An Introduction to Rate Design

PRESENTED BY

Ahmad Faruqui

Agustin Ros

Sanem Sergici

PRESENTED FOR

CPS Rate Advisory Committee

San Antonio

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Brattle

BACKGROUND

Rate designs (tariffs) never fail to stir up an argument

"There has never been any lack of interest in the subject of electricity tariffs. Like all charges upon the consumer, they are an unfailing source of annoyance to those who pay, and of argument in those who levy them. There is general agreement that appropriate tariffs are essential to any rapid development of electricity supply, and there is complete disagreement as to what constitutes an appropriate tariff."

- D.J. Bolton, Costs and Tariffs in Electricity Supply, London (1938)

BACKGROUND

Typically, tariffs consist of multiple elements

Mass market (residential and small commercial) customers

- **Customer charge** (aka fixed charge/service charge/monthly charge)
  - a monthly fee that doesn't vary with the level of consumption
- **Energy charge**
  - Measures the flow of electricity ($/kWh)
  - May vary by time of consumption
  - Usually makes up the bulk of the bill

Large commercial and industrial customers

- Also have a bill similar to that of mass market
- **Demand charges**
  - Measures the width of the pipe ($/kW)
  - Can be max demand or max coincident demand or both

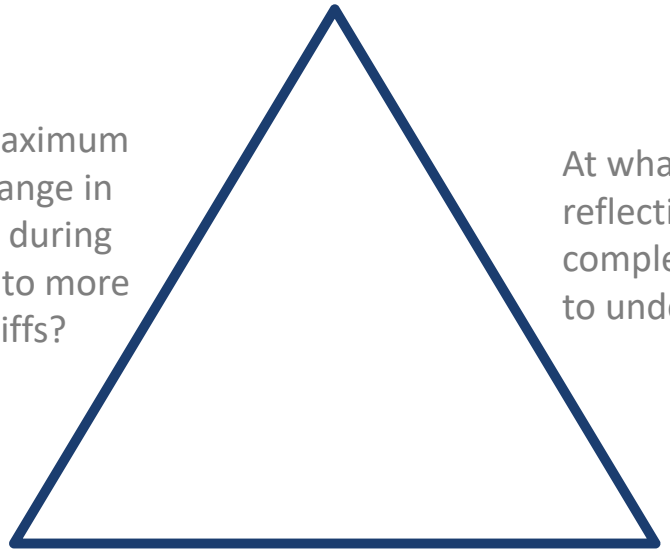
RATE DESIGN PRINCIPLES

Rate design involves making **trade-offs** against three competing goals

Cost Reflective

What is the maximum acceptable change in customer bills during the transition to more cost based tariffs?

At what point is a cost reflective tariff too complex for customers to understand?



Bill Impact

Do simple tariffs lead to significant over/under-payment by certain customer segments?

Simplicity/ Acceptability

Rate design principles have evolved over the years

The following principles are derived from the academic literature and filed experience.

They are most often cited in utility rate cases throughout North America:[1]

- Economic Efficiency
- Equitable Cost Allocation Among Customers
- Revenue Stability
- Bill Stability
- Customer Satisfaction
- Affordability
- Decarbonization

[1] The seminal work on rate design is by James C. Bonbright, Principles of Public Utility Rates, Columbia University Press, 1961.

Rate design principles - Economic efficiency

The price of electricity acts should be set equal to the incremental cost of providing electricity

- Once that happens, the optimal amount of electricity will be produced and consumed
- This will ensure that resources are not wasted

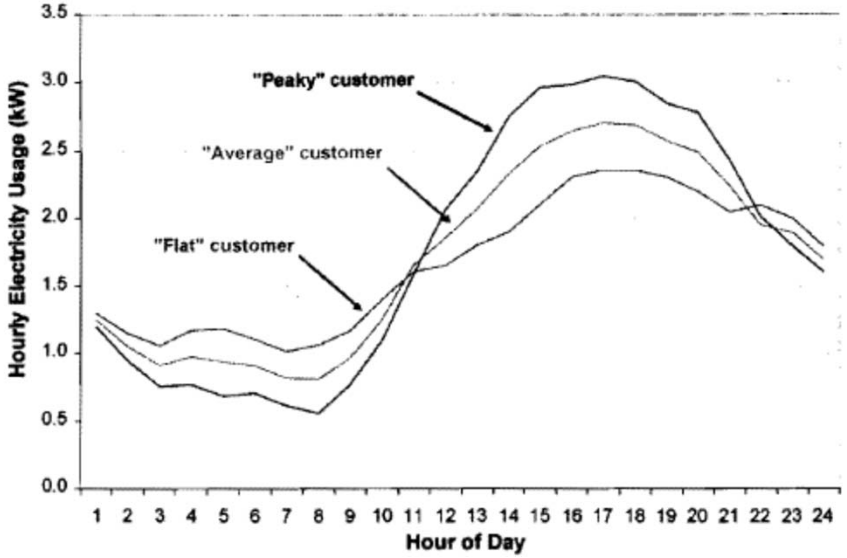
Other Considerations

- Utilities may not be able to achieve full cost recovery if price is set equal to incremental cost since they have a lot of fixed costs in generation, transmission and distribution assets
- This principle does not prioritize social goals such as protecting vulnerable consumers and promoting renewable energy sources

Rate design principles – Allocating costs among customers

No consumer should unintentionally subsidize another consumer (often referenced to as cross-subsidization)

- Rates should reflect the full cost of service
- For example, under flat rates, customers with “peaky” load shapes don’t pay the full cost of serving them and are subsidized by customers with “flatter” load shapes
  - Brattle has estimated that under flat rate pricing, inter-customer subsidies may amount to $3 billion per year in California



Other Considerations

- Views on “Equity” are changing and we will need to align to community expectations
- “Fair” is subjective, may not take into account social goals such as protecting vulnerable consumers and promoting renewable energy sources

Rate design principles – Revenue stability

To continue providing reliable utility service, utilities need revenue stability

- By its very nature, utility service is a capital-intensive business
- Substantial investment is required to acquire, maintain and operate generation, transmission and distribution assets
- Revenue stability ensures access to capital

Other Considerations

- Utilities need to achieve full cost recovery
- Does not explicitly account for social goals such as protecting vulnerable consumers and promoting renewable energy sources

Rate design principles – Bill stability

Customers don’t want their bills fluctuating wildly

- Bill stability ensures that they will be able to manage their cash flows better
- There is month to month variation in bills due to seasonality and weather variations
- Most customers are able to cope with that but some are not
- Several utilities provide balanced bill payment plans to address that concern
- Some are now offering subscription plans

Other Considerations

- Achieves predictable, stable bills for customers and utility financials
- De-seasonalized rate structures may not align with cost structure, does not incentivize energy efficiency or sustainability at times (like summer)

Rate design principles - Customer satisfaction

Need customer “buy in” for a rate to work

- Rates need to be simple:
  - Electricity is not customers’ number one priority
  - Rates need to be simple to understand
  - AND they need to be simple to respond to

- Different rate options might be necessary:
  - Customers have different needs and risk tolerances
  - Choice of rates may allow them to optimize for their own preferences
  - Choice may alleviate political concerns about discrimination and social justice

Other Considerations
- Simplicity makes the rate likely to be embraced by customers
- Sometimes works against optimal

Rate design principles – Affordability

More and more attention is being paid to the issue of affordability

- At the national level, a widely used estimate of the energy burden is placed at 6%
- In other words, electricity and gas bills as a percent of customer's gross income should not exceed 6%
- Utilities and government agencies undertake a variety of measures to meet that goal
- Rate design is one of those measures (along with others such as weatherization and lighting upgrades)

Considerations

- Energy efficiency, demand response and load flexibility provide financial incentives to customers as do bill discounts focused on low income customers (California's CARE program provides a 35% discount on electric bills and 20% on gas bills)
- Low-income customers may not benefit from rate designs encouraging rooftop PV installations

Rate design principles – Decarbonization

More and more utilities are setting goals to decarbonize their operations by certain dates, such as 2035

- Rate designs that encourage efficient use of appliances are being given priority
- An example is the use of time-of-use (TOU) rates to encourage efficient charging of electric vehicles (EV's) during off-peak hours

Other Considerations

- Utilities can accomplish decarbonization provided that incentives are aligned
- Decarbonization-focused rate designs may be financially detrimental to utilities in the long run if not designed properly
- Low income customers may not be able to take advantage of rebates and low interest financing that are designed to encourage energy efficiency and solar installations

Questions and Discussion

Do you have any comments on the seven principles that we have shared with you?

- If so, please share your comments.

Are there any other rate designs principles that you would like to suggest?

- If so, please describe them briefly and tell us why they are important.

We will now discuss briefly some rate designs that are being offered by utilities in North America

- We will have a more in-depth conversation about rate design in the next RAC meeting

TRENDS IN RATE DESIGN AND CASE STUDIES

Why are rate designs changing?

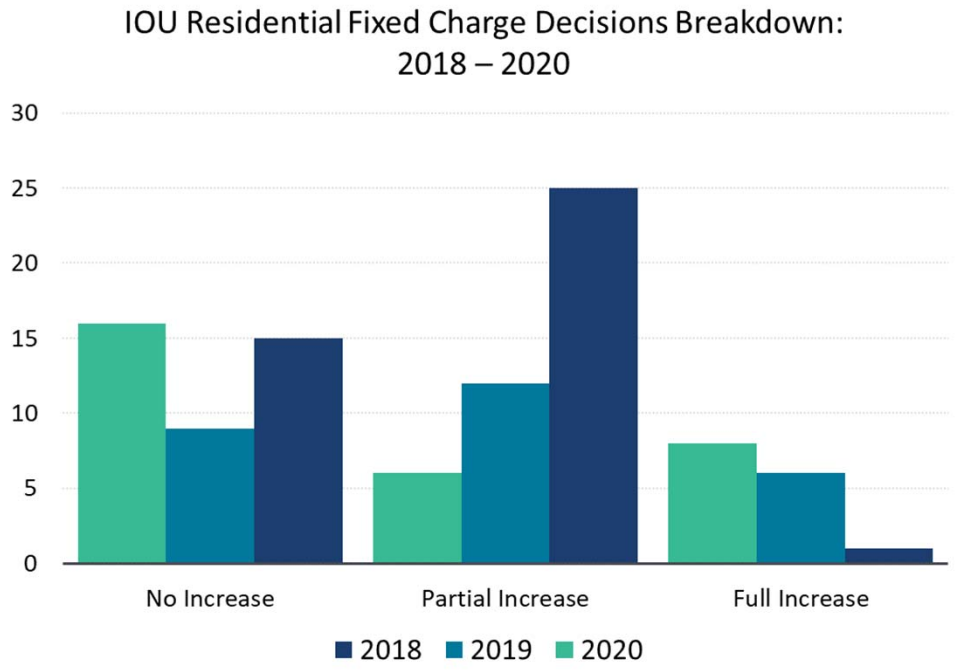
Utilities throughout the US and indeed throughout the globe are rethinking rate designs

- A major driver is the adoption of smart, digital, WiFi technologies by customers
- A second driver is the “greening” of customer tastes
- Another driver is the desire by customers to have options in rate design
- A major enabler is the rollout of smart meters
- As these drivers impact utility financial models, utilities need to adjust rate design in order to continue providing service.

TRENDS

Throughout the industry, 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



Source: NC Clean Energy, "The 50 States of Solar," 2020 Annual Review. Average partial increase was 26% of utility's request in 2017, and 40% in 2018.

TRENDS

There is a desire to introduce 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 50 utilities across 24 states in the United States

Utilities such as Arizona Public Service and Salt River Project offer these rates to customers with solar panels on their roofs

TRENDS

And there is a desire to offer time-varying rates

According to the US Energy Administration's Form-861, **365 U.S. utilities offer at least one form of time-varying rate** to residential customers in 2019

- 335 offer Time-of-Use (TOU) rates
- 31 offer Critical Peak Pricing (CPP)
- 13 offer Peak Time Rebates (PTR)
- 6 offer Variable Peak Pricing (VPP)
- 9 offer Real-Time Pricing (RTP)

Nationally, 4.5% (6 million) of all residential customers are enrolled on one of these time-varying rates

By 2025, the percentage of customers on time varying rates is expected to rise to 15%

In the rest of this presentation, we will briefly discuss some utility case studies

CASE STUDIES

Sacramento Municipal Utility District (SMUD) - TOU

Sacramento Municipal Utility District (SMUD), with 600,000 residential customers, transitioned all residential customers in 2019 to default TOU rates

- The rate has a peak period of 5-8 PM year around
  - Summer rates, which are higher than in non-summer, feature a peak rate of $0.2941/kWh, an off-peak rate of $0.1209, and an additional mid-peak rate (for noon-5 PM and 8 PM-midnight) of $0.1671/kWh

Before filing for TOU, SMUD conducted a successful pilot program in 2012 and 2013 testing TOU, CPP, and TOU/CPP rates

- The pilot found significant load shifting, customer preference for TOU over CPP, and ~50% higher average reductions with opt-in versus opt-out (which had 90% retention)

The Time-of-Day (TOU) results of the first summer in 2019 showed that:

- TOD supports the Board's goal of reducing carbon by 12,800 tons
- Customers reduced the residential peak by ~8%
- Customers saved about 2% or $3 per month on their summer electric bill
- 96% of customers stayed on the TOU rate
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SMUD™
Sacramento Municipal Utility District

CASE STUDIES

California's investor-owned utilities (IOUs) - TOU

Pacific Gas & Electric (PG&E) currently has ~400,000 customers on opt-in time-varying rates. The other two California IOUs, Southern California Edison (SCE) and San Diego Gas & Electric (SDG&E), have approximately 370,000 and 155,000 customers on opt-in time-varying rates respectively

- Almost 99% of customers that participated in SCE and SDG&E's TOU pilots chose to stay on a TOU plan

All three IOUs have begun moving their customers to default TOU rates

- SDG&E began its rollout in March 2019, offering two TOU plans with a 4-9 PM peak period and a 2.1:1 peak/off-peak period, as well as an additional super off-peak period from 12-6 AM
- PG&E and SCE will transition customers in October 2020

The CPUC has ordered two customer guarantees as part of the rollout

- Customers will be provide an estimate of how their TOU bill compares with what their bill would have been on their old rate so they can see if they saved money or not
- A 12-month bill guarantee, such that customers whose first-year bill under the new TOU rate is higher than it would have been under their old rate will be credited the difference

SOUTHERN CALIFORNIA EDISON
Energy for What's Ahead®

PG&E

SDGE
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CASE STUDIES

Holy Cross Energy (HCE), Colorado - PTR

HCE, a cooperative in Colorado, offers a Peak Time Payback (PTP) program to both residential and commercial members.

- The baseline is calculated using historical hourly interval data to represent what a participant would have used in each hour during the event.
- Participants earn a bill credit of $1 for each kWh reduced compared to their baseline usage during “critical events,” and $0.5 for each kWh reduced during “high events.”
- Events typically occur between 4 and 9 PM on weekdays and typically last for two to three hours and the number of PTP event hours to be no more than 96 in a calendar year.
- No penalty for not reducing consumption when events are called.

CASE STUDIES

Fort Collins – TOU with a modest fixed charge

Fort Collins, a municipal utility in Colorado, went to mandatory Time-of-Day Pricing in 2018 for all customers.

- Fixed charge at $8 per month
- Off-peak hours cost approximately 30 percent less than current electric rates with higher prices during on-peak hours

- Summer On-peak hour (2 pm – 7 pm) and Off-peak (all other hours) with peak/off-peak ratio of 3.6.
- Winter On-peak hour (5 pm – 9 pm) and Off-peak (all other hours) with peak/off-peak ratio of 3.1.

CASE STUDIES

Ontario Energy Board – TOU charges for energy and flat bills for distribution

Some 90 percent of Ontario's 4 million residential customers have been purchasing their energy through a regulated supply option, which features a three-period TOU rate.

- The TOU charge is deployed on an opt-out basis as smart meters were deployed in the province in 2014
- Off-peak, mid-peak, and on-peak prices are defined by season
- The TOU rates only apply to the energy portion of the customer's bill
- Analysis showed that load shifting impacts were lower in winter than in the summer period

The distribution charge is set equal to a flat bill, reflecting the fixed and non-volumetric nature of distribution costs.

Questions and Discussion

Do you have any comments on the various rate designs that we have shared with you?

- If so, please share your comments.

Are there any other rate designs that you would like to suggest?

- If so, please describe them briefly and tell us why they are important.

During the next RAC meeting, we will do a deeper dive into rate designs

The Brattle Team

Presented By

Ahmad Faruqui

PRINCIPAL
SAN FRANCISCO

Ahmad.Faruqui@brattle.com

+1.925.408.0149

Ahmad Faruqui is an internationally recognized authority on the design, evaluation and benchmarking of tariffs. He has analyzed the efficacy of tariffs featuring fixed charges, demand charges, time-varying rates, inclining block structures, and guaranteed bills. He has also designed experiments to model the impact of these tariffs and organized focus groups to study customer acceptance. Besides tariffs, his areas of expertise include 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, Saudi Arabia, and Texas. He has presented to governments in Australia, Egypt, Ireland, the Philippines, Thailand, New Zealand and the United Kingdom and given seminars on all 6 continents. He has also given lectures at Carnegie Mellon University, Harvard, Northwestern, Stanford, University of California at Berkeley, and University of California at Davis and taught economics at San Jose State, the University of California at Davis, and the University of Karachi.

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 a member of the editorial board of The Electricity Journal. He holds BA and MA degrees from the University of Karachi, both with the highest honors, and an MA in agricultural economics and a PhD in economics from The University of California at Davis, where he was a research fellow.

Presented By

Agustin Ros

PRINCIPAL
BOSTON

Agustin.Ros@brattle.com

+1.617.864.7900

Dr. Agustin J. Ros is a Principal of the Brattle Group with expertise in public utility economics. He has more than 25 years of consulting experience and specializes in cost of service, rate design, and performance-based ratemaking and competition in electricity. He has consulted on dozens of embedded and marginal cost of service studies in electricity, telecommunications, natural gas and water sectors and has filed expert reports in more than a dozen agencies in the U.S. and throughout the world. He teaches at the annual Edison Electric Institute ("EEI") Advanced Rate Course in Madison, Wisconsin on embedded and marginal cost of service as well as efficient rate design principles and practices and is an Adjunct Professor at the International Business School at Brandeis University where he teaches a course on public utility regulation and antitrust economics. Dr. Ros began his career working at the Illinois Commerce Commission as Executive Assistant to the Chairman and was involved in all aspects of public utility issues facing Illinois utilities. He has published research on the economics of public utilities in academic, peer-reviewed journals such as *The Energy Journal, Journal of Regulatory Economics, Review of Industrial Organization, Review of Network Economics, Telecommunications Policy and Info.*

Presented By

Sanem Sergici

PRINCIPAL
BOSTON

Sanem.Sergici@brattle.com

+1.617.864.7900

Dr. Sanem Sergici is a Principal in The Brattle Group's Boston, MA office specializing in innovative retail rate design and economic analysis of distributed energy resources (DERs). She regularly assists her clients in matters related to electrification, grid modernization investments, emerging utility business models and alternative ratemaking mechanisms.

Dr. Sergici has been at the forefront of the design and impact analysis of innovative retail pricing, enabling technology, and behavior-based energy efficiency pilots and programs across North America. She led numerous studies in these areas that were instrumental in regulatory approvals of grid modernization investments and smart rate offerings for electricity customers. She also has significant expertise in resource planning, development of load forecasting models and energy litigation.

Dr. Sergici regularly publishes in academic and industry journals and presents at industry events. She was recently featured in Public Utility Fortnightly Magazine's "Fortnightly Under 40 2019" list. She received her PhD in Applied Economics from Northeastern University in the fields of applied econometrics and industrial organization. She received her MA in Economics from Northeastern University, and BS in Economics from Middle East Technical University (METU), Ankara, Turkey.