Control Theory

CHALLENGE

The increasing penetration of stochastic and variable renewable power generation (both centralized and distributed) in many electrical transmission and distribution grids decreases the availability of traditional forms of generation used to control real power for balancing load and reactive power for regulating voltage magnitude. These changes are driving an emerging transition to leverage a large latent capability in the grid to control distributed energy resources (DERs), which include distributed generation, battery storage, and loads.

To address these concerns, solutions must be developed and deployed that allow a vast number of DERs to participate in optimizing and controlling the electrical grid, enabling reliable and cost-effective operation with leaner power reserve margins to better serve stakeholders such as utilities and consumers.

APPROACH

A team of researchers from multiple national laboratories and their industry partners are developing new solutions in grid control architectures, algorithms, and deployment strategies that will enable large DER deployments to the power grid and help to maintain system efficiency and cost-effectiveness. The main objectives of the project are as follows:

- Develop hierarchical control strategies to enable control and coordination of more than 10,000 DERs with widely different responses.
- Ensure the compatibility of newly developed control solutions with existing and grid architectures addressing legacy systems, communications-heavy systems, and communications “lite” systems.
- Systematically manage uncertainty related to intermittent power generation and control error.
- Incorporate power flow physics and network constraints into control solutions.
- Enable integration of DERs with legacy systems and bulk power system markets.
- Test and validate the control systems; this includes developing test methods, protocols, and scenarios that are relevant to industry operating systems and requirements, and are vetted with a wide range of stakeholders.

At-A-Glance

PROJECT LEADS

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PARTNERS

- Oncor Electric Delivery
- PJM Interconnection
- United Technologies Research Center

BUDGET

$6.5 million

DURATION

April 2016 – April 2019

TECHNICAL AREA

Systems Operation and Control

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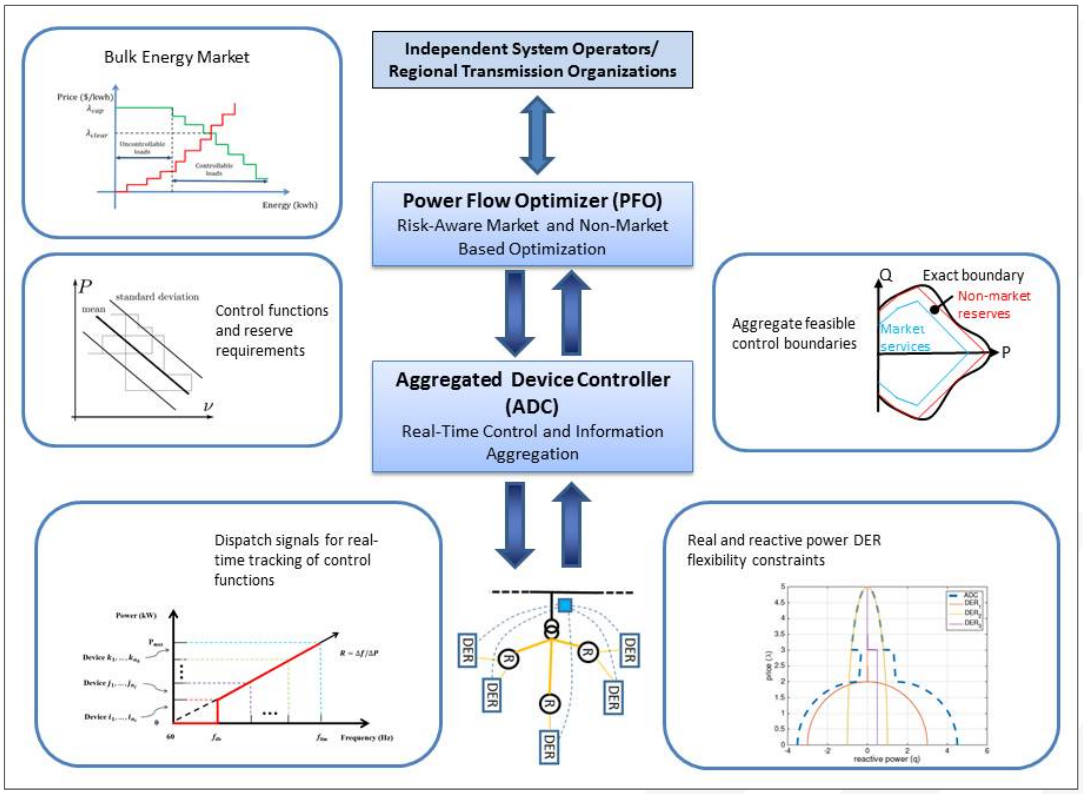
EXPECTED OUTCOMES

The main outcomes of this project are novel control solutions for large deployments of DERs that create an electric system that is more flexible than the legacy system to maintain and improve system reliability and cost-effectiveness, while integrating a large number of renewable resources. Solutions will enable the following:

- integrated optimization and control systems that are more effective at keeping operating conditions within safety margins;
- a 33% decrease in the cost of power reserve margins, while still maintaining reliability; and
- interconnection of intermittent power generation with less need for electrical storage and lower integration costs.



Interfaces for power flow optimizers and controllers are being developed for the integration of large numbers of DERs into distribution grids.

LAB TEAM

Launched in November 2014 under the U.S. Department of Energy's Grid Modernization Initiative, the GMLC is a strategic partnership between DOE Headquarters and the national laboratories, bringing together leading experts and resources to collaborate on national grid modernization goals. The GMLC's work is focused in **six technical areas** viewed as essential to modernization efforts:

Devices and Testing | Sensing and Measurements | Systems Operations and Control
Design and Planning | Security and Resilience | Institutional Support