



U.S. DEPARTMENT OF
ENERGY

unifi

is co-led by NREL, University of Washington, and EPRI

unifi
consortium

universal interoperability
for grid-forming inverters

Modeling and Simulation R&D

Wei Du

Point of Contact for Modeling & Simulation Area

November 17, 2021

Outline

- UNIFI Overview
 - Introduction
 - High-Level Goals
 - Project Team and Organization
- Modeling and Simulation R&D
 - High-Level Deliverables

What is UNIFI ?

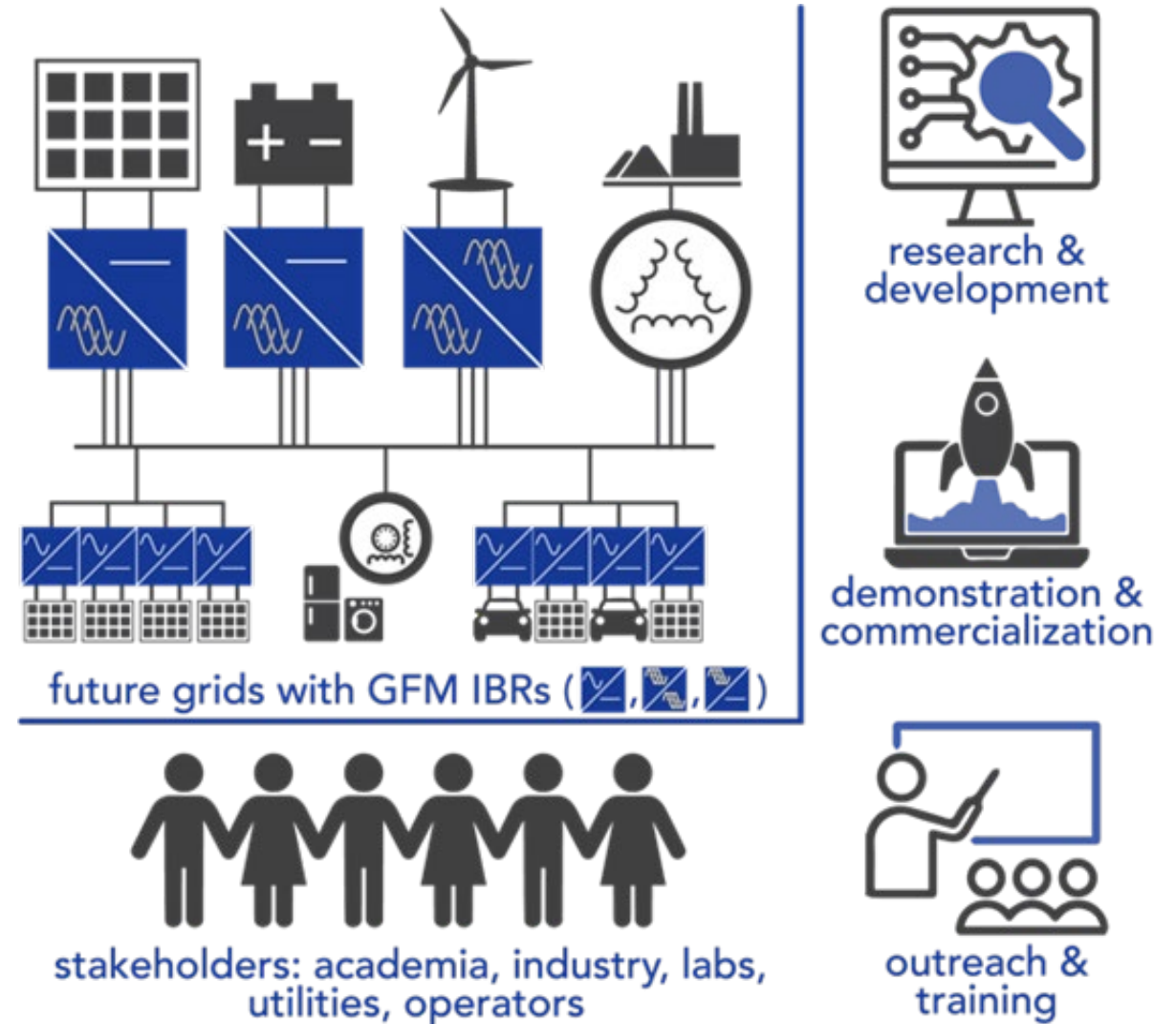
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The **UNIFI Consortium** is a forum to address fundamental challenges in seamless integration of grid-forming (GFM) technologies into power systems of the future

Bringing the industry together to unify the integration and operation of inverter-based resources and synchronous machines

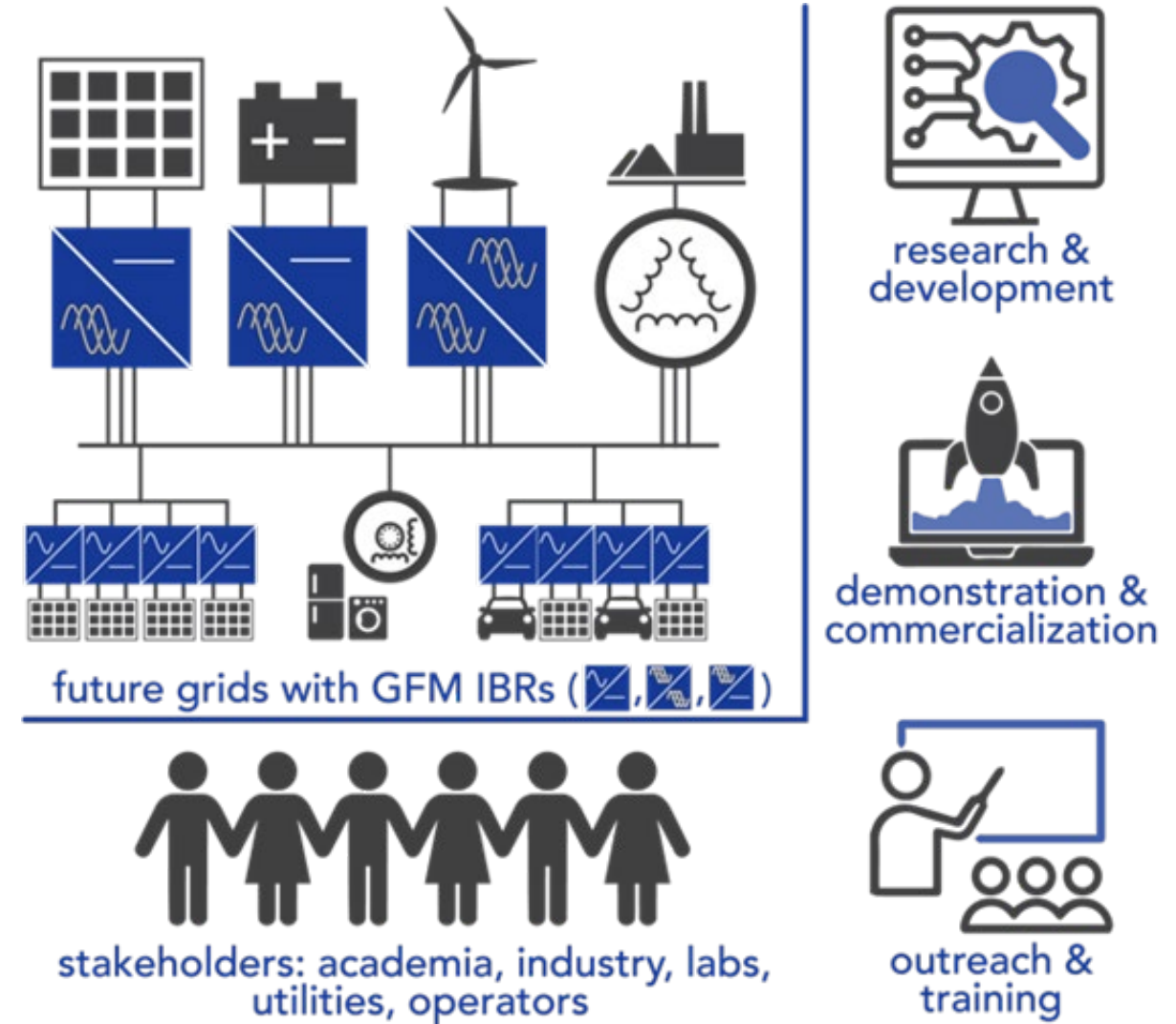
Three major focuses:

- Research & Development
- Demonstration & Commercialization
- Outreach & Training







High-level Goals

- **Establish** the US as a leader in PV, wind, storage via cutting-edge research in GFM systems integration
- **Foster** ecosystem for
 - Research & Development (R&D)
 - Demonstration & Commercialization (D&C)
 - Outreach & Training (O&T)to drive next-generation GFM technologies
- **Curate** vendor- and technology-agnostic
 - *Interoperability Guidelines (@system level)*
 - *Functional Requirements (@IBR level)*that standardize performance and benchmark capabilities of GFM technologies across scales
- **Cultivate** inclusive culture and leverage member cooperation for sustained innovation
- **Convene** continuous collaboration between inverter manufacturers (on one end) and system operators and utilities (on the other) to bridge gaps between power-systems and power-electronics industries









Project Team

National Labs

-  **National Renewable Energy Laboratory (NREL)**
B. Kroposki, B. Mather, Y. Lin, A. Hoke, G.-S. Seo, J. Wang
-  **Pacific Northwest National Laboratory (PNNL)**
W. Du, T. McDermott, Q. Huang, M. A. Elizondo
-  **Sandia National Laboratories (Sandia)**
A. Ellis, J. Flicker, M. Reno, B. Pierre
-  **Lawrence Berkeley National Laboratory (LBNL)**
C. Roberts, J. Eto

Inverter Manufacturers

-  **General Electric (GE)**
R. Legg, S. Achilles, P. Arsuaga, R. Dutta, M. Bowman
-  **Enphase Energy (Enphase)**
D. Zimmanck, P. Chapman
-  **Siemens Corporate Technology (Siemens)**
U. Muenz
-  **Hitachi ABB Power Grids (HAPG)**
D. Das
-  **Danfoss**
D. Isaksson, M. A. Awal, L. D. Flora
-  **Eaton**
A. Rockhill

Real-time Simulation & Software Vendors

-  **Typhoon**
I. Celanovic
-  **OPAL-RT**
S. Chakraborty
-  **Electranix**
A. Isaacs


Universities

-  **University of Washington (UW)**
B. Johnson
-  **University of Minnesota (UMN)**
S. Dhople
-  **Georgia Tech (GT)**
D. Divan
-  **Arizona State University (ASU)**
V. Vittal, R. Ayyanar
-  **North Carolina State University (NCSU)**
I. Husain, S. Lukic, D. Lubkeman
-  **University of Alaska Fairbanks (UAF)**
M. Shirazi
-  **University of California Berkeley (UC Berkeley)**
D. Callaway
-  **Temple University**
X. Lu
-  **University of Illinois at Urbana-Champaign (UIUC)**
A. Domínguez-García, O. Ajala
-  **University of Puerto Rico, Mayagüez (UPRM)**
E. I. O. Rivera
-  **University of Wisconsin-Madison (UW-Madison)**
D. Gross
-  **Virginia Tech (VT)**
A. Mehrizi-Sani

-  Project Co-lead
-  Team Member
-  ANNH
-  AANAPISI
-  HSI

legend

Industry Lab

-  **Electric Power Research Institute (EPRI)**
A. Tuohy, D. Ramasubramanian, E. Farantatos, A. Huque, B. Seal, W. Wenzong, J. Boemer

Utilities

-  **Hawaiian Electric Company (HECO)**
C. Ching, D. Ishimura
-  **Southern California Edison (SCE)**
J. Castaneda
-  **Pacific Gas & Electric Company (PG&E)**
S. Xu
-  **Portland General Electric (PGE)**
L. Bekkedahl
-  **New York Power Authority (NYPA)**
G. Stefopoulos
-  **Commonwealth Edison (ComEd)**
A. Vukojevic
-  **Southern Company**
C. R. Black
-  **PacifiCorp**
S. Wang

System Operators

-  **ISO New England (ISO-NE)**
X. Luo
-  **Midcontinent ISO (MISO)**
J. Harrison

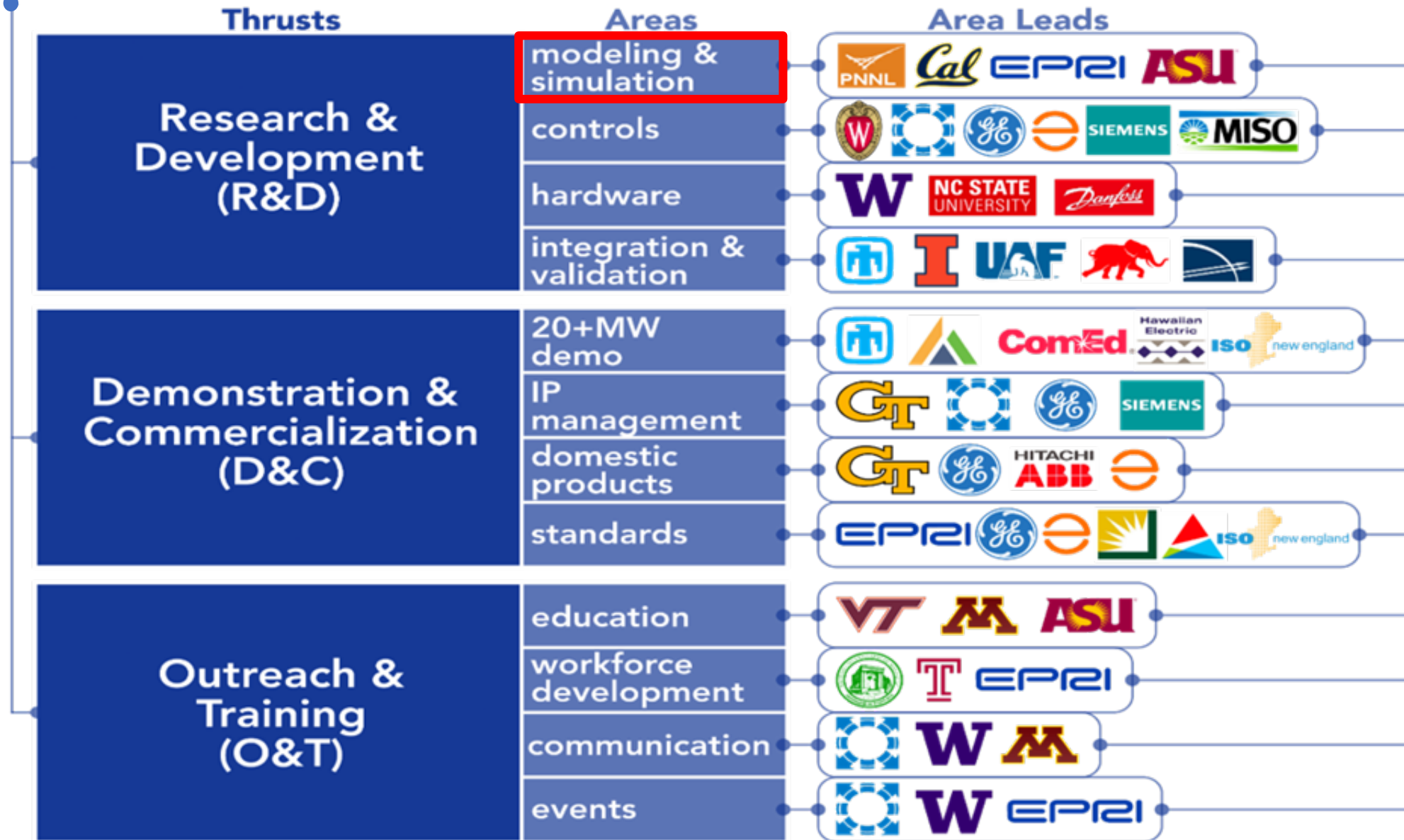
Project Team is either receiving DOE funding and/or providing cost share

Additional Industry Partners



The strong team provides an opportunity to adopt a system-oriented approach to advance research, development, and commercialization of GFM technologies.

Leadership and Management Team



Modeling and Simulation R&D

Co-led by PNNL, EPRI, and UC Berkeley

High-Level Deliverables [HDs]

- [HD 1]: Create a model library to include GFM models with various resolutions developed by UNIFI.
 - EMT models
 - Phasor models
 - Other innovative models
- [HD 2]: Create a software testbed system library that can be used to study different scales of power grids with a mix of GFMs, GFLs, and synchronous machines.
 - Microgrids
 - Distribution feeders
 - Isolated power grids
 - Bulk power systems
 - Software testbed to support the 1+ MW multi-vendor hardware demonstration
 - Software testbed to support the 20+ MW field demonstration

These deliverables are currently under negotiation.

High-Level Deliverables [HDs]

- [HD 3]: Develop innovative modeling and simulation methods/tools to improve the model accuracy and simulation scalability.
 - Model and network order reduction/aggregation tools
 - Co-simulation tools
 - Artificial-intelligence-based methods to accelerate solving ordinary differential equations
 - Recommendations for how to select GFM models and simulation tools for different simulation purposes
- [HD 4]: Develop and document analytical approaches to study the system stability with high penetration of IBRs. [cross-cutting area]
 - Small signal analysis
 - Impedance-based approaches
- [HD 5]: Demonstrate GFM model interoperability in simulation environment.
 - A template for GFM model interoperability
 - Demonstration of the GFM model interoperability through working with manufacturers and software vendors from UNIFI consortium

These deliverables are currently under negotiation.

The background is a dense, repeating pattern of various icons in shades of blue and grey. These icons represent a wide range of fields including technology (laptops, tablets, networks), engineering (gears, circuit boards, capacitors), science (molecules, graphs), and industry (factories, wind turbines).

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Thank you

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