Assessing the Effect of Different Market Designs on the Security of Electricity Supply – A Quantitative Analysis and Policy Recommendations

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Overview

While the security of electricity supply in Germany and central Euorpe has historically been on an absolute level, interruptions of the electricity supply in California are currently a frequently observed phenomenon. Building on existing research focusing in relevant fields (see e.g. Nolting and Praktiknjo, 2020 or Praktiknjo and Erdmann, 2016), we therefore address the following research questions:

- *What are the main causes of frequent electricity supply interruptions in California?*

- *To what extent could similar situations occur in Germany and Central Europe in the future?*

- *What role does the design of the electricity market play in this context?*

Methods

To answer these questions, we proceeded in three main steps: (1) reviewing the literature on the known causes of electricity interruptions in California (see e.g. Caiso, 2021), (2) qualitatively comparing different market designs and their implications for electricity security of supply (see e.g. Keppler, 2017), and (3) implementing and evaluating a market model to quantitatively examine the effects of different market designs on investment incentives for generation and storage capacity.

In all steps, the study benefited greatly from the collaboration between scientists based in California and researchers with a German background. This interaction enabled a detailed comparison of different market designs and their corresponding impacts on the levels of security of electricity supply."

Results

In general, the results of our work show that in particular the design of the electricity markets as *energy-only markets* in combination with a high share of renewable electricity generation plants can lead to capacity bottlenecks. On the other hand, the introduction of *capacity markets* provides incentives for the construction of peak load capacities, but at the same time requires high payments for the operators of such plants, which have to be passed on to the electricity consumers or taxpayers.

More specific, the results of our quantitative assessment using an optimization-based market model implemented in Python show the substantial impact of the market design on the installed capacities of peak load power plants, renewable generation plants and storage technologies (see Figure 1 for the impact of different scarcity prices in an *energy-only market*).

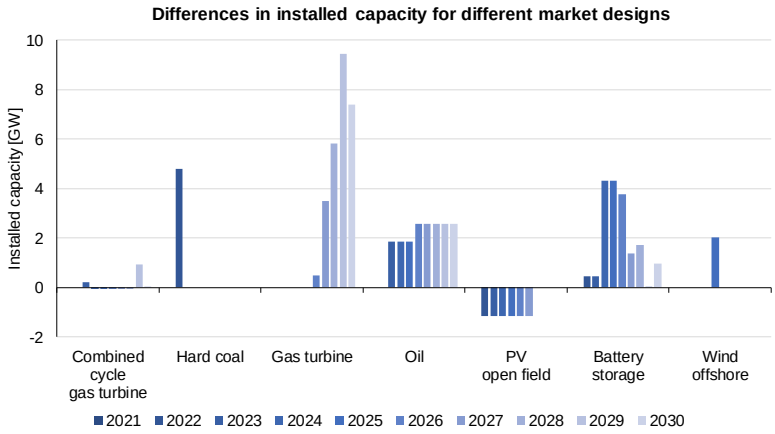

Figure 1: Model-based development of installed capacities in an energy-only market for Germany in the period 2021-2030. The differences of capacities for a scarcity price of 5000 EUR/MWh to a scarcity price of 500 EUR/MWh are shown. The results shown here are preliminary and do not take into account import effects.

Beyond investigating the effects of different market designs on incentives for capacity investements, we also analyse impacts on security of supply levels. Figure 2 shows the amount of energy not served for different capacity payments in a *capacity market*.

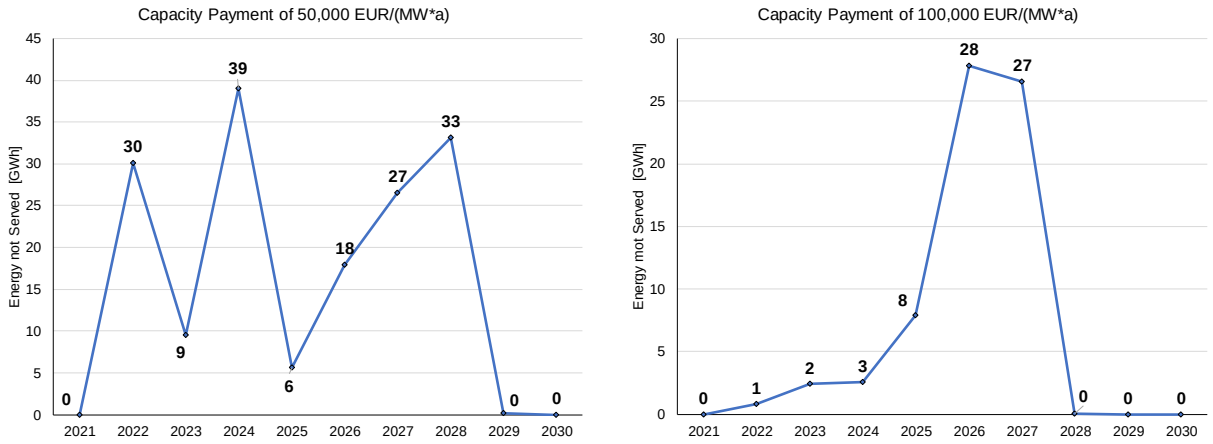

Figure 2: Effects of capacity payments on security of electricity supply. Preliminary results.

Conclusions

Based on the comparison of different market designs, we conclude that the current market design in Germany might not create sufficient incentives to ensure the historically quasi absolute level of security of electricity supply in future. We hence derive policy recommendations how German regulators could learn from the Californian case to make a sustainable and affordable energy transition possible while guaranteeing for high levels of reliability in the electricity system. In particular, we recommend to internalize the externality of security of supply to move the market outcome towards a total cost optimum.

References

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