

**EXH. AF-4
DOCKET UE-22 ___/UG-22 ___
2022 PSE GENERAL RATE CASE
WITNESS: AHMAD FARUQUI**

**BEFORE THE
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION**

**WASHINGTON UTILITIES AND
TRANSPORTATION COMMISSION,**

Complainant,

v.

PUGET SOUND ENERGY,

Respondent.

**Docket UE-22 ___
Docket UG-22 ___**

**THIRD EXHIBIT (NONCONFIDENTIAL) TO THE
PREFILED DIRECT TESTIMONY OF**

AHMAD FARUQUI

ON BEHALF OF PUGET SOUND ENERGY

JANUARY 31, 2022

PSE's Time-Varying Rates Pilot Design Considerations

Stakeholder Meeting 1



May 19, 2021

Welcome, Introduction & Ground Rules

Moderator: Birud Jhaveri, PSE (Birud.Jhaveri@pse.com)
Speakers: Dr. Ahmad Faruqui, The Brattle Group
Dr. Sanem Sergici, The Brattle Group

Ground Rules

- Meeting is being recorded; please mute yourself
- Come with a clean slate and open mind
- Be respectful of diverse view points
- Listen actively to others and ask questions – no question is too elementary
- Do not interrupt other participants
- Manage your input – no long speeches please
- Leave the meeting with a clear sense of next steps

Agenda

1. Proposed Approach to Designing PSE's Time-Varying Rate (TVR) Pilot (40 mins)
 - Objectives of the Pilot
 - Overview of the Process
2. Overview of TVR Options (60 mins)

BREAK (10 mins)

3. Overview of Other Jurisdictions' Experience with TVRs and Lessons Learned (40 mins)
4. Next Steps and Further Discussion (30 mins)



1- Proposed Approach to Designing Time-Varying Rates (TVR) Pilot



Project background

- In Puget Sound Energy's (PSE) 2018 General Rate Case (GRC), the Washington Utilities & Transportation Commission (WUTC) Staff made a recommendation in testimony for the creation of Time-of-Use (TOU) and Critical Peak Pricing (CPP) pilots.
- The Commission is also eager for customers to realize benefits from the PSE's investment in Advanced Metering Infrastructure (AMI). PSE is currently in the process of implementing AMI, with an expected system-wide completion in 2023.
- PSE is very interested in and fully supports exploring time-varying and other outcome based pricing for its customers in the residential and small commercial classes. They can be helpful in managing system and local peak, mitigating customer costs, and/or integrating variable renewable generation, among other use cases.
- As a result, PSE plans to conduct a TVR pilot, including multiple treatments, with its customers to explore the efficacy of time-varying rate designs to influence customer behavior, while providing system benefits, increased customer choice, customer bill reductions, and grid flexibility.

TVR Pilot objectives

File a TVR pilot with the UTC with a target date of Q1 2022. PSE's TVR design/outcome based pricing vision encompasses four overarching objectives:



System cost minimization: Reduce costs to serve customers by improving capacity utilization, encouraging economic conservation and peak shaving.



Customer choice: Offering customers options to help them manage their energy bills.



Equity and accessibility: Design and offer rates and programs that consider needs and effects on low-income/vulnerable populations



Renewables integration: Investing in and successfully and economically integrating renewable resources to help PSE achieve its 100% carbon free goals.

What are we expecting to learn from the pilot?

- The TVR pilot will provide valuable insights regarding customers' ability, willingness, and experience as it relates to responding to price signals to shift load away from system peaks, thus reducing system costs.
- Whether PSE customers will show interest in the TVRs and once they are on the rate will they respond to the price signals by modifying their electricity consumption
- Based on the load impacts quantified in the pilot, whether PSE can expect meaningful peak demand savings if deployed at a larger scale
- Low income customer responsiveness and impact
- Small business customer responsiveness and impact
- TVR responsiveness in a winter peaking climate, where the evidence is more limited
- Whether the price response persists over the course of the pilot
- Whether certain treatments are more/less effective towards objectives
- Effectiveness of customer outreach, education and support
- Whether PSE customers were satisfied with the TVRs as they experience it

High-level Design Elements for the Pilot

- Multiple TVR options will be tested on an opt-in basis
- Separate treatment samples for residential, small business, low income and EV customers
- Minimum two-year pilot to evaluate persistence of impacts
- Scientifically valid pilot design principles will be followed to ensure estimated impacts are statistically significant and unbiased
- PSE is committed to incorporating stakeholder feedback throughout the development of the pilots in the next several months

Overview of pilot activities



Customer research: To ensure time-varying rate pilots reflect the preferences of our customers, PSE will conduct five focus groups in early June. The objective of this activity is to better understand how customers think about time-varying rates and how various rates may impact behavior, determine the most effective rate structures, and test interest, appeal, and barriers. The results from these focus groups will be supplemented with Brattle’s data from nearly 400 TVR treatments.



Stakeholder engagement: To align pricing pilots with the objectives and preferences of our stakeholder community, PSE will hold a series of collaborative workshops in May – August of 2021. The objectives are to solicit feedback from stakeholders, and use that feedback to inform the rate and pilot design.



Detailed rate and pilot design: After gathering preliminary feedback from stakeholders and customers, PSE and Brattle will work jointly to develop the detailed rate and pilot designs for the pilots to be filed in early 2022. This will include development of the rate structure, pilot design, customer engagement plan, and evaluation & measurement plan.



Filing package: Once the detailed rate and pilot designs are complete, PSE and Brattle will work jointly to prepare the pilots to be filed with the WUTC.

Stakeholder engagement process overview

Stakeholder collaborative 1 (May 19th, 9am-12pm):

Provide an overview of PSE's approach to designing the TVR pilot, overview of TVR options, and lessons learned from other jurisdictions, and solicit overall feedback.

Stakeholder collaborative 3 (late Aug):
Present final proposed rates, as well as proposed pilot design and EM&V approach.
Seek input from stakeholders.

Email update:
Provide a summary of focus group results and stakeholder survey results, and an overview of rate option direction.

Stakeholder collaborative 2 (late July):
Present draft rate designs, including expected load impacts, and solicit feedback from stakeholders.

Discussion

- Do you agree with PSE's objectives for the pilot?
- What are you interested in learning/studying in this pilot?
- Do you have any feedback on the stakeholder engagement process?
- Other notable planning elements PSE should consider?

2- Overview of Time-Varying Rate Design Options

Rate designs are evaluated with respect to well known rate design principles

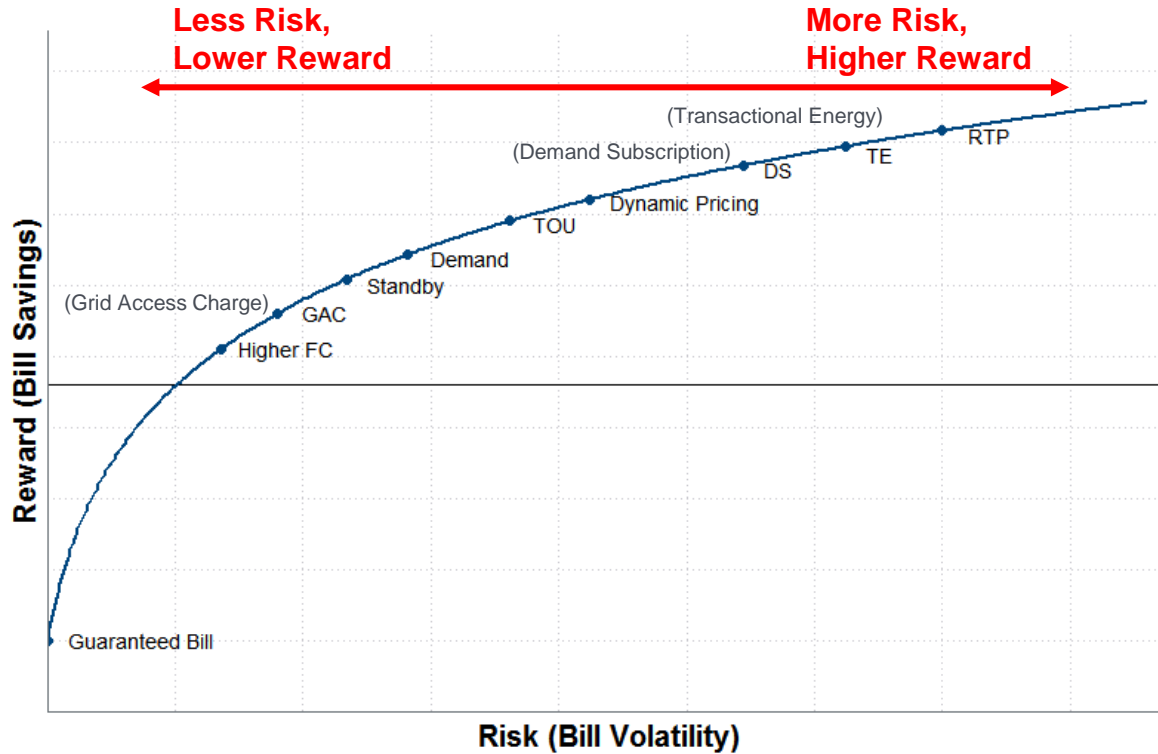
Principles	Objective
1. Cost causation	<ul style="list-style-type: none"> Rates should reflect cost causation, including embedded costs, long-run marginal and future costs, and the fixed cost nature of delivering electricity
2. Encourage efficient outcomes	<ul style="list-style-type: none"> Rates should encourage economically efficient and market-enabled decision-making, for both efficient use of the grid by customers and new investments
3. Fair Value	<ul style="list-style-type: none"> Customers and utility should both be paid the fair value for the grid services they provide
4. Customer Orientation	<ul style="list-style-type: none"> Rates should aspire for simplicity while providing customer choices
5. Stability	<ul style="list-style-type: none"> Customer bills should be relatively stable
6. Equity	<ul style="list-style-type: none"> Electricity should remain affordable and accessible for vulnerable sub populations
7. Gradualism	<ul style="list-style-type: none"> Rate changes should be implemented in a manner which would not cause any large bill impacts
8. Economic Sustainability	<ul style="list-style-type: none"> Rate design should reflect a long-term approach to price signals, remain neutral to any particular technology or business cycle and avoid cross-subsidies and prevent abuse/gaming/arbitrage



Customers have diverse preferences

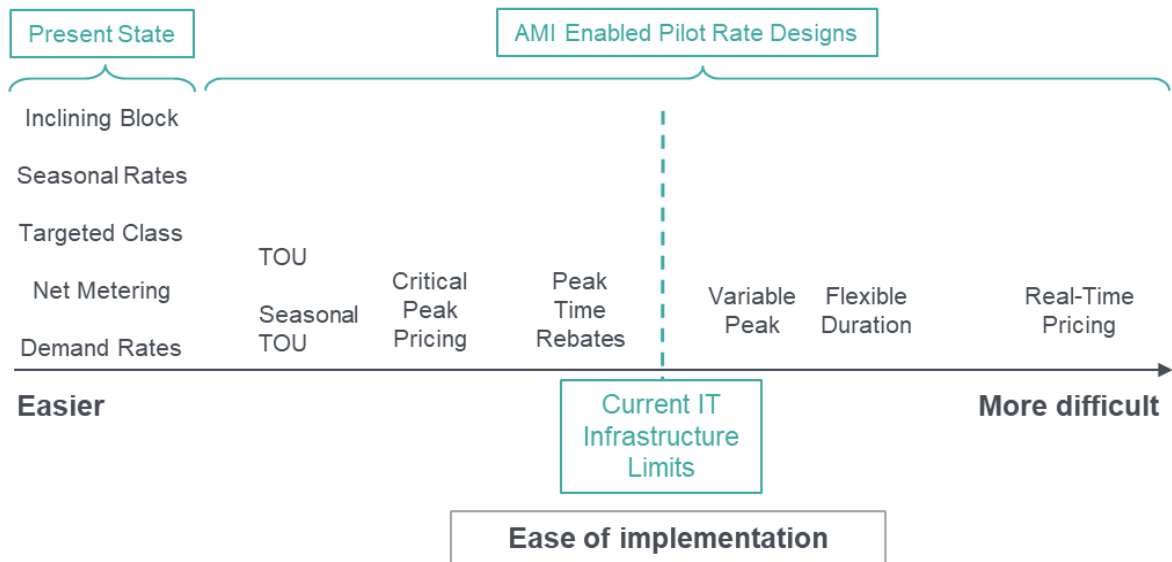
- Market research studies and surveys undertaken in the context of time-based pricing pilots reveal valuable insights on customer preferences
 - Some customers want the lowest price
 - They are willing to be flexible in the manner in which they use electricity
 - Some want to lock in a guaranteed bill
 - They are willing to pay a premium for peace-of-mind
 - Many others are in between these two bookends
 - Some might want a guaranteed bill but may be willing to lower it if rebates are offered for reducing demand during peak periods
 - Others may wish to subscribe to a given level of demand
- All customers want choice but *they only want what they want*

These alternative rates create an efficient pricing frontier along which customers would make risk/reward trade-offs



PSE's immediate TVR pilot capabilities

In the long term, PSE envisions a broad menu of alternative pricing options and price-enabled programs. To get there, PSE will pilot and continuously improve capabilities around TVR concepts. In the near term, current IT infrastructure capabilities restrict what types of rates we can implement.



AMI enables a variety of modern rates, including TVRs

Rates being considered in this Pilot

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)



Different rate designs meet different rate design objectives

Rates being considered in this Pilot

Rate Design	Cost causation	Customer Orientation	Equity	Revenue Stability	Bill Stability
TOU	M	M	M	M	M
CPP	M	L	M	M	L
PTR	L	H	H	L	H
RTP	H	L	L	H	L
Three-part rate	H	L	L	H	L
Fixed bill with incentives	L	H	M	H	H

1- Time-of-Use (TOU) Rate

The day is divided into time periods which define peak and off-peak periods. Prices are higher during the peak period to reflect the higher cost of supplying energy.

Pros	Cons
<ul style="list-style-type: none">❖ Captures the natural variation in the cost of supplying electricity to customers❖ Helps raise load factors and lower average costs for all customers❖ Reduces inter-customer cross-subsidies❖ Leads to a “base-level” load shifting from those customers who like the certainty of their rates and are willing to make small adjustments on a daily level	<ul style="list-style-type: none">❖ There may be customer dissatisfaction with having to modify behavior to solve what customers essentially view as the utility’s problem❖ Would raise bills for customers with peakier than average load shapes (“instant losers”), and thus may not enroll even though they drive up costs for all customers. Meanwhile, customers with higher than average load factors may receive lower bills without changing their behavior (“instant winners”)❖ Is not dynamic in the sense that the rates do not change based on the system conditions

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

Pros

- ❖ Best suited for addressing system needs when the grid is stressed the most (for a typical utility, the top 1% of hours with the highest usage may account for 8%-18% of annual peak load, requiring peaking capacity to be kept idle most of the time)
- ❖ More responsive to changing system conditions than TOU, allowing for more timely load reductions during critical events and reducing need for peaking capacity
- ❖ Customer load response is required on a select number of days
- ❖ Customers receive a discount for most of the hours in a year in exchange for very high prices on a limited number of hours

Cons

- ❖ High prices on the critical event days can make customers nervous about participating in the program
- ❖ Customers need to make sure that they can receive event notifications from their utility in a timely manner to make adjustments to their consumption
- ❖ Missing a few event days may lead to bill increases

3- Peak Time Rebate (PTR)

Customers receive credits for load reductions during critical events, estimated relative to a forecast of what the customer would have otherwise consumed (their “baseline”)

Pros

- ❖ Instead of charging a higher price during the critical hours, provides a rebate during those hours, which may be more appealing to customers
- ❖ The scarcity value of providing power during the critical hours is conveyed as an opportunity cost (lost opportunity for earning a rebate) and not as a higher price (CPP)
- ❖ Similar to CPP, more responsive than TOU in addressing extreme system conditions

Cons

- ❖ In order to compute the rebate, the utility needs to know what the customer would have consumed if the rebate had not been given (i.e., estimate baseline usage)
- ❖ Since the price does not change in either the peak or the off-peak period, the PTR rate is not as cost-reflective as the CPP tariff or even the TOU tariff
- ❖ The source of the PTR payments becomes an issue to resolve for large scale deployments

TOU Design Considerations

- TOU is the simplest and most widely used form of TVR throughout the world
- TOU could be offered along with CPP rates
- A well-designed TOU rate with significant savings opportunities and a narrow peak period appeal to the customers
- A more sharply differentiated TOU rate with a super off-peak period could be offered for EV owners
- Seasonal differences in load shapes and price differentials should be considered in designing the rates
- Simplicity of the design is key in increasing the uptake
- Behavioral messaging, smart thermostats and bill impact tools can accompany the rates to enhance comprehension and responsiveness
- Target a peak/offpeak ratio > 3 for sizable impacts although jurisdictional circumstances may affect the outcomes
- Educate customers on ways to change behavior; offer bill impact analyses
- EV TOU rates would involve different design considerations

CPP Design Considerations

- The design of the rate should balance system efficiency and cost savings with customer experience
- Number of event days and frequency of critical peak events should be carefully considered (8-12 days in a given season)
- CPP is typically designed to reflect long-run marginal cost of capacity to meet system peak and short-run marginal cost of energy during critical peak hours
- CPP should be sufficiently high to give customers meaningful incentives for load shifting (CPP/offpeak > 6)
- Customers should be given sufficient notice to plan their load shifting activities. However, the shorter the lead time, the demand reductions from the CPP becomes more valuable from a utility planning perspective

PTR Design Considerations

- The opportunity cost of consuming 1 kWh of electricity during the event hours (all-in rate plus the rebate level) should reflect the capacity and energy costs during these hours
- Number of event days and frequency of critical peak events should be carefully considered (8-12 days in a given season)
- Developing a reliable baseline is critical for the success of a PTR offering and to minimize free-riders and gaming behavior while on the rate
- Customers should be given sufficient notice to plan their load shifting activities. However, the shorter the lead time, the demand reductions from the CPP becomes more valuable from a utility planning perspective
- Source of the rebates and broader rate impact implications should be considered, if eventually would be offered to a larger group of customers

Designing TVRs for winter-peaking utilities

While the TVR experience in winter climates is limited, broader principles for designing TVRs are still valid:

- Undertake a detailed cluster analysis of the system load shape and marginal energy costs to determine the seasons, peak and offpeak periods
- Undertake sensitivity analyses to gauge whether there are any changes to the system and period definitions by:
 - Extending the analysis a few years out into the forecast period
 - Considering the role of non-dispatchable renewable resources in the resource mix and their impact on the load to be served
- Undertake bill-impact analyses using the load research sample to study the implications of the TVRs on different customer types (i.e. high load factor vs. low load factor, electric vs. non-electric heating, etc.)

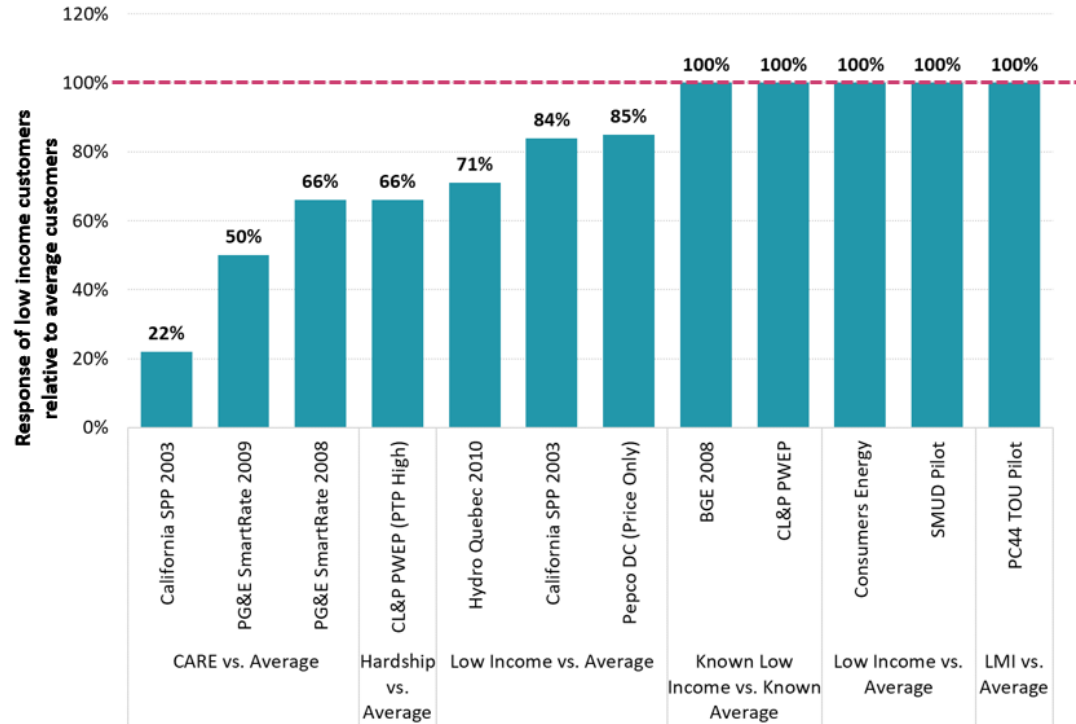
Designing TVRs for Low Income/Vulnerable Customers

One of the common concerns about TVR deployments is the possibility of low-income customers being adversely affected by time-variant rates

There are several reasons and data points to indicate why this is not likely to be the case:

- Low income customers are more likely to have “flatter” load profiles as opposed to “peaky” profiles. This implies that they are likely to be better off under the TVRs, especially if they can find ways to respond
- Several pilots undertook a separate analysis of low income customer price responsiveness and found that low income customers responded to the TVRs and in some cases as much as the average customers
- When offered on an opt-in basis, customers have the choice to not sign up for these rates

Low income customers respond to TVRs and sometimes just as much as an average residential customer



Notes: For the Pepco DC pilot, the average residential response excludes low income customers from RAD program. The average population for Hydro Quebec and Consumers Energy refers to specifically residential customers.

Source: The Brattle Group

PSE is committed to understanding its low income/vulnerable customers' experience with TVRs

- PSE proposes to create a separate treatment group to study impacts of TVR on low income/vulnerable customers
- TVR pilot will involve a statistically sizable sample of low income customers
- While the specific rate offering for these customers and the associated mechanisms are still to be determined, there are multiple alternatives:
 - Offering only PTR
 - Offering Discounted TOU rates
 - Offering TOU+PTR
 - Offering TOU rates with some level of bill protection during the first year to be phased out in the second year
 - Others?

Rate Design Decisions

There are several questions to be addressed during the rate design stage:

1. Should the rates be year-round or winter-only?
2. Should the TVR offering for low income customers differ from that of average residential customers?
3. What are the pros and cons of offering bill protection to the pilot customers during the first year of the pilot?
4. What are the pros and cons of offering detailed bill analyses to the potential pilot customers during the recruitment stage?
5. What are the pros and cons of offering shadow bills to the customers? If offered, what should be the frequency?
6. Should any of the rate designs be paired with enabling technologies?
7. How should the TVRs be structured so that the transition from block rates can be achieved most smoothly and transparently?
8. Others?

Discussion

- Which rate design objectives should be prioritized by PSE in designing the TVRs?
- Which TVR options would best meet the objectives of the pilot?
- Other concerns/reactions

3- Overview of Other Jurisdictions' Experience with TVR

Residential TVRs have been deployed around North America and the rest of the world

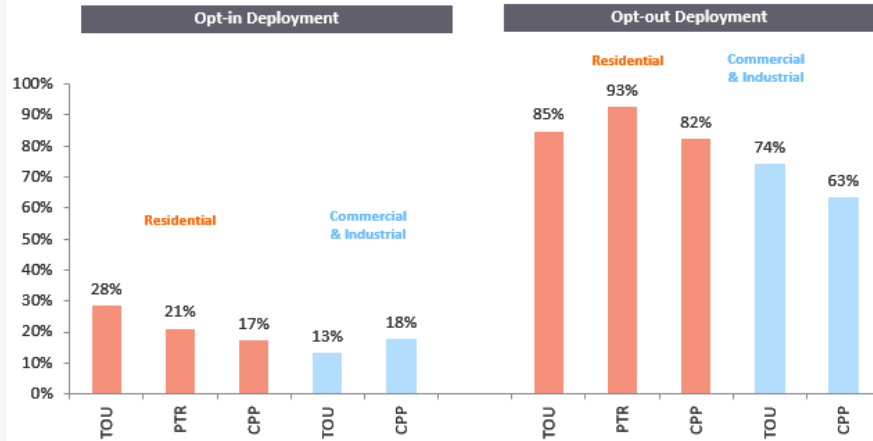
	Type of Rate	Applicability	Participating Customers
Oklahoma (<i>OGE</i>)	Variable Peak Pricing (VPP)	Opt-in	20% (130,000)
Maryland (<i>BGE, Pepco, Delmarva</i>)	Peak Time Rebate (PTR)	Default	80%
Ontario, Canada	Time-of-Use (TOU)	Default	90% (3.6 million)
Great Britain	Time-of-Use (TOU)	Opt-in	13% (3.5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



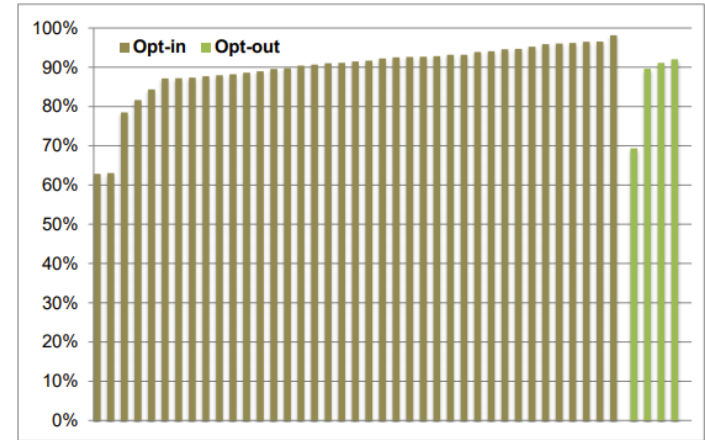
While there are a handful of states offering default TVRs on a mandatory or default basis, TVRs are most commonly offered as opt-in rates at this time

Enrollment in Time-Varying Rates

(Average Across 6 Market Research Studies and 14 Full Scale Deployments)



Retention Rates by Treatment Type: Opt-in vs. Opt-out



A DOE Meta Study (*) on 10 TVR pilots found that, while adoption and enrollment rates are lower under opt-in deployment compared to opt-out, retention is slightly higher

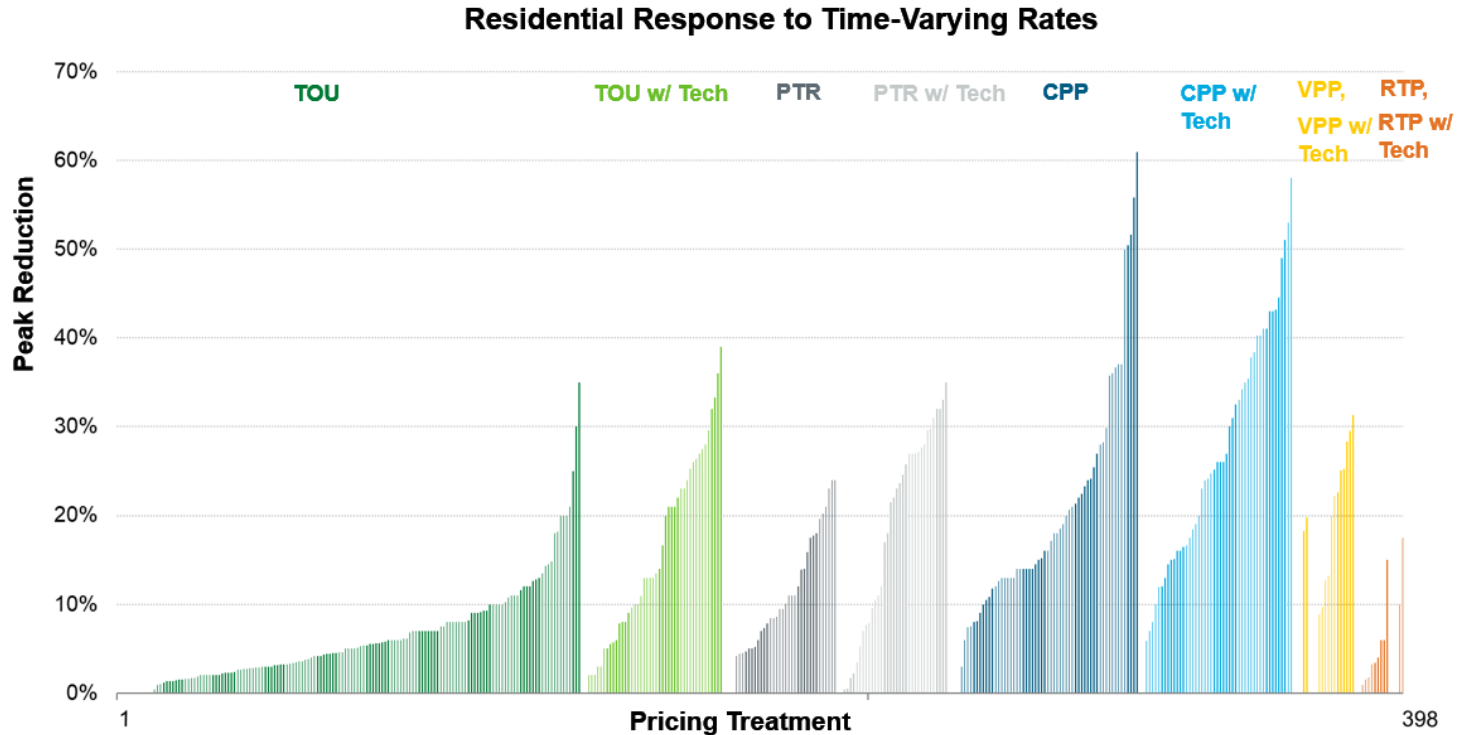
(*)DOE LBNL, "Final Report on Customer Acceptance, Retention, and Response to Time Based Rates from the Consumer Behavior Studies , November 2016

https://www.energy.gov/sites/prod/files/2017/01/f34/CBS_Final_Program_Impact_Report_20161107.pdf

- TVR opt-in rates are around 20% for residential and 15% for C&I customers
- TVR opt-out rates are around 85% for residential and 70% for C&I customers



There is compelling evidence from ~400 treatments that customers respond to TVRs

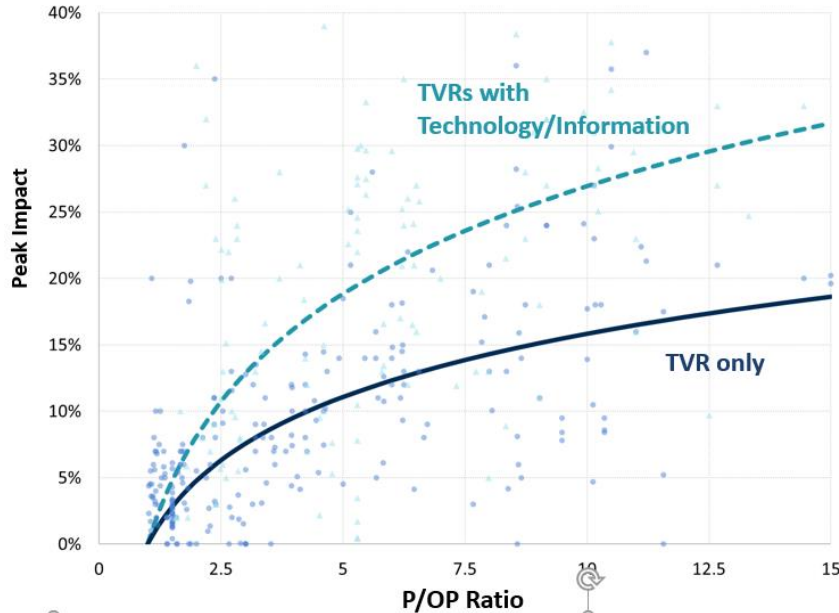


Source: Results from 79 pricing pilots and programs and 398 individual treatments in the Arcturus database.



As the ratio of peak to off-peak prices increases, peak load impacts increase, but at a decreasing rate

Arc of Price Response: TVR Only vs. TVR+Tech/Info

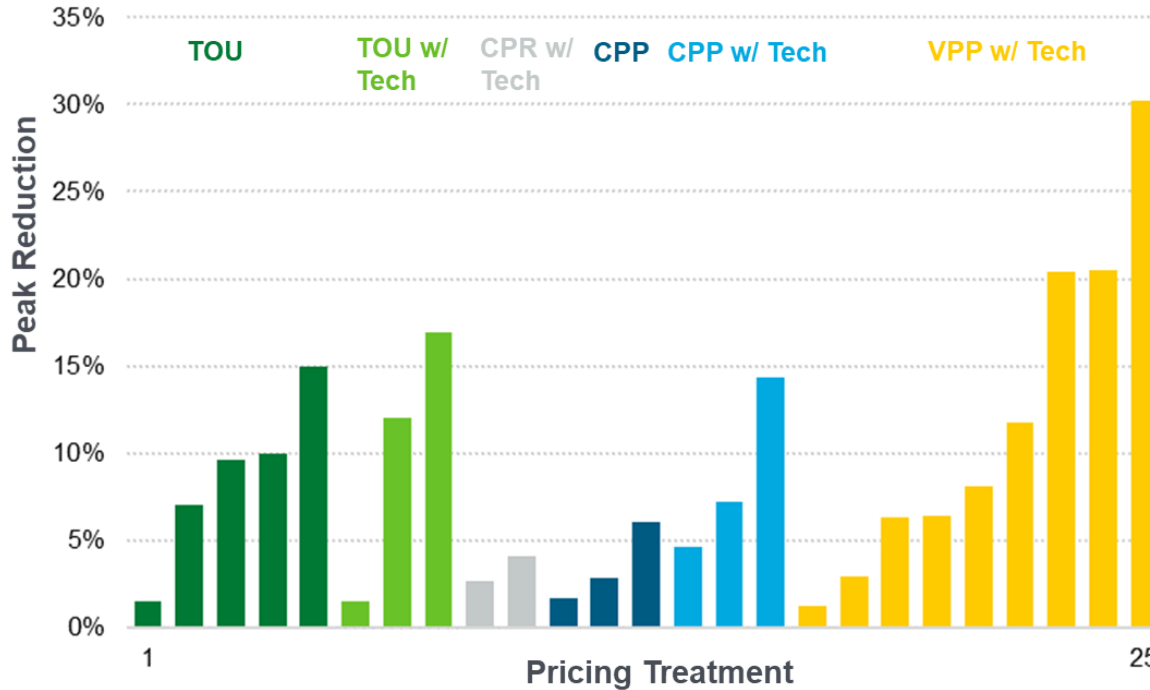


- Using 387 treatments, we regressed the reduction in peak demand on the peak to off-peak price ratio
- This yielded two “**Arcs of Price Response**,” one for price-only treatments and one for price+enabling technology treatments
- When TVRs are paired with enabling technologies and/or informational feedback, the peak impacts are higher than that with TVRs

Notes: Data from 74 pilots and programs and 387 individual treatments. RTP treatments are excluded.



Small C&I customers were also shown to respond to TVRs but the evidence is more limited



Source: Results from 4 pricing pilots and 25 individual treatments in these pilots. Con Edison's Innovative Pricing Pilot (2019-2020) was also reviewed but the small C&I impacts were not statistically significant.

U.S. Benchmark for Residential TVRs

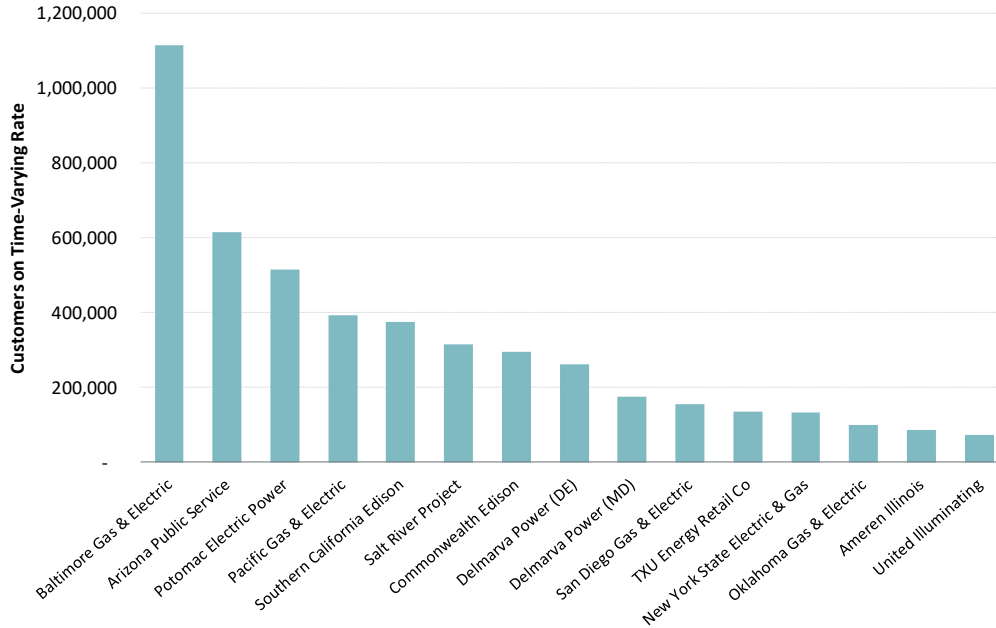
According to 2018 EIA Form-861, **322 U.S. utilities offer at least one form of TVR** to residential customers

- 303 offer Time-of-Use (TOU)
- 29 offer Critical Peak Pricing (CPP)
- 14 offer Peak Time Rebate (PTR)
- 9 offer Variable Peak Pricing (VPP)
- 6 offer Real-Time Pricing (RTP)

Altogether, **5.5 million customers** (or 4% of all residential customers) are enrolled on one of these TVRs

Largest Residential TVR Deployments

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



U.S. Benchmark for the Commercial Customer TVRs

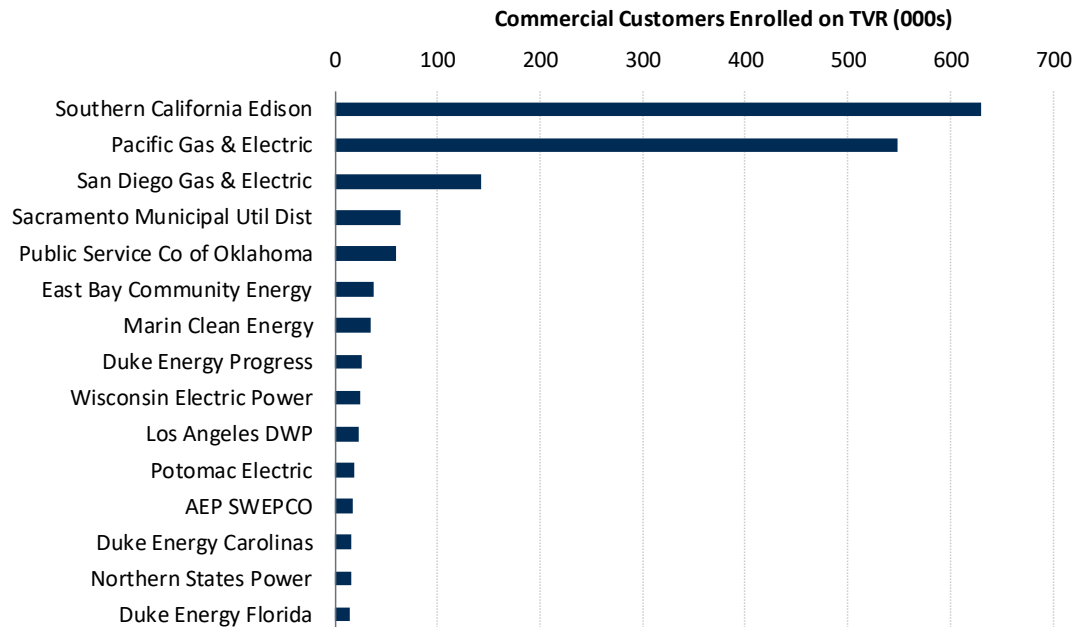
According to 2018 EIA Form-861, **463 U.S. utilities offer at least one TVP to their commercial customers**

- 401 offer Time-of-Use (TOU)
- 57 offer Real-Time Pricing (RTP)
- 49 offer Critical Peak Pricing (CPP)
- 16 offer Peak Time Rebate (PTR)
- 18 offer Variable Peak Pricing (VPP)

Altogether, **approximately 2 million customers** (16% of commercial customers served by these utilities, or 9% of all commercial customers) are enrolled on one of these commercial TVPs

Largest Commercial TVR Deployments

The list of utilities with the most commercial customers on TVPs is dominated by California's utilities, which account for 77% of all commercial customers on TVPs. The three investor-owned utilities (SCE, PG&E, SDG&E) alone account for 68% of such customers

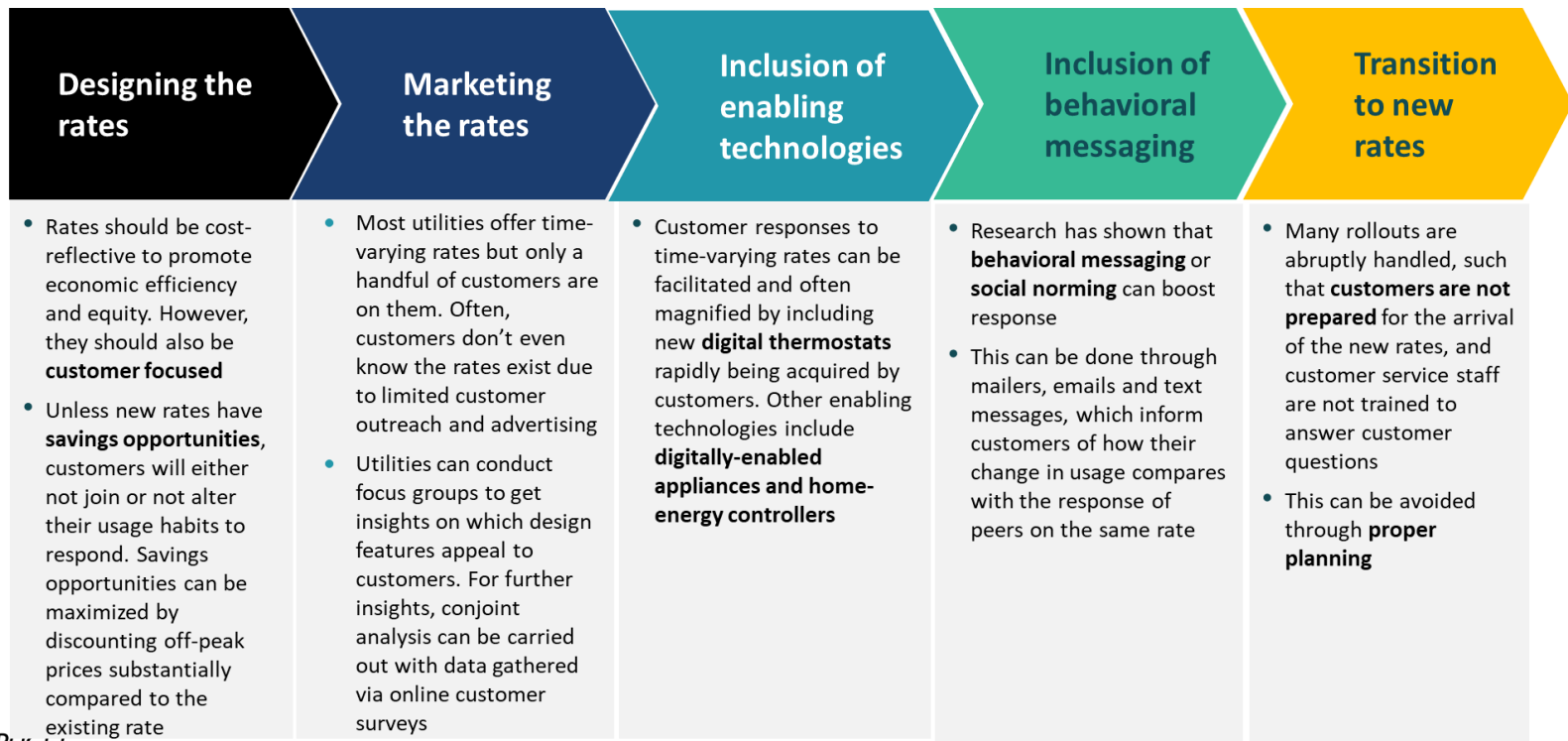


Winter peaking utility experience with TVRs is limited

	Study Years	Form(s) of TVP	Peak Price Ratio	Peak Impact	Notes
Puget Sound Energy	2001-2002	TOU	1.4	~5% reduction in peak period usage per month over a 15-month period	Involved four pricing periods. Customer response was encouraging in the first year, but declined in the second after a reduction in the peak price ratio and negative media coverage (in one quarter, customers experienced an average 80 c/month loss)
Pacific Power	2004	TOU	1.7-2.1	9% in winter morning, 8% in winter evening	Did not meet cost-effectiveness from a total resource cost perspective, in part due to low participation coupled with a high dropout rate
BC Hydro	2006-2008	TOU, TOU/CPP	TOU: 3-6 CPP: 7.9	2%-4% reduction in on-peak TOU period, 5% in critical peak period	Analysis of the second winter found that enabling tech (in-home display) doubled estimated TOU and CPP reductions
Hydro-Québec	2008-2010	TOU, TOU/CPP	TOU: 1.4-1.7 CPP: 3	Only significant in critical peak period under TOU/CPP rate (~6% reduction)	Hydro-Québec is now gradually offering opt-in PTR and CPP rates, detailed in a later slide
Portland General Electric	2016-2018	TOU, PTR, TOU/PTR	TOU: 1.8-2.6	TOU: Only statistically significant in summer PTR: 7%-12% winter demand savings for opt-in, 5% for opt-out PTR TOU/PTR: 1%-5%	Usage reductions were less significant in winter than summer, in part because approximately 60% of TOU participants have gas heating



Key lessons learned during the past two decades of deployment



Discussion

- Given the evidence presented, any inputs on PSE's proposed pilot path forward?
- Any other important learnings we should strive to achieve with the TVR pilot?
- Other feedback?

Next Steps

Next steps

- **Follow-up survey – please complete by EOD Friday**
- Customer focus groups (early June)
- Interim communication from PSE on stakeholder survey results, focus group results, and proposed rate design direction
- Stakeholder Collaborative 2 (late July)
- Stakeholder Collaborative 3 (late August)
- Finalize rate and pilot designs (September)