

The Brattle Group

Dynamic Pricing for Residential and Small C&I Customers



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Outline

- The benefits
- Examples
- The state of play
- A glimpse at the future
- Customer response
- Objections
- The unknowns
- Dynamic pricing without tears



THE BENEFITS

Why dynamic pricing?

- It is widely practiced in all capital intensive industries such as airlines, hotels, car rentals, sporting events and concerts
- Lately, it is also being practiced on certain freeways, bridges, entrance to central cities, parking in central cities
- *Why? Because* it improves load factors, lowers average costs and ensures that spaces are available for high valued uses
- In the electric industry, it also serves as a bridge between wholesale and retail markets that allows wholesale prices to be passed through to retail customers, preventing a recurrence of the California Syndrome

Benefits (concluded)

- It also eliminates inter-customer subsidies that have existed for a century between customers with flatter-than average load shapes and peakier-than average load shapes
- Flat rates do not promote rate equity
- In the evolving energy economy, dynamic pricing helps integrate renewables and plug-in electric vehicles into the electric grid

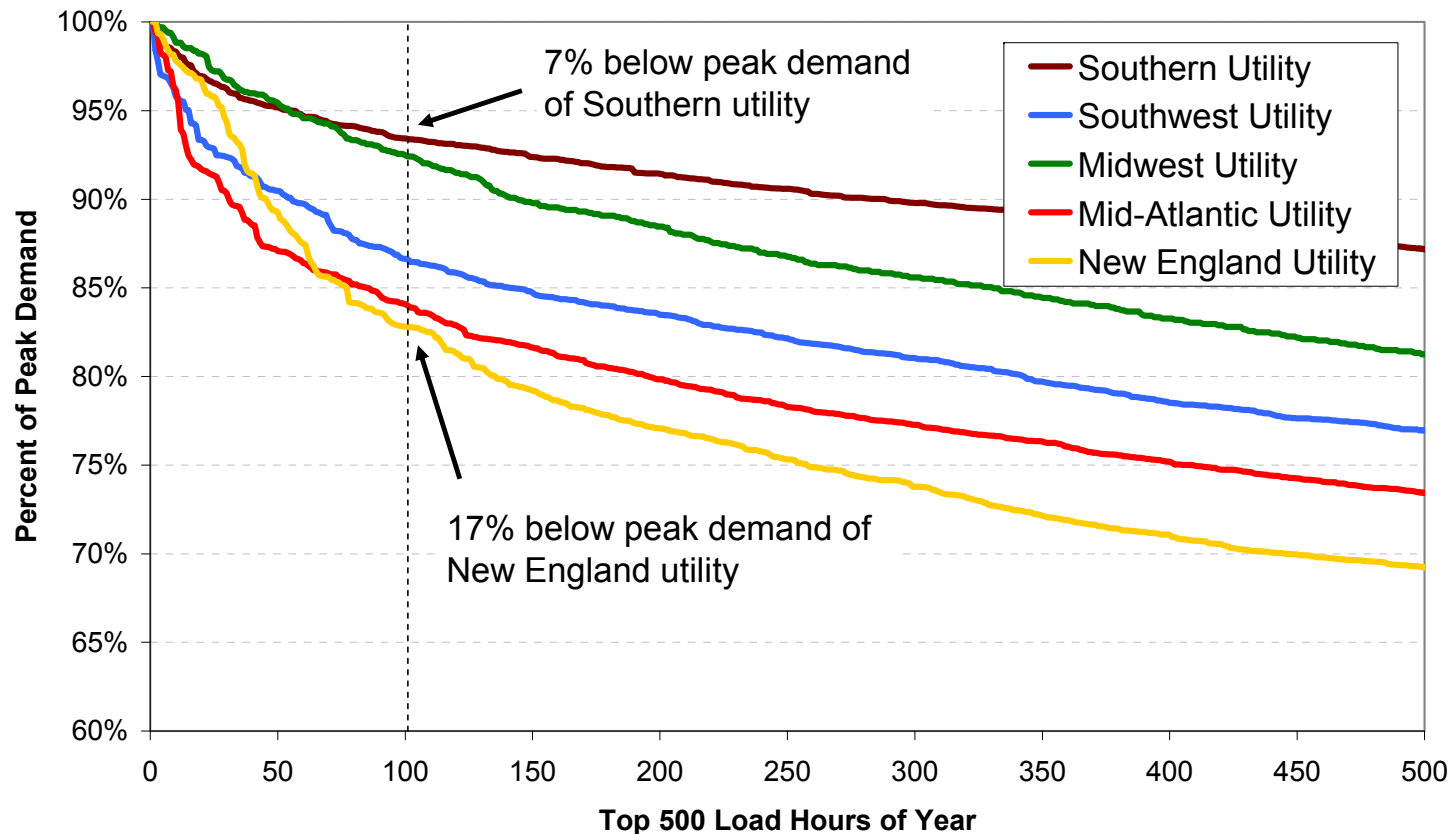


EXAMPLES

Features of dynamic pricing

- Reflects the marginal cost of providing electricity, which varies by time of day
- Under dynamic pricing, either the price of electricity and/or the time it will be activated are uncertain
- Compared to flat (non-time varying) rates, dynamic pricing can clip off the highest peak loads during the year which can account for 7 to 17 percent of system load (see next slide)

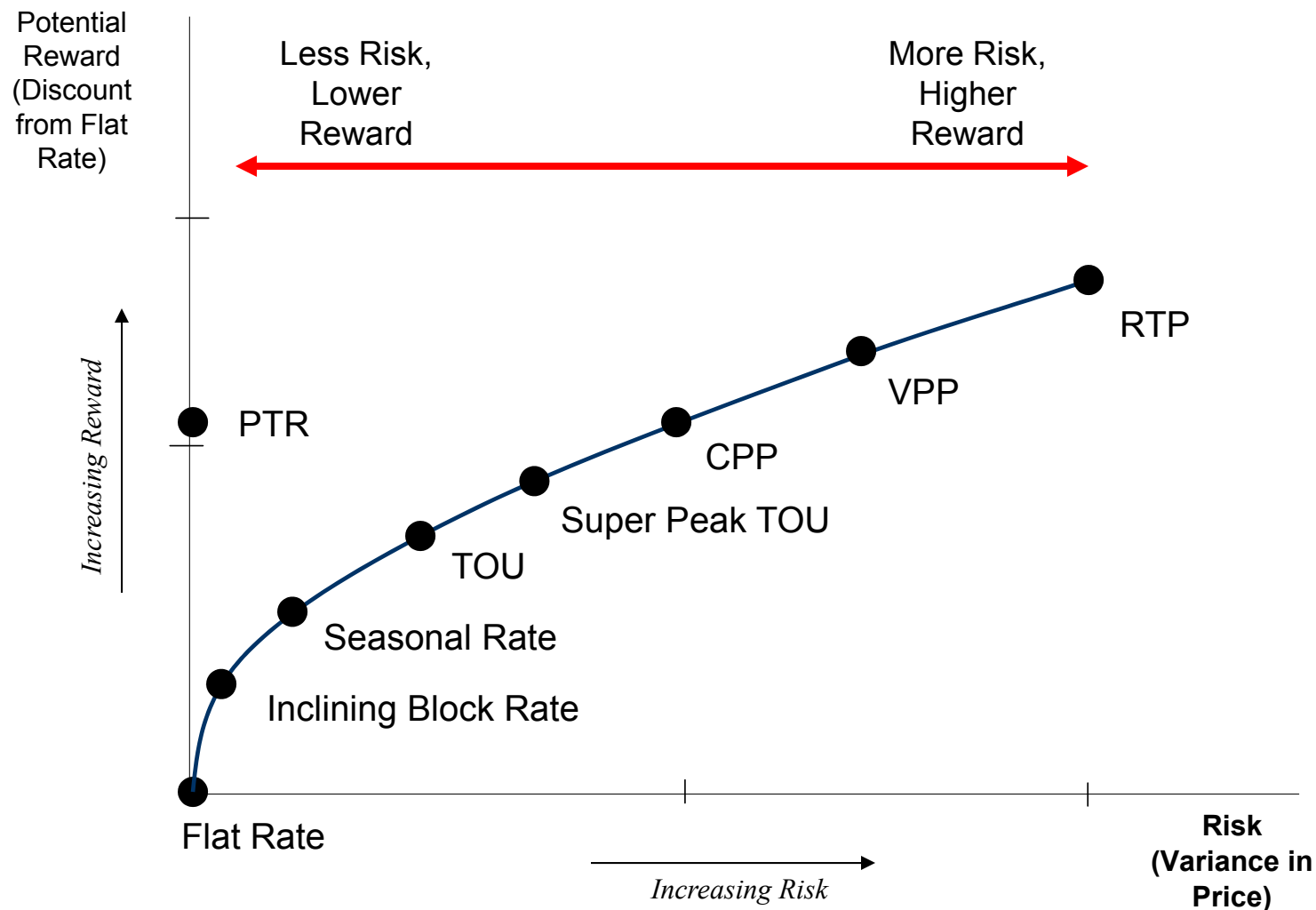
Peak demands are concentrated in the top 100 hours in most power systems



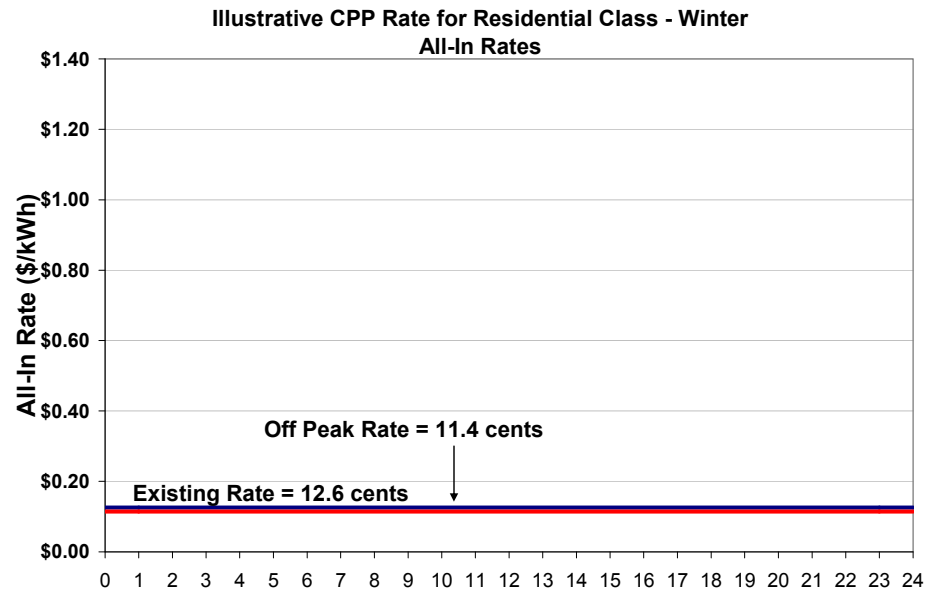
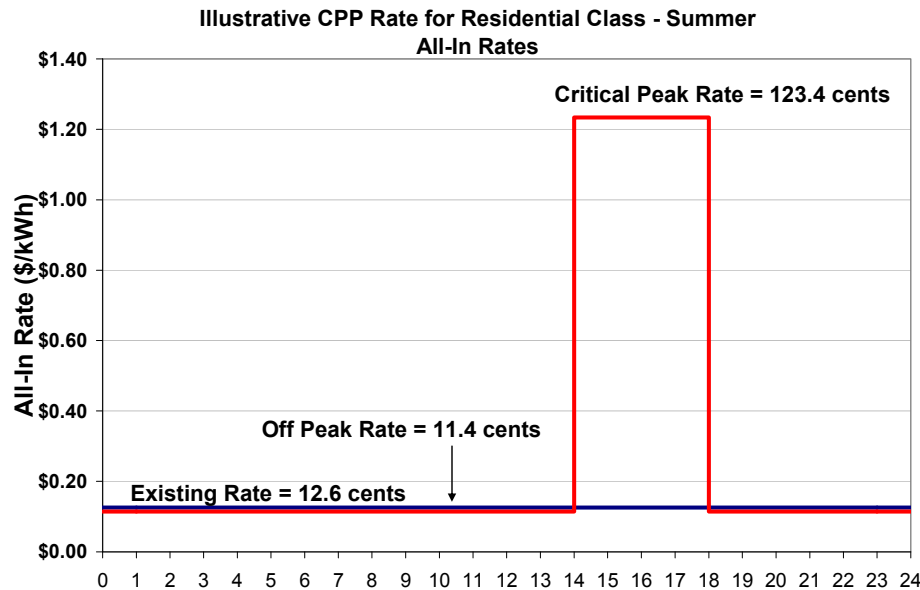
Dynamic pricing comes in many flavors

Rate	Description
Time-of-Use (TOU)	Charges a higher price during all weekday peak hours and a discounted price during off-peak and weekend hours
Super Peak TOU	Similar to the TOU with the exception that the peak window is shorter in duration (often four hours), leading to a stronger price signal
Inclining Block Rate (IBR)	Customer usage is divided into tiers and usage is charged at higher rates in the higher tiers; meant to encourage conservation
Critical Peak Pricing (CPP)	Customers are charged a higher price during a few hours and a discounted during the remaining hours
Variable Peak Pricing (VPP)	Critical Peak Pricing rate with added variability
CPP-TOU Combination	A TOU rate in which a moderate peak price applies during most peak hours of the year, but a higher peak price applies on limited event days
Peak Time Rebate (PTR)	Customers can earn a discount by reducing usage during critical hours
Real Time Pricing (RTP)	A rate with hourly variation that follows LMPs, but with capacity costs allocated equally across all hours of the year
Critical Peak RTP	A rate with hourly variation based on LMPs and with a capacity cost adder focused only during event hours

Dynamic pricing facilitates customer choice

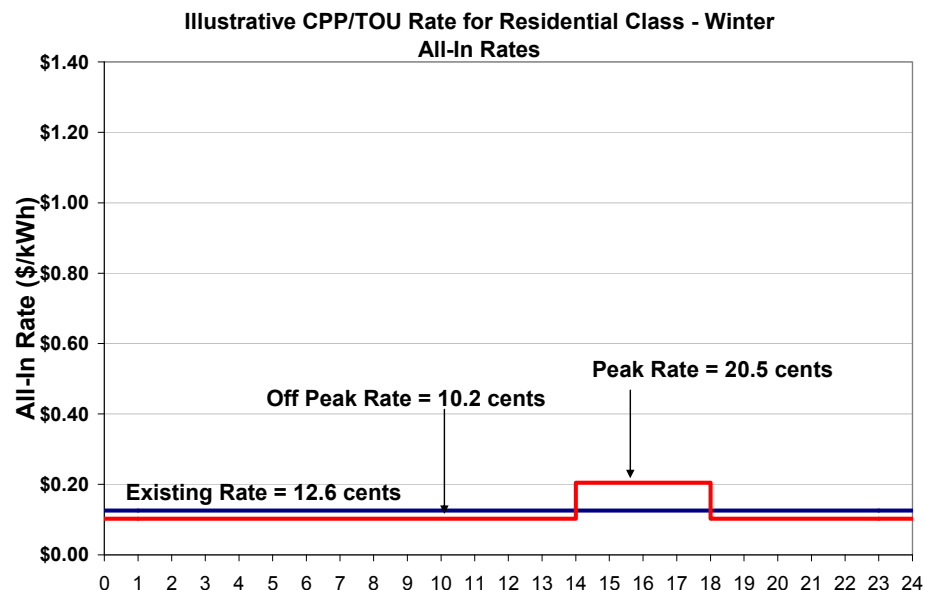
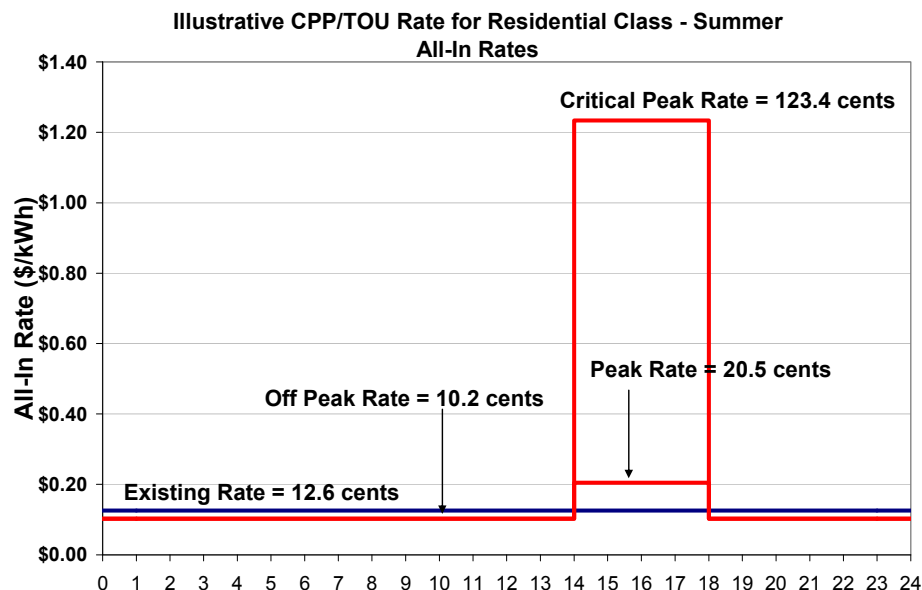


The critical-peak pricing (CPP) rate



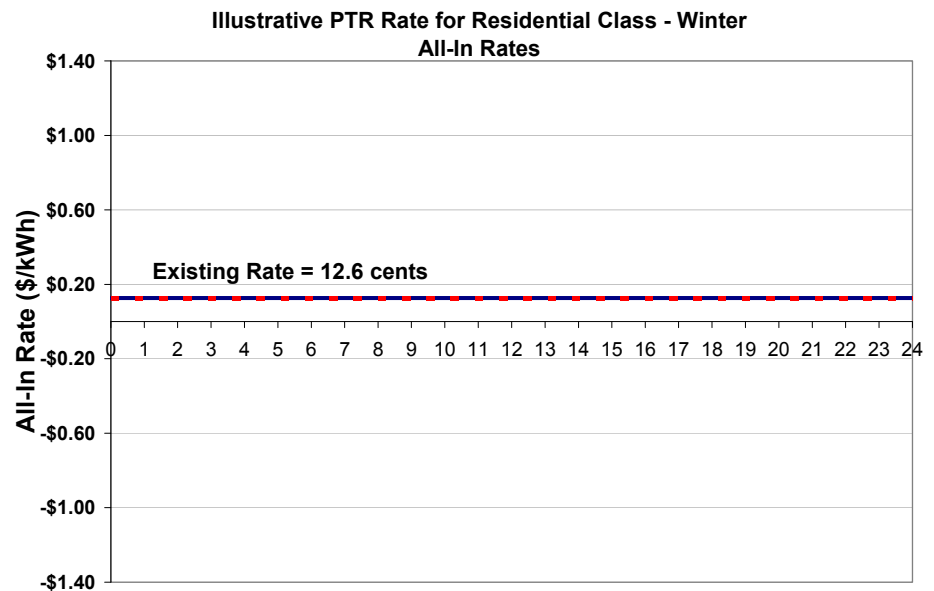
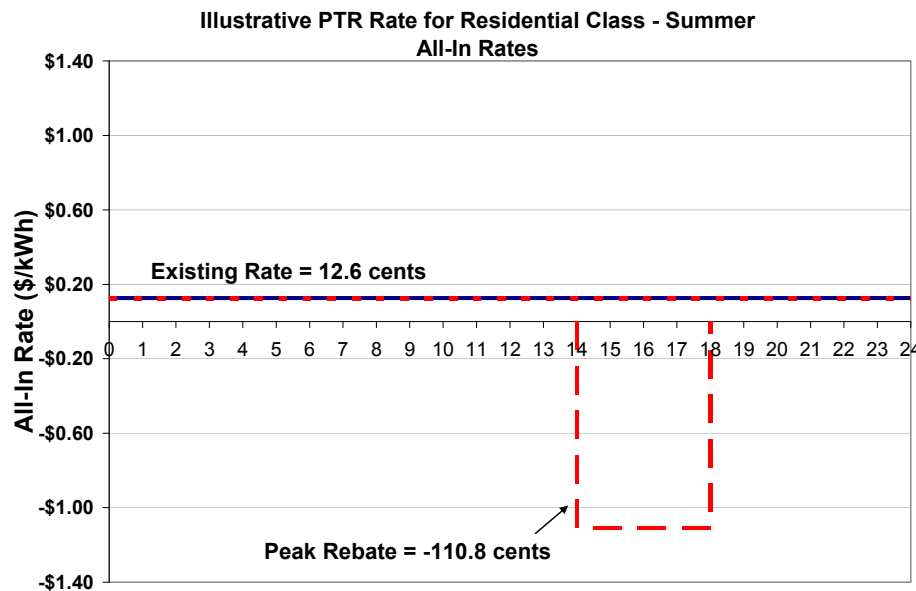
- Customers get a discount on all hours except a few critical hours of the year
- On a few critical days, customers pay a substantially higher price equal to the cost of capacity plus the average critical peak LMP

A hybrid CPP and time-of-use (TOU) rate



- Customers are on a mild TOU rate on all non-critical days
- On critical days, they pay a much higher price during the critical hours

The peak-time rebate (PTR) is a mirror image of the pure CPP rate



- Customers pay the default rate for all kWh used; if they make no changes in their usage they continue to pay the default rate with no extra costs (“carrot only” approach)
- On critical days customers can earn a rebate reductions in usage below an estimate of what they otherwise would have consumed (their “baseline” calculation)

Dynamic pricing encourages technological innovation

Web portal



Source: <http://news.lehsys.com/2009/06/google-power-meter-energy>

Programmable communicating thermostat



Source: <http://www.zigbee.org/Products/CertifiedProducts/ZigBeeSmartEnergy.aspx>

In-home display



Source: <http://www.prlog.org/10527353-aztechs-in-home-display-achieves-zigbee-certification.html>

Home area network



Source: <http://www.cisco.com/web/consumer/products/hem.html#~consumers>



Source: <http://www.examiner.com/city-hall-in-louisville/ge-to-make-new-smart-washers-and-dryers-louisville>



THE STATE OF PLAY

Recent trends

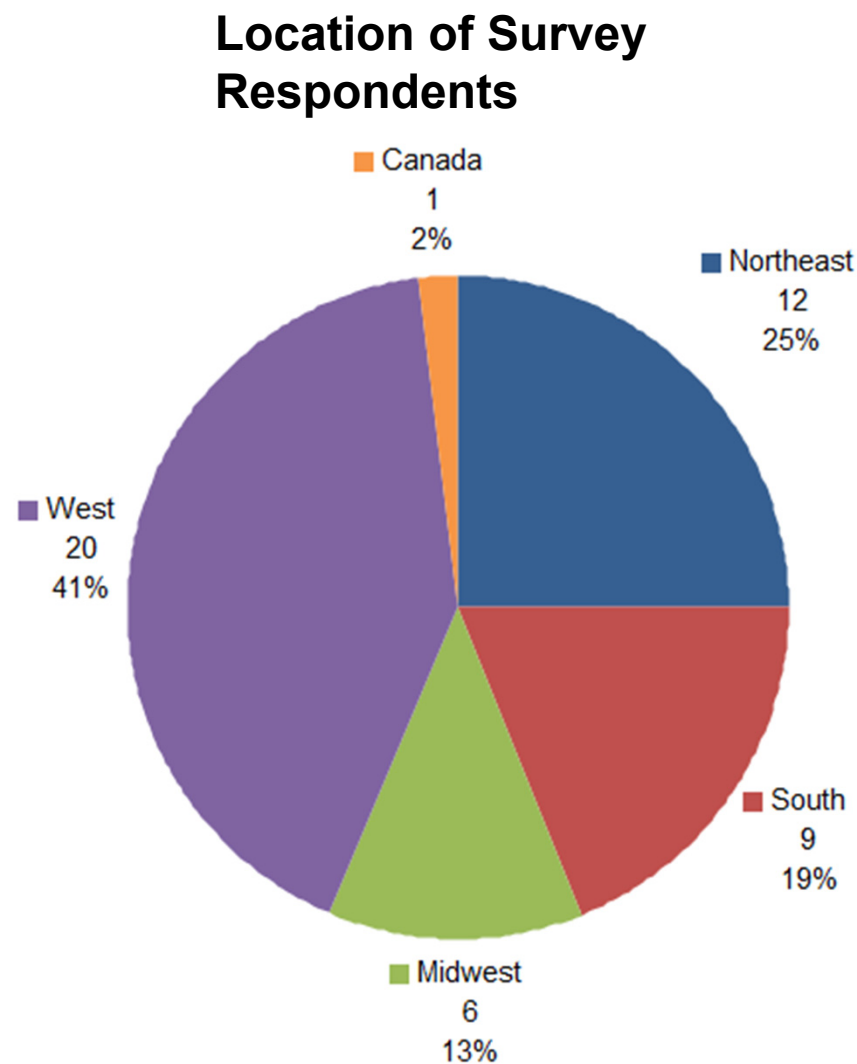
- Less than one percent of small customers are on any kind of time-varying rate in the United States
- More than two dozen pilots have been carried out in North America, Europe and Australia over the past decade
- Commissions in the Mid-Atlantic region have ruled favorably on large-scale deployment of dynamic pricing
- A recent survey of AMI business cases indicates that about half embody dynamic pricing in some form
- Another survey reveals that dynamic pricing is one of the top five issues for utility executives
- The US DOE has invested more than \$4 billion in pilot and demonstration projects involving the smart grid, some of which involve dynamic pricing; a few are being carried out in Ohio



A GLIMPSE AT THE FUTURE

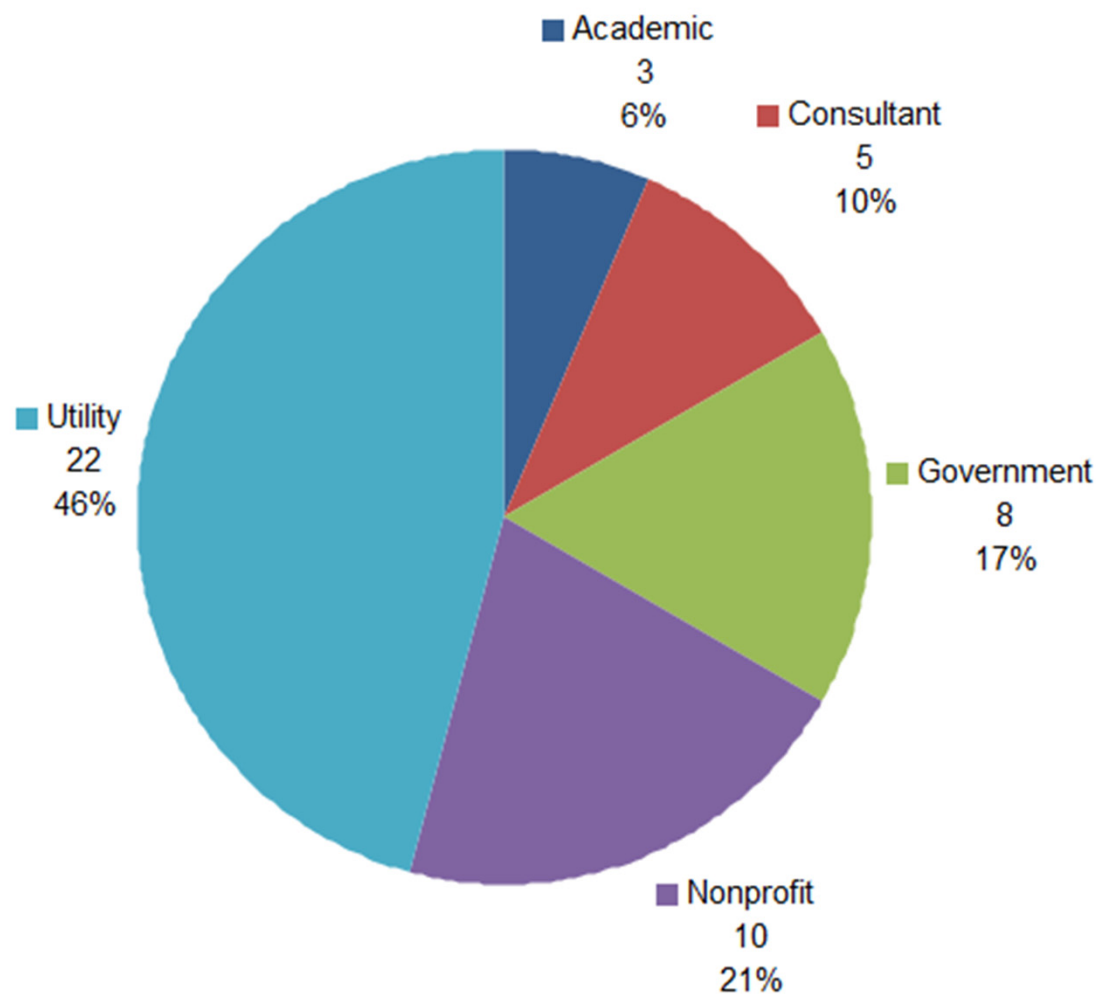
The likely future impact of dynamic pricing

- We polled 50 experts on the likely impact of demand response on peak demand in the year 2020



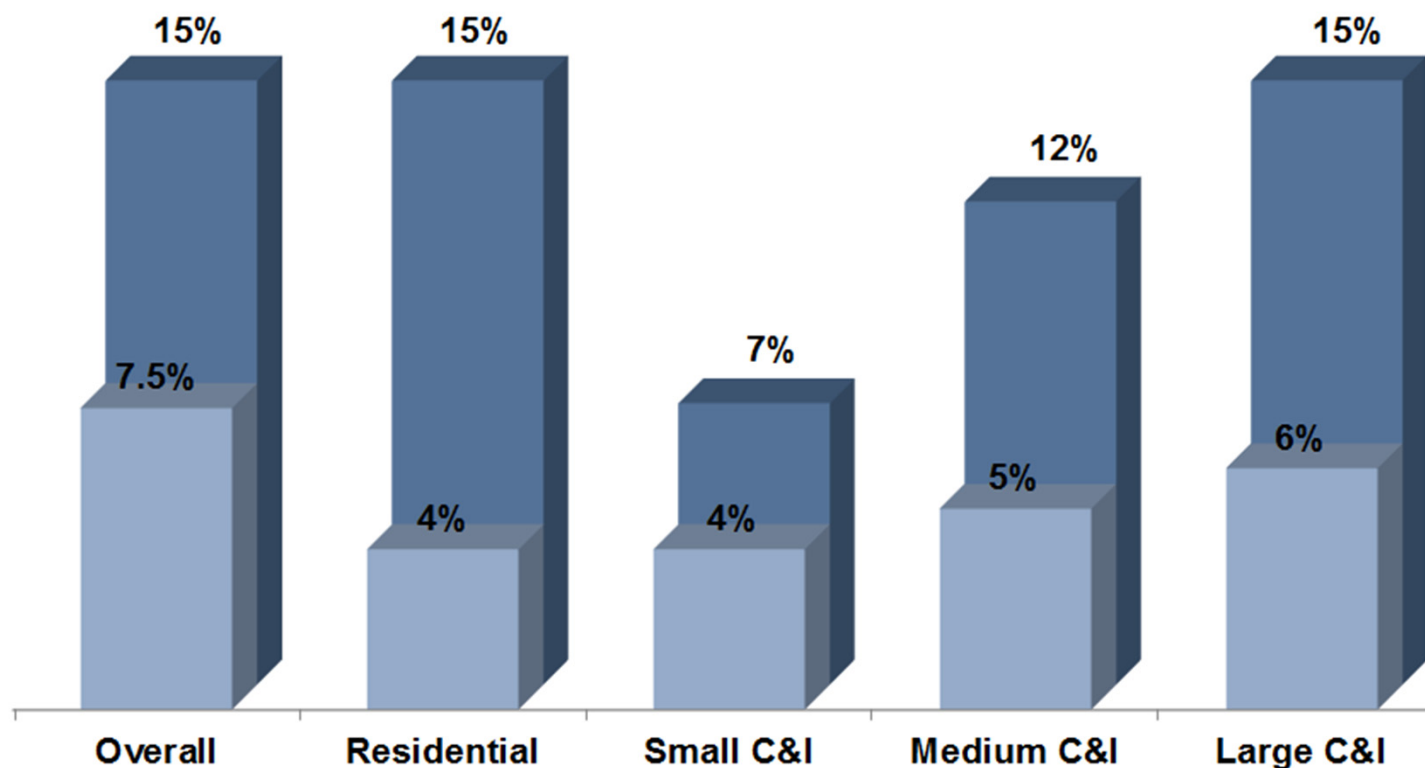
The responders spanned a range of affiliations

Profession of Survey



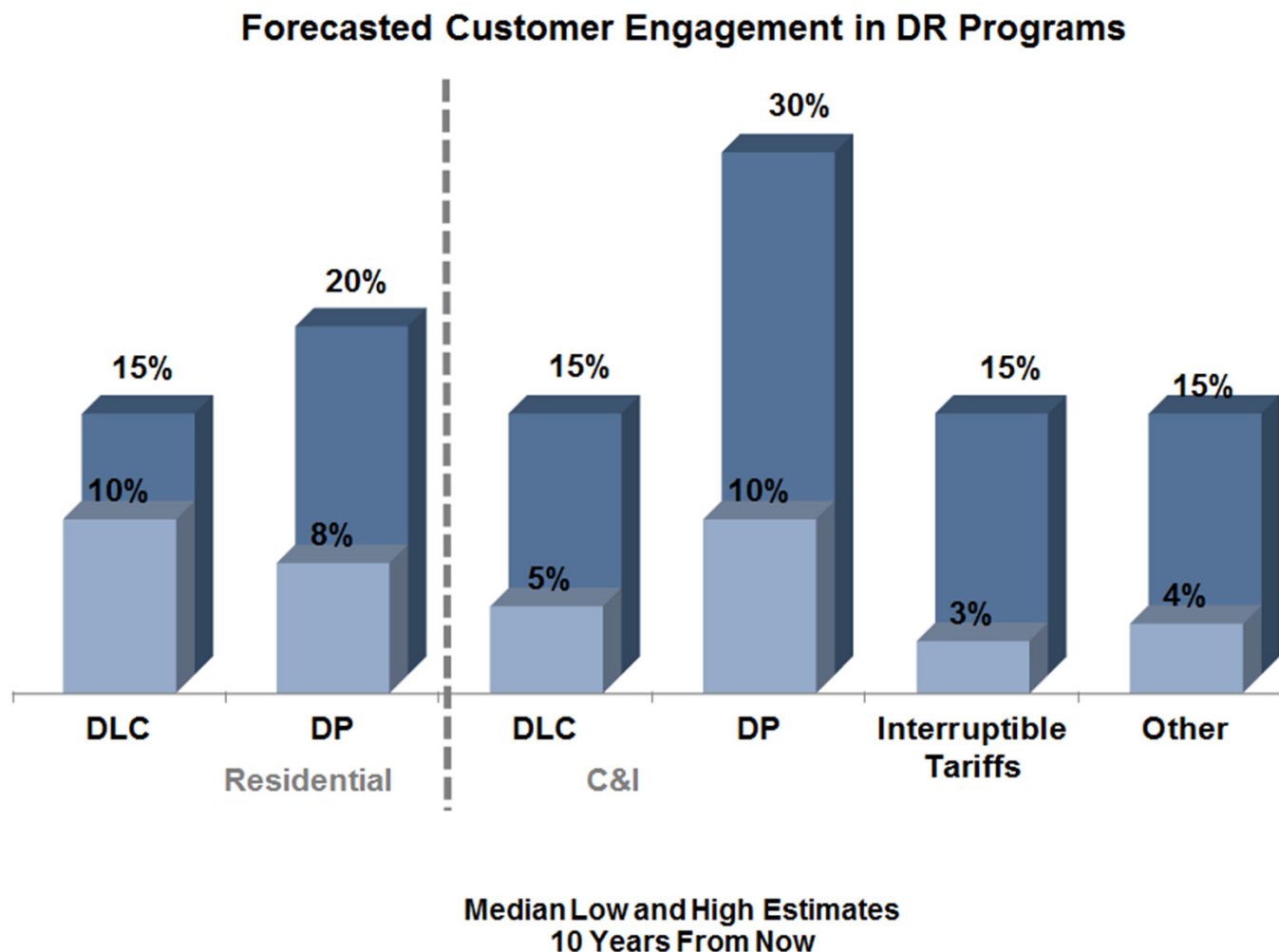
The potential for demand response ranges from 7.5% to 15%

Forecasted Peak Demand Savings



Median Low and High Estimates
10 Years From Now

Dynamic pricing is expected to play a significant role in the future



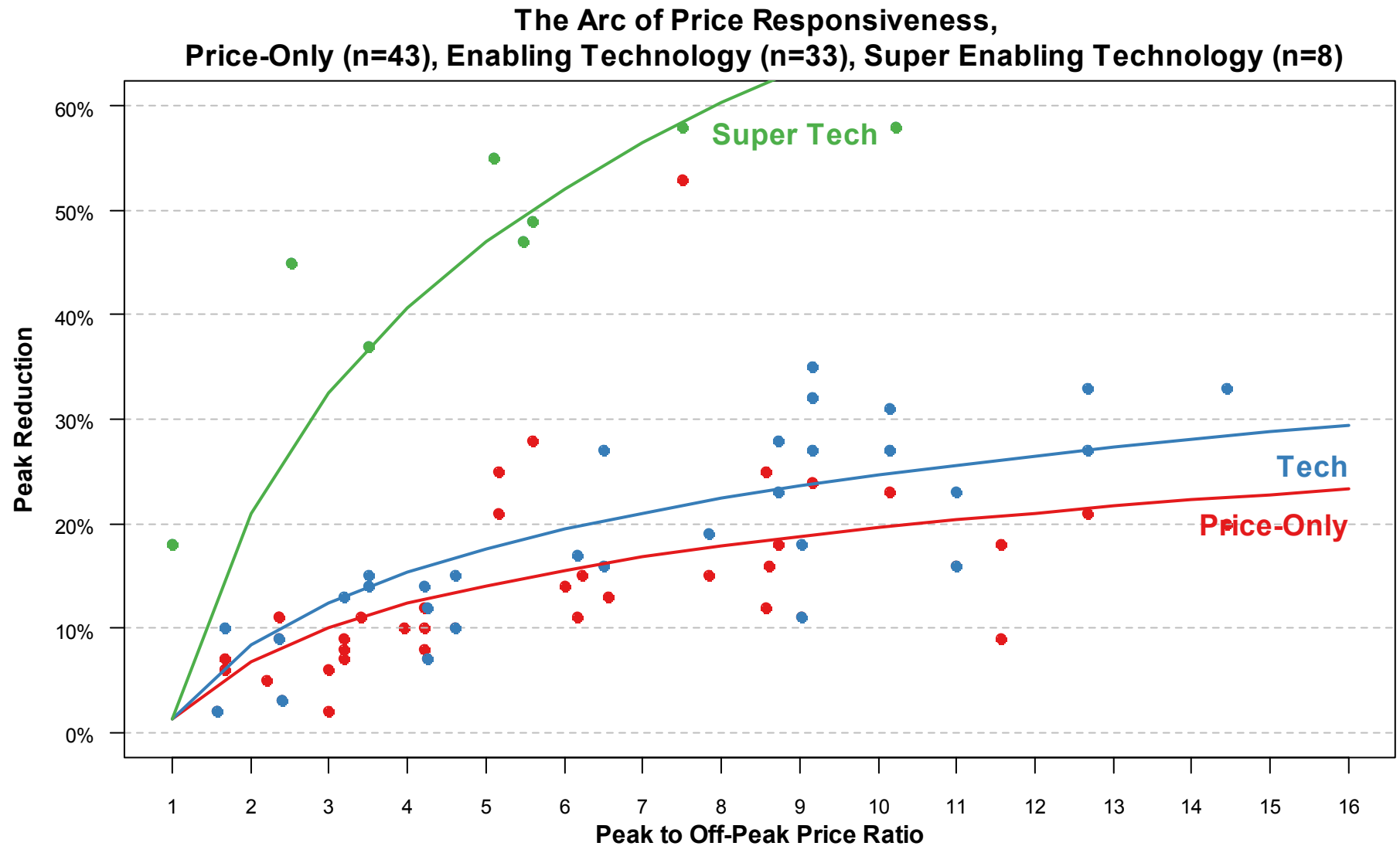


CUSTOMER RESPONSE

There is mounting evidence that they do respond

- Much evidence exists from pilots that have been carried out during the past decade in three continents
- A total of **28** pilots have been carried out, featuring **134** tests of specific rate designs and enabling technologies
- Of these **134** tests, **84** have high quality experimental designs and have reported results that can be used to conduct an informal “meta analysis”

With enabling technology, customer response is even greater





OBJECTIONS

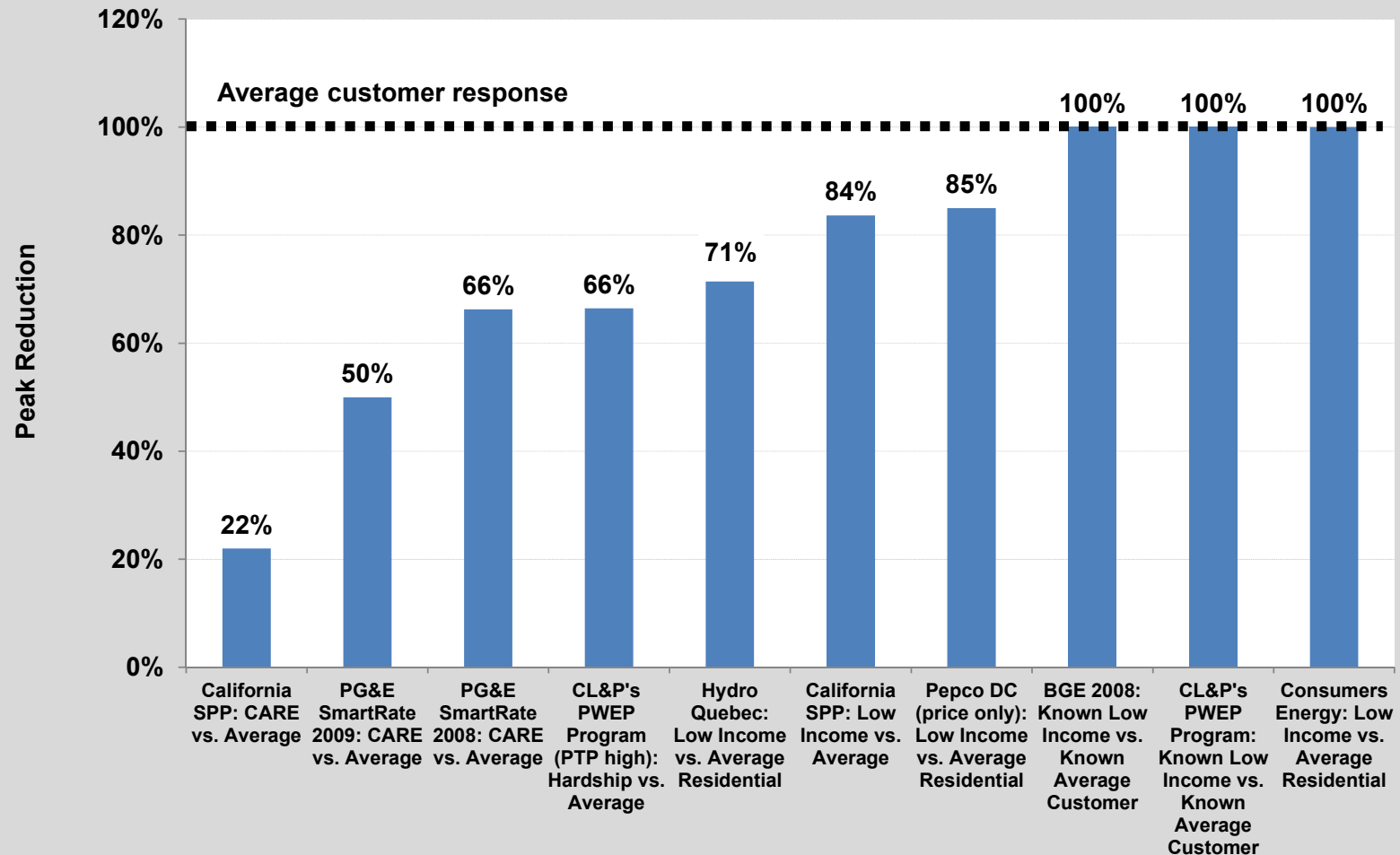
Dynamic pricing is punitive because ...

- Customers cannot respond to higher prices since electricity is a necessity
 - Unlike other goods and services sold in the marketplace, demand for electricity is not price responsive
 - This is specially so for low income customers, senior citizens and people with disabilities

Mark Toney, TURN, in California has voiced these concerns

- He spoke at an event sponsored by the Kellogg Alumni Association in San Francisco last year
- You can watch the conversation at <http://www.vimeo.com/20206833>.
- Similar views have been expressed by Barbara Alexander, Nancy Brockway and other consumer advocates and their consultants

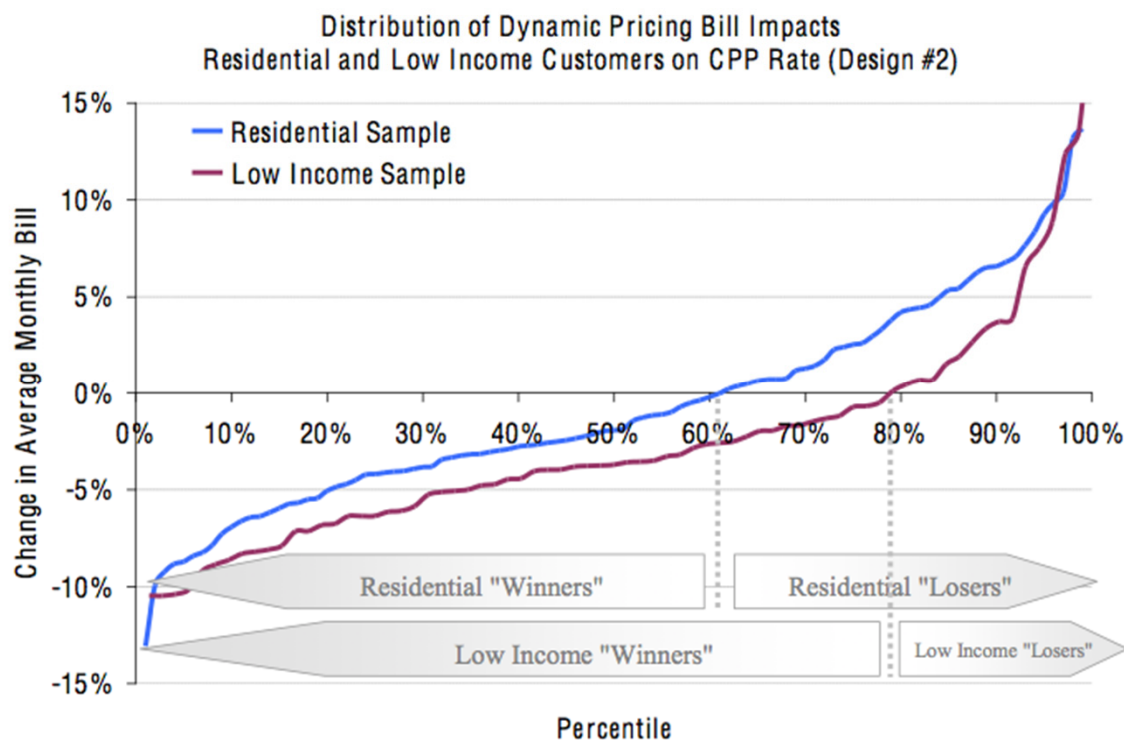
The response of low income customers is about two-thirds of the average customer's response



Note: For the PepcoDC pilot, the average residential response excludes low income customers that qualify for the RAD program

Most low income customers are instant winners

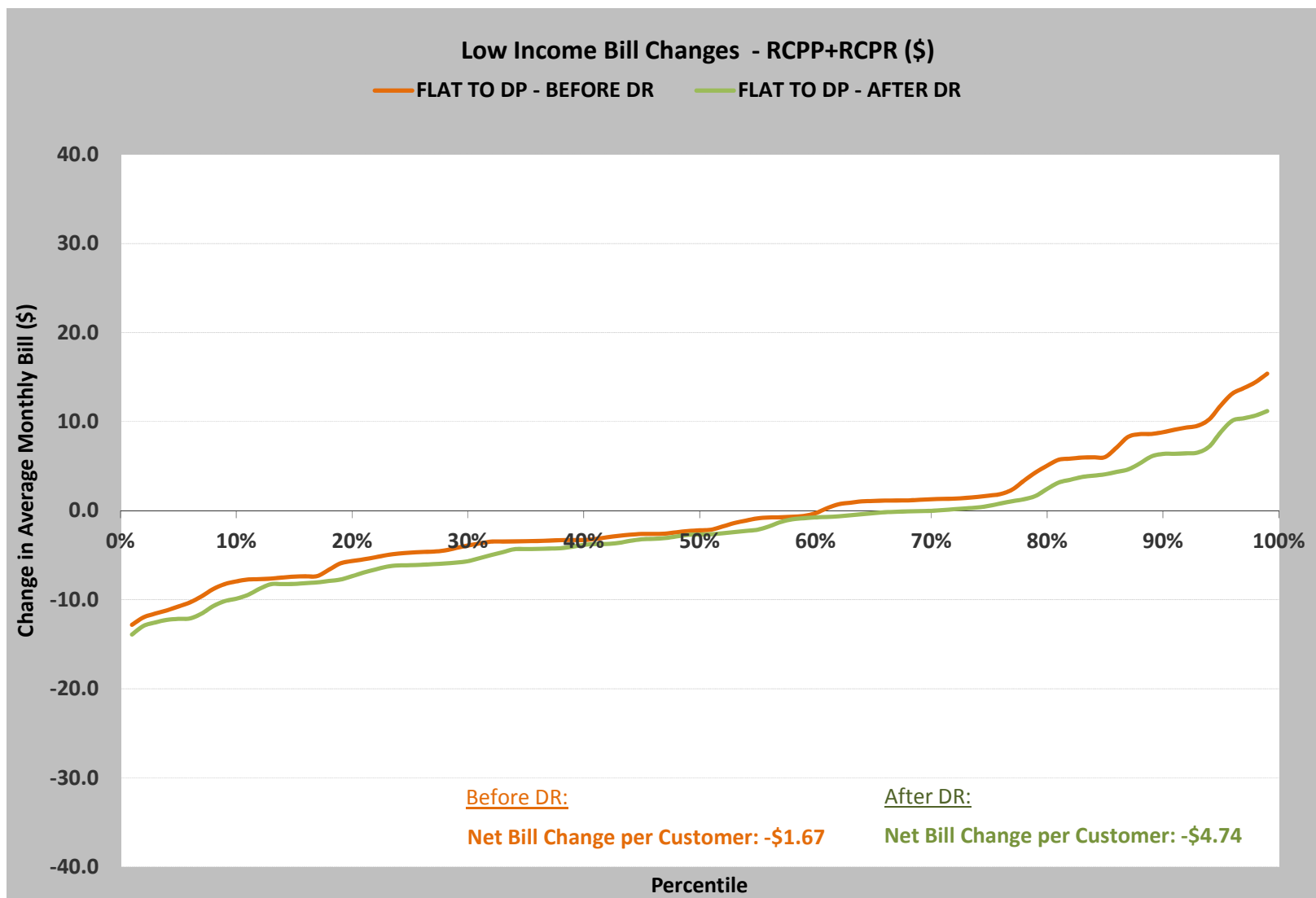
They benefit without changing behavior, even if they stay at home all day. All receive advantages of better reliability and lower operating costs.



Opportunity to win via simple behavior changes.

Protections can be kept in place for medically frail.

Additional evidence comes from neighboring Michigan



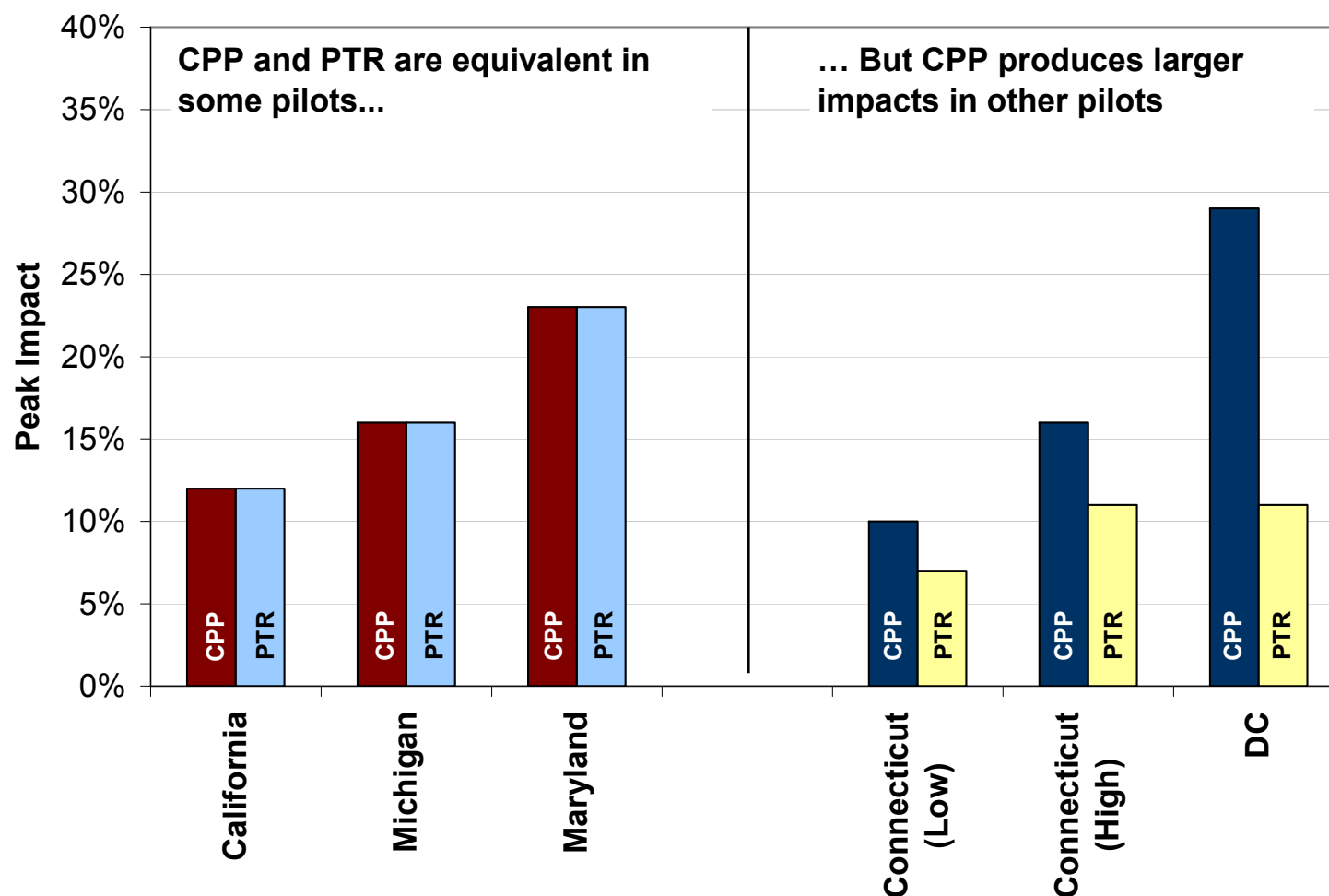


THE UNKNOWNNS

How does customer response vary by segment?

- Single-family versus multi-family
- Owners versus renters
- Low-income versus high-income
- High school graduates versus college graduates
- Rural versus urban areas

A question for behavioral economists: are CPP and PTR equivalent?



Note: For California, Michigan, and Maryland, CPP impacts are simulated using a PTR-equivalent rate design and price elasticities from the respective pilots

That is why we do need more pilots but they should be designed to ensure internal and external validity

- The best option is a scientific experiment with randomly selected treatment and control groups
- A second-best option is a quasi-experiment
- The following options cannot yield generalizable results
 - A demonstration of a new rate design or technology
 - A proof of concept
 - A showcase

Ways to ensure validity and generalizability

- Control group should be comparable to treatment group – or you can't measure cause-effect relationship
- Pre-treatment measurement – or you can't eliminate the effects of weather and other “confounding” variables
- Random sampling methods – or you can't generalize results outside of the pilot

Ensuring validity II

- Include sufficient number of treatments – need at least 2 price points to estimate a demand curve and a price elasticity
- Have a sufficient sample size – small sample cell sizes lead to statistically-imprecise estimates (need > 100 points per cell)
- Be cautious when paying participants – OK to provide a post-pilot “appreciation payment” but not a bill protection plan

The Gold Standard

	Control Group	Treatment Group
Before Treatment	C_1	T_1
After Treatment	C_2	T_2

- I. True Impact Measure = $(T_2 - T_1) - (C_2 - C_1)$
 - “Gold standard” for assessing program impacts
 - All other variables are held constant
 - Random assignment to control or treatment group
- II. Alternative Measures of Impact
 - (1) $T_2 - T_1$
 - (2) T_2
 - (3) $T_2 - C_2$



DYNAMIC PRICING WITHOUT TEARS

The architecture of choice

- How you frame the choices makes a huge difference in customer adoption rates
- Should it be opt-in?
 - What if there are no takers?
- Should it be opt-out?
 - Will people riot in the streets?
- Should it be mandatory?
 - Commercial and industrial customers are on such tariffs in many states

Ways of doing opt-in

- Simple opt-in with existing flat rates
 - It will be difficult to get much customer participation since customers are risk averse and there is a large amount of inertia in customer decision making
- Opt-in to dynamic pricing with higher-cost flat rates as the default rate
 - The flat rate may be set based on individual customer load profiles or the class load profile
 - This method is likely to yield higher adoption rates than the first one

Ways of doing opt-out

- Opt-out a la Ontario, Canada. Make dynamic pricing rates the default tariff and let customers opt-out to other offerings from competitive retailers if they so desire.
- Modified Ontario. Introduce an additional regulated option featuring flat rates that reflect the higher cost of serving peakier loads.

Still other ways of doing opt-out

- The default tariff is dynamic but in the first year customers have full bill protection, in the second year this drops to 75%, in the third year to 50%, in the fourth year to 25%; by the fifth year, customers are trained and it is removed
- The default tariff is dynamic but consumers can limit their exposure by buying forward a certain quantity and buying the remainder on the spot market; initially, the amount bought forward can be set based on their historical load profile

Conclusions

- Dynamic pricing works not just in the class room but also in the field
 - While there are unknowns, they are exceeded by the knowns
 - There is enough evidence to move forward, even though for some issues piloting may still be needed
- It is important to frame the choices in such a way that consumers are protected but societal benefits are maximized

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Biography

Ahmad Faruqui is a principal with *The Brattle Group* who specializes in the strategy and tactics of smart energy use. He has helped design, monitor and evaluate customer-side investments for a wide range of electric and gas utilities and independent system operators. Dr. Faruqui has testified or appeared before a dozen state and provincial commissions and legislative bodies in the United States and Canada. He has also advised the Alberta Utilities Commission, the Edison Electric Institute, the Electric Power Research Institute, the Federal Energy Regulatory Commission, the Institute for Electric Efficiency, the Ontario Energy Board and the World Bank. His work has been cited in publications such as *The Economist*, *The New York Times*, and *USA Today* and he has appeared on Fox News and National Public Radio. The author, co-author or editor of four books and more than 150 articles, papers and reports on efficient energy use, he holds a Ph.D. in economics from The University of California at Davis and B.A. and M.A. degrees in economics from The University of Karachi with the highest honors.

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