OE's Research and Development Division Smart Grid Activities

Presented at the Electricity Advisory Committee Meeting

Eric Lightner

Director, Smart Grid Task Force

March 6, 2012

DOE Smart Grid Implementation Plan

Vision

A smart grid that uses digital technology to improve reliability, security, and efficiency (both economic and energy) of the electric system from large generation, through the delivery systems to electricity consumers and a growing number of distributed-generation and storage resources

Smart Grid Characteristics

- Enables Informed Participation by Customers
- Accommodates All Generation & Storage Options
- Enables New Products, Services, & Markets
- Provides Power Quality for the Range of Needs
- Optimizes Asset Utilization & Operating Efficiency
- Operates Resiliently to Disturbances, Attacks, & Natural Disasters

Smart Grid Challenges

- Advancing Functionality with New Technologies
- Building a Strong Business Case for Smart Grid Investment
- Developing Appropriate Standards for Interoperability
- Forecasting Consumer Participation in Energy Management
- Enhancing Cybersecurity
- Sustaining a Skilled Workforce

Key Activities

- Smart Grid Demonstrations and Deployment
- Research and Development
- Standards
- Interconnection Planning and Analysis
- Workforce Training
- Stakeholder Engagement and Outreach
- Monitoring National Progress

Source: Office of Electricity Delivery and Energy Reliability

Smart Grid R&D Program

Dollars in Thousands	
FY 2011	FY 2012
23,000	19,924

Promotes the development of an efficient, fully integrated "smart" grid through the adaptation and integration of digital information and communication technologies into the Nation's electricity delivery system.

Guided by MYPP* focusing R&D on:

- Integration of DER/DR/PEV
- Distribution automation
- Microgrids
- Standards and best practices

* MYPP available at:
http://www.smartgrid.gov/sites/default/files/oe_mypp.pdf

Smart Grid Characteristics and DOE Program Goals

7 Characteristics

- Power Quality for 21st Century
- Self Healing
- Resilient against Attacks and Disasters
- Customer Participation
- Integrate All Generation & Storage Options
- New Markets and Operations
- Asset Optimization and Operational Efficiency

Long-term Goals

Self-healing Distribution Grid for Improved Reliability

Full Integration of DER/DR/PEV for Improved System Efficiency

2020 Targets

20% SAIDI reduction in distribution outages

>98% reduction in outage time of required loads

20% load-factor improvement

Illustrative DER & DR Integration

Renewable and Distributed Systems Integration (RDSI)

- 9 demonstration projects in 8 states to integrate use of DER to provide at least 15% peak demand reduction on distribution feeder or substation

Technology Development

- **DECC:** Develop and test adaptive power and voltage controls for multiple inverters and their interoperations
- **DR:** Realize the potential benefits of DR from residential "smart appliances"
- **Varentec:** Dynamic VAR compensators w. battery ESS for fast voltage regulation to address rapid voltage changes from fluctuating renewables

GridLAB-D Simulation & Modeling

- Simulated benefits of representative smart grid technologies (DR, renewables integration, energy storage, distribution automation) on prototypical feeders
- Apply multi-objective control algorithms for DR, energy storage, and PEV charging; Simulate microgrid operations; Integrate NREL's RE models

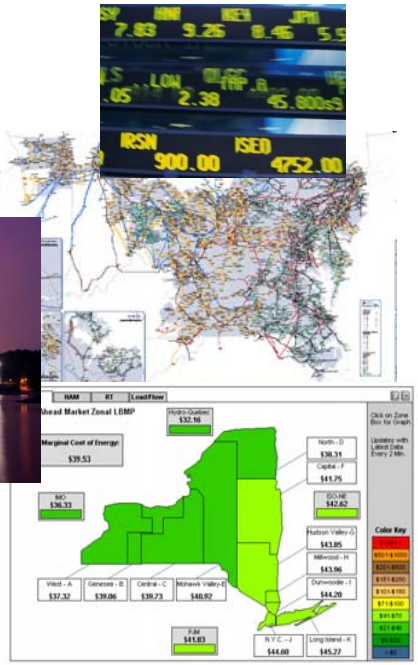
Evaluation & Demonstrations: Test Beds

- **LANL:** Develop a local decision support system for munies and co-ops to aid with the integration of renewables by leveraging local DER

GridLAB-D: A Unique Tool for Designing and Studying Smart Grids

Unifies models of the key elements of a smart grid:

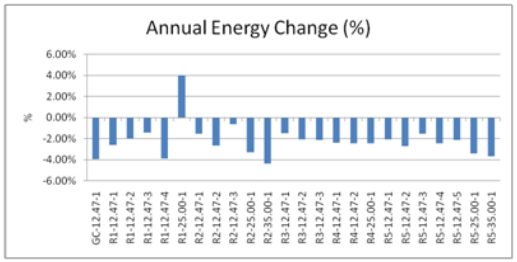
Power Systems ***Loads*** ***Markets***

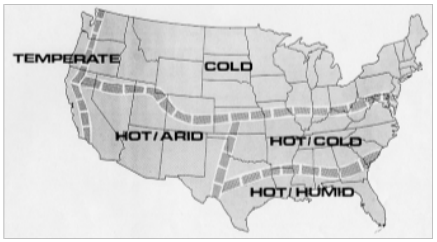


- ✓ Smart grid analyses
  - field projects
  - technologies
  - control strategies
  - cost/benefits
- ✓ Time scale: sec. to yrs
- ✓ Open source
- ✓ Contributions from
  - government
  - industry
  - academia
- ✓ Vendors can add or extract own modules

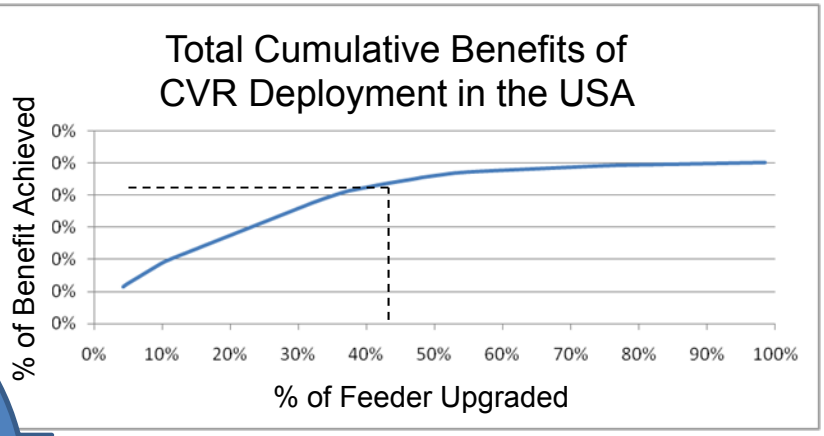
- GridLAB-D is a DOE-funded, open–source, time-series simulation of all aspects of operating a smart grid from the substation level down to loads in unprecedented detail
- Simultaneously solves:
  - Unbalanced, 3-phase power flow (radial or network), w/explicit control strategies
  - End use load physics, voltage-dependency, behavior & control in 1000s of buildings
  - Double-auction retail supply/demand markets

National Conservation Voltage Reduction Study





Region	Feeder	kV	# of feeders	% within a region
Region 1	R1-12.47-1	12.5	2,200	20.56%
	R1-12.47-2	12.47	2,500	23.36%
	R1-12.47-3	12.47	2,000	18.69%
	R1-12.47-4	12.47	1,800	16.82%
	R1-25.00-1	24.9	1,200	11.21%
	GC-12.47-1	12.47	1,000	9.35%
Region 2	R2-12.47-1	12.47	3,500	18.72%
	R2-12.47-2	12.47	3,200	17.11%
	R2-12.47-3	12.47	3,000	16.04%
	R2-25.00-1	24.9	3,500	18.72%
	R2-35.00-1	34.5	4,000	21.39%
	GC-12.47-1	12.47	1,500	8.02%
Region 3	R3-12.47-1	12.47	1,500	30.00%
	R3-12.47-2	12.47	1,500	30.00%
	R3-12.47-3	12.47	1,000	20.00%
	GC-12.47-1	12.47	1,000	20.00%
Region 4	R4-12.47-1	13.8	14,000	33.14%
	R4-12.47-2	12.5	15,000	35.50%
	R4-25.00-1	24.9	12,500	29.59%
	GC-12.47-1	12.47	750	1.78%
Region 5	R5-12.47-1	13.8	400	8.79%
	R5-12.47-2	12.47	600	13.19%
	R5-12.47-3	13.8	650	14.29%
	R5-12.47-4	12.47	500	10.99%
		12.47	450	9.89%
	00-1	22.9	450	
	R5-35.00-1	34.5	500	
	GC-12.47-1	12.47	1,000	21.



GridLAB-D
25 feeders x 1 minute
over 1 year x 2 cases

Key Results:

1. **Peak load reductions between 0.5% and 3%**
2. **Benefits vary widely depending on feeder, etc.**
3. **100% deployment saves ~3% national energy**
4. **40% deployment saves ~2.4% national energy**

Ref: **Evaluation of Conservation Voltage Reduction on a National Level**
Schneider, K.P., Fuller, J.C., Tuffner, F., Singh, R. *Pacific Northwest National Laboratory report for the US Department of Energy, 2010*

Smart Grid Maturity Model (SGMM)

A management tool to help utilities plan, implement, and manage a smart grid transformation

1 Preparation

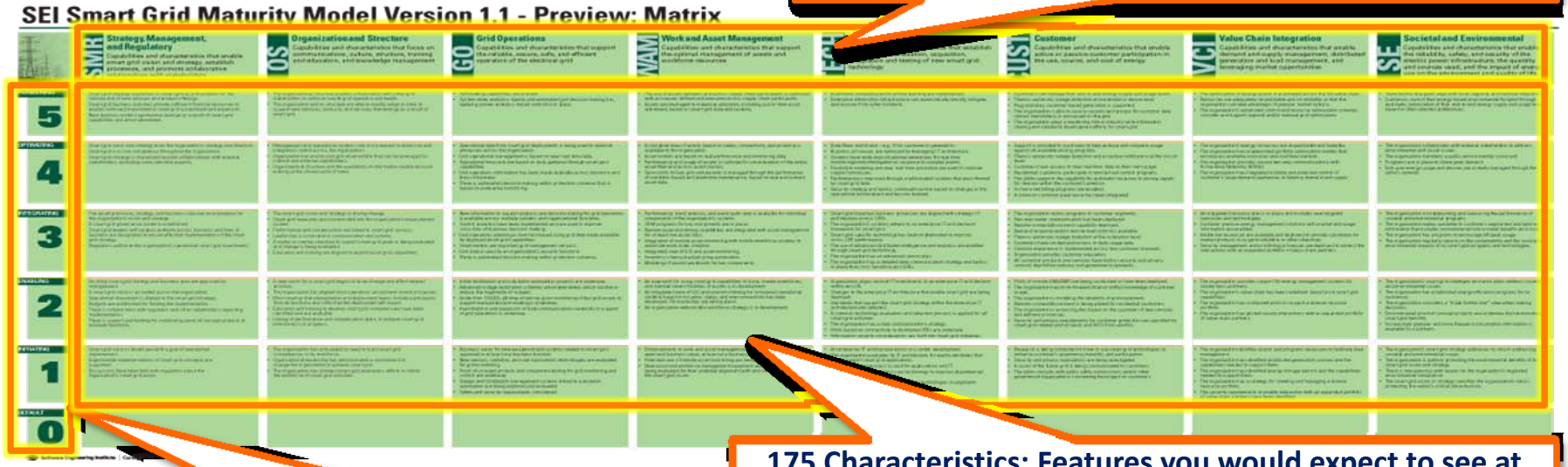
2 Survey Workshop

3 Analysis

4 Aspirations Workshop

5 Wrap Up

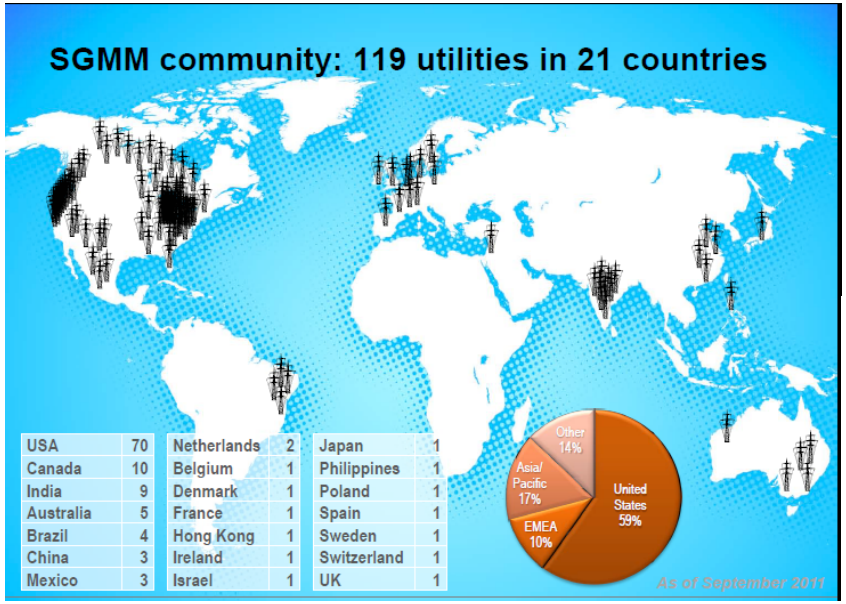
8 Domains: Logical groupings of smart grid related capabilities and characteristics

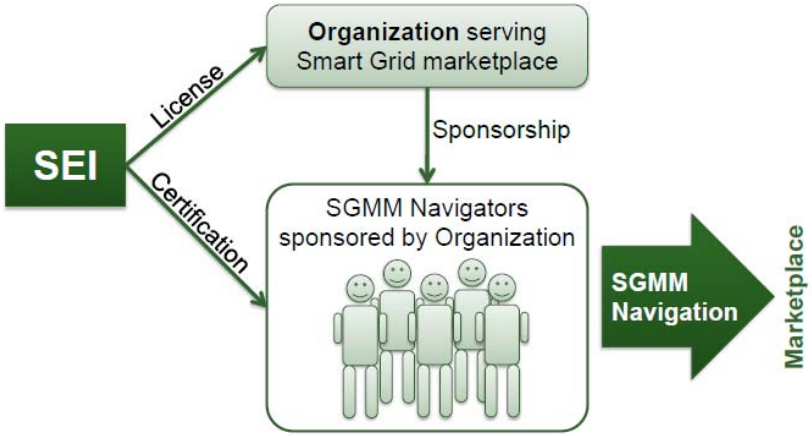


6 Maturity Levels: Defined sets of characteristics and outcomes

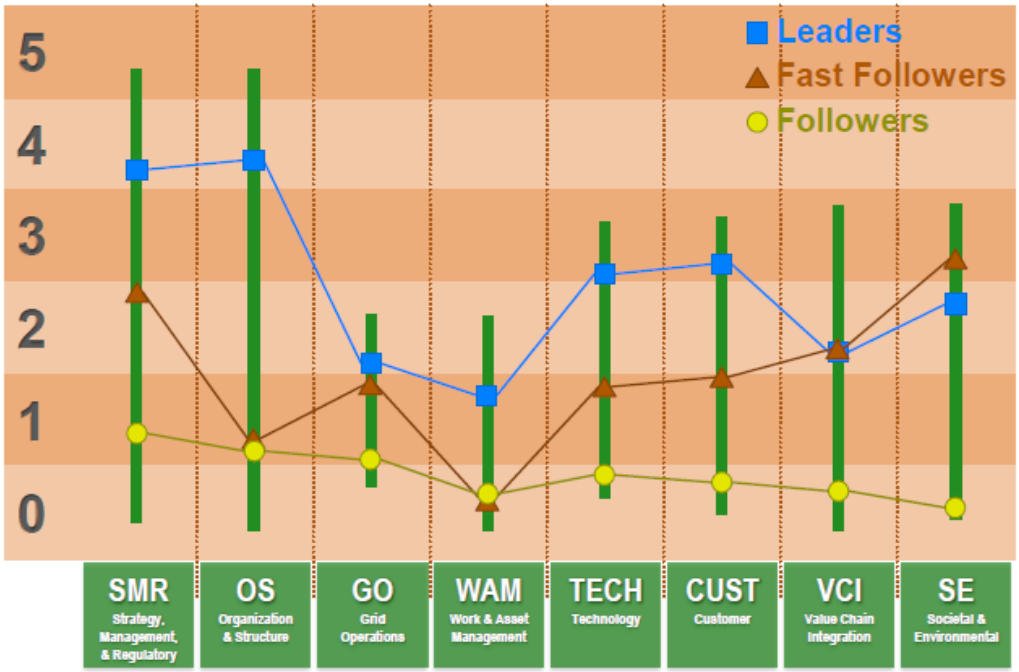
175 Characteristics: Features you would expect to see at each stage of the smart grid journey

SGMM Progress & Sample Results





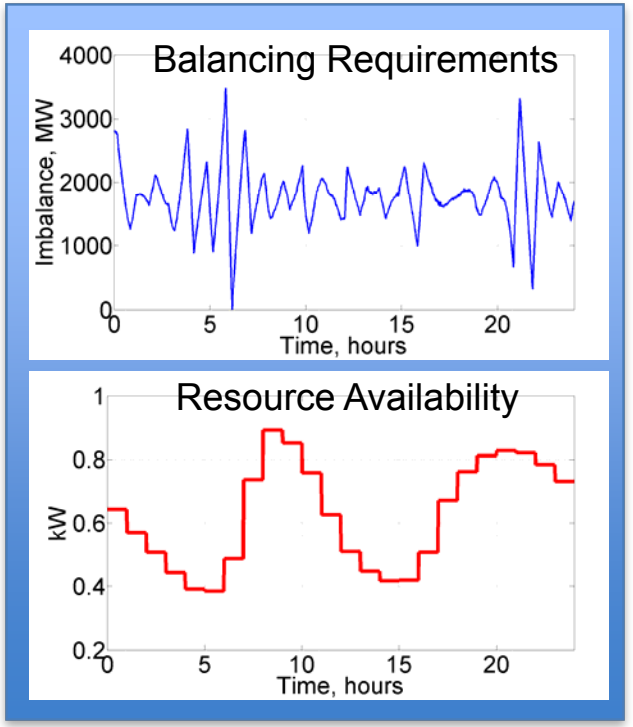
Sample Results on Leaders, Fast Followers, Followers

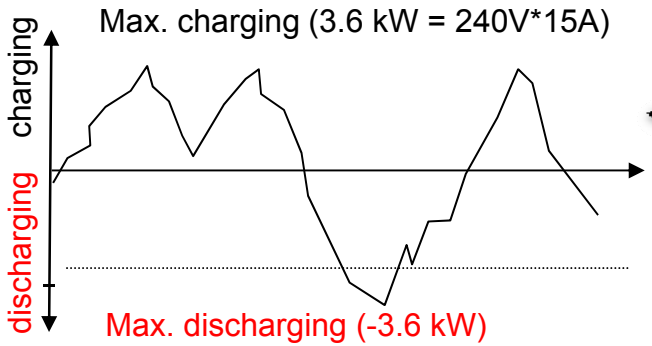


Smart Grid for Integration of PEV and Renewables

Use plug-in hybrid electric vehicles to aid in renewable generation source integration

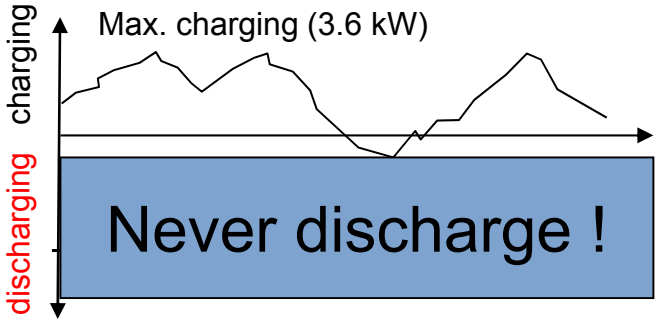
- Determine balancing requirements for 10 GW of additional wind
  - NWPP oriented
  - Represents 12% RPS requirement
- Determine resource availability
  - Use 2001 NHTS Data for driving habits and population information
  - Use V2GHalf and V2GFull charging





V2GFull

V2GHalf



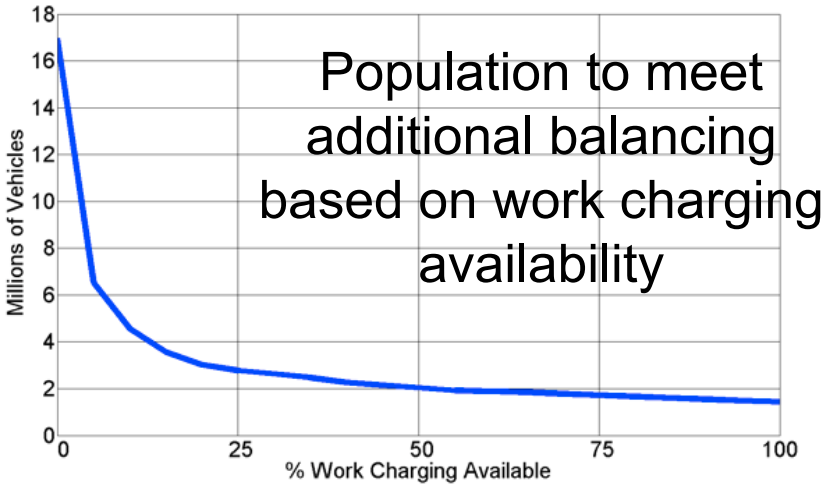
New Electric Vehicle Load as a Grid Resource

Completed report with the following key insights

- All new balancing requirements for 10GW of new wind capacity in NWPP by 2020 could be furnished by electric vehicles
- Small reduction in number of vehicles required when transitioning from V2GHalf to V2GFull
- Solution insensitive to battery size
- Availability of infrastructure during day is essential
- Only 10% of vehicles need to be able to charge during day to capture 80% of value of day-charging

% of NWPP vehicle fleet to meet new balancing requirements

Charging type	Battery Size Scenario			
	PHEV 33		BEV 110	
	Home only	Home and Work	Home only	Home and Work
V2GHalf	180%	13%	126%	12%
V2GHalf and V2GFull	132%	10%	103%	8%
V2GFull	113%	8%	94%	8%



Population to meet additional balancing based on work charging availability

Smart Grid Task Force: Federal Coordination

To ensure awareness, coordination, and integration of the diverse smart grid activities in the Federal Government

Member Organizations

DOE (OE / EERE / NETL)	FERC	DHS
DOC (NIST, ITA, NOAA, NTIA)	EPA	DoD
USDA	FCC	USTDA
FTC	OSTP	

2011/12 Work Plan

Federal Government as a Driver for Smart Grid

- Assessment of impacts of federal policies on employing smart grid

Inventory of the International Smart Grid Activities of Each U.S. Agency

- Development of an inventory framework
- Population of the inventory with agency data and information

Strategic Planning for International Activities

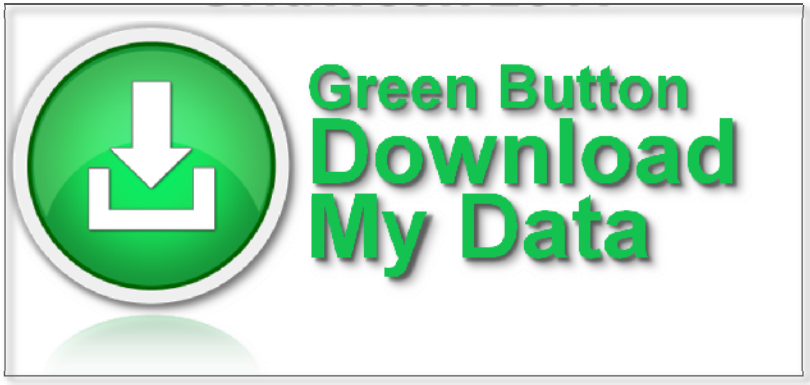
- Task force member collaboration website
- Industry outreach

Smart Grid Data Access FOA

- FOA requirements defined through multi-agency process
- Task force members serving on the review committee

What is Green Button and ESPI?

The vision – collaboration and inspiration, using voluntary adoption of industry standards



"From concept to specification to implementation in 90 days"

What is Green Button?

- *Common-sense idea that electricity customers should be able to download their own energy usage information in consumer- and computer-friendly format.*

- *A common experience, from provider to provider, setting clear expectations that their information is theirs to have – and share.*

Source: SMARTGRID.GOV RECOVERY ACT SMART GRID PROGRAMS

Green Button: An overnight success years in the making.

- *OpenADE: Requirements specification for secure delivery of historical and ongoing usage information to a 3rd Party*
- *SGIP Priority Action Plan 10 resulted in North American Energy Standards Board (NAESB) REQ18/WEQ19 PAP10 Energy Usage Information (EUI) standard in December 2010*
- *Further standardization produced NAESB REQ21 Energy Services Provider Interface*
  - Based on UCAIug OpenADE and NAESB PAP10 standards
  - Ratified in October 2011
- *Together these define a flexible file format basis for Green Button, with initial implementations using a subset of ESPI and EUI*

What might Green Button data good for?

Empower Consumers and Spur Innovation

Insight: entrepreneur-created web portals analyze energy usage and provide actionable tips;

Heating and Cooling: customized heating and cooling activities for savings and comfort;

Education: community and student energy efficiency competitions;

Retrofits: improved decision-support tools to facilitate energy efficiency retrofits;

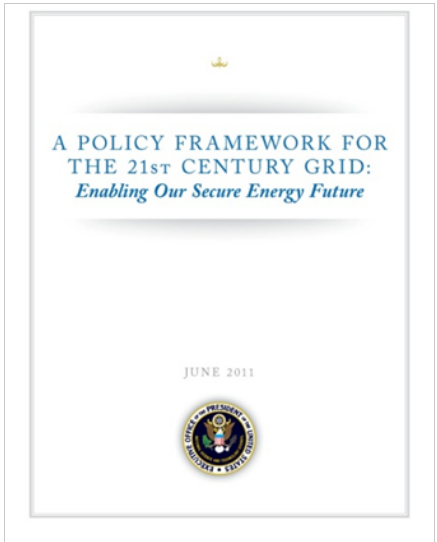
Verification: measurement of energy efficiency investments;

Real Estate: provide energy costs for tenants and/or new home purchasers; and

Solar: optimize the size and cost-effectiveness of rooftop solar panels.

Source: SMARTGRID.GOV RECOVERY ACT SMART GRID PROGRAMS

DOE Smart Grid Data Access FOA
(DE-FOA-0000579)



FOA Supports NSTC recommendation & Implementation of Green Button Initiative

- Requires standardized data format be made available to residential customers and designated third parties
- Specifies NAESB PAP EUI and ESPI (Green Button)standards

Phase I

- **Demonstrate** third-party consumer-oriented information tool that creates a value-added service for a minimum of 1,000 residential consumers
- 12 awards max., up to $500,000 per award (plus 50% cost share), 15-month POP

Phase II

- **Adopt** the data access tool demonstrated in Phase I across an entire service territory, region, or community
- 1 award, up to $2,000,000 (plus 50% cost share), 9-month POP

DOE Workshop on Data Privacy (January 31, 2012 in DC)

Purpose: Determine if a national strategy could help coordinate efforts and identify potential steps toward data privacy development

Workshop recommendations for the federal government

1. **Facilitate the development of a consumer data privacy framework.* The framework should**
   - **Provide guidelines not mandates**
   - **Be developed through a collaborative process involving all stakeholder groups**
   - **Define jurisdictional lines (state versus federal)**
   - **Define consumer consent**

80 participants from 51 entities, representing utilities, consumer advocates, vendors, and state and federal governments

2. **Develop and compile an information library of ongoing activities with access by all stakeholders, including best practices and lessons learned**
3. **Provide education to consumers to help them understand the value of the data, what consent means and the reason for grid modernization efforts**
4. **Act as a convener to bring together stakeholders to discuss key issues surrounding privacy and share information and solutions**

The electricity consumption data privacy framework will be developed following the blueprint outlined in the White House report titled "*Consumer Data Privacy in a Networked World: A Framework for Protecting Privacy and Promoting Innovation in the Global Digital Economy*," available at http://www.whitehouse.gov/sites/default/files/privacy-final.pdf

Regional Peer-to-Peer Workshop

Workshops on consumer engagement and technical implementation of smart grid related technologies:

- Provide a forum to share lessons learned to help replicate successes
- Foster productive communication among stakeholder groups (consumers, utilities, and the various governing bodies in grid modernization)
- Help keep us informed of any ongoing challenges

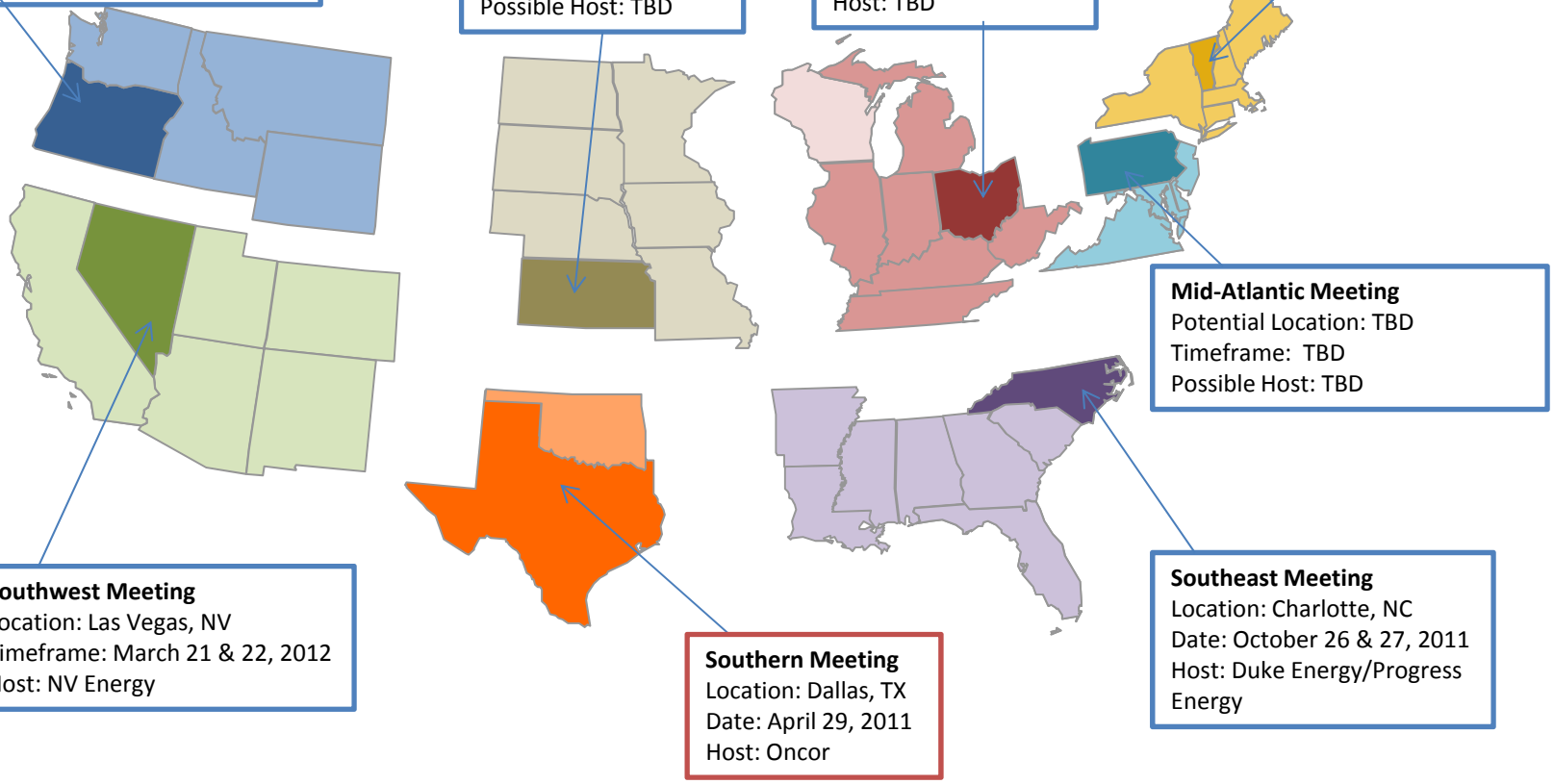
Workshop Themes

One size does NOT fit all	Communication with Customers/Public
Address Customer Concerns	Set Reasonable Expectations

"...there was a consistent theme of community involvement as essential to that success (of the grid modernization work)," **blog by Assistant Secretary Pat Hoffman on her attendance of the Southeast Workshop**

Regional Peer-to-Peer Workshops

A forum for stakeholders to share lessons learned to help replicate successes



Contact Information

Eric M. Lightner
Director, Smart Grid Task Force
Office of Electricity Delivery and Energy Reliability
U.S. Department of Energy
(202) 586-8130
eric.lightner@hq.doe.gov

For more Smart Grid information:

OE: www.oe.energy.gov

Smart Grid: www.smartgrid.gov

Smart Grid Task Force:
http://www.smartgrid.gov/federal_initiatives/federal_smart_grid_task_force