May 17, 2012

Office of Electricity Delivery & Energy Reliability

The Impact of Smart Grid Projects Funded by the Recovery Act of 2009

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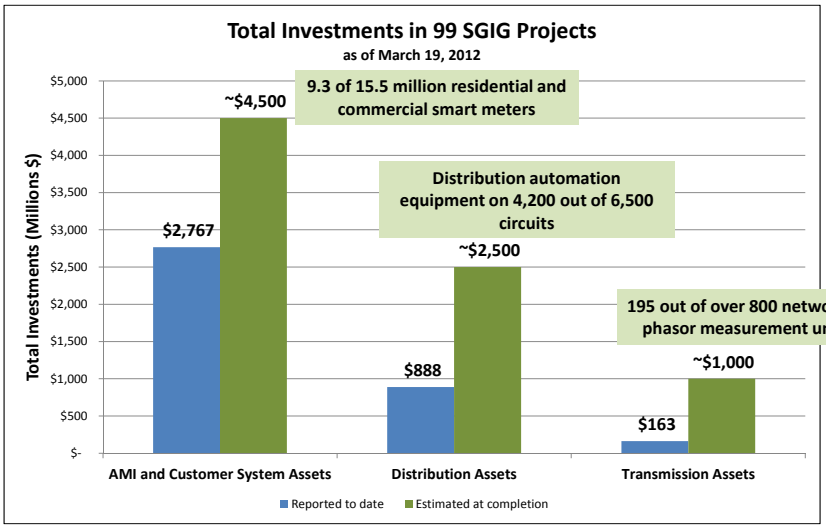
US Department of Energy
Asia-Pacific Economic Cooperation Workshop, Quebec City, May 16-17, 2012

Technology Deployment

SGIG/SGDP Areas of Smart Grid Technology Deployment				
Customer Systems	Advance Metering Infrastructure	Electric Distribution Systems	Electric Transmission Systems	Equipment Manufacturing
				
• Displays • Portals • Energy management • Direct load controls	• Smart meters • Data management • Back office integration	• Switches • Feeder optimization • Equipment monitoring • Energy Storage	• Wide area monitoring and visualization • Synchrophasor Technology • Energy Storage	• Energy devices • Software • Appliances

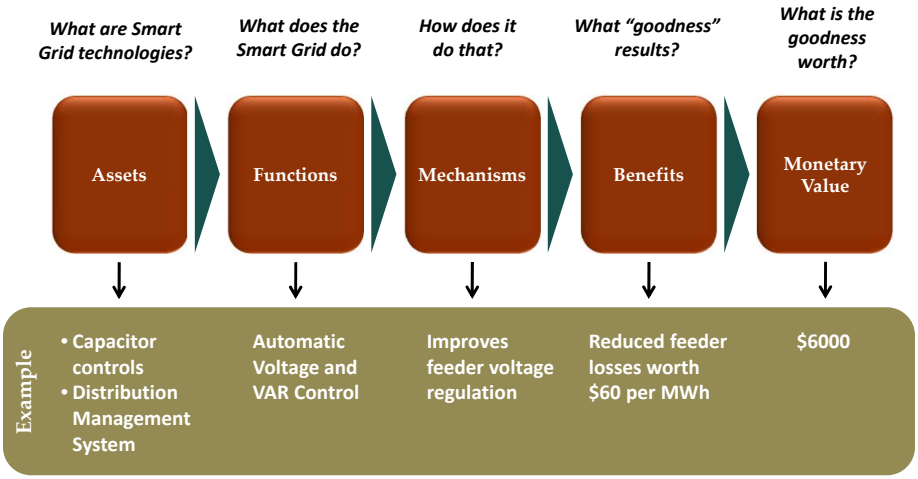
SGIG Deployment Status



Observations

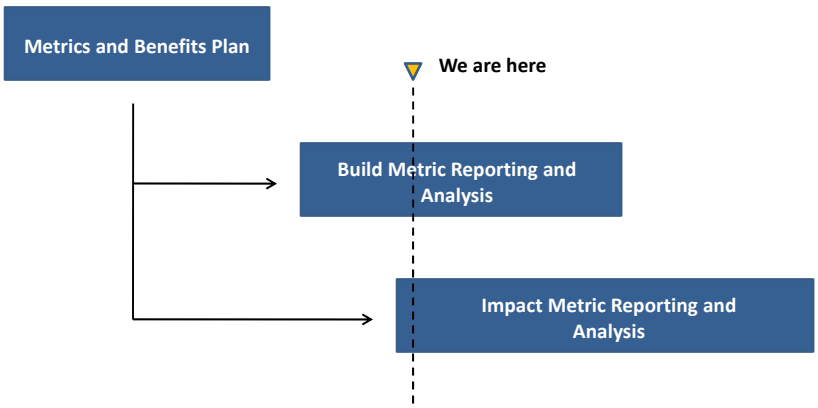
- Local- and State-level decisions primarily affect investments in smart grid technology, especially decisions affecting consumers
  - The adoption of synchrophasor technology will depend on decisions at regional (ISO) levels
- "We have never done this before"….. Utilities are working through interoperability, systems integration and cyber security issues for the first time
  - There is intense interest to share experiences, lessons-learned and best practices throughout the industry
  - Every utility is at a different starting point
- The value proposition of smart grid technology is still under review
  - What are the costs vs the benefits?

DOE Analytical Approach



Schedule for Benefits Analysis

The DOE Metrics and Benefits work is transitioning into the reporting and analysis of impact metrics. See www.smartgrid.gov



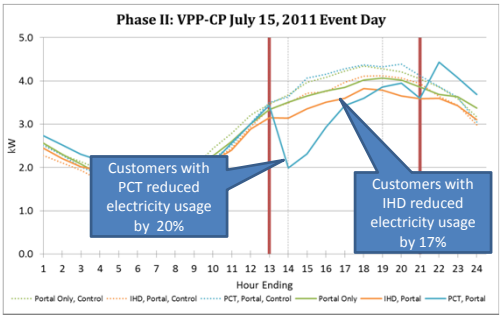
Application of Advanced Metering Infrastructure

Investments in AMI are being made by 75% of the SGIG projects

Peak and Overall Demand Reduction	Operational Efficiency Improvement
62 projects are pursuing …… • 40 w/ pricing programs • 25 w/ customer systems • 21 w/ direct load control devices	**60 projects are pursuing ……** • 60 w/ automated meter reading • 44 w/ voltage and power quality monitoring • 51 w/ outage detection and notification • 50 w/ tamper detection • 48 w/ remote service switch
↓	↓
• **Reducing requirements for generation capacity and energy (less fuel)** • **Improved asset utilization** • **Lower emissions (CO_2, NOx, SOx)** • **Lower bills**	• **Operations and maintenance (O&M) cost reductions** • **Greater responsiveness to customer** • **Lower outage duration** • **Improved energy efficiency**

Pricing Pilot at Oklahoma Gas & Electric

OGE deployed TOU-CP and VPP-CP programs in Summer 2011, VPP-CP is highlighted here.



Price Level	Residential VPP-CP Price	Number of days in summer 2011 at each price level
Low and off-peak	4.5¢ per kWh	63
Standard	11.3¢ per kWh	25
High	23.0¢ per kWh	28
Critical	46.0¢ per kWh	6
Critical Event	46.0¢ per kWh	7 (included in the above)

Potentially Avoid Future Generation:

- Study results show a 1.3 kW reduction per customer is possible
- Hoping for 20% participation by Dec 2014
- Targets: Enroll ~ 40K customers in 2012 with 72MW peak reduction; 150K customers by Dec 2014 with 210 MW peak reduction (offsets a natural-gas fired peaking plant)
- Discontinue roll out of IHD in 2012

Consumer Behavior Studies

	Sierra Pacific	Nevada Power	OG&E	MMLD	CVPS	VEC	MN Power*	CEIC	SMUD	DECo	Lake land	Total
Rate Treatments												
TOU	●	●							●		●	3
CPP	●	●	●	●	●		●		●	●		8
CPR					●			●				2
VPP			●			●						2
Non-Rate Treatments												
Education	●	●								●		3
Cust. Service						●						1
IHD	●	●	●		●	●	●	●	●	●		9
PCT	●	●	●					●		●		5
DLC								●				1
Features												
Bill Protection	●	●	●	●							●	4
Experimental Design												
Opt In	●	●	●	●	●	●	●		●	●	●	9
Opt Out								●	●	●	●	3
Within									●			1
Number of Participants												
	9,509	6,853	3,196	500	3,735	6,440	4,025	5,000	97,480	5,400	3,000	**145,138**

Sierra Pacific and Nevada Power are testing the effect of a technology package, including an IHD and a PCT

* MN Power is also testing the difference between hourly energy feedback and daily energy feedback

Operational Efficiency Improvements at Talquin Electric Cooperative

Background:

- For over 70 years, members submitted their own meter readings (highly inaccurate)
- Rolling trucks 6,000 times/year for routine service connection/reconnection and 9,000 times/year for non-payment problems ($40-$50/truck roll)
- Outage locations based on pattern of customer phone calls

Technician changes out analog meter with a smart meter

TEC's SmartGrid Program:

- Deployed AMI to about 56,000 customers and upgraded 46 of 86 circuits with advanced capacitors for voltage control and outage management.
- With AMI, TEC avoided 8,800 truck rolls in 2011 for non-payment problems saving more than $350,000
- Expecting to avoid additional 5,500 truck rolls for routine service connections (savings of $200,000/year)
- Expecting to reduce outage durations from more precise pinpointing of faults and dispatching of repair crews to exact locations without guesswork.

Facts & Figures

Total Project Budget: $16,200,000

Federal Share: $ 8,100,000

Customers Served: 57,000

Service Area: 2,600 square miles spanning 4 counties in northern Florida

Distribution Automation

DA investments are being made by over 50% of the SGIG projects

Distribution Reliability	Volt/VAR Control
48 projects are pursuing distribution system reliability improvements • 42 w/ automated feeder switches • >6 w/ equipment monitoring • 27 w/ DMS integration • 21 w/ AMI integrated with OMS	**47 projects are pursuing voltage/VAR control and optimization** • 35 w/ automated capacitor banks • 32 w/ automated voltage regulators • 22 w/ DMS integration
↓	↓
• **SAIDI, SAIFI and CAIDI improvements** • **O&M cost reductions**	• **Energy efficiency improvements** • **O&M cost reductions**

Reliability Improvements

One utility has installed 230 automated feeder switches on 75 circuits in an urban area. From Apr 1 – Sep 30 2011:

SAIDI improved 24%; average outage duration decreased from 72.3 minutes to 54.6 minutes (or by 17.7 minutes).

Estimated Avg. Customer Interruption Costs US 2008$ by Customer Type and Duration

Customer Type	Interruption Cost Summer Weekday	Interruption Duration				
		Momentary	30 mins	1 hr	4 hr	8 hr
Large C&I	Cost Per Average kWh	$173	$38	$25	$18	$14
Small C&I	Cost Per Average kWh	$2,401	$556	$373	$307	$2,173
Residential	Cost Per Average kWh	$21.6	$4.4	$2.6	$1.3	$0.9

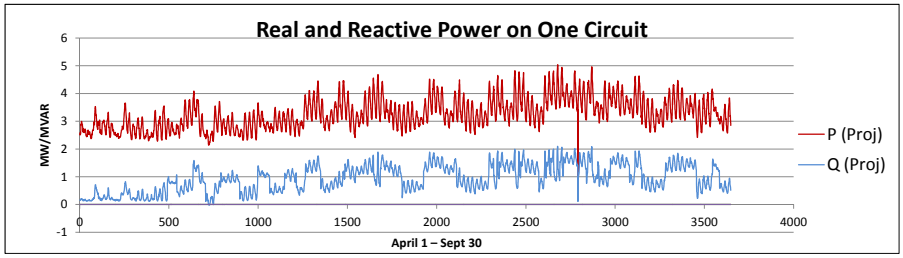
Sullivan J, Michael, 2009 *Estimated Value of Service Reliability for Electric Utility Customers in the US*, xxi

VOS Improvement Δ = Δ SAIDI x Customers Served x Avg Load x VOS Coefficient

VOS Estimate for SAIDI Improvement on 75 feeders from Apr 1 to Sep 30 2011

Customer Class	Δ SAIDI	Customers Served within a Class	Average Load (kW) Not Served	VOS Coefficient ($/kWh)	Δ VOS
Residential	17.7 mins (0.295 hrs)	107,390	2	$ 2.60	$ 164,736
Commercial		8,261	20	$ 373.00	$ 18,179,477
Industrial		2,360	200	$ 25.00	$ 3,481,325
Total		**118,011**			**$ 21,825,537**

Measuring Line Losses



Energy Savings: Apr 1 – Sept 30

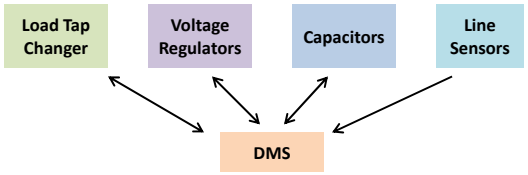
	Losses (MWh)	Diff. (%)
No Caps	355.3	---
W/ Caps	340.3	4.2%

Observations (17 feeders):

1. **Automated capacitors reduced losses by about 3%**
2. **Feeders with high reactive loads showed the greatest improvements in losses**
3. **Sometimes the capacitor bank(s) overcompensated**

Conservation Voltage Reduction

Objective: Reduce energy consumption and peak load via operating at the low end of the ANSI C84.1 Range A Band (114V – 126V)



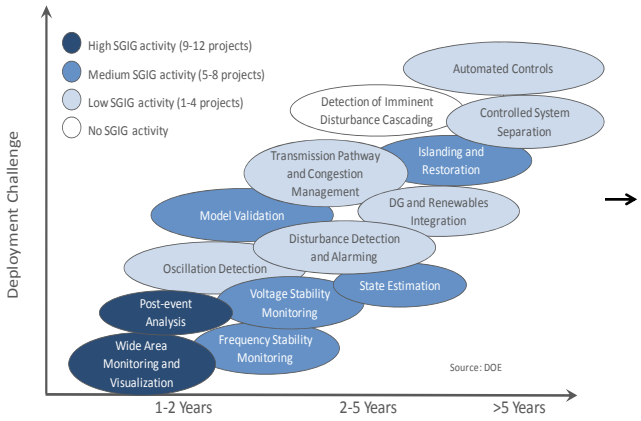
Near-real-time feedback loop enables optimized operation of these components. However, deployment strategies differ with respect to objectives and levels of sophistication.

Results Averaged across 11 Circuits	Initial Results	Potential Customer Savings (estimated for a 7 MW peak circuit with 53% load factor)	
Customer Energy Reduction	2.9%	943 MWh/year	$75,440 (at $.08/kWh)
Peak Demand Reduction	3%	210 kW	Defer construction of peaking plants

NOTE: Utilities and regulatory commissions will need to work together to establish appropriate recovery of fixed costs as consumption is reduced

Application of Synchrophasor Technology

Investments in synchrophasor technology are being made by 10 SGIG projects



Benefits:

- **Improved reliability and resiliency**
- **Improved asset utilization**
- **Reduced transmission congestion**
- **Integration of distributed generation and renewables**

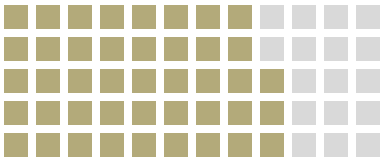
Scope and Challenges

SGIG Spending $7.9 billion with cost share to be spent through 2015

Adoption Rate Factors:

- Economy
- Policy
- Technology
- Consumer Acceptance
- Reliability Needs

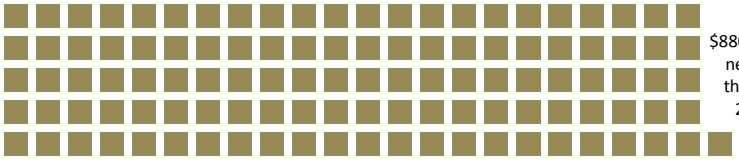
EPRI Estimate



$338 - $476 billion needed through 2030

EPRI. Estimating the costs and benefits of the smart grid: A preliminary estimate of the investment requirements and the resultant benefits of a fully functioning smart grid. EPRI, Palo Alto, CA; 2011.

Brattle Group Estimate



$880 billion needed through 2030

Chupka, M.W. Earle, R., Fox-Penner, P., Hledik, R. Transforming America's power industry: The investment challenge 2010 – 2030. Edison Electric Institute, Washington D.C.,: 2008.