Residential Rates for the Utility of the Future

PRESENTED TO

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PRESENTED BY

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THE Brattle GROUP

Residential rate design is ripe for rethinking

Flat rate pricing is ubiquitous today and it has persisted over the past century because of two reasons

- Lack of advanced metering
- A perception that residential customers are not ready for a change, which has become a self-fulfilling prophecy
- A long time ago, Professor Bonbright warned us of guarding against the "tyranny of the status quo"

For many utilities, their residential rates and costs are grossly misaligned

Cost categories

Variable ($/kWh)
- Fuel
- Operations & maintenance

Fixed ($/customer)
- Metering & billing
- Overhead

Size-related (demand) ($/kW)
- Transmission capacity
- Distribution capacity
- Generation capacity

Utility's Costs | **Customer's Bill**

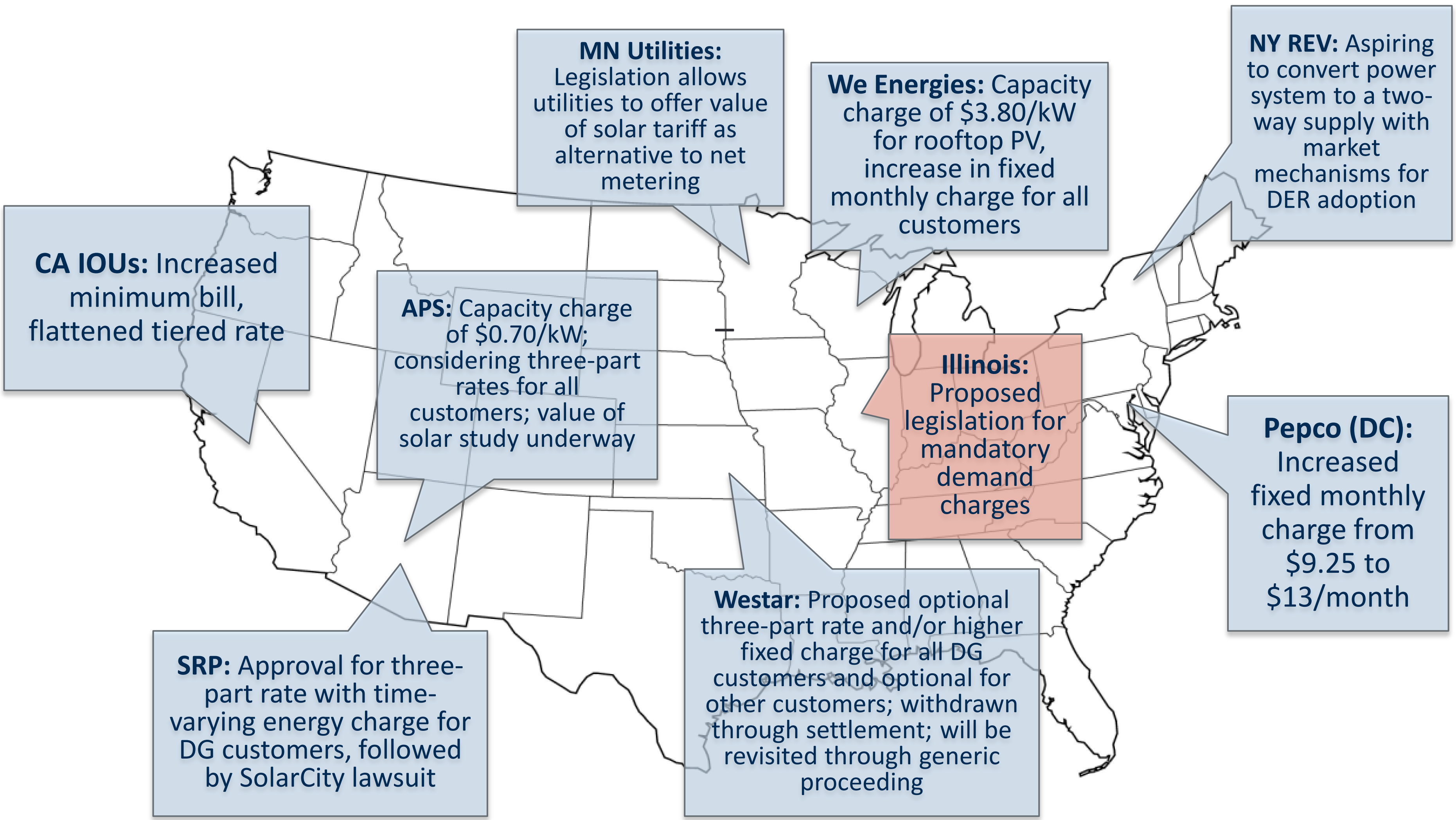
This is not just a problem for the utility's shareholders

The oversized volumetric rate can be avoided through investment in high-efficiency appliances and distributed generation

Customers who don't (or can't) make these investments, particularly low income customers, subsidize those who do

The cross-subsidy has significant implications with regard to equity and fairness – two important ratemaking criteria (more later)

Utilities and regulators realize there are problems with current residential rates



Residential technology is changing -- the "house of the future" is here today

Digital technology is becoming ubiquitous, i.e., the Internet of Things

- Smart thermostats, smart appliances, smart light bulbs and smart plug loads
- Home energy management systems
- These allow households to manage their loads dynamically in real time

If prices fall in the middle of the day, e.g., as renewable energy resources kick in, customer loads will rise automatically

As prices rise later in the evening, loads will fall automatically

Utilities want smart customers making smart decisions, but flat rates can misguide them

+

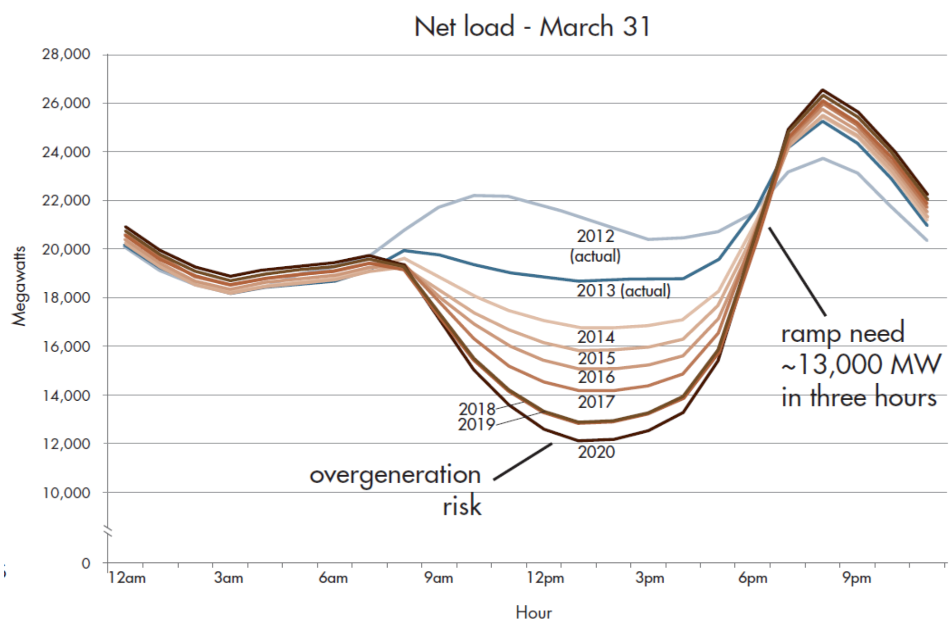
= ?

If customers adopt uneconomic levels of DG, this will raise energy costs for all customers

Increases in customer generation may have two effects:

- Reduce capacity costs
  - Depends on the degree generation is coincident with system peak
  - Depends on the degree of customer generation reliability
- Increase other costs
  - Intermittency may result in
    - Increased generation ramping requirements [the duck! (now a goose)]
    - Increased level of operating reserves (idling generation)
    - Reduced efficiency of unit commitment
  - There may also be additional costs associated with maintaining power quality
  - And distribution-level capacity upgrades may be needed

The California ISO "Duck Curve"



A variety of new flavors are being considered

- Demand Charges
- Buy-Sell Arrangement (FIT/VOS)
- Fixed Monthly Charge
- Time-Varying Rates
- Capacity Charge
- Installed Capacity Fee (Grid Access Charge)
- DG Output Fee
- Interconnection Fee
- Minimum Bill
- Standby Rates

Time-varying prices should be the foundation for all energy rates

Economic efficiency

- The costs of supplying and delivering electricity vary by day, and some economists have argued that the electricity used in each hour is a separate commodity
- Unless consumers see this time variation in prices, they will have no incentive to modify their pattern of energy usage
- Excess capacity will have to be built and kept on reserve to meet peak loads during a few hundred hours of the year

Equity

- Under flat energy rates, customers who consume relatively less power during peak periods subsidize those who consumer relatively more power during peak periods

TVP will lower energy costs and reduce cross-subsidies

There are almost 60 million households with smart meters today but less than 2 million of them are on TVP

That prevents us from harnessing the benefits of universal dynamic pricing

- $7 billion per year in lower energy costs
- $3 billion per year in reduced cross-subsidies between customers

Some are considering TVP +

A few utilities have begun moving to a three part rate, i.e., a monthly service charge, a demand charge and time-variant pricing (TVP), and many others are expected to follow

- Such rates have a long history for commercial and industrial customers, backed up by a long series of papers dating back to Hopkinson and Wright (see the appendix)

Markets and regulation mute the price signal - demand charges supplement TVP

Utilities that supply energy need prices that signal

- Customer's impact on resource requirements
- Transmission system burdens from their load
- Distribution system burdens from their load
- Metering and customer service costs

For distribution-only utilities with real-time market price pass-through

- Demand charge must signal distribution system burdens
- Metering and customer service costs

These rates signal all aspects clearly

Utilities that supply energy would use a five-part rate

- Monthly service charge
- Charge for connected load (or maximum customer demand)
- Maximum demand charge (coincident with the distribution peak)
- Charge for generation capacity
- Time-varying energy charge

Distribution-only utilities would use a three-part rate

- Monthly service charge
- Charge for connected load (or maximum customer demand)
- Maximum demand charge (coincident with the distribution peak)

These rates may serve as a reasonable approximation

Utilities that supply energy would use a three-part rate

- Time-varying energy charge
- Monthly service charge
- Maximum demand charge (coincident with the system peak)

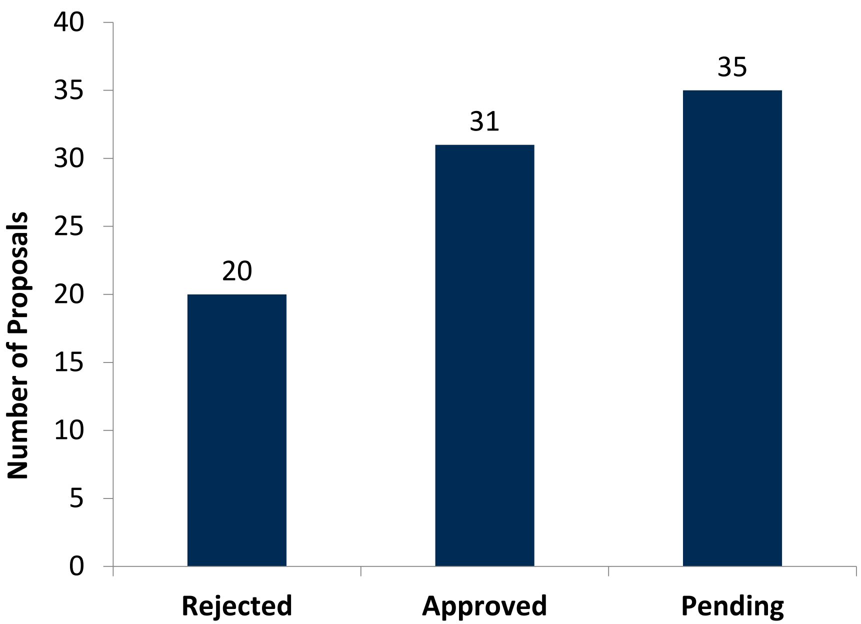
Distribution-only utilities would use a two-part rate

- Monthly service charge
- Maximum demand charge (coincident with the distribution peak)
- Market price pass through serves as TVP for its customers

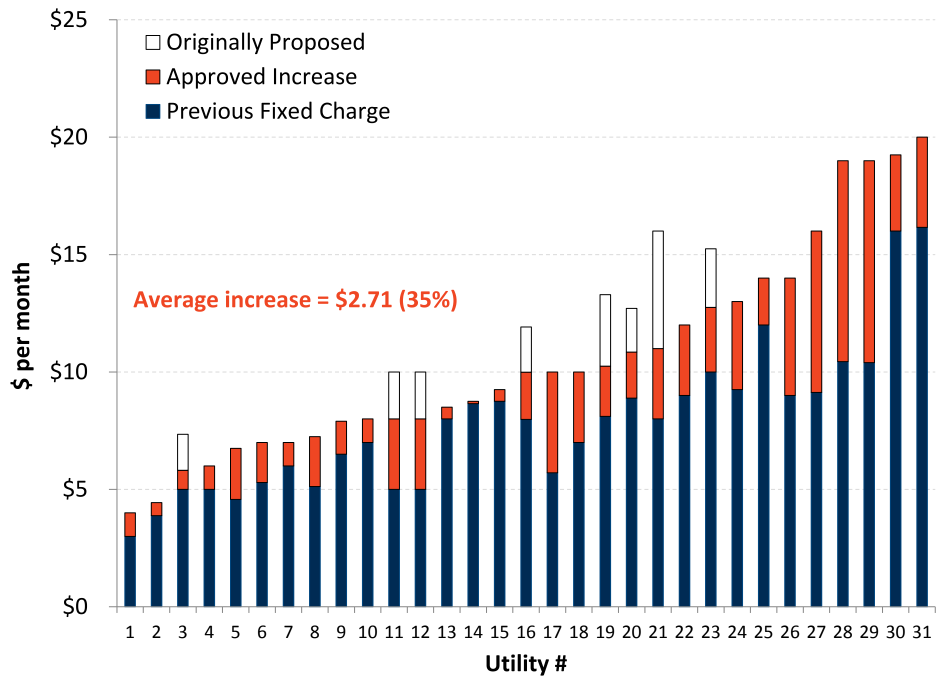
The Case for Raising Fixed Charges

Many utilities have proposed to increase the fixed charge, with varying degrees of success

Recent Proposals to Increase Fixed Charge



Amount of Approved Increase



Data sources: NC Clean Energy, “The 50 States of Solar,” Q2 2015. Supplemented with review of additional utility rate filings.

Fixed charges can help to address the "cost shift" problem

In the absence of AMI, rate design options for addressing the cost-shift issues associated with DG adoption and volumetric rates are somewhat limited

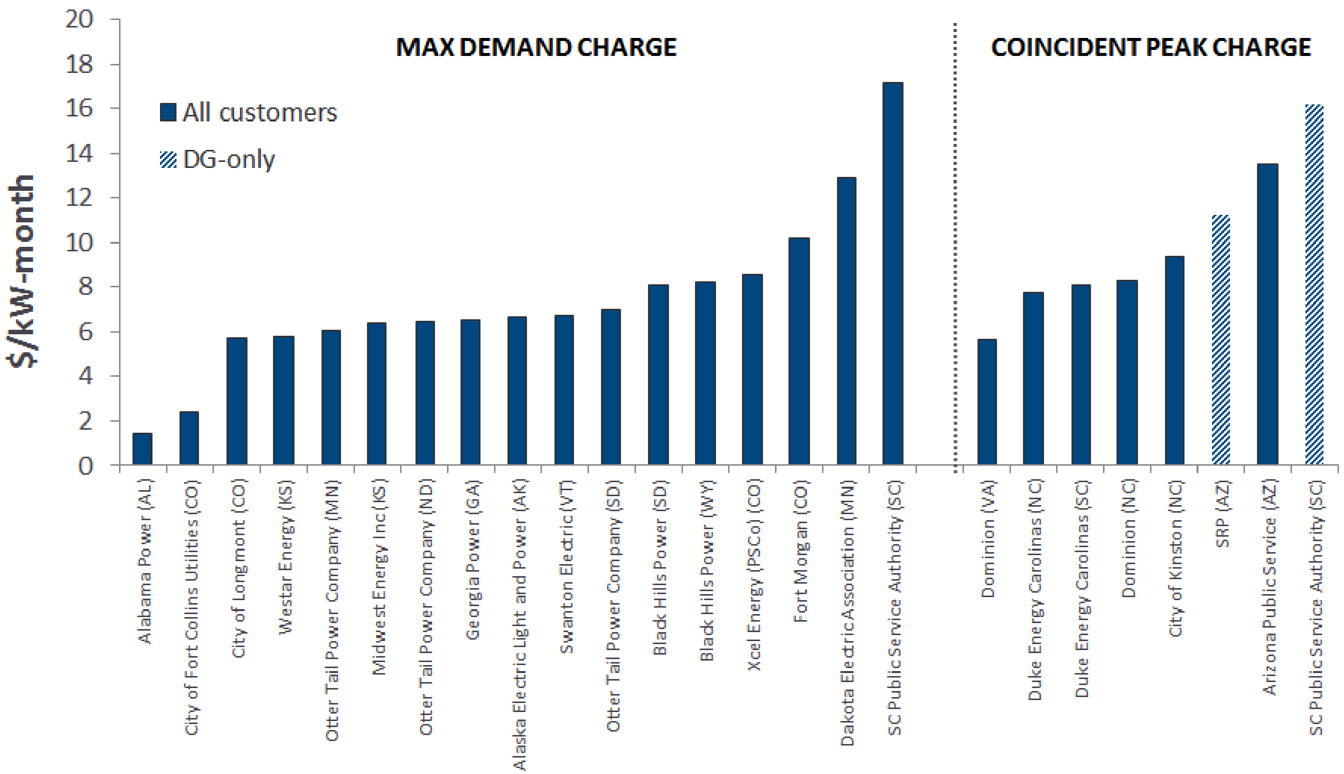
Fixed charges are one option for addressing the cost-shift issue that does not require metering upgrades

Some costs, such as metering, billing, and general overhead are clearly fixed and vary with the number of customers, not with the amount of electricity consumed

The Case for Demand Charges

Some utilities already offer residential demand charges

Summer Demand Charges in Existing Rates



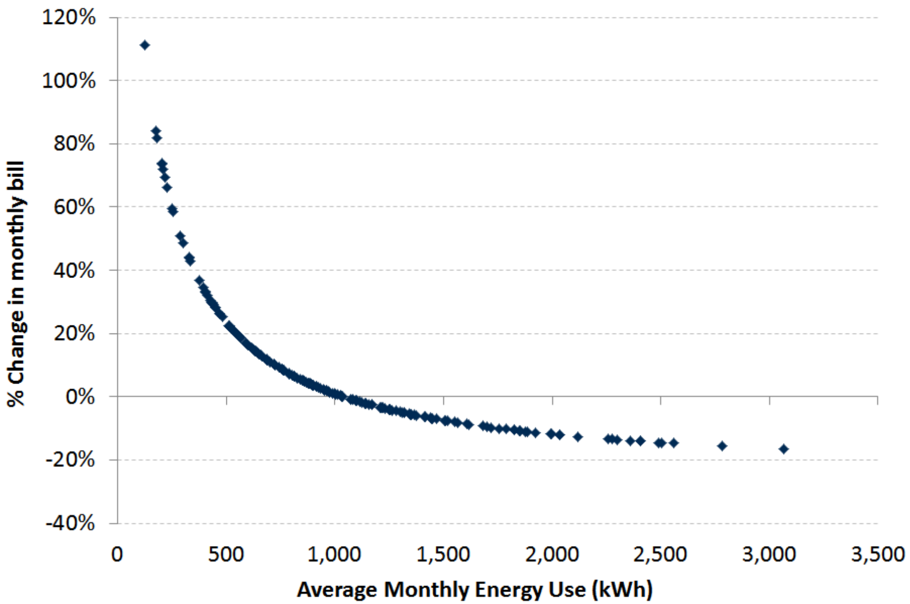
Notes:
1) All rates are drawn from their respective utility tariff sheets, valid as of July 2015.
2) The SRP rate is tiered and varies by season and amount of demand; we show the average summer demand charge for a 10 kW customer for illustrative purposes.
3) The SC Public Service Authority DG rate includes a peak rate of $11.34/kW-mo and an off-peak rate of $4.85/kW-mo. We present the sum for simplicity.

Comments

- 19 utilities offer residential demand charges, 10 of which are IOUs
- They were proposed by Westar, NV Energy, ComEd and are being considered by other utilities

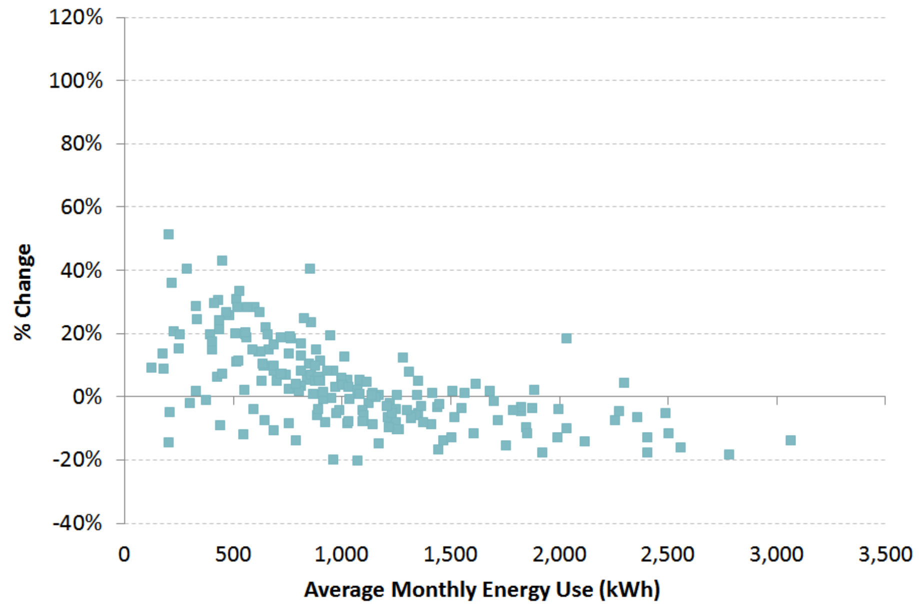
Demand charges do not automatically increase bills for small customers

With Increased Fixed Charge



Note: The three-part rate includes a monthly fixed charge of $10, an energy charge of $0.077/kWh, and a demand charge of $6/kW. The revenue-neutral two-part rate includes a monthly fixed charge of $40 and an energy charge of $0.083/kWh.

With New Demand Charge



Note: The three-part rate includes a monthly fixed charge of $10, an energy charge of $0.060/kWh, and a demand charge of $9/kW. The revenue-neutral two-part rate includes a monthly fixed charge of $40 and an energy charge of $0.083/kWh.

- Correlation between bill impact and customer size is stronger with increased fixed charge
- Whether small customers are low income customers is another question entirely…

Can residential customers understand demand charges?

Anyone who has purchased a light bulb has encountered watts; ditto for anyone who has purchased a hair dryer or an electric iron

Customers often introduced to kWh's by way of kWs; e.g., if you leave on a 100 watt bulb for 10 hours, it will use 1,000 watt-hours, or one kWh

Similarly, if you run your hair dryer at the same time that someone else is ironing their clothes and lights are on in both bathrooms, the circuit breaker may trip on you since you have exceeded its capacity, expressed in kVA's or kW's

Customers don't need to be electricity experts to understand a demand charge

Responding to a demand charge does not require that the customers know exactly when their maximum demand will occur

If customers know to avoid the simultaneous use of electricity-intensive appliances, they could easily reduce their maximum demand without ever knowing when it occurs

This simple message should be stressed in customer marketing and outreach initiatives associated with the demand rate

Examples from utility websites

- APS: "Limit the number of appliances you use at once during on-peak hours"
- Georgia Power: "Avoid simultaneous use of major appliances. If you can avoid running appliances at the same time, then your peak demand would be lower. This translates to less demand on Georgia Power Company, and savings for you!

Staggering the use of a few key appliances could lead to significant demand reductions

Avg. Demand Over 15 min

Appliance	Avg. Demand (kW)	
Clothes Dryer	4.0	Flexible Load (18.5 kW)
Oven	2.0	
Stove	1.0	
Hand iron	0.5	
Central air conditioner	5.0	
Spa heater and filter	6.0	
Misc. plug loads	0.2	Inflexible Load (1 kW)
Lighting	0.3	
Refrigerator	0.5	
Total	19.5	

Comments

- Use of some of the appliances is inflexible (1 kW)
- Use of other appliances could be easily staggered to reduce demand
- Simply delaying use of the clothes dryer, oven, stove, and hand iron would reduce the customer's maximum demand by 7.5 kW
- This would bring the customer's maximum demand down to 12 kW, **a roughly 38% reduction in demand**

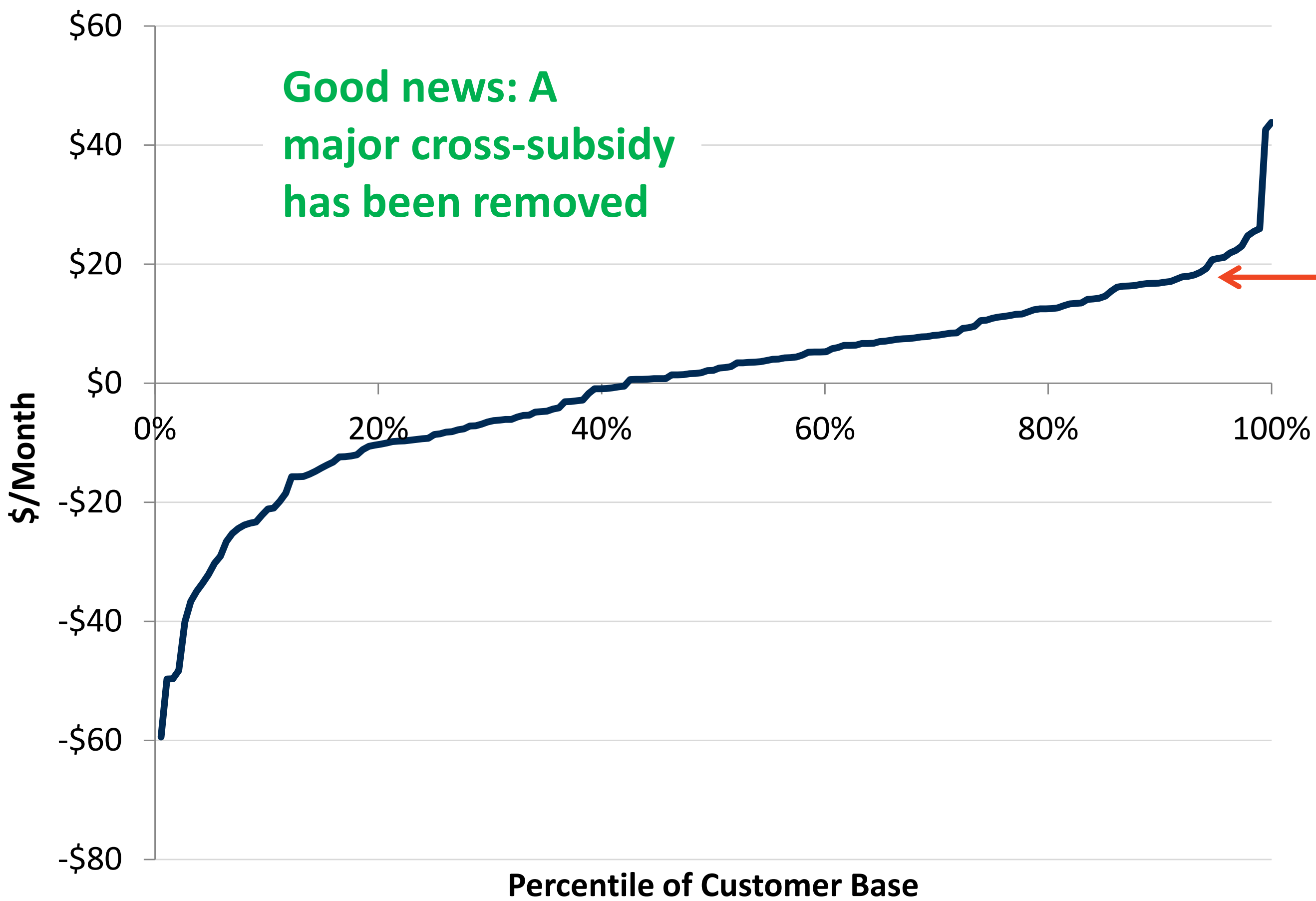
Making the Transition

Bonbright Reloaded for the 21st century

The ideal rate design should promote economic efficiency, enhance customer equity, ensure the financial health of the utility, be transparent to customers, and empower customer choice.

Changing to TVP will affect each customer's bill differently

Distribution of Bill Changes



Bad news: Some customers will experience bill increases

More good news: Transition plans help facilitate the change for these customers

Stakeholder concerns can be addressed through some new initiatives - I

Codify and learn from the experience of utilities that have deployed new rates in the US and in Europe

Quantify bill impacts, particularly for low- and moderate income customers

Assess customer understanding of the new rates through market research (interviews, focus groups and surveys) and identify the best way to communicate the concept and to design the rates

Stakeholder concerns can be addressed through some new initiatives - II

Assess customer response to new rates through a new generation of experiments whose design builds on insights gleaned from prior work on time-of-use pricing experiments

Study ways in which to mitigate financial impact on vulnerable customers, maybe by excluding them initially from the new rates, or by phasing in the rates, or by providing them financial assistance for installing energy efficiency measures

Conclusions

We are standing at the cusp of a revolution in rate design, driven by the arrival of the Internet of Things, the deployment of smart meters and the greening of consumers

Over the next three to five years, residential rates will begin evolving into three-part rates, featuring fixed charges, demand charges and time-varying energy charges

Energy-smart customers facing meaningful prices is a win-win for all

Videos

Georgetown University's CSIS. A 90-minute panel session on time-variant pricing. Washington, DC.

https://www.youtube.com/watch?v=0p6ZHaXszRQ

NYU School of Law. A day-long a conference on time-variation pricing as part of the REV Proceedings. New York, NY.

http://www.sallan.org/Sallan_In-the-Media/2015/04/rev_agenda_time_variant_p.php

Northwestern University's Kellogg Alumni Club. A two hour debate on the merits of dynamic pricing. San Francisco, CA.
https://vimeo.com/20206833

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Ahmad Faruqui is an internationally recognized expert on rate design. He has testified or appeared before regulatory bodies, governmental agencies, and legislatures in the US and abroad. The venues have included Alberta, Arizona, Australia, California, the District of Columbia, Connecticut, Illinois, Indiana, Maryland, Michigan, Minnesota, New Mexico, Oklahoma, Ontario and Saudi Arabia. Ahmad's academic, consulting and research activities have spanned four decades, during which time he has advised more than 125 clients in 34 states, the District of Columbia, and eleven countries. He has made the case for cost-based rates on six continents. Within the US, he has presented at the Goldman Sachs Power and Utility Conference, the EEI Rates Committee, NARUC and the New York ISO. His work has been cited in The Economist, The New York Times and the Washington Post. He has appeared on Fox Business News and NPR. He holds a doctorate in economics from the University of California at Davis, where he was a Regents Fellow, and baccalaureate and master's degrees from the University of Karachi, Pakistan, both with the highest honors.

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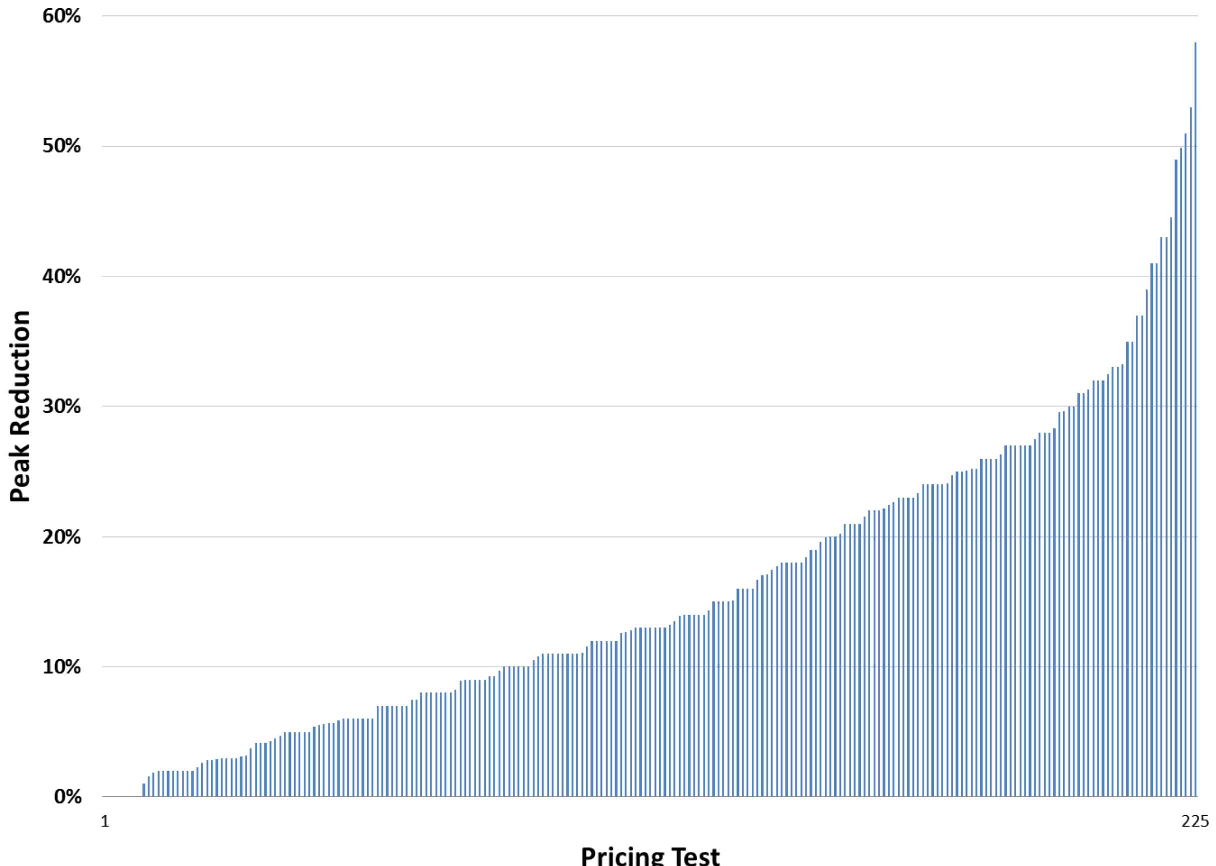
Appendix B:
Time Varying Prices

Seven misconceptions stand in the way of TVP, raising fears of a consumer revolt

1. Customers won’t respond to time varying prices
2. And if they do respond, their response is unpredictable
3. Enabling technologies don’t boost responsiveness
4. Customer response won’t persist
5. TVP violates ethical norms
6. Customers have never encountered TVP
7. Customers don’t want TVP

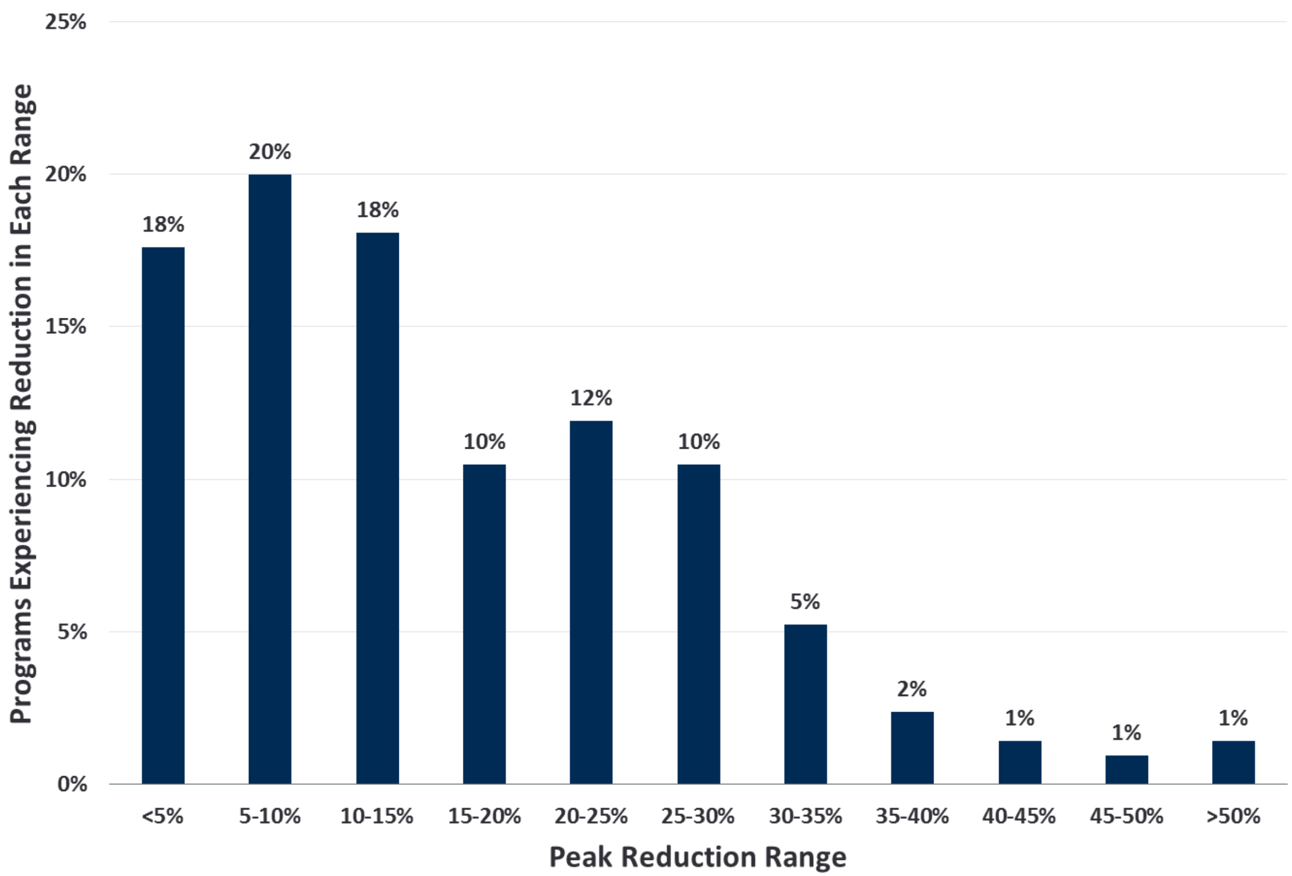
Myth #1: Customers won't respond to TVP

Because results vary widely, some conclude that we have learned nothing about customer response



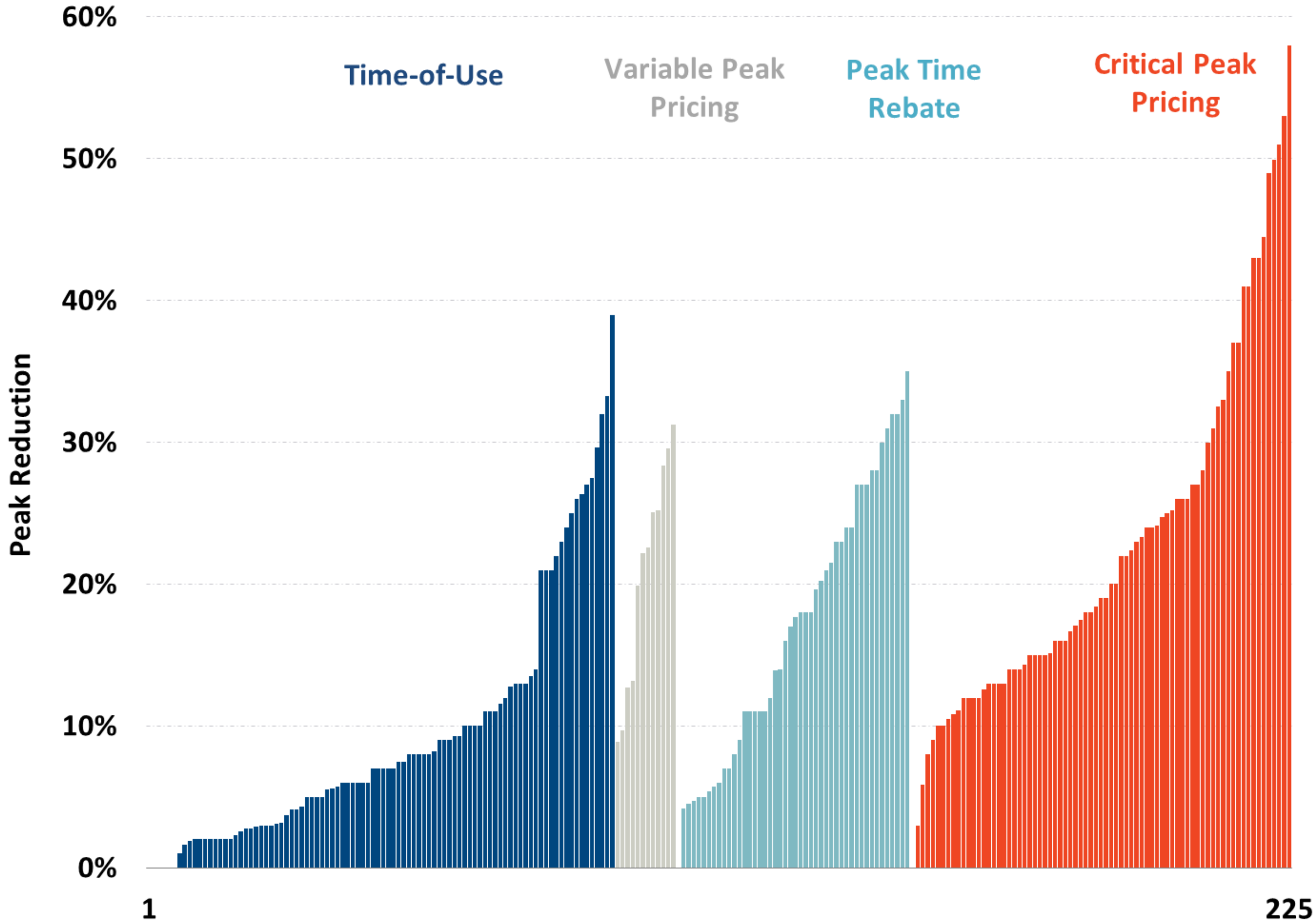
Source: Faruqui, Ahmad. "Arcturus." The Brattle Group.

60% of the tests have produced peak reductions of 10% or greater

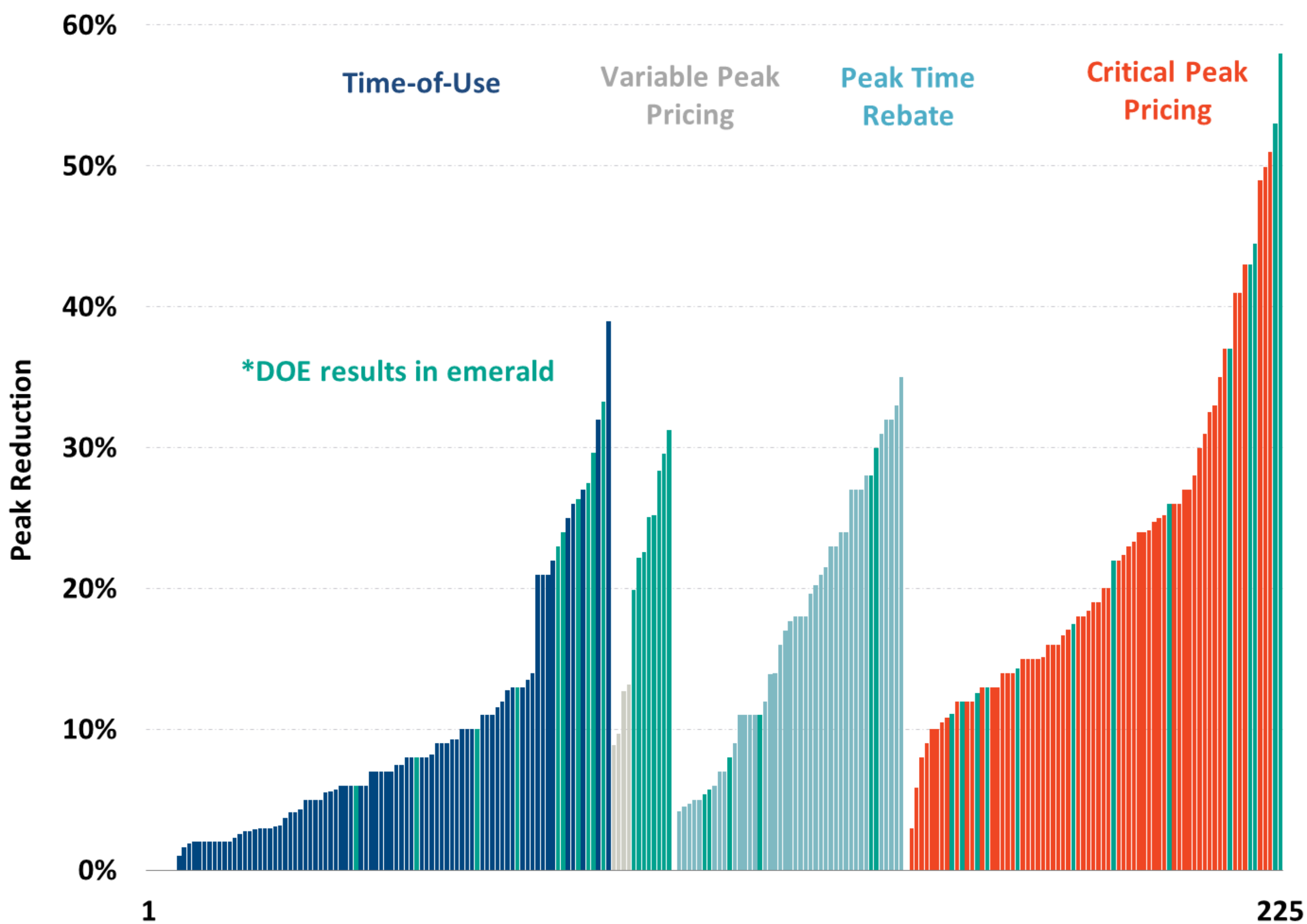


Source: Faruqui, Ahmad. "Arcturus." The Brattle Group.

Grouping results by tariff design helps explain some of the variation in impacts



Of the 225 treatments, 37 are part of tests carried out with support from DOE funding



The DOE treatments yield results that tend to be higher than those from other studies

Average Impacts Across Pilots

Rate	Average Impacts Without DOE	Average Impacts of DOE	Number of DOE Treatments	Total Number of Treatments
TOU	8.0%	20.1%	10	92
VPP	11.1%	25.5%	8	12
PTR	17.2%	14.7%	6	46
CPP	21.3%	28.0%	13	75

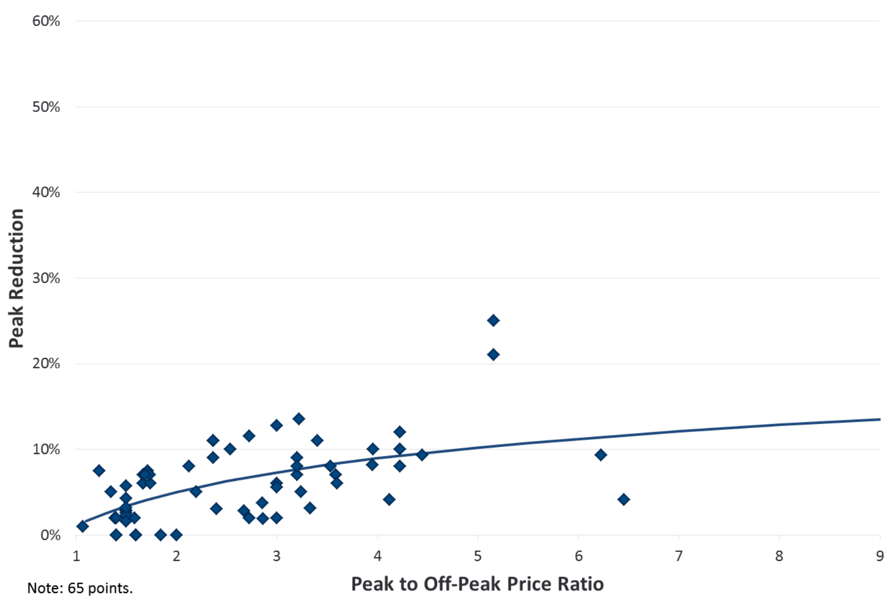
Myth #2: And if they do respond, their response is unpredictable

Not only do customers respond, but the magnitude of their response varies with the price incentive. The higher the incentive, the greater their demand response

To study this relationship between price incentive and peak energy reduction, we have estimated the Arc of Price Responsiveness. The Arc is based on 210 time-varying pricing treatments from around the world

We plot demand response against the peak to off-peak price ratio

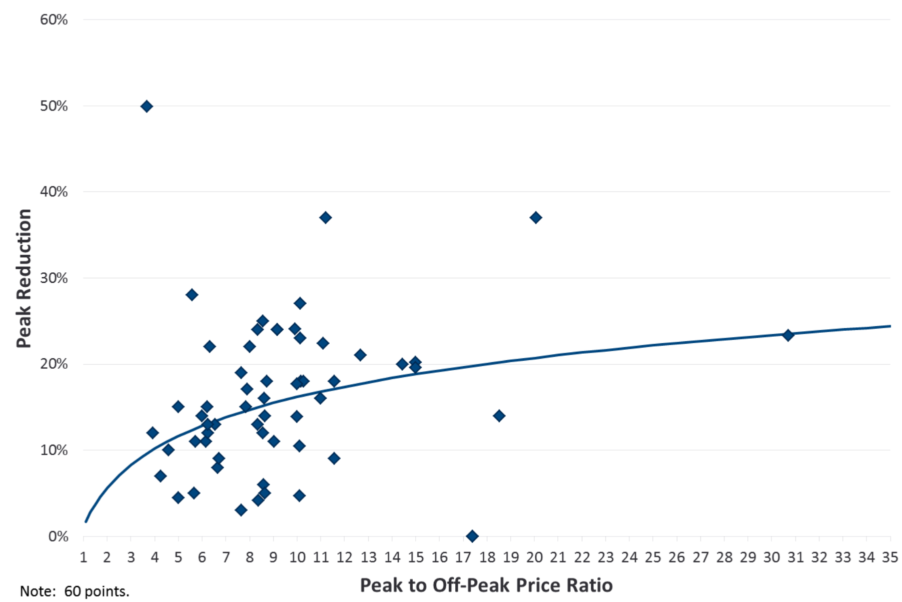
TOU Impacts (price only)



Note: 65 points.

Source: Faruqui, Ahmad. "Arcturus." The Brattle Group.

Dynamic Pricing Impacts (price only)



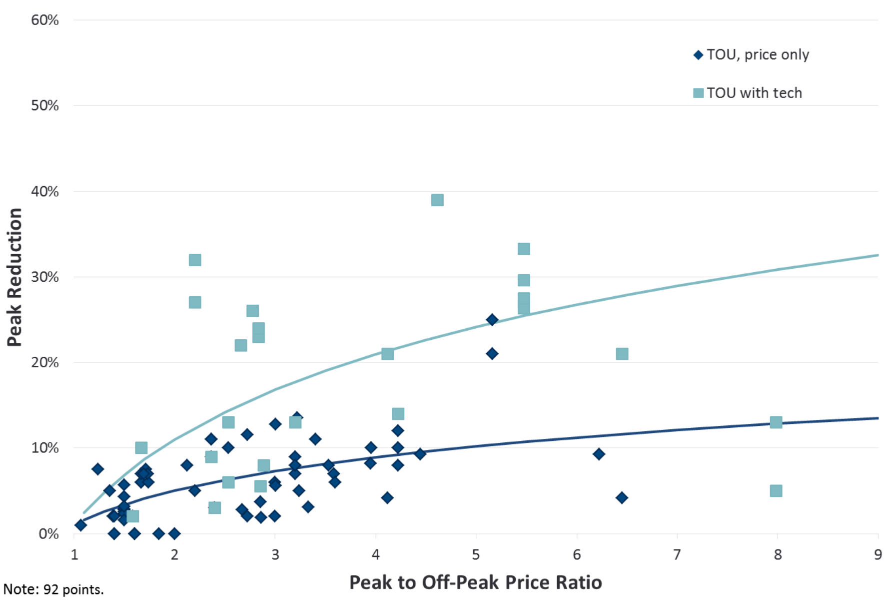
Note: 60 points.

Source: Faruqui, Ahmad. "Arcturus." The Brattle Group.

Myth #3: Enabling technologies don't boost demand response

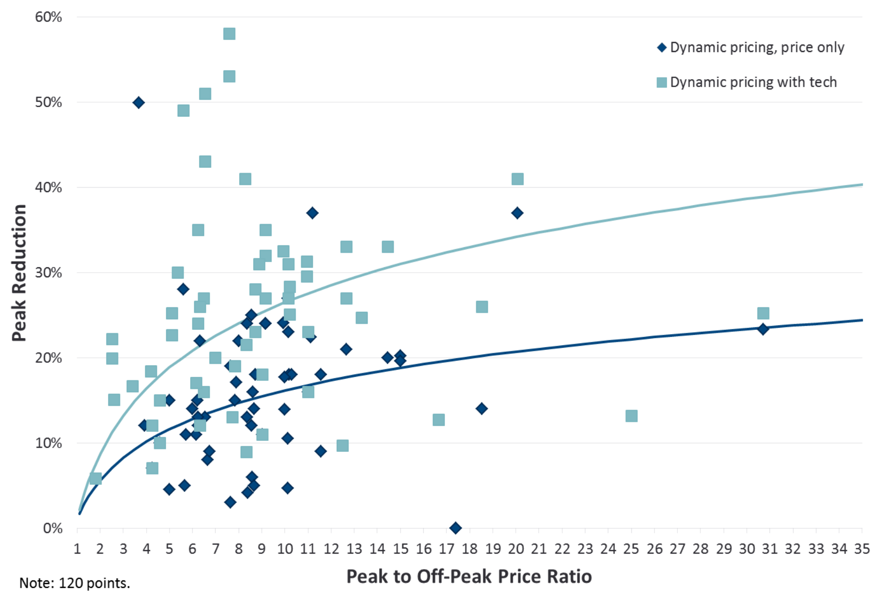
The data shows that enabling (i.e., self-actualized/automatic) technologies boost price responsiveness

TOU Impacts



Note: 92 points.
Source: Faruqui, Ahmad. "Arcturus." The Brattle Group.

Dynamic Pricing Impacts



Note: 120 points.
Source: Faruqui, Ahmad. "Arcturus." The Brattle Group.

Myth #4: Customer response won't persist

Customer response has persisted in long-lived pilots

- California, Washington, D.C., Oklahoma for 2 years
- Maryland for 4 years

TOU programs have been in place for decades

- The French *tempo* tariff goes back to 1965
- Arizona's TOU rates go back to 1980

Myth #5: TVP violates ethical norms

In 2011, Mark Toney of TURN argued that dynamic pricing will hurt low income customers at the Kellogg Alumni Club in San Francisco. https://vimeo.com/20206833

In 2010, an entire conference was devoted to the "ethics of dynamic pricing" at Rutgers University. It was videotaped and the key papers published in *The Electricity Journal*

In 1971, Columbia University's Nobel Prize winning economist William Vickrey stated that people shared the medieval notion of a just price and regarded prices that varied with demand-supply imbalances as evil

Myth #6: Customers have never encountered TVP

While that may have been true of that charming TV character, Archie Bunker, today's consumers experience TVP in routine transactions every day, except when it comes to their purchase of electricity

In the modern economy, TVP is pervasive. It is to be found in a wide range of industries: airlines, bridge tolls, freeway lanes, groceries, hotels, railroads, rental cars, sporting events, and theaters

Even the ubiquitous parking meter displays a form of TVP

Myth #7: Customers don't want TVP

Because customers don't ask for TVP, utilities/regulators assume they don't want TVP. Nobody ever asked for an iPhone, either.

Customers have reported high levels of satisfaction with dozens of TVP pilots and programs in Australia, California, Canada, District of Columbia, Connecticut, Ireland, Japan, Michigan, Maryland, Oklahoma, just to name a few

Contrary to popular expectation, in order to benefit from TVP, customers don't have to get up at 2 am to do their laundry

Most customers value the opportunity to save money by making small adjustments in their energy lifestyle

Appendix C:
Back to the future of rate design

Back to the future of rate design

Year	Author	Contribution
1882	Thomas Edison	• Electric light was priced to match the competitive price from gas light and not based on the cost of generating electricity
1892	John Hopkinson	• Suggested a two–part tariff with the first part based on usage and the second part based on connected demand
1894	Arthur Wright	• Modified Hopkinson's proposal so that the second part would be based on actual maximum demand
1897	Williams S. Barstow	• Proposed time-of-day pricing at the 1898 meeting of the AEIC, where his ideas were rejected in favor of the Wright system
1946	Ronald Coase	• Proposed a two-part tariff, where the first part was designed to recover fixed costs and the second part was designed to recover fuel and other costs that vary with the amount of kWh sold
1951	Hendrik S. Houthakker	• Argued that implementing a two-period TOU rate is better than a maximum demand tariff because the latter ignores the demand that is coincident with system peak
1961	James C. Bonbright	• Laid out his famous Principles of Public Utility Rates

Back to the future (concluded)

Year	Author	Contribution
1971	William Vickrey	• Fathered the concept of real-time-pricing (RTP) in *Responsive Pricing of Public Utility Services*
1976	California Legislature	• Added a baseline law to the Public Utilities Code in the *Warren-Miller Energy Lifeline Act*
1978	U.S. Congress	• Passed the *Public Utility Regulatory Act (PURPA),* which called on all states to assess the cost-effectiveness of TOU rates
1981	Fred Schweppe	• Described a technology-enabled RTP future in *Homeostatic Control*
2001	California Legislature	• Introduced *AB 1X,* which created the five-tier inclining block rate where the heights of the tiers bore no relationship to costs. By freezing the first two tiers, it ensured that the upper tiers would spiral out of control
2001	California PUC	• Began rapid deployment of California Alternative Rates for Energy (CARE) to assist low-income customers during the energy crisis
2005	U.S. Congress	• Passed the *Energy Policy Act of 2005*, which requires all electric utilities to offer net metering upon request

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