Offshore vs. Onshore Wind Energy: Effects of the Technological Capacity Mix on Regional Market Values in Germany

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Overview

Achieving ambitious climate targets entails an extensive utilisation of renewable energy sources. Nevertheless, the weather-dependent generation from variable renewable energy (VRE) sources such as wind lead to significantly lower market values in comparison to dispatchable technologies. This is even reinforced by a decline in wholesale electricity prices. The value factor[1] of onshore wind for example has followed a linear decline with increasing market shares over the last years (merit-order effect) as indicated in Figure 1a. The value factor of offshore wind instead remains at a constant level. Consequently, the difference of the value factor between onshore and offshore wind has increased in the recent years (Figure 1b). This poses interesting questions about what fundamental factors exactly drive the development of current and future market values.

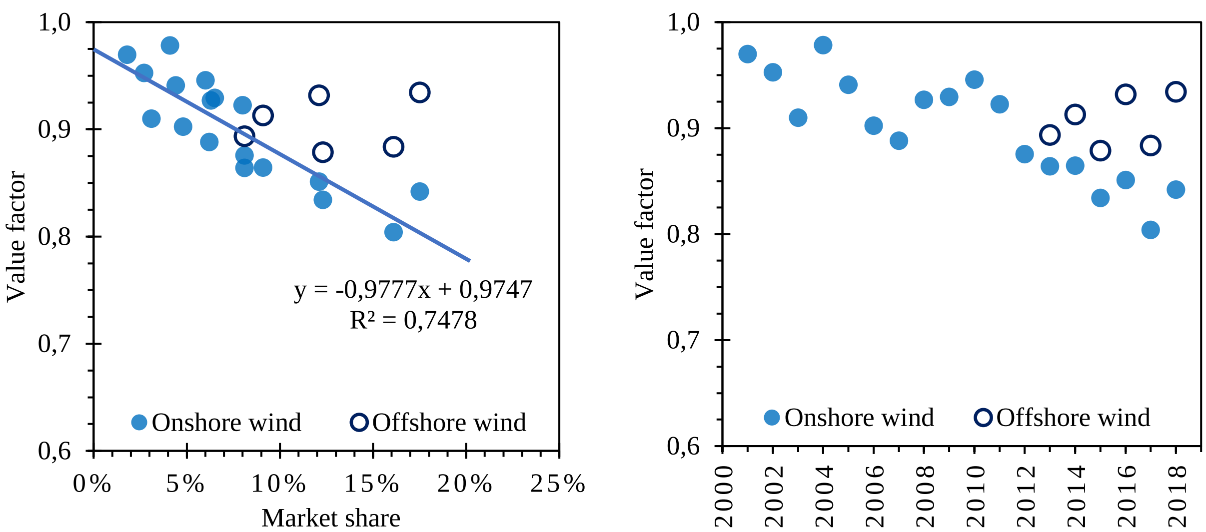

Figure 1: Development of onshore and offshore wind power value factors by overall wind market share (a) and by year (b) in Germany

Methods

The objective of this work is twofold: First, the future development of national as well as regional market values of wind generation are quantified. Secondly, a deeper understanding about the impact of the capacity mix between offshore and onshore technologies on the market values is derived. For this purpose, the European electricity market model ELTRAMOD is applied. ELTRAMOD is a bottom-up model of the European[2] electricity market that optimises the power plant dispatch to serve a given demand under technical generation and exchange constraints. The model is solved for 8760 hours and hourly electricity prices are derived for different wind energy expansion scenarios. A rather onshore driven scenario is compared against a scenario with higher shares of offshore wind to identify the impact of the technology mix. Post-run calculations comprise the determination of technology specific market values on a highly regional degree. To cope for balancing effects of distributed generation feed-in time series with a high regional resolution are utilised.

[1] In order to compare absolute market values across different years and price levels the value factor was introduced as a normalised metric by academia. The value factor of a technology is defined as its generation-weighted wholesale price, the market value, divided by the average wholesale price. Value factors greater 1 mean that generators earn revenues at a price level above the average wholesale price throughout the year and vice versa.

[2] In this work, the regional scope of the model is limited to Germany and its neighbouring countries.

Results

The results show that the technological composition of the wind capacity portfolio affect significantly the national as well as local market value. The decline of wind value factors continues while regional differences increase, indicating a growing importance of utilising regional wind patterns in energy system planning. The consideration of site-specific market values will become more relevant for operators. While LCOE are approaching from site to site due to a non linear relation of (decreasing) investments for wind technologies with the long term generation cost, differences between value factors throughout Germany will further increase. In addition, high shares of offshore wind in the portfolio seem to be beneficial to stabilise both, the market value of onshore as well as offshore wind generation.

Conclusion

It can be concluded that site-specific market values are increasingly important for system planners as well as wind farm operators: From an investor's perspective, the results of this work can support the decision on the technology as well as the choice of the location for investments under the current market premium scheme. From a policy maker's perspective, results assist in configuring efficient portfolios of offshore and onshore wind and to define regional wind capacity trajectories.

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