Wholesale electricity prices in European power systems with high shares of variable renewables – the impact of market designs

(1) Energie-/Klimapolitik, Versorgungssicherheit

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Motivation and research question

Driven by extremely high wholesale electricity prices in fall 2022, the current debate around European electricity market design is discussed with a focus on protecting consumers from high prices and preventing windfall-profits for low-marginal cost technologies. Yet, an adverse problem is likely to occur in fully renewable power systems: Wholesale electricity prices are likely to decrease with increasing shares of variable renewables (vRE) because of the well-known merit-order effect [1, 2, 3]. Since vRE will constitute the dominant source of power in a decarbonized European energy system, this effect might be exacerbated, if vRE become price-setting in a significant number of hours [4, 5]. Furthermore, equilibrium prices could be affected by market designs targeted at financing vRE as they influence price bids in wholesale markets [6]. This paper studies the effectiveness of different types of Contracts for Difference (CfDs) to incentivize investment in fully European power systems and how they impact wholesale electricity prices and dispatch.

Method

We apply the flexible energy system modelling framework Backbone to carry out a cost-minimizing investment and operation planning of fully renewable European power system scenarios for a full year [7]. Based on our scenarios, we model two reference systems with variable renewable shares of 85% and 95%, respectively, which we enforce by adding corresponding constraints to our minimization problem. We build our model based on data collected by the Horizon2020-project TradeRES [8]. Similar to [9] and [10], we analyze the reference system results with a focus on profitability of variable renewables as well as wholesale electricity prices, for which we use the model's marginal system costs. Subsequently, we introduce two types of CfDs targeted at financing variable renewables. For this purpose, we calculate levelized cost of energy (LCOE) and average wholesale market prices from our reference system results and apply them as the CfDs' strike and reference price, respectively. Similar to [6], resulting subsidies are calculated for a one-way-CfD type and a two-way-CfD type and used as variable operation costs in subsequent market design simulations.

Results and Conclusion

First, our results show that renewables become price-setting in a number of hours in several bidding zones across Europe. Figure 1 presents national price duration curves in the Italian bidding zone resulting from our 95%-variable-renewables-scenario and the two types of CfDs modelled. It can be seen that renewables with their near zero marginal costs set the price around more than half of the year. In the presence of CfDs that lead to subsidies in the Italien case, negative prices occur in a significant number of hours. Furthermore, we are able to show that both types of CfDs modelled are able to incentivize investments in variable renewables. Yet, our particular design of CfDs seem to favor more expensive technologies in terms of LCOE. In the case of a two-way-CfD we can show that anticipation of CfD payments by generators can harm invest in certain technologies. Finally, our results show that total system costs and average prices are lower in the 1-way-CfD-case, yet at the price of higher subsidies.

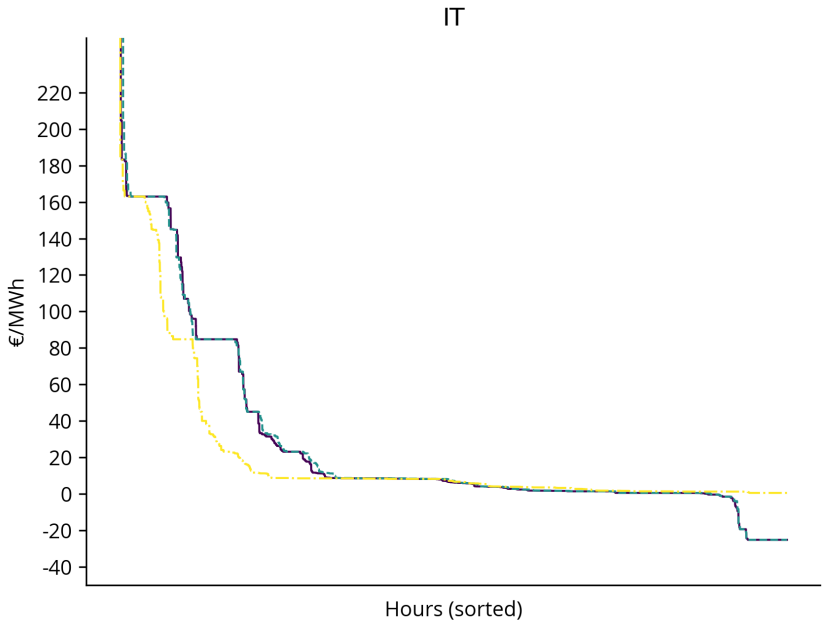

Figure 1: Comparison of price duration curves in the Italian bidding zone by scenario (Reference constitutes our 95%-variable-renewables-scenario)

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