

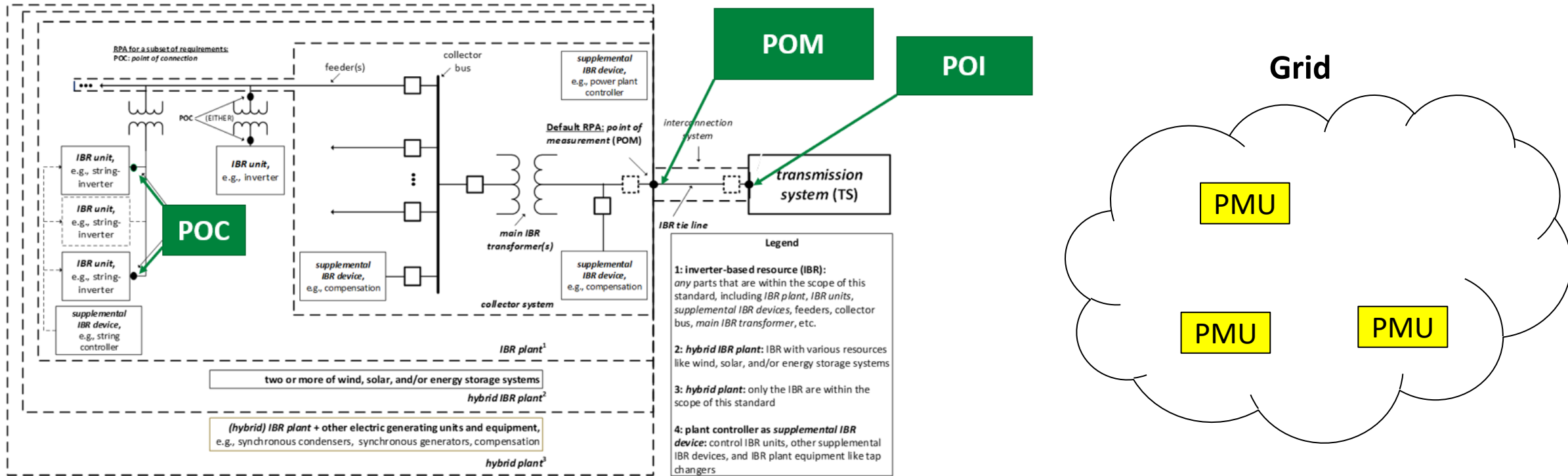
# Synchronized Measurements for Controlling Inverter Based Resources

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Distribution Task Team  
NASPI Work Group Meeting  
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# IBR Control Hierarchy



Source: IEEE 2800-2022 Std.

## Local Control

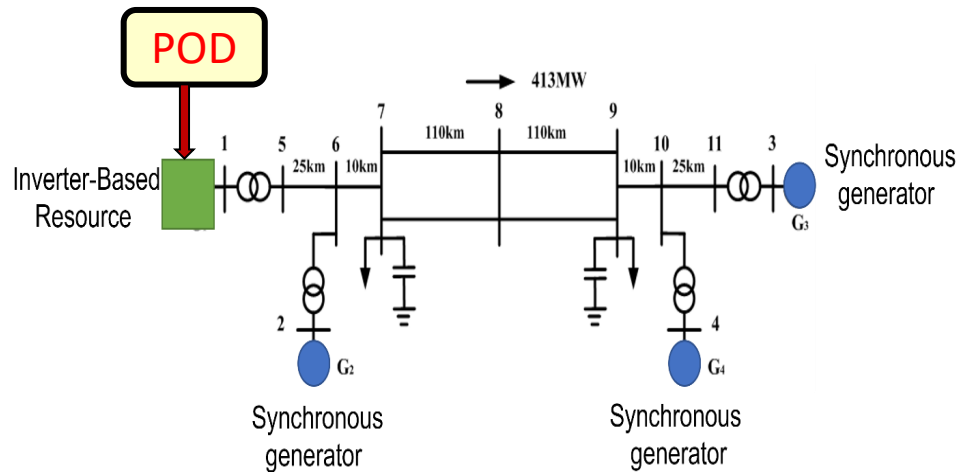
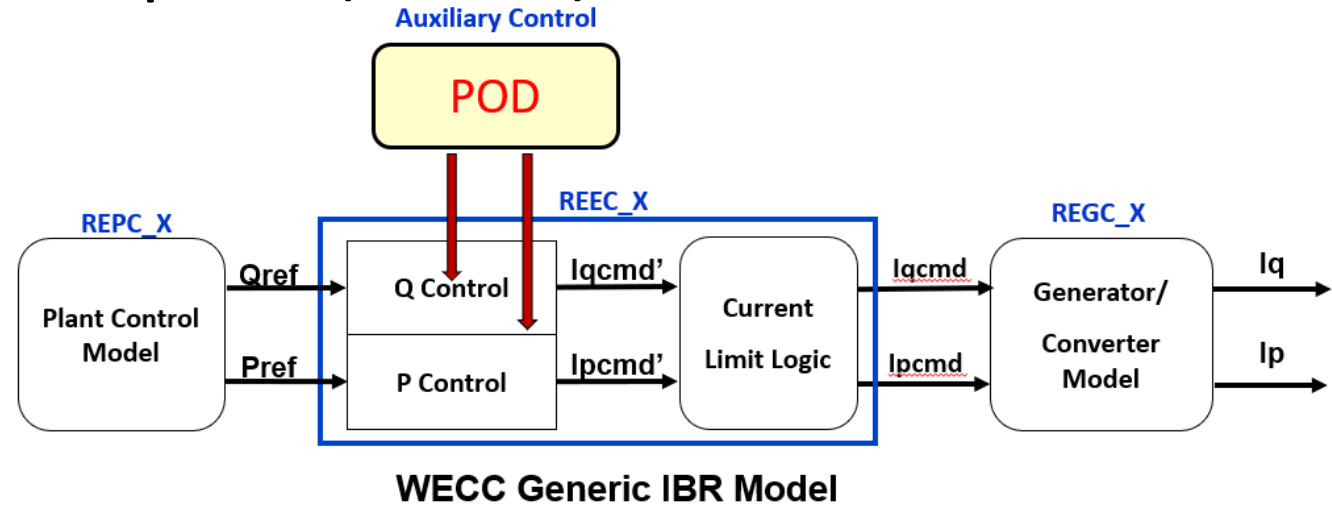
- Plant level control
  - POM measurement data
- Inverter level control
  - POC (inverter terminal) measurement data

## Wide-Area Control

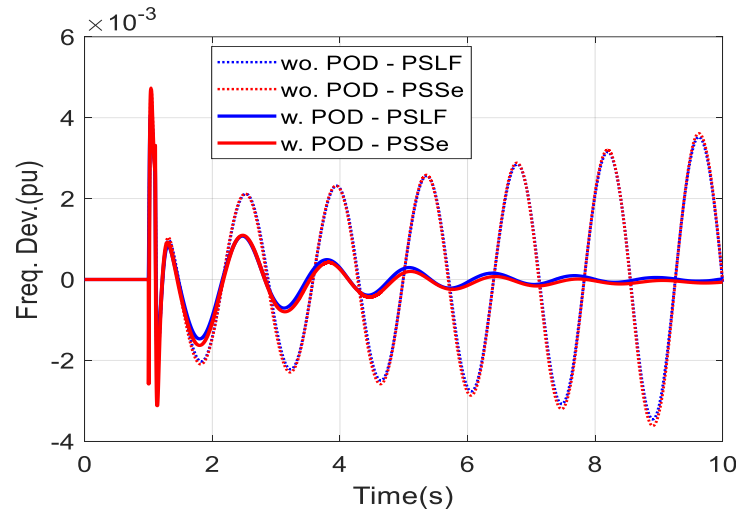
- Wide-area PMU data
- Separate controller at the IBR plant

# IBR Power Oscillations Damper (POD)

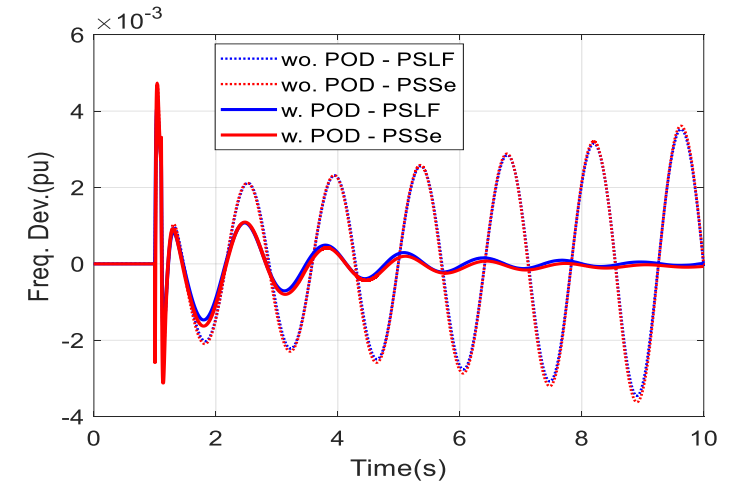
- Objective: IBRs providing oscillations damping control similar to synchronous generators with PSS
- Local control
- P or Q control



## P Modulation



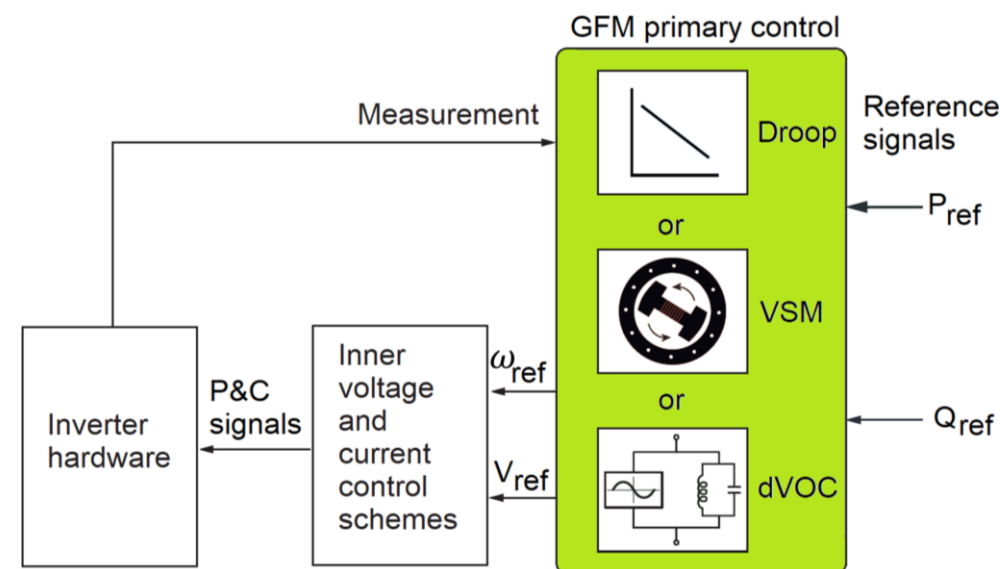
## Q Modulation



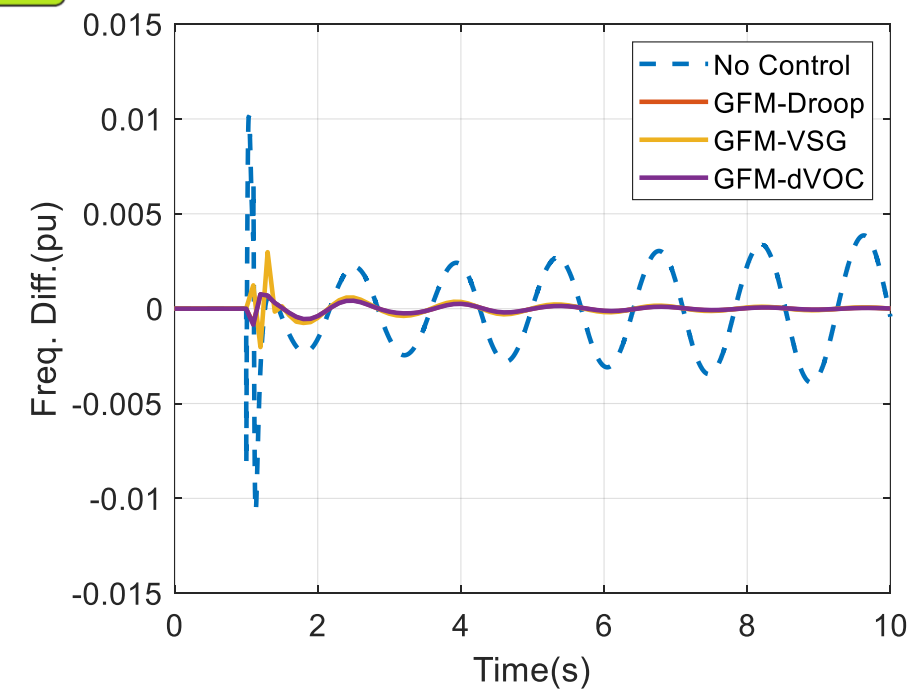
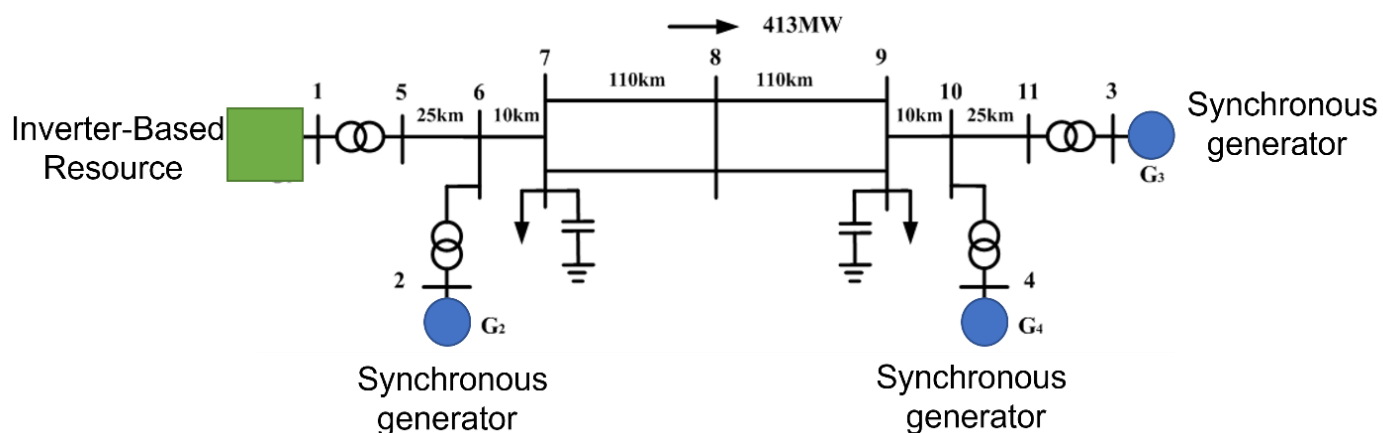
**IBR POD stabilizes the system with either P or Q modulation**

# Grid Forming Inverter POD

- Objective: Investigate inherent capability of grid forming (GFM) inverter controls to provide oscillation damping

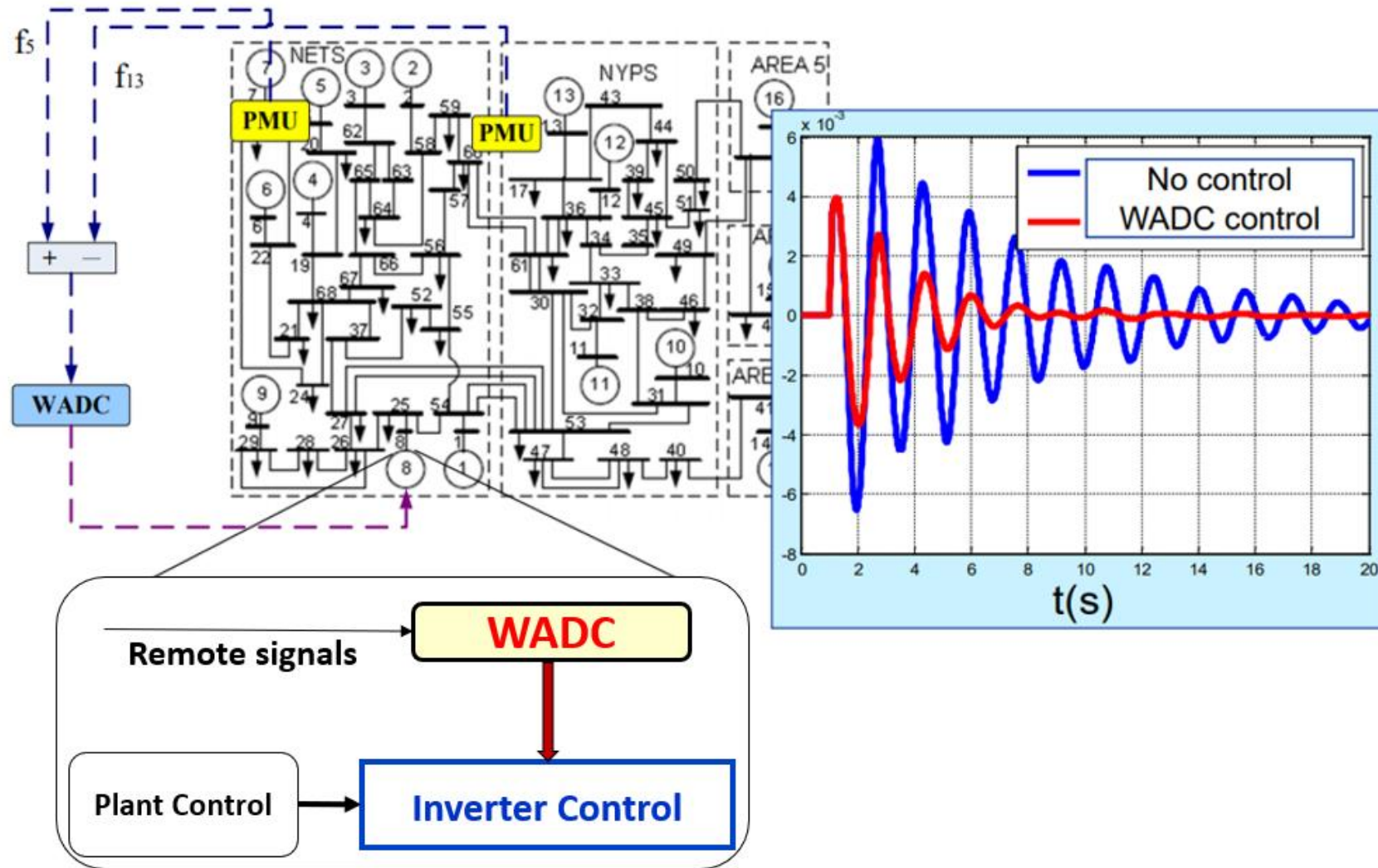


- GFM control designs
  - Droop
  - Virtual synchronous machine
  - Dispatchable Virtual Oscillator (dVOC)



**GFM control stabilizes the system**

# Synchrophasor-Based Wide Area Oscillation Damping Controller

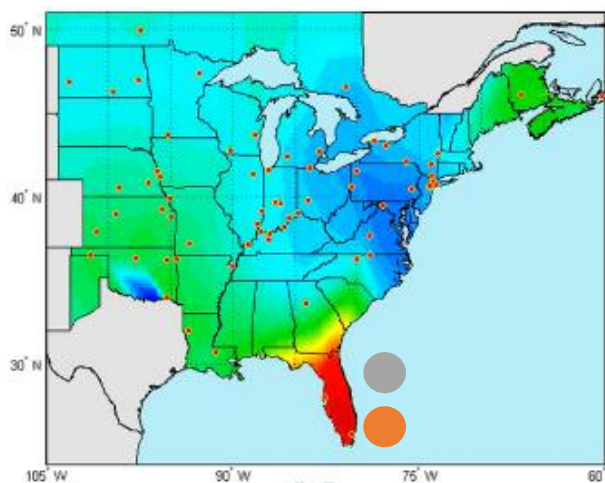


- Improved Damping of Target Inter-area/Intra-area Oscillation Mode
- Application of Synchrophasor Technology in Closed Loop Wide Area Control

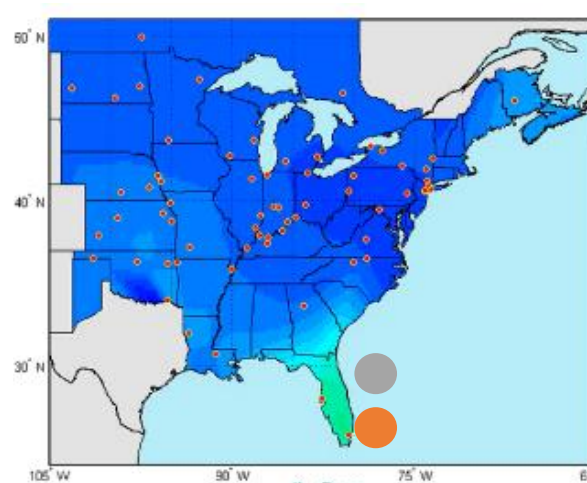
# Forced Oscillations Control

## Suppress Forced Oscillations Magnitude

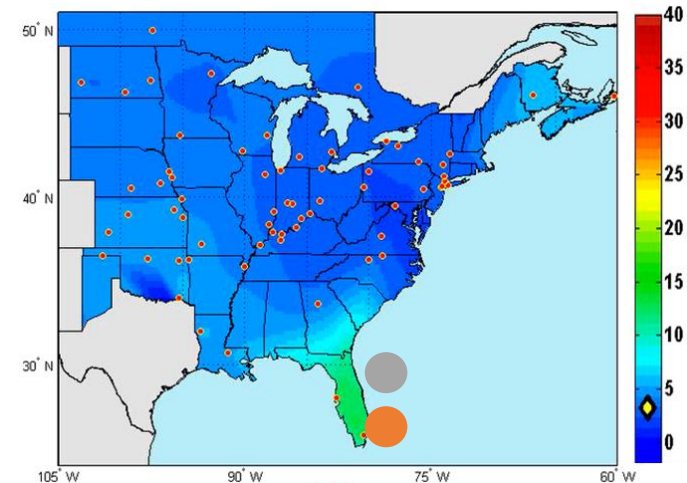
- Case study: El 70k Bus Model - Jan. 11, 2019 Event
- Forced Oscillation Source: Generator in Florida
- Actuator: BESS in Florida
- Scenarios
  - Case 1: No Control
  - Case 2: With Control, one 409 MW BESS
  - Case 3: With Control, 12 distributed 35 MW BESSs



No Control



With Control  
(1×409 MW BESS in Florida)



With Control  
(12 ×35 MW BESS in Florida)

Source:

Florida



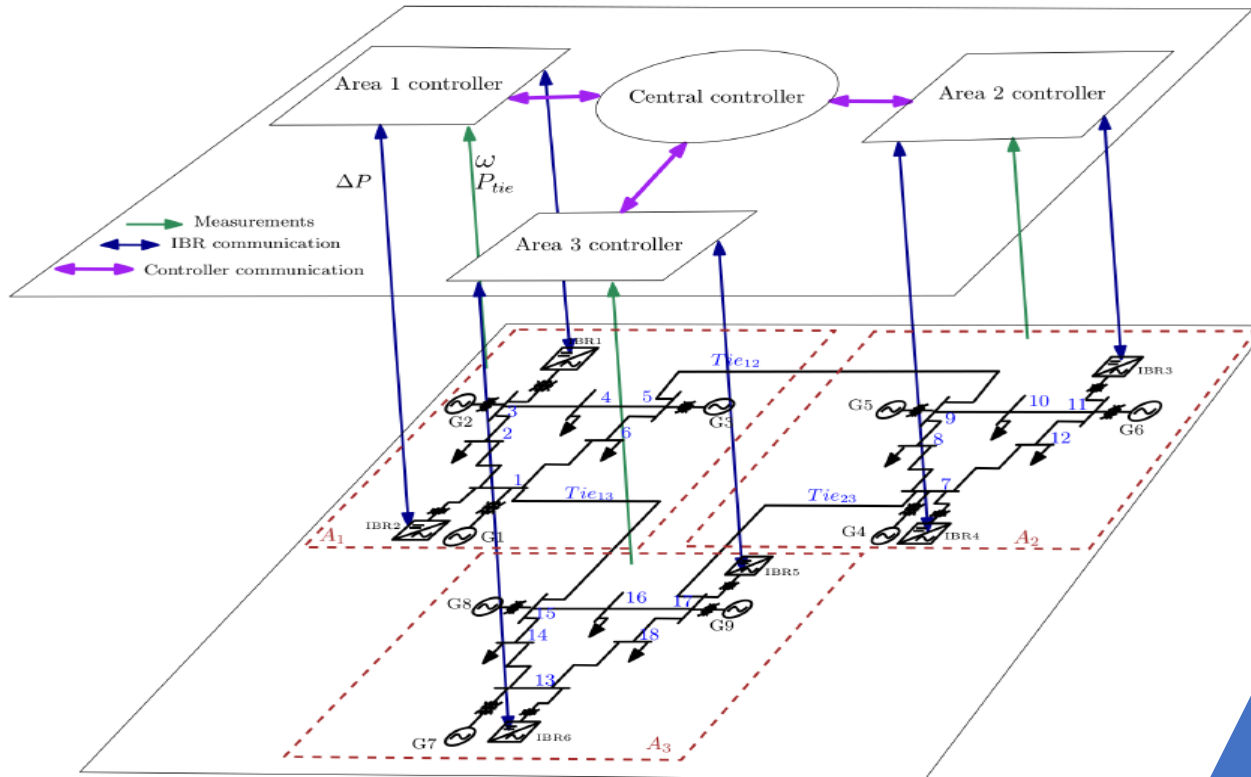
Battery:

Florida



# Hierarchical Decentralized Frequency Control

## Frequency control layers



### Central Controller

- Coordinates local area controllers
- Slower global response

### Local Area Controllers

- Monitoring and control signals only from/to area resources
- Faster local area response

### IBR Constant Frequency Control

- Fast frequency control
- Using only local frequency measurements for expedited response

Use of  
PMU  
data



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**ENERGY**

unifi is co-led by NREL, University of Texas at Austin, and EPRI

**unifi**  
**consortium**

**universal interoperability  
for grid-forming inverters**

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

# UNIFI Members - Project Team (continuously updated)

National Labs & Research Institutes



Transforming ENERGY



Universities



Industry

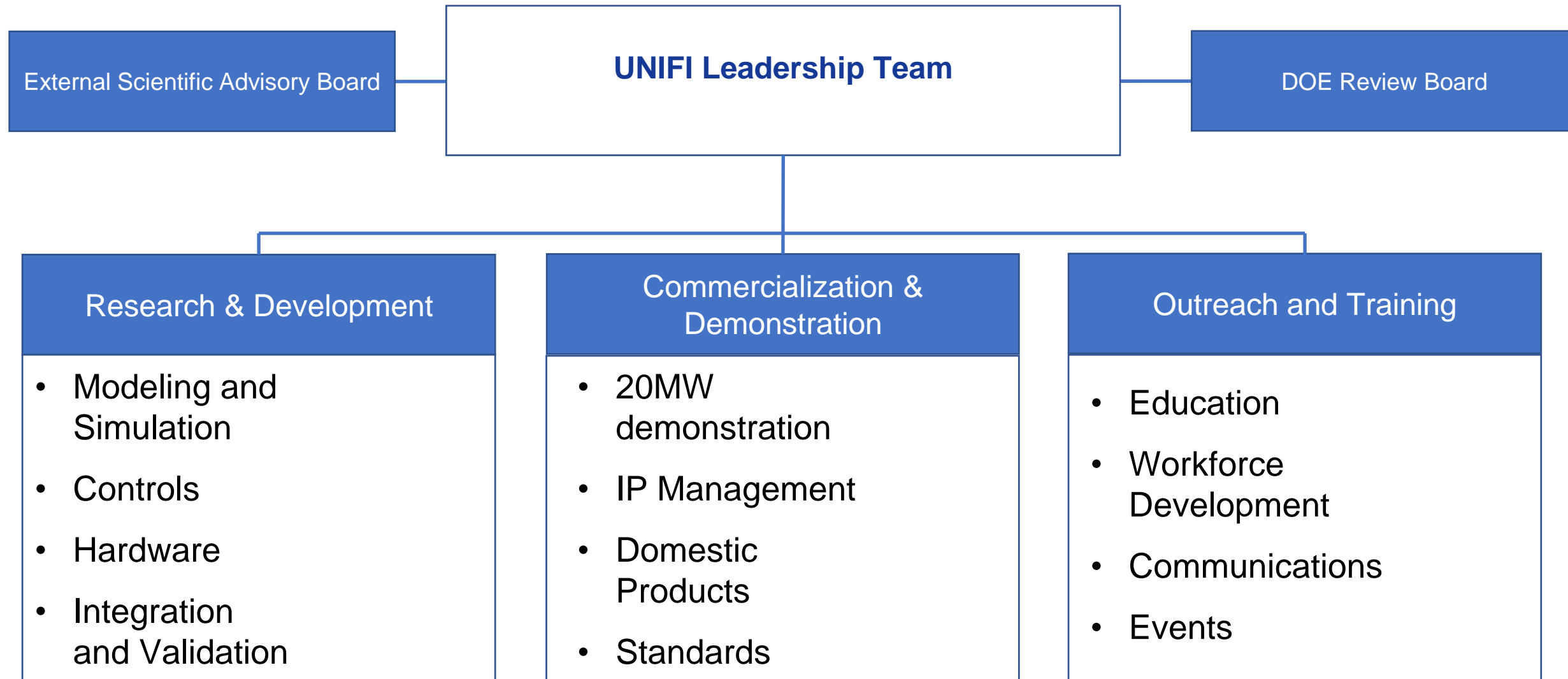


Utilities & System Operators



unifi consortium

# UNIFI Organizational Structure



A blue-tinted photograph of four people standing in a row. From left to right: a man with curly hair and glasses in a lab coat; a man with glasses in a lab coat and tie; a woman in a hard hat and work shirt; and a man with glasses in a button-down shirt. The text 'Together...Shaping the Future of Energy®' is overlaid in white in the center.

Together...Shaping the Future of Energy®