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Spatial economic potential of post feed-in tariff wind turbines in Germany

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Within the coming ten years, more than 25 GW of onshore wind will reach the end of 20 year feed-in tariff (FiT) scheme according to the German Renewable Energy Law (EEG). This urges operators to take decision on repowering, lifetime extension or shutdown. In order to support the operators' decision this study discusses and analyses the economic potential of lifetime extension or shutdown. Due to the limited lifetime extension of post-FiT turbines, rather short-term alternative revenue schemes on the day-ahead market, either via direct marketing or via a merchant PPA, appear as a reasonable option.

For these post-FiT business models, the methodology at hand introduces a revenue and cost cascade. The value and cost categories derive from a power system perspective cascade introduced by Hirth et al. (2015) complemented by transaction costs and additional revenue streams, e.g. from Guaranties of Origin (GoO).

The applied spatial economic analysis calculates region-specific contribution margins for post-FiT wind turbines in Germany in two steps:

- Calculation of regionally dispersed value factors [%], market values [€/MWh$_{el}$] and annual market revenues [€/MW] using hourly day-ahead price time series and hourly wind feed-in time series for German NUTS2 regions.
- Identifying the distribution of wind turbine operational expenditures (OPEX) from the literature and analysing their regional-specific magnitude. Capital expenditures from the initial wind turbine investment or grid connection are considered as sunk costs and can be neglected.

Subtracting spatial OPEX from spatial market values reveals region-specific contribution margins and the economic potential for continuing wind turbine operation. The conclusion is threefold:

- Location-specific market values strongly affect the contribution margin: year-to-year evolution of day-ahead price levels translates into high volatility of contribution margin. Capacity-dense regions show lower empirical market values. This trend of regional disparities will increase (Eising et al., 2020) due to increasing cannibalisation effect at ever-increasing wind market shares.

- Variation in OPEX assumptions influence the locational contribution margins: the literature review on wind turbine OPEX levels reveals a wide assumption range between 21,4 – 46 €/MWh_{el} and a data gap on actual OPEX for post-FiT wind turbines. In addition, the level distribution of cost causation in energy driven [€/MWh_{el}] and capacity driven [€/MW] OPEX together with the regional variation in wind speeds leads to a significant regional OPEX sensitivity.
- In general, wind-intense sites nowadays deliver higher contribution margins. This overperformance arises from higher absolute market revenues [€/MW] and relatively lower OPEX [€/MWh_{el}]. However, relatively lower market values already appear in the observed timeframe 2006 - 2016 at capacity-dense regions in central-northern Germany.

Overall, this study highlights the importance of acknowledging the spatial distribution of market values for analysis of business models, in particular for post-FiT wind turbines, instead of power system analysis as in the vast majority of market value studies.

References

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