

# Residential Rates for the Utility of the Future

## **PRESENTED TO**

Alternative Rate Design Stakeholder Process for Xcel Energy

## **PRESENTED BY**

Ahmad Faruqui, Ph. D.

With contributions from Ryan Hledik and Phil Hanser

May 13, 2016



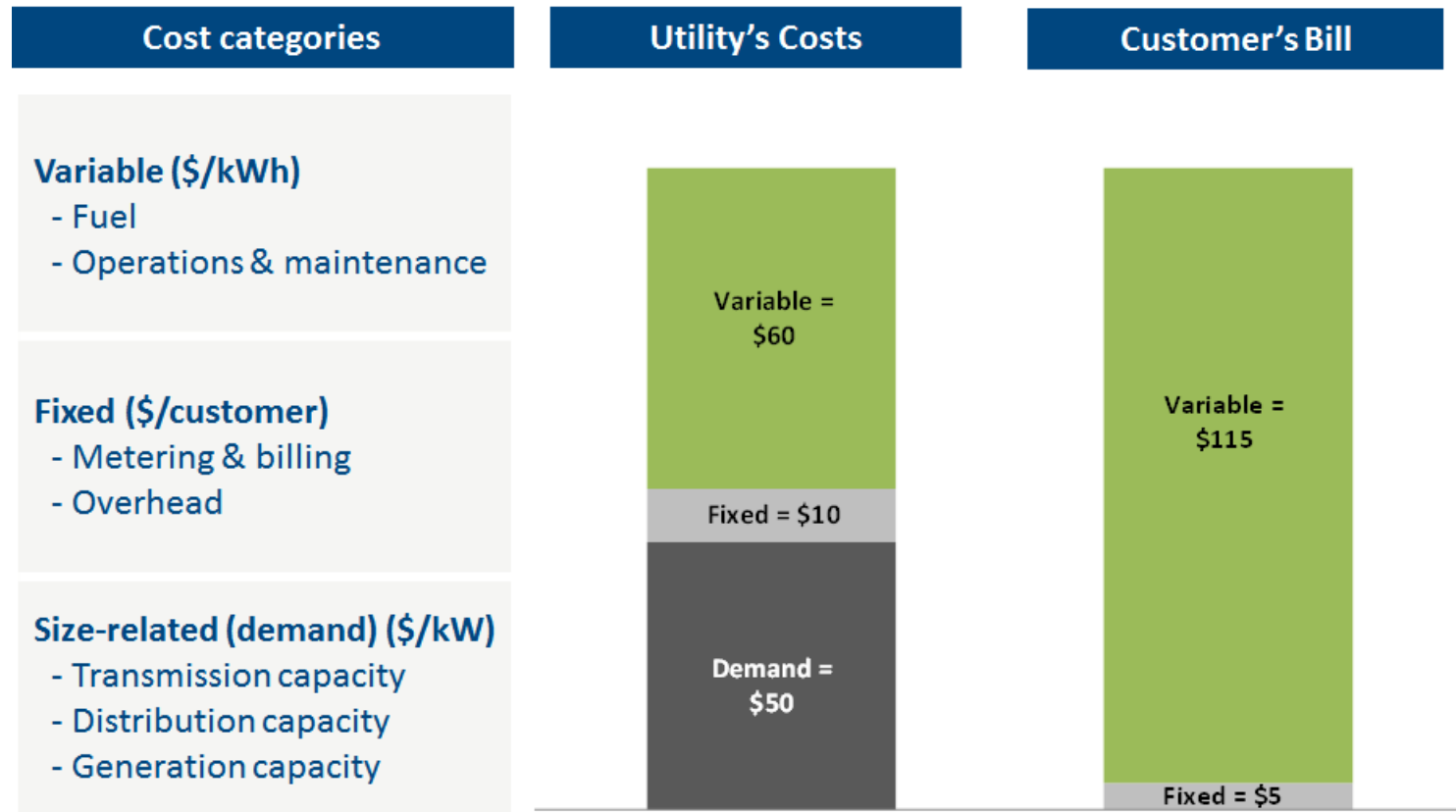
# Residential rate design is ripe for rethinking

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**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



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

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**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)**

# Residential technology is changing and demand flexibility will soon be the norm

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**Digital technology is becoming ubiquitous (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**

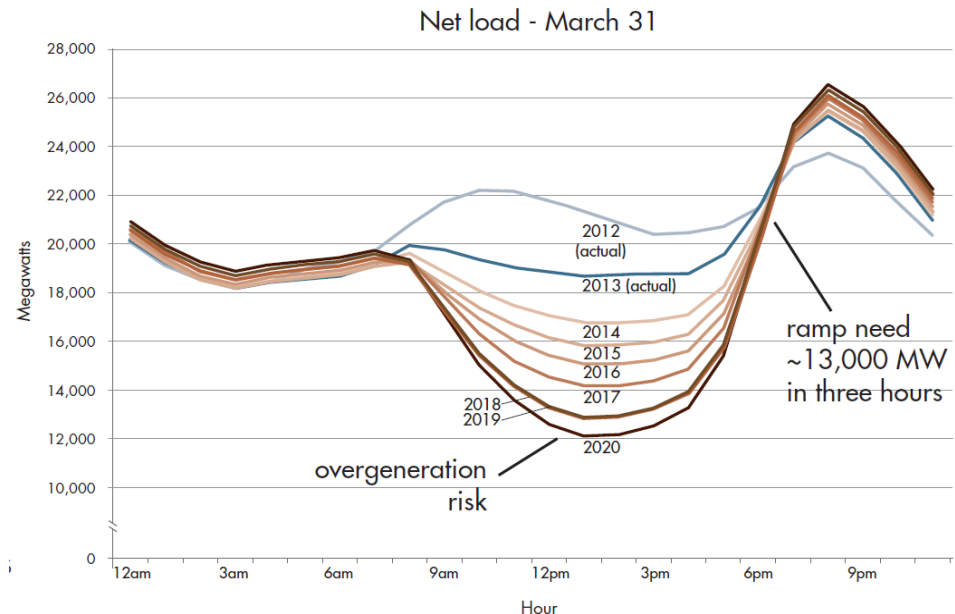
**MIT's Fred Schweppe called this "homeostatic control" in 1981**

# However, 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”



# Several new flavors are being considered

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- 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

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## 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**

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**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

# But the story does not end with TVP, it just begins with it

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**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 (C&I) customers, backed up by a long series of papers dating back to Hopkinson and Wright (see Appendix A and C)
- TVP of energy does not eliminate the need for demand charges; Georgia Power has 2,200 C&I customers on real time pricing but these customers still face a demand charge for their use of the grid. [https://www.georgiapower.com/docs/rates-schedules/marginally-priced/6.20 RTP-DA.pdf](https://www.georgiapower.com/docs/rates-schedules/marginally-priced/6.20_RTP-DA.pdf)
- Facility-based demand charges will persist in California even when CPP is rolled out for C&I customers

# Three part rates convey a cost-based price signal

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## Utilities that supply energy would use a five-part rate

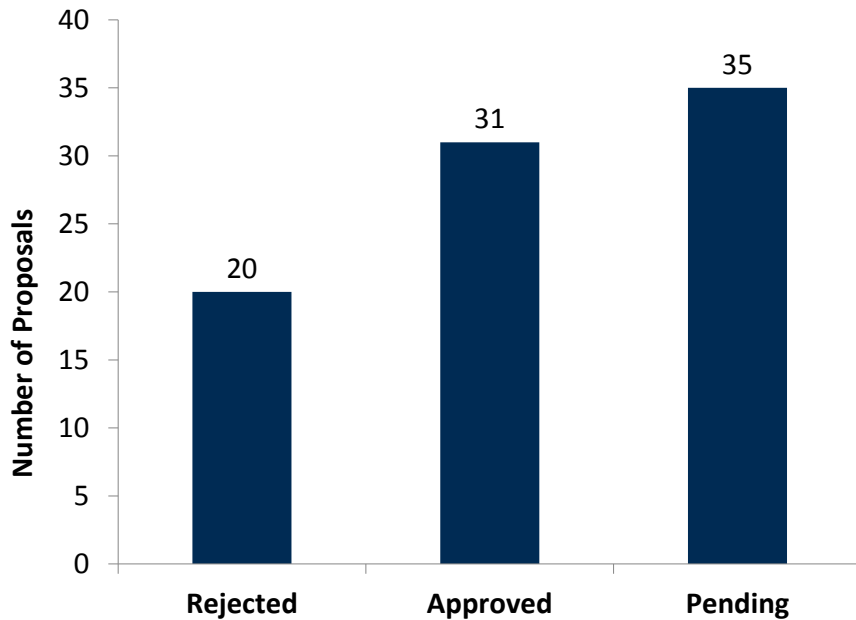
- Monthly service charge
- Charge for connected load (or maximum customer demand)
- Maximum demand charge (coincident with the distribution peak)
- Charge for generation capacity
- Time-varying energy charge

## Distribution-only utilities would use a three-part rate

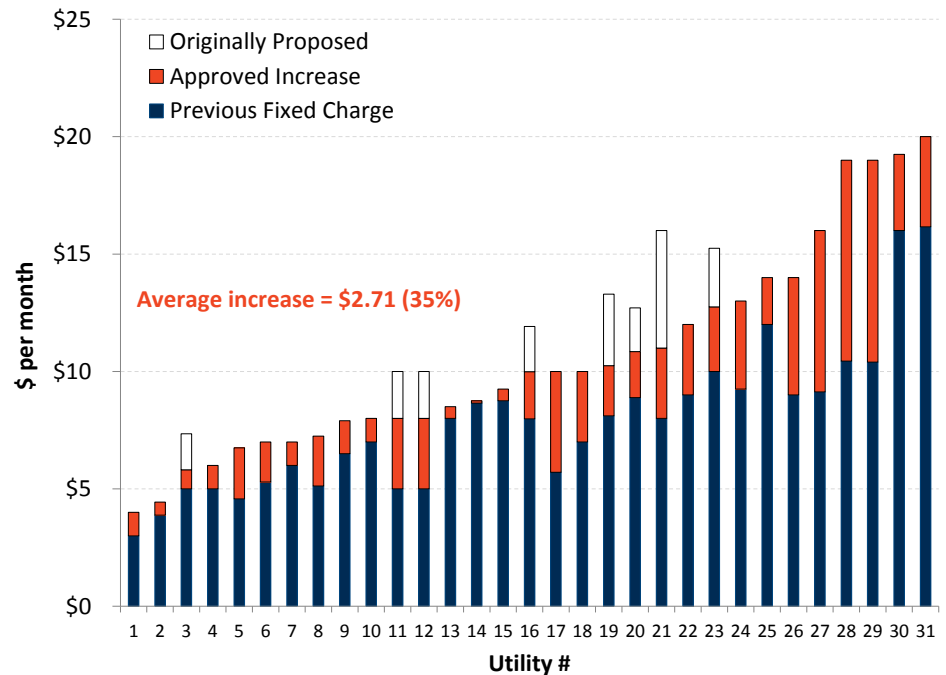
- Monthly service charge
- Charge for connected load (or maximum customer demand)
- Maximum demand charge (coincident with the distribution peak)

# Many utilities have proposed to increase the fixed charge and stick with a two-part rate

## 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**

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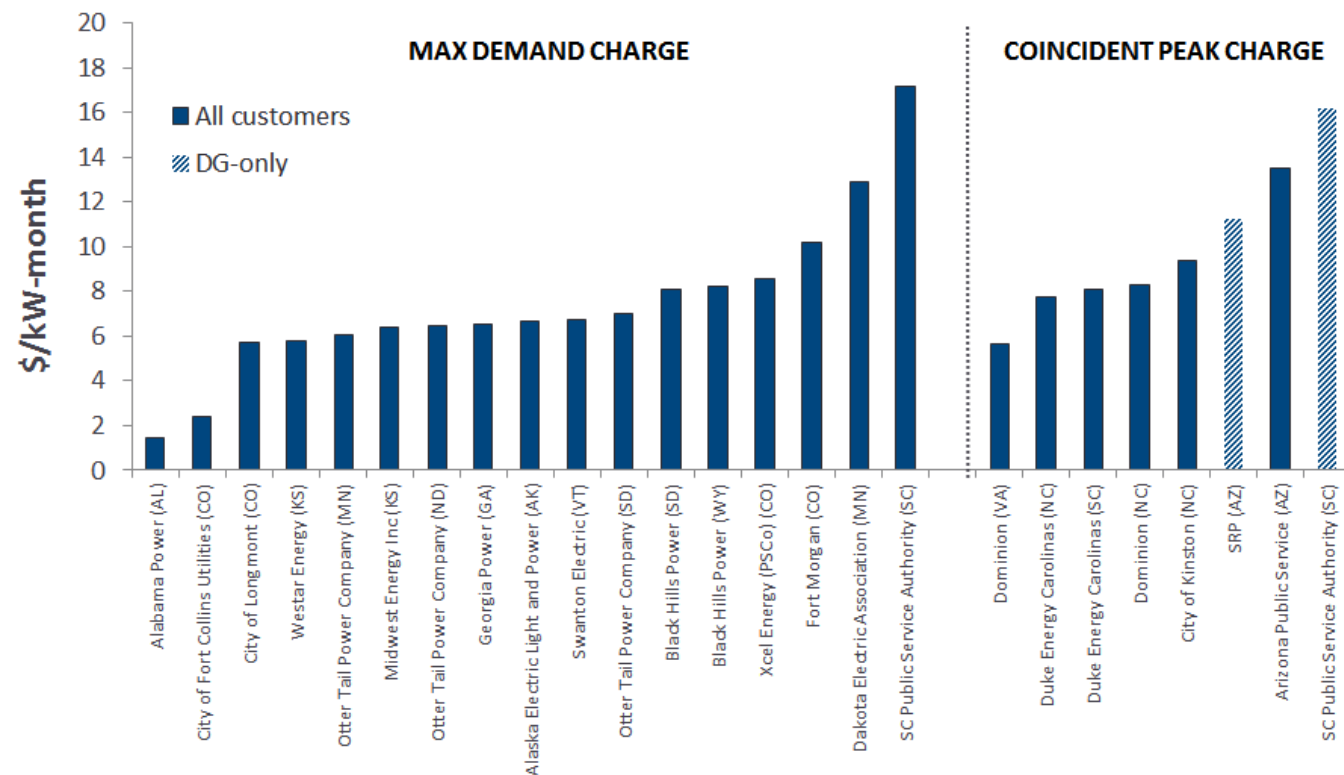
**In the absence of advanced metering infrastructure (AMI), rate design options for addressing the cost-shift issues associated with DG adoption and volumetric rates are somewhat limited**

**Fixed charges are one option for addressing the cost-shift issue and do 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**

# Many utilities are considering demand charges, which are already being offered by some others

## Summer Demand Charges in Existing Rates



## Comments

- 19 utilities offer residential demand charges, 10 of which are IOUs
- They have been proposed in Arizona, Kansas, Illinois, Nevada, and Oklahoma

### 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.

# Can residential customers understand demand charges?

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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 kW's; 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

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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	Inflexible Load (1 kW)
Misc. plug loads	0.2	
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**

# Bonbright Reloaded for the 21<sup>st</sup> century

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*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.*

# **Stakeholder concerns can be addressed through some new initiatives - I**

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**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

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**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

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**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**

**When energy-smart customers face cost-based prices, a win-win outcome that emphasizes economic efficiency and restores equity among customers will become increasingly likely**

# Presenter Information

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Ahmad Faruqui is an economist whose consulting practice is focused on the efficient use of energy. His areas of expertise include rate design, demand response, energy efficiency, distributed energy resources, advanced metering infrastructure, plug-in electric vehicles, energy storage, inter-fuel substitution, combined heat and power, microgrids, and demand forecasting. He has worked for more than a hundred clients on five continents. These include electric and gas utilities, state and federal commissions, independent system operators, government agencies, trade associations, research institutes, and manufacturing companies. Ahmad has testified or appeared before commissions in Alberta (Canada), Arizona, Arkansas, California, Colorado, Connecticut, Delaware, the District of Columbia, FERC, Illinois, Indiana, Kansas, Maryland, Minnesota, Nevada, Ohio, Oklahoma, Ontario (Canada), Pennsylvania, ECRA (Saudi Arabia), and Texas. He has presented to governments in Australia, Egypt, Ireland, the Philippines, Thailand and the United Kingdom and spoken at energy seminars on all six continents. His research on the energy behavior of consumers has been cited in Business Week, The Economist, Forbes, National Geographic, The New York Times, the San Francisco Chronicle, the San Jose Mercury News, the Wall Street Journal and USA Today. He has appeared on Fox Business News, National Public Radio and Voice of America. He is the author, co-author or editor of four books and more than 150 articles, papers and reports on energy matters. His work has appeared in peer-reviewed journals such as Energy Economics, Energy Journal, Energy Efficiency, and the Journal of Regulatory Economics and trade journals such as The Electricity Journal and the Public Utilities Fortnightly. He holds bachelors and masters degrees from the University of Karachi and a doctorate in economics from The University of California at Davis.

The views expressed in this presentation are strictly those of the presenter(s) and do not necessarily state or reflect the views of The Brattle Group.

# Appendix A: References

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# **Appendix B: Time Varying Prices**

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

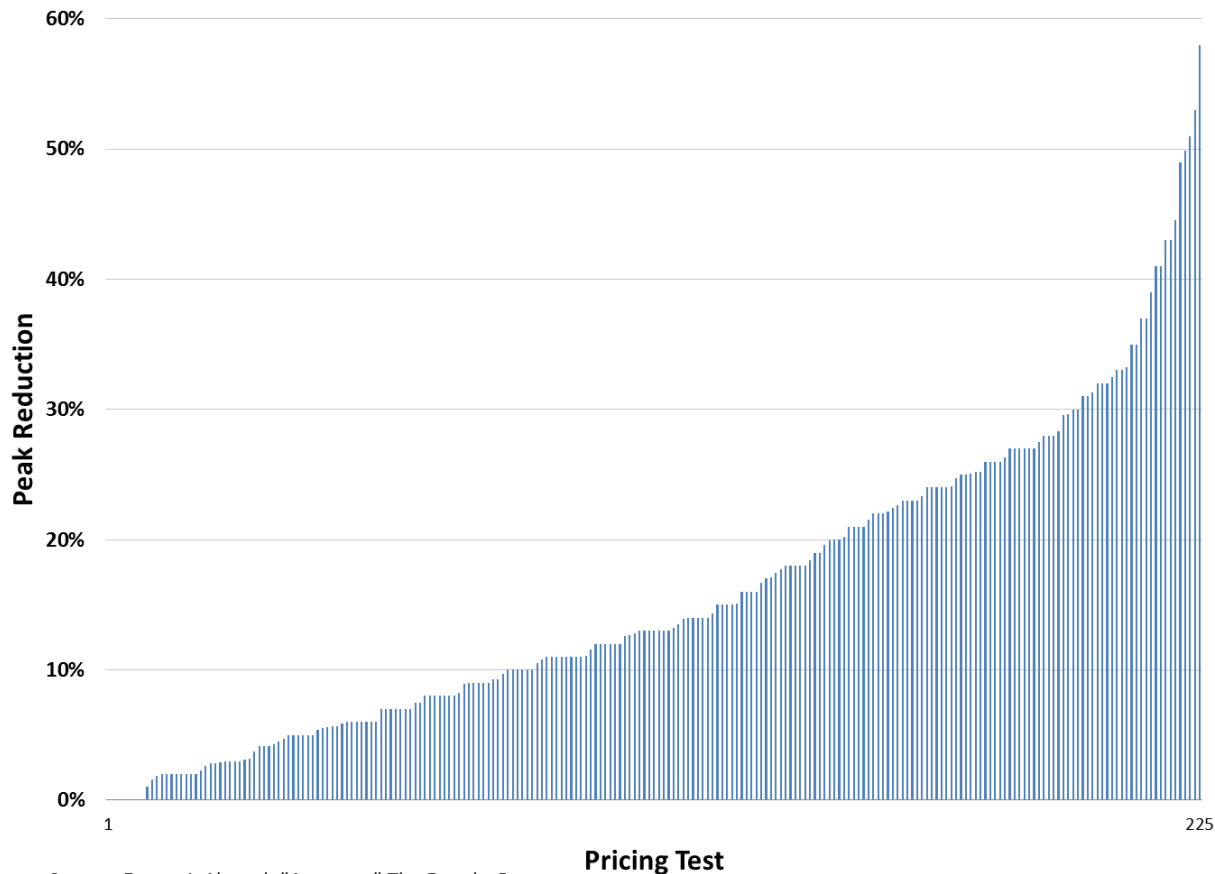
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1. Customers won't respond to time varying prices
2. And if they do respond, their response is unpredictable
3. Enabling technologies don't boost responsiveness
4. Customer response won't persist
5. TVP violates **ethical norms**
6. Customers have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

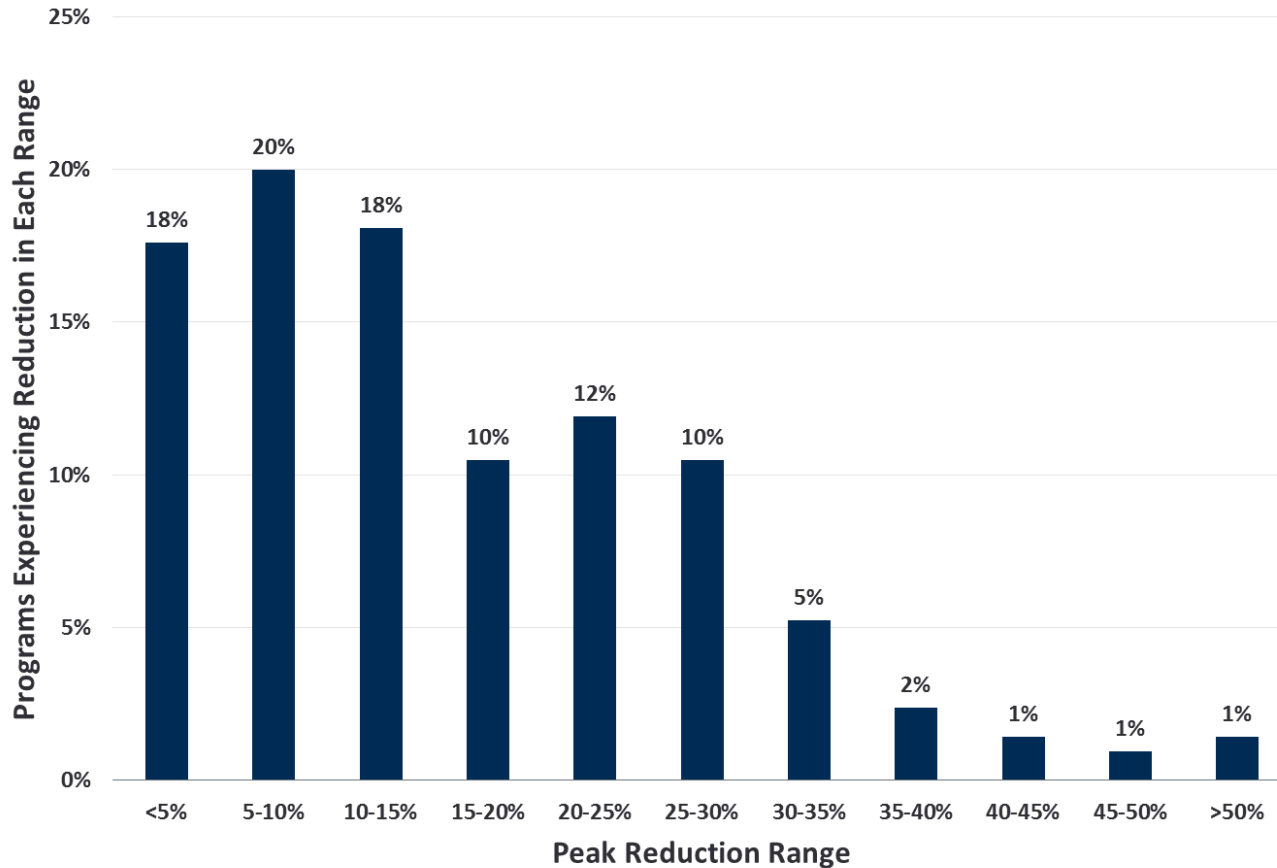


# Myth #1: Customers won't respond to TVP

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

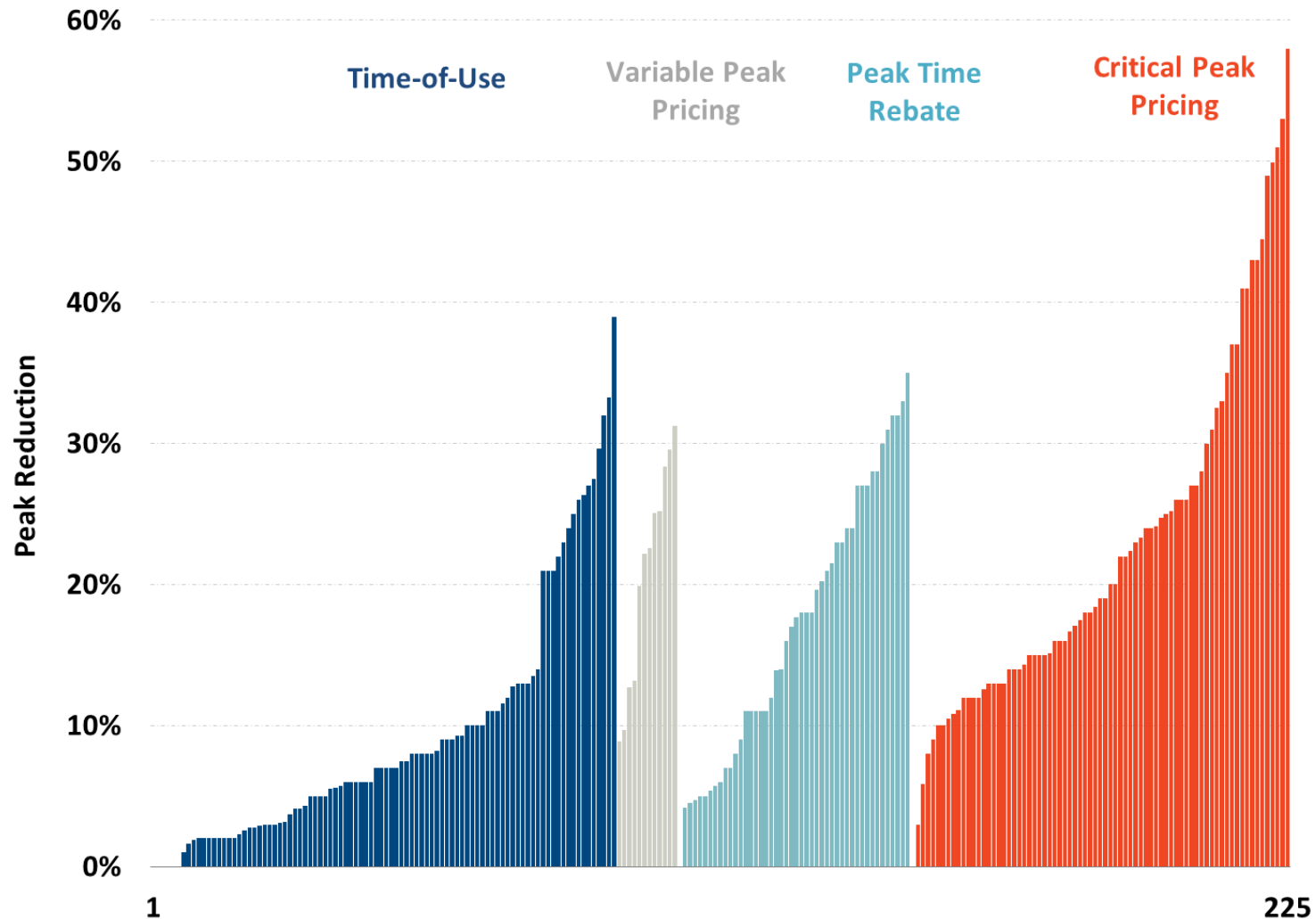


# 60% of the tests have produced peak reductions of 10% or greater

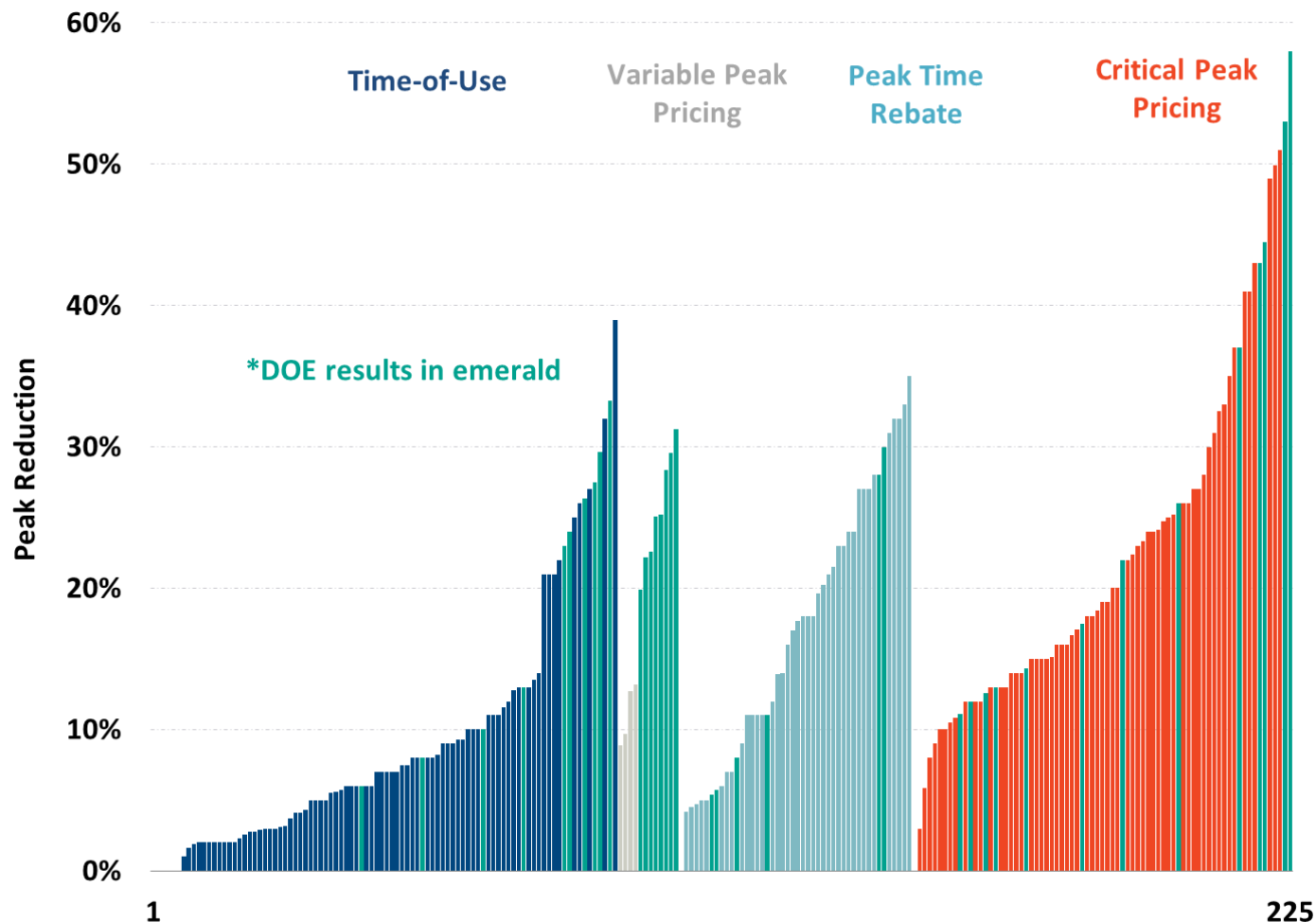


Source: Faruqi, Ahmad. "Arcturus." The Brattle Group.

# 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

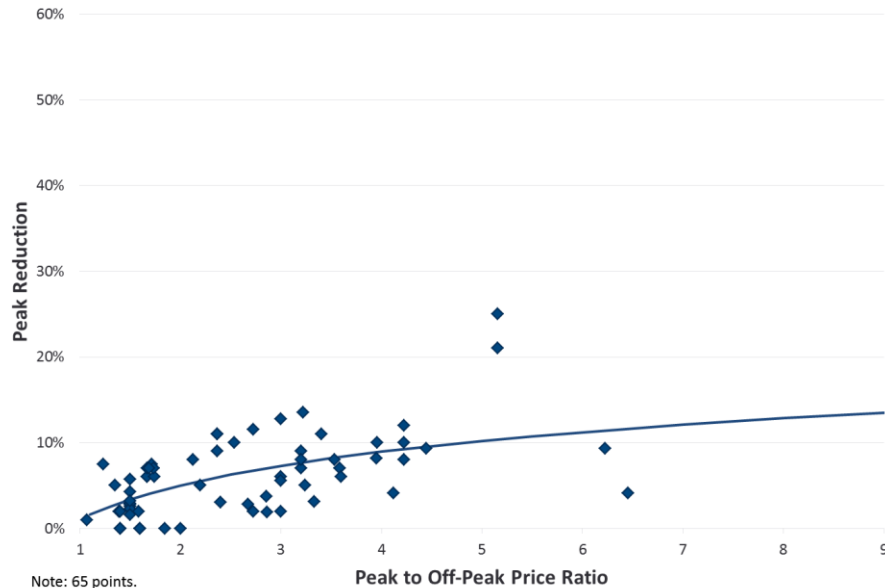
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Not only do customers respond, but the magnitude of their response varies with the price incentive. The higher the incentive, the greater their demand response

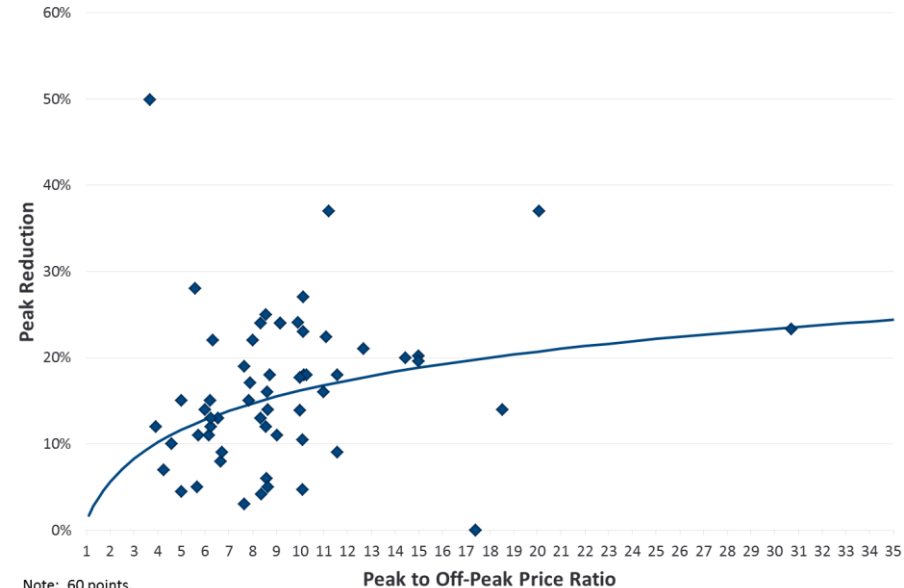
To study this relationship between price incentive and peak energy reduction, we have estimated the Arc of Price Responsiveness. The Arc is based on **210** time-varying pricing treatments from around the world

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

## TOU Impacts (price only)



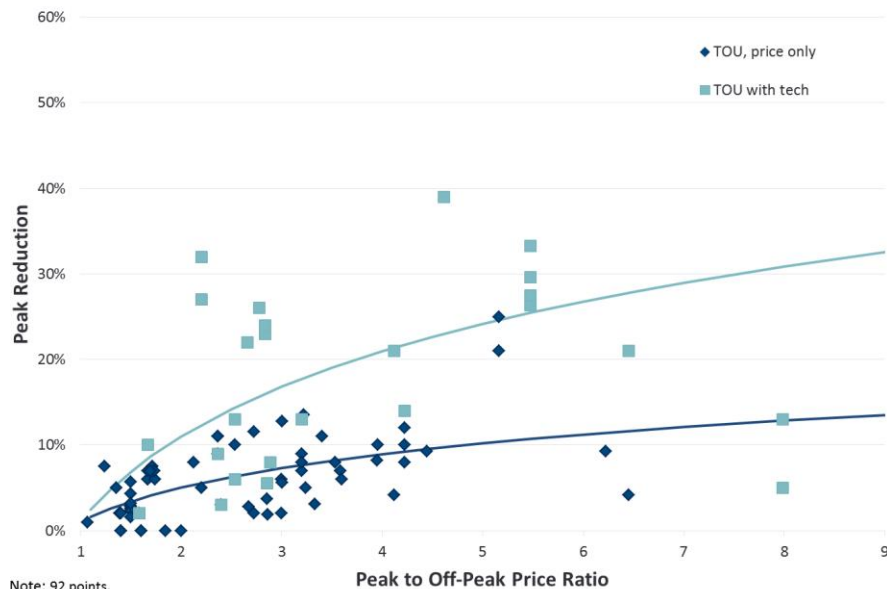
## Dynamic Pricing Impacts (price only)



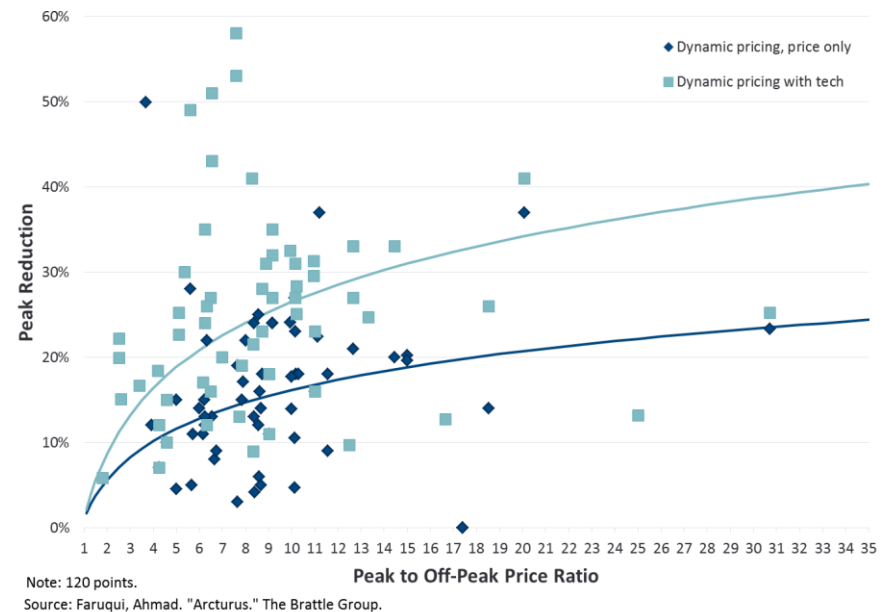
# Myth #3: Enabling technologies don't boost demand response

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

## TOU Impacts



## Dynamic Pricing Impacts





# Myth #4: Customer response won't persist

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## 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

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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**

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**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**

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**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**

# Videos

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**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](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>

# **Appendix C:**

## **Back to the future of rate design**

# Back to the future of rate design

Year	Author	Contribution
1882	Thomas Edison	<ul style="list-style-type: none"><li>Electric light was priced to match the competitive price from gas light and not based on the cost of generating electricity</li></ul>
1892	John Hopkinson	<ul style="list-style-type: none"><li>Suggested a two-part tariff with the first part based on usage and the second part based on connected demand</li></ul>
1894	Arthur Wright	<ul style="list-style-type: none"><li>Modified Hopkinson's proposal so that the second part would be based on actual maximum demand</li></ul>
1897	Williams S. Barstow	<ul style="list-style-type: none"><li>Proposed time-of-day pricing at the 1898 meeting of the AEIC, where his ideas were rejected in favor of the Wright system</li></ul>
1946	Ronald Coase	<ul style="list-style-type: none"><li>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</li></ul>
1951	Hendrik S. Houthakker	<ul style="list-style-type: none"><li>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</li></ul>
1961	James C. Bonbright	<ul style="list-style-type: none"><li>Laid out his famous Principles of Public Utility Rates</li></ul>

# Back to the future (concluded)

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Year	Author	Contribution
1971	William Vickrey	<ul style="list-style-type: none"><li>Fathered the concept of real-time-pricing (RTP) in <i>Responsive Pricing of Public Utility Services</i></li></ul>
1976	California Legislature	<ul style="list-style-type: none"><li>Added a baseline law to the Public Utilities Code in the <i>Warren-Miller Energy Lifeline Act</i></li></ul>
1978	U.S. Congress	<ul style="list-style-type: none"><li>Passed the <i>Public Utility Regulatory Act (PURPA)</i>, which called on all states to assess the cost-effectiveness of TOU rates</li></ul>
1981	Fred Schweppe	<ul style="list-style-type: none"><li>Described a technology-enabled RTP future in <i>Homeostatic Control</i></li></ul>
2001	California Legislature	<ul style="list-style-type: none"><li>Introduced <i>AB 1X</i>, 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</li></ul>
2001	California PUC	<ul style="list-style-type: none"><li>Began rapid deployment of California Alternative Rates for Energy (CARE) to assist low-income customers during the energy crisis</li></ul>
2005	U.S. Congress	<ul style="list-style-type: none"><li>Passed the <i>Energy Policy Act of 2005</i>, which requires all electric utilities to offer net metering upon request</li></ul>



# About Brattle

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**The Brattle Group provides consulting and expert testimony in economics, finance, and regulation to corporations, law firms, and governments around the world. We aim for the highest level of client service and quality in our industry.**

**We are distinguished by our credibility and the clarity of our insights, which arise from the stature of our experts, affiliations with leading international academics and industry specialists, and thoughtful, timely, and transparent work. Our clients value our commitment to providing clear, independent results that withstand critical review.**

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