Smart Grid and DSM: Issues and Activities

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Smart Grid

- The smart grid is an interconnected system of information and communication technologies and electricity generation, transmission, distribution, and end-use technologies that has the potential to:
  - Enable consumers to manage their usage and choose the most economically efficient energy service offerings,
  - Enhance delivery system reliability and stability through automation, and
  - Improve system integration of the most environmentally benign generation alternatives, including renewable resources and energy storage

Adapted from Roger Levy, presentation to the Utah Public Service Commission, 13 May 2009

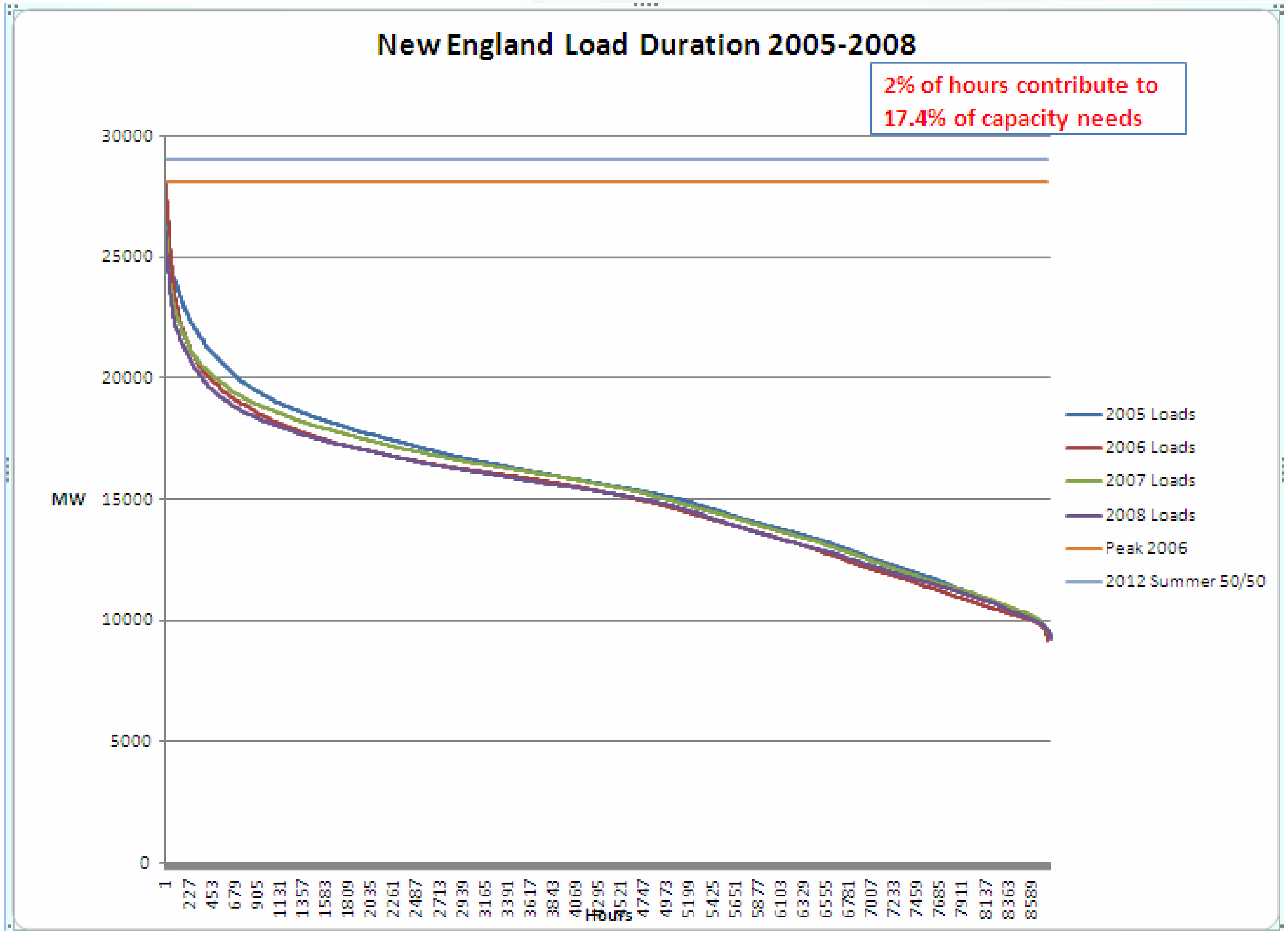
DSM

- Demand-Side Management means many things to many people
  - In the US, *DSM* as a catch-all term is typically no longer used
    - Replaced by *energy efficiency and demand response*
    - In the US, *DSM* refers to either “demand response” or “ratepayer-funded energy efficiency”
  - In this presentation, it refers to all investments and activities that affect customers’ load shapes and usage

Some Goals of Smart Grid

- Lowering costs of service (utility costs, capacity utilization, unit costs, environmental footprint)
- Strengthening system reliability and security
  - Improved management of increasingly complex system
    - Users become resources that provide value to the system
    - Increased deployment of distributed technologies – generation and end-use efficiency
  - Better integration of non-dispatchable resources
- Increased consumer economic efficiency through:
  - Information and automation and
  - More advanced (dynamic) pricing structures
    - TOU prices, Critical Peak Pricing (or rebates), Real-Time Pricing
- Improved EM&V of end-use energy efficiency programs
- Fostering innovation and entrepreneurship

Primary Target: Cost of Peak



Key Technology & System Components

- Communications
  - Medium: wireless, internet/broadband, telephone, power-line
  - Utility-customer, utility-appliance, customer-appliance, aggregator-utility, aggregator-customer
- Intelligence configuration
  - "Smart" systems: Automated meters & advanced "smart" metering – the intelligence is in the meter or with the system operators
  - "Dumb" systems: Communications backbone but intelligence is not in the meter . Instead it is in the customer's computer, appliances themselves, or in hand of an aggregator, etc.
- Integration into system operations
  - New operating protocols
  - Impacts on system reliability standards
- Integration into system planning

Some Supply-Side Smart Grid Applications

- Generation control
- Regulation (voltage/VARs, etc.)
- Real-time energy balancing
- Reserve augmentation
- Intra-day production shifting
- Diurnal, weekly, and seasonal leveling
- Firming of renewables

Distributed Resources: Smart Grid Applications

- Local area networks (home, campus, etc.)
- Direct load control
- Demand response aggregation
- Distributed Generation
- Micro-grids
- Energy storage

A Utility View

Smart Grid Technology can Accommodate Rapid Load Changes

Smart Technology Definition

Technology that provides advanced information, automation and control capabilities to help us distribute, measure and use energy more efficiently, reliably, safely and sustainably – all the way from the point of bulk power generation of various types to consumer-owned generation and appliances

	What is Smart Technology?	What does it allow you to do?
Meter	• Meter that records interval data • 2-way communications, remote configuration • Informative display • Load Control and Energy Storage Management	• Automatic meter reading • Enable customer choice and control • Choice of tariffs e.g. time of use – peak shifting • Remote management of selected house loads and home energy sources via inverter inputs
Grid	• Sensors & measuring devices • Energy Storage to provide or absorb kWh • Faster & two-way Voltage Regulators • Feeder management systems to deal with highly variable customer energy sources	• Accommodate Variable Distributed generation • Remotely detect, diagnose, predict and correct network problems & faults • Maintain feeder voltage within desired range despite widely varying loads and generation
Home	• Customer portal & Home Area Network • Automated controls for PHEV and EV Chargers • More advanced control for customer-owned generation and energy storage (ES)	• Automatically optimize selected home appliances • Allow premium kWh sales from renewable and ES systems

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nationalgrid
The power of action:

Pennsylvania

- Six electric distribution companies (EDCs) have fully deployed or are completing deployment of advanced metering networks with varying levels of “smart” functionality
  - PECO, PPL Electric, Duquesne, Citizens, Wellsboro, and UGI
- All EDCs would have to upgrade their system to provide hourly pricing

Pennsylvania (cont.)

PPL Electric Utilities	
Project description	Upgrading AMR network, without replacing meters, to provide an hourly pricing option for all customers by 2010 consistent with Act 129
Number of meters	1.3 million
Costs and benefits	Est. operational benefits alone outweigh costs by $7 million (15-yr NPV)
Original deployment	2002-2004

Texas

CenterPoint Energy - Houston		
Project description	AMI with two-way network (WiMax radios); remote connect/ disconnect; consumer education; home monitors for low-income	
Number of meters	2.4 million	
Costs and benefits	Capital cost - $639.6 million	Est. savings and benefits - $120.6 million during surcharge period (12 years)
Deployment	2009 through 2014	
Planned enhancements	ARRA funding proposal may include remote control switches, a Distribution Management System to enable management and control of microgrids and integration of wind and solar, fault location characterization software, predictive failure analysis software, and PHEV demo	

Sources: Filings in TPUC Docket No. 35639; *Smart Grid Today*, 4/27/09; CenterPoint filing in Project No. 36674.

Multiple States

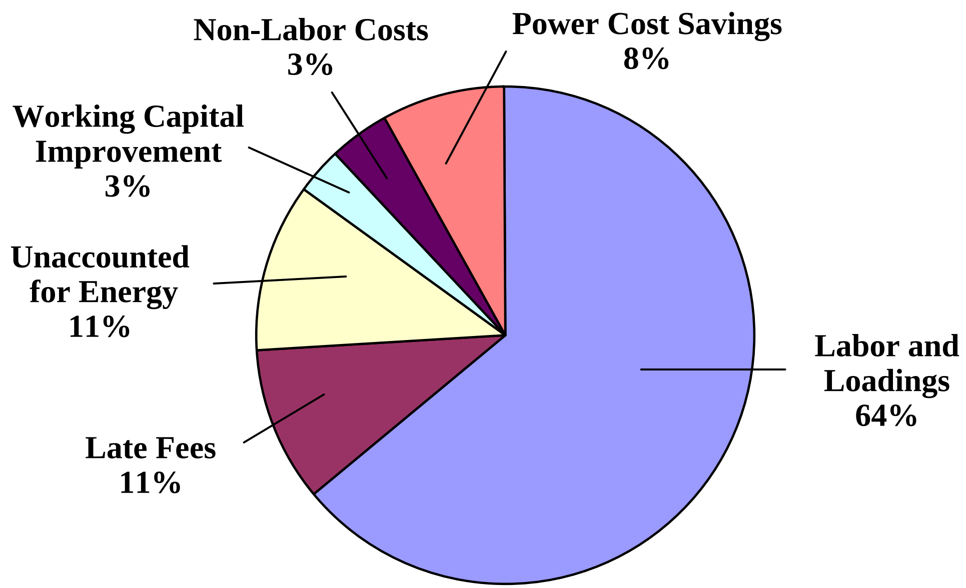
American Electric Power – gridSMART	
South Bend, Indiana, Pilot (late 2008-late 2009; $7 million)	10,000 meters installed; customer access to prior day hourly data; A/C load control; TOU rate option; remote connect/disconnect; 6-10 MW/yr of utility-scale battery storage; PHEV charging, dist. mgt. system on 2% of circuits (reconfiguration/optimization, real-time monitoring and diagnostics, fault location i.d.)
Texas	Installing 1 million smart meters in Texas over next several years
Planned enhancements	Smart meters to all 5 million customers by 2015; microgrids; EPRI “green circuit”; 25 MW of energy storage by 2010; 1,000 MW of demand reduction from efficiency and DR by 2012
Ohio substation pilot	Demo of high-speed, IP-based communications to connect three substations using high-voltage BPL (USDOE funding); applications include protective relaying, SCADA expansion, remote station surveillance and advanced sensing

Oregon

Portland General Electric		
Project description	Two-way RF AMI, remote connect/disconnect on all multi-family meters	
Number of meters	850,000	
Costs and benefits	Capital cost - $132 million	Est. operational savings in 2011 - $18.2 mil. (*not* incl. DR, etc.); net benefits $33 million (20-yr PVRR)
Deployment	Mid-2008 (systems acceptance testing) through 2010	
Planned enhancements	CPP pilot for residential customers beginning 2010, turnkey demand response programs (via recent RFP) may use AMI system, integration of AMI with new outage management system, energy usage and tools on Internet, better information on bills, distribution asset utilization, stimulus fund projects	

Oregon

- Where are Portland General Electric's expected operational savings?



European Union

Enel SpA - Italy	Enel coordinates ADDRESS, a consortium of 11 EU countries developing large-scale interactive distribution energy networks.
Project description	• 32 million smart meters installed from 2000 to 2005 • Real-time display of home energy usage • Pricing options and participation in energy markets • Automatic management of the grid in case of outage • Monitoring of status of network components • >100,000 substations remotely controlled • Automated fault clearing • Mobile applications for field crews
Costs and benefits	Cost - €2.1 billion Projected annual savings – €500 million
Planned enhancements	• More fault detectors, • New voltage and current outdoor sensors, • Distributed generation protection, • Enable active participation of small and medium customers in power market.

Sources: "Echelon teams with T-Mobile for cell-based AMI," *Smart Grid Today*, 4/23/09;
Enel Spa presentations at Grid Week 2008 and Brussels, 3/19/09

European Union (cont.)

EDF – France, Italy, Germany, UK		
Project description	2010: 1% pilot (300,000 meters, 7,000 concentrators) to test information system and deployment process and validate business case; installing advanced digital controls for distribution automation at substations 2012-2016 – 35 million meters; 700,000 collectors	
Costs and benefits	Cost - $6.4 billion (est.)	Est. yearly savings - $430M on metering services; ~$220M on non tech. losses
Smart grid demos	PREMIO - Distributed energy resources, renewable resources, energy efficiency and demand response FENIX – Aggregate distributed energy resources to create a large-scale virtual power plant	

Source: Richard Schomberg - EDF VP Research North America, GridWeek 2008

Getting Smart

- Advanced metering infrastructure (AMI – smart meters and 2-way communication) may be a 1st step, providing new capabilities such as:

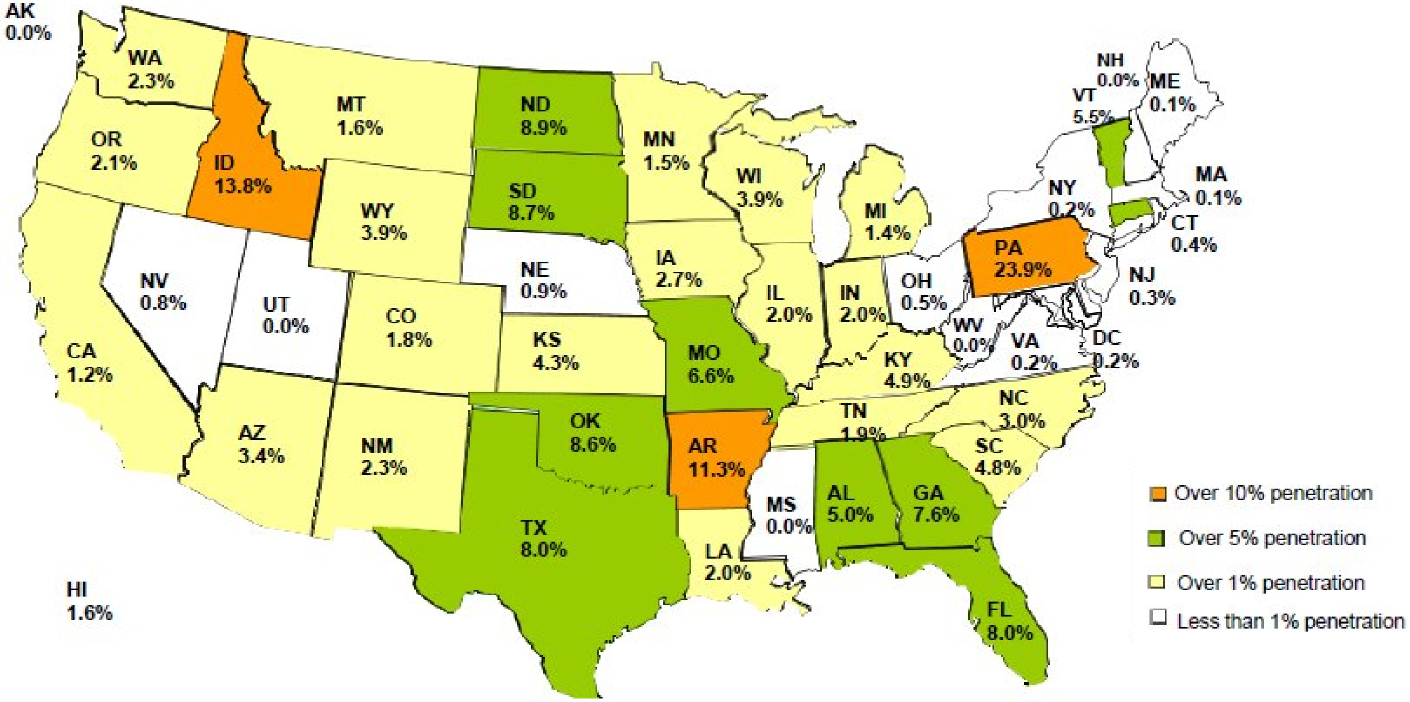
  - Time-varying pricing options coupled with enabling technology like smart communicating thermostats
  - Useful usage information for consumers and CSRs
  - Improved outage detection and response
  - Right sizing of distribution assets

Getting Smart (cont.)

- FERC survey conducted in 1st half of 2008
  - 4.7% of meters in U.S. are “advanced”
    - Highest penetration rates in Pennsylvania, Idaho, Arkansas, North Dakota and South Dakota (IOUs in PA and ID; co-ops elsewhere)
    - That does not include installations by the three California IOUs, CenterPoint, Oncor, Southern Co., PGE, Detroit Edison, Alliant, etc.
  - 8% of U.S. consumers participate in a demand response program
    - Potential resource contribution is about 41,000 MW – about 5.8% of U.S. peak demand

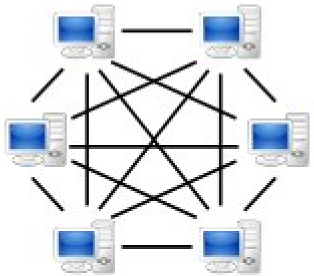
US Deployment of AMI

AMI Penetration Rates – 2008



Source: KEMA presentation to Northwest Energy Efficiency Alliance, 2/11/09, using FERC survey data from the first half of 2008

Microgrids

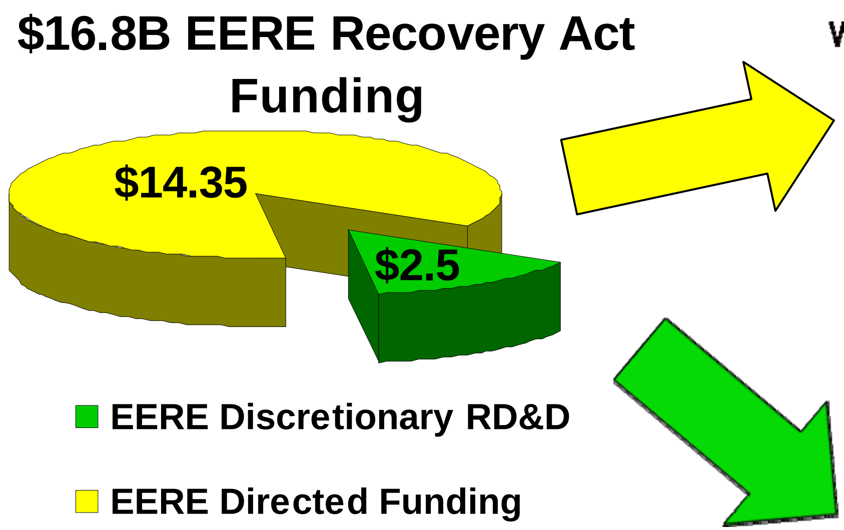


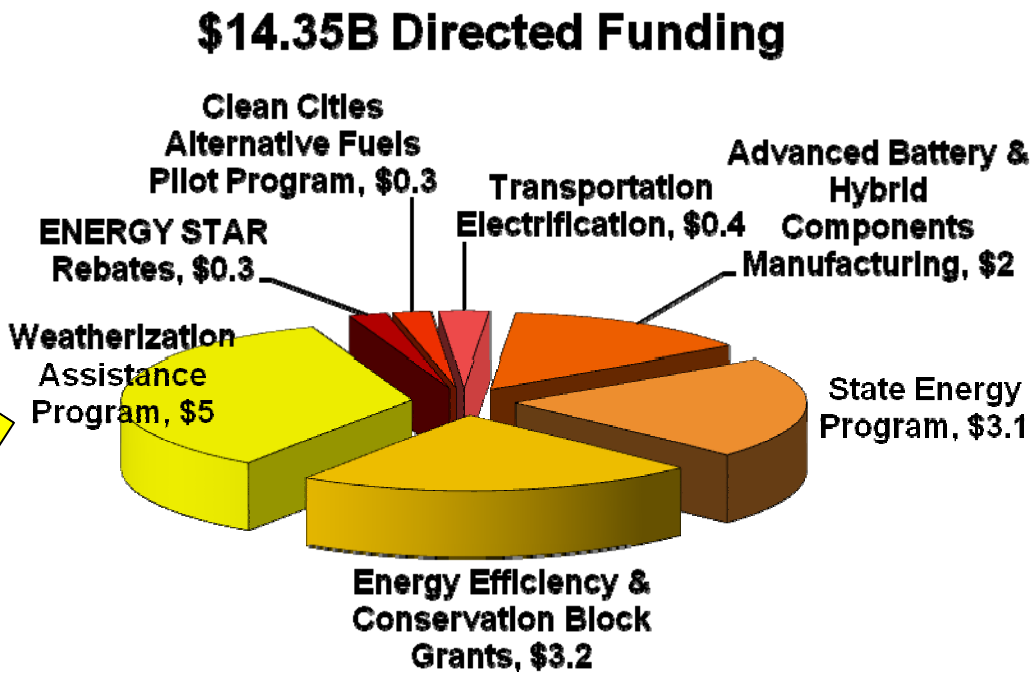
- Interconnected network of distributed energy systems (loads/resources) that can function connected to or separate from grid
- During a grid disturbance, a microgrid isolates itself from the utility seamlessly with no disruption to loads within; automatically resynchronizes and reconnects to grid seamlessly when grid conditions return to normal
- Current projects
  - CERTS Microgrid Test Bed (AEP) - Testing started 11/06
  - GE demo - Advanced controls, energy mgt. and protection technologies
  - US Army CERL/Sandia Labs Energy Surety Project - Controls, optimization of resources and storage

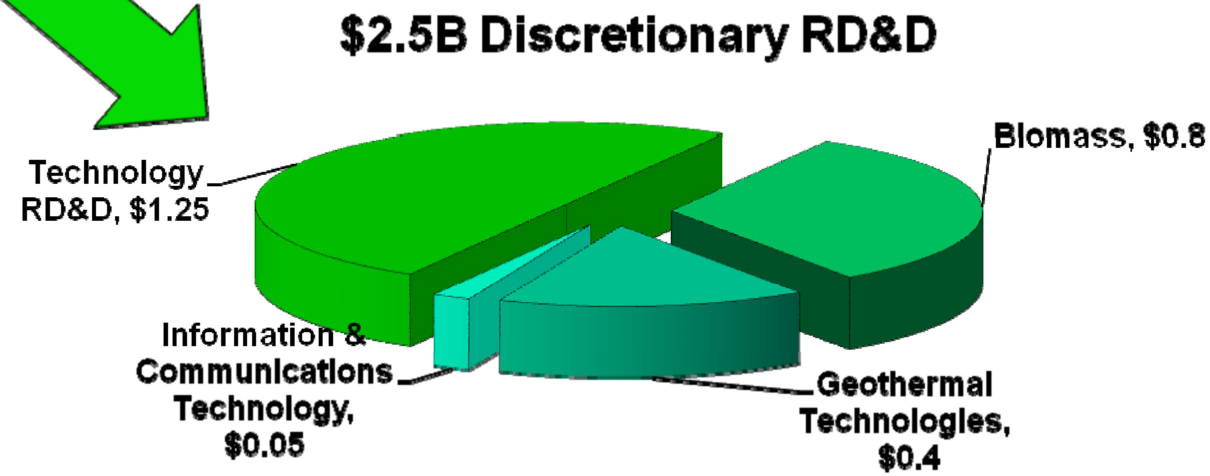
The American Recovery and Reinvestment Act of 2009 (ARRA)

- Signed into law on 17 February 2009
- $787 billion total funding
- For FY2009-FY2012
- DOE portion
  - $32.7 billion, excluding loan programs
  - $12.5 billion in loan programs
    - Rapid deployment of renewable energy systems -- $6.0 billion
    - DOE power administration borrowing authority -- $6.5 billion

ARRA $ for DOE Energy Efficiency and Renewables Work







Amounts are in billion US Dollars

Some Key Implementation Issues

- What is the objective of deployment? – i.e., what problem are you solving?
  - Carbon impacts: both operational and planning
- High front-end infrastructure cost
- Chicken or egg? – absence of smart appliances – if you build it will they come?
- Identifying the values of different applications
  - Who benefits and who pays?
  - Inter-generational issues
- Access to information
  - Customers & aggregators must have timely & easy access to consumption data

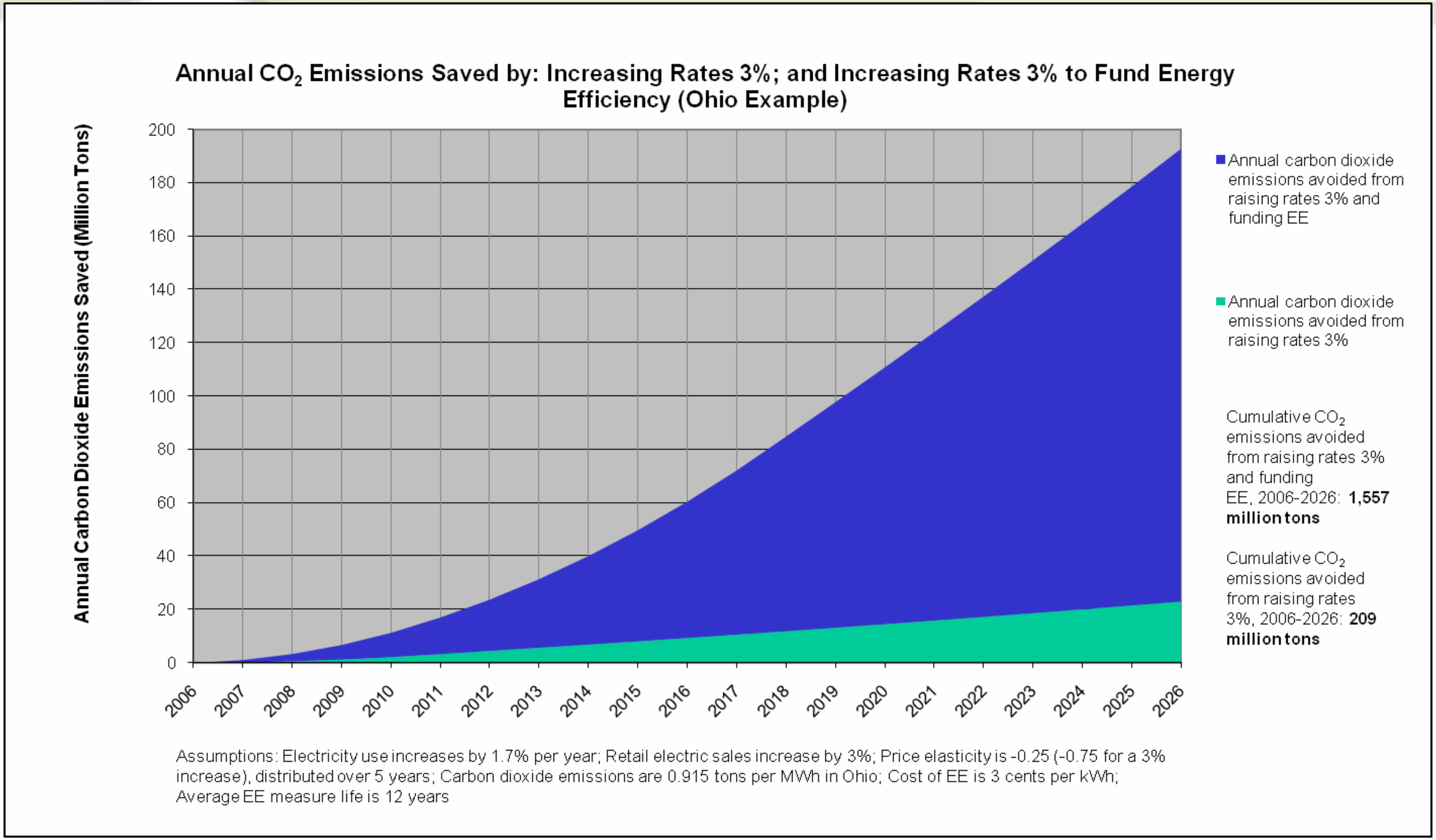
More Key Implementation Issues

- Where does the "smart" part go:
  - In the meter?
  - In the appliance?
  - On a separate platform (e.g., personal computer)?
  - Potential big winners and losers
    - Technology developers (everybody wants "their" technology to be "the" technology)
    - Utilities (usually want to "own" the customer relationship)
- Open source versus proprietary systems
  - Communications protocols
  - Data format
  - Control signals

Cautions

- Is a smart grid a green grid?
  - Assertions of savings, particularly energy savings from changes in consumer behavior, may be optimistic
  - Improved price signals do not eliminate all barriers to end-use efficiency
    - Direct programmatic spending on energy efficiency can save seven times as much energy (and carbon) per consumer $ than can carbon taxes or prices
    - Carbon benefits of load-shifting depend on resource mix
- Does focus on smart grid distract policymakers from more cost-effective means of achieving same ends?
  - Integrated long-run analysis needed to determine highest and best uses of limited ratepayer dollars

Recycling the $$ into EE Saves Seven Times More Carbon



The Smart Grid Suite

Smart Appliances:
Controllable load
Status reporting
PHEV as resource

Smart Operations:
Dispatch savings
Reliability
Ancillary Services
Service connection/disconnection, etc.
Integration & firming of renewables

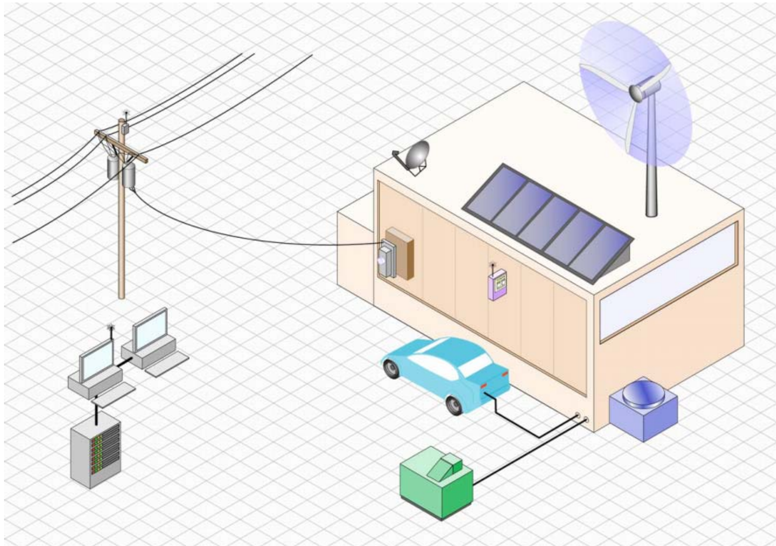
Smart Policies:
Clear policy objectives
Net Benefits Framework
Maximization of carbon reductions

Smart Pricing:
Value differentiated pricing
Aggregation pricing
Market participation

Smart Planning:
Deferral or avoidance of new supply-side construction
Applies to G, T & D
Least-cost/least-carbon system planning

From Smart to Smarter

- "Smart Grid" continuing to evolve
  - Demos and rollout of pieces
  - Fully integrated projects with these features are just starting
    - Real-time communication
    - Active interaction with loads
    - Distribution system management
    - Optimized integration of distributed generation and storage



EPRI graphic