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Effects of geographical and technological diversification on the development of spatially disaggregated wind and solar power market values

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Ambitious climate and energy targets require environmentally compatible energy generation with a high utilisation of renewable energy sources. However, due to the intermittent appearance of wind and PV feed-in, variable renewable energy (VRE) reveals significantly lower market values than conventional dispatchable power (Joskow, 2011). Additionally, with higher VRE shares a significant market value drop of wind and solar power has been observed in recent years as a result of the merit order effect (Hirth, 2013). Moreover, results by Engelhorn and Müsgens (2018) and Becker and Thrän (2018) have indicated regional disparities in empirical market values for Germany. This poses interest on what exactly drives and how to quantify the development and spatial distribution of VRE market values.

Against this background, an electricity market model is applied to trace the development of spatial market values based on model-endogenous electricity prices. A special feature of the model is the inclusion of highly regionally disaggregated weather data which allows to investigate effects of different geographical and technological VRE diversification strategies in Germany until 2035 (Eising et al., 2020). The results of this research are threefold:

- Technological diversity: results show a significant decrease in PV and onshore wind value factors as VRE shares increase. Replacing onshore wind energy by offshore wind energy reduces the volatility and counteracts the value drop of onshore wind, offshore wind and PV.
- Geographical diversity: results indicate that geographical diversification does not necessarily mitigate decreasing VRE value factors. Under specific circumstances, a higher concentration at sites with lower full-load hours and corresponding higher feed-in volatility potentially mitigates positive effects from more spatially distributed generation.
- Spatial distribution of value factors: for all mitigation strategies and for wind and PV the spatial value factor distribution shows future increases in regional disparities. However, regional value factor disparities are most distinct in case of onshore wind. The analysis reveals two significant drivers: first, a negative relationship between the regional wind capacity density and their

regional value factors can be observed. Second, results indicate a negative relationship between site-specific wind feed-in volatility and the value factor.

Summarising, the analysis highlights the importance of considering spatial market values in efficiently designing future electricity markets.

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