THE IMPACT OF WIND POWER PRODUCTION AND ELECTRICITY FLOW ON THE ELECTRICITY PRICE OF THE NEW ZEALAND

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Overview

The integration of intermittent Renewable Energy Sources (RES), such as wind and solar photovoltaic (PV) power has been provoking a profound redesign and restructuring of electricity markets. The electricity production from wind and solar PV power has been claimed of declining the electricity price, mainly because of their nearly zero marginal costs. This phenomenon, also known as the Merit-Order Effect (MOE), seems to be raising concerns related with the "missing money issue" (Mays, 2021). This means that the profit of conventional and/or flexible generators is likely to be decreased and thus, reducing their willingness to invest in backup capacity, that is undoubtedly crucial for maintaining the reliability in electricity markets. Therefore, electricity markets are nowadays struggling to face three main issues, namely: (i) the abrupt decrease of electricity prices; (ii) the increase on the volatility levels of electricity prices; and (iii) guarantee the electricity supply in periods of RES scarcity, by electricity produced from flexible and/or controllable energy sources, which usually have higher marginal costs. In literature, there is evidence for the existence of the MOE in most electricity markets. However, the magnitude of this effect is likely to vary according to both the specific features of each generation mix and/or the equilibrium between electricity supply and demand. For instance, the MOE from wind power was underlined in Portugal, while not observed in case of the solar PV power (Macedo et al., 2020). In Slovakia, the MOE from solar PV power was almost negligible mainly because of the low potential of solar PV power radiation in this country (Janda, 2018). Meanwhile when confronting two countries, (Rintamäki et al., 2017) concluded that the electricity produced from wind power has different impacts on electricity price volatility of Denmark and Germany. In Denmark, electricity prices' volatility seems to decrease, mainly because wind power's production is distributed along the day. Meanwhile, in Germany the electricity production from wind power occurs predominantly in off-peak hours of consumption. One strategy that pledges the maximization of the exploitation of RES has been the increase of interconnections capacity, e.g., through the exchange of surplus of electricity between cross-border countries. This paper analyses the New Zealand (NZ) electricity market which is characterized as one of the least regulated markets worldwide. The electricity produced from RES has negligible marginal costs, so that there are high concerns with the low return of investments for electricity producers especially in NZ, where remuneration incentives are also almost not awarded. Moreover, the NZ electricity system is a small electricity market that seems to operate under autarky conditions, which may minimize the profitability of investments in RES capacity. As such, is expected that the consequences of the MOE on the NZ electricity system are likely to differ from those usual observed in electricity markets with greater capacity of interconnections. The main goal of this research is to assess the MOE from wind power, as well as the volatility on the final electricity price in NZ. Furthermore, this paper also studies whether the electricity flow between nodes is likely to reduce imbalances in the system.
The nodes with electricity produced from wind power are analysed, namely the BPE0331, LTN0331, NMA0331 and TWH0331. The research questions that this study aims to answer are the following: (i) is the MOE occurring in the NZ electricity market?; (ii) does the magnitude of the MOE vary between nodes ?; (iii) how persistent is volatility of electricity prices in NZ?; and (iv) is the volatility of electricity price likely to be influenced positively or negatively by the electricity flow?

Methods

The integration of RES has augmented uncertainty and volatility in electricity prices. The electricity price is indeed a versatile commodity that captures all seasonal fluctuations, so that its dynamic behaviour can be described into four main components, namely: high volatility, price spikes, mean reversion and seasonality. Given this, conditional heteroscedasticity models are the most suitable to assess the electricity price behaviour, as well as its volatility. Hourly data and a Seasonal Autoregressive Moving Average with exogenous regressors combined with a Generalized Autoregressive Conditional Heteroskedasticity (GARCH) is the method applied in this research. The database is retrieved from the official website of the Electricity Authority of the NZ and it includes the following variables: the spot electricity price, electricity flow, prognosis of both electricity consumption and wind power.

Results

The preliminary results suggest the MOE from wind power in the NZ power system in all four nodes. *A priori*, the MOE from wind power appears to have slightly low magnitude compared to those observed in the European countries. This result is reasonable because, as the NZ electricity market have low political intervention, where remuneration incentives are rather nil. Besides that, the magnitude of the impact of the electricity consumption on electricity prices reveals low, comparatively to these also observed in European electricity markets. Contrary to what is observed in these latter electricity markets, electricity consumers have an active participation in the NZ market. Overall, electricity producers in the NZ electricity market does not beneficiate from incentives with guaranteed prices. For this reason, electricity prices in NZ are likely to be highly competitive. Furthermore, it must be highlighted that, despite of the NZ being an energy only market with low capacity of interconnections, it beneficiates from a high share of hydro electricity produced. The large share of hydro power offers a great opportunity to be used as a backup capacity and, it could actually reduce the volatility of electricity prices. This study affords a benchmark analysis by comparing the results of these study with those obtained in literature. This analysis aims to identify strategies and regularities and thus discuss policies aiming the evolvement of electricity markets towards sustainable systems.

Conclusions

The main results of this paper evidences that wind power contributes for the decrease of the NZ electricity price. Meanwhile, the NZ electricity system appears to be highly vulnerable to unexpected market events, which means that electricity market participants are likely to make an overreaction to sudden shocks in electricity prices. Besides that, this study also suggests that the increase of interconnections capacity, generation system with flexible energy sources capacity and electricity storage could indeed help balancing fluctuations. A deep analysis of the MOE must be performed in different geographical areas, by assessing different structures of generation mix, as well as, respective patterns of consumption. This benchmarking analysis aims to identify policy measures that incentivizes an efficient integration of RES in electricity markets. Finally, the high complexity in electricity markets makes fundamental the design of policies that relates the electricity price formation with demand-side management measures. Moreover, policymakers must acknowledge electricity market uncertainties and thus, provide additional hedging strategies to guarantee a certain revenue for market participants.

References

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