

Data and facts

Application Center for Integration of Local Energy Systems

Research for the transformation of the energy system at Fraunhofer IWES

We launched the Application Center ILES in close cooperation with Hamburg University of Applied Sciences (HAW) in 2020. At the ILES, we focus on topics such as the model-based control of decentralized, local energy systems and their integration into energy grids. The main research interest lies in the cross-sectoral application of wind and hydrogen technologies, among others. Here, we have a system-oriented view and are interested in the transient behavior of electrical and electrochemical components in order to be able to investigate highly dynamic phenomena.

These investigations are important for the development of innovative operational management strategies for complex asymmetric grid topologies. Grid-forming control for the integration of hybrid power plants, especially with electrolyzers, represents another research focus.

Our competences at a glance

- Location-specific optimization of component size and operation: For the planning of new sites or the expansion of existing systems.
- Extensive test infrastructure on a large scale for hydrogen technologies and electrical components
- Detailed modeling (EMT) of the components for the energy system, e.g., wind turbines and electrolyzer
- Development of optimal operation strategies



Energy transformation

The transition to a decentralized and converter-based energy system with volatile renewable energy generation leads to new requirements for ensuring stable and reliable grid operation. The coupling of energy sectors and the use of renewable energy sources and hydrogen technologies will strongly shape the future energy system. For us, the focus here is on the use of electricity from wind turbines to produce hydrogen. The first step is the analysis of the system, which requires the characterization and mathematical description of all the mechanisms associated with the grid, including the grid connection conditions and energy markets. The representation of the local energy systems with modeling methods adapted to the task forms the basis for our research, allowing us to develop new concepts for grid operation.

Research needs

New modeling methods are required in order to be able to represent the future energy system. Among other things, we are researching the use of multilinear time-invariant (MTI) models. This model class makes it possible to achieve very good approximations of the detailed nonlinear system behavior – while significantly reducing the computational complexity. Promising results have already been obtained in several publications.¹

Our fundamental core questions:

- Grid integration How can we analyze conditions for the integration of local energy systems systematically?
- Stability How can we employ state-of-the-art methods to assess the stability of the electrical grid or ensure it through suitable control concepts?
- Optimal operational management How can we achieve optimal operation of the distributed energy grid?
- Standards What are the requirements of the components in a cross-sector energy grid – e.g., for electrolyzers and regulation systems?
- Regulation How can regulatory criteria be meaningfully combined with technical ones?
- Tool development What tools do we need to be able to answer these questions and how can we develop them sustainably?



Linear increase of model complexity with the number of components through decomposition of parameter tensors of multilinear models¹

Source 1 Gerwald Lichtenberg et al. - Implicit multilinear modeling. An introduction with application to energy systems 2021, Picture credits photo page1: © Paul Langrock, photo page 2: © malp - stock.adobe.com 09|2024



Collaboration possibilities

Fraunhofer IWES already collaborates with a wide range of industrial partners and research institutes. In this respect, we are always open to new partners and projects in both a national and an international context. In addition, we offer research services such as simulation studies. Please feel free to get in touch.

Further information



Cooperation with Hamburg University of Applied Sciences (HAW): www.haw-hamburg.de/en/university/

faculty-of-life-sciences/research/fraunhofer-iles

Fraunhofer IWES develops innovative methods to accelerate the expansion of the wind energy and hydrogen economy, minimize risks and increase cost efficiency. Innovations in technological developments are validated and innovation cycles are shortened. Planning and development of offshore wind farms are accelerated and made more precise. At present, there are more than 300 scientists and employees as well as more than 100 students employed at the nine sites: Bochum, Bremen, Bremerhaven, Görlitz, Hamburg, Hannover, Leer, Leuna, and Oldenburg.

Contact

Aline Luxa Research Associate Phone: +49 471 14290-488 aline.luxa@ iwes.fraunhofer.de Dr. Georg Pangalos Senior Scientist Phone: +49 471 14290-494 georg.pangalos@ iwes.fraunhofer.de

Fraunhofer Institute for Wind Energy Systems IWES Am Schleusengraben 22, 21029 Hamburg, Germany www.iwes.fraunhofer.de