SPOT MARKET PRICE EFFECTS OF RESERVE PROVISION – ANALYSES BASED ON A PARSIMONIOUS FUNDAMENTAL MODEL

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Overview

Various fundamental electricity market models have weaknesses in explaining price peaks and troughs. This typically includes overestimation (too high fundamental prices) in hours with low load, especially at night. One reason for this behaviour is no or insufficient consideration of provision of reserve. Reserve power is an important component of energy systems with a high proportion of renewable energies and thus plays a special role in the German energy transition. Due to technical restrictions spinning reserve must furthermore be provided by online capacity.

In this paper, we introduce a simplified approach to include reserve provision into fundamental models and in this way improve model accuracy. Our work particularly focusses on the effects on the bidding curve resulting from the provision of reserve. Based on this, we present a simplified fundamental model to simulate reserve prices. We integrate our approach into the parsimonious fundamental model (ParFuM) developed by Kallabis et al. (2016) and Beran et al. (2018) and apply it to the German day-ahead spot market for the years 2016-2018.

The preliminary results show two effects: First, the provision of reserve reduces the capacity available for the spot market, resulting in a steeper bidding curve in the area of the marginal power plant. Second, more capacity must be online leading to a new must-run block that is added on the left side of the bidding curve. The preliminary results also show that our simplified approach for the consideration of reserve procurement improves the spot market model quality with regard to prices and production volumes.

Methods

Our approach is based on the ParFuM as presented in Kallabis et al. (2016) and Beran et al. (2018). We determine spot market prices as resulting from the intersection of aggregated supply and demand functions. Our methodology approximates the supply curve by a piecewise linear function with consideration of fundamental information, e.g., power plant capacities and availabilities, fuel prices, must-run production and cross-border exchange.

Reserve procurement is integrated with the help of two factors into the initial model on the supply side. On the one hand, a maximum proportion of reserve power per technology class (alpha) is introduced. Secondly, since control power can only be provided by operating power plants, a minimum capacity factor (gamma) is introduced. For economic reasons, it is best if the demanded reserve energy is provided by the marginal power plant and adjacent units (see Baldursson et al. (2017)). This modifies the shape of the bidding curve and thus directly influences price formation on the spot market. At the same time, the marginal costs and quantities of power plants offering reserve power are known. With the help of this reserve power bidding curve and equilibrium assumptions (based on Baldursson et al. (2017)), a fundamental reserve price can be determined.

Results

First, we develop a simple approach to model reserve procurement that can be easily integrated in a ParFuM.

Second, we identify two systematic effects that affect the bidding curve in the spot market by providing reserve capacity: On the one hand, the available power in the spot market is reduced, which leads to a steeper bidding curve in the area of the marginal power plant. On the other hand, must-run capacity in the spot market increases, which shifts the bidding curve. We show that the model quality of a fundamental model can be increased by reserve considerations and demonstrate the quantitative effects for the German electricity market in the years 2016 to 2018.

Third, we present a simple, fundamental approach to model reserve capacity prices and validate them with actual prices.

Conclusions

The consideration of reserve capacity in fundamental electricity market models can improve model quality. The integration of the proposed reserve capacity approach into a ParFuM preserves its low data requirements and the simple structure and thus its transparency, but at the same time improves the quality of the results. In particular, the identified effects on the bidding curve lead to larger price jumps with extreme values of residual load and thus result in more volatile fundamental prices. This is an important aspect that enables new areas of application for the proposed model, especially in the valuation of power plant flexibilities.

References

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