

THE IMPACT OF WIND AND SOLAR ON PEAK AND OFF-PEAK PRICES - EVIDENCE FROM TWO YEAR PRICE ANALYSIS

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1. Overview

A mechanism which constrains German grid operators since 2010 to sell total produced renewable energies at the spot market day ahead increased the total traded volume at the German spot market. Since wind and solar energy produce at zero marginal costs they push more expensive generators out of the market and decrease spot market prices. The mechanism of the merit order curve has found some attention in research mainly within the discussion of costs regarding wind and solar power generation (Sensfuß, 2011). These calculations are mostly based on simple market models and vary due to different underlying assumptions for e.g. fuel price development (Traber & Kemfert, 2010). Even though scientists outline annual cost benefits, analysis about the impact on a seasonal or hourly level has not been conducted so far.

2. Methods

We develop a statistical approach to better understand the impact of wind and solar power on hourly spot market prices. We use two year historical wind and solar power generation (N=35040) as well as spot market data from 2010-2011. First, we study the characteristics of daily spot market price data in this period and filter the data from exogenous factors. In the second step, we develop the Wind-Solar Spot Price Market Model (WS-SPMM) which is used to assign hourly spot market prices to renewable energy penetration levels. We cluster our analysis in four seasons to perform an in depth analysis of different wind and solar portfolios and their impact on hourly spot market prices.

3. Results

Generation technology matters: The level of impact of wind and solar generation on spot market prices varies depending on the season and the hour of the day as well as the share of wind and solar power within a system. We find that a generation of 10.000 MW might lead to a price reductions of up to 40% compared to average spot market price levels in times of zero wind and solar generation. Our analysis shows that based on the technology generation pattern the impact on spot market prices differs. We argue that especially solar power decreases peak prices whereas wind generation contributes on a more consistent level.

Market mechanism unable to cope: The analysis of historical data outlines that there are times in which the phenomenon of the merit order curve is unable to cope with market mechanism. Our research shows that in times of very high renewable energy generation (14.000-18.000 MW) spot market prices might even be higher than the average spot market price level. However, based on the mechanism of the merit order curve power generators with zero marginal costs should theoretically decrease spot market prices (Weber, 2010). We argue that higher prices might be due to conventional generators that are unable to shut down operations or hazard the consequence of revenues that are lower than their marginal costs.

4. Conclusions

On two-year wind and solar generation and spot market price data, our research provides new insights on the impact of renewable energy generation on spot market prices on a seasonal as well as on an hourly basis. We add to literature by proposing a statistical approach to evaluate price reduction effects caused by wind and solar power. Our findings show that there is an essential change in historical price levels caused by high wind and solar penetration. Policy makers and managers could benefit from these findings to better understand the impact of zero marginal power generators on spot market prices to draw implications for a future market design.

5. Keywords

Renewable Energy, Merit order, electricity prices

References

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