



i-PCGRID Workshop 2014

Innovations in Protection & Control for Greater Reliability Infrastructure Development



Sustainable Energy Trends

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Smart Solutions, Practical Results



Outline

Industry Trends & Drivers

Aging Infrastructure Drivers & Solutions

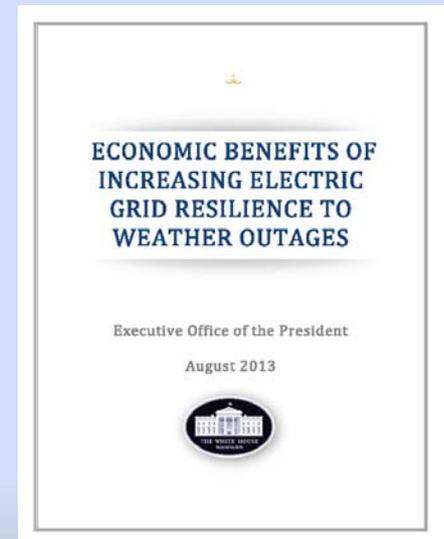
Outlook on & Benefits of Microgrids



U.S. Industry Trends

Electric System Resiliency – Dept. of Homeland Security lists 17 critical infrastructures with Energy on the top as others require it

- Aging Infrastructure Investment - Electric grid in need of upgrading & uprating for up to \$2 trillion by 2030, including generation (EEI)
 - Obama Administration to conduct a Quadrennial Energy Review to focus on a comprehensive strategy for T&D
- Reliability Investment – DOE estimates outage cost of \$125B
 - White House report estimates that weather-related outages cost the economy between \$18 and \$33 billion annually
- Renewables and EV Integration and Microgrids Investment
- Natural Gas Interdependency





Industry Drivers

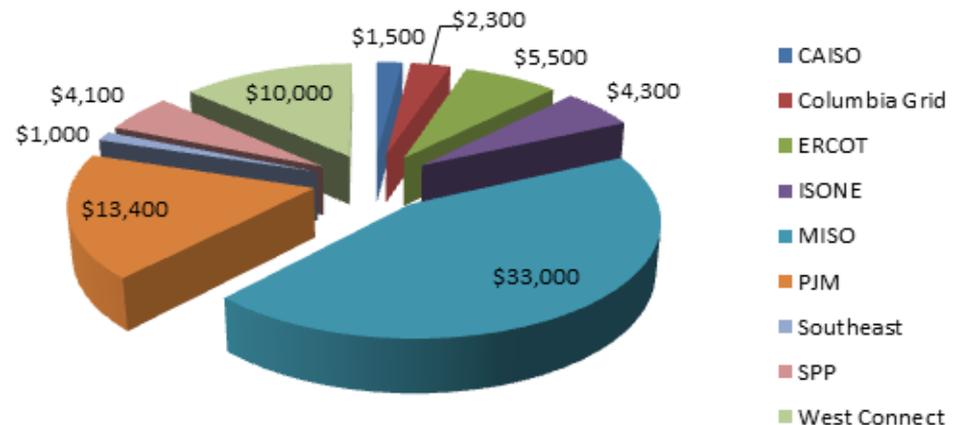
FERC Order 1000

- Competitive process for system improvements
- Requires an open planning process
- Requires Cost Allocation methodology
- Incumbents lose Right of First Refusal
- RTOs/ISOs filed processes w/ FERC



Total: \$95B

**Transmission Capital Spend by Region
2014 to 2019 (\$M)**





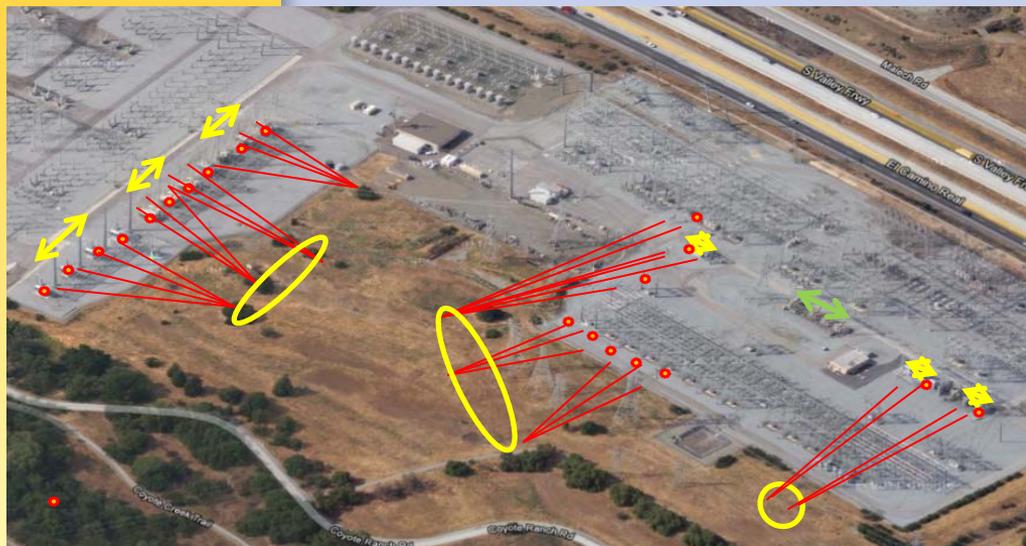
Industry Drivers

Grid Resiliency

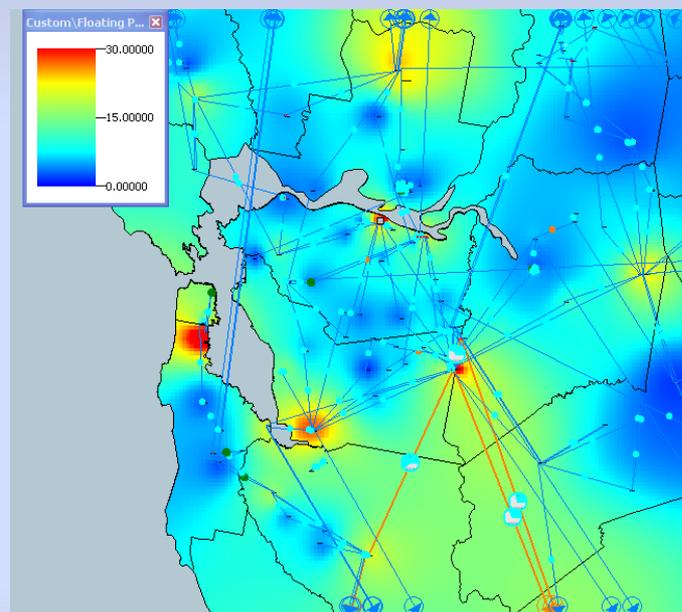
- Cost of Major Outages
- Public Safety & Security
- Critical Infrastructure Protection
- *Physical vulnerability*

Physical Vulnerability

- Transmission Equipment
- System - Selecting critical substations
- Need for Standards?



Equipment with gunshot damage





Industry Events

Utilities Headed for a Cliff? – Energybiz, Jan/Feb 2014

"There will be companies...supplying 40% or more electricity utilities originally provided You'll see the development of a significant number of microgrids that will protect the grid against cyber attack."

Jim Rogers, former Duke Energy CEO

- Wall Street Journal interview with J. Wellinghof, former FERC chairman : "Assault on California Power Station Raises Alarm on Potential for Terrorism"
- C. LaFleur, FERC chairman: "Publication of sensitive information about the grid gives those who would do us harm a roadmap to achieve malicious designs."
- Deputy Assistant Energy Secretary D. Ortiz : "The grid is resilient and disabling many locations would be difficult. FERC's findings had value 'as a way of starting a conversation on physical security."

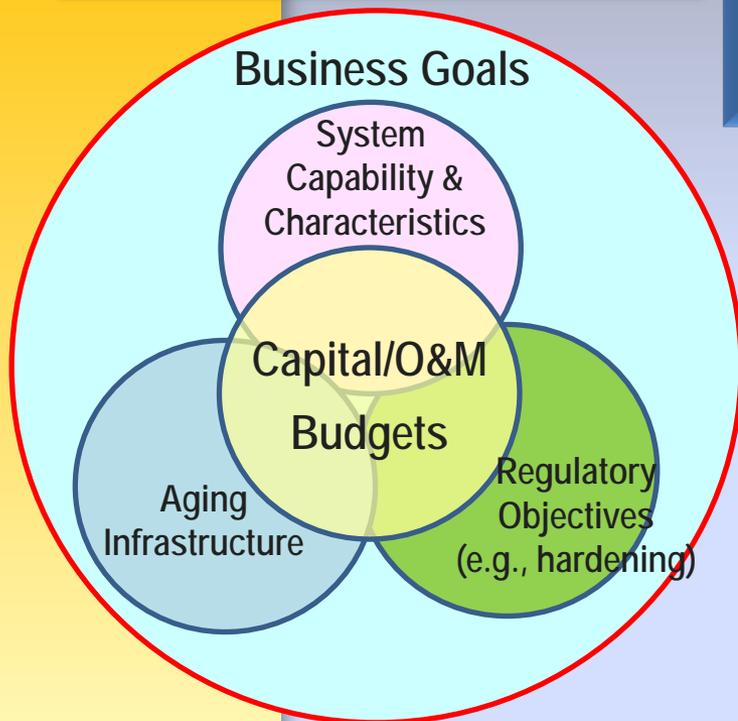
IEEE PES T&D Show "Hot Topic" panel on "Industry Initiatives on Responding to Physical Threats"

PG&E, ComEd, Dominion, DOE



Holistic Asset Management

Asset management: Predictability of Cost & Reliability



Average systems in U.S. 50 to 60 years old

25% of U.S. electric infrastructure is of an age and situation where condition is a concern

Demand for maintenance will double over the next 10-20 y

Awareness of long-term issues gaining attention of regulators, utility boards and analysts

- As system ages, operating cost increases and reliability decrease - limited resources for wholesale replacements
 - Performance based rates require focused asset management strategies
 - How to manage Smart Grid assets?
- Sound strategy for controlling the symptoms of aging within the utility's overall business plan - ROAMSM asset renewal program used to maintain accepted levels of T&D performance



Why Microgrids?

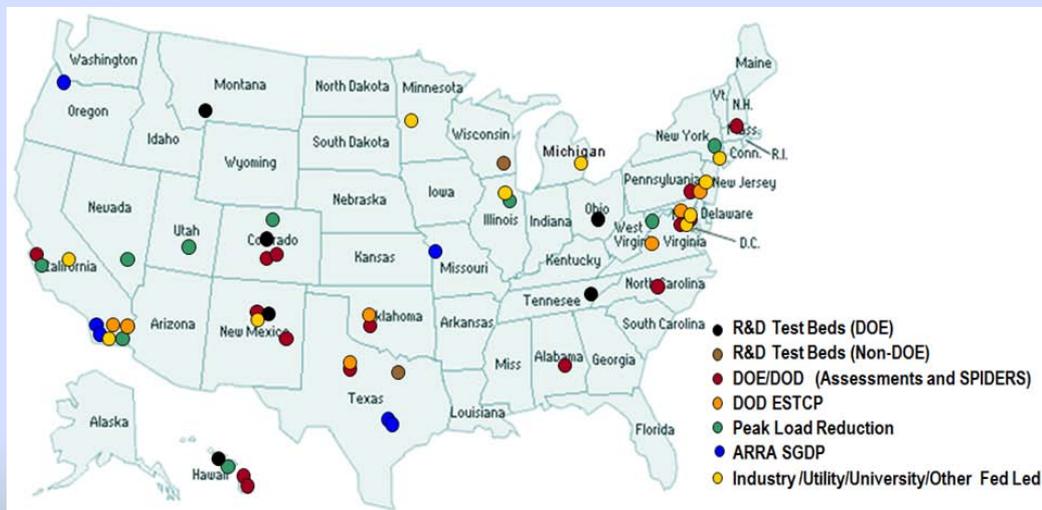
- **Capacity, Reliability and Power Quality**
 - A low-cost augmentation/alternative to a utility system
 - Better power quality and outage management for critical, premium and remote customers (e.g. for weather related events)
- **Sustainability** – Enables optimal dispatch of renewables and high customer involvement
 - Emissions reduction
 - Green marketing
 - Community management
- **Cost Savings** – Portfolio of resources managed locally, but *optimized on the system level*
 - Enables a hedge against fuel cost increase
 - Net-zero model (still relies on the grid)





Optimized Hybrid Microgrids

- Energy Efficiency and Asset Management – lower OPEX:
 - Reduced equipment utilization and losses as generation supplied closer to the load
 - Peak load shaving – in conjunction with market pricing
- Utility grid as backup – Neither the MG nor the traditional system can fulfill all the needs of the local service, e.g. serving all the load, all the time – They must work synergistically
- New tools – Not easy to design and operate

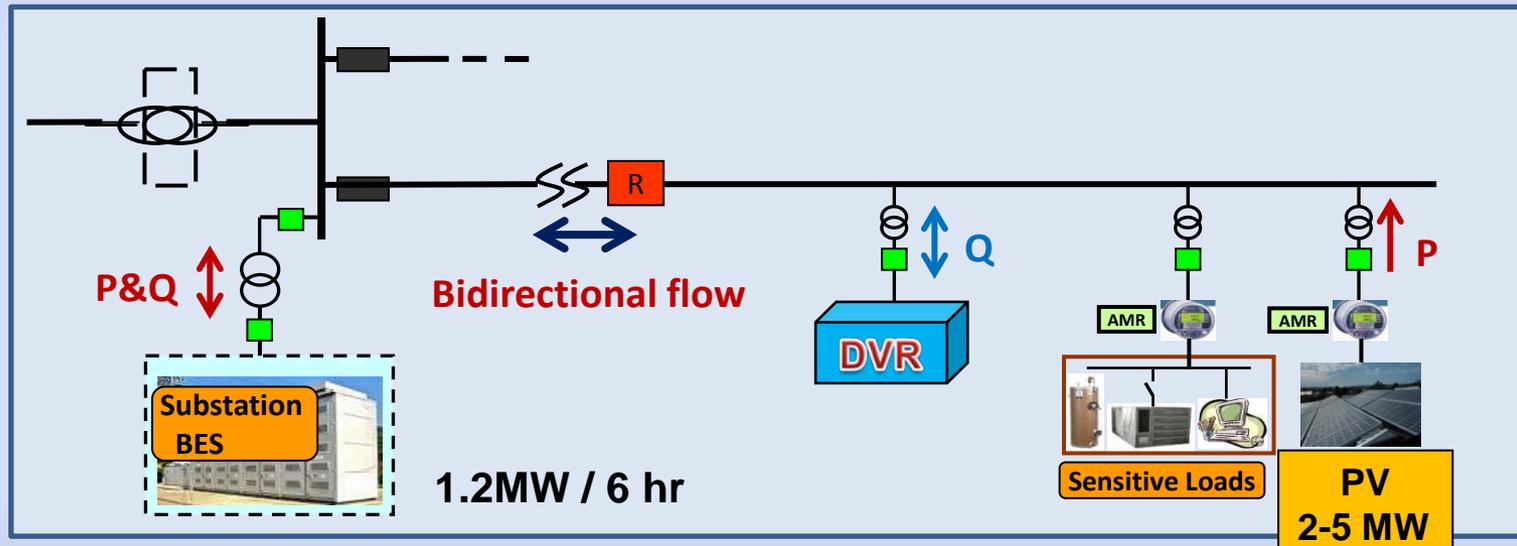


Current Microgrid Landscape in USA (source: DOE)



Early Adopters Value Proposition

- Who is best positioned to optimize use of microgrids?
Life cycle costs, efficiency, reliability, safety, grid resiliency, etc.
- Proactively gain experience with a potential disrupting technology that has the interest of regulators – Educate regulators on business case benefits for end users!
- Gain experience with different types of storage technologies
- Interconnection standards





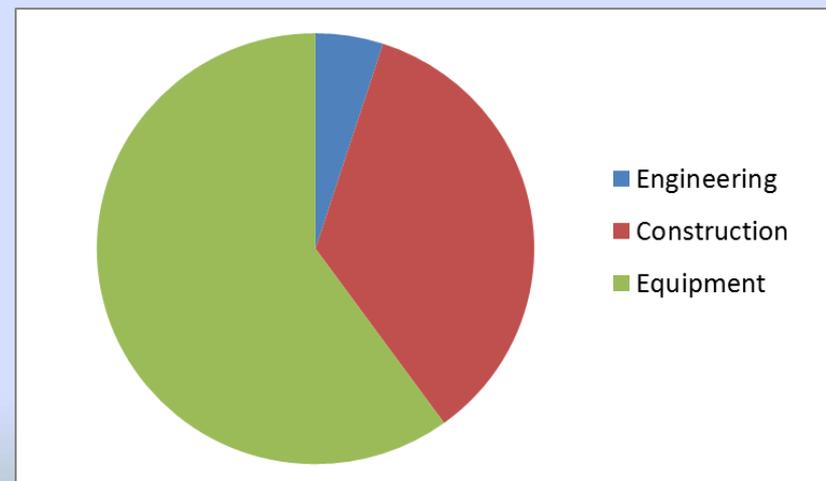
Cost & Benefit Components

Added Value Example:

- Revenue from Renewable Generation
 - Estimated at 18 cents/kWh
 - Firm capacity: Average number of sunny hours per day (3.6 hrs/day)
- Renewable Energy Portfolio (REP) incentives
- Emission reduction benefits
- Lower maintenance
- Reliability and PQ improvement
- Soft benefits, e.g. social

Costs:

- High initial eq. cost
- Upgrade cost
- O&M cost





Conclusions

- Industry is rapidly changing
- Focused Asset Management program required to control costs and manage regulatory requirements
- Significant growth in microgrids – What will be the extent?