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Office of Electricity Delivery & Energy Reliability

Progress and Results from ARRA Smart Grid Programs

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Presented to the Electricity Advisory Committee

DOE Goals & Objectives and Beyond

Goal - Leverage Recovery Act smart grid investments to catalyze and accelerate grid modernization across the U.S.

1. **Rapidly deploy smart grid technologies and systems** as prescribed under EISA and ARRA.

2. **Communicate the results and costs/benefits** to support decisions for continued investment. (advance cost/benefit methodology)

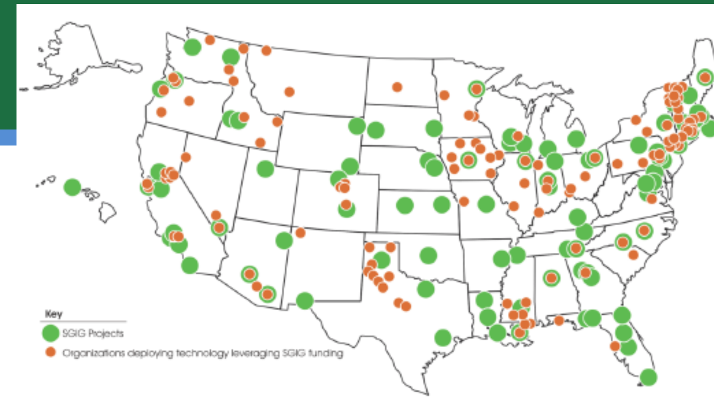
3. **Actively engage key stakeholders** to better understand and address issues affecting investment decisions. (including States/local govts examining grid futures)

4. **Advance the state-of-the-art in cybersecurity** to ensure smart grid systems are properly protected.

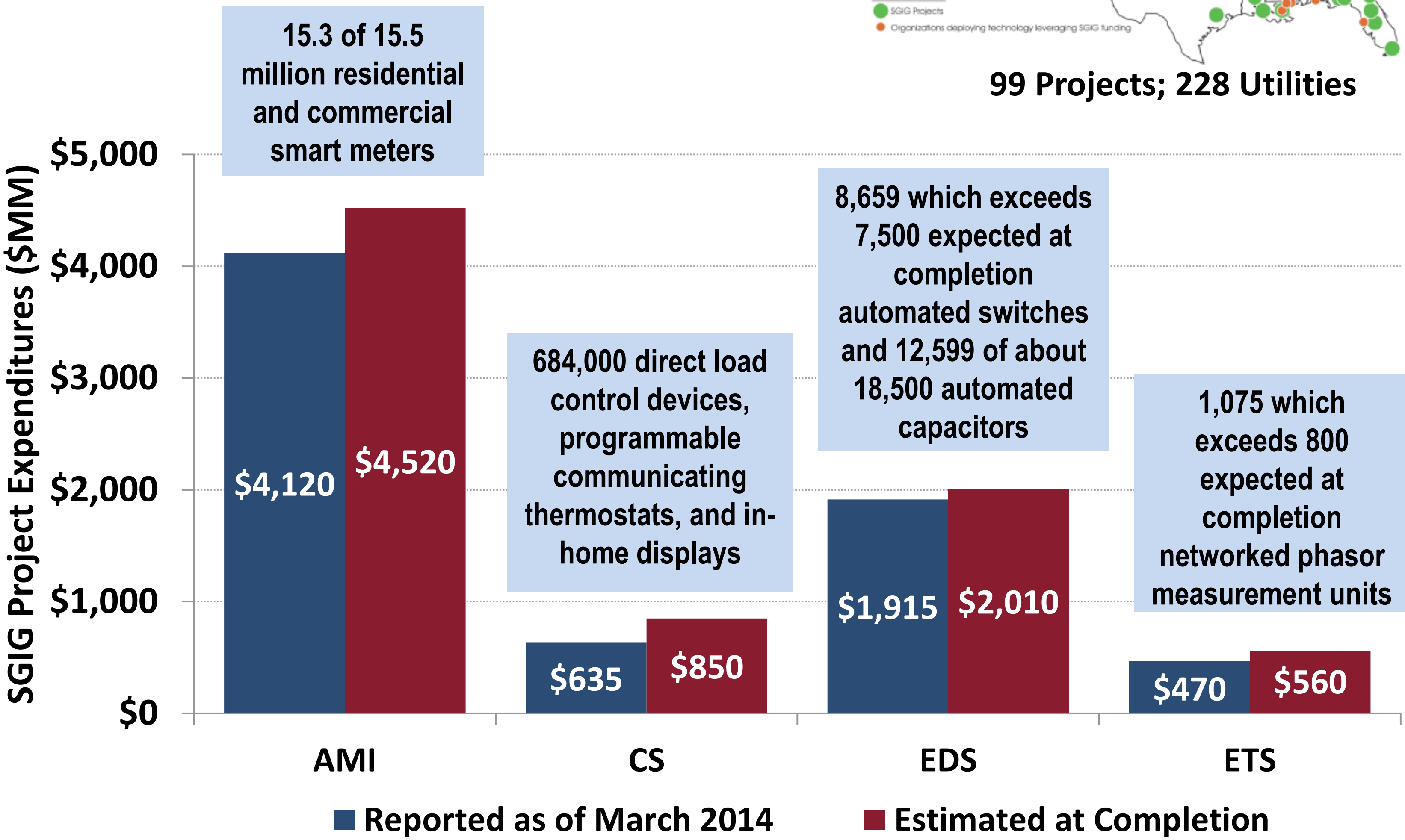
5. **Advance smart grid interoperability and standards** to improve efficiency and enable greater adoption. (including grid architecture, information management and control systems for advanced grid)

6. **Evaluate progress of grid modernization across the United States.** (Smart Grid Systems Report)

SGIG Deployment Status



99 Projects; 228 Utilities



Smart Grid Demonstration Program Status

Demonstrates how a suite of existing and emerging smart grid concepts can be innovatively applied and integrated to prove technical, operational, and business-model feasibility

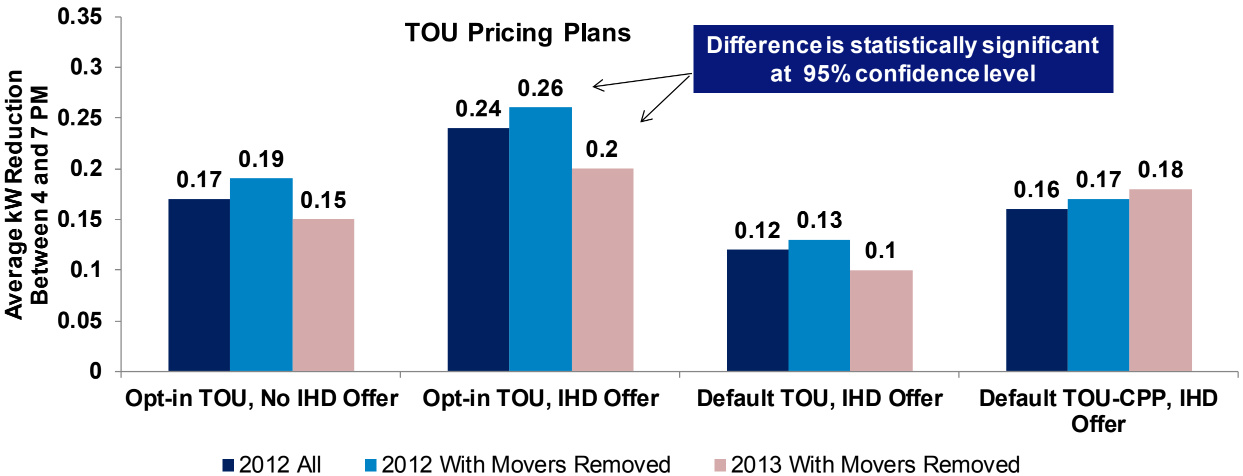
Period-of-Performance Expended: *82.9%*
Funds Expended: *82.0%*

Applications and Benefits Matrix

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
	• Time-based pricing • Customer devices (information and control systems) • Direct load control (does not require AMI)	• Meter services • Outage management • Volt-VAR management • Tamper detection • Back-Office systems support (e.g., billing and customer service)	• Automated feeder switching • Fault location • AMI and outage management	• Condition-based maintenance • Stress reduction on equipment	• Peak demand reduction • Conservation Voltage Reduction • Reactive power compensation	• 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	✔	✔	✔	✔	✔	✔

SMUD Consumer Behavior Study Summary

SMUD deployed opt-in and opt-out Flat w/ CPP, TOU and TOU w/CPP in Summers 2012-2013



Rate Period	Price Level (¢/kWh)		
	Flat w/CPP	TOU	TOU w/CPP
Base/Off-Peak <700 kWh	8.5	8.5	7.2
Base/Off-Peak >700 kWh	16.7	16.6	14.1
Peak	n/a	27.0	27.0
Critical Event	75.0	n/a	75.0

- **Opt-out customers produced lower average peak period load impacts in response to TOU than Opt-in customers but…**
- **Acceptance rates were much higher for Opt-out (>93%) than Opt-in (16-18%); drop-out rates were low in ALL cases (5-9% for Opt-In and 4-8% for Opt-Out)**
- **Survey results indicate 59% of customers preferred some type of time-based pricing design (TOU or CPP) over the existing tiered rate structure and preferred TOU over CPP pricing by roughly 2 to 1**
- **Due to the study's results, SMUD has decided to alter the standard residential rate design from a tiered rate to a TOU in 2018**

Scenario	Benefit/Cost Ratio	10 Year NPV ($ millions)		
		Benefits	Costs	Net Benefits
Default TOU, no IHD	4.48	$66.9	$15.0	$52.0

AMI Improvements in Operational Efficiencies

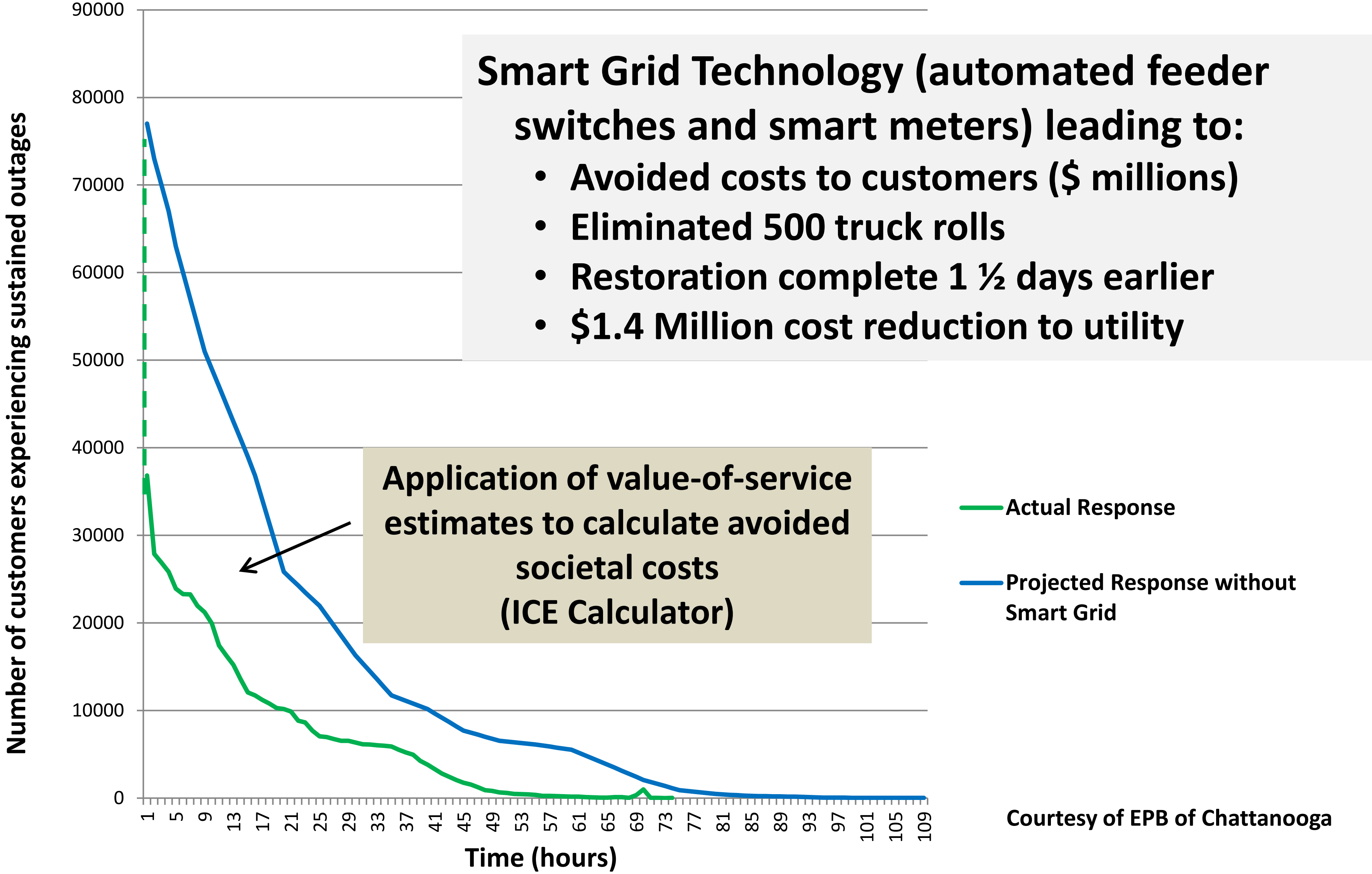
Results from 15 projects due to automation of metering service tasks and reductions in labor hours and truck rolls

Smart Meter Capabilities	O&M Savings	% Reduction
• Remote meter reading • Remote service connections/disconnections	Meter Operations Cost	13-77
	Vehicle Miles	12-59

Talquin Electric Cooperative - In 2011 and 2012, smart meters avoided 6,000 truck rolls for service connections and disconnections and 9,000 for non-payments saving more than $640,000.

Additional Capabilities	Expected Benefits
• Tamper detection and notification	Enables potential recovery of ~1% of revenues that may be lost from meter tampering
• Outage detection and notification	Enables faster restoration (e.g., PECO avoided 6,000 truck rolls following Superstorm Sandy and accelerated restoration by 2-3 days)
• Voltage and power quality monitoring	Enables more effective management of voltages for conservation voltage reductions and other VVO applications

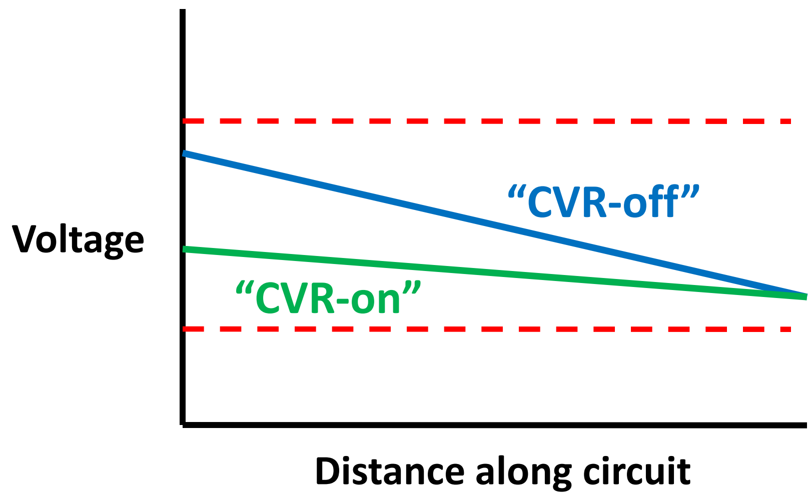
July 5, 2012 Storm Response in Chattanooga



Courtesy of EPB of Chattanooga

Applying Volt/VAR Optimization to Improve Energy Efficiency

Conservation voltage reduction (CVR) reduces customer voltages along a distribution feeder for lowering peak demands and overall energy consumption



OG&E:

- Control algorithm 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)

PNNL 2010 GRID-LAB-D Analysis:

National deployment of CVR can provide a 3.0% reduction in annual energy consumption for the electricity sector. 80% of this benefit can be achieved from 40% of feeders.

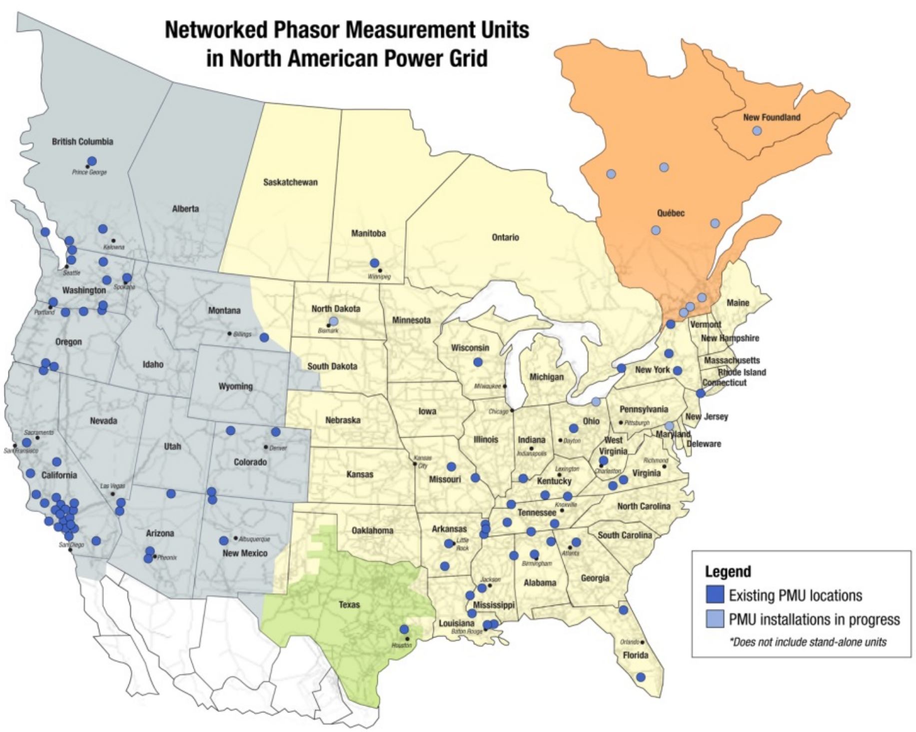
CVR Study (due October 2014):

Report on technology applications, impacts and institutional hurdles. Seeing energy reductions ranging from 0.75 – 3.0% and peak reductions from 0.84 – 7.0%.

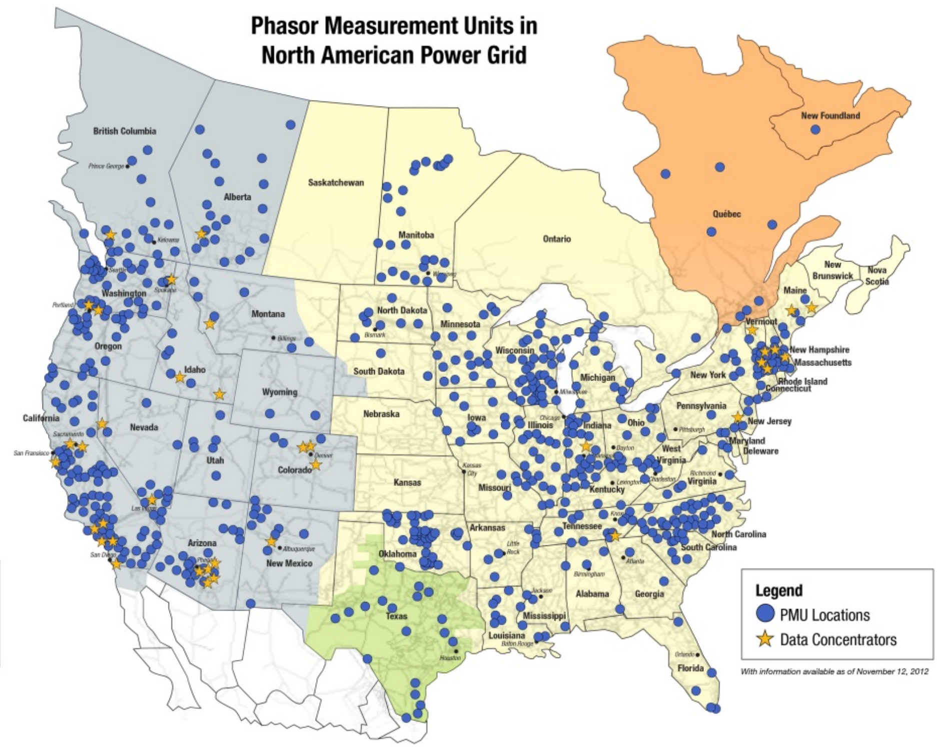
Synchrophasor Technology for Transmission System Operations

Improved reliability, capacity and operational efficiency – Energy flows on the California-Oregon Intertie can be increased by 100 MW or more reducing energy costs by an estimated $35 - $75 million over 40 years without new capital investments

April 2007



November 2012



Sharing Results and Promoting Collaboration

SGIG/SGDP Information
(DOE and Awardee Generated)

- SGIG Progress Reports
- Metrics and Benefits Reports
- Case Studies
- Presentations/Briefings & Articles
- Best Practices/Lessons-Learned
- Consumer Behavior Reports
- Technology Performance Reports

Communication Strategy

Maintain and develop key stakeholder relationships for sharing information and addressing issues:
- EEI, EPRI, APPA, NRECA, NARUC, NASPI
- IEEE smart grid community

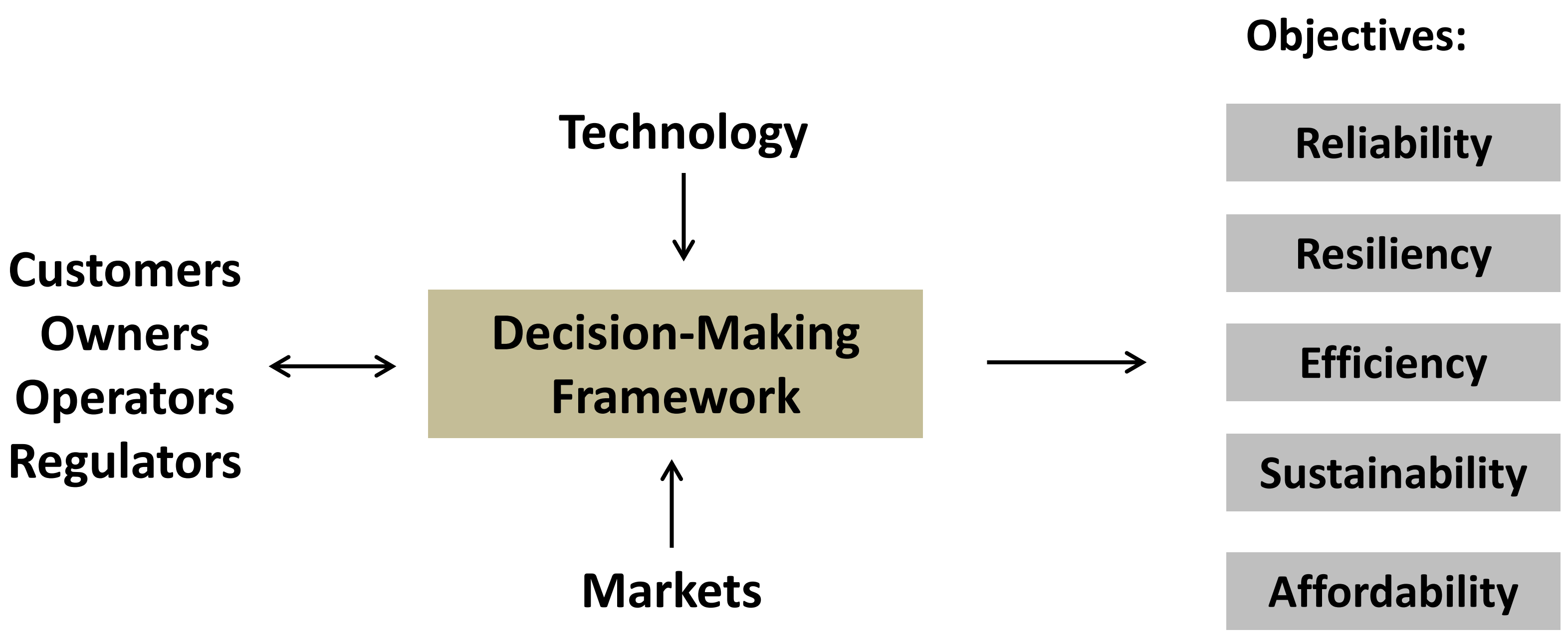
Continue to use smartgrid.gov as the library for ARRA materials
- Improve search capability (matrix)
- Create portal to other sites
- Mailing list

Share results at conferences, e.g.,:
- IEEE (ISGT), Distributech, Town Hall Meetings, EPRI, NARUC

Organize webinars and focus groups

Address key audiences (e.g., States)

Long-Term Investment Strategy



Questions/Comments

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