GRID MODERNIZATION

SEAB Briefing

Office of Electricity Delivery and Energy Reliability

Office of Energy Efficiency And Renewable Energy

Energy Policy and Systems Analysis

9/5/14

Future Grid

Desirable Characteristics

- Secure
- Safe
- Minimum Environmental Footprint
- Robust
- Affordable
- Scalable
- Flexible
  - Options
  - Interoperable
- Ability to Finance

Future Grid Properties

- Increased Control (e.g. power flow control, storage, control signals)
- Reliable
- Greater Visibility
- Increase predictability
- Efficient and Optimized

Limitations

Age: Transformers
Workforce: 60% - retirement eligible
Cost: EEI estimates that by 2030 investment will need $1.5 -$2.0 trillion total investment

Trends

Increased Data Volumes/Devices	• Rise in distributed energy resources and active loads – thousands to billions of devices requiring system integration
Changing Fuel Mix	• thermal generation to renewables; of natural gas as a replacement for coal in generation
Two-Way Power Flow	• The increase of distributed generation and iinked distribution systems are resulting in a massive increase in two-way power flow.
Evolving Control System	• Central versus distributed control and automation.
Storage	• California goal: 1.3 GW of storage by 2020
Building to grid convergence	• Commercial building owners and grid operators are recognizing the potential value beyond traditional demand response to allow for two way exchange of energy services.

Trends

Evolving industry/Business Model	• States are reviewing the roles and responsibilities of the distribution grid operators
Resilience: Physical, Cyber and Climate	• Metcalf, Hurricane Sandy, ICS exploits
Interdependencies	• Natural Gas / Electric.
Increased system complexity	• DR/DG, responsive generation (e.g. frequency response).

Business as Usual Will Not Achieve Efficient, Timely Modernization

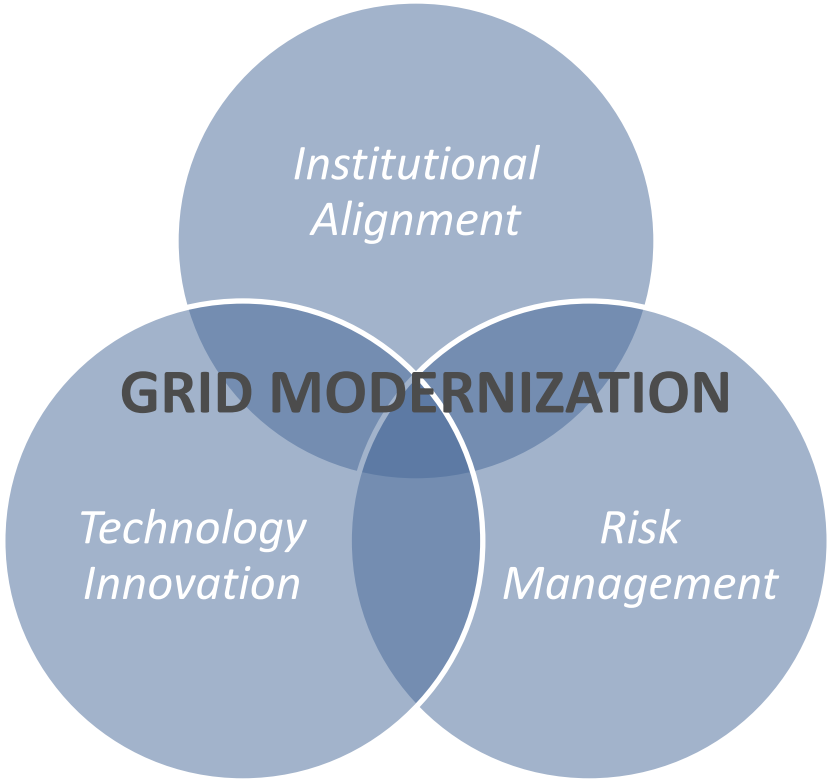
- The Industry is Fragmented
  - No single entity owns the grid
  - Maze of federal, state, and local jurisdictions and policies
  - Variety of market and regulatory structures
- Innovation is Inhibited
  - Rate-based regulation stifles innovation (low risk tolerance)
  - Electricity markets do not sufficiently capture externalities
  - Advances need to be compatible with legacy systems
- Risk and Uncertainty are More Prevalent
  - Outages are not tolerated by consumers and regulators
  - Difficulty choosing among long-lived investment options
  - Utilities and regulators face a sour investment climate

All of this constrains capital investment

QER- Questions on Electric Power

- What are the system vulnerabilities? What methods/metrics can be used for planning and paying for resilience?
- What are the limiting factors in integrating and maintaining zero and low carbon generation in the operation of the power grid?
- What improvements can be made in the use of real-time data, analysis and communication of transmission system conditions?
- How does the current market structure affect the ability to finance infrastructure?

Grid Modernization Strategic Thrusts



- ***Institutional Alignment:*** Focus on key policy questions related to regulatory practices, market designs, and business models.
- ***Technology Innovation:*** Increase the emphasis on coordination and create tools and technologies that measure, analyze, predict, and control the grid of the future.
- ***Risk Management through Multi-scale Demonstrations:*** Collaborate with regulators, utilities and other stakeholder groups to test and demonstrate combinations of promising new technologies and new institutional approaches.

Grid Transformation: Working Together

OE	EERE	EPSA
OE leads the Department of Energy's efforts to ensure a resilient, reliable, and flexible electricity system. OE accomplishes this mission through research, partnerships, facilitation, modeling and analytics, and emergency preparedness	Energy efficiency, and renewable power, and sustainable transportation technologies are integrated into the energy system in a safe, reliable, and cost effective manner at a relevant scale to support the nation's goals of 80% clean electricity by 2035 and reducing oil imports by 33% by 2025.	EPSA is the lead for developing policy options and will provides a framework to harmonize policy development. EPSA has the lead for the Department on the Quadrennial Energy Review.

Results: Coordinated/One AOP; leveraging resources; reducing duplication; integration of laboratory expertise

Future Grid Properties

Institutional Alignment	•Evaluate regulatory and policy options and implications of various grid ownership and operations models – new utility business models evaluated
Technology Innovation: Design and Planning Tools	•Develop planning tools that integrate transmission and distribution and system dynamics and can use high performance computing platforms - deliver 50x speed-up
Technology Innovation: System Control and Power Flow	•Increase ability to coordinate and control up to millions of devices and integrate with energy management systems – coordinate millions of devices; enable one-minute contingency analysis at the interconnect scale
Technology Innovation: Sensing and Measurements	•Develop sensors, analytics, and visualizations that enable 100% observability of generation, loads and system dynamics across the electric system – develop low cost sensors at all scales, handle 1000x data volumes, visualization tools, dynamic accuracy
Technology Innovation: Devices and Integrated Testing	•Develop advanced grid control and integration devices and validate integrated systems that can optimize operations at high variable RE penetrations and provide high reliable service – validate 50-100% DG penetration scenarios on feeders
Technology Innovation: Security and Emergency Response	•Develop advanced security (cyber and physical) solutions and real-time incident response capabilities – capable of identifying cyber events in real-time and analyzing within 12 hours.
Risk Mitigation through Multi-scale Demonstrations	•Develop megawatt-scale demonstrations that show transfer of the technologies developed through R&D activities into the field

Examples of Coordination Across DOE

- Next Generation Energy Management System (Transmission Operations)
  - OE will lay the foundation for the next-gen EMS by integrating a variety of real-time operational measurements with advanced modeling and simulation capabilities
  - OE will develop high-performance, model-based analytical capabilities for assessing potentially destabilizing events in real-time
  - EERE will enhance variable generation forecasting tools and stochastic tools
- Distributed Energy Resources (Distribution Operations)
  - OE will develop predictive distribution grid components and system impact models for integration and to enhance resiliency against extreme weather events (changes required in grid operations)
  - EERE will characterize distributed resources on a common framework to understand their impacts on the grid (e.g. value of distributed energy). EERE will design and construct techno-economic models for the grid-building interface
  - EPSA will develop the Departmental Policy.
- Transactive Controls (Advanced Distribution Controls)
  - OE will research hybrids of control theory and economic theory for transactive controls
  - OE will develop distribution system simulation tools that handle high-variability scenarios, allowing the evaluation of advanced control approaches
  - EERE will coordinate with OE to develop data standardization within buildings, solar, EVs, and fuel cells to enable transactive controls

Discussion

- What trends are foundational or game changers in driving the grid transformation?
- What would cause the greatest concern during this transformation?
- What are the top three priorities for DOE in supporting this transformation?

Background Materials:
http://energy.gov/epsa/downloads/qer-public-meeting-portland-or-electricity-transmission-storage-and-distribution-west

http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/26be8a93967e604785257cc40066b91a/%24FILE/ATTK0J3L.pdf/Reforming%20The%20Energy%20Vision%20(REV)%20REPORT%204.25.%2014.pdf

http://energy.gov/oe/services/electricity-advisory-committee-eac/electricity-advisory-committee-2014-meetings/june-16