The Brattle Group

DEMAND RESPONSE & ENERGY EFFICIENCY
The Long View

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1. Introduction
2. Demand Response programs
3. Projected impacts of Demand Response
4. Energy Efficiency programs
5. Projected impacts of Energy Efficiency
6. Uncertainties
7. The path forward

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The prolonged recession has dampened the enthusiasm for programs that emphasize the smarter use of energy

However, the long term drivers are still there

- The absence of inexpensive, carbon-free supply-side options
- Increasing dependence on imported oil
- Continued population growth
- Development of new uses of electricity
- Public concerns about climate change
- Changing customer values – especially noticeable among the younger generation of consumers

Demand Response and Energy Efficiency are first cousins

Both Demand Response and Energy Efficiency encourage customers to save energy but in different ways

- Demand Response focuses on reducing peak demand
  - Demand Response programs are created to provide incentives to reduce energy use for a short period of time at a certain time of day, typically during times when the electric system is stressed
- Energy Efficiency focuses on reducing overall use of energy
  - Energy Efficiency programs are created to provide incentives to reduce energy use throughout the year

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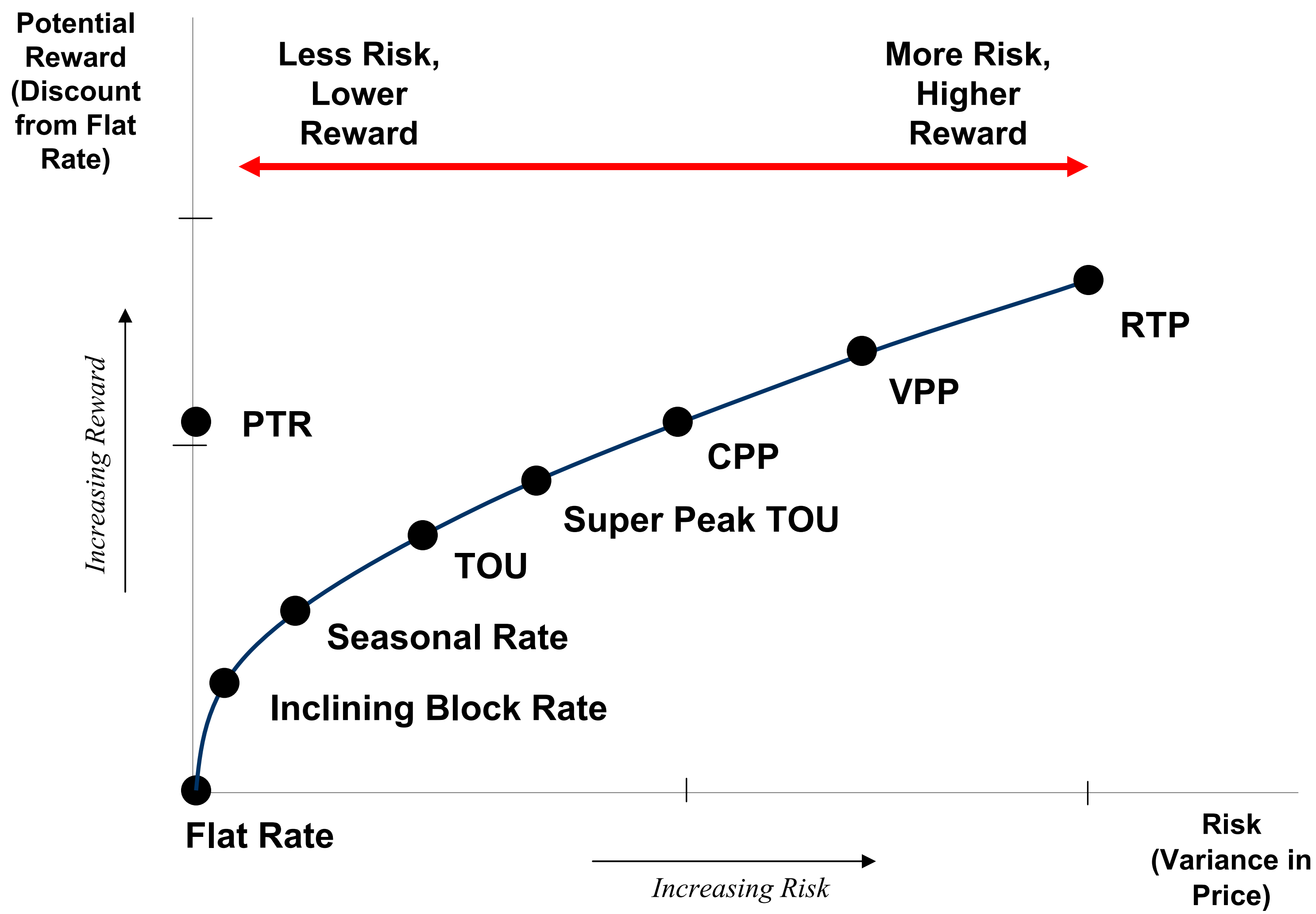
Demand Response can be reliability- or price-triggered

The objective is to reduce demand when the system is stressed

- Reliability-triggered
  - Direct load control (DLC): customer end-uses are directly controlled by the utility and are shut down or moved to lower consumption
  - Interruptible tariffs: customers agree to reduce consumption to a pre-specified level, or pre-specified amount, in return for an incentive payment
- Price-triggered
  - Time-of-use rate (TOU): The rate is time-varying to correlate to system peak, but the prices are static and not related to real-time system needs
  - Dynamic pricing: The rate is time-varying and adjusted in (near) real-time to address current system needs

The risk-reward frontier for electric rates



Over 22,000 MW of Demand Response is being implemented today by the Top 10 states

Top 10 Current Peak Demand Reductions by State

2009 data, ranked by Business as Usual MW peak demand reductions

Rank	State	Peak Demand (MW)	Business As Usual (MW)	Business As Usual (% of peak)
1	CA	58,395	3,330	6%
2	FL	50,296	2,924	6%
3	NY	34,167	2,803	8%
4	PA	32,007	2,516	8%
5	IL	31,019	2,302	7%
6	MI	23,820	2,153	9%
7	MN	14,798	2,056	14%
8	MD	13,806	1,726	12%
9	NC	27,120	1,388	5%
10	IN	23,266	1,370	6%

Source: FERC National Assessment of Demand Response Potential

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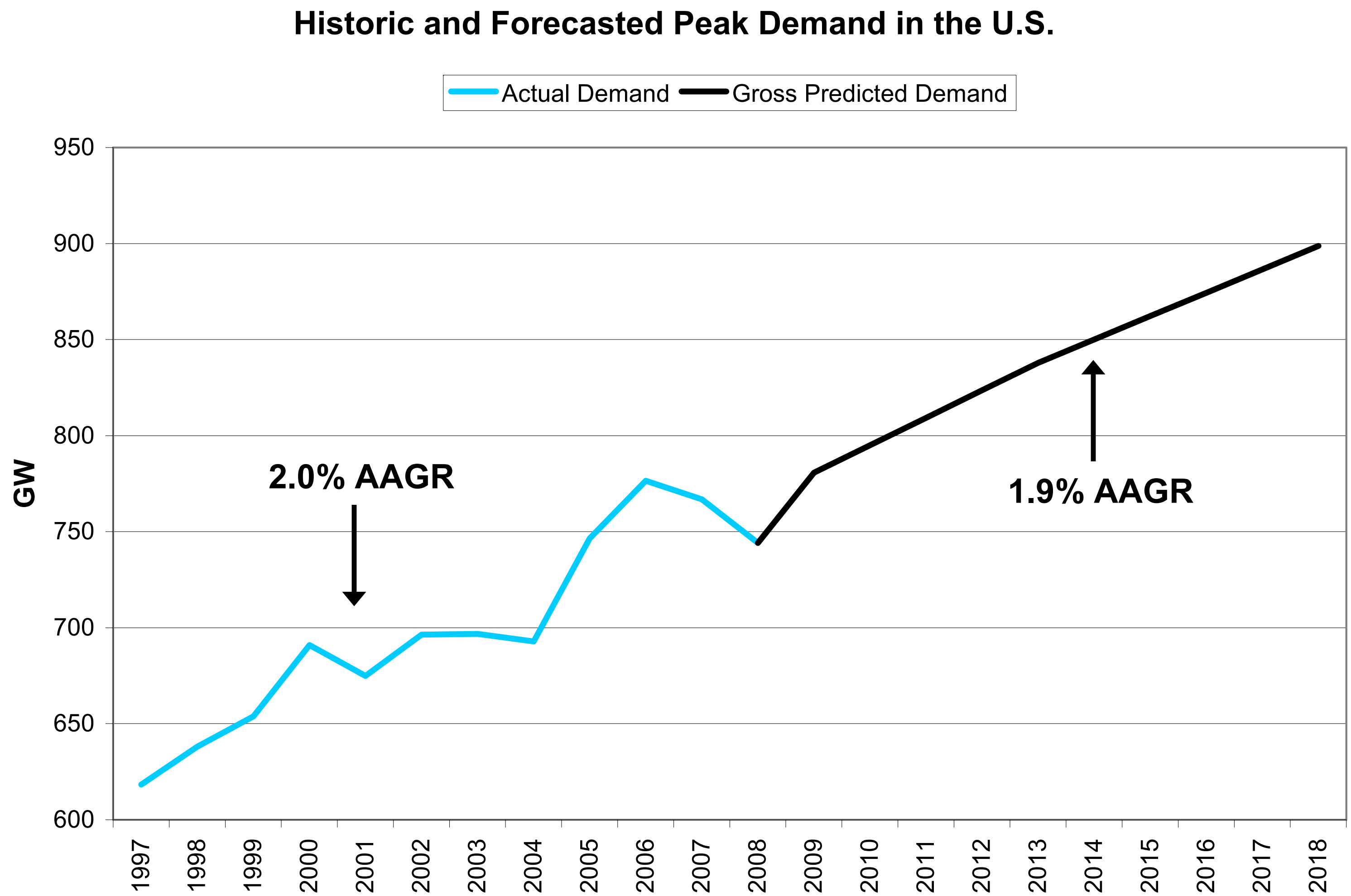
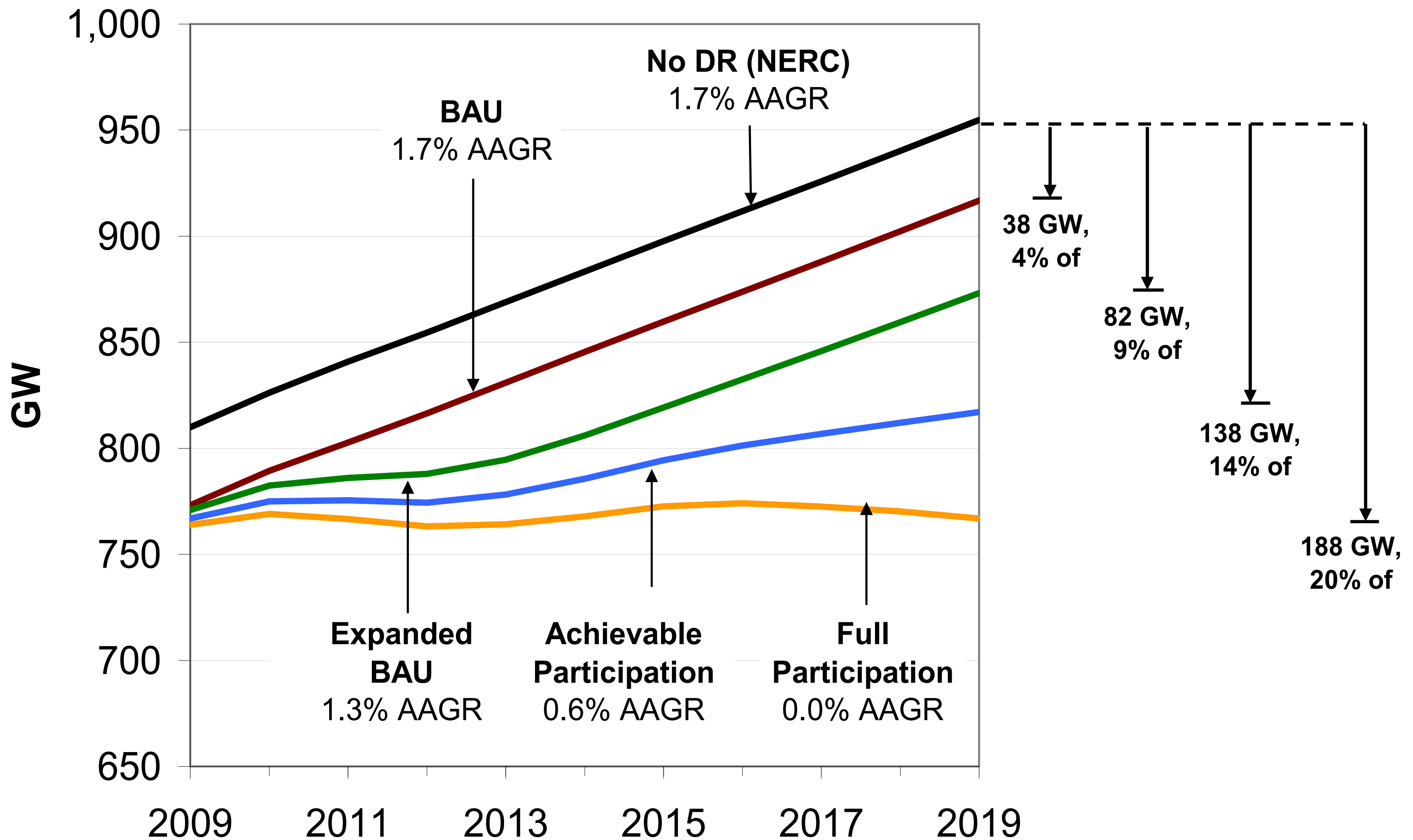
Peak demand is forecasted to increase 15% by 2018 without Demand Response



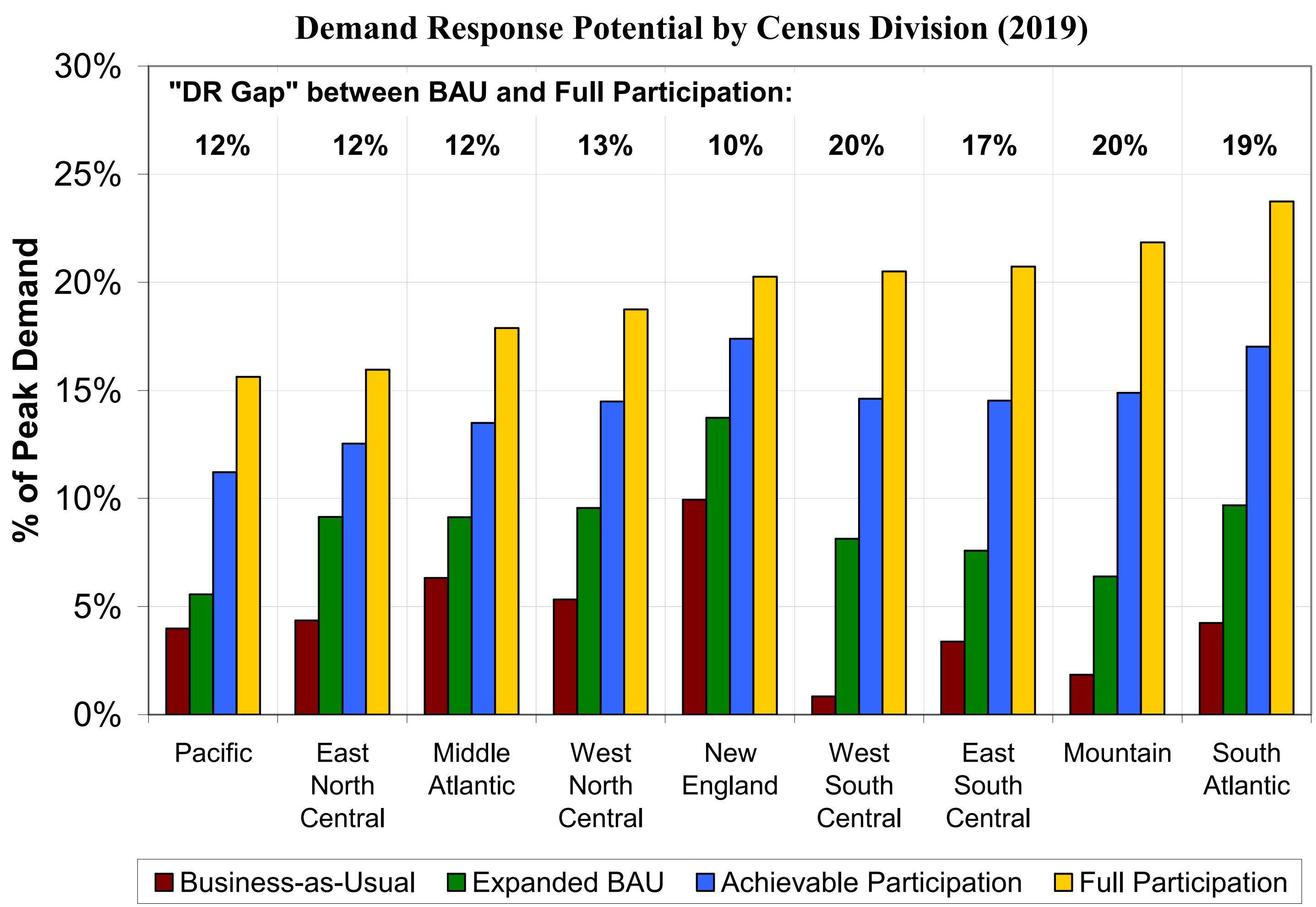
Source (Actual Demand): EIA Electric Power Annual 2008
Source (Gross Predicted Demand): NERC Long-Term Reliability Assessment, 2009-2018

The FERC Assessment predicts Demand Response can reduce peak demand by up to 20% in 2019



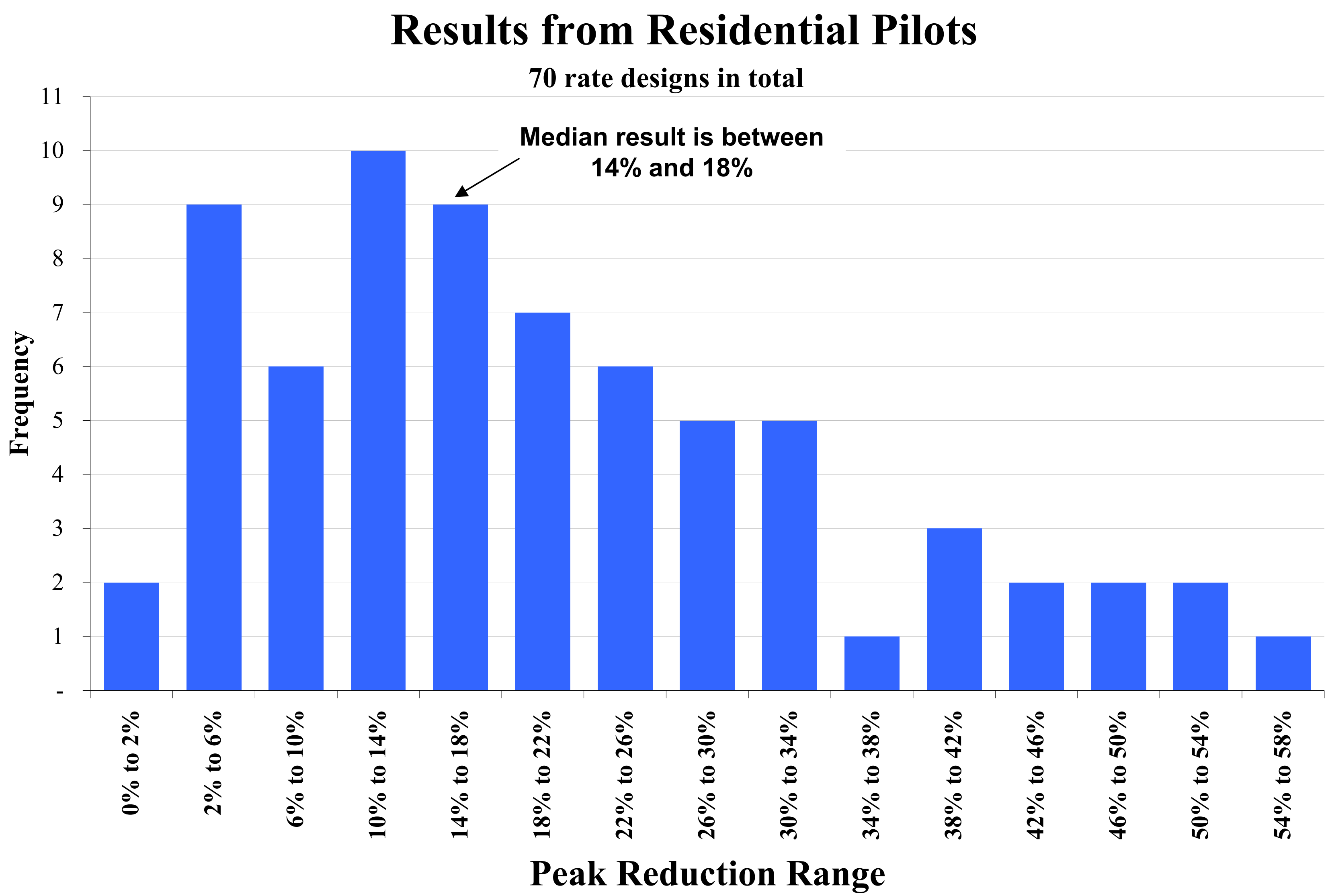
Source: FERC National Assessment of Demand Response Potential

Demand Response potential exhibits regional variation

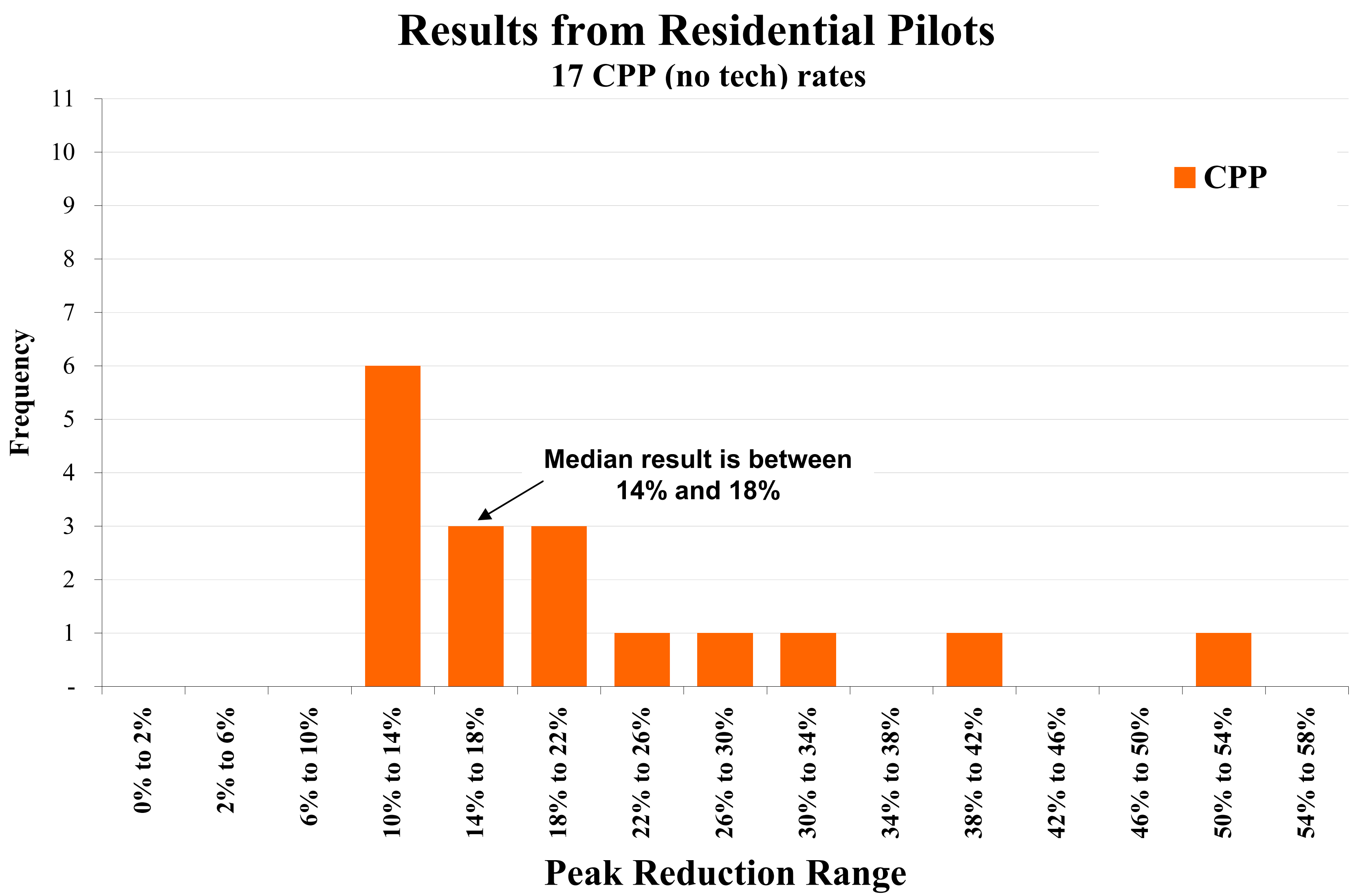


Source: FERC National Assessment of Demand Response Potential

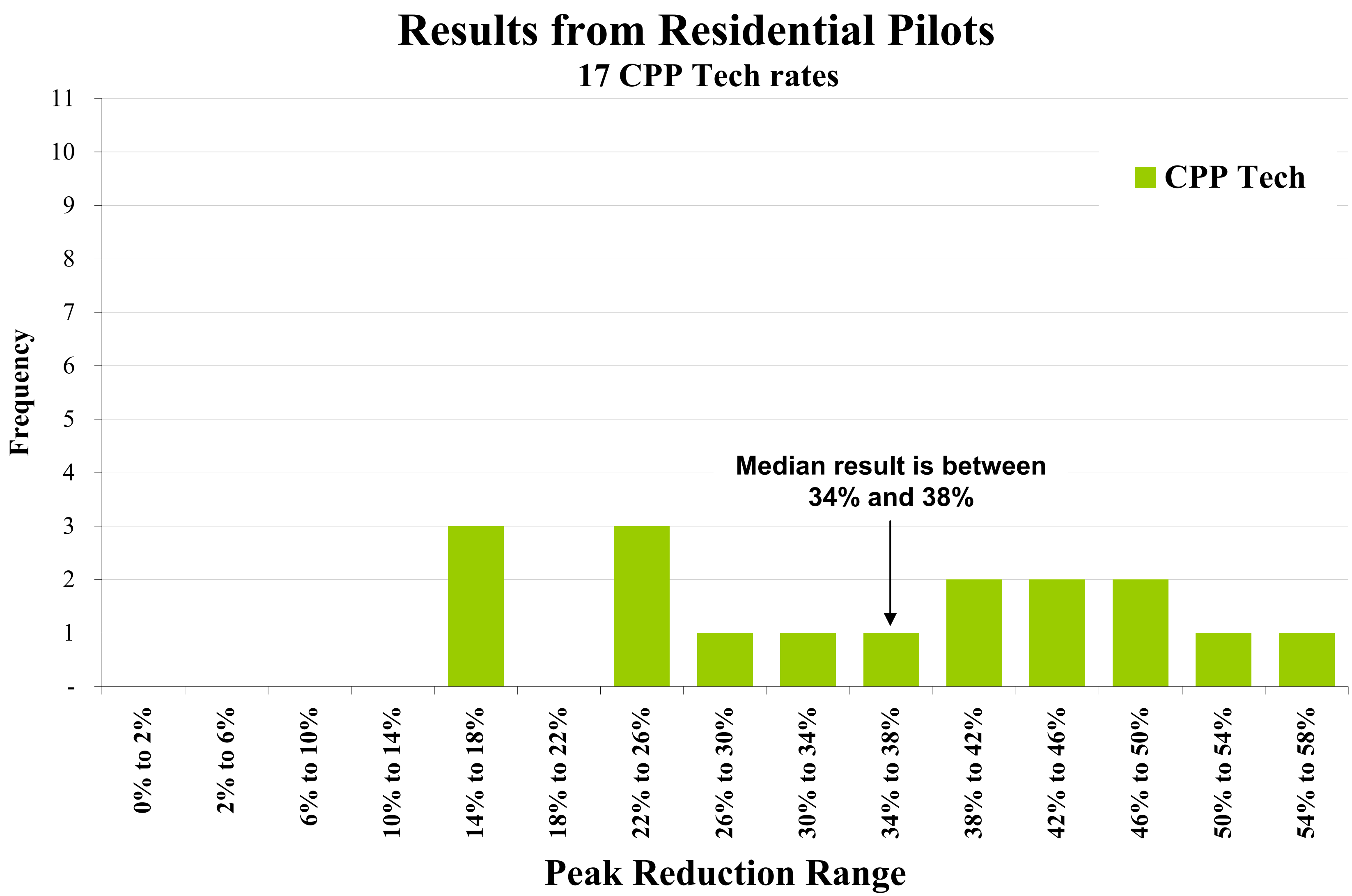
The new ingredient is dynamic pricing, which has shown much promise in 70 pilots across three continents



Critical peak pricing has demonstrated peak reductions greater than 10%



The inclusion of technology with the critical peak pricing rate enhances peak reductions



The arrival of the smart grid has made Demand Response much easier to implement

Investments in the smart grid are growing

- ♦ The Federal government invested $3.4 billion in Smart Grid Investment Grants through the American Recovery and Reinvestment Act of 2009 (ARRA)
  - The money was allocated to 100 grantees
  - 31 of the grants were for Advanced Metering Infrastructure (AMI), 11 of which mention dynamic pricing
  - Federal support for AMI is $816 million, resulting in a total AMI investment of $2 billion including cost-sharing
- ♦ More than $57 million of ARRA money went to smart grid demonstration projects
- ♦ Nationally, 60 million AMI meters will be in operation by 2019
  - 47% of U.S. households will have AMI
  - 38 states have utilities with AMI deployments, plans, or proposals

Source: www.smartgrid.gov
Source: Institute for Electric Efficiency, "Utility-Scale Smart Meter Deployments, Plans & Proposals." February 2010.

The financial benefits of Demand Response may exceed $65 billion by 2030

The *iGrid* model was used to quantify the benefits

- Our calculations are driven by key assumptions about:
  - Avoided capacity and energy costs
  - Customer adoption and response rates
  - Central air conditioning saturation

Smart Grid Valuation Summary, 2010 - 2030
Present Value of Avoided Costs, Millions of $

	Meter O&M	Generating Capacity	Energy from Electricity	Carbon	Total
AMI	$32,747	$0	$0	$0	**$32,747**
DR (Dynamic Pricing)	$0	$15,729	$5,902	$1,269	**$22,900**
DR (Enabling Technology)	$0	$6,939	$2,719	$585	**$10,242**
Total benefits	**$32,747**	**$22,668**	**$8,621**	**$1,854**	**$65,890**

See Faruqui, Ahmad, Peter Fox-Penner, and Ryan Hledik. "Quantifying Benefits." Public Utilities Fortnightly. July 2009, for more details on iGrid

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There is no single solution to Energy Efficiency

Information

- ♦ About energy costs as they are incurred and ideas on how to manage those costs

Codes and standards

- ♦ For new appliances, buildings and industrial processes

Enabling technologies

- ♦ For controlling costs in real-time conditions through price-sensitive thermostats and appliances

Rebates and financing

- ♦ Accelerating the adoption of smart end-use technologies

Smart rate design

- ♦ Inclining block rates for Energy Efficiency and dynamic pricing rates for peak load management

Total U.S. electric Energy Efficiency spending has doubled in two years, from $2.2 billion in 2007 to $4.4 billion in 2009

Top 10 Current Energy Efficiency Savings by State

2007 data, ranked by total MWh savings

Rank	State	Total Incremental Electricity Savings (MWh)	Savings as Percent of Electricity Sales
1	CA	3,393,016	1.3%
2	WA	635,062	0.7%
3	NY	540,612	0.4%
4	MA	489,622	0.9%
5	WI	467,725	0.7%
6	MN	463,543	0.7%
7	TX	457,808	0.1%
8	OR	437,494	0.9%
9	CT	371,899	1.1%
10	FL	348,208	0.2%

Source: ACEEE 2009 State Energy Efficiency Scorecard
Source: DOE EERE News

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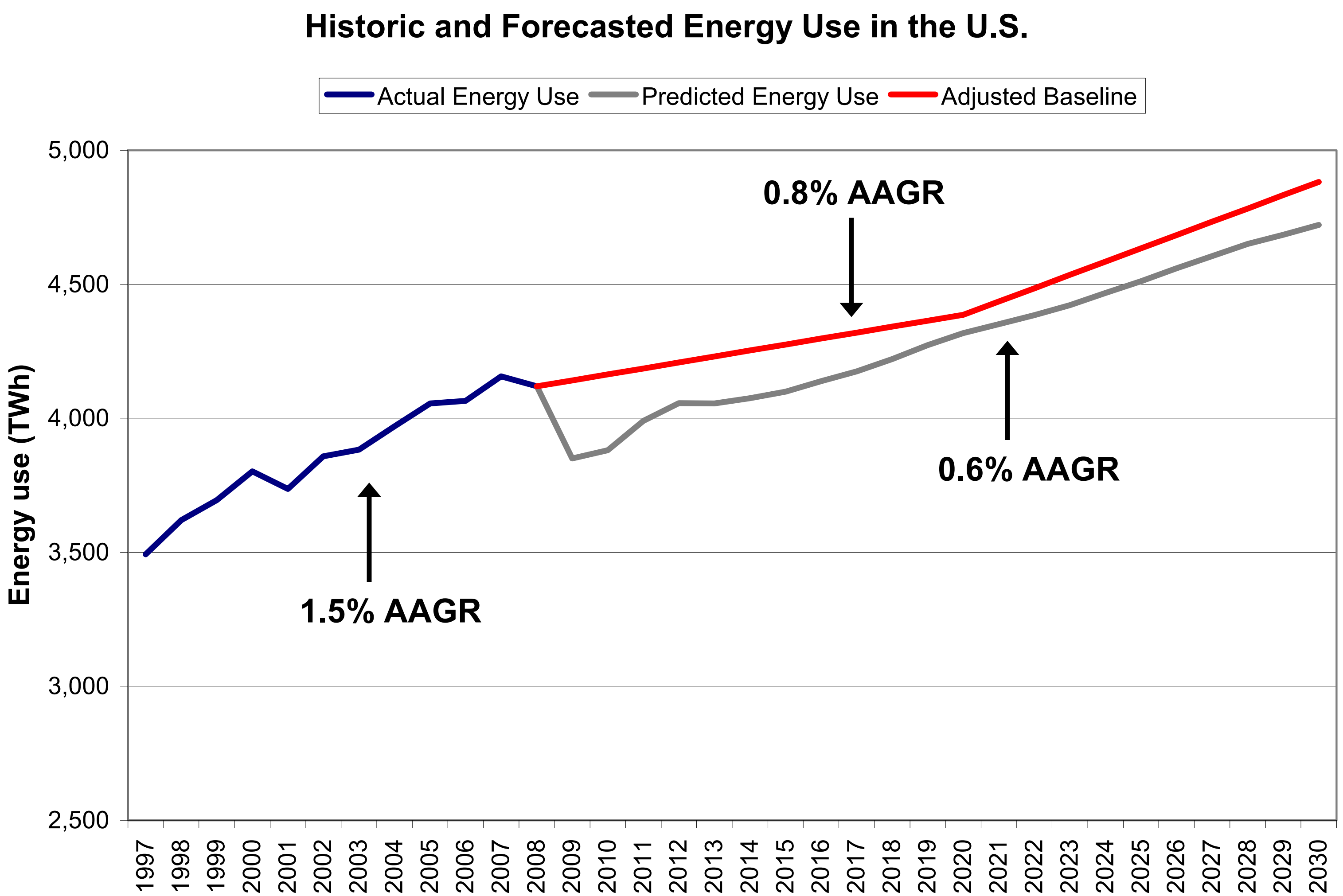
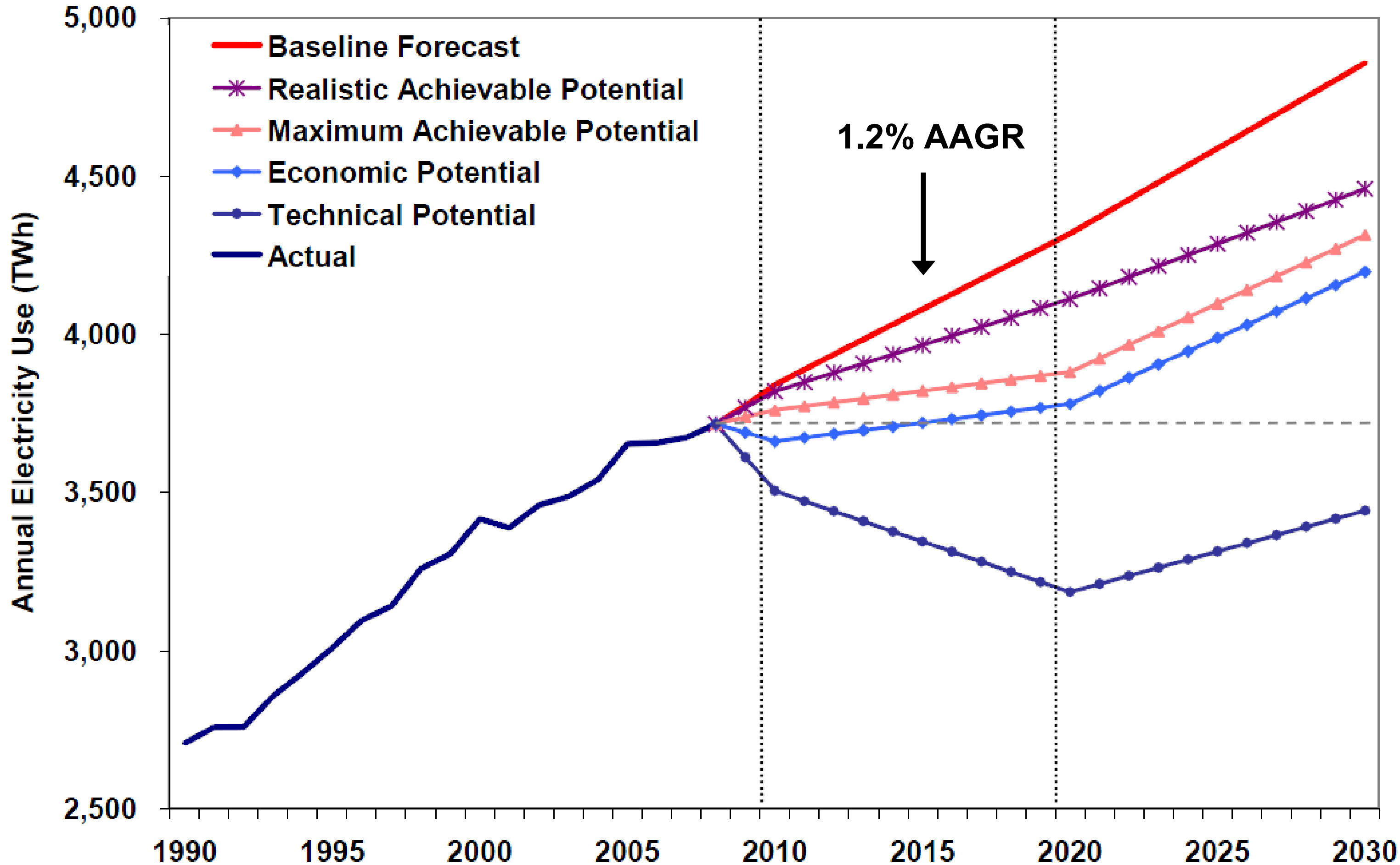
Energy use is predicted to decline due to the recession, but eventually to rebound



Source (Actual Energy Use): EIA Electric Power Annual 2008
Source (Predicted Energy Use): EIA Annual Energy Outlook 2010

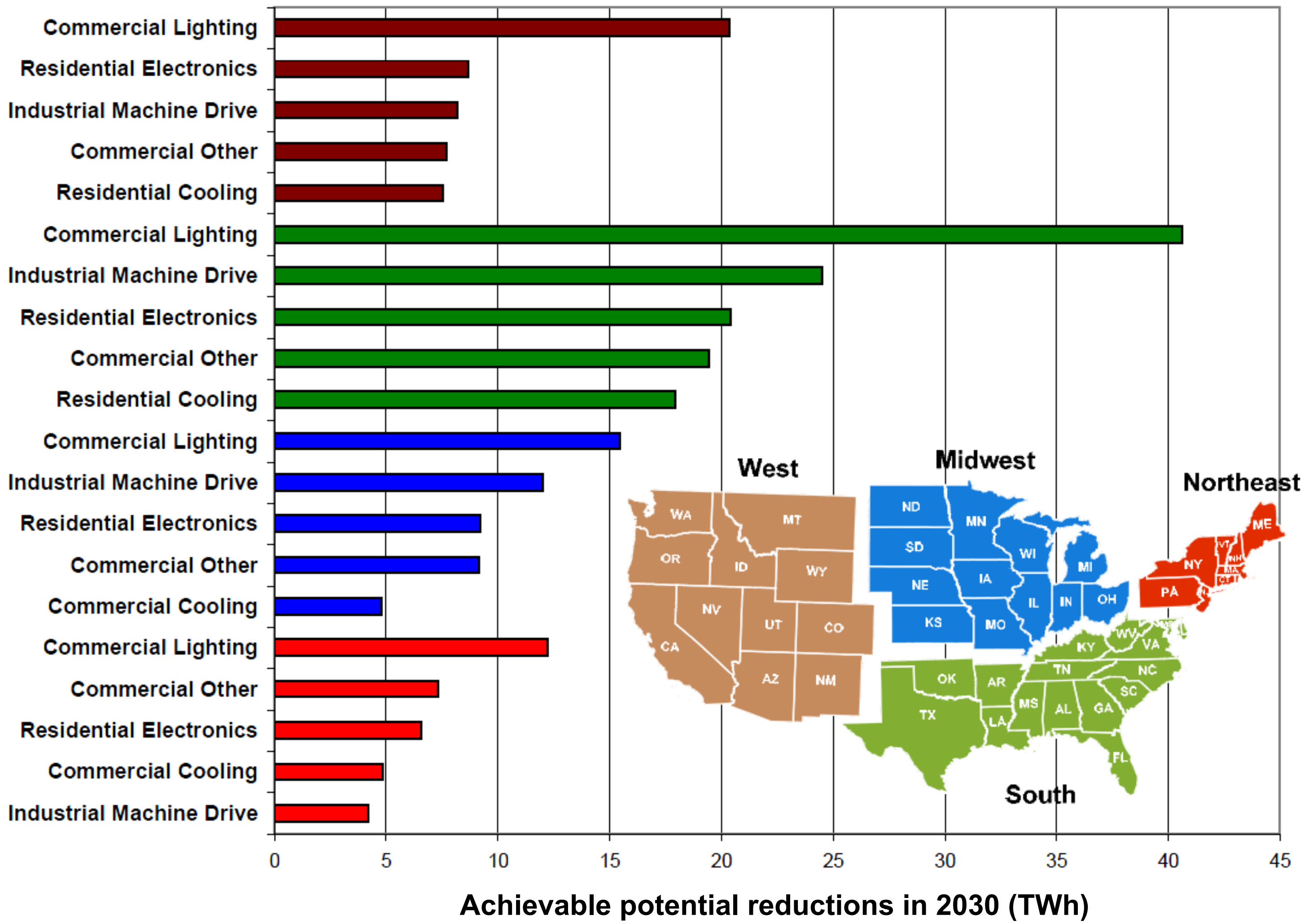
A recent EPRI study of Energy Efficiency predicts an economic potential reduction of 14% in 2030

Energy Efficiency Potentials from EPRI Study



Source: EPRI Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S.

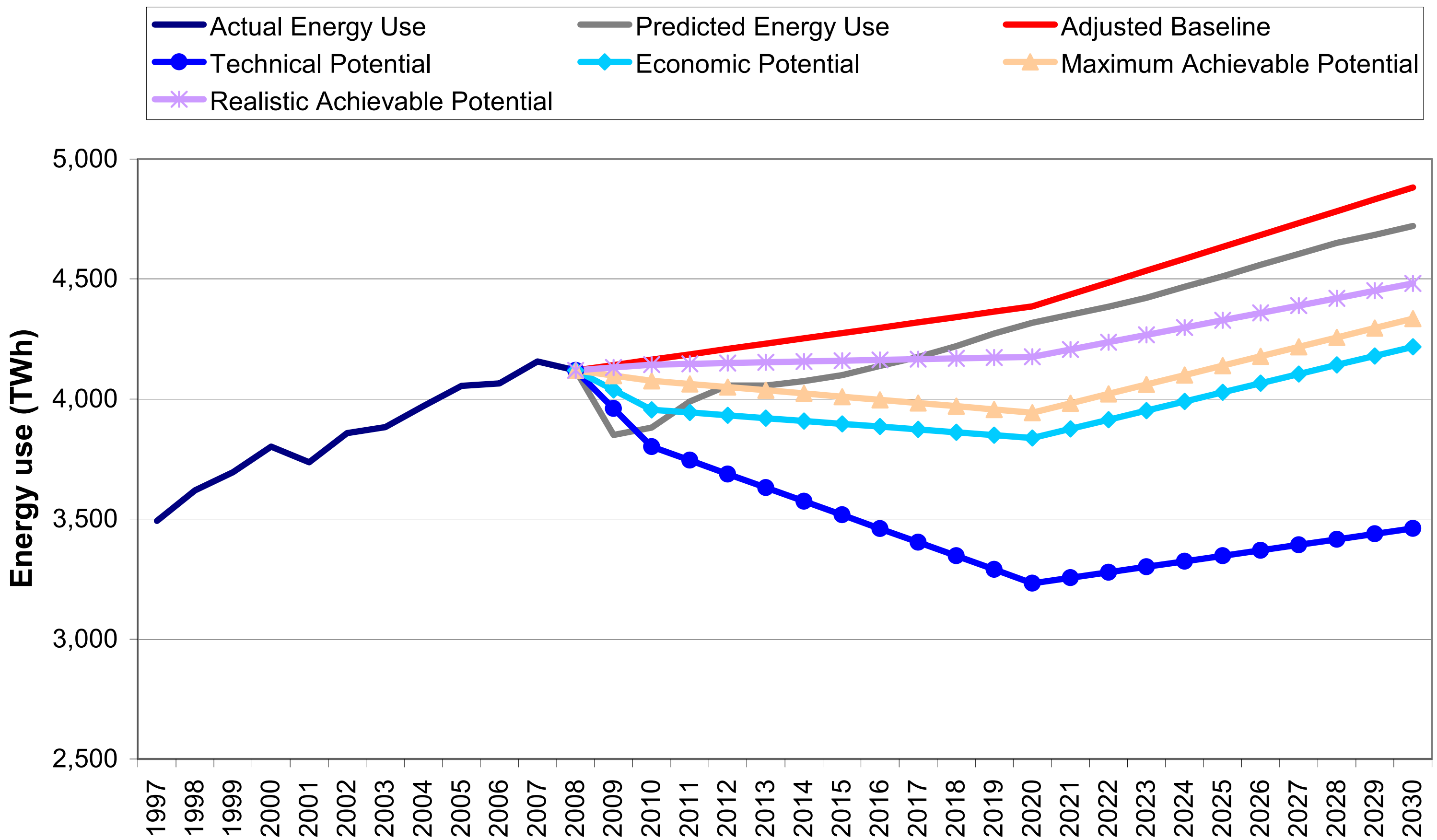
The measures driving Energy Efficiency in the U.S. vary by region



Source: EPRI Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S.

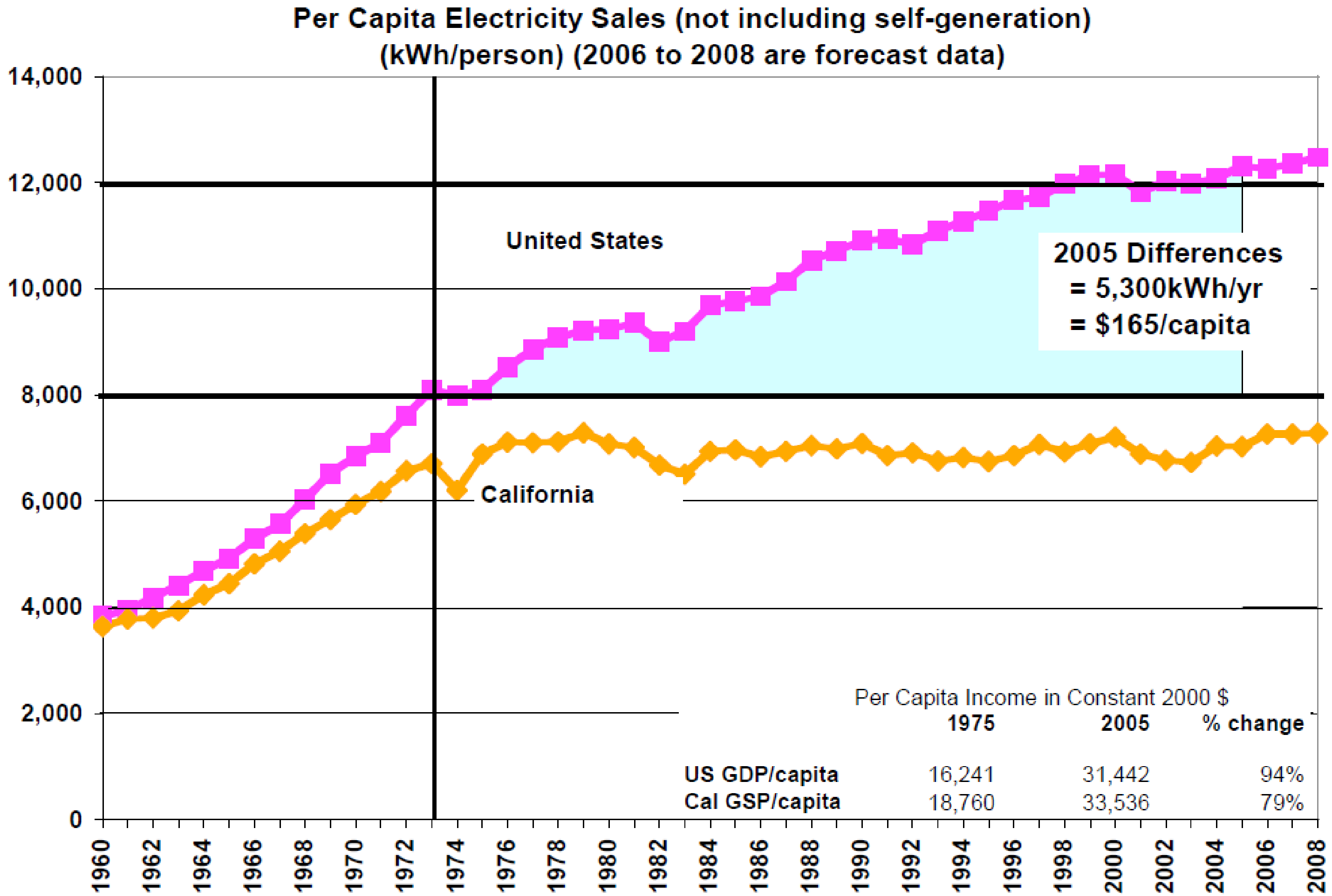
The economic potential scenario yields a reduction of 664 TWh in 2030

Historic and Forecasted Energy Use in the U.S., with EPRI energy efficiency reductions



Source (Actual Energy Use): EIA Electric Power Annual 2008
Source (Predicted Energy Use): EIA Annual Energy Outlook 2010
Source: EPRI Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S.

California has demonstrated the viability of Energy Efficiency measures over many decades



Per Capita Income in Constant 2000 $

	1975	2005	% change
US GDP/capita	16,241	31,442	94%
Cal GSP/capita	18,760	33,536	79%

Source: Rosenfeld, Arthur. Energy Efficiency in California. November 2008.

Energy Efficiency is also a priority elsewhere in the country

Many states are enacting their own legislation setting targets

- Under Maryland's EmPOWER initiative, the state will reduce energy consumption by 15 percent by 2015
- Pennsylvania's Act 129 requires a 1% reduction in consumption by May 31, 2011 and of 3% reduction in consumption (as well as a 4.5% reduction in peak demand) by May 31, 2013
- The Arizona Corporation Commission requires electric utilities to reduce the amount of power they sell by 22 percent by 2020
- New Mexico has a stated goal of a 20 percent reduction by 2020

Federal standards also play an important role in Energy Efficiency

- A voluntary agreement between the appliance industry and energy conservation advocates proposes that the U.S. DOE and EPA establish higher base efficiency standards for major appliances

The financial benefits of just two smart-grid enabled Energy Efficiency programs may exceed $60 billion by 2030

The *iGrid* model was used to quantify the benefits of two types of Energy Efficiency that are associated with the smart grid

- Our calculations are driven by the following assumptions
  - Avoided costs of capacity and energy
  - Customer adoption and response rates for in-home displays
  - Impact of building commissioning upgrades

Smart Grid Valuation Summary, 2010 - 2030
Present Value of Avoided Costs, Millions of $

	Meter O&M	Generating Capacity	Energy from Electricity	Carbon	Total
EE (IHDs)	$0	$3,534	$22,703	$4,883	**$31,120**
EE (Building Commissioning)	$0	$4,443	$20,267	$4,359	**$29,069**
Total benefits	**$0**	**$7,977**	**$42,970**	**$9,242**	**$60,189**

See Faruqui, Ahmad, Peter Fox-Penner, and Ryan Hledik. "Smart Grid Strategy: Quantifying Benefits." Public Utilities Fortnightly. July 2009, for more details

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Demand Response and Energy Efficiency are not the only customer-side initiatives on the horizon

Plug-in hybrid vehicles (PHEV) and distributed energy resources (DER) may shape the industry's long-term future.

- The final outcome will depend on:
  - Battery charging efficiency
  - Miles driven per year
  - Customer adoption rates

Smart Grid Valuation Summary, 2010 - 2050
Present Value of Avoided Costs, Millions of $

	Meter O&M	Generating Capacity	Energy from Electricity	Energy from Gasoline	Carbon	Reliability	Total
DERs	$0	$4,191	$10,088	$0	**$1,113**	**$8,019**	**$23,411**
PHEVs	$0	-$5,740	-$112,118	$297,418	**$1,626**	**$0**	**$181,185**
Total benefits	**$0**	**-$1,549**	**-$102,030**	**$297,418**	**$2,738**	**$8,019**	**$204,596**

See Faruqui, Ahmad, Peter Fox-Penner, and Ryan Hledik. "Smart Grid Strategy: Quantifying Benefits." Public Utilities Fortnightly. July 2009.

“The future, though imminent, is obscure.” Winston Churchill

The Known Unknowns

- The cost of supplying electricity
- The cost of conserving electricity
- Legislative mandates and incentives
- State commission policies, orders and decisions
- Customer attitudes and preferences toward saving energy

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The road ahead is clouded with uncertainty

Sensing game changing opportunities, new entrants are entering the traditional preserve of the electric utility

- Cisco, Google, Microsoft
- Comverge, EnerNoc, Honeywell
- GE, IBM, Oracle, SAP
- OPower and Recycle Bank

Some utilities will conclude that the best option is to do nothing, and "let California go first"

This may not be the best way for them to position themselves for a radically different future

There is a need to rethink the electric utility's business model

Should the utility just be a wires company?

Should it be a provider of end-use services?

Should it co-opt the new entrants or take them on?

Two business models seem to be emerging

- Smart Integrator: "Operates the power grid and its information and control systems but does not actually own or sell the power delivered by the grid. Its mission will be to deliver electricity with superb reliability from a wide range of sources…"
- Energy Services Utility: "Provides lowest-cost energy services to its customers – light, heat, cooling, computer-hours, and the dozens of other things we get from power each day. It is a regulated entity whose prices and profits are controlled, though not without major changes to traditional cost-of-service regulation."

Source: Fox-Penner, Peter. Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities, 2010.

The *sine qua non* of success

1. Customer engagement

- End-users need to be viewed as "customers," not "rate payers"
- AMI deployment has run into a few well-publicized bumps that have little to do with technology and everything to do with customer engagement

2. New planning paradigm

- Gives full weight to customer response in evaluating alternative resource plans
- May require long term pilot programs to demonstrate persistence

3. Consistent policy-making

- Regulators have to provide consistent signals in the decades to come on issues such as environmental regulation, renewable energy, and electric vehicles

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Biography

Ahmad Faruqui is an expert on the customer-facing aspects of the smart grid. He has performed cost-benefit analysis for electric utilities in two dozen states and testified before a dozen state and provincial commissions and legislative bodies. He has designed and evaluated some of the best known pilot programs involving dynamic pricing and in-home displays and his early experimental work is cited in Bonbright's canon.

During the past two years, he has assisted FERC in the development of the "National Action Plan on Demand Response" and in writing "A National Assessment of Demand Response Potential." He co-authored EPRI's national assessment of the potential for Energy Efficiency and EEI's report on quantifying the benefits of dynamic pricing. He has assessed the benefits of dynamic pricing for the New York Independent System Operator, worked on fostering economic Demand Response for the Midwest ISO and ISO New England, reviewed demand forecasts for the PJM Interconnection and assisted the California Energy Commission in developing load management standards. His most recent report, "The Impact of Dynamic Pricing on Low Income Customers," has just been published by the Institute for Electric Efficiency.

The author, co-author or editor of four books and more than 150 articles, papers and reports, he holds a doctoral degree in economics from the University of California at Davis.

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Electricity Market Modeling
Energy Asset Valuation
Energy Contract Litigation
Environmental Compliance
Fuel and Power Procurement
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Rate Design, Cost Allocation, and Rate Structure
Regulatory Strategy and Litigation Support
Renewables
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