# The changing landscape of rate design


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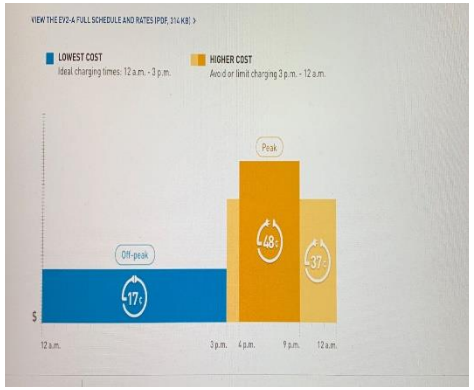
# The tariffs of yesterday will not work tomorrow; they hardly work today

Flat volumetric rates with low fixed charges

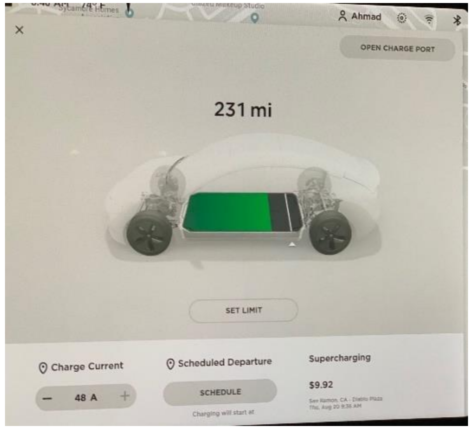
Inclining or declining block rates with low fixed charges

Seasonal rates with low fixed charges


# Yesterday's customer is today's prosumer and tomorrow's prosumager






# The tariffs of tomorrow are beginning to take shape before our eyes

TOU rates with significant price differential and shorter peak periods (SMUD)

Three-part rates with demand charges (Ameren, Arizona Public and Georgia Power)

Dynamic pricing rates with higher fixed charges (OGE)

Real-time pricing (RTP) rates with day-ahead and hour-ahead frequency (Georgia Power)

RTP which flows directly to devices

# Time-varying prices (TVPs) 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) |

# Residential TVPs have been deployed around the world

| | Type of Rate | Applicability | Participating Customers |
|---|---|---|---|
| **Oklahoma** *(OGE)* | Variable Peak Pricing (VPP) | Opt-in | 20% (130,000) |
| **Maryland** *(BGE, Pepco, Delmarva)* | Peak Time Rebate (PTR) | Default | 80% |
| **Ontario, Canada** | Time-of-Use (TOU) | Default | 90% (3.6 million) |
| **Great Britain** | Time-of-Use (TOU) | Opt-in | 13% (3.5 million) |
| **Hong Kong** *(CLP Power Limited)* | Peak Time Rebate (PTR) | Opt-in | 27,000 |
| **Arizona** *(APS, SRP)* | Time-of-Use (TOU) | Opt-in | APS: 57%, SRP: 36% |
| **California** *(PG&E, SCE, SDG&E)* | Time-of-Use (TOU) | Default (2020) | TBD – 75-90%* |
| **California** *(SMUD)* | Time-of-Use (TOU) | Default | 75-90%* |
| **Colorado** *(Fort Collins)* | Time-of-Use (TOU) | Mandatory | 100% |
| **Illinois** *(ComEd, Ameren IL)* | Real Time Pricing (RTP) | Opt-in | 50,000 |
| **Michigan** *(Consumers Energy)* | Time-of-Use (TOU) | Default (2020) | TBD – 75-90%* |
| **France** | Time-of-Use (TOU) | Opt-in | 50% |
| **Spain** | Real Time Pricing (RTP) | Default | 40% |
| **Italy** | Time-of-Use (TOU) | Default | 75-90%* |

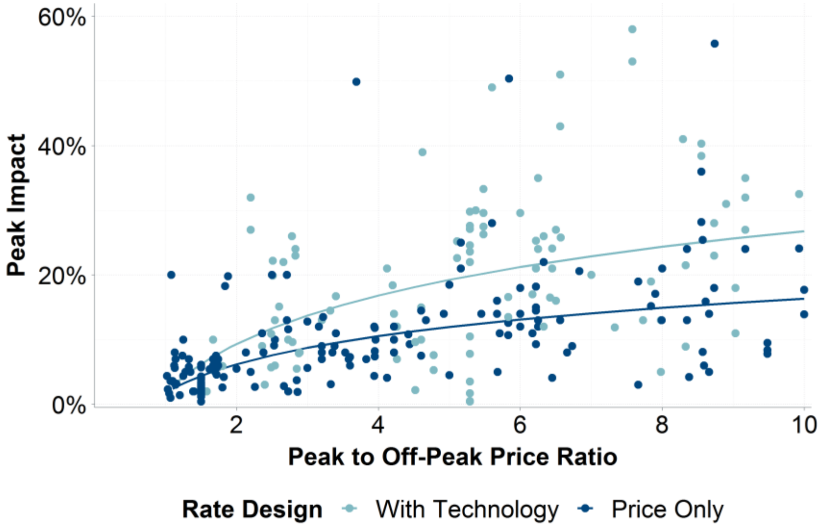
*Estimated participation based on historical trends

# The magnitude of demand response varies by the strength of the price signal

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 TVPs paired with enabling technologies reduce peak usage by 11% for every 10% increase in the price ratio




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

# TVP Offerings in the United States

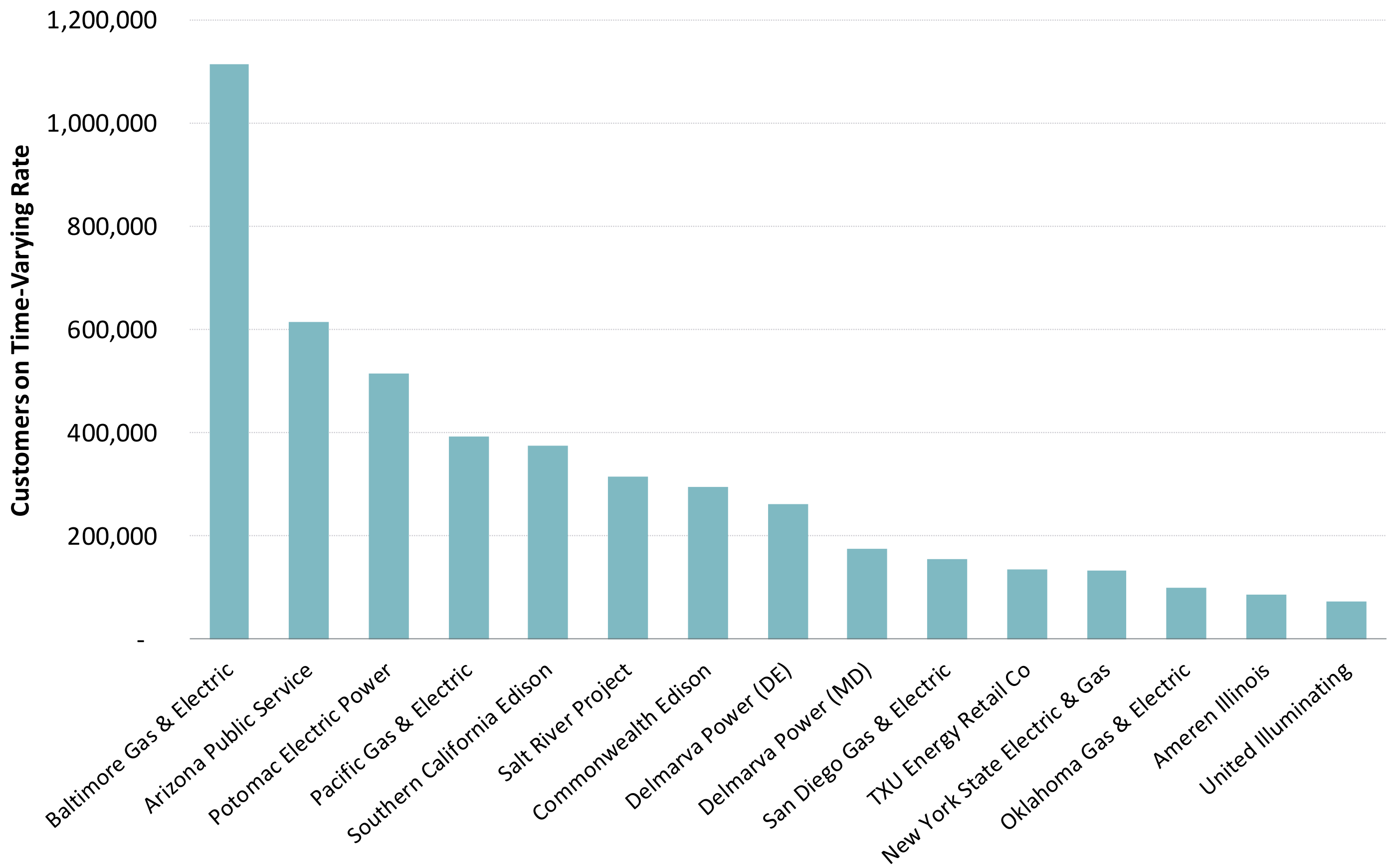
According to 2019 EIA Form-861, **338 U.S. utilities offer at least one form of time-varying rate** to residential customers

- 330 offer Time-of-Use (TOU)
- 33 offer Critical Peak Pricing (CPP)
- 15 offer Peak Time Rebate (PTR)
- 6 offer Variable Peak Pricing (VPP)
- 11 offer Real-Time Pricing (RTP)

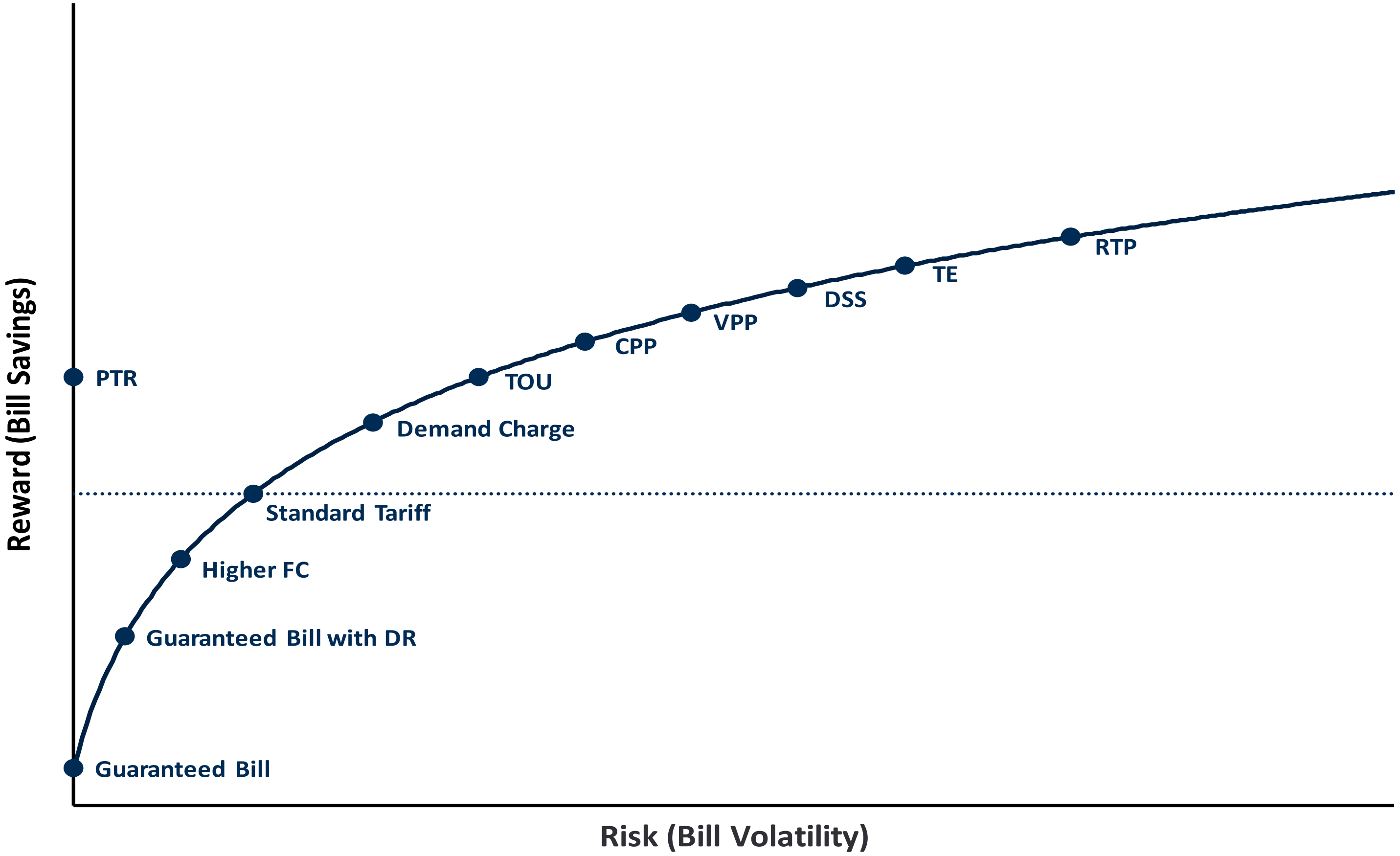
Altogether, **6.8 million customers** (or 5% of all residential customers) are enrolled on one of these time-varying rates

# Largest TVP Deployments

The following **15 utilities accounted for 86% of all customers** enrolled on a time-varying rate



# Utilities are beginning to offer choices of tariffs to customers



# Best-in-class tariffs that exist today

Georgia Power’s RTP rate for commercial and industrial customers serves

- Serve more than 2,000 commercial and industrial customers
- it’s a two-stage rate
- Customers subscribe to a baseline load shape and pay for that on their existing three-part tariff
- Changes in load shape are billed on hourly prices
- Hour ahead for customers >1 MW load; day ahead for others

OGE’s residential variable-peak pricing rate (“Smart Hours”)

- Serves 20% of residential customers
- Customers set the thermostat based on their comfort level and savings target
- Price signals are transmitted to the thermostat
- Collectively, customers lower their peak demand by 40% and their bills by 20%

SMUD’s residential TOU pricing rate, default offering

- Has nearly 98% of residential customers on it
- The peak to off-peak ratio is 2.4:1

# What's likely to happen in the next few years

Ameren Missouri and Georgia Power are rolling out several TOU rates and a three-part rate to residential customers

California's investor-owned utilities are rolling out mildly time-differentiated TOU rates to all residential customers on a default basis

Public Service Company of Colorado and Consumers Energy in Michigan are expected to do the same but their rates will have a significant differential between peak and off-peak prices

As the notion of getting prices-to-devices become real, dynamic pricing rates will begin to be offered to residential customers throughout the nation

That's the only was to deal with a generation mix that will be dominated by renewable energy in a decade, if not sooner

# In the past, five “Immortal” Objections have impeded tariff modernization

**Objection 1**: While time-varying rates might reduce peak load, they will not lower customer bills

**Objection 2:** Lower peak demand will not lower transmission and distribution costs since they do not depend on load

**Objection 3:** On-going pilots with time-varying rates show minimal customer reaction to price signals in changing their load profiles

**Objection 4:** Customers have little time or interest in becoming a home energy manager. They just want the lights to come on when they flip the bill and get an affordable bill at the end of the month.

**Objection 5 :** Time-varying tariffs will harm low income customers, senior citizens and people with medical disabilities

# In the future, we can overcome the objections by following this process

1. Select rate design for deployment
2. Compute bill changes
3. Understand which customers will see adverse bill impact
4. Re-run bill impact analysis with DR
5. Consider remedies to adverse bill impact
6. Conduct focus groups
7. Run a pilot to measure response
8. Determine rollout strategy
9. Track deployment of modern rate design

# Did Griddy just write the obituary of dynamic pricing?

“The news of my death is greatly exaggerated.” W. C. Fields

Around one percent of customers in ERCOT were on hourly pricing with a cap of $9/kWh. They probably never thought the price would hit that level.

A wide range of hedging instruments are available to prevent a recurrence, as discussed earlier.

Dynamic pricing is not a panacea. E.g., airlines use it to balance demand and supply. If the flight is oversold, they offer vouchers to passengers who are willing to take a later flight. The vouchers are analogous to peak-time rebates.

However, if the plane has a mechanical problem, it won’t fly, regardless of how much you are willing to pay for it.

# Let me close by quoting Arthur C. Clarke

You can always expect a radical new idea to generate three reactions:

“ *It is completely impossible”*

“ *It’s possible but not worth doing”*

“ *I said it was a good idea all along”*

# APPENDIX A

## ADDITIONAL READINGS

# 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.

# APPENDIX B

## QUOTABLE QUOTES

# 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

## THE CONSUMER OF THE FUTURE

# APPENDIX E

## A POCKET HISTORY OF RATE DESIGN

# A Pocket History 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 kW 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 | • 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 | • Proffered 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*, creating a two-tiered inclining rate |
| 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 |

# Presenter Information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Dr. Faruqui provides expert advice and testimony on rate design, load flexibility, energy efficiency, demand response, distributed energy resources, demand forecasting, decarbonization, and electrification. He has worked for over 150 clients on five continents and appeared before regulatory bodies, governments, and legislative councils.

He has authored or coauthored more than 100 papers in peer-reviewed and trade journals and co-edited books on industrial structural change, customer choice, and electricity pricing. His work has been cited in *Bloomberg, Business Week, The Economist*, and *Forbes*, in addition to *The New York Times* and the *Washington Post*, and he has appeared on NPR and Fox Business News.

Dr. Faruqui has taught economics at San Jose State, UC Davis and the University of Karachi and delivered guest lectures at Carnegie Mellon, Harvard, Idaho, MIT, New York, Northwestern, Rutgers, Stanford, and UC Berkeley. He obtained an MA in Agriculture Economics and a PhD in Economics from UC Davis, and a BA and an MA in Economics from the University of Karachi.