

MODERNIZING DISTRIBUTION TARIFFS FOR HOUSEHOLDS

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PRESENTED BY
Ahmad Faruqui, Ph. D.

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THE **Brattle** GROUP



Distribution tariffs today are no different than those of the last century

The “classic” tariff structure is phenomenally simple

1. a monthly fixed charge
2. a flat (non-time varying) energy charge

The bulk of distribution revenue comes from the kWh charge, even though the bulk of distribution costs do not vary with the energy flowing through the wires

This tariff structure is predicated on three assumptions

1. Households cannot understand any other tariff design
2. Households have dumb meters
3. Networks cannot handle any other tariff design

Utilities have begun modernizing tariffs in North America

Ontario, Canada: Flat bill applies for distribution, Time-of-Use (TOU) charge for default energy supply

Arizona: 20% of customers on opt-in demand charges for one utility; mandatory demand charges for DG customers for another utility; TOU energy rates popular for both

California: Mandatory TOU rates plus minimum bill for DG customers; Moving all other customers to default TOU in 2019/20; SMUD has already begun moving its customers to default TOU; LADWP has introduced a fixed monthly charge that varies with customer kWh usage

Tariff modernization in North America (continued)

Colorado: Fort Collins moved all customers to mandatory TOU rates last month

Idaho: DG customers have been designated a separate rate class

Kansas: Mandatory three-part rates for DG customers; opt-in for others

Montana: Utility has filed for designating DG customers as a separate rate class and for moving them to mandatory three-part rates

Tariff modernization in North America (concluded)

New York: Considering moving DG customers to demand charges or TOU energy rates or a combination

Oklahoma: 20% of customers on a dynamic pricing rate with smart thermostats

Texas: Considering moving distribution charges to a flat bill, similar to Ontario's

Tariff modernization in Great Britain

UK Power Networks in London is piloting a peak time rebate (PTR) targeted specifically at low-income customers

A couple of pilots have tested other types of time-varying rates

- One rate featured a “wind twinning” tariff, which was intended to encourage consumption increases/decreases at times of unexpectedly high/low output from wind generation
- Some of the rates tested were dynamic in nature

Ofgem, the regulator, is examining new ways to increase the role of price responsive demand, including the possible introduction of Amazon and Google

Tariff modernization in Great Britain (concluded)

13% of customers are on a TOU rate (Economy 7) designed for customers with thermal energy storage

- The rate that has been offered for many years, is based on old technology, and the number of participants is in decline but provides a conclusive evidence of customer acceptance and response to time-varying tariffs

A start-up retailer has introduced a TOU tariff with a strong price signal

British Gas offers a FreeTime tariff, which allows customers to pick one weekend day during which their electricity is free

A pilot tested the “Sunshine Tariff,” which charged a lower price during mid-day hours to alleviate local distribution system constraints due to net excess solar generation

Tariff modernization in Hong Kong

CLP Power ran a pilot with peak-time rebates (PTR) for its residential customers

The pilot found that customers understand price incentives and respond to them

The utility, which has universal deployment of smart meters, has begun deploying PTR to several thousand customers

Tariff modernization in the EU

Millions of customers in Spain are on a real-time pricing tariff, which represents the default energy supply option

In Estonia, real-time pricing is also the default energy supply option and thousands of customers have elected to take power on it

In Italy, millions of customers are on a default time-of-use rate

Some general themes have begun to emerge

Modern tariff designs are being introduced throughout the globe

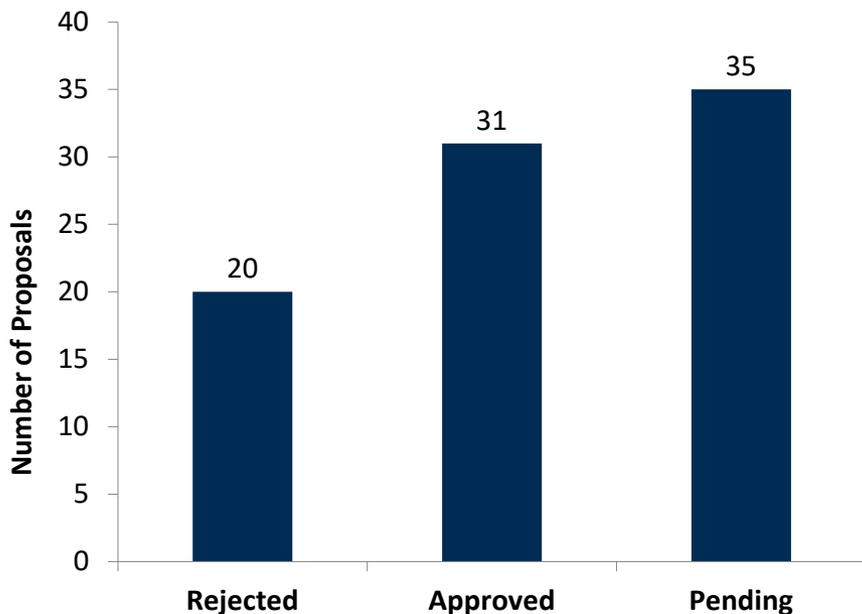
Customers understand modern tariffs and respond to them, enhancing economic efficiency in the use of scarce financial and energy resources, and promoting equity between customers

Modern tariff design encompasses three elements: time-varying energy rates, demand charges to recover capacity costs, and fixed charges to recover the costs of “revenue cycle” services

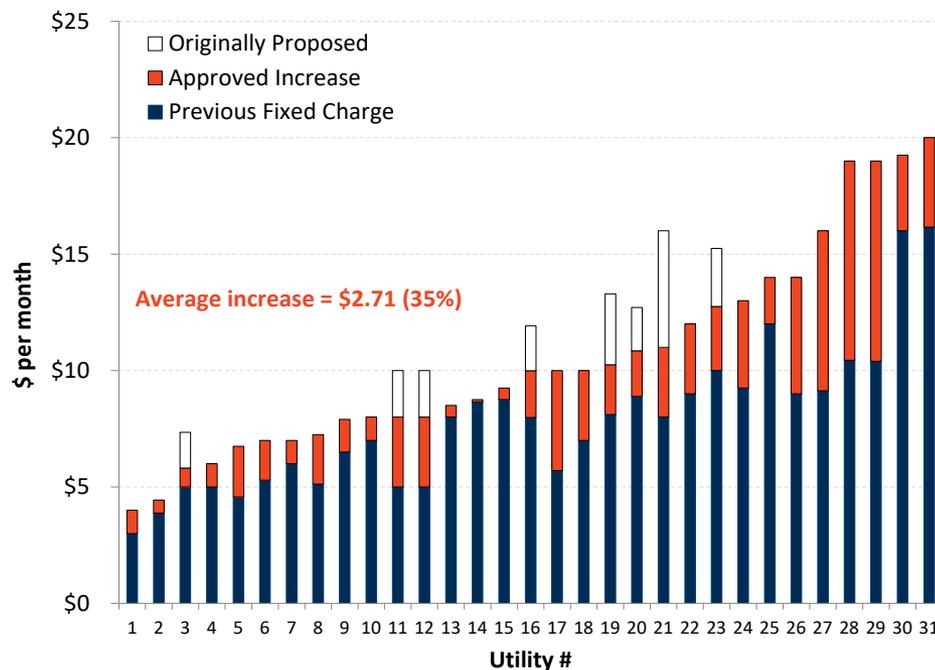
There is a desire to move Fixed Charges closer to fixed costs

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

Recent Proposals to Increase Fixed Charge



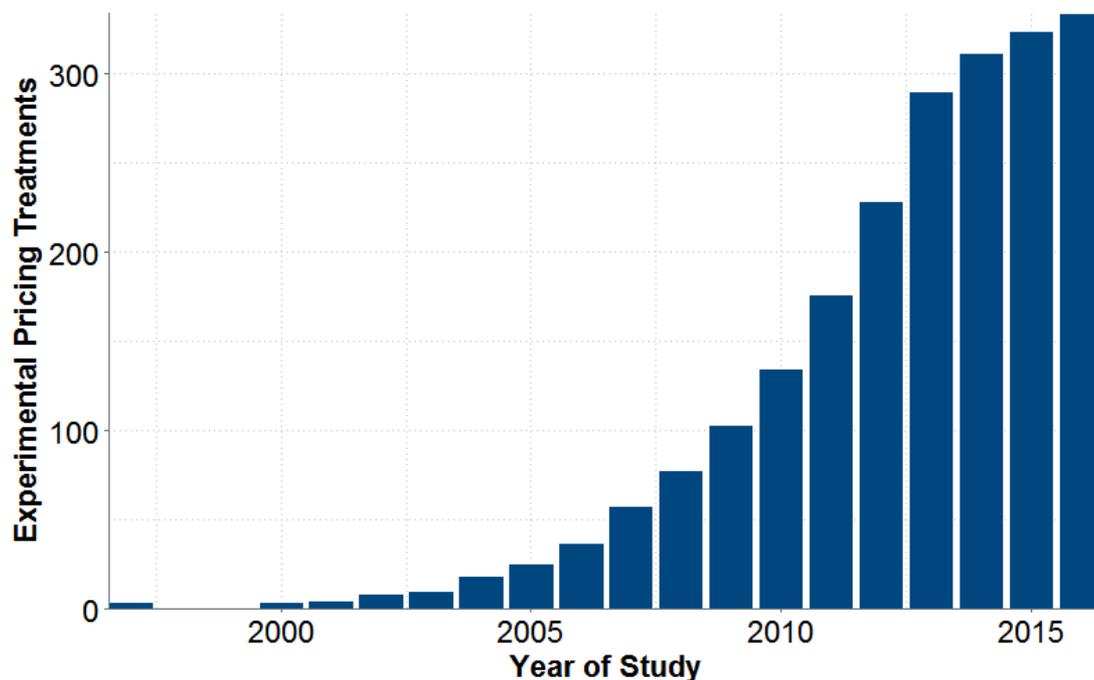
Amount of Approved Increase



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

There is a mountain of evidence that customers respond to tariff structures

At least nine countries spanning four continents have tested more than 300 time-varying rates in 62 pilots



Source: Ahmad Faruqui, Sanem Sergici, and Cody Warner, "Arcturus 2.0: International Evidence on Time-Varying Rates," *The Electricity Journal*, 2017.

The magnitude of demand response varies by price ratio and rate design

Pilots feature a combination of rate designs

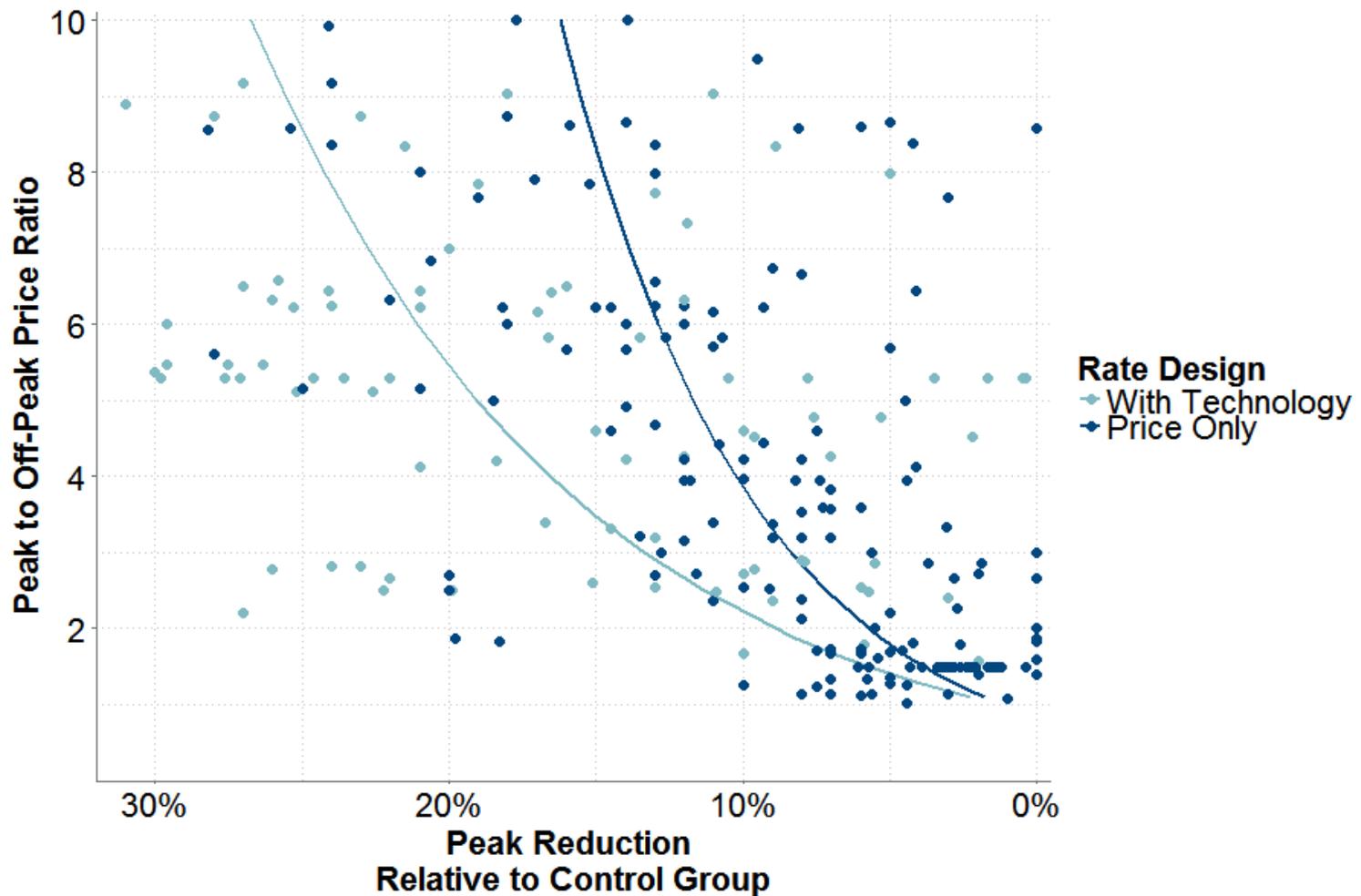
- Time-of-use, critical-peak pricing, peak-time rebates, and variable-peak pricing

On average, residential customers reduce their on-peak usage by 6.5% for every 10% increase in the peak-to-off-peak price ratio

In the presence of enabling technology, such as smart thermostats, the effect is stronger

- On average, customers enrolled on time-varying rates that offer enabling technologies reduce peak usage by 11.1% for every 10% increase in the price ratio

Price responsiveness follows a downward-sloping demand curve



Source: Ahmad Faruqui, Sanem Sergici and Cody Warner, "Arcturus 2.0: A Meta-Analysis of Time-Varying Rates for Electricity," The Electricity Journal, 2017.

Demand charges

Capacity charges based on the size of the connection are mandatory for residential customers in France, Italy, and Spain

Demand charges are being offered by more than 30 utilities in the United States, including a few rural cooperatives

Utilities such as Arizona Public Service, NV Energy, and Westar Energy have filed applications to make them a mandatory tariff for customers with PVs on their roof

- Salt River Project in Arizona, a municipally owned system, has instituted a mandatory tariff for DG customers
- Commissions in Idaho and Kansas have ruled that DG customers can be considered a separate class

Will residential customers understand demand charges?

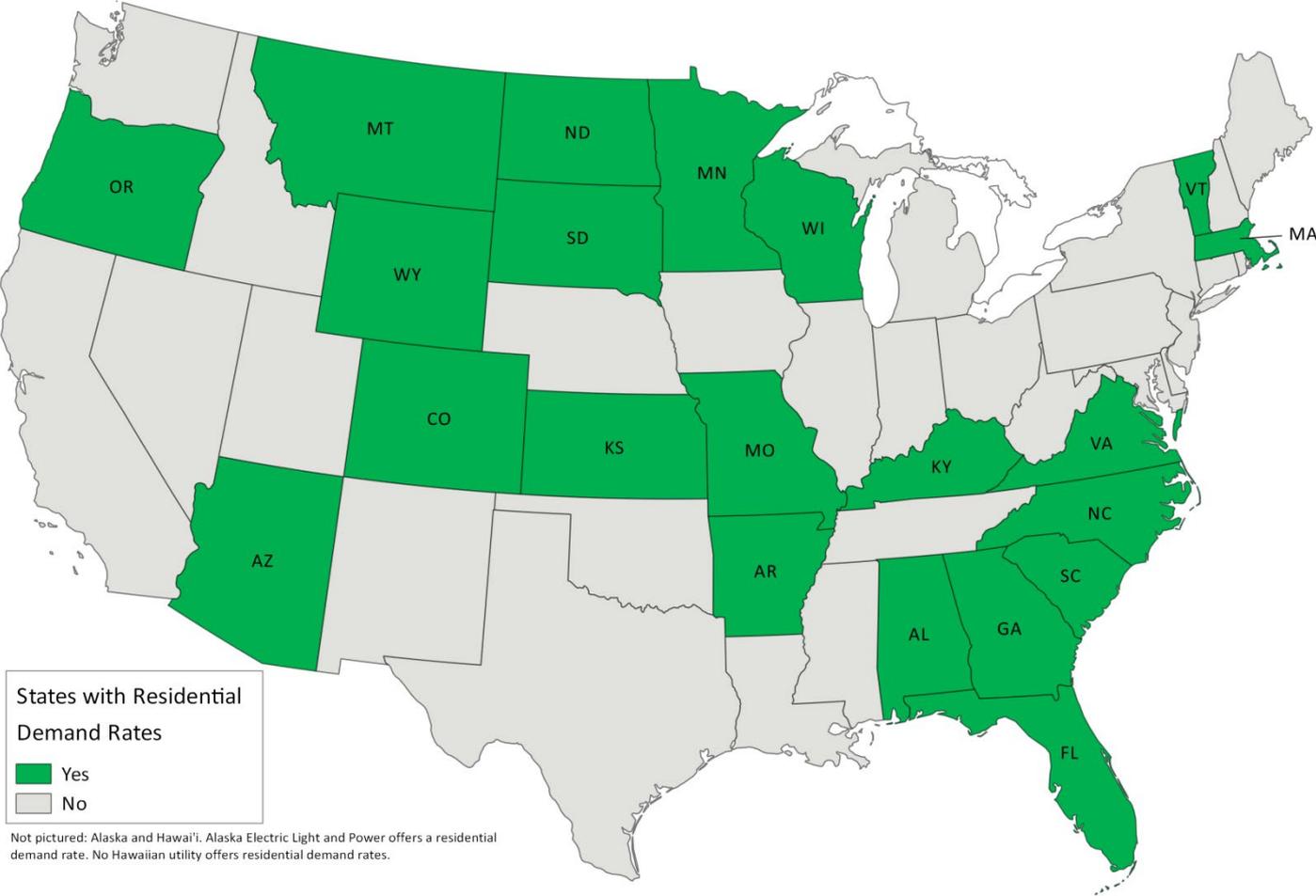
Demand charges can be easily explained to customers using the example of a light bulb, which is expressed in watts, and by referring to the circuit breaker as an example of a household-specific capacity constraint

Customers can be provided typical demand ratings of major appliances and loads in their house

The message, successfully expressed by utilities in Arizona, needs to be simple: “Don’t use all your major appliances at the same time.”

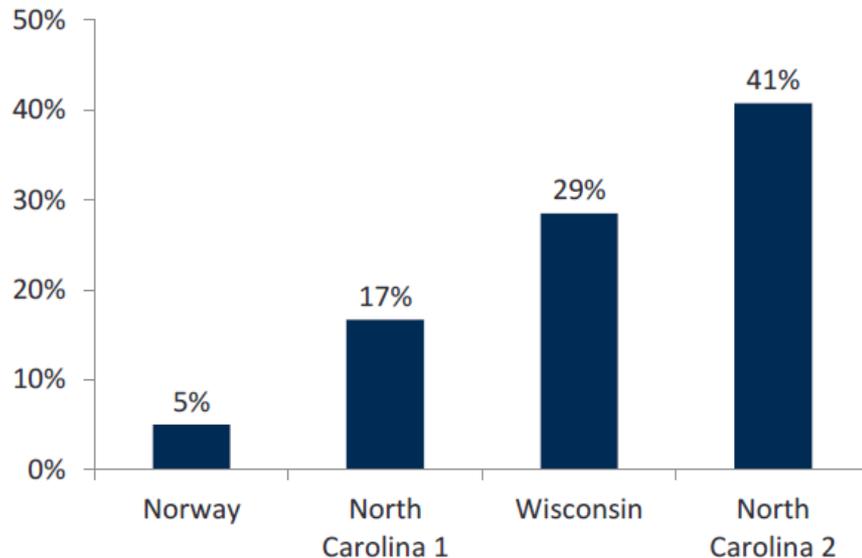
Residential demand charges in the US

22 states are offering demand charges to residential customers



Three experiments have detected significant response to demand charges

Average Reduction in Max Demand



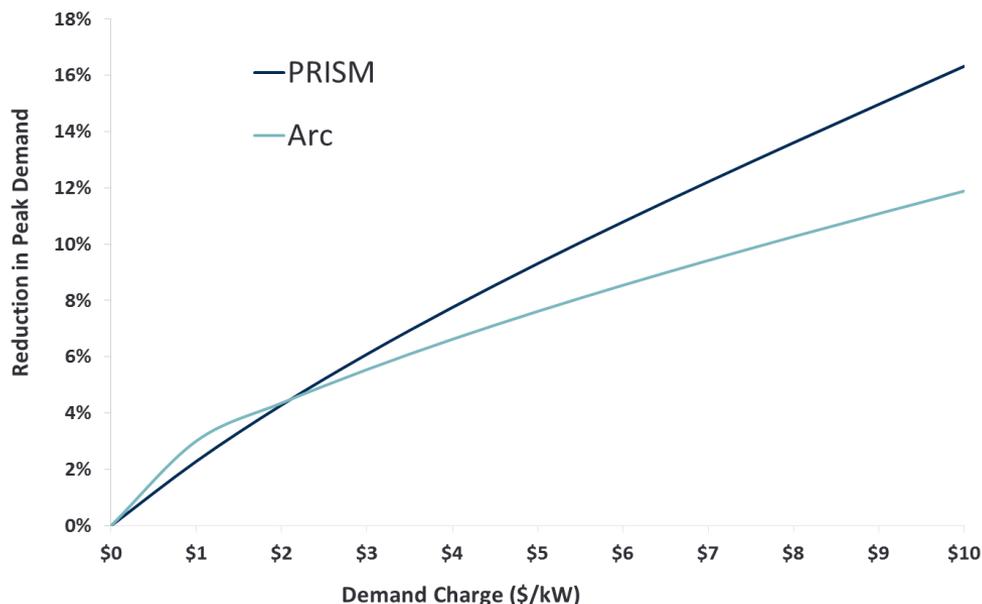
Note: North Carolina was analyzed through two separate studies using different methodologies; both results are presented here

However...

- Two of the pilots are old and the third is from a unique climate
- The impact estimates vary widely
- Findings are based on small sample sizes

Estimating the impact of demand charges

Demand Charge Price Responsiveness

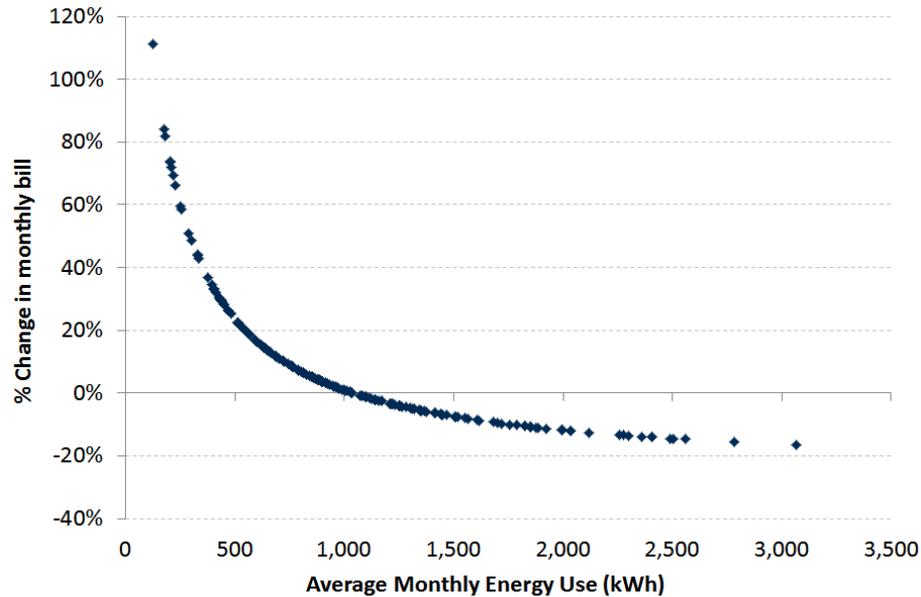


Comments

- Estimates based on PRISM and the Arcturus database
- This example is for a stylized customer using 1,000 kWh/month
- Old rate consists of:
 - \$10/month customer charge
 - \$0.10/kWh volumetric charge
- New rate is a revenue neutral three part rate with various levels of demand charges

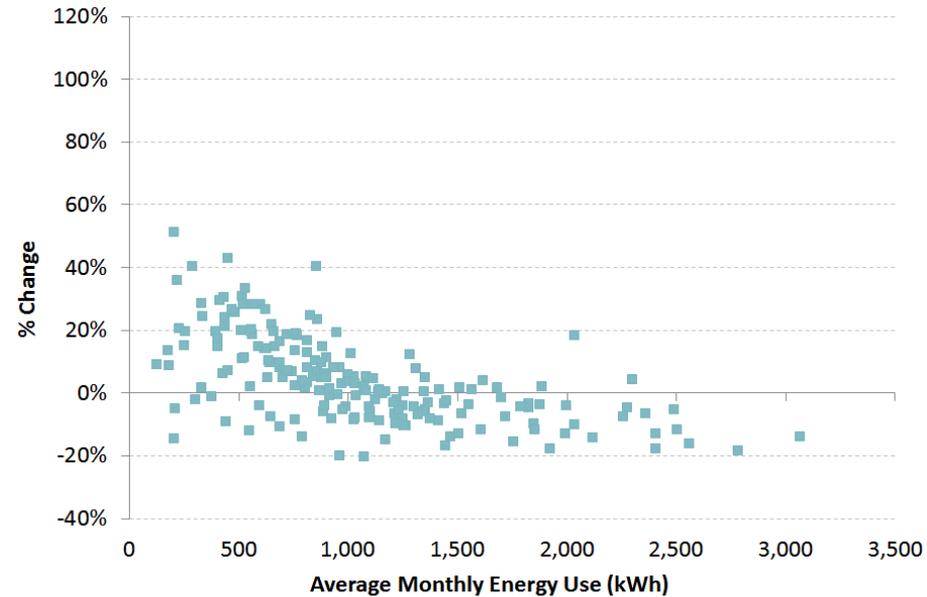
While increased fixed charges raise bills for small customers, demand charges do not

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.

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...

Demand response may cushion the impact of demand charges on customer bills

Demand response can be simulated using empirical evidence from the literature or by running models such as PRISM

See Appendix A for a US case study

Modern tariffs come in several textures

Flat bill (e.g., Ontario, possibly Texas)

Subscription service (e.g., France, Italy and Spain)

Subscription service with demand response

Demand charges (Non-coincident peak, coincident peak, or a combination)

Fixed monthly fee and a demand charge

Fixed monthly fee, a demand charge, and a time-varying energy charge

Getting started with the transition

It won't be easy since any change in tariffs will create winners and losers, which empowers the status quo

Begin by estimating the bills impact of the modern tariffs on a representative distribution of customers –see appendix

Re-estimate the bill impacts by simulating demand response estimates – reference the Xcel Energy example

Conduct pilots to refine your understanding of customer acceptance and demand response

There are many ways of beginning the transition to modern tariffs

Roll out the modern tariffs gradually and precede the roll-out with customer education and a media and stakeholder information campaign

Provide bill protection for the first year and then phase it out over the next three to five years

Make the modern tariffs mandatory for the largest customers, opt-in for vulnerable customers, and the default tariff for everyone else

Structure the tariff in two stages, where the first stage corresponds to a historical baseline which the customer buys “forward” and which locks in their current bill; apply the new tariff to the second stage, which the customer buys on the spot market

Appendix A: Simulating demand response

The following slides present the results of a simulation that was carried out for Xcel Energy in Colorado

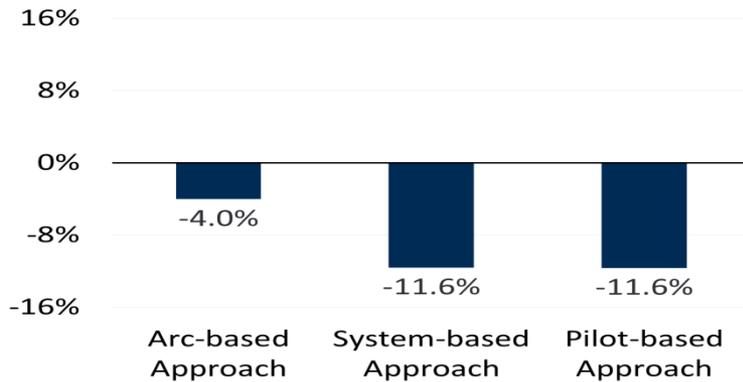
Simulating demand response from demand charges for Xcel Energy (Colorado)

- 1) Empirical approach. Demand response is based on the magnitude of the peak-to-off-peak price ratio and its relationship to price response as estimated in more than 60 residential pricing pilots.
- 2) Model-based approach. Like the empirical approach, customers are assumed to respond to the new rate as if it were a time-varying rate and a regression model is used to project response. It has been used in California, Connecticut, Florida, Maryland, Michigan, and abroad.
- 3) Pilot-based approach. Peak demand reductions are based directly on the average results of three residential demand charge pilots. One of the pilots found specifically that customers respond similarly to demand charges and equivalent TOU rates.

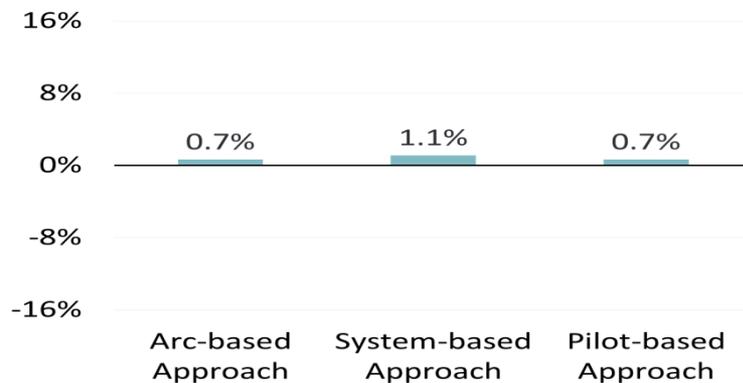
The simulated impact on peak demand

Comments

Change in Avg Peak Period Demand (Summer)



Change in Annual Electricity Consumption



- Average peak demand reductions during summer months range from 4.0% to 11.6% across all customers
- Average annual energy consumption increases slightly; this is driven by a number of factors, including (1) that the average price of electricity decreases for most hours of the year for all customers and (2) the average daily rate decreases for large customers

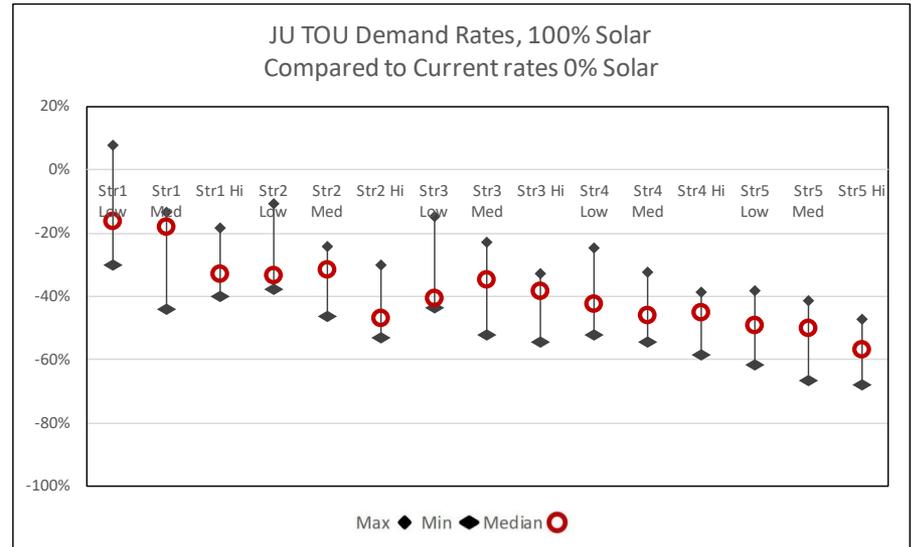
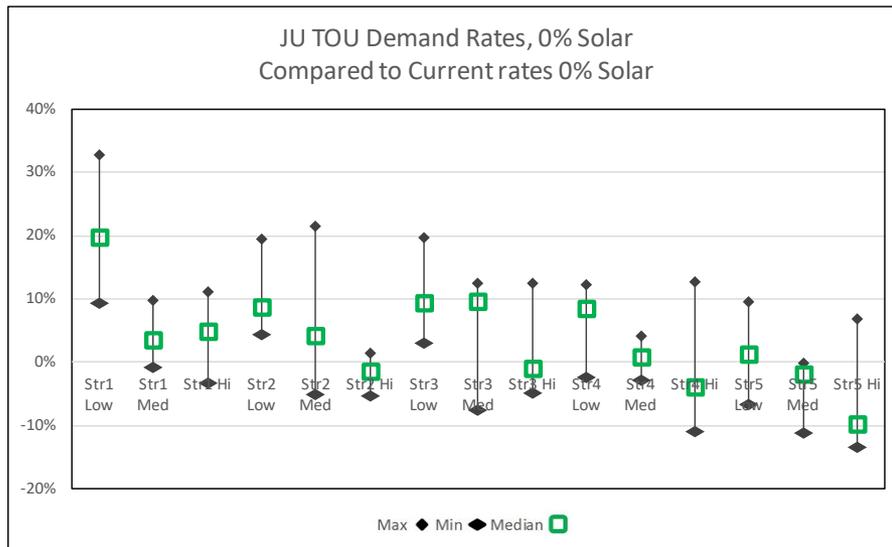
Appendix B: Simulating Bill Impacts

The following slides show how the Joint Utilities in New York have estimated the impact of four different distribution tariffs on customer bills in the context of developing “successor” tariffs to the existing net energy metering (NEM) tariffs

Residential Bill Impact Comparisons

JU TOU Demand Rates

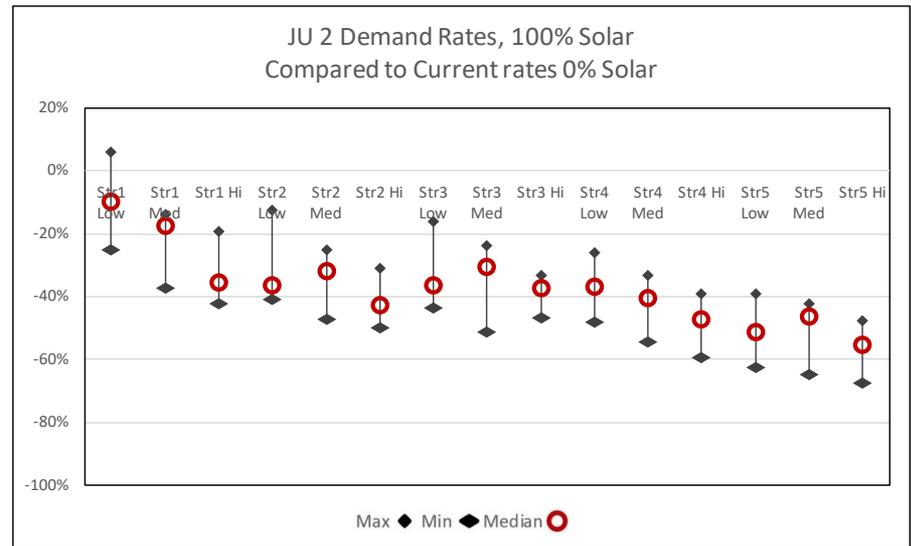
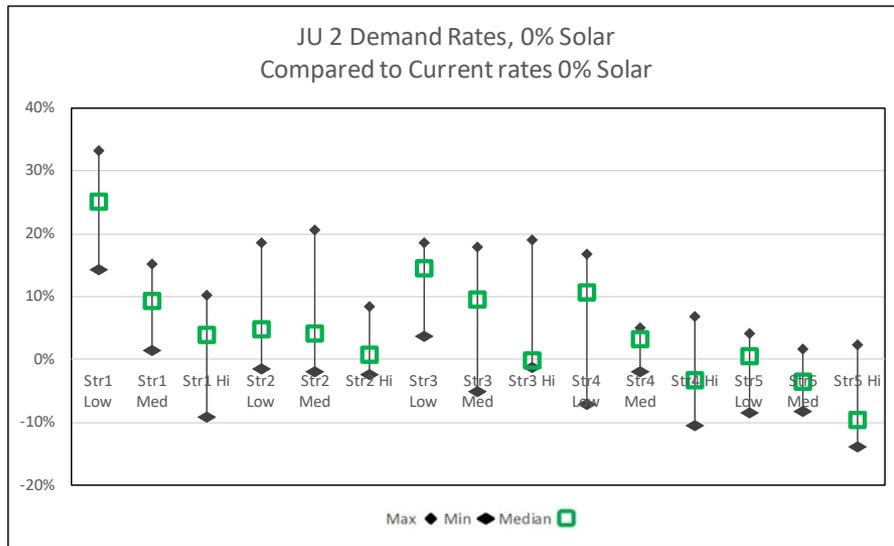
The charts below and on Slides 15 – 17 provide summary statistics based on residential customer bill impacts for Con Edison, National Grid, NYSEG, Orange and Rockland, and RG&E.



Note: Because Central Hudson’s end-use based stratum bill impacts are not comparable to the size-based stratum bill impacts of the other Joint Utilities, Central Hudson’s bill impacts are not included in the charts on this slide. See Slide 4 for further detail.

Residential Bill Impact Comparisons (Continued)

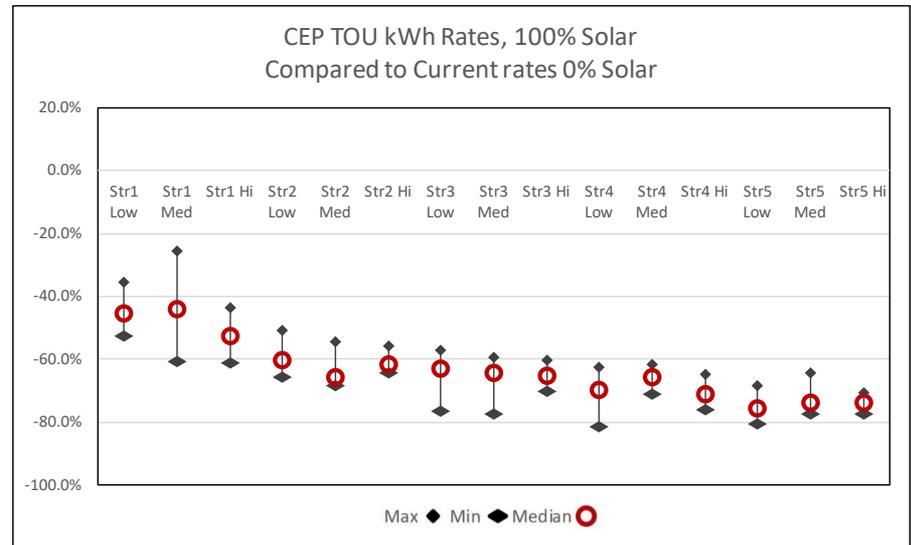
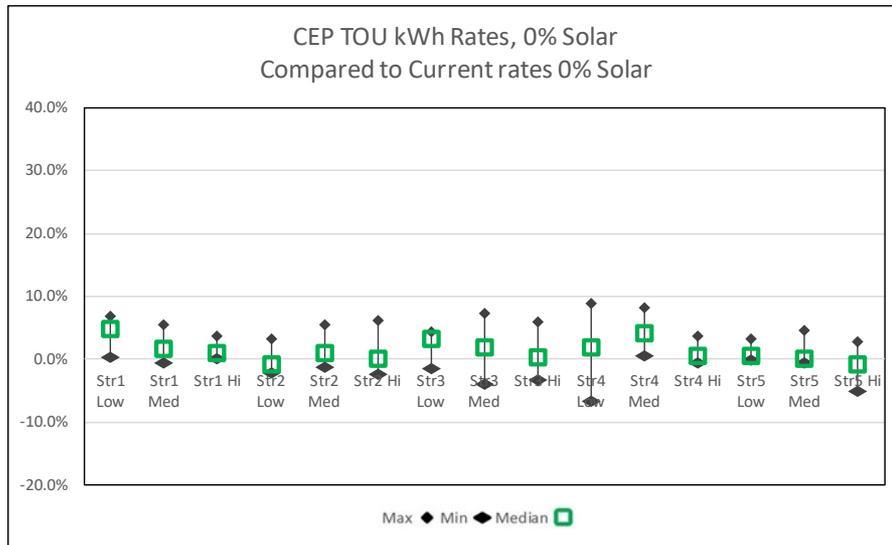
JU 2 Demand Rates



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Residential Bill Impact Comparisons (Continued)

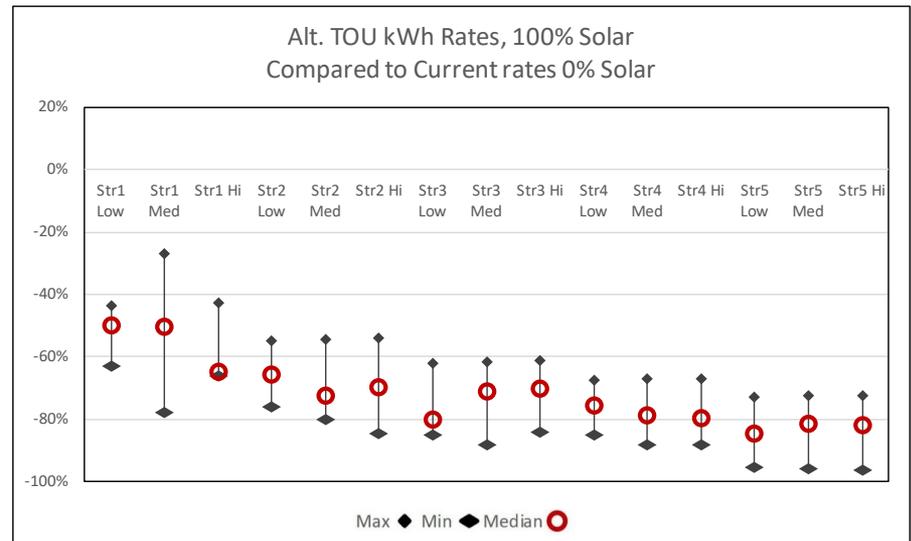
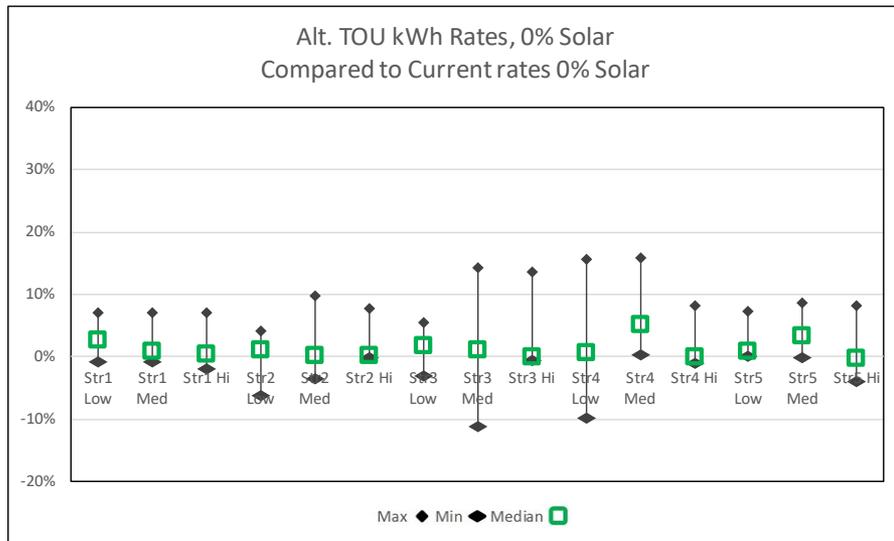
CEP TOU kWh Rates



Note: Because Central Hudson's end-use based stratum bill impacts are not comparable to the size-based stratum bill impacts of the other Joint Utilities, Central Hudson's bill impacts are not included in the charts on this slide. See Slide 4 for further detail.

Residential Bill Impact Comparisons (Continued)

Alternative TOU kWh Rates



Note: Because Central Hudson’s end-use based stratum bill impacts are not comparable to the size-based stratum bill impacts of the other Joint Utilities, Central Hudson’s bill impacts are not included in the charts on this slide. See Slide 4 for further detail.

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Presenter Information



AHMAD FARUQUI, PH.D.

Principal | San Francisco, CA
Ahmad.Faruqui@brattle.com
+1.925.408.0149

Ahmad Faruqui's 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 nearly 150 clients on 5 continents, including electric and gas utilities, state and federal commissions, governments, independent system operators, trade associations, research institutes, and manufacturers. 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 given seminars on all 6 continents. His research been cited in Business Week, The Economist, Forbes, National Geographic, The New York Times, San Francisco Chronicle, San Jose Mercury News, 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 4 books and more than 150 articles, papers and reports on energy matters. He has published in peer-reviewed journals such as Energy Economics, Energy Journal, Energy Efficiency, Energy Policy, Journal of Regulatory Economics and Utilities Policy and trade journals such as The Electricity Journal and the Public Utilities Fortnightly. He is on the editorial board of The Electricity Journal. He holds BA and MA degrees from the University of Karachi, and an MA in agricultural economics and a PhD in economics from The University of California at Davis.

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