Fraunhofer IWES

Data and facts

Application Center for Integration of Local Energy Systems

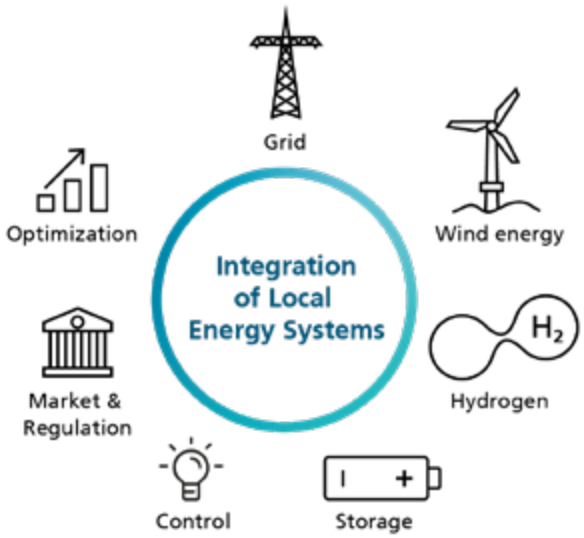
Research for the transformation of the energy system at Fraunhofer IWES

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 regulation for the integration of hybrid power plants, especially with electrolyzers, represents another research focus.

Our competences at a glance

- 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 operational management strategies



Energy transformation

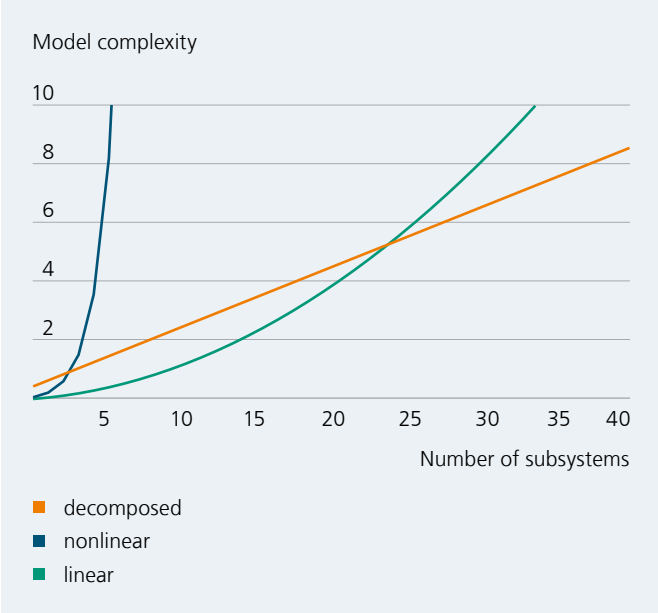
The transition to a decentralized and converter-based energy system with volatile renewable energy generation leads to new requirements for ensuring stable and reliable grid operation. The coupling of energy sectors and the use of renewable energy sources and hydrogen technologies will strongly shape 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 models[1]

Source 1 Gerwald Lichtenberg et al. - Implicit multilinear modeling. An introduction with application to energy systems 2021, **Picture credits** photo page1: © AA+W - stock.adobe.com, photo page 2: © malp - stock.adobe.com
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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 on their behalf. 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 secures investments in technological developments through validation, shortens innovation cycles, accelerates certification procedures, and increases planning accuracy by means of innovative measurement methods in the wind energy and hydrogen technology sectors. 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, Leer, Görlitz, Hamburg, Hanover, Leuna and Oldenburg.

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