ELECTRICITY MARKET EQUILIBRIA WITH HIGH SHARES OF WIND POWER

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Overview

Increasing shares of volatile electricity generation by renewable energy sources such as wind and photovoltaics brought structural changes to many electricity markets. One example is the need for flexibility and resulting changes in price structures. Historically, a flexible supply side (mostly either thermal power stations or hydro storage) balanced a time varying demand. Today, increasing shares of variable RES depend on meteorological conditions (e.g. wind conditions or solar irradiation). Hence, the availability of these generation capacities on the supply side is uncertain and fluctuating.

This paper will focus on variable RES' impact on price volatility. There has been some research analysing additional RES in a ceteris paribus setting, i.e. leaving thermal capacities constant. We will extend that research by analysing how the price volatility develops when adjustments in thermal capacities and storage capacities are taken into account, i.e. a (partial) market equilibrium is analyzed.

Methods

In this paper, we analyse the effect of an increasing share of variable RES on electricity prices, particularly on the price variance. To that end, we develop and apply an electricity spot market dispatch and investment model. This model is formulated as a linear optimization problem (LP) which minimizes the total costs of the electricity production in the underlying system. Key constraints are: generation equal to demand for every hour, generation below installed capacity, generation above partial load requirement of running capacity, …

We use a full cost approach, i.e. investment costs of the installed capacity are taken into account. Thus, we focus on equilibria in the electricity market taking into account changes in thermal capacities due to changes in RES investments. These changes are triggered by variations in the investment costs of RES. Furthermore, we implement the investment option of pump storages to provide additional flexibility to the system.

Results

We analyse the influence of RES integration, in particular wind power. By applying a full cost approach we address market equilibria on the electricity market. Thus, we are able to observe system adjustments by two meanings, first variations in the installed capacity of thermal technologies and second the effects of RES on the electricity production, i.e. on the economic dispatch of generation capacity.

As a final output we receive marginal electricity prices on a fundamental basis. We analyse the resulting electricity prices with a focus on price volatility. Furthermore we quantify the effect of additional flexibility by including storage power plants.

Conclusions

This paper analyses a future German electricity market with increasing shares of RES. We analyse a partial equilibrium, i.e. adjustments in thermal capacity are taken into account. We thus analyse a system where excess capacities, currently lowering both prices and price spreads in Europe, have been reduced to an efficient endowment. We show how the price structure, in particular the variance of electricity prices, is driven by fluctuating RES and the availability of flexibility options. We thus provide a new aspect in an ongoing discussion on RES influence on risk and price volatility.