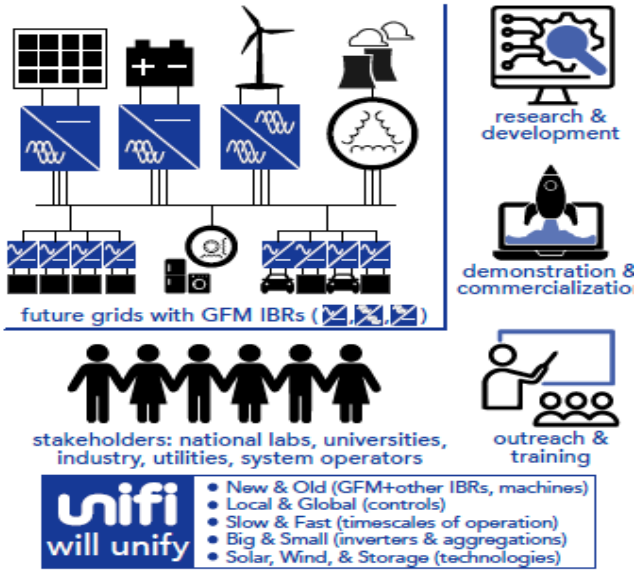
Modeling, Control, Demonstration, and Standardization of Grid Forming Inverters – UNIFI Consortium



Project Highlights

- Define system-level Interoperability guidelines and unit-level functional requirements for GFM technology
- Create generic models of different GFM while ensuring portability across multiple simulation environments
- Conduct hardware and demonstrations to validate GFM behavior
- Through industrial standardization process, define technical minimum capability for GFM technology

Background, Objectives, and New Learnings

At present, power-system operations and controls are primarily dictated by and tailored to the physical characteristics of synchronous machines. The fundamental form and feasible functionalities of power systems are rapidly evolving as more inverter-based resources (IBRs) are integrated into the grid. To manage the grid effectively, system operators and utilities will need accurate models of inverters and their controllers to assess stability and performance under a variety of operating conditions. It is challenging, however, to acquire full visibility of inverter models and controllers, as vendors are understandably averse to disclosing IP-protected technology. Further, increasing use of nonlinear control, dynamically varying system topologies and configurations, machine learning at the grid edge, and over-the-air software updates to millions of inverters from scores of vendors further compound challenges associated with scalable system-level analysis, performance verification, stability certification, and universal interoperability. As IBRs with grid forming (GFM) inverters become more widely deployed, system-level performance and stability guarantees cannot be an afterthought.

Together with a large stakeholder group that spans leading researchers, technology vendors, utilities and grid operators, and other stakeholders, the U.S. Department of Energy (DOE) has launched the Universal Interoperability for Grid-Forming Inverters (UNIFI) Consortium to collaboratively pursue advances in a broad range of GFM inverter technologies. The consortium is co-led by the National Renewable Energy Laboratory, the University of Washington and EPRI. UNIFI will cultivate and foster a culture of engagement and innovation to identify and fill gaps in technologies, business models, standards, and human factors. In particular, UNIFI will conduct and coordinate research, development, and demonstration, as well as create educational- and workforce-training materials focusing on planning, designing, and operating grids with a high level of GFM IBRs. Guided by the goal of unleashing the full potential of GFM technologies, UNIFI intends to unify timescales of operation and control across spatial scales for IBRs and associated technologies

In support of UNIFI, the objectives of this supplemental project are to:

- Enable members of the supplemental to also be members of the consortium
- Enable members to participate in meetings of the consortium and provide input on draft versions of various deliverables
- Facilitate technology transfer and collaboration between the consortium and members of the supplemental

Benefits

This project is intended to develop vendor-agnostic guidelines for seamless integration of GFM technologies via system-theoretic constructs that outline desired performance and describe pertinent phenomena at the point of grid interconnect. This will facilitate coordinated operation of a plurality of GFM technologies from multiple vendors, while ensuring stability and reliability. It is also intended to identify technical minimum capability that may be desired and standardized with GFM technology. This will allow for specifications of interconnection requirements that can define specific services required from GFM technology.

Participants in the Consortium will help identify research priorities and provide immediate feedback on research work as it is being conducted. Further, participants will be able to access Consortium research results as it develops.

Project Approach and Summary

The consortium work effort is organized around three main thrusts:

Thrust 1: Research and Development

Conduct fundamental research to improve mathematical models and simulation environments; improve both inverter- and plant-level control extending to wide-area control and coordination; and validate developed controls and models using hardware test beds. The research in this thrust will provide system planners and operators with the key tools to carry out their studies to understand the behavior of the power system with increased percentage of GFM technology. Further, it will address research questions such as how much GFM is needed and where it should be located?

Thrust 2: Demonstration and Commercialization

Through a series of 1 MW demo projects, and at least one 20 MW demo project, the performance of the GFM technology developed in Thrust 1 will be verified. In collaboration with inverter vendors, a plan for commercialization of verified GFM technology will be identified. Additionally, this thrust will conduct activities related to standardization of GFM technology performance.

Thrust 3: Outreach and Training

Both university education and workforce development initiatives will be identified and conducted through this thrust. For workforce development, this includes training and guidance on use and application of advanced simulation tools, models and analysis techniques that will enable efficient planning of the future power network.

Deliverables

- Consortium membership.
- Participation in consortium activities and meetings.
- Regular updates (webcasts or short reports) to facilitate collaboration and summarize progress and results for each project thrust.

The non-proprietary results of this work will be incorporated into EPRI's Transmission Operation and Planning and Bulk System Renewables and DER Integration R&D programs and made available to the public for purchase or otherwise.

Price of Project

The project cost is $250,000 ($50,000 per year for five years).

This project qualifies for tailored collaboration (TC) and self-directed funding (SDF). There is no minimum number of funders required to start the project.

Project Status and Schedule

The total duration of the project will be for five years (2022–2026).

Who Should Join

Utilities already facing or anticipating system reliability issues due to the interconnection of inverter-based resources into weak areas of their system. Additionally, utilities who are already considering GFM technology and are in need to additional guidance.

Contact Information

For more information, contact the EPRI Customer Assistance Center at 800.313.3774 (askepri@epri.com).

Technical Contact

Deepak Ramasubramanian at 865.218.8178 (dramasubramanian@epri.com)
Anish Gaikwad at 865.218.8066 (agaikwad@epri.com)
Aidan Tuohy at 865.387.5298 (atuohy@epri.com)
Brian Seal at 865.218.8181 (bseal@epri.com)

Member Support Contacts

Dan Tavani at 704.595.2714 (dtavani@epri.com)
Vincent Marec at 708.653.6475 (vmarec@epri.com)
Rich Menar at 650.855.8707 (rmenar@epri.com)
Brian Long at 704.408.8139 (blong@epri.com)

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EPRI
3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com