Entwicklung des Regelleistungsmarktes in Deutschland bis 2025

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Agenda

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3. Model Structure
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Motivation

- We built a fundamental electricity sector model and apply it to the German dataset
  - with a focus on the balancing market;
  - Including the anticipation of calls by the market participants in the reservation phase,

- Our model calibrated to represent the year 2013. Questions:
  - Is a proper representation of the balancing market in a fundamental model possible?
  - How do quantities, prices and costs match the real market outcome?
  - Does the anticipation of calls in the reservation phase increase the quality of the results?

- Application for 2025: How does the balancing market react on the future power plant fleet?
  - The future scenario setting is based on the “Szenariorahmen 2025 Scenario B“
  - Entry of new market participants from different areas is likely (PV, wind, DSM, heating, etc.)
  - We include:
    - Participation of wind power in providing negative reserves
    - Increased flexibility of conventional combined heat power plants
Model Structure

- Cost minimization unit-commitment model with hourly resolution, 365 x 12+24+12 hours
- Block sharp representation of power plant portfolios
- Fixed import and exports for neighboring countries’ cross border interaction
- Two-step model: 1) reservation and 2) reserve activation
- Optional: Anticipating the cost of activated reserve volumes

- Certain CHP plants have the possibility to store their heat for several hours
- Wind turbines can reserve up to 5 % of the actual infeed as negative balancing power
Positive Secondary Control Calls in Germany 2013

- When the historical call distribution is anticipated:
- 10 blocks with varying probability and size are fitted to match the actual curve
Results: 2013 and 2025 spot market

- Model shows a good representation of 2013.
- In 2025: Nearly 1000 hours with a price of zero and an average price of 39€/MWh
- Exports are reduced from 33 TWh to 9 TWh. (Calculated with a European load flow model and an extended dataset to provide Information on cross border flows for this application)
Results: Balancing Market in 2013 – Effect of Anticipation

- **Average Prices for positive balancing capacity** (12€ per MW*h) meet real market outcome
- Most reservation in coal and gas fired power plants, few lignite, some hydro storage
- With anticipation:
  - Slight changes in reservation towards less gas and more coal
  - Increase in average price of about 2€
Results: Balancing Market in 2013 – Effect of Anticipation

- Prices for negative balancing capacity do not represent the market outcome in 2013
- No better representation when anticipating the cost of possible calls
- Even negative prices occur due to anticipation of saved fuel cost
- Significant change in reserved capacities
  - Less water and lignite / more gas and coal because of higher cost saving due to higher fuel costs
Results: Positive Balancing Market in 2025

- **Prices for positive balancing capacity** are reduced in comparison to 2013 (average 7€ per MW*h)
- Power plants are more often in part load or even at minimum load due to the spot market outcome. Hence they can provide positive balancing reserves without additional costs
- **More gas and lignite capacities reserved**
  - Due to the lower residual load lignite is more often in part load situations → 1000 hours with a price of zero at the spot market
Results: Negative Balancing Market in 2025 – Wind participation

- Better (?) representation of possible prices for negative balancing capacity
- Positive prices observed in up to 700 hours (average 1.4 € per MW*h)
- More gas/water and less lignite due to lower hours above minimum load
- Participation of wind for negative reserves reduces prices to an average of 0.8 € per MW/h
- Reserved capacities for all technologies are reduced
Conclusion

- Prices for positive balancing reserves can likely be approximated using an fundamental model.
- The model significantly underestimated prices for negative balancing reserves and does not represent the current market outcome.
- Anticipation of call cost increase prices for positive reserves but must not lead to more realistic results - especially not for negative reserves.
- The boundary conditions 2025 compared to 2013 leads to lower cost for positive balancing reserves and higher cost for negative reserves, with overall still lower costs.
- Hence high penetration of volatile renewables could lead to lower prices on the positive balancing markets and higher on negative balancing markets.
- Negative balancing prices can significantly be reduced by the participation of wind.
  - Even with conservative assumptions on the availability.
- The formulation of CHP constraints and the inclusion of part load costs are crucial for the existence of balancing prices in a fundamental model.
Thank You for Your Attention!

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