Use of Probabilistic Forecasting Tools in Energy Trading

Session 7: Renewable Energy, Energy Trading, Market Evolution and the Role of Forecasting
Atlanta, GA, June 20, 2017

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Real-time products are available 4 times per day and up to 180 hours ahead for all continents.

75 independent weather forecasts

Probabilistic weather, wind & solar power forecasts
A brief history in time: Trading of Wind Power (Renewables)

A) Traditionally trading of Renewables starts at System Operator level

B) Often there are market forces that claim SO’s are not efficient

C) Competition shall increase performance

---→ so far so good... but is this possible?
Let’s see what happened in two of the pioneering markets?

=> Denmark: from 1 TSO to 3 Traders
The “association of wind farm owners” split their pool (80%) among 2
The “Bad BRP”, i.e. TSO (Energinet.dk) outsources the remaining FIT farms to 1

=> Germany: from 4 TSOs to approx. 4-6 Traders
- Bonus system created 30+ trading companies to compete in the market
  → small companies should also be able to trade
- 3 years after the bonus was removed, ca. +/-5 traders are effectively
  trading the 90% of wind capacity
A brief history in time: Trading of Wind Power on market terms

Experience from the privatization of trading in Denmark and Germany:

→ no real competition, but instead price “war” on forecasts
→ no more development on forecasting
→ increasing balancing costs for TSOs due to speculations
→ market manipulation (traders are not regulated as much…)
→ ….

So, while we talk about the benefits of probabilistic forecasting the -
reality looks quite different !!!

While we wonder, why uncertainty forecasting and probabilistic methods do not “take off” - reality looks quite different !!!
Why is speculation against system balance in the power market contra-productive?

It is part of the DNA of traders to look for profits -

What do you do, if you can’t earn money where you should?

**If classical trading does not bring profits – speculation starts!**

---→ if the entire market uses same procedures, it’s easy to speculate against system imbalance!

---→ if there is no real competition and the same tools are used to balance and to trade, it’s easy to speculate and manipulate!

---→ if curtailment increases, it’s easy to cheat wind farm owners!

**Result:**
Higher balancing costs on the system *(more expensive reserve...)*
Lower system security *(missing reserve in extreme events)*
Ultimately higher costs for consumers *(e.g. EEX prices fall, consumer prices increase...)*
What could prevent this situation?

Use of uncertainty forecasts can “heal the cancer in the system”

Traders become price makers

Traders reduce system imbalance by bidding the “secure” part of forecast

System operator is prepared for outliers and extremes

System operator allocates dynamic reserve

System operator is confident and “aware of the situation”

We can prevent speculation by

increasing the incentive to increase system balance
and
penalise generation of imbalances
How to practically change trading practices

Strategic Daily Spot Market Bidding

1. Split your pool into portions and become price maker
2. Optimize your trading volume with intra-day balancing
3. Base your bids on a preliminary plan for the balance process
4. Make sure you help to avoid negative prices

The impact of increased Intra-day Trading

1. Reduces the day-ahead schedule error with approx. 50%
2. Reduces the need of peak reserve
3. Reduces the volatility of balancing costs
4. More volume in the market
5. Small pools may not need to be 24x7 in the market
What you need to know about working with uncertainty forecasts

Case 1

Day-ahead forecast

Trading volume

Short-term forecast

Case 2

Uncertainty band of the forecast

Case 3

What you need to know about working with uncertainty forecasts
What you need to know about working with uncertainty forecasts

Case 1
- Day-ahead forecast
- Trading volume
- Forecast inside uncertainty band - no intraday trading!

Case 2
- Short-term forecast
- Forecast uncertainty
- no intraday trading
What you need to know about working with uncertainty forecasts

- Case 1: Day-ahead forecast
- Case 2: Short-term forecast
- Case 3: Forecast inside uncertainty band - no intraday trading!
What you need to know about working with uncertainty forecasts

Case 1: Day-ahead forecast

Case 2: Short-term forecast

Case 3: Forecast inside uncertainty band - no intraday trading!

Case 4: Uncertainty band of the forecast

Trading volume

Time
How to practically change trading practices

There are 4 cases to consider:

Case 1: Short-term forecast is higher than Day-ahead
   Action: Sell the volume between minimum short-term and day-ahead

Case 2: Short-ahead forecast is higher than day-ahead, BUT lies within the uncertainty band of short-term forecast
   Action: Do nothing!

Case 3: Short-ahead forecast is lower than day-ahead, BUT lies within the uncertainty band of short-term forecast
   Action: Do nothing!

Case 4: Short-ahead forecast is lower than day-ahead, BUT lies within the uncertainty band of short-term forecast
   Action: Buy the volume between maximum short-term and day-ahead
Thumb rule 1: decide objectively which forecast to trust

Forcasts change over time – the latest forecast is not always the best

Solution:
Use physical uncertainty to make deterministic decisions decide objectively which forecast to trust/give high weight!

Example: large difference and uncertainty between previous and latest forecasts...could also be different providers
Thumb rule 2: a smooth forecast avoids double punishment and provides “opportunities”

Forecasts never really resemble the variability of measurements: makes it important to avoid double punishment!
How to become a price maker in the market

What are the incentives to bid in with higher prices:

- increase income
- generate realistic prices that mirror the real costs
  Renewables have a free resource, but also need maintenance!
- avoid negative prices in high-penetration situations
- in case of expected shortage to level out higher intra-day prices
- in case of expected surplus to be able to sell lower at intra-day
How to become a price maker: an example

MIN

MAX

MEAN

19h

20h

21h

22h
How to become a price maker in the market

Example of how to generate a price bid

Problem: risk for shortage or negative prices!
- My pool: 200 MW controllable power
- Uncertainty (MAX-MIN): 450MW
- LS-optimised FC: 1200MW

=> strategy: bid safe and add some small risk volume for profit and balance

Example at hour 1:
- Bid unlimited: 1200MW
- Bid price 1 (=0): 80MW
- Bid price 2 (>0): 60MW
- Bid price 3 (>>0): 40MW
- Bid price 4 (>>>0): 20MW
How to become a price maker in the market

Example at hour 1:
Bid unlimited 1200MW → market price
Bid price 1 (=0) 80MW → has to prevent negative prices
Bid price 2 (>0) 60MW → has helped increase the market price
Bid price 3 (>>0) 40MW → ...
Bid price 4 (>>>>0) 20MW → did not get a contract || need to balance in intraday
How to become a price maker in the market

**OPPORTUNITY**

Real production

Low uncertainty: Least-square optimized or MEAN forecast good!

High uncertainty: **Opportunity to**
- reduce imbalance costs
- increase income
- avoid negative prices
Thumb rules for Trading in DK-NO-SE and DE-AT

Meteorologically insignificant small differences in path of low pressure system impact market price!

Key factors to consider in any strategy:
- system imbalance
- negative prices
- curtailment

North of Denmark: too much wind → **risk of negative prices**

South Sweden: no production → **high imbalance (cost)**

Baltics: congestion from high northsea offshore production → system imbalance high reserve costs, **curtailment**
How to become a price maker in the market

Recipe:

Know your pool’s controllable and non-controllable generation

Use appropriate uncertainty forecast intervals to:

- trade the “safe” part with a mean or deterministic day-ahead forecast
- trade uncertain parts with higher prices and control curtailment yourself
- trade in the intra-day market only difference outside uncertainty band

Design price levels considering

- time of the day
- current weather situation
- liquidity in the market
- expected load
- risk for negative process
- risk for curtailment
How to become a price maker in the market

Know, which methodology works for your target problem!

(A) Deterministic NWP Forecast → Pure Statistical approach → Marginal/spacial probability distribution

(B) Deterministic NWP Forecast → Statistically-based dependence structures → Spacio-temporal scenarios

(C) Ensemble NWP Forecasts → Physical ensembles inclusive extremes

(D) Deterministic NWP model → Initial/bnd. Cond. perturbations → Physical ensembles with target horizon

For trading purposes you need an **hour-to-hour uncertainty**, approach:

(A) generating only a spacial probability distribution lacks the time dimension

(D) with target horizons needs calibration for the time component
Thumb rules for trading with uncertainties

Use the **appropriate approach** for your target:
- one that is looking forward in time
- not a statistical/climatology based forecast
- not one that has specific target times

The **incentive** MUST be **avoidance of imbalance costs** while increasing your income

Become a price maker to **reflect real system costs**

Only **trade when it make sense**
- avoid trading every hour/time interval
- only trade within the uncertainty band
- the most current forecast is not always the best !!!
THANK YOU FOR YOUR ATTENTION

Questions?

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