

PRESS RELEASE

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Fraunhofer ISE develops test procedure for grid-forming inverters

In addition to expanding renewable energy generation, a successful energy transition requires stable system operation at all times. To achieve this, renewable energies and storage power plants will have to take on extensive system services and essential grid-forming properties in the future. In the “GFM Benchmark” project, Fraunhofer ISE developed a test procedure for grid-forming inverters on behalf of the four German transmission system operators and applied it to devices from various manufacturers. On the one hand, the project provided a comprehensive overview of the market readiness of grid-forming inverters. On the other hand, the project results provide an important practical check for new national and European testing standards.

The fully integrated grid components with grid-forming properties planned by the transmission system operators will not be able to fully meet the demand for grid-forming power. Therefore, customer systems must also contribute to stabilizing the power grid: They should behave in a grid-forming manner, i.e., contribute to providing a grid voltage with stable amplitude and frequency. But what exactly does that mean? In recent years, many scientific studies and publications have been produced on this topic, and some countries have grid operator documents that describe grid-forming behavior. However, there is no uniform standardization or definition, which leaves room for interpretation.

Therefore, in the first step of the project, the Fraunhofer ISE team worked with the grid operators 50Hertz Transmission GmbH, Transnet BW GmbH, Amprion GmbH, and Tennet TSO GmbH to develop a measurement and evaluation procedure for the stabilizing properties of inverters, incorporating findings from both grid operation and research.

Major differences in grid-forming behavior

“We wanted to see what manufacturers understand by grid formation and how they implement this in the programming of their devices,” explains department head Dr. Sönke Rogalla from Fraunhofer ISE. “So we invited them to put their devices to the test in our laboratory.”

Seven companies responded to the call and had their storage inverters, which cover a power range from a few kilowatts to five megawatts, measured according to the new

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test procedure. They came from different countries and were at different technology readiness levels, from pilot to prototype to series production. The researchers used the tests to investigate the differences between the devices in terms of grid formation by exposing them to various operating conditions in the laboratory. In addition to normal operation, critical grid situations such as rapid frequency changes, short circuits, and phase jumps were simulated.

“The devices exhibited similar behavior under clearly defined requirements. In other cases, however, there were major differences, and we were able to provide the manufacturers with suggestions for optimization for almost every device,” explains project manager Roland Singer from Fraunhofer ISE. The willingness and commitment of manufacturers to advance the development of grid-forming inverters is high.

Proven verification methods are essential for market launch

At the same time, the project provided relevant practical experience in testing grid-forming inverters and optimized the test procedures. Important findings were incorporated into the ongoing standardization work at the European level even during the project phase. The Fraunhofer ISE team contributed its expertise to the creation of the VDE FNN note “Grid-forming properties.” The recently published document describes the requirements and verification procedures for grid-forming units. It forms the normative basis for participation in the future market for instantaneous reserve, which will start at the beginning of 2026 and represents an additional interesting remuneration path, especially for battery storage systems.

With its experience in the “GFM Benchmark” project, the team at Fraunhofer ISE is ideally positioned to support manufacturers and users of grid-forming units with certification measurements in accordance with the FNN note. Standardization work at the European level is also progressing. ENTSO-E, the network of European transmission system operators, is working on an implementation guide with comprehensive grid-forming requirements, which should facilitate the transition to national regulations.



Preparation of a grid-forming inverter for measurement in Fraunhofer ISE's multi-megawatt lab.
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The results of the tests will be published anonymously and presented to the public for the first time at the 24th [Wind & Solar Integration Workshop](#) on October 8.