SELF-REINFORCING NEGATIVE PRICE DYNAMICS UNDER THE VARIABLE MARKET PREMIUM SCHEME

Kristina Nienhaus, German Aerospace Center, +49.711.6862-461, Kristina.Nienhaus@dlr.de
Martin Klein, MartinKlein@posteo.de
Christoph Schimeczek, German Aerospace Center, +49.711.6862-8223, Christoph.Schimeczek@dlr.de
Marc Deissenroth, German Aerospace Center, +49.711.6862-8139, Marc.Deissenroth@dlr.de
Ulrich Frey, German Aerospace Center, +49.711.6862-8118, Ulrich.Frey@dlr.de

Overview

We report a potential self-reinforcing design flaw in the variable market premium scheme that occurs if variable renewable energy (VRE) power plants receiving a premium become price-setting in the market. A high share (>60%) of renewable energies is a goal of many countries on their transformation path to a sustainable future. Accordingly, policies like feed-in tariffs have been in place for many years in many countries to support investment. To further market alignment, variable market premia have been introduced. We demonstrate with an agent-based simulation model (AMIRIS) that the combination of variable premia and a high share of renewables in the market may lead to a downward spiral of prices if unchecked. Given current policy schemes [1, 2], these results apply to at least 12 European countries and a dozen additional countries world-wide. Hence, we evaluate the severity of this market design flaw and discuss countermeasures.

Methods

We use the model AMIRIS [3], an agent-based wholesale electricity market model for Germany for the assessments. The model allows studying the impact of energy policy instruments on the economic performance of renewable energy sources for electricity (RES-E) operators and marketers. The model has an hourly resolution and computes wholesale electricity prices fundamentally based on the simulation of strategic bidding behavior of prototyped market actors. This bidding behavior does not only reflect marginal prices, but it also takes into account effects of support instruments like market premia.

The examined variable premium acts as a financial compensation for the difference between energy-source-specific levelized cost of electricity (LCOE) and the market value. It is adjusted on a continuous basis. Premium plus average return from sales at the market shall thus ensure refinancing [4]. A first, very simple scenario has been parametrized with photovoltaic (PV, 200 GW) and gas (120 GW) as the only two electricity generation technologies and a carbon price of 0 €/t. Gas power plants produce at fixed marginal cost of 50 €/MWh. Another extended scenario has been configured with PV (200 GW), wind onshore (80 GW), wind offshore (20 GW), different conventional generation technologies (together 75 GW) with varying marginal cost and 20 GW of storage technologies under the assumption of a carbon price of 50 €/t.

Results

Figure 1 shows the resulting market prices in the simple scenario. In hours with a negative residual load, PV becomes price setting. As PV bids at marginal cost minus the variable market premium to maximize the chances of acquiring the premium, negative prices occur. The prices decline month by month since the market premium is adjusted monthly and reflects the decreasing market value of PV. This decline continues as long as PV is able to cover the demand in a significant share of the monthly hours.

The extended scenario shows the same pattern of increasing negative electricity prices (Figure 2). This mechanism depends on the variable market premium and the strategic bidding behaviour of the marketers of PV and wind. In hours with a negative residual load, PV and wind become price setting. Their strategic bidding behaviour, i.e. bids at marginal cost minus the variable market premium, drives prices down. With decreasing prices, PV's and wind's average monthly values start to decline (Figure 3). To ensure refinancing, the variable market premium needs to be increased to cover the LCOE (Figure 4). PV and wind bids will include this increased premium and prices become even more negative – this downward spiral continues as long as these technologies are price-setting at a significant share of hours per month. This requires another premium increase, and thus a self-reinforcing effect is set in motion.

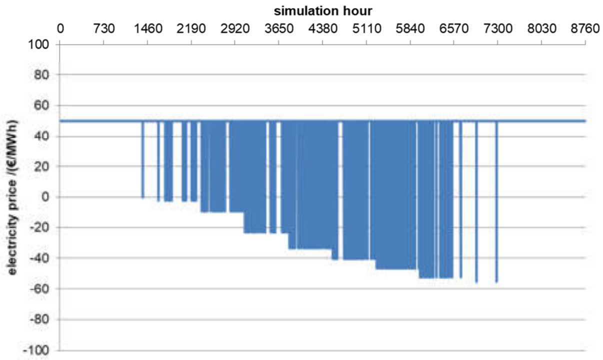

Figure 1. Market prices for one year in the simple scenario.

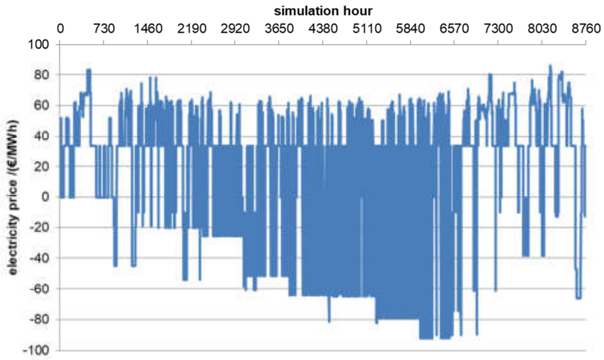

Figure 2. Market prices for one year in the extended scenario.

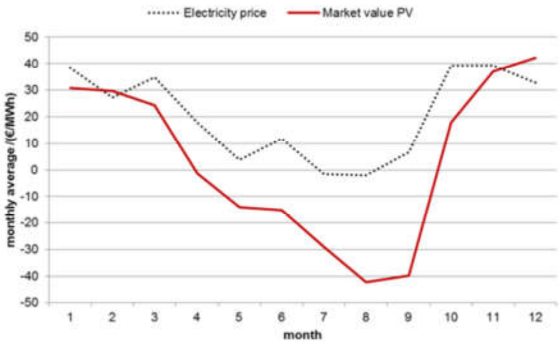

Figure 3. Development of electricity prices and market values for PV in the extended scenario.

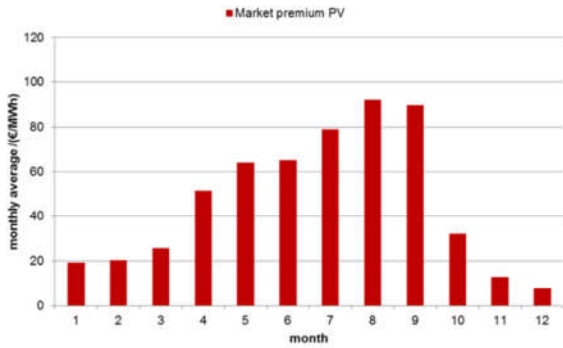

Figure 4. Development of the market premium for PV in the extended scenario.

Conclusions

Simulations with the agent-based simulation model AMIRIS show that high shares of fluctuating renewables in combination with variable market premia may lead to a downward spiral of electricity prices and increasing costs for their support. The described dilemma is not trivial to avert in the current market setting, as voluntary change in bidding behavior is not to be expected. In addition, upper and lower limits are expected to jeopardize refinancing and fixed market premia would also entail immense investment risks.

Extended analyses are required to answer the question whether the variable market premium's steering effect is still efficient and effective at very high VRE-shares and how refinancing can be ensured in the future.

References

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