The Brattle Group

The Case for Dynamic Pricing

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In this presentation, we discuss the following issues

- What is dynamic pricing?
- What are its benefits?
- Do customers respond to dynamic pricing?
- How do technology and information affect customer response?
- Do the impacts vary across customers?
- How will dynamic pricing affect low income customers?

Dynamic pricing is a common practice in many industries

Parking meters

- Only applicable during daytime of weekdays

Traffic congestion pricing

- Central London, San Francisco-Oakland Bay Bridge

Cell Phones

- Daytime minutes

Sporting events

- San Francisco Giants, Buffalo Sabres

Are there others as well?

Why dynamic pricing for electricity?

The case has been made several times but is worth restating briefly

Compared to flat (non time varying) rates, dynamic pricing can lower power system costs (by improving the system load factor) and raise economic efficiency

It does this by clipping off the highest peak loads during the year which can account for anywhere from 7 to 17 percent of system load

The financial benefits of dynamic pricing may exceed $65 billion by 2030

The *iGrid* model was used to quantify the benefits

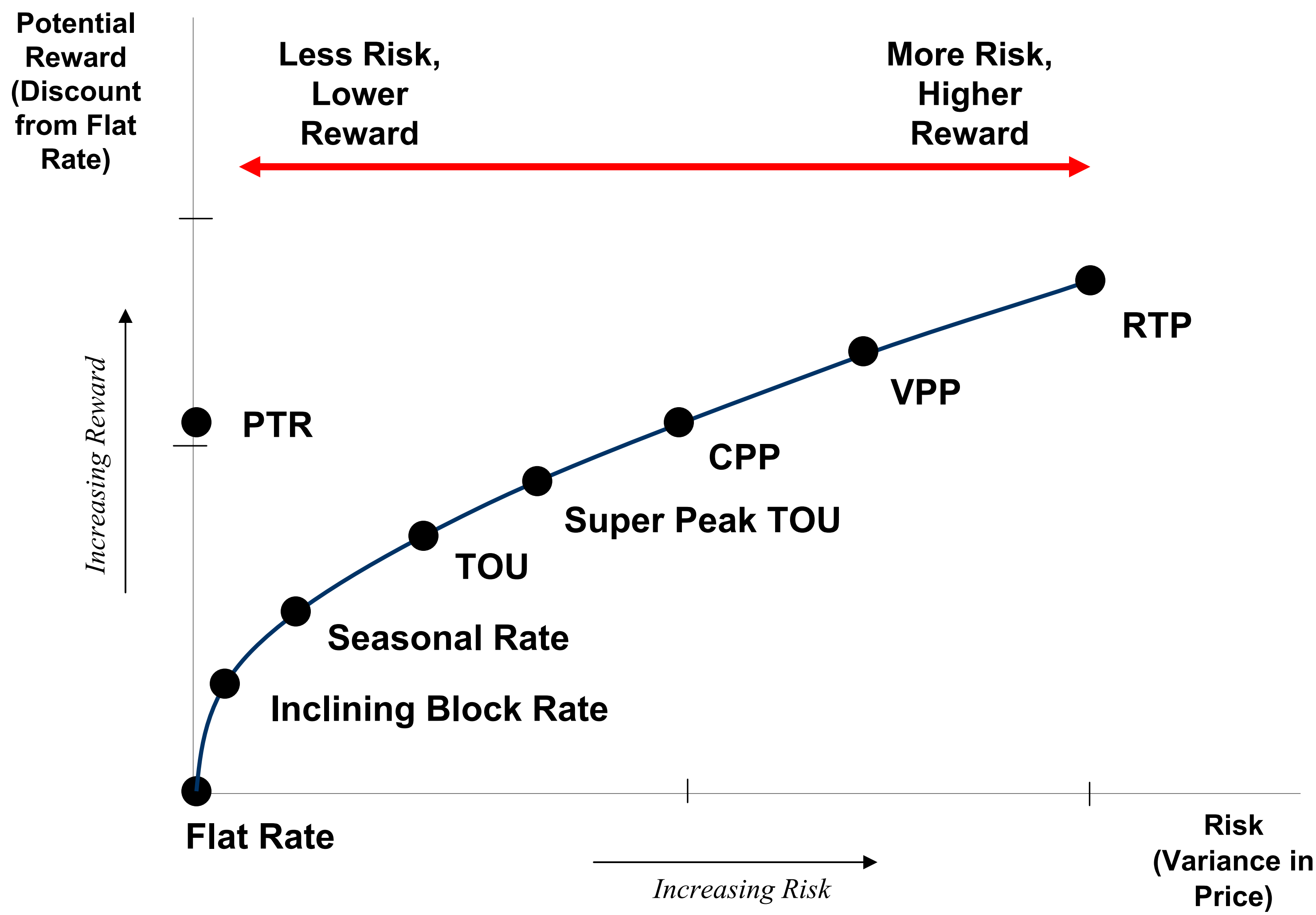
- Our calculations are driven by key assumptions about:
  - Avoided capacity and energy costs
  - Customer adoption and response rates
  - Central air conditioning saturation

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

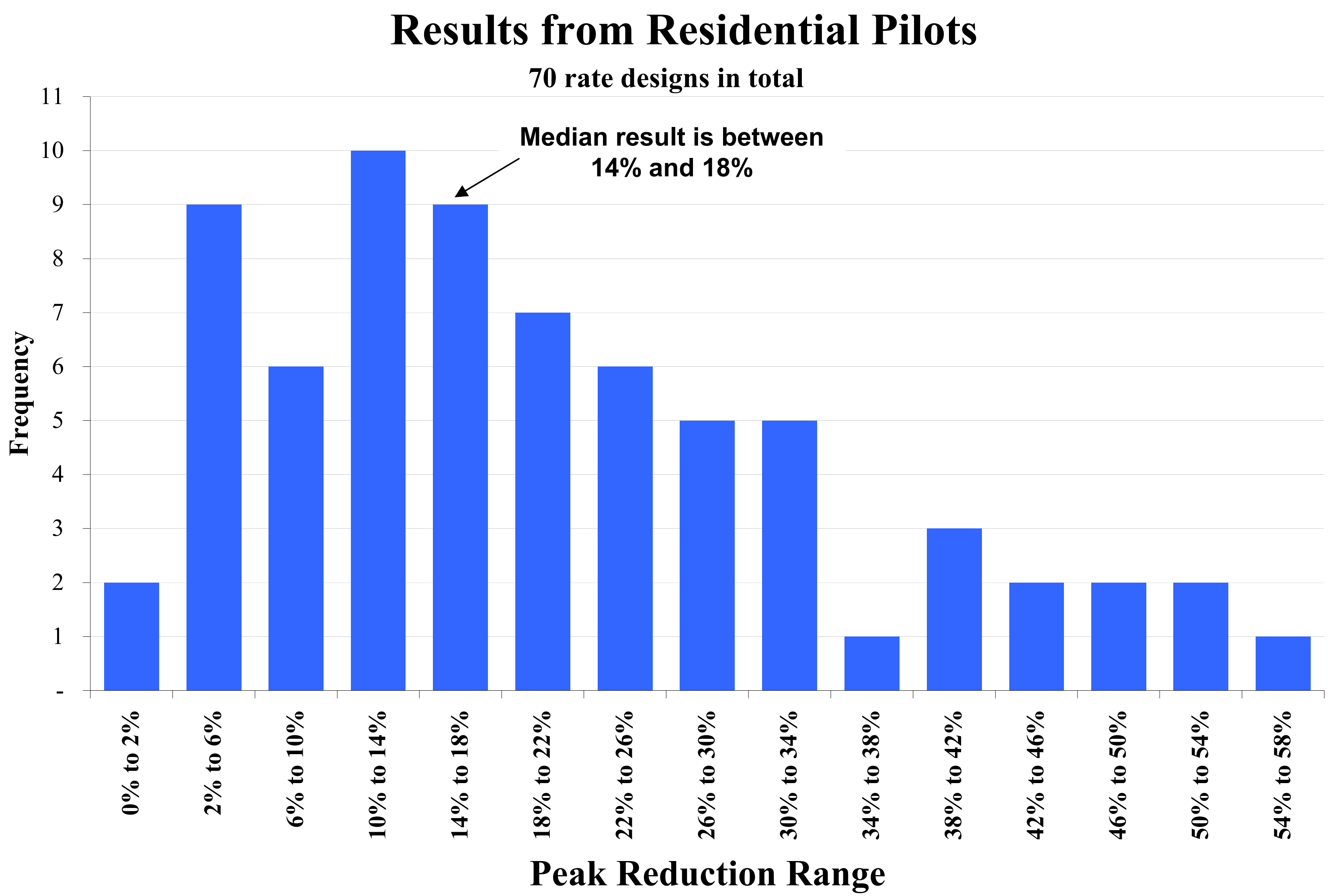
	Meter O&M	Generating Capacity	Energy from Electricity	Carbon	Total
AMI	$32,747	$0	$0	$0	**$32,747**
DR (Dynamic Pricing)	$0	$15,729	$5,902	$1,269	**$22,900**
DR (Enabling Technology)	$0	$6,939	$2,719	$585	**$10,242**
Total benefits	**$32,747**	**$22,668**	**$8,621**	**$1,854**	**$65,890**

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

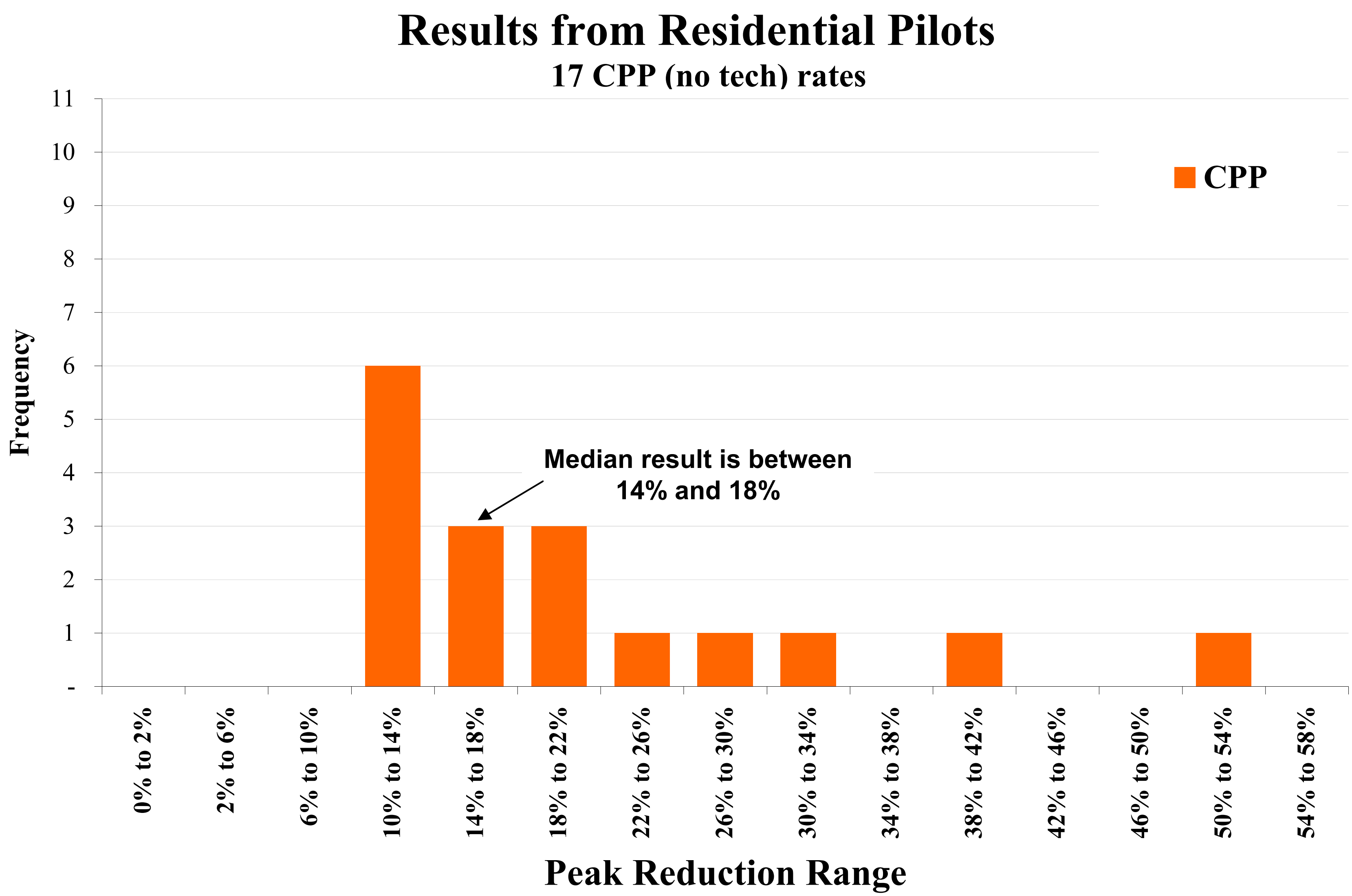
The dynamic pricing possibilities frontier



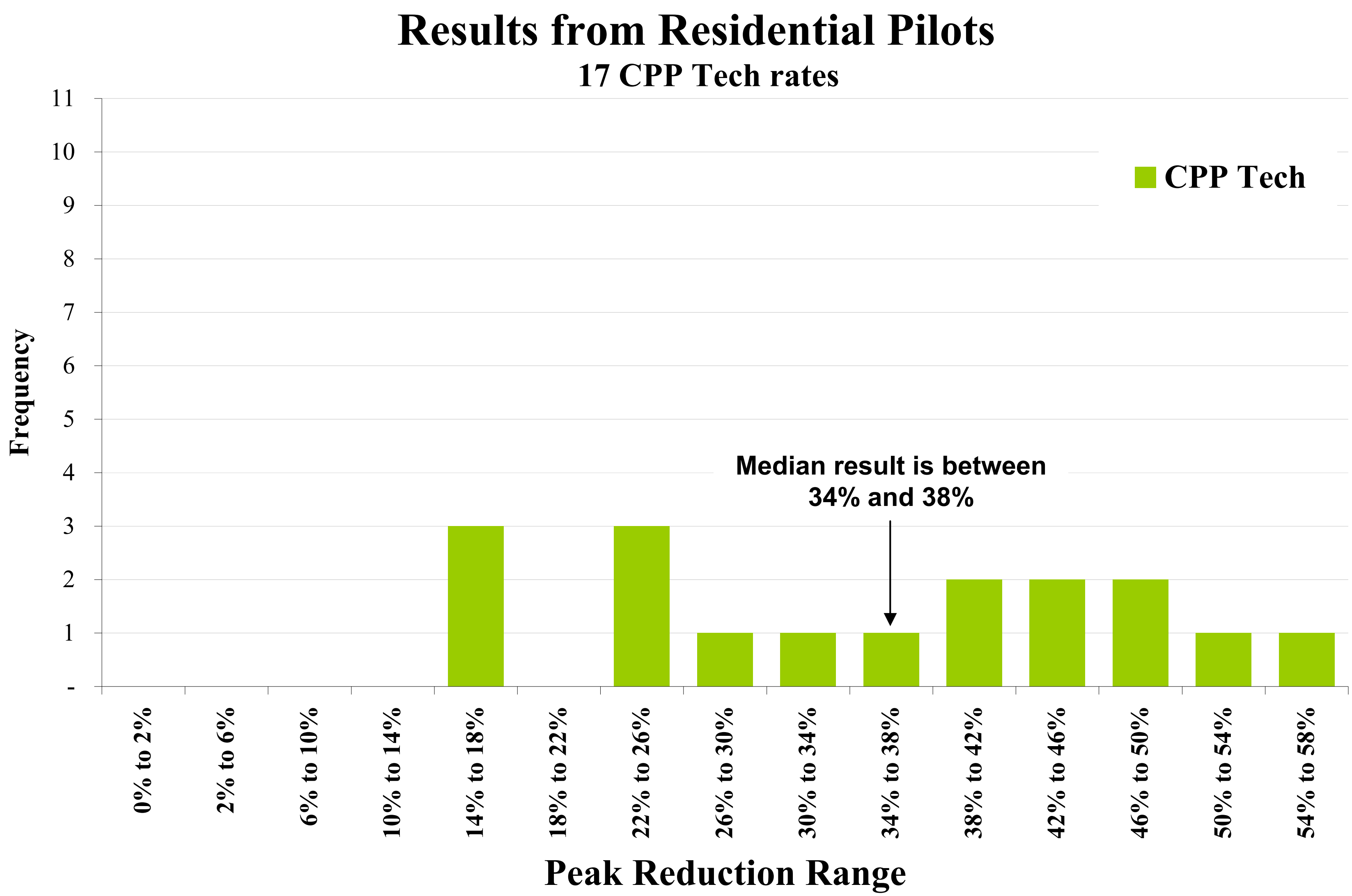
Dynamic pricing has yielded positive results in 70 pilots across three continents



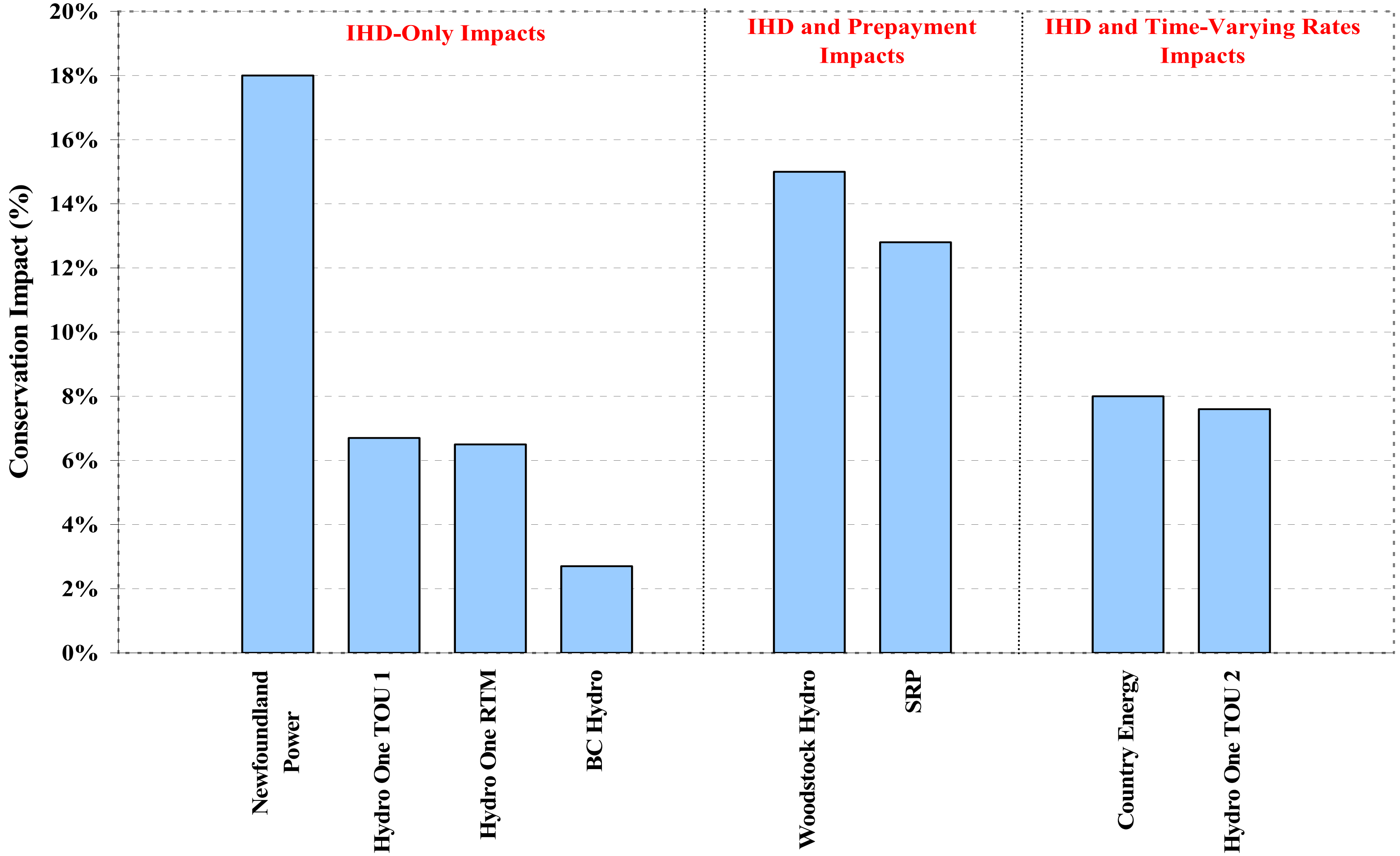
Critical peak pricing has demonstrated peak reductions greater than 10%



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



Improved access to information can also lead to overall conservation



This chart is expected to expand over the next couple of years

These recent pilots have answered some important questions…

Conclusive findings from recent pricing pilots:

- Customers respond to price by lowering peak usage
- Response rises with prices but at a diminishing rate
- Enabling technologies boost response
- Hotter temperatures lift response values
- Response does not wilt in a heat wave
- Response persists across years
- Response varies by region and customer class
- Informational feedback leads to energy conservation

… but some areas are in need of more research

Customers respond equally to the “carrot” and “stick” in some cases but not in others

Customers respond to informational feedback but

- By how much is still somewhat uncertain (wide range of impacts)
- The impact on peak demand is uncertain (conflicting results)
- Whether this response would persist over time is also uncertain

Customer preferences for various time-varying and non-time-varying rate options is an under-researched area

- Most of today’s evidence comes from focus groups and attitudinal surveys
- In focus groups, customers express concern about price volatility but the vast majority of pilot participants indicate that they would remain on the rate upon completion of the pilot

New pilots would be most valuable if focusing on these under-researched areas

What are the impacts across customers?

Load shapes vary by customer

- Different customers impose different cost on the power system

However, today’s flat rates ignore this principle

- Everyone’s “shopping cart” incurs the same average rate

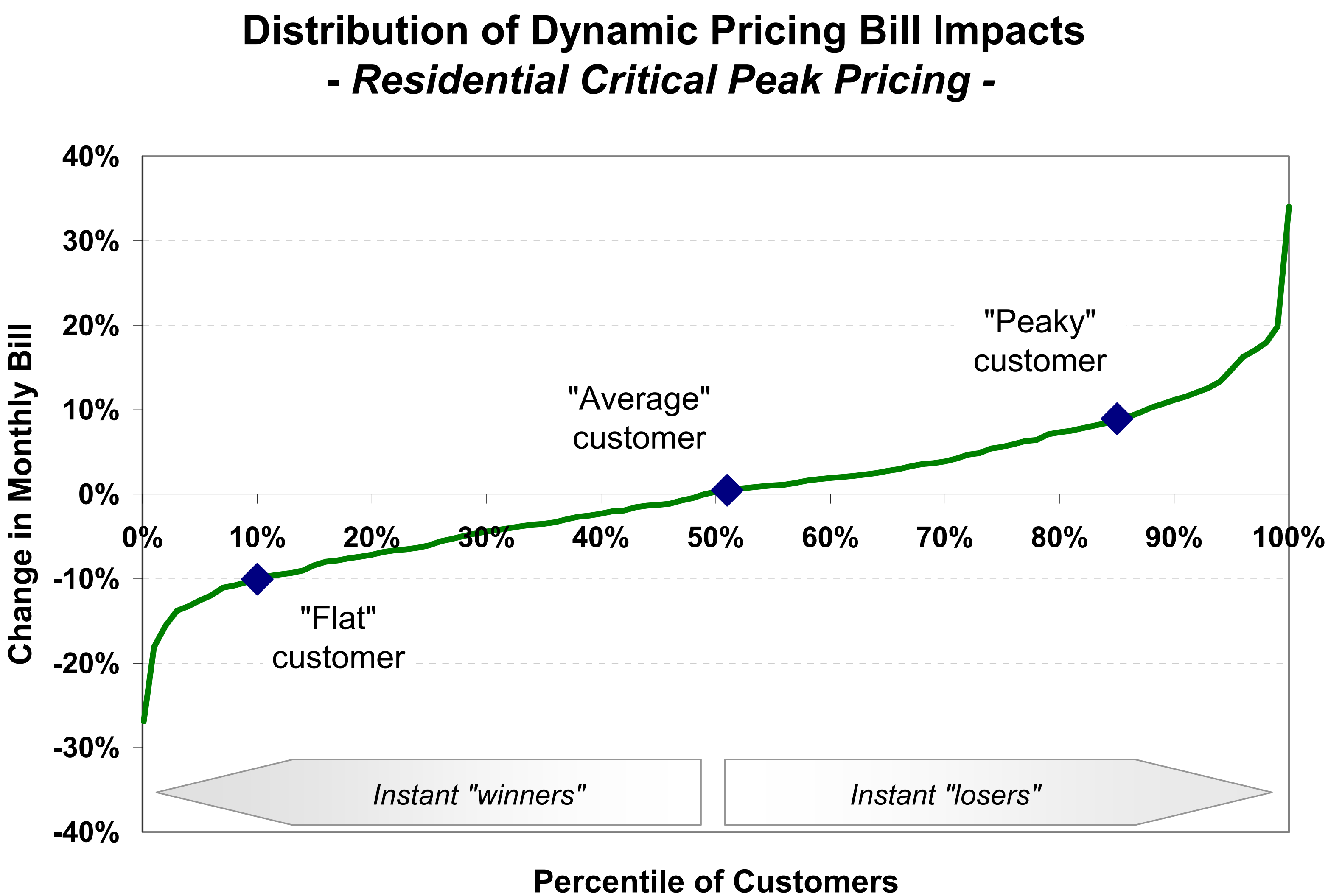
The result is significant cross-subsidization

- Customers with poor load factor (large homes with central air conditioners and swimming pools) are subsidized by those with high load factor
- Subsidy could be in the range of $4 billion for a population of 10 million customers over a 10-year period (see Appendix A)

Dynamic pricing would eliminate these subsidies

- Under the right regulatory and market conditions, dynamic pricing can create win-win outcomes for the overwhelming majority of customers

Absent demand response, dynamic pricing rates will produce instant “winners” and “losers”



Of course, load shapes (and bills) are likely to change in response to dynamic pricing

Customers will have an incentive to reduce peak usage by curtailing and/or shifting usage to off-peak periods

- The level of load shifting is dictated by many factors, a primary one being the price signal

This is not just a theoretical conjecture but backed by a wide range of pilot programs

- North America, Europe and Australia/New Zealand

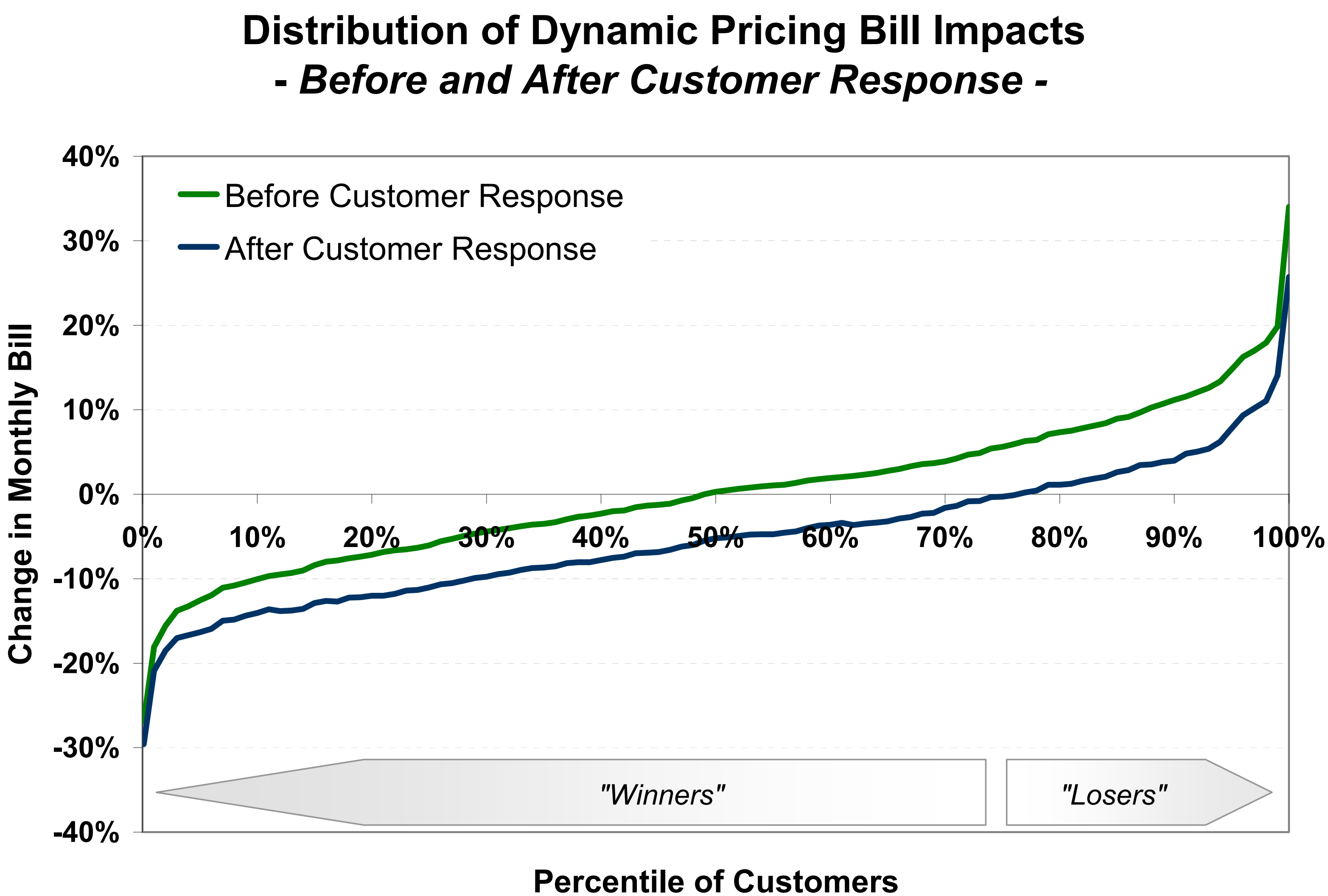
There are many ways customers can reduce peak usage

Residential
Shift laundry
Use appliances less
Turn off lights
Turn AC off/use less
Shift dishwasher use
Reduce laundry water temperature
Shift pool/spa pump/filter use
Improvements to home EE
Turn up AC temperature
Turn off appliances
Turn off TV/computer
Do not use stove/oven
Leave house
Shift cooking time
Reduce fan usage
Line dry clothes
Use "Heat off" setting on dishwasher

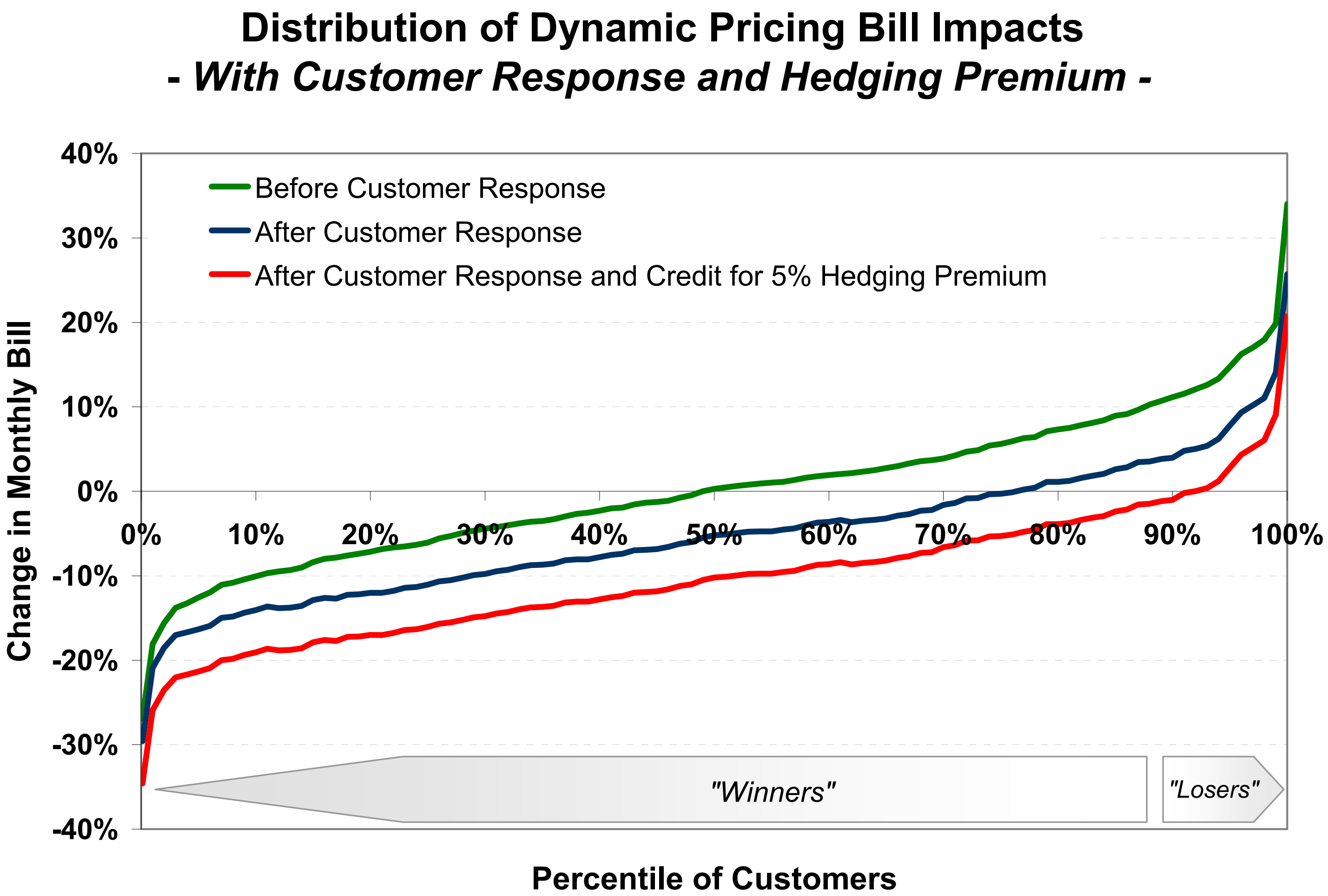
Business
Turn lights/equip off when not needed
Turn AC off more
Raise thermostat setting on AC
Replace lights/fixtures with more efficient
Install programmable thermostat
Change hours of operation
Remove lights/reduced wattage
Install lights/equipment timers
Make improvements to facility EE
Shift employee work schedule
Chang hours of operation
Replace old equipment

Source: Compiled from several reports on end-of-pilot surveys conducted during the California Statewide Pricing Pilot.

As customers shift usage to lower priced hours, the percentage of “winners” will increase



Crediting participants with the avoided hedging cost could make 90 percent better off



See Appendix B for more detail

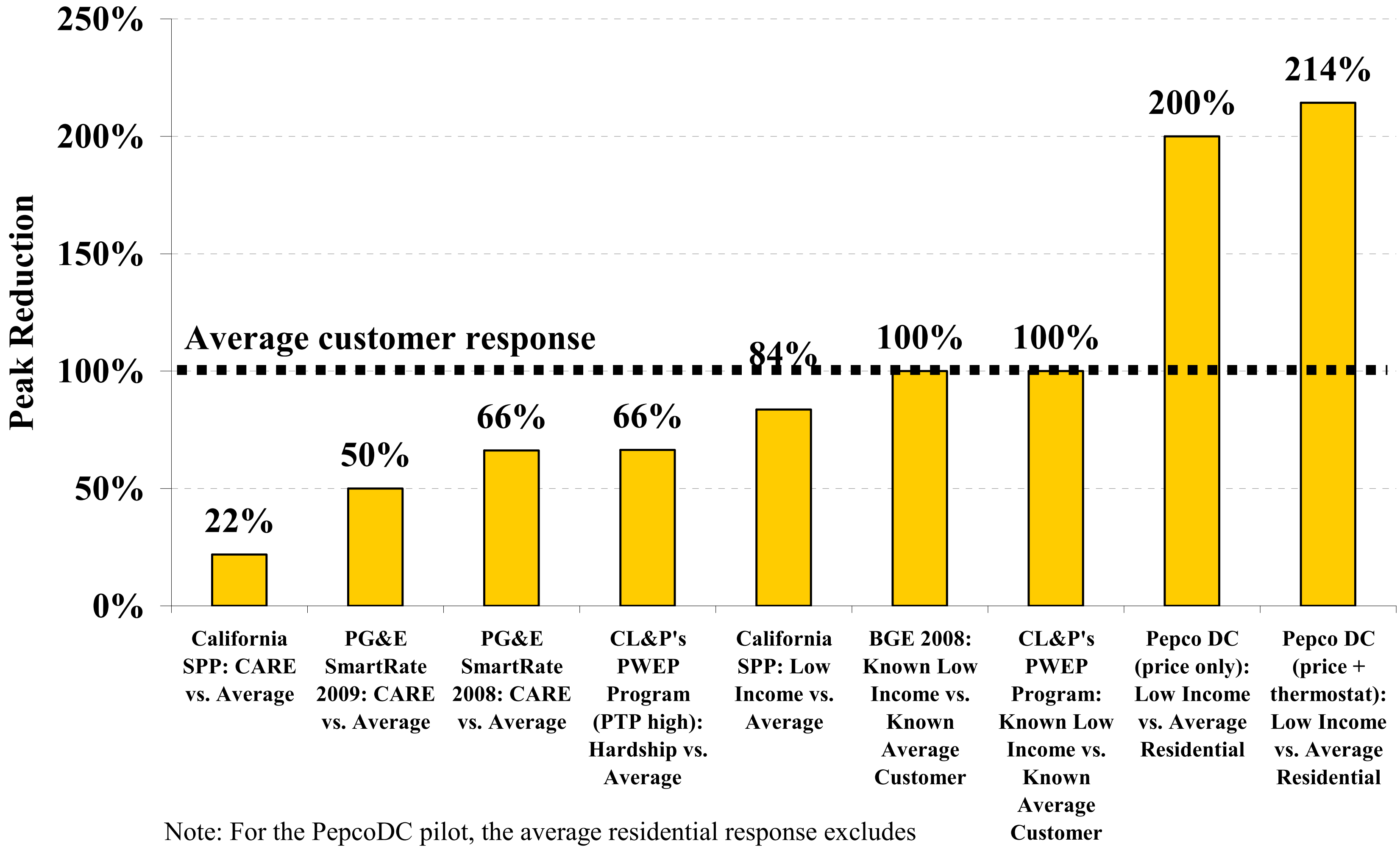
How will it affect the well-being of low income customers?

Arguments against dynamic pricing for this segment of the residential class include

- They don’t know how to respond to dynamic rates
- They don’t have any curtailable load
- Their bills will increase
- They aren’t interested in enrolling in dynamic rates

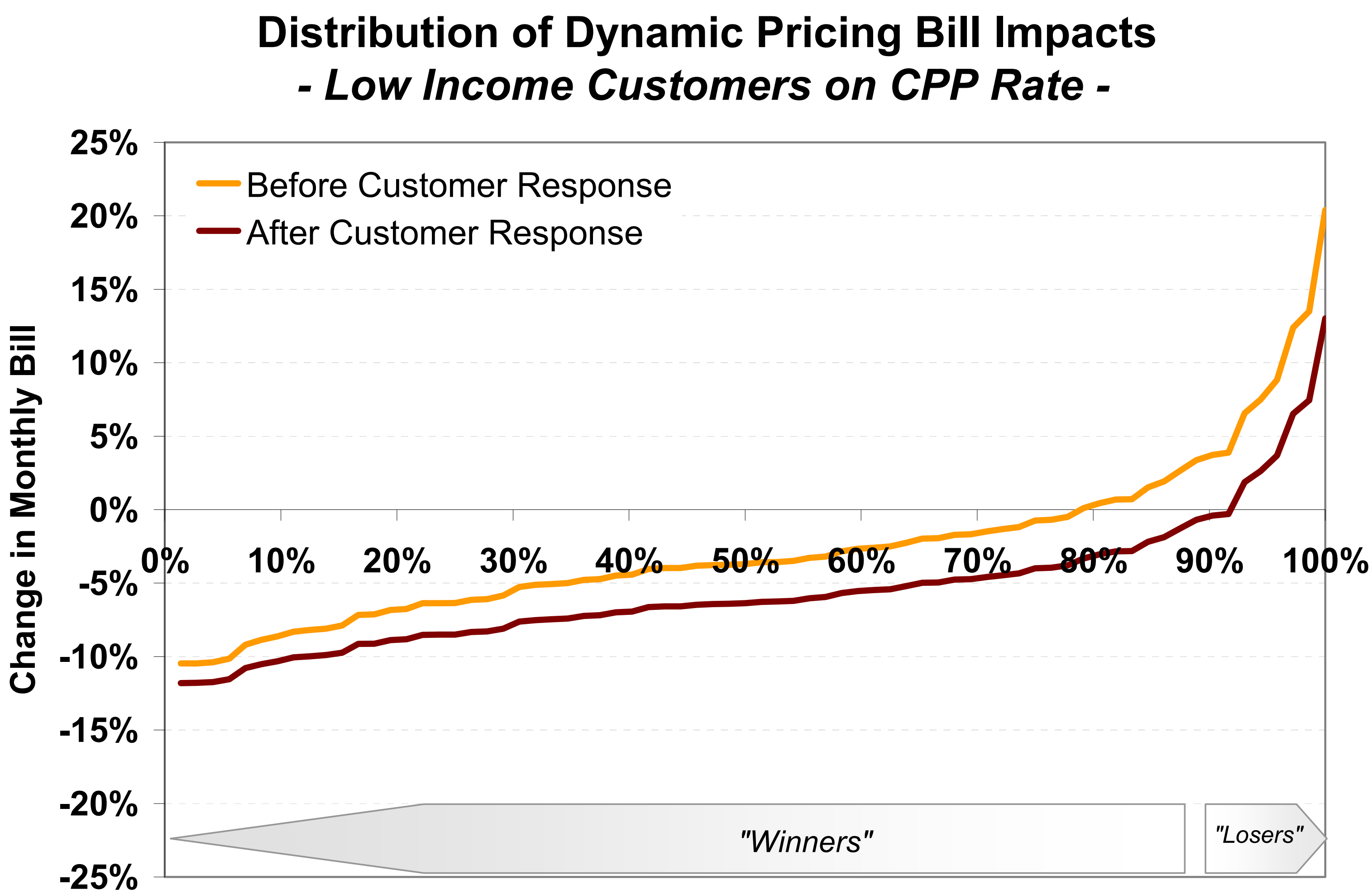
However, empirical evidence suggests that this is not the case

Low income customers have demonstrated significant price responsiveness



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

Most low income customers would automatically benefit from dynamic pricing



There are options for accommodating the objections to default dynamic pricing

Creating customer buy-in

- Changing a century-old ratemaking practice will require significant customer education and management of expectations

Offering tools

- Improved billing information
- In-home information displays
- Enabling/automating technologies

Two-part rate design

- Allows customers to manage the amount of usage exposed to the dynamic rate

Peak-time rebates

- Creates a "no lose" situation for all customers, while still providing the incentive to reduce peak usage

Accommodating the objections (concluded)

Bill protection

- A "no losers" proposition for the first few years
- Phase out over time as part of educational initiative

Crediting customers for the hedging premium

- Flat rates sometimes include a premium to account for the price and volume risk associated with wholesale power purchases
- If price fluctuations are passed through to the retail rate, this risk is transferred to the customer and the premium is eliminated or reduced

Creating a menu of tariffs anchored around dynamic pricing

- Give customers the option of migrating to other time-varying rates or even hedged flat rates

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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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Appendix A:
Quantifying the Subsidy in Today's Flat Rates

First, we define a representative hypothetical customer mix

Assumptions include

- ♦ A base of 10 million residential customers
- ♦ A balanced mix of "flat," "average," and "peaky" customers
- ♦ A flat rate of 10 cents/kWh
- ♦ A revenue neutral TOU rate with a peak price of 20 cents/kWh and an off peak price of 6.7 cents/kWh

Summary of Customer Population Characteristics

Consumption Profile	Monthly Consumption (kWh per Customer)			Weighted Average Rates (cents/kWh)	
	Peak	Off-Peak	Total	Flat	TOU
Flat	50 (10%)	450 (90%)	500 (100%)	10.00	8.00
Average	125 (25%)	375 (75%)	500 (100%)	10.00	10.00
Peaky	200 (40%)	300 (60%)	500 (100%)	10.00	12.00

The total subsidy is nearly $4 billion over a 10-year period

- The cross-subsidy is estimated by calculating each customer's bill on a flat rate and a TOU rate
- While the average customer is no better or worse off, the $4 billion subsidy between flat and peaky customers is eliminated
- Results could vary for other time-based rate designs

NPV of Cross-Subsidy over Ten Year Period

Consumption Profile	Monthly Electricity Cost ($)		Monthly Benefit/Loss From Flat Rate ($)	Total Benefit/Loss ($ Billions)
	Flat	TOU		
Flat	50.00	40.00	(10.00)	(3.92)
Average	50.00	50.00	0.00	0.00
Peaky	50.00	60.00	10.00	3.92

Appendix B:
The Hedging Cost Premium

It is possible to make dynamic pricing more attractive by crediting customers for avoided hedging costs

- A conservative estimate of these costs is 5% (see next slides)
- Studies have implied premiums of 15% to 30% for a fully hedged service
- A recent study by ISO-NE utilized risk premiums that varied by pricing plan
  - RTP: 3%
  - VPP: 5%
  - TOU: 8%
  - Flat rate: 15%

Enter the risk premium

- Flat rates embody an *implicit* but real risk premium that insures customers against price volatility
- The risk premium is [exponentially] proportional to the volatility of loads, the volatility of spot prices and the correlation between loads and spot prices
  - Thus, if load volatility is 0.2, price volatility is 0.6 and price-load correlation is 0.4, the risk premium is about 5%

- $\pi = \exp(\sigma_L, \sigma_P, \rho_{L,P})$

Where:

- π = Risk Premium
- σ_L = Load Volatility
- σ_P = Spot Price Volatility
- $\rho_{L,P}$ = Correlation Between Load and Spot Price

Quantifying the risk premium