TradeRES
New Markets Design & Models for 100% Renewable Power Systems

TradeRES Research Bulletin

The impact of sector coupling and demand-side flexibility on electricity prices in a close to 100% renewable power system

Niina Helistö [(1)], Silke Johanndeiter [(2)], Juha Kiviluoma [(1)]

[1] *VTT Technical Research Centre of Finland, Espoo, Finland*
[2] *Ruhr-University Bochum, Bochum, Germany*

Full paper: https://doi.org/10.1109/EEM58374.2023.10161962, https://cris.vtt.fi/en/publications/the-impact-of-sector-coupling-and-demand-side-flexibility-on-elec

Summary

Since variable renewables with low marginal costs will constitute the dominant source of power in a fully renewable European power system, wholesale electricity prices could be expected to decrease due to the resulting shift in the marginal cost curve for the power supply. Yet, this effect can be mitigated by the increasing elasticity of demand. We model scenarios of fully renewable European power systems with varying levels of flexibility on the demand side and thermal capacity on the supply side. First, we apply the open-source energy system modelling framework Backbone to optimise investments in new capacities in the scenarios. We enforce the desired level of thermal capacity by adding respective constraints to the model. On the demand side, we include other energy sectors by introducing industrial hydrogen demand, energy demand for electric vehicles, and heating demand for buildings. Using the resulting optimal capacity mixes, we subsequently optimise operations to simulate the European electricity market. As a result, we find that the flexible actors on the demand side can help stabilise wholesale electricity prices in renewable power systems, particularly with very high shares of variable renewables that incur very low marginal costs.

Highlights

- Scenarios with varying levels of wind and solar energy and demand-side flexibility
- Wind and solar energy increased the variability of electricity prices
- The need for thermal baseload plants is replaced by a need for flexible units
- Additional demand-side flexibility from sector coupling helped reduce the variability of the prices
- Flexibility was provided by investments in hydrogen turbines if demand-side flexibility was not available
- Electricity prices are sensitive to the exogenous thermal capacity mix and electricity demand

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864276