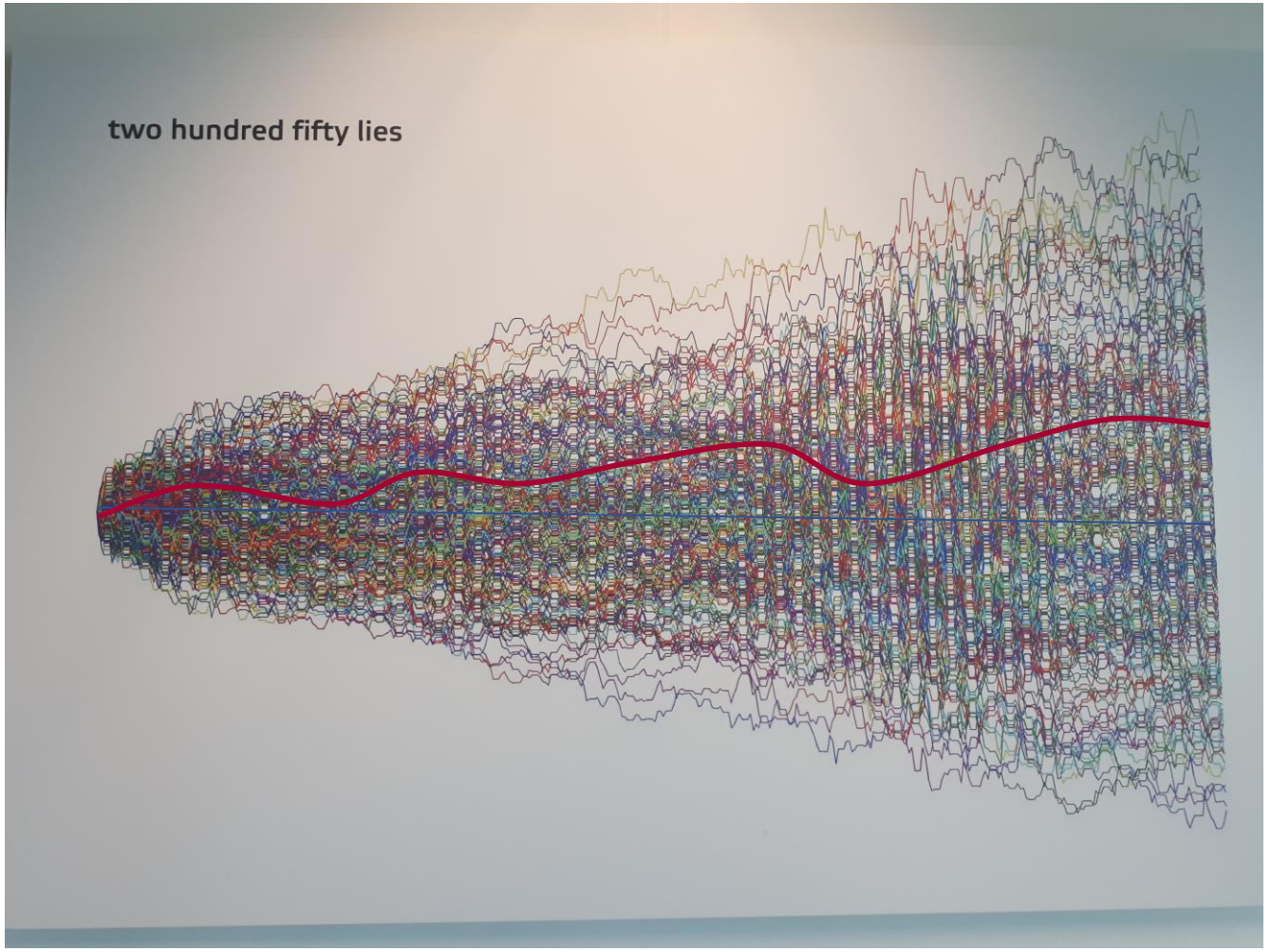
Net imbalance volumes NL

Trend of larger imbalance volumes continues

› epexspot

The short-term power market in **the Netherlands** reached a combined 38.7 TWh (2018: 39.5), with a 55.7% growth rate on the Intraday marked which reached 3.3 TWh (2018: 2.1 TWh).

How to manage the uncertainty?



Common approach:
Mean absolute or mean squared error optimized point-forecast

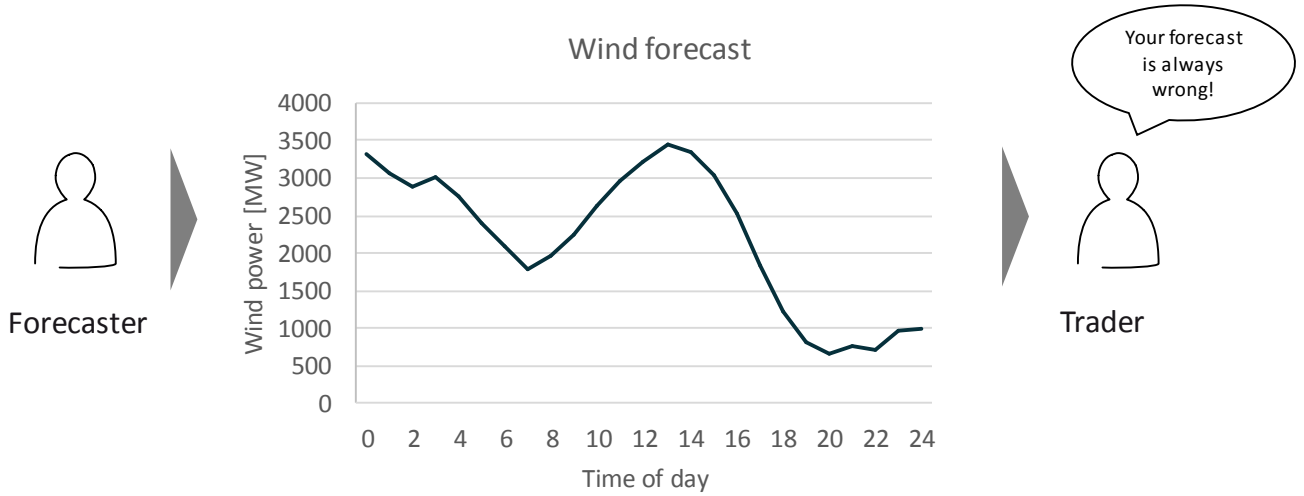
How to manage the uncertainty?

Misconceptions:

- Point-forecasts are often given too much confidence
  - "Your forecast is always wrong" implies the expectation that the forecast needs to be "right"
- The measures of forecast error, whether it be MAPE, WMAPE, MAE, RMSE or any similar metric, all assume that the perfect forecast can be expressed as a single number

How can we do better?

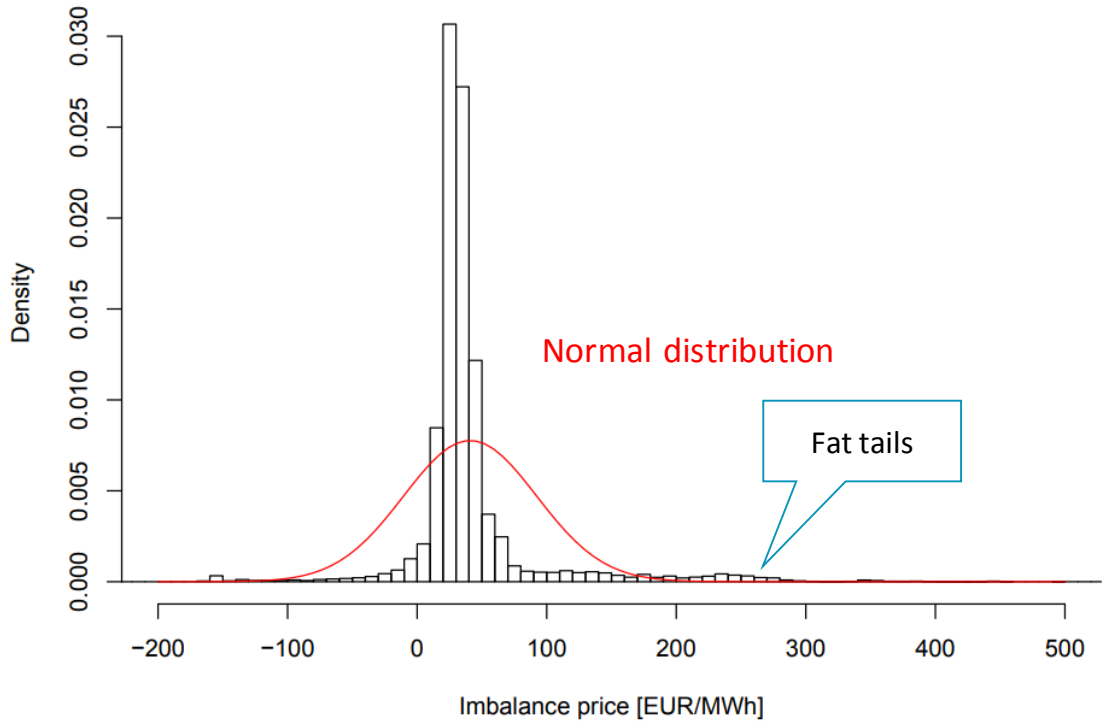
- Transparency
  - No "black box" models
  - What is the Input/output data?
- Uncertainty
  - While we can't predict wind power production perfectly due to its inherent weather variability, we can predict the weather variability
  - Maximizing the likelihood of a correct prediction rather than minimizing the imbalance / variance



Volume ≠ Value

- Forecasts optimized on error metrics like MAE, RMSE aim to reduce the imbalance volume / the variance
- When selling 1 MW throughout whole 2019 in the Dutch Imbalance Market, **50%** of the profit is generated **in just 20% of the time**
- Imbalance price distribution is asymmetrical
  - Mean = 40.87 EUR
  - Median = 31.46 EUR
- Imbalance price distribution has fat tails -> the extreme values have the biggest impact

Dutch imbalance prices in 2019



Volume ≠ Value

"…'If you go out in the evening with a shotgun and see two flocks of ducks, and you aim for the least-squares location, you will go home hungry' Miller says. The maximum-likelihood approach is to aim for one of the flocks instead..."

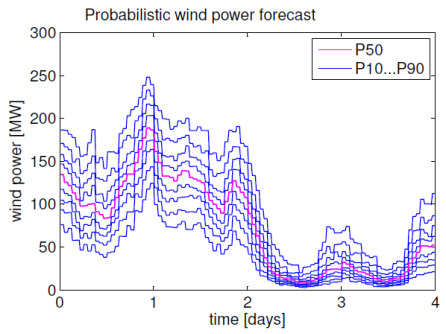
Source: "Ensemble Kalman Filters Bring Weather Models Up to Date", Dana Mackenzie, SIAM News, Volume 36, Number 8, October 2003

Probabilistic forecasting methods

Physical

- Numerical weather prediction ensembles

e.g. ECMWF ensemble forecast:



- Uncalibrated
- Not valid for very short-term

Statistical

Estimation of quantiles

- Quantile regression
  - No assumptions about the distribution of the residuals

- Preventing quantile crossing can become difficult

Prediction intervals

- Range of coverage probabilities assuming normally distributed forecast errors

- Uncertainty expressed in one number
- Symmetric distribution

Full density functions

- Parametric
  - E.g. process is assumed to be Gaussian
- Non-parametric
  - Kernel density estimation
  - Analog Ensembles
  - Bayesian methods

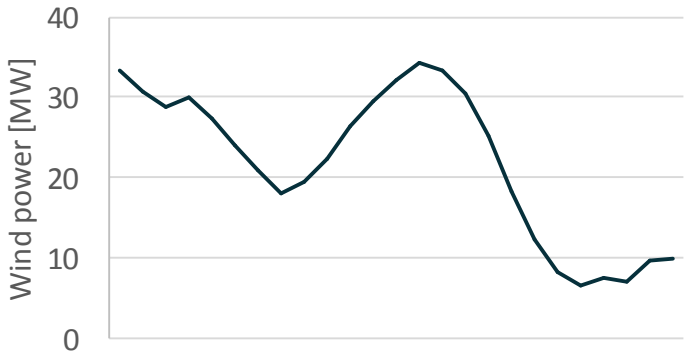
- Can be computationally expensive

Probabilistic forecasting methods

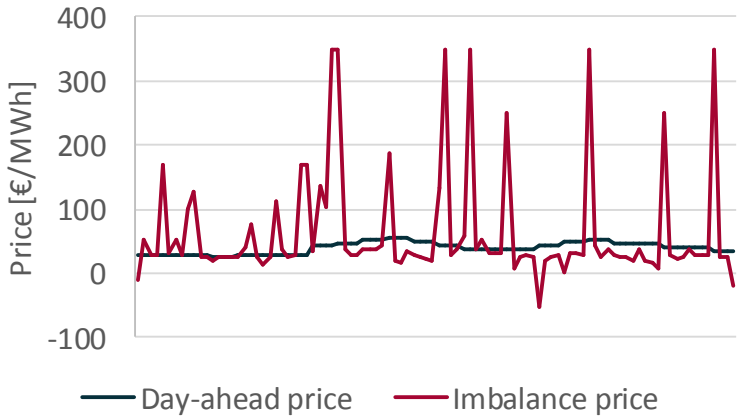
Optimized bids of a Belgium Wind farm using stochastic optimization models

Input data:

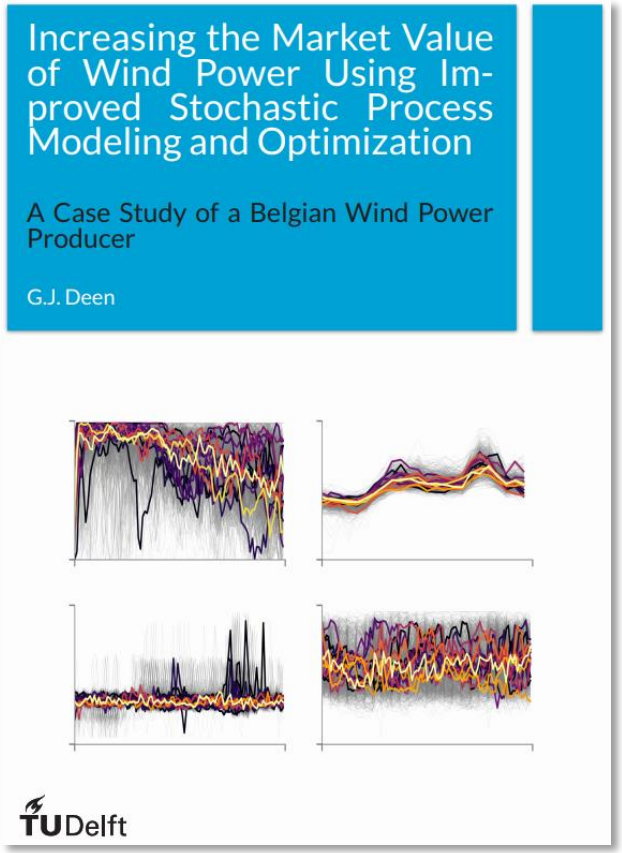
Day-ahead wind power forecast



Day-ahead & imbalance prices



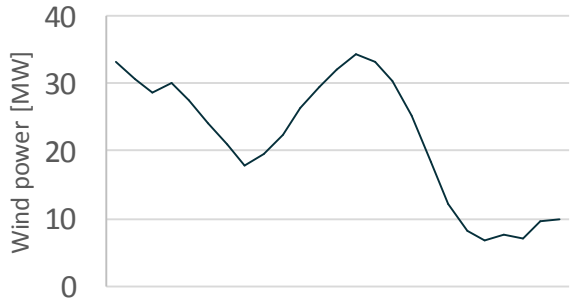
Gerrit Deen
Researcher at Whiffle



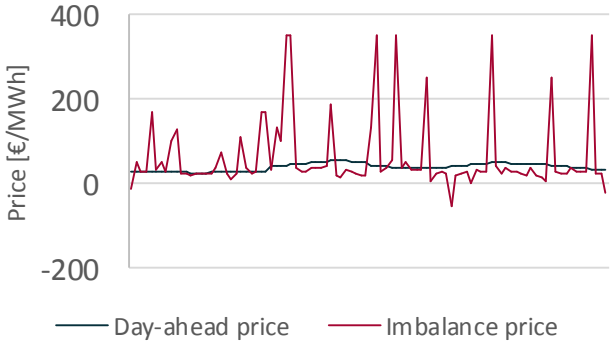
Stochastic Process Modeling

Approach: model forecast errors as stochastic processes using conditional Kernel Density (CKD) estimation

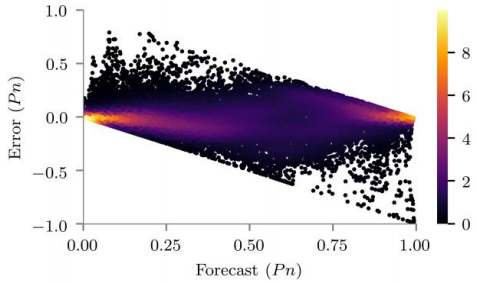
Day-ahead wind power forecast



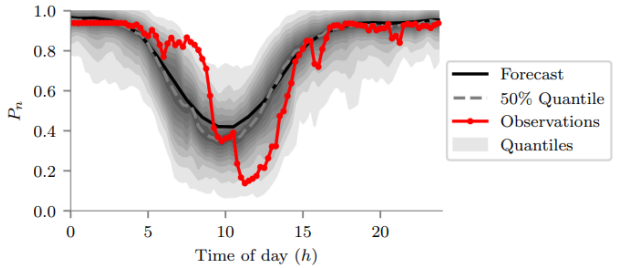
Day-ahead & imbalance prices



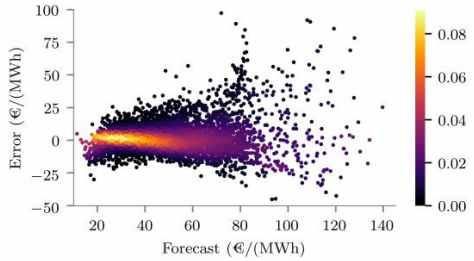
CKD wind forecast error vs. load factor



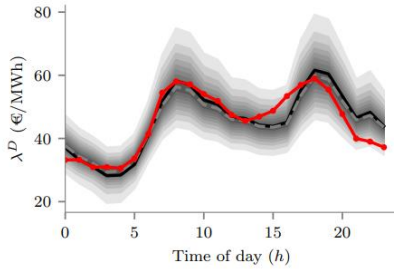
Quantile wind forecast



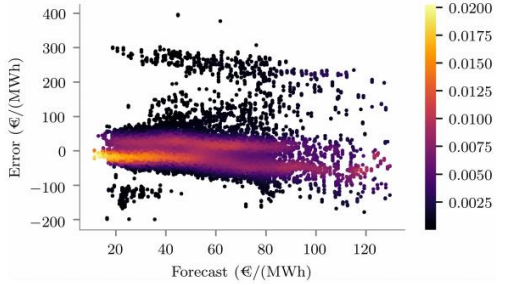
CKD D-1 price forecast error vs. price



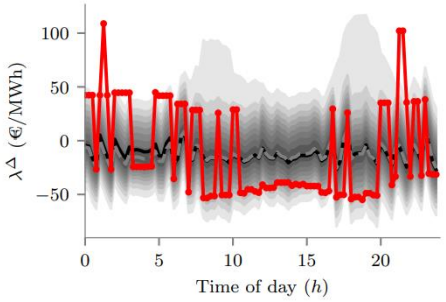
Quantile D-1 price forecast



CKD imbalance price forecast error vs. price



Quantile imbalance price forecast

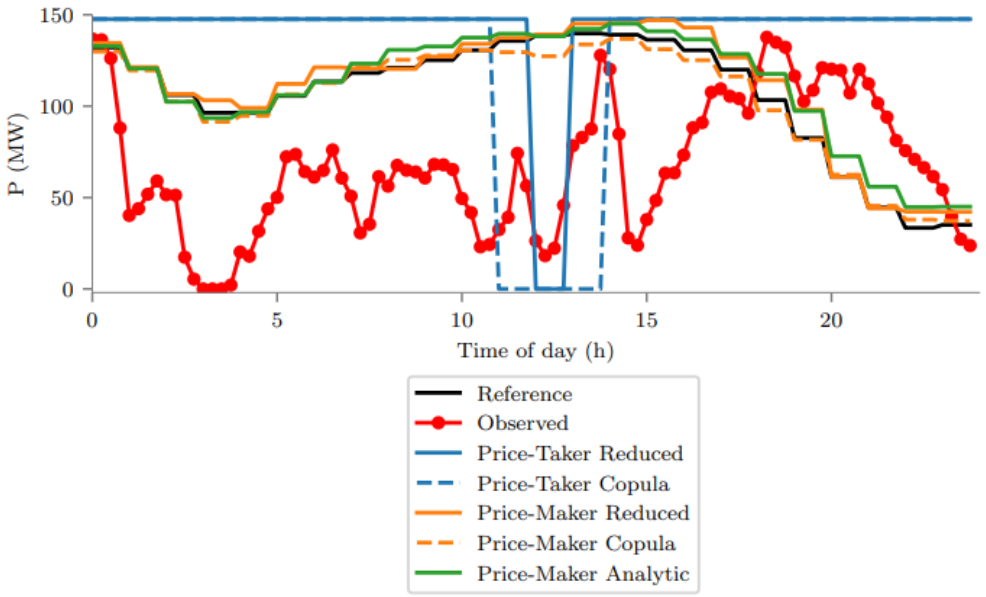


Source: Gerrit Deen, 2019, "Increasing the Market Value of Wind Power Using Improved Stochastic Process Modeling and Optimization"

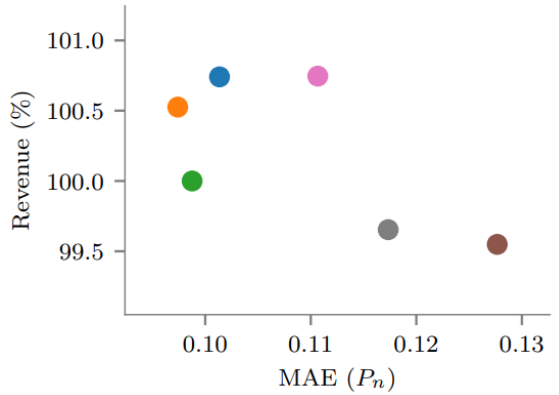
Optimized bids of a Belgium Wind farm

Results

Optimized bids



Forecast error vs. Revenue



Conclusions:

- Higher MAE & higher revenue (-> Volume ≠ Value)
- Reduced total system costs
- Reduced risk of extreme system imbalance

Source: Gerrit Deen, 2019, "Increasing the Market Value of Wind Power Using Improved Stochastic Process Modeling and Optimization"

Thank you!

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