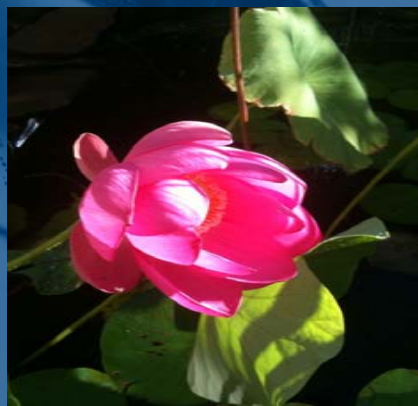


The Brattle Group

DYNAMIC PRICING & CUSTOMER BEHAVIOR



Ahmad Faruqui, Ph. D.
Fourth Annual Electricity Conference
Carnegie Mellon University
March 9, 2010

Copyright © 2009 The Brattle Group, Inc.

Antitrust/Competition Commercial Damages Environmental Litigation and Regulation Forensic Economics Intellectual Property International Arbitration
International Trade Product Liability Regulatory Finance and Accounting Risk Management Securities Tax Utility Regulatory Policy and Ratemaking Valuation
Electric Power Financial Institutions Natural Gas Petroleum Pharmaceuticals, Medical Devices, and Biotechnology Telecommunications and Media Transportation

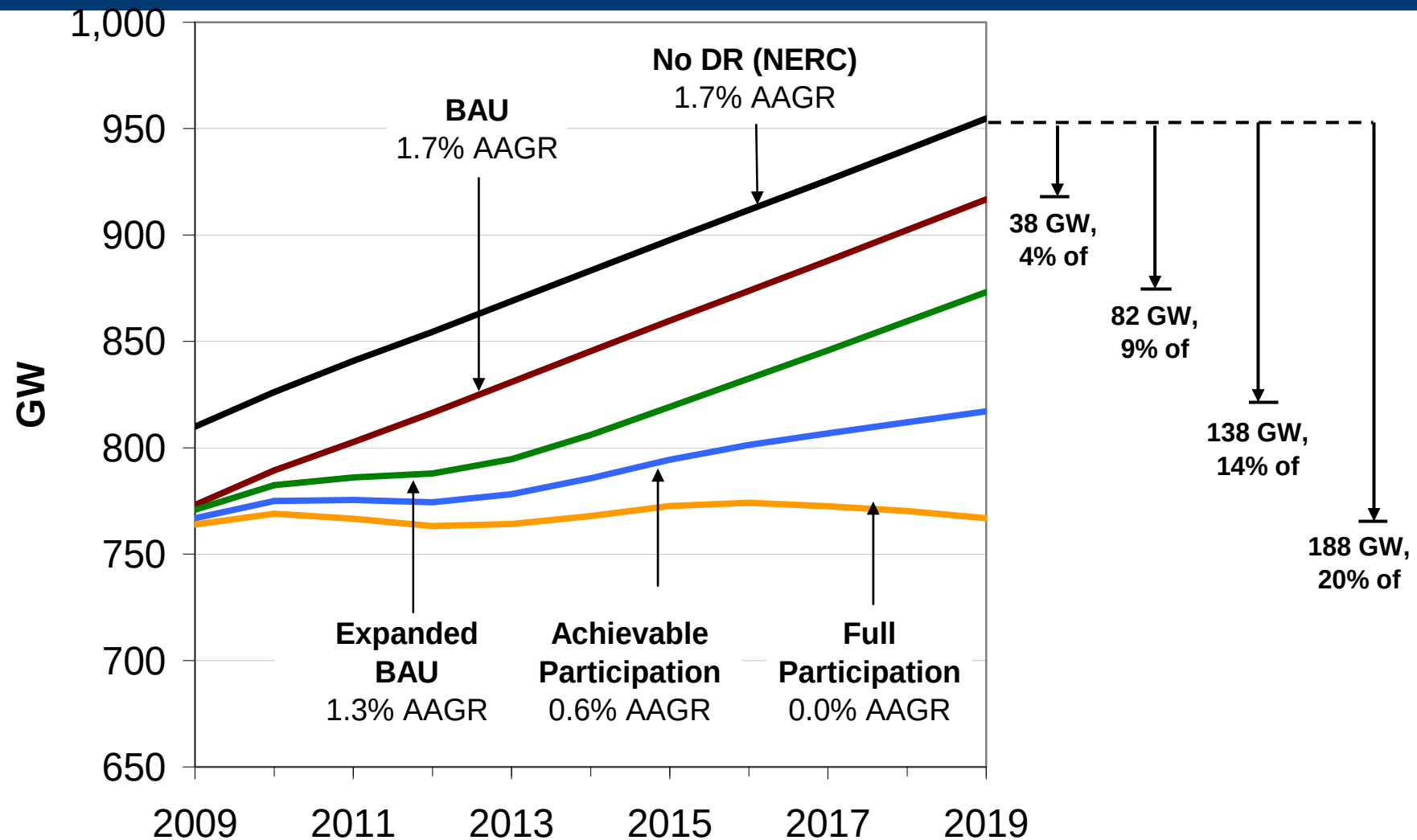
The potential impact of dynamic pricing

The FERC projects that 20% of US peak demand could be offset by demand response programs if dynamic pricing programs are universally deployed to all electric customers in the United States

This will require the universal deployment of smart meters; at this time, five percent of the meters are smart, up from one percent just two years ago; in the next five years, about 50 million of the 145 million meters are expected to become smart

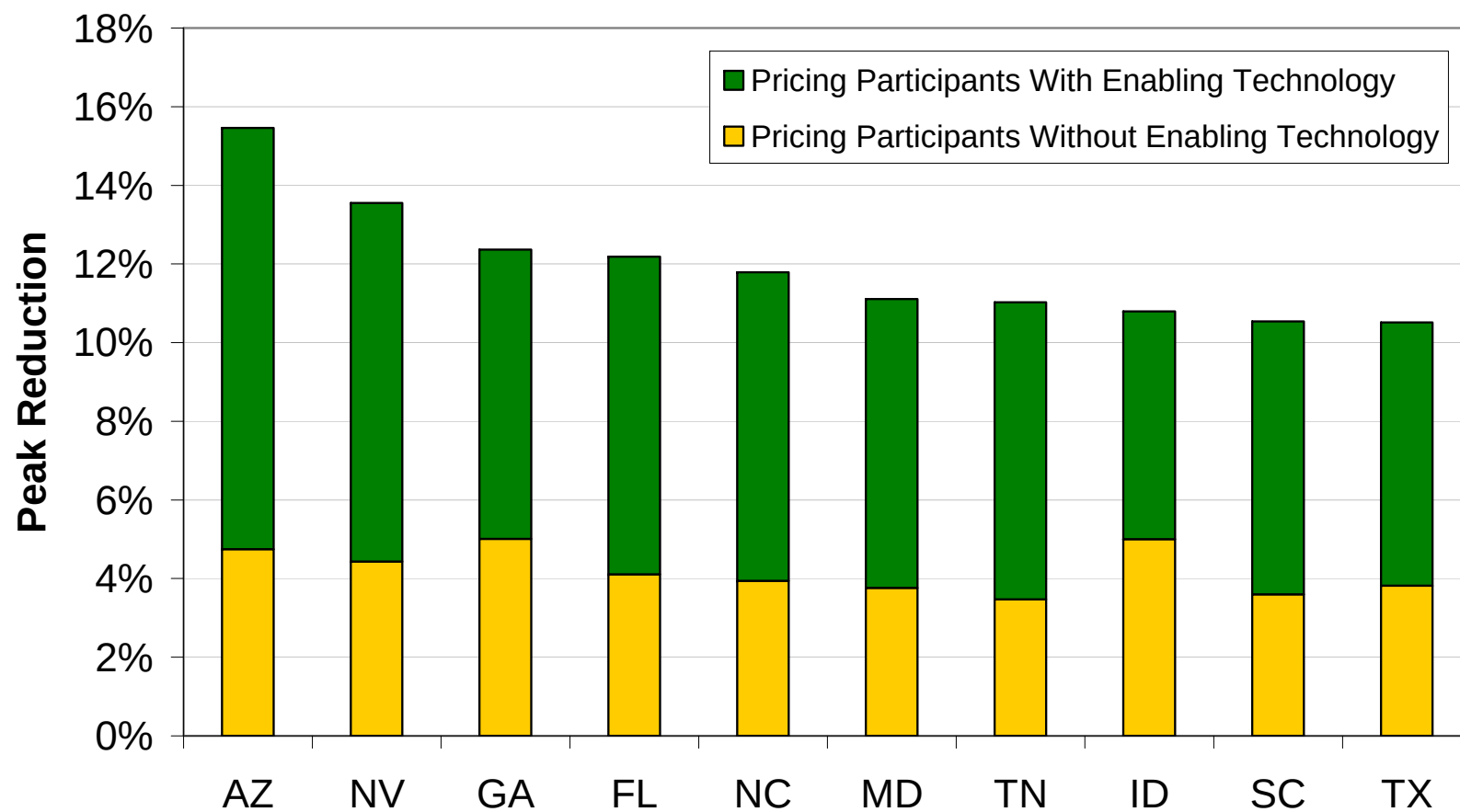
And it will require a major change in the way Americans think about their electric service

The FERC Assessment



The Top 10 states

Achievable Potential Peak Reduction from Pricing with Tech: *Top 10 States*



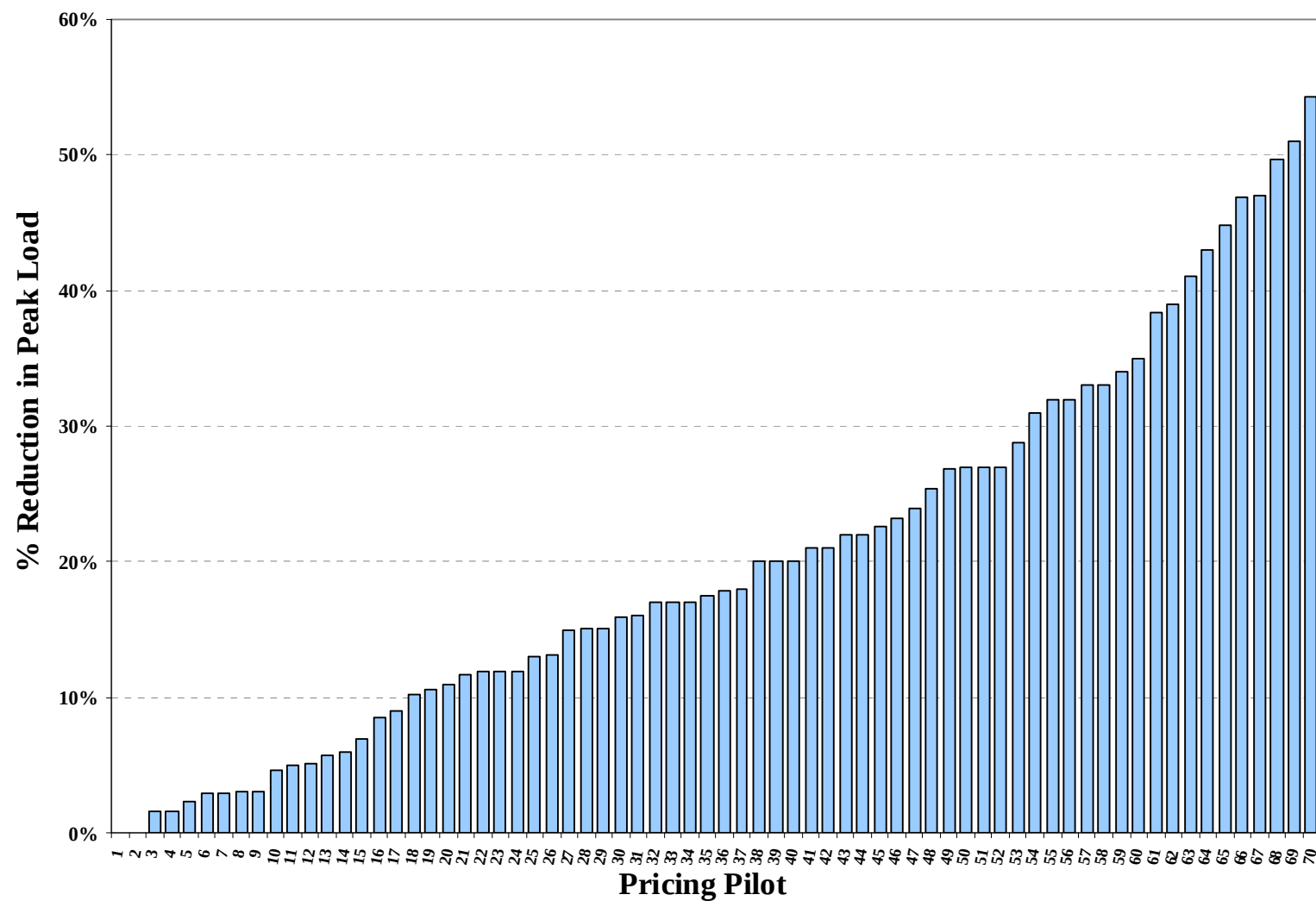
What do we know about customer behavior?

Over the past decade, several pilots have been carried out within the US, Canada, the European Union and Australia

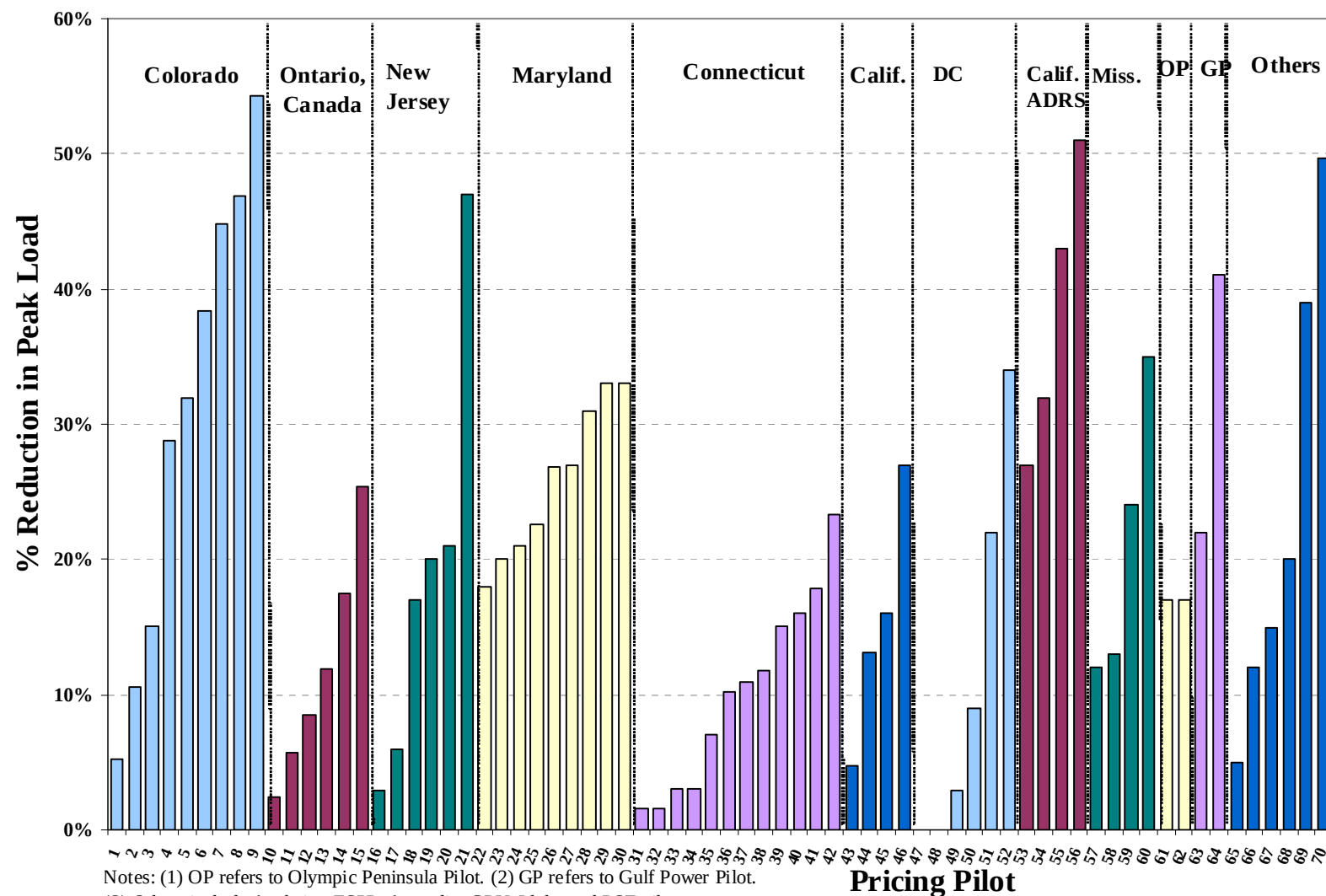
These pilots have featured 70 tests of dynamic pricing some of which can be called experiments, others can be called quasi experiments and the remainders are simply technology demonstrations

While there is much variation in the quality of results from the 70 tests, they have yielded valuable insights about customer response to dynamic pricing

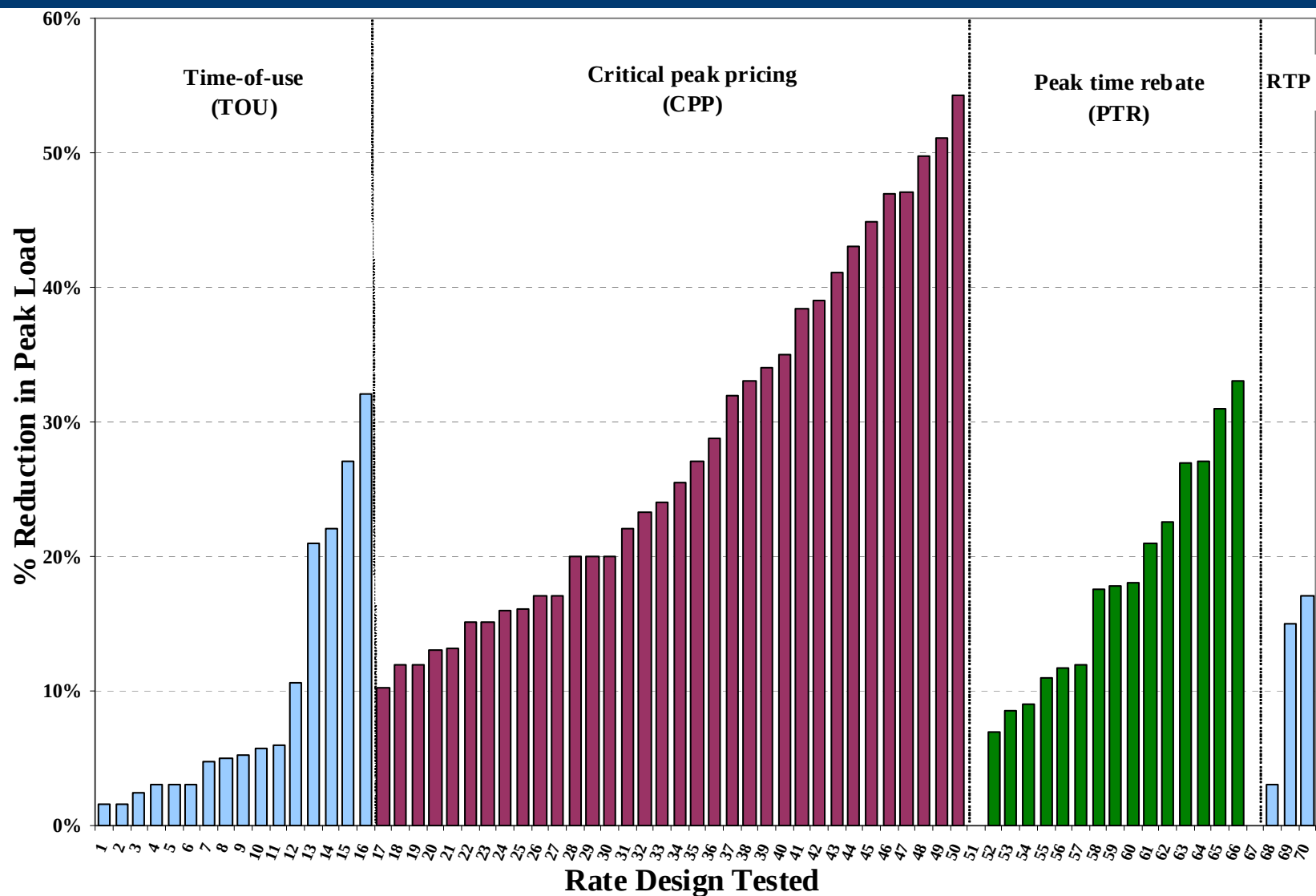
A bird's eye view of the 70 tests



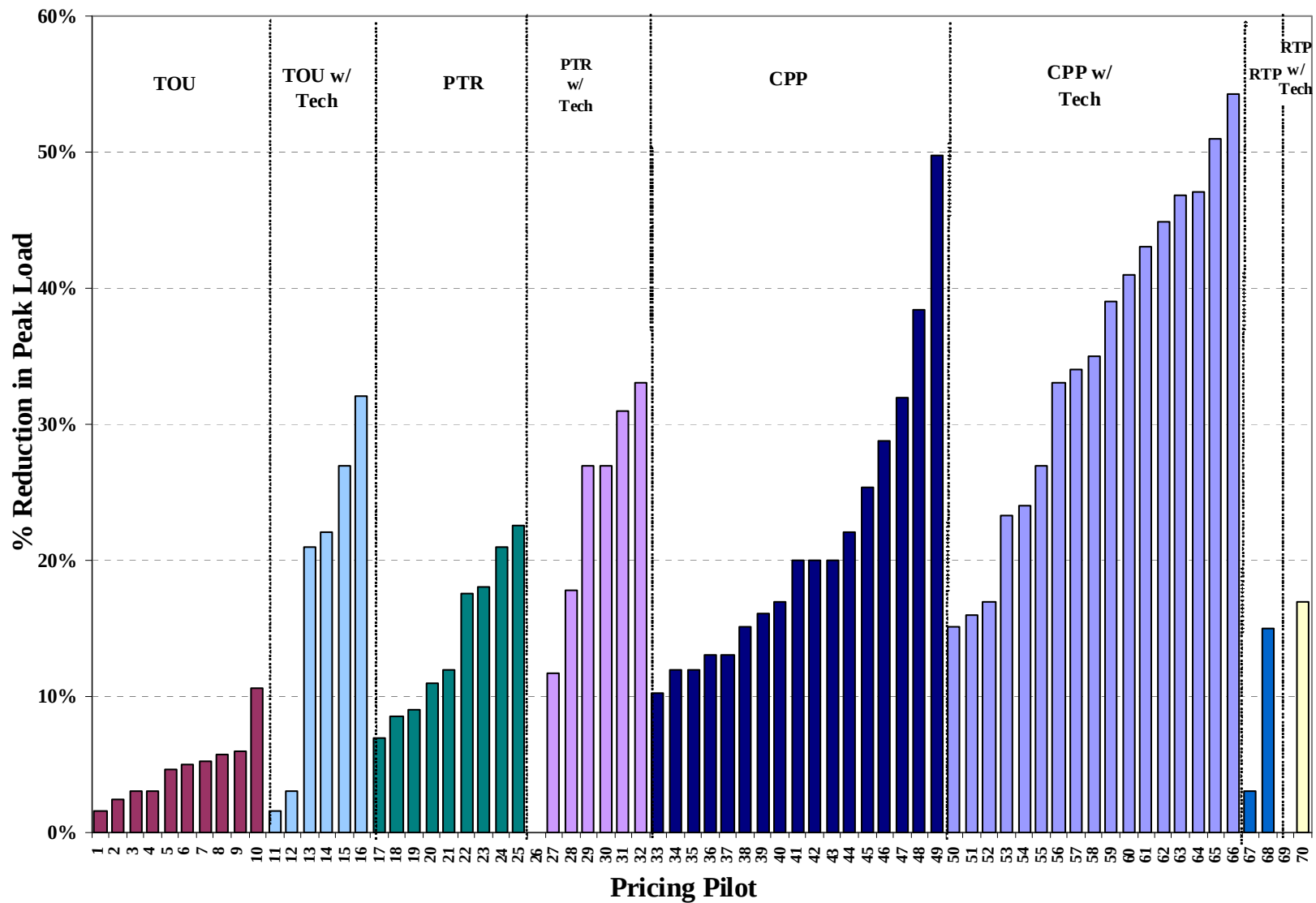
The picture improves if results are sorted by pilot



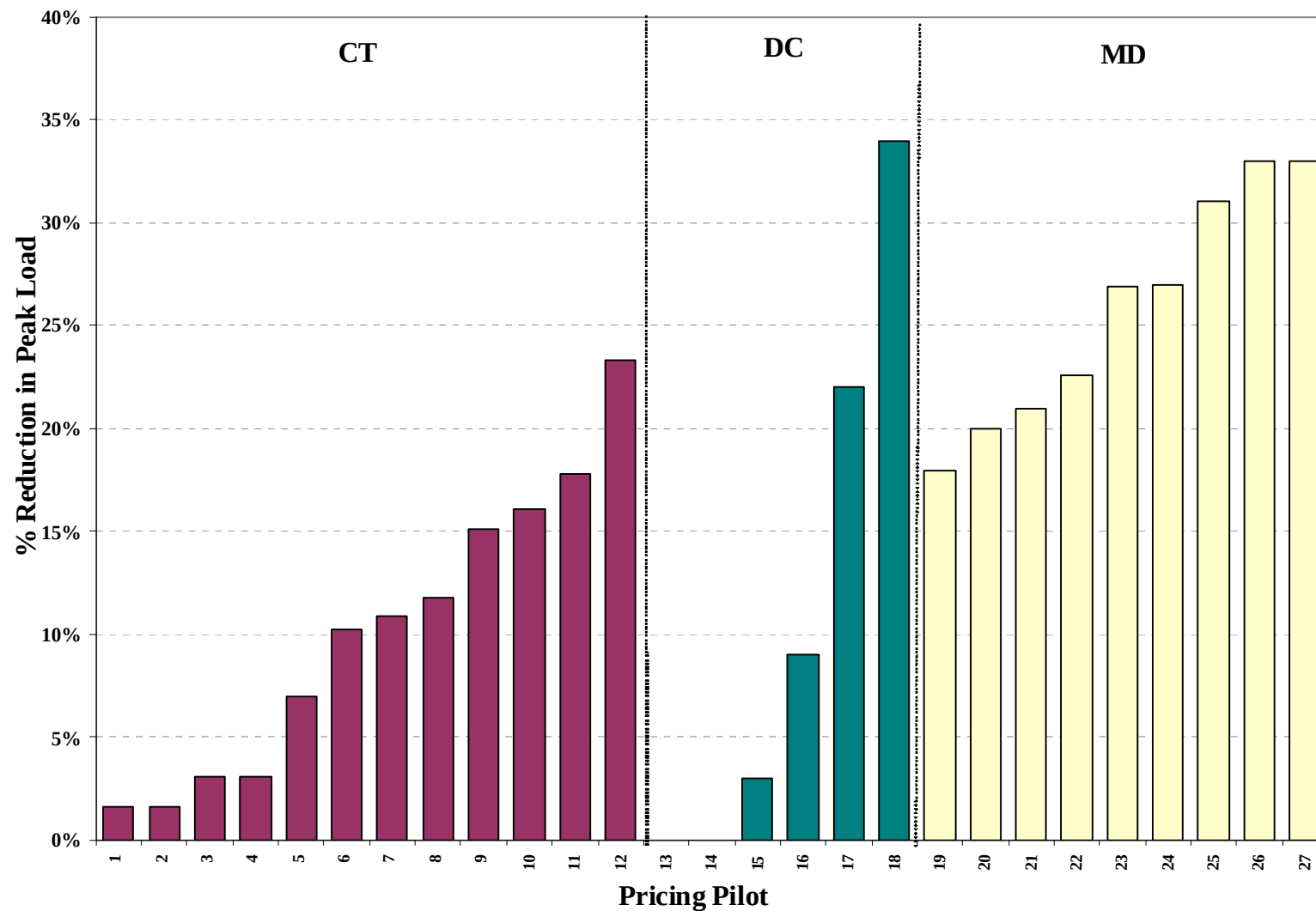
It also improves if the results are sorted by rate



And it improves further with technology



The newest results come from the Northeast

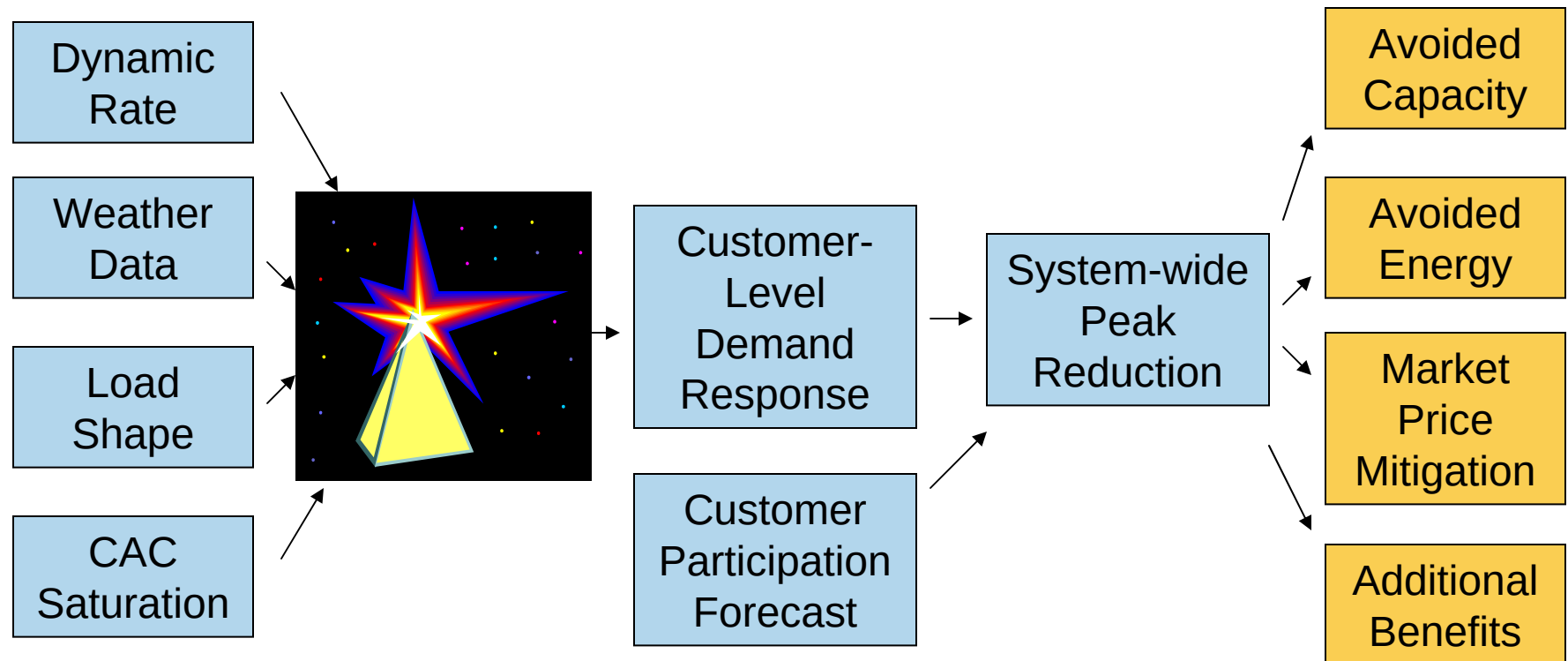


There is much unexplained variation

This can be probed further by using a common modeling framework, such as that provided by the widely-used Price Impact Simulation Model (PRISM)

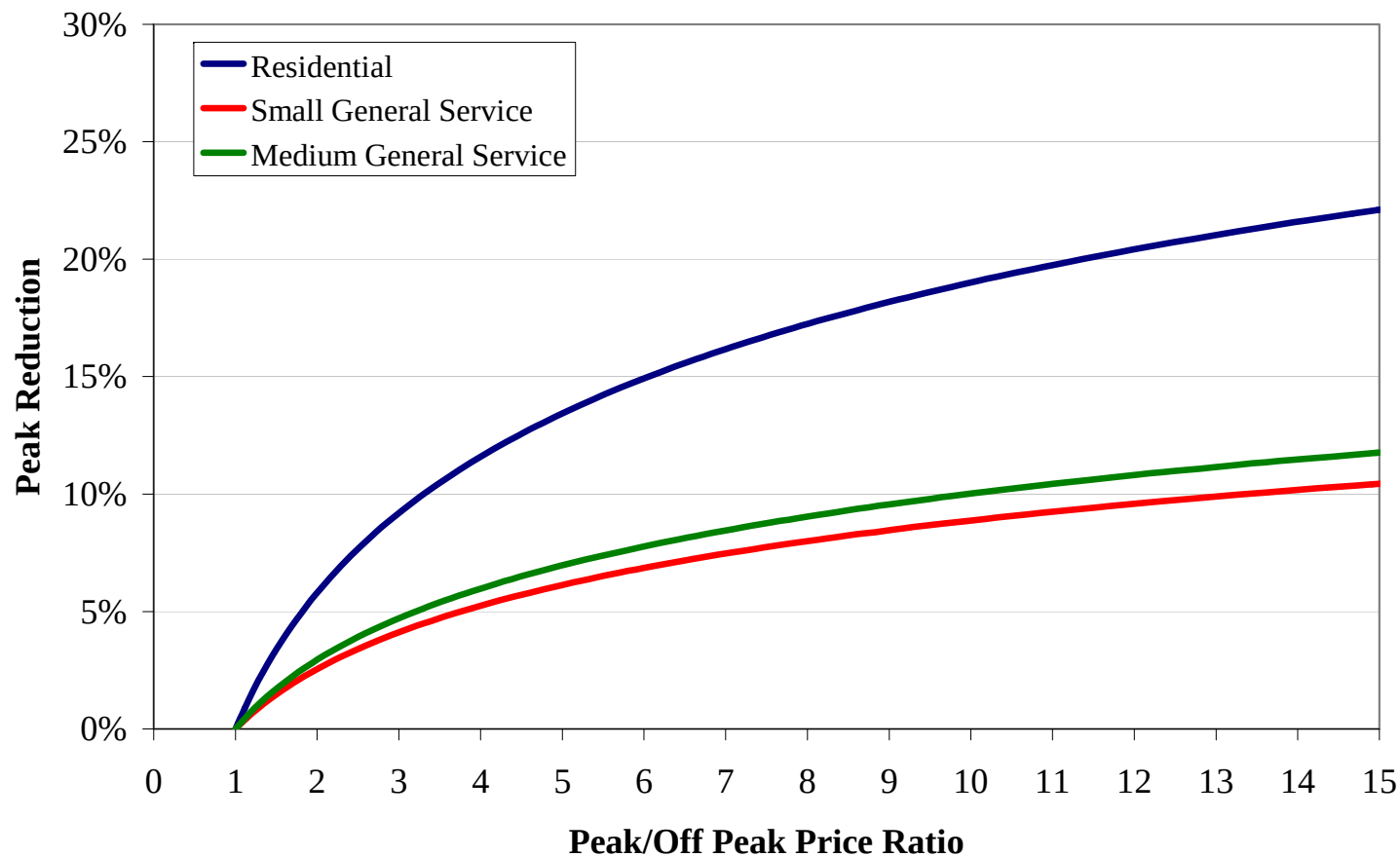
The architecture of PRISM revolves around two fundamental equations, one of which models changes in load shapes that are induced by rate design and one of which models changes in energy consumption that are induced by changes in rate level

The Zen of PRISMetrics



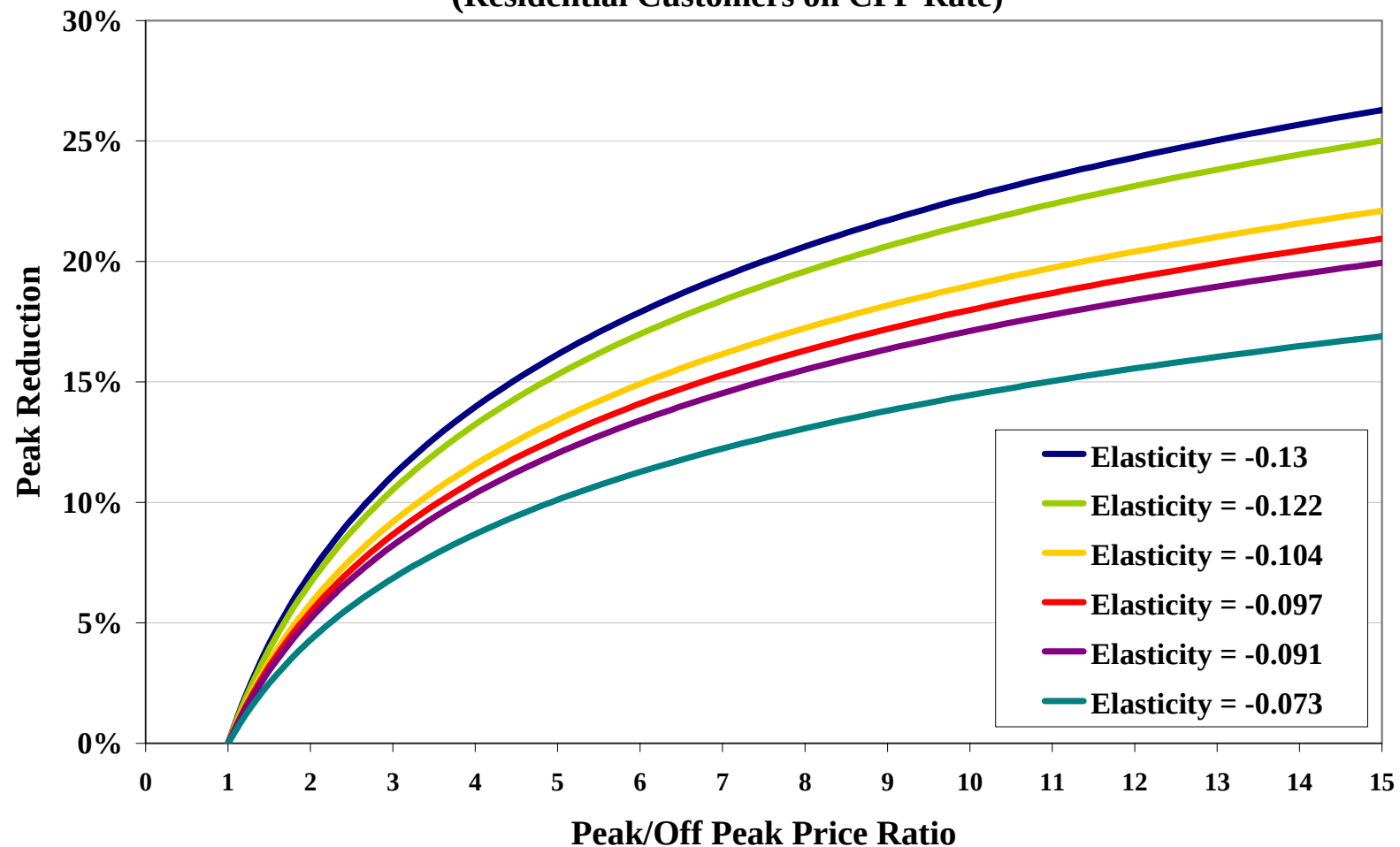
For a given elasticity of substitution, demand response rises with the peak-to-off peak price ratio

Peak Reduction with Different CPP Peak/Off Peak Price Ratios



Demand response varies with elasticity

Peak Reduction with Different Elasticities
(Residential Customers on CPP Rate)



What we know quite well

Customers respond to price by lowering usage during expensive periods

Customer response rises with prices but at a diminishing rate

Customer response gets a boost with enabling technologies

Customer response gets a boost with hotter temperatures

Customer response persists across two or three days that are called in sequence

Customer response persists across two or three days

Customer response is generally higher for customers who have college education, higher than average incomes and live in single family homes

What we know imperfectly

Customers respond equally to peak time rebates and critical peak pricing in some tests and unequally in other tests

Customers respond to informational feedback about energy usage, prices and utility bills but by how much they respond remains uncertain and whether this response would persist over time is also uncertain

The variation in response across various technologies such as web portals, in-home displays and energy orbs is uncertain

What we don't know

Customer preferences for dynamic pricing over standard, flat rate pricing are poorly understood

Most of the evidence comes from focus groups, attitudinal surveys and pilots

In focus groups, customers who are first introduced to the notion of dynamic pricing articulate concerns about price volatility and higher bills

After they have participated in a pilot, most customers are satisfied or very satisfied with dynamic pricing rates

Attitudinal surveys of non-participants indicate that between 10-20 percent of customers would participate in well-designed and well-marketed opt-in dynamic pricing programs

They also indicate that between 65-80 percent of customers would stay enrolled in dynamic pricing programs that are offered on an opt-out basis

Do we need more pilots?

Yes, because customer needs differ across regions and because they also change over time

But the next generation of pilots needs to focus on different issues than the previous generation

We also need some large-scale deployments to validate the experimental results

Legend for the newest results (slide 10)

Index of Pilots and Rates

1	CL&P, TOU	15	Pepco DC, RTP
2	CL&P, TOU-w/ technology	16	Pepco DC, PTR
3	CL&P, TOU	17	Pepco DC, CPP
4	CL&P, TOU-w/ technology	18	Pepco DC, CPP-w/ technology
5	CL&P, PTR	19	BGE, PTR
6	CL&P, CPP	20	BGE, CPP
7	CL&P, PTR	21	BGE, PTR
8	CL&P, PTR-w/ technology	22	BGE, PTR
9	CL&P, CPP-w/ technology	23	BGE, PTR-w/ technology
10	CL&P, CPP	24	BGE, PTR-w/ technology
11	CL&P, PTR-w/ technology	25	BGE, PTR-w/ technology
12	CL&P, CPP-w/ technology	26	BGE, CPP-w/ technology
13	Pepco DC, RTP-w/ technology	27	BGE, PTR-w/ technology
14	Pepco DC, PTR-w/ technology		

Sources of experimental results

Pilot Programs and Sources I

State/ Province	Experiment	Utility	Sources
California	Anaheim Critical Peak Pricing Experiment	Anaheim Public Utilities (APU)	Wolak, Frank A. (2006). "Residential Customer Response to Real-Time Pricing: The Anaheim Critical-Peak Pricing Experiment." Available from http://www.stanford.edu/~wolak .
California	California Automated Demand Response System Pilot (ADRS)	Pacific Gas & Electric (PG&E), Southern California Edison (SCE) and San Diego Gas & Electric (SDG&E)	Rocky Mountain Institute (2006). "Automated Demand Response System Pilot: Final Report." Snowmass, Colorado. March.
California	California Statewide Pricing Pilot (SPP)	Pacific Gas & Electric (PG&E), Southern California Edison (SCE) and San Diego Gas & Electric (SDG&E)	Charles River Associates (2005). "Impact Evaluation of the California Statewide Pricing Pilot." March 16. The report can be downloaded from: http://www.calmac.org/publications/2005-03-24_SPP_FINAL_REP.pdf .
Colorado	Xcel Experimental Residential Price Response Pilot Program	Xcel Energy	Energy Insights Inc. (2008a). "Xcel Energy TOU Pilot Final Impact Report." March. Energy Insights Inc. (2008b). "Experimental Residential Price Response Pilot Program March 2008 Update to the 2007 Final Report." March.
Connecticut	Connecticut Light & Power Plan-it Wise Energy Pilot program	Connecticut Light & Power Company (CL&P)	The Brattle Group (2009). "CL&P's Plan-it Wise Program Summer 2009 Impact Evaluation". Prepared for Connecticut Light & Power (CL&P). November.
DC	Smart Meter Pilot Project, Inc. (SMPPI)	Pepco	eMeter Strategic Consulting (2009). "PowerCentsDC™ Program: Interim Report."

Sources II

Pilot Programs and Sources II

State/ Province	Experiment	Utility	Sources
Florida	The Gulf Power Select Program	Gulf Power	Borenstein, Severin, Michael Jaske, and Arthur Rosenfeld (2002). "Dynamic Pricing, Advanced Metering and Demand Response in Electricity Markets." Center for the Study of Electricity Markets, Paper CSEMWP 105, October 31. Levy, Roger, Ralph Abbott and Stephen Hadden (2002). New Principles for Demand Response Planning. EPRI EP-P6035/C3047, March.
France	Electricite de France (EDF) Tempo Program	Electricite de France (EDF)	Giraud, Denise. 2004. "The tempo tariff," Efflocon Workshop, June 10. http://www.efflocom.com/pdf/EDF.pdf . Giraud, Denise and Christophe Aubin. 1994. "A New Real-Time Tariff for Residential Customers," in Proceedings: 1994 Innovative Electricity Pricing Conference, EPRI TR-103629, February. Aubin, Christophe, Denis Fougere, Emmanuel Husson and Marc Ivaldi (1995). "Real-Time Pricing of Electricity for Residential Customers: Econometric Analysis of an Experiment," Journal of Applied Econometrics, 10, S171-191.
Idaho	Idaho Residential Pilot Program	Idaho Power Company	Idaho Power Company. 2006. "Analysis of the Residential Time-of-Day and Energy Watch Pilot Programs: Final Report." December.
Illinois	The Community Energy Cooperative's Energy-Smart Pricing Plan (ESPP)	Commonwealth Edison	Summit Blue Consulting, LLC. (2006). "Evaluation of the 2005 Energy-Smart Pricing Plan-Final Report." Boulder, Colorado. August. Summit Blue Consulting, LLC. (2007). "Evaluation of the 2006 Energy-Smart Pricing Plan-Final Report." Boulder, Colorado.
Maryland	Baltimore Gas & Electric Company's Smart Energy Pricing Pilot	Baltimore Gas & Electric Company	The Brattle Group (2009). "BGE's Smart Energy Pricing Pilot Summer 2008 Impact Evaluation". Prepared for Baltimore Gas & Electric Company. April.
Missouri	AmerenUE Residential TOU Pilot Study	AmerenUE	RLW Analytics (2004). "AmerenUE Residential TOU Pilot Study Load Research Analysis: First Look Results." February. Voytas, Rick (2006). "AmerenUE Critical Peak Pricing Pilot," presented at U.S. Demand Response Research Center Conference, Berkeley, California, June.

Sources III

Pilot Programs and Sources III

State/ Province	Experiment	Utility	Sources
New Jersey	GPU Pilot	GPU	Braithwait, S. D. (2000). "Residential TOU Price Response in the Presence of Interactive Communication Equipment." In Faruqui and Eakin (2000).
New Jersey	Public Service Electric and Gas (PSE&G) Residential Pilot Program	Public Service Electric and Gas Company (PSE&G)	PSE&G and Summit Blue Consulting (2007). "Final Report for the Mypower Pricing Segments Evaluation." Newark, New Jersey. December.
New South Wales (Australia)	Energy Australia's Network Tariff Reform	Energy Australia	Colebourn H. (2006). "Network Price Reform." presented at BCSE Energy Infrastructure & Sustainability Conference. December.
Ontario (Canada)	Ontario Energy Board Smart Price Pilot	Hydro Ottawa	Ontario Energy Board. 2007. "Ontario Energy Board Smart Price Pilot Final Report." Toronto, Ontario, July.
Washington	Puget Sound Energy (PSE)'s TOU Program	Puget Sound Energy	Faruqui, Ahmad and Stephen S. George. 2003. "Demise of PSE's TOU Program Imparts Lessons." Electric Light & Power Vol. 81.01:14-15.
Washington and Oregon	Olympic Peninsula Project	Bonneville Power Administration, Clallam County PUD, The City of Port Angeles, Portland General Electric, and PacifiCorp	Pacific Northwest National Laboratory. 2007. "Pacific Northwest GridWise Testbed Demonstration Projects Part 1: Olympic Peninsula Project." Richland, Washington. October.

Reading list

Faruqui, Ahmad, Ryan Hledik and Sanem Sergici, “Rethinking pricing: the changing architecture of demand response,” *The Public Utilities Fortnightly*, January 2010.

Faruqui, Ahmad, Ryan Hledik, and Sanem Sergici, “Piloting the smart grid,” *The Electricity Journal*, August/September, 2009.

Faruqui, Ahmad and Sanem Sergici, “Household response to dynamic pricing of electricity—a survey of the experimental evidence,” January 10, 2009. <http://www.hks.harvard.edu/hepg/>

FERC, “A National Assessment of Demand Response Potential,” June 2009, <http://www.ferc.gov/legal/staff-reports/06-09-demand-response.pdf> .

Biography

Ahmad Faruqui led FERC's state-by-state assessment of the potential for demand response, co-authored EPRI's national assessment of the potential for energy efficiency and co-authored 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. He has performed cost-benefit analysis of demand response options for utilities in nearly dozen states and testified before several state commissions and legislative bodies. He has designed and evaluated some of the nation's best known pilot programs and his early experimental work is cited in Bonbright's canon. The author, co-author or editor of four books and more than a hundred articles and papers, he holds a doctoral degree in economics from the University of California at Davis.