

Smart Grid Subcommittee Overview and Report: Distributed Energy Resources (DER) Valuation and Integration

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Subcommittee Chair

Electricity Advisory Committee
June 7, 2017

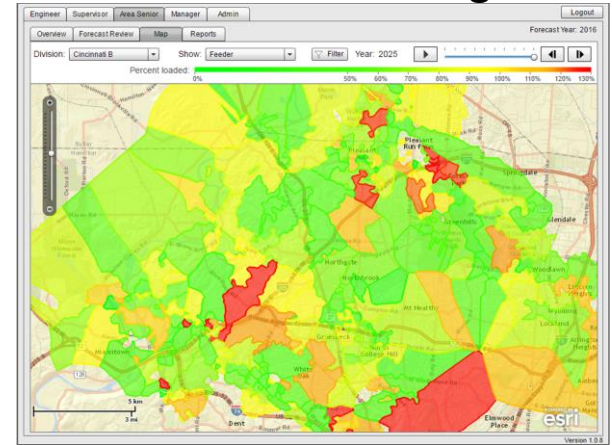
Subcommittee Overview

- Energy Independence & Security Act §1303 - Subcommittee advises DOE:
 - The development of smart grid technologies, the progress of a national transition to the use of smart-grid technologies and services, the evolution of widely-accepted technical and practical standards and protocols to allow interoperability and inter-communication among smart-grid capable devices, and the optimum means of using Federal incentive authority to encourage such progress.
- Sought Input from Leading Industry, Academic, and DOE Experts
 - March 2016 EAC Meeting: DER Panel
 - June 2016 EAC Meeting: Transactive Energy Panel
 - Second Half 2016 : Review of DOE's Grid & DER related R&D
 - January 2017 Subcommittee Focus: Cyber Security
 - March 2017 EAC Meeting: Internet of Things Panel
 - Spring 2017: Complete DER Valuation and Integration Paper

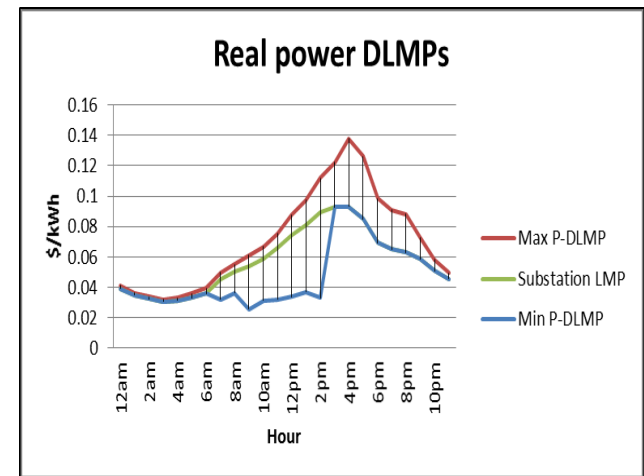
DER Value & Distribution Level Markets

- Bill Kallock, Integral Analytics:
 - Need Granular analysis to capture full utility benefits of DER at the edge of the grid
- Prof. Michael Caramanis, Boston University
 - Centralized Market Clearing for system with high DER NOT Tractable
 - Distributed Market Clearing Tractable
 - Issues that require further study:
 - Interplay of real and reactive power with provision of reserves
 - Market power issues
 - Communication architecture & Security

Spatial Distribution Planning Forecasts



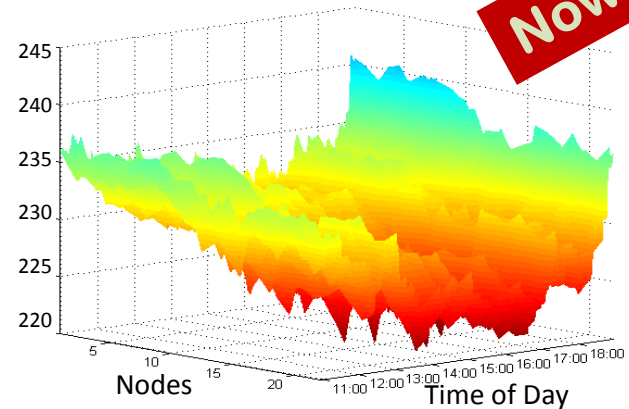
Modeling: Summer Day, High DER for 800 Bus Distribution Feeder



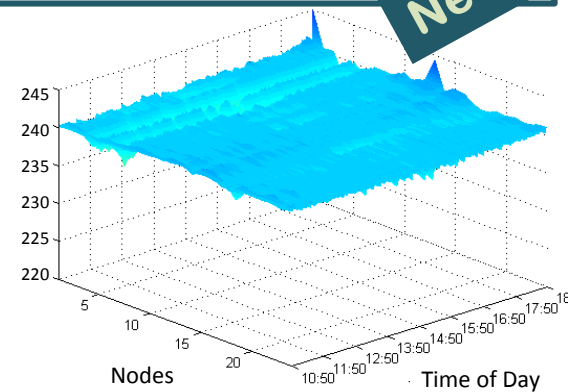
Distributed Control Systems

- Prof. Deepak Divan – Georgia Tech Center for Distributed Energy
- Recommendations included:
 - Enhanced dynamic and distributed grid models and simulation tools needed to understand system behavior – *new tools to manage the new system*
 - Interaction of massively distributed autonomous assets with each other & with existing grid control poorly understood – *research initiative needed*
 - Mixed market model – *centralized dispatch, transactive at mid-level, autonomous at edge*

Centralized Control



Distributed Control



Distributed Resources: Significant & Growing

- Over 14 million customers are supplying power back into the grid
- More than 80 GW of combined heat and power generation, equal to 8% of total U.S. generating capacity
- Near doubling of distributed PV from 7.3 GW in 2014 to 13.8 GW in 2017
- Over 16 million customers in demand response or time-varying rate programs
- Millions of consumers with back-up generators or energy storage systems
- 535,000 Electric Vehicles with charging that could be price responsive
- Advanced power electronics in some cases providing >5% energy & demand savings through voltage optimization and power flow control

DER Valuation & Market Integration

- **Finding: DOE should develop tools to support efficient wholesale markets that provide increasingly granular price signals to help integrate DERs and should coordinate with FERC and state regulators**
 - DER Value is time-, system-, circuit-, location-, product-, & often customer-specific
 - State activities in: AZ, CA, HI, IL, MD, MA, MI, MN, NH, NY, OH, RI, & VT
 - Existing markets often fail to provide incentives for the efficient use of DERs
 - RTOs typically settle the load side of wholesale markets based on average hourly and zonal prices, often based on historical customer class load profiles, and this is a roadblock to development of efficient markets for DER
- **DER Valuation and Integration work should continue with key objectives :**
 - Develop increasingly detailed, accurate, and transparent, methods, and tools for valuing DERs in the context of system planning and the consideration of DERs as an alternative or supplement to conventional grid investment
 - Develop an increasingly granular market model that supports efficient pricing of the electric products and services that DER provide, extending competition policies further into the power system and creating accurate price signals for the development and operation of DER where and when it is economic to do so

DER Valuation & Market Integration

- ***Recommendation: Additional R&D on methods and tools to ensure appropriate time-, location-, and product-specific valuation of DER, efficient integration of DERs into power system planning and operations, and improved market models for more efficient pricing of the electric products and services that DERs provide***
- ***Recommendation: Continuing and expanding work to support regulatory authorities in consideration of policies and rate structures that advance economically efficient integration of DER into markets & grid operations***

Planning & Operations: Methods & Tools

- **Finding: DOE has an essential role in the development of frameworks, methods, and tools needed for DER valuation and integration**
 - Power grid is characterized by “ultra-large scale complexity; DER are making it more distributed, dynamic, and challenging to plan and operate
 - DER likely to require fundamental changes in distribution planning, power markets and pricing, and system operations
 - Research needed on the interactions and balance among markets that rely on centralized dispatch, mid-level distributed transactive markets, and autonomous devices operating at the edge of the grid
 - Given a thin and highly regulated market, no private sector firm or group of firms is well positioned by itself to undertake the needed R&D
 - ***Recommendation: Continuing R&D on tools, including computational methods for managing operations with more dynamic and distributed grid, simulation tools to understand system behavior in high DER environment, and research on the interactions and balance in markets with DER***
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Basic & Goal-Directed Applied R&D

- **Finding: DOE plays a positive role & provides essential leadership in both basic research conducted through the Office of Science and forward-looking, applied R&D for modernizing the grid and addressing DER**
- DOE's goal-directed and forward-looking applied R&D programs play a positive role in addressing the specific challenges of integrating DER
- Valuable DOE programs include and are not limited to:
 - Grid Modernization Initiative
 - Cybersecurity for Critical Energy Infrastructure program
 - Support for power system standards development
 - Advanced Research Projects Agency for Energy power grid focused research programs: ADEPT, GENI, Grid Data, NODES
- ***Recommendation: Continuing support for Grid Modernization Multi-year Program Plan***

Coordination, Information & Technical Assistance

- **Finding: DOE is uniquely positioned to convene the diverse entities involved in grid operations and control, facilitate the stakeholder dialog, and provide scientifically supported information and technical assistance**
 - Oversight and operation of the nation's electric grid is divided between FERC and state regulatory authorities and among seven regional transmission system operators and more than 3,200 utilities
 - This Federal system enhances experimentation and opportunities to integrate new technology while reflecting local perspectives
 - DOE's role in facilitating cooperation and access to information is critical to ensuring appropriate valuation and integration of DERs
 - ***Recommendation: Collecting and harmonizing the various frameworks under development in leading states***
 - ***Recommendation: Approaching integration and valuation from both a customer perspective and a grid or utility perspective***
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On-going Work for 2017

- Internet of Things:
 - Continue Examination of Security Concerns
 - Investigate Potential Applications & Benefits: e.g. Potential benefits, barriers, and opportunities for smarter, more efficient buildings and uses of electricity
- Infrastructure Investment in the Grid:
 - Examine how to facilitate most economically valuable investments
 - Examine how to maintain U.S. leadership in technologies for power grid

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