

POLICY INSTRUMENTS AND MARKET INTEGRATION OF RENEWABLES - AN AGENT-BASED MODEL ANALYSIS

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Overview

To further ensure a successful integration of electricity from renewable energy sources (RES), technical, financial and organisational aspects of the electricity system have to be redesigned. Due to the fluctuating character of renewables a main challenge is the alignment of renewable energy generation and demand. Several options are being discussed to approach this problem. One possibility is the market integration of renewables by linking the generation of renewable electricity to the price signals of the energy exchange markets. In the year 2012 the German government introduced a sliding market premium for supporting the direct marketing of electricity from renewable energies. Our agent-based simulation model AMIRIS allows analysing the impacts of the market premium on the involved market actors (e.g. income situation of renewable power plant operators and direct marketers) on the micro level of the energy market system as well as effects on its macro level (e.g. energy exchange prices and market structure).

Methods

Agent-based models (ABM) are particularly suitable (Wooldridge 2009) for the analysis of complex and multiple linked systems with autonomous actors. Our model considers decisions of actors of the energy markets as well as the adaption of their behaviour (Reeg et al. 2013), e.g. to changes of policy instruments which may impact their business. Such simulations require an elaborate analysis of relevant actors. This analysis has been carried out with qualitative methods from social science, led by theoretical assumptions of the sociological Neo-Institutionalism (Fligstein and McAdam 2011). With the help of document analysis and semi-structured interviews with representatives of the relevant actor groups and a following expert workshop propositions were formulated. These results were translated into a formalised model language and implemented into the AMIRIS model. Actors are aggregated and mapped as agents into the model. They are situated in and influenced by a dynamic environment, which is simultaneously shaped by the actions of the agents - thus creating a complex structure with feedback loops. The heterogeneous agents are modelled having individual states, actions and goals. By implementing tactics and strategies it is also possible to model long-term action strategies.

Results

Among others, it is studied how factors like the portfolio composition, the quality of forecast, cost for profile services etc. affect the market position of intermediaries. Figure 1 shows operation profits per accounting year for four of in total nine simulated types of intermediaries taking part in RES direct marketing via the electricity exchange. The operation profits include all revenues and expenses which are directly or indirectly related to the issues of direct marketing. The profits' development is illustrated for the years 2012 to 2019 assuming three variants of the management premium, which is paid to cover the costs for marketing: high, low and zero. The findings indicate that an important factor for economic success is the quality of output forecast that directly influences the costs for balancing energy. Thus, especially intermediaries having experiences in direct marketing and related activities and which early signed contracts with RES plant operators profit from the premium ('international utilities'). Smaller intermediaries with smaller portfolios and accordingly lower forecast

quality ('big municipal utilities', 'small municipal utilities' and 'intermediaries without experience') in comparison are rather negatively affected by the lowered management premium.

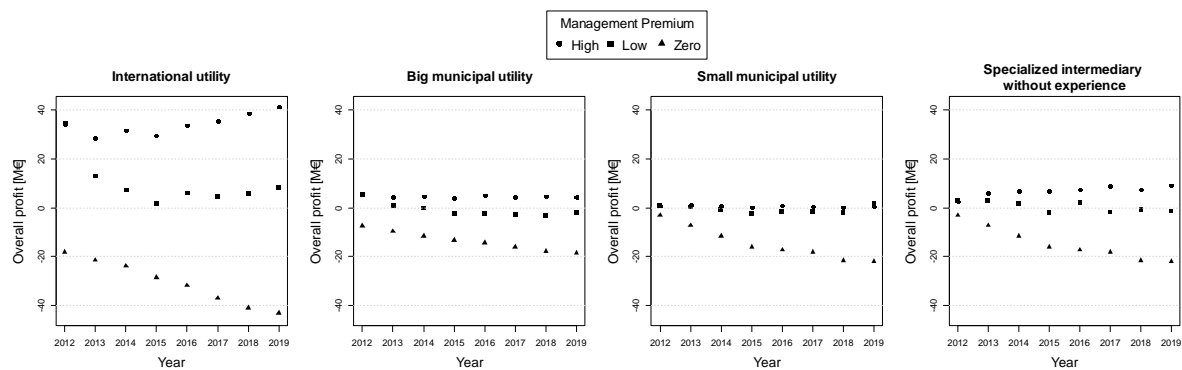


Figure 1: Profits of selected intermediaries. The profits include all income and expenses that are accumulated per accounting year and which are directly or indirectly related to direct marketing issues.

Regarding RES plant operators, it is analysed which remuneration classes profit most from direct marketing. As bonus payments of the intermediaries are high (due to a higher management premium for intermittent RES), especially in proportion to the corresponding feed-in-tariffs, wind power plant operators profit clearly from direct marketing and the market premium. The simulation results show additional revenues of about 2.99% to 3.35% on average for on-shore power plants for the period between 2012 and 2019. Biomass power plants, which actually are well suited for demand oriented supply due to their non-volatile feed-in, profit least compared to all other renewables. But for solid fuel plants as well as for big biogas plants direct marketing becomes lucrative when taking part in the reserve power market. They gain additional revenues of more than 10% relative to the feed-in-tariff only. The importance of participating at the reserve power market is even raised when assuming an expected degression of the relative market value of biomass plants. With an increase of the installed power of PV power plants, peak prices at noon will strongly decrease until 2020, so that the relative market value of biomass plants operating a day-night cycle falls below 100%.

Conclusion

The AMIRIS model is a flexible tool for political consulting as simulations can be configured and parameterised in manifold ways. The results show that the participation of fluctuating RES in direct marketing may be profitable for intermediaries as long as a premium for compensating costs is paid. The amount of premium promising a successful business depends on the intermediaries' portfolios and quality of output forecast. In case of a low or even an abatement of the premium it seems likely that several actors encounter severe losses, thus leading to market concentration. For plant operators taking part in direct marketing which is supported by the sliding market premium is financially attractive. However, due to degression of relative market values, it remains unclear, if a more flexible operation with day-night cycle of biomass plants could generate enough profit from the wholesale market in order to refinance investments in storage and additional generation capacity. The impact of the degression of market values of biomass plants on their economic success indicates the importance of considering interdependencies between the feed-in of different renewables when analysing market potentials.

References

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