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

TradeRES Research Bulletin

Impact of operational details and temporal representations on investment planning in energy systems dominated by wind and solar

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Full paper: https://doi.org/10.1016/j.apenergy.2021.116712

Summary

Planning of future energy systems with higher prevalence of wind and solar energy requires a careful representation of the temporal and operational characteristics of the system in the investment planning model. This study aims to identify the aspects that should be considered when selecting the representation for a particular system. To demonstrate the impacts that various model representations have in terms of model accuracy and computational effort, we carry out case studies on two test systems implemented within the Backbone energy systems modelling framework. The results show that the temporal and operational representations have different benefits and weaknesses in different system types. The findings provide general guidelines on the relative importance of different model details, depending on the characteristics of the system under study, such as the (potential) prevalence of short-term and long-term storage as well as wind and solar energy. Furthermore, the interactions between energy sectors and the operational limits of the technologies for sector coupling should be correctly captured, as they significantly impact on the value of different technologies and their flexibility. Finally, we recommend testing several temporal and technical representations for each particular system in order to ensure the feasibility of the selected method for that purpose. The findings inform energy system modellers about improvements that will facilitate higher quality planning results.

Highlights

- Several temporal and operational model structures are systematically evaluated.
- Weighted representative periods can better capture solar and short-term storage.
- Aggregated, continuous representation is suitable with wind and long-term storage.
- Adequate technology modelling is crucial for capturing energy sector interactions.
- Testing several model structures for each system and purpose is important.

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