

GE Digital Energy

Grid-Facing Options & Opportunities

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MA DPU Grid Modernization Working Group
Grid-Facing Subcommittee Meeting #1

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imagination at work

Agenda

- 1 Technologies and taxonomy
- 2 DOE Smart Grid Initiative
- 3 State regulatory activities

Grid modernization maturity levels



Apparatus.....Physical grid devices

Protection.....Devices to reduce injury or equipment damage

Monitoring.....Maintaining safety, reliability & quality

Metering.....Load management, billing, & system stability

Control.....Operating apparatus & control of power flows

SCADA.....Supervisory Control And Data Acquisition

Automation.....Automatically monitoring & controlling devices

Optimization.....Improving economics, efficiency, reliability & safety

Technology taxonomy... EPRI's view

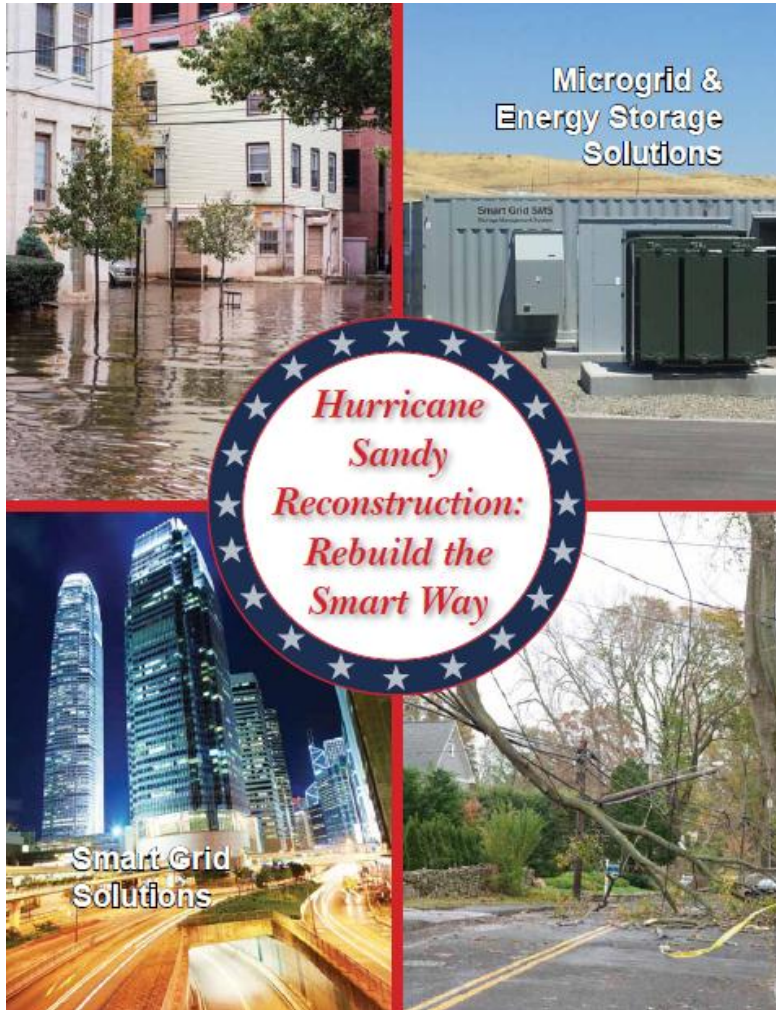
Smart Grid Assets	Functions												
	Fault Current Limiting	Wide Area Monitoring, Visualization, and Control	Dynamic Capability Rating	Flow Control	Adaptive Protection	Automated Feeder Switching	Automated Islanding and Reconnection	Automated Voltage and VAR Control	Diagnosis & Notification of Equipment Condition	Enhanced Fault Protection	Real-Time Load Measurement & Management	Real-time Load Transfer	Customer Electricity Use Optimization
Advanced Interrupting Switch										•			
AM/Smart Meters								•			•		•
Controllable/regulating Inverter							•	•					
Customer EMS/Display/Portal													•
Distribution Automation					•	•	•	•				•	
Distribution Management System			•		•	•	•	•			•	•	
Enhanced Fault Detection Technology									•				
Equipment Health Sensor			•						•				
FACTS Device				•									
Fault Current Limiter	•												
Loading Monitor			•						•			•	
Microgrid Controller							•						
Phase Angle Regulating Transformer				•									
Phasor Measurement Technology		•											
Smart Appliances and Equipment (Customer)													•
Software - Advanced Analysis/Visualization		•	•										
Two-way Communications (high bandwidth)		•			•	•	•	•			•	•	
Vehicle to Grid 2-way power converter													
VLI (HTS) cables				•									

Source: EPRI, Methodological Approach for Estimating the Benefits and Costs of Smart Grid Demonstration Projects, January 2010

Technology taxonomy... DOE's view

Benefits	Smart Grid Technology Applications					
	Consumer-Based Demand Management Programs (AMI-Enabled)	Advanced Metering Infrastructure (AMI) Applied to Operations	Fault Location, Isolation and Service Restoration	Equipment Health Monitoring	Improved Volt/VAR Management	Synchrophasor Technology Applications
	<ul style="list-style-type: none"> • Time-based pricing • Customer devices (information and control systems) • Direct load control (does not require AMI) 	<ul style="list-style-type: none"> • Meter services • Outage management • Volt-VAR management • Tamper detection • Back-Office systems support (e.g., billing and customer service) 	<ul style="list-style-type: none"> • Automated feeder switching • Fault location • AMI and outage management 	<ul style="list-style-type: none"> • Condition-based maintenance • Stress reduction on equipment 	<ul style="list-style-type: none"> • Peak demand reduction • Conservation Voltage Reduction • Reactive power compensation 	<ul style="list-style-type: none"> • Real-time and off-line applications
Capital expenditure reduction – enhanced utilization of G,T & D assets	✓		✓	✓	✓	✓
Energy use reduction	✓	✓	✓		✓	✓
Reliability improvements		✓	✓	✓		✓
O&M cost savings		✓	✓	✓		
Reduced electricity costs to consumers	✓				✓	
Lower pollutant emissions	✓	✓	✓		✓	✓
Enhanced system flexibility – to meet resiliency needs and accommodate all generation and demand resources	✓	✓	✓	✓	✓	✓

Technology taxonomy... NEMA's view (Grid Resiliency)



1. Smart Grid Solutions

- Smart meters /AMI
- Feeder automation
- Fault detection, isolation, restoration

2. Microgrid & Energy Storage Solutions

- Microgrid controllers
- Distributed generation
- Distributed energy storage

3. Hardened Equipment

- Wiring
- Cabling
- Electrical components

4. Back-up Generation

- Diesel or NG generators
- Batteries, fly-wheels, etc.

5. Equipment Repositioning

- Elevating back-up generators
- Substation siting

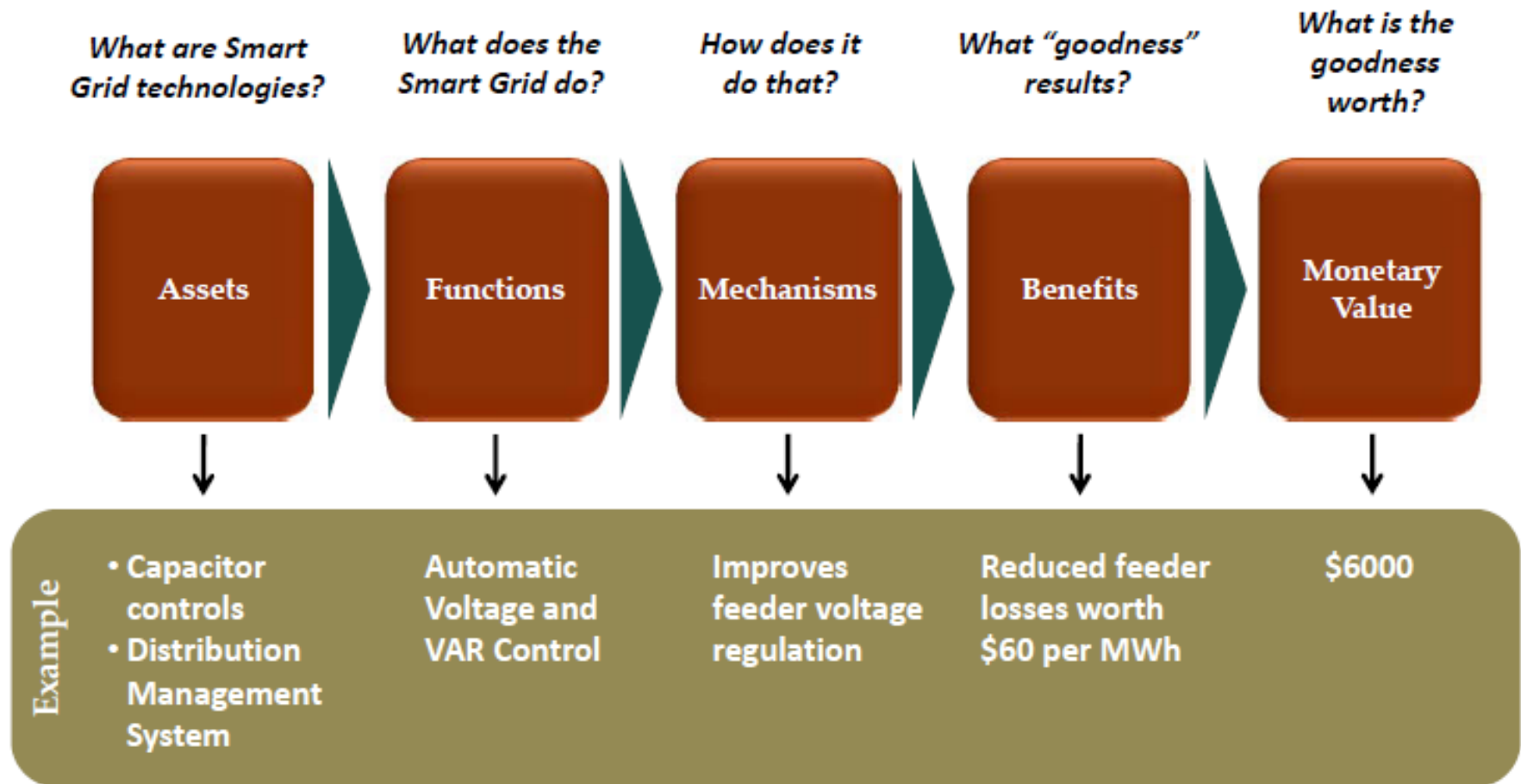
DOE Smart Grid Initiative

Initiative at a glance



- Two programs authorized in EISA 2007
 - ✓ Smart Grid Investment Grant (SGIG)
 - ✓ Smart Grid Demonstration Program (SGDP)
- Funded by ARRA in 2009... \$4.5 B
- SGIG
 - ✓ \$3.4 B in matching Federal grants
 - ✓ 99 projects
 - ✓ \$7.8 B with cost-share
- SGDP
 - ✓ \$615 M in matching Federal grants
 - ✓ 32 projects
 - ✓ \$1.6 B with cost-share

DOE's analytic approach



Program elements and objectives

Smart Grid Investment Grant Program

Build Metrics

- Quarterly reporting by recipients
- By project and aggregated for the program

Impact Metrics

- Semi-annual reporting by recipients
- Aggregated results

Meta-Analysis of Performance Impacts

- Analytical focus areas
- Insight for use in business case analysis

Consumer Behavior Studies

- Evaluation Reports (per project)
- Meta-Analysis of consumer behavior studies

Smart Grid Demonstration Program

Build Metrics

- Quarterly reporting by recipients
- By project and aggregated for program

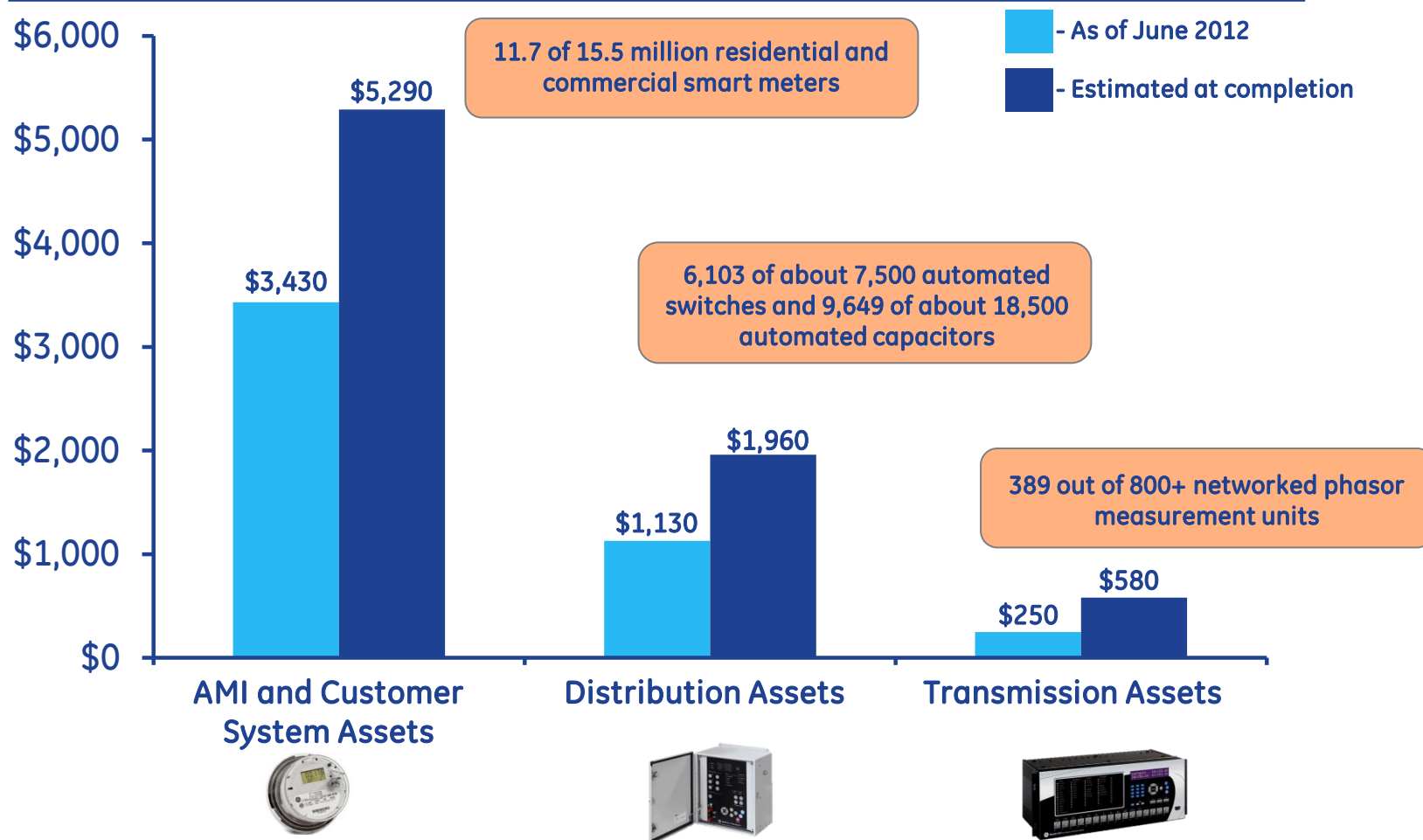
Technology Performance Reports

- Interim and final reports on technology performance per project

SGIG deployment status

Smart Grid Investment Grant total spending, by asset category

(\$ Millions)



Initial results... reliability

48 SGIG projects applying distribution automation technologies to improve reliability:

- 42 deploying automated feeder switches (1 to > 1000's of switches)
 - Enables fault location, isolation and service restoration functions (FLISR)
- Multitude of system integration schemes (AMI/OMS/DMS/SCADA/GIS)
 - 26 projects are applying distribution management systems
 - 36 implementing AMI outage notification
 - 22 deploying equipment health sensors

Reliability Index	Description	Weighted Average* (Range)
SAIFI	System Average Interruption Frequency Index (outages)	-22 % (-11% to -49%)
MAIFI	Momentary Average Interruption Frequency Index (interruptions)	-22 % (-13% to -35%)
SAIDI	System Average Interruption Duration Index (minutes)	-18 % (+4% to -56%)
CAIDI	Customer Average Interruption Duration Index (minutes)	+8 % (+29% to -15%)

*Initial results from 4 Projects (1,250 feeders); April 1, 2011 through March 31, 2012

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Initial results... efficiency

25 SGIG projects are deploying advanced Volt/VAR control:

- 11 are applying conservation voltage reduction (CVR) to reduce peak load –
 - Up to 200 MW reduction for one utility (over 100's of circuits)
- 7 are using CVR to reduce energy consumption
- Many are improving ability for reactive power compensation
- Multitude of equipment integration and control schemes –
 - Many are applying distributed management systems
 - Some are using smart meter data
- Utilities are seeing a 1% improvement in energy efficiency for a 1% reduction in voltage

OG&E Example:

- Implementing a control algorithm to set voltage levels at the substation
 - Applying smart meter data
 - Capability turned on when power price exceeds \$0.22/kWh
- Achieved 8 MW reduction from application of VVC technology on 50 circuits during Summer 2011
- Goal – 74 MW reduction over 400 circuits by 2017 (SGIG contributes to 16 MW)

State regulatory activities

Observations from the states

- PUC activities around grid modernization primarily focused on AMI and consumer-facing matters
- PUC efforts have also been largely reactive... with some notable exceptions
 - Michigan – MPSC Staff Report on Smart Meters
 - <http://efile.mpsc.state.mi.us/efile/docs/17000/0455.pdf>
 - Colorado – Privacy Docket
 - Docket #10I-099EG (opened March 2010)
 - Texas – AMI rulemaking
- Some PUCs have initiated long-term planning efforts... but implementation has been mixed
 - California – Smart Grid 2020 Roadmaps
 - New York – NY State Smart Grid Roadmap; Docket #10-E-0285
 - Motion to Consider Regulatory Policies Regarding Smart Grid Systems and the Modernization of the Electric Grid

Texas' experience with AMI



State Legislature

HB 2129 (2005)

- “Encouraged” utility adoption of smart meters and AMI
- Directed PUC to establish a surcharge for cost recovery
- Instituted bi-annual reporting requirement for PUC

HB 3693 (2007)

- Acknowledged linkage between AMI and EE, conservation policy objectives
- Authorized PUC to create programs for delivery of residential usage info.
- Required utilities to provide customers with educational materials on smart meters and EE



Commission

Project #31418 (2007)

- Authorized cost recovery surcharge
- Established minimum smart meter functionalities

Project #34610 (ongoing)

- Launched Advanced Metering Implementation Team (AMIT) to address:
 - ✓ ERCOT Settlement (15 min.)
 - ✓ Smart Meter Texas web portal
 - ✓ Home Area Networks
 - ✓ Security
 - ✓ Demand Response
 - ✓ Customer Education

Other proceedings

- Smart Meter opt-out

Proactive... Coordinated...Transparent

Illinois grid modernization

Energy Infrastructure Modernization Act

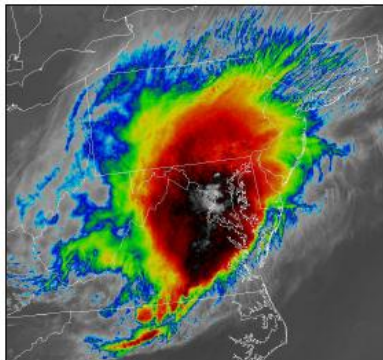
- Authorizes Illinois' IOUs to invest \$3.2 B over 10 years
 - ✓ Distribution Automation
 - ✓ Substation digital relay upgrades
 - ✓ AMI
 - ✓ Associated communications networks
- Establishes performance-based formula rate tariff
 - ✓ Reliability metrics (over 10 years)
 - System SAIFI – 20% reduction in outage frequency
 - System CAIDI – 15% reduction in average outage duration
 - Service Reliability Target – 75% improvement in total # of customers who exceed service reliability targets
 - ✓ Customer benefit metrics (over 10 years)
 - Estimated Bills – 90% reduction
 - Consumption on Inactive Meters – 90% reduction
 - Unaccounted for Energy – 50% reduction
 - Uncollectable Expenses - \$30 M reduction

Maryland grid resiliency

Governor's Grid Resiliency Task Force

WEATHERING THE STORM

Report of the
Grid Resiliency Task Force



September 24, 2012
Office of Governor Martin O'Malley
Executive Order 01.01.2012.15

Task Force assembled in July 2012 to evaluate:

1. Effectiveness and feasibility of undergrounding supply and distribution lines;
2. Other options for infrastructure investments to improve grid resiliency;
3. Options for financing and cost recovery for capital investment

Key recommendations issued in September 2012:

1. Establish tracker mechanism for accelerated or incremental investments to improve resiliency;
2. Evaluate incentive-based ratemaking structure that "aligns customer and utility incentives by rewarding reliability that exceeds established reliability metrics and penalizes failure to reach those metrics." The

End