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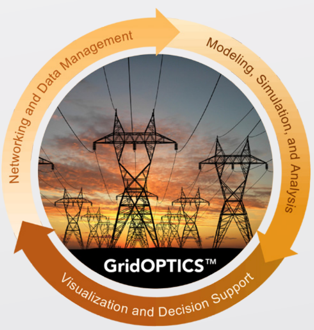



U.S. DEPARTMENT OF ENERGY

FUTURE POWER GRID INITIATIVE

# Future Power Grid Control Paradigm

## OBJECTIVE

This project will construct a novel control paradigm to

» Achieve enhanced system-wide reliability

» Enable renewable integration & exploit the potential of distributed smart grid assets

» Significantly reduce the risk and impact of cascading failure

More specifically, the focus is on

» Constructing distributed hierarchical robust controllers (DHRC)
  - Improve transient stability of system over wide operating range
  - Coordinate DHRC with remedial action schemes (RAS)
  - Optimal voltage control for improved voltage stability
  - Use PMU measurements for dynamic state estimation to be used in DHRC

» Integrating Distributed Energy Resources (DERs) and quantifying impact on the bulk system

» Validating proposed controllers on test systems and WECC model

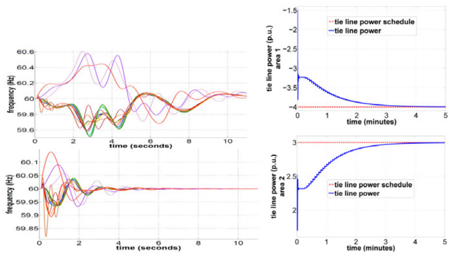
» Prototyping proposed control strategy utilizing high performance computing (HPC)

## APPROACH

» The proposed control paradigm will
  - Improve transient stability and restore system conditions (frequency & tie line power) after contingencies
  - Coordinate voltage resources to improve voltage security margin

» Transient stability
  - Design decentralized (local) robust controllers using Linear Matrix Inequality (LMI) to quickly stabilize system
  - Modify AGC to only focus on restoring tie line power to scheduled values
  - Model an existing remedial action scheme (acceleration trend relay)
  - Coordinate DHRC with remedial action schemes (RAS)

» Voltage stability
  - Minimize voltage deviation from desired voltage profile using minimum control effort subject to operational constraints
  - Employ Model Predictive Control technique



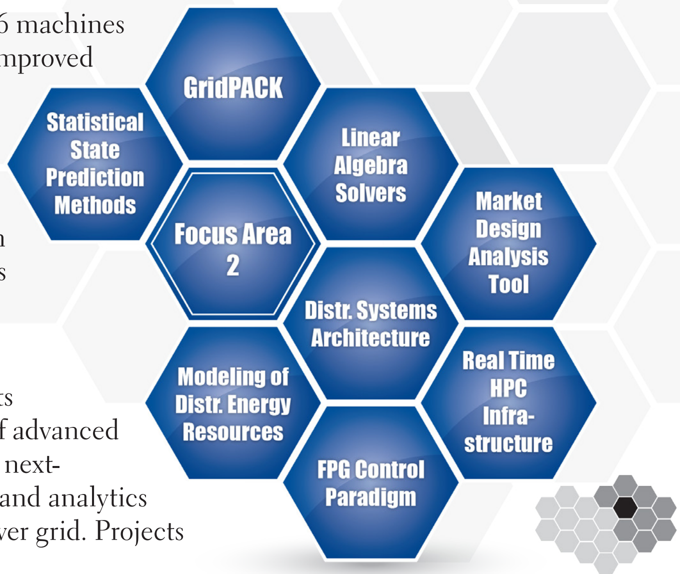

## IMPACT

Coordination of DHRC and AGC

- Conventional control unable to stabilize system
- Decentralized robust controller quickly stabilizes system
- Oscillations of all 16 machines damped quickly – improved frequency performance
- AGC ensures tie line power flows for all 5 areas return to scheduled values

## FOCUS AREA

**Focus Area Two** targets research in the areas of advanced mathematical models, next-generation simulation and analytics capabilities for the power grid. Projects in Focus Area Two will use high-throughput data streams produced by projects in Focus Area One and integrate them with sophisticated mathematical models to conduct large-scale power grid simulation and analysis. Focus Area Two strives to advance the state-of-the-art in modeling and simulation in order to achieve much higher fidelity situational awareness and global comprehension for power grid stability, efficiency and flexibility. **Focus Area Leads:** Ian Gorton (ian.gorton@ pnnl.gov), and Ning Zhou (ning.zhou@ pnnl.gov)




## ABOUT FPGI

The Future Power Grid Initiative (FPGI) will deliver next-generation concepts and tools for grid operation and planning and ensure a more secure, efficient and reliable future grid. Building on the Electricity Infrastructure Operations Center (EIOC), the Pacific Northwest National Laboratory's (PNNL) national electric grid research facility, the FPGI will advance the science and develop the technologies necessary for meeting the nation's expectations for a highly reliable and efficient electric grid, reducing carbon emissions and our dependence on foreign oil.

## ABOUT PNNL

Pacific Northwest National Laboratory is a Department of Energy Office of Science national laboratory where interdisciplinary teams advance science and technology and deliver solutions to America's most intractable problems in energy, the environment and national security. PNNL employs 4,900 staff, has an annual budget of nearly $1.1 billion, and has been managed by Ohio-based Battelle since the lab's inception in 1965.



**For more information, please visit the FPGI website or contact:**

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