

Electricity Ratemaking and Equitable Rate Design

A SURVEY OF BEST PRACTICES

PRESENTED BY

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Who sets electricity rate for utilities?



The principles of ratemaking include economic efficiency, equity, revenue stability, customer satisfaction and decarbonization

- The principles are generally similar across investor-owned utilities, publicly owned utilities and cooperatives but institutional differences do play a role in how they are implemented
- Additional differences arise if retail choice of supplier exists within utility service areas

For investor-owned utilities, state regulatory commissions set rates, for publicly owned utilities, city councils set rates and, for cooperatives, boards of directors set rates

In each case, utility management has to submit their rate proposal for approval by the relevant authorities

- The frequency of rate applications varies by utility, being annual, biennial or triennial in several cases, less frequent in others
- In most cases, stakeholders representing various segments of society will intervene in the rate case and present their viewpoint to the relevant authorities

How are rates determined?

The first step is to set the revenue requirement for a test year, which could be historical or forecast

- Revenue requirement is the sum of operating expenses and a return on capital spending
- The return on capital spending is the product of a rate of return times the size of the capital spending (which is sometimes called the rate base)
- Each element is reviewed, scrutinized, and debated prior to being approved or rejected

The second step is to apportion the revenue requirement across various customer classes such as residential, commercial, and industrial

The third step is to divide the revenue requirement by customers class into fixed charges, demand charges and energy charges

The second and third steps require the conduct of a cost of service study

How are rate structures or rate designs determined?

Traditional rate structures for residential customers primarily recover revenue from a volumetric charge and secondarily from a nominal fixed monthly charge

- The volumetric charge is either a constant cents/kWh number or a charge that varies with volume
- When it rises, the rate is called an inclining block rate; when it falls it is called a declining block rate
- Much debate goes into setting the fixed monthly charge

Small commercial rates generally follow the same design as residential rates

Large commercial and industrial rates have a three-part rate (TPR) structure that includes a demand charge in addition to a fixed monthly charge and an energy charge

- The demand charge may be based on coincident or non-coincident peak demand
- Separate charges may be collected for generation, transmission and distribution services
- The energy charge may vary by time of day

How are rate structures evolving as the electricity sector evolves?

We are at the cusp of a revolution in rate design, facilitated in large part by the deployment of more than 100 million smart meters in the US

The revolution will be facilitated by the emergence of advanced customer technologies

- Examples include WiFi enabled thermostats, electric vehicles, rooftop solar panels, battery storage and heat pumps

Smart meters enable the provision of advanced rate designs such as:

- Time-of-use rates (TOU)
- Critical-peak pricing rates (CPP)
- Peak-time rebates (PTR)
- Variable-peak pricing rates (VPP)
- Real-time pricing (RTP)
- Three-part rates (TPR)
- Subscription plans combined with peak-time rebates

Modern rate designs come in many shapes and forms

| Rate | Definition |
|--------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1- Time-of-Use (TOU) | The day is divided into peak and off-peak time periods. Prices are higher during the peak period hours to reflect the higher cost of supplying energy during that period |
| 2- Critical Peak Pricing (CPP) | Customers pay higher prices during critical events when system costs are highest or when the power grid is severely stressed |
| 3- Peak Time Rebates (PTR) | Customers are paid for load reductions on critical days, estimated relative to a forecast of what the customer would have otherwise consumed (their “baseline”) |
| 4- Variable Peak Pricing (VPP) | During alternative peak days, customers pay a rate that varies by day to reflect dynamic variations in the cost of electricity |
| 5- Real-Time Pricing (RTP) | Customers pay prices that vary by the hour to reflect the actual cost of electricity |
| 6- Two-part Real-Time Pricing (2-part RTP) | Customer’s current rate applies to a baseline level of consumption. A second, marginal cost based, price applies to deviations from the baseline consumption |
| 7- Three-part Rates (3-part Rates) | In addition to volumetric energy charge and fixed charge, customers are also charged based on peak demand, typically measured over a span of 15, 30, or 60 minutes |
| 8- Fixed Bill with Incentives | Customers pay a fixed monthly bill accompanied with tools for lowering the bill (such as incentives for lowering peak usage) |

What are examples of industry best practices in rate design?

In Arizona, APS and SRP offer TOU rates on an opt-in basis to their residential customers

In California, SMUD deployed default TOU rates two years ago and the three investor-owned utilities are in the process of moving to default TOU rates

In Colorado, Fort Collins has mandatory TOU rates and Xcel Energy has been authorized to move ahead with deploying TOU rates as it rolls out smart meters

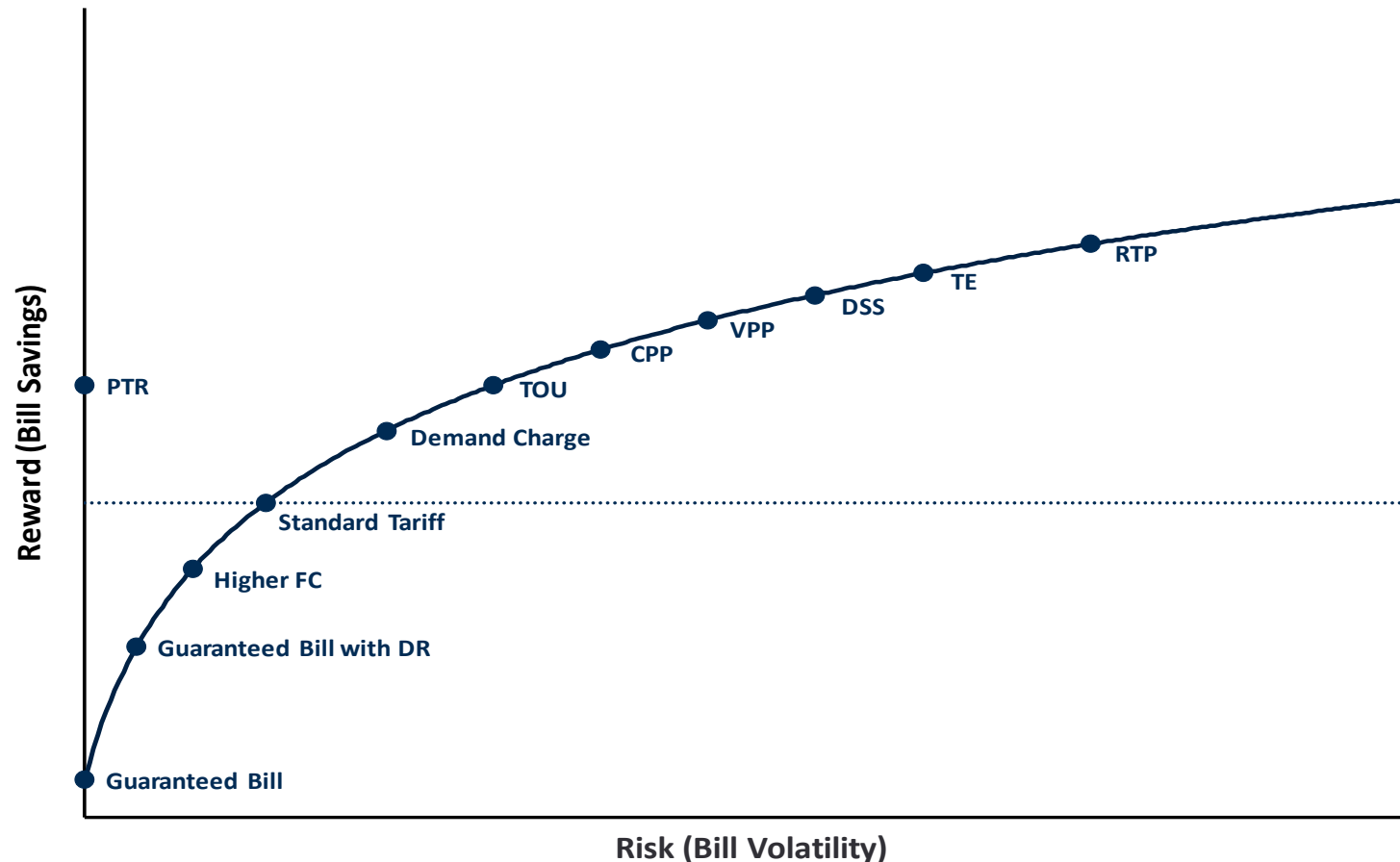
In Illinois, ComEd and Ameren offer RTP to residential customers

In Maryland, BGE and Pepco offer peak time rebates on a default basis

In Michigan, Consumers Energy is moving to default all its residential customers to TOU rates this month

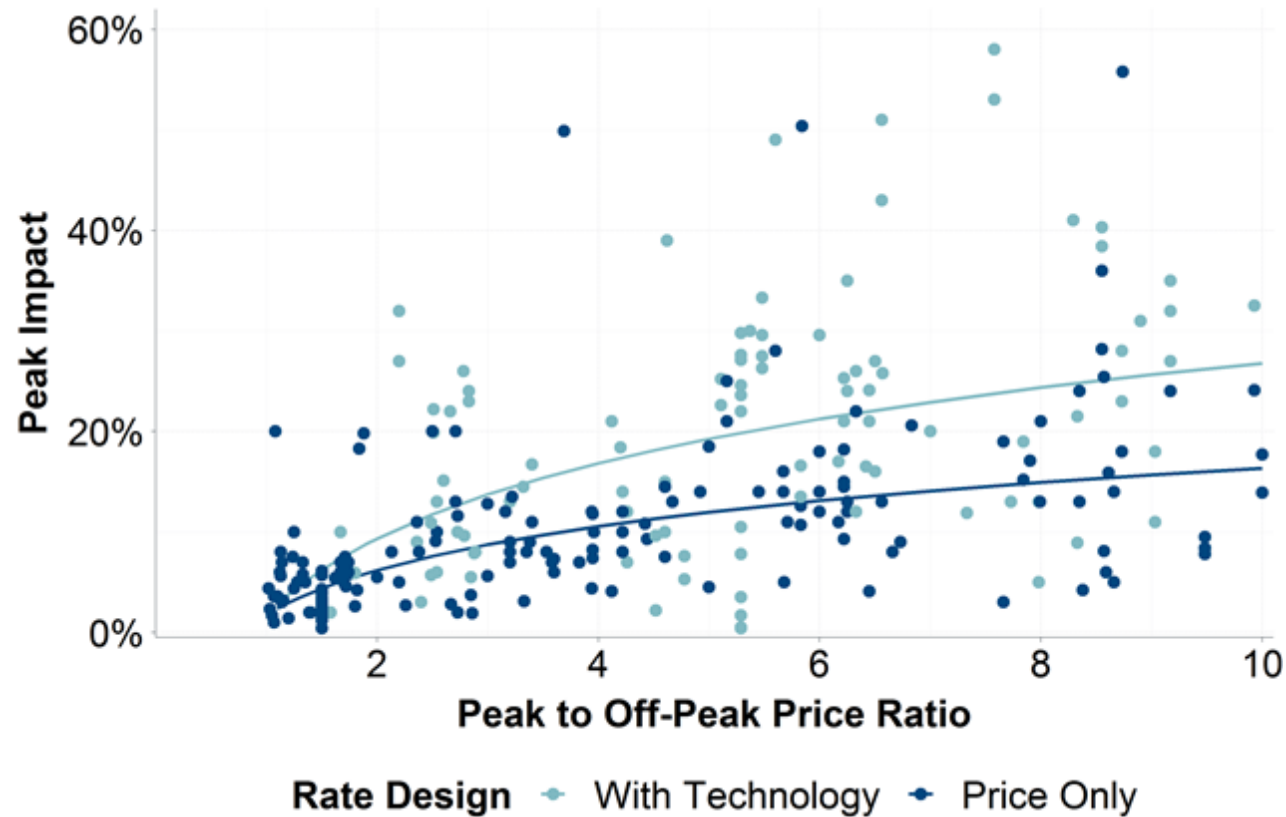
In Oklahoma, OGE offers variable peak pricing paired with smart thermostats

In the post-modern world, utilities will offer choices of tariffs to customers that lie along an efficient pricing frontier

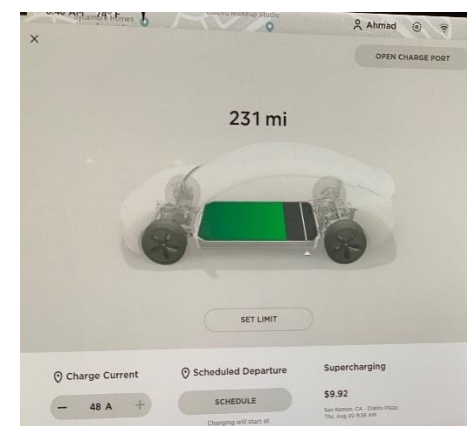
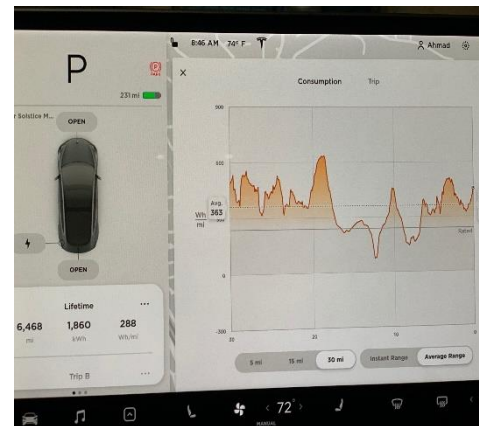
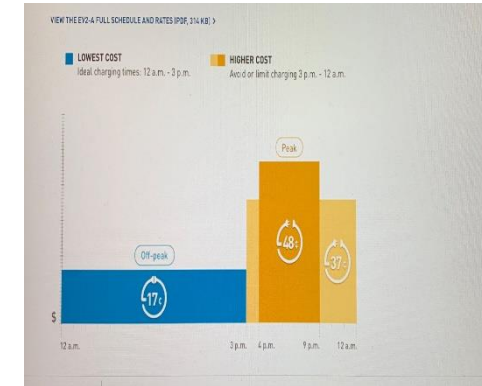


Do customers respond to time-of-use rates?

Yes, based on results from nearly 400 pilots around the globe which are stored in the Arcturus database



Customers have begun decarbonizing consumption. Yesterday's customer is today's prosumer and tomorrow's prosumager.



Does ratemaking enable or hinder access to affordable clean energy?

Rate designs can be used to incentivize affordable clean energy, along with rebates for purchasing clean energy equipment

TOU rates can incentivize the smart charging of electric vehicles, central air conditioners, heat pumps for space conditioning and heat pumps for water heating by letting customers know when is the lowest cost time to run these technologies

TOU rates can also incentive the smart use of rooftop solar panels and the charging and discharging schedule of battery storage that is paired with the solar panels

Additionally, regulators can provide utilities with performance incentives for achieving clean energy goals

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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 has 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.

Appendix A

ADDITIONAL READINGS



APPENDIX A

Selected papers on pricing and customer-centricity

“Refocusing on the consumer,” *Regulation*, Spring 2020.

“Customer centricity: Lynchpin of strategy,” *Public Utilities Fortnightly*, November 1, 2019.

“The Tariffs of Tomorrow: Innovations in Rate Designs,” *IEEE Power and Energy Magazine*, vol. 18, no. 3, pp. 18-25, May-June 2020.

“2040: A Pricing Odyssey,” *Public Utilities Fortnightly*, June 1, 2019.

“Rate Design 3.0 – Future of Rate Design,” *Public Utilities Fortnightly*, May 2018.

“Innovations in Pricing: Giving Customers What They Want,” *Electric Perspectives*, September/October 2017.

“A memoir of Chicago.” <https://dailytimes.com.pk/320211/a-memoir-of-chicago/>

Appendix B

QUOTABLE QUOTES



APPENDIX B

Why do we have so little price-responsive demand?

“The greatest barriers [to price responsive demand] are legislative and regulatory, deriving from state efforts to protect retail customers from the vagaries of competitive markets.” —Eric Hirst

“In electricity markets, as generating capacity constraints are reached, relatively little demand can be rationed by short-term price movements and, instead, must be rationed administratively with rolling blackouts. [This situation could be avoided if more demand-side instruments were available such as having] more customers who can see and respond to rapid changes in market prices and expanded use of price-contingent priority rationing contracts. The demand response instruments that are available are poorly integrated with spot markets ... moreover, the prices that are paid ... are too low compared to the long-run cost of generating capacity.” —Paul Joskow

Appendix C

A POCKET HISTORY OF RATE DESIGN



A Pocket History of Rate Design

| Year | Author | Contribution |
|------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1882 | Thomas Edison | <ul style="list-style-type: none">Electric light was priced to match the competitive price from gas light and not based on the cost of generating electricity |
| 1892 | John Hopkinson | <ul style="list-style-type: none">Suggested a two-part tariff with the first part based on usage and the second part based on connected kW demand |
| 1894 | Arthur Wright | <ul style="list-style-type: none">Modified Hopkinson's proposal so that the second part would be based on actual maximum demand |
| 1897 | Williams S. Barstow | <ul style="list-style-type: none">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 | <ul style="list-style-type: none">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 | <ul style="list-style-type: none">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 | <ul style="list-style-type: none">Published "Principles of Public Utility Rates" which would become a canon in the decades to come |

A Pocket History of Rate Design (Concluded)

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