Recently Awarded DOE Grants

(https://energy.gov/eere/sunshot/enabling-extreme-real-time-grid-integration-solar-energy-**energise**)

ADVANCED MICROGRID SOLUTIONS
Project Description: This project takes a holistic approach to address critical challenges that prevent high levels of distributed solar penetration in power system networks. The team is coordinating interaction of solar generation units, electric cars, energy storage devices, and demand side management programs to provide multiple grid services in real-time. This project aims to deploy a general-purpose software platform that will create an optimal dispatch of distributed resources while ensuring secure and normal operations of electric power distribution networks. The project will ultimately enable a large scale deployment of the solution to other cooperatives and municipal- and investor-owned utilities.

CITY OF RIVERSIDE - PUBLIC UTILITIES
Project Description: This project designs, deploys, and demonstrates at scale a novel distributed energy resource management system. Its main component is a sophisticated numerical analysis platform that will enable an optimal and active network management solution for real-time control. The solution provides secure and optimal dispatch of distributed energy resources for power system networks (both transmission and distribution) on feeders with over 50% PV penetration. This technology deployment and demonstration will be transformational to utilities that may not have financial resources to deploy full advanced distribution management systems.

NATIONAL RENEWABLE ENERGY LABORATORY
Project Description: This project develops, validates, and deploys a unique and innovative data enhanced hierarchical control (DEHC) architecture that enables the efficient, reliable, resilient, and secure operation of future distribution systems with a high penetration of distributed energy resources like solar energy. The DEHC architecture enables a hybrid control approach where a centralized control layer will be complemented by distributed control algorithms for solar inverters and autonomous control of grid edge devices. The architecture aims to be fully interoperable and include all the cybersecurity aspects that are necessary for reliable and secure system operation.

NATIONAL RENEWABLE ENERGY LABORATORY
Project Description: This project develops a novel control scheme that provides system-wide monitoring and control using a small fraction of the active devices on the grid. The key innovation of this project's approach is to proactively manage very large distributed energy resource populations using only a few measurement points for input through predictive state estimation and a few carefully selected control nodes identified and dispatched through online multi-objective optimization. The platform gives utilities the capability to seamlessly dispatch legacy devices and distributed energy resources to achieve system-wide performance and reliability targets.

NORTHEASTERN UNIVERSITY
Project Description: This project develops, implements, tests, and validates a comprehensive state estimation algorithm for combined monitoring of transmission and distribution systems. This approach allows the computational complexity and solution time to be bounded regardless of the system size and number of measurements. The approach utilizes a mixed set of measurements under different network configurations and is able to handle any number of available solar photovoltaic (PV) units connected to the distribution system.

PPL ELECTRIC UTILITIES
Project Description: This project leverages several different grid technologies to deploy a distributed system platform that bridges the gap between existing and future technologies by monitoring, controlling, and optimizing a high penetration of solar generation. PPL is also developing a multi-layer device and communications architecture and a 500-customer pilot on at least 10 distribution circuits. The project team plans to perform an extensive one-year demonstration, proving all of the target parameters before deploying it system-wide.

QUANTA TECHNOLOGY, LLC

Project Description: This project develops a new power grid operation architecture that combines distributed control with centralized dispatch to provide power system frequency and voltage support. This includes the design and development of a new generation of PV inverters that operates and behaves like a synchronous generator. The solution integrates any available data with a new wide-area PV monitoring and control platform to increase the visibility and controllability of distributed solar generation resources. It provides an accurate estimation of the current power system status for making control decisions in real-time operations, integrating transmission and distribution control strategies.

SANDIA NATIONAL LABORATORIES

Project Description: This project creates an open-source advanced distribution management system that encompasses distribution circuits and distributed energy resource management, including state estimation, voltage regulation, protection coordination, economic optimization, interoperability, and cybersecurity. This system software provides real-time visibility into distribution circuits and optimizes the active and reactive settings to meet voltage regulation, protection, and economic objectives in the presence of forecast uncertainty. The open-source software is being incorporated into a commercial vendor's platform to demonstrate the technology with extensive testing and field demonstrations at 20 feeders located within two utilities.

SOUTHERN CALIFORNIA EDISON

Project Description: This project leverages existing information systems and processes to increase efficient communication exchange between the utility and customer/resource provider interconnection process by optimizing control of the resource. This complete lifecycle approach defines the necessary data to be exchanged, the grid and device characteristics, and the operating constraints and protocols to enable effective controls and operations. This structured and automated exchange of characteristics and parameters accelerates the interconnection process, establishes common information requirements, and enables effective operational connection of distributed energy resources to the grid.

UNIVERSITY OF CALIFORNIA, BERKELEY

Project Description: This project designs, implements, and demonstrates an innovative framework to enable penetration levels of solar PV generation greater than 100% on the distribution grid. By explicitly controlling voltage phasors at specific network nodes, this framework simultaneously addresses multiple operational challenges, including high resource variability, reverse power flow, grid visibility, and coordination between transmission and distribution systems. The framework solves the problem of complex interdependencies in large networks by creating options for partitioning the grid both physically and computationally.

UNIVERSITY OF CENTRAL FLORIDA

Project Description: This project designs and develops a scalable architecture and a set of algorithms for distributed control and optimization. The platform encompasses automatic fault location isolation and service restoration and Volt-VAR optimization; distribution system state estimation algorithms for both the conventional non-convex task and the convex state estimation task; a three-phase unbalanced power flow model that captures the non-linear behavior of system components and enables rapid computation of sub-transmission network and unbalanced distribution network; a two-stage stochastic security-constrained algorithm for real-time operational planning; and a distribution energy market framework that utilizes both model-based and data-based techniques to provide market-based signals for real and reactive power control of PV systems.

UNIVERSITY OF SOUTHERN CALIFORNIA

Project Description: This project uses data to develop novel representations of distributed energy resource owners' interactions via data-driven models along with stochastic reserve optimizations that enable net-load balancing in near real-time. The project develops a transformational distributed grid control architecture as a part of an enhanced system layer at the distribution network level that optimizes the coordinated usage of large numbers of variable and distributed resources, decentralized energy storage, and load to ensure real-time, system-wide, net-load management and automated adaptation to real-time variability in a cost-effective, secure, and reliable manner.

UNIVERSITY OF VERMONT

Project Description: This project develops a layered predictive optimization and coordination framework to coordinate the flexible resources available in the distribution grid, as well as the legacy control devices, to ease the fluctuations and variability in solar generation. Solar forecast data is leveraged to schedule the dispatchable flexible resources in a look-ahead fashion, while any mismatch due to solar forecast errors will be solved through real-time coordination of the controllable resources. New estimation methods are leveraging data from smart meters and sensors to estimate the available flexibility in the distribution system, as well as identify the real-time operating conditions, to aid in the informed decision making process. Aggregated models of the flexible resources will be leveraged in a hierarchical fashion to implement autonomous response to contingencies.

Other Topics:

1. Distributed reactive power support from PV with Conservation Voltage Reduction - http://ieeexplore.ieee.org/document/6804573/
2. Load Models Effects on Distribution System Losses: http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6672823
3. Distribution Grid Edge Control: http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=7742011
4. Battery-Assisted Distribution Feeder Peak Load Reduction: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7741848
5. Impact of high PV penetration including harmonic distortion - http://ieeexplore.ieee.org/document/6194986/
6. Investigations on control schemes of solar-PV power generation in distribution feeder with battery storage - http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=7793251
7. Assessing maximum DG penetration levels in distribution feeders by using OpenDSS - http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7783416
8. Load management in distribution system by utilizing smart meter data - http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7861373
9. Cloud shadow model for analysis of PV power variability - http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7742024
10. ???