Retail Pricing: A Low Cost Approach to Load Flexibility

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Primary Mission of Retail Pricing

First and foremost function of retail rates is to recover utility's revenue requirement in the most economically efficient and equitable fashion

At the same time, rates should reflect the structure of the costs incurred to serve them and lead to **efficient price signals** to:

- Encourage optimal consumption decisions;
- Lead to bill stability for customers and revenue stability for utilities; and
- Be easily understandable by customers

When the rate construct is laden with other objectives, such as incentivizing new technologies and subsidizing certain customer groups, rates start to **fall short of delivering on their primary mission**, may lead to inter- and intra-class cost shifts, and convey inefficient price signals that lead to over- or under-consumption of electricity

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

Principles	Objective
1. Cost causation	• 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	• 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	• Customers and utility should both be paid the fair value for the grid services they provide
4. Customer Orientation	• Rates should aspire for simplicity while providing customer choices
5. Stability	• Customer bills should be relatively stable
6. Equity	• Electricity should remain affordable and accessible for vulnerable sub populations
7. Gradualism	• Rate changes should be implemented in a manner which would not cause any large bill impacts
8. Economic Sustainability	• 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

Source: Bonbright Principles adapted based on “NYREV Order Adopting A Ratemaking and Utility Revenue Model Policy Framework,” May 2016.

There are various alternatives to standard volumetric rates, most of which are enabled by AMI

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)

Retail Rates as a Load Flexibility Resource

While it is typical to think of **cost-causation** as a backward-looking concept for cost allocation, it is equally **forward-looking**

- How costs are allocated also affects price signals, which in turn affects future demand and system costs

Given the overwhelming evidence on customer response to price signals, **time varying rates** (TVR) emerge as an important and cost-effective load flexibility resource (especially for jurisdictions with AMI)

- As customers respond to time-varying price signals and move their consumption from high-priced periods to low-priced periods, they help avoid future generation, transmission and distribution capacity costs, reduce energy costs, help with the integration of renewable resources by reducing curtailments

Customers have diverse 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

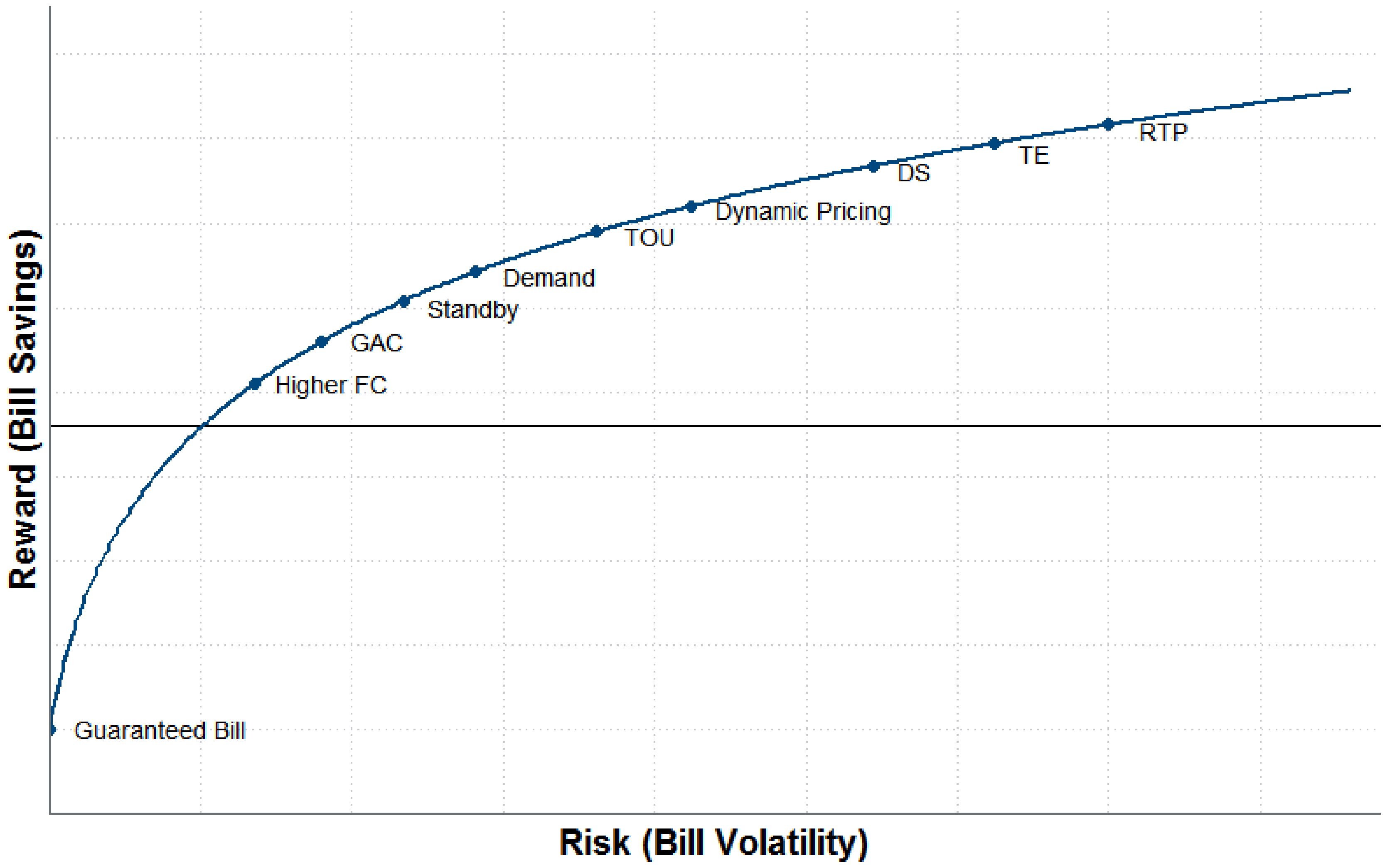
Many others are in between these two bookends

- Some might want a fixed bill but may be willing to lower it if rebates are offered for reducing demand during peak periods

All customers want choice but *they only want what they want*

Also, if the alternative rates are not appealing to customers, the most cost-reflective and most meticulously designed rates will not have many takers

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



Different rate designs meet different objectives

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

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

U.S. Benchmark for the Residential and Commercial 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 time-varying rates

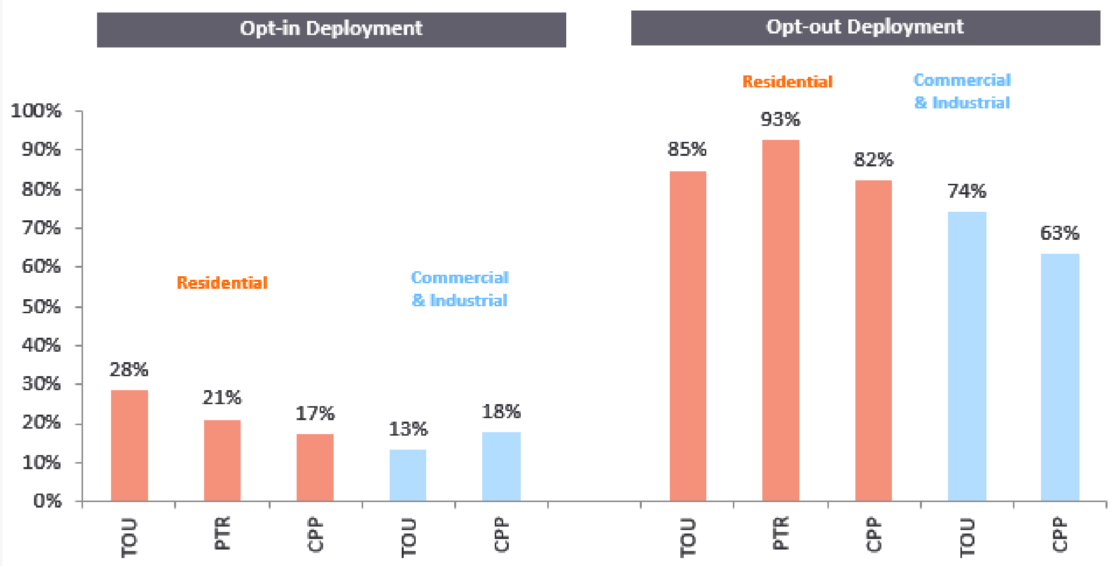
According to 2018 EIA Form-861, **463 U.S. utilities offer at least one TVR** to their commercial customers

- 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 (**9% of all commercial customers**) are enrolled on one of these commercial TVPs

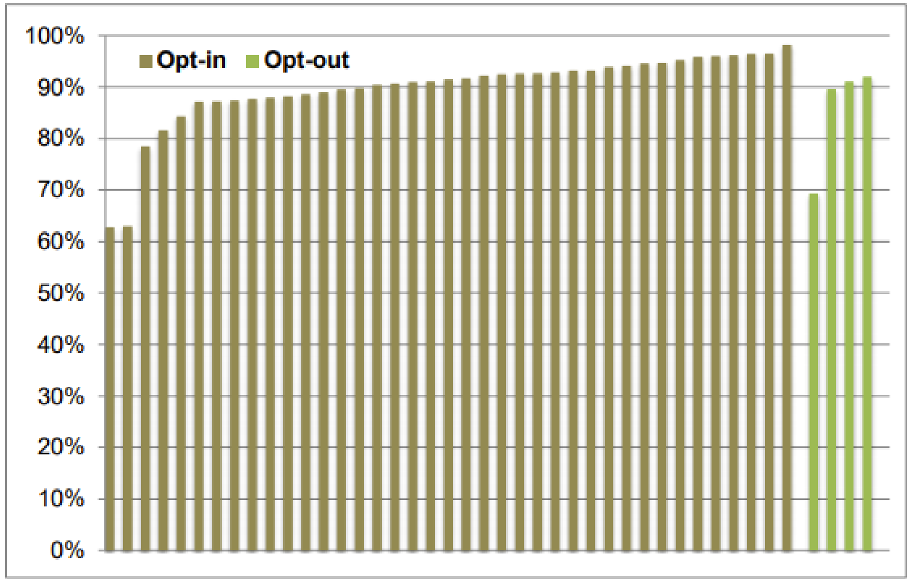
While there are a handful of states offering default TVRs on a mandatory or default basis, TVRs are most commonly offered as opt-in rates at this time

Enrollment in Time-Varying Rates
(Average Across 6 Market Research Studies and 14 Full Scale Deployments)



- **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

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

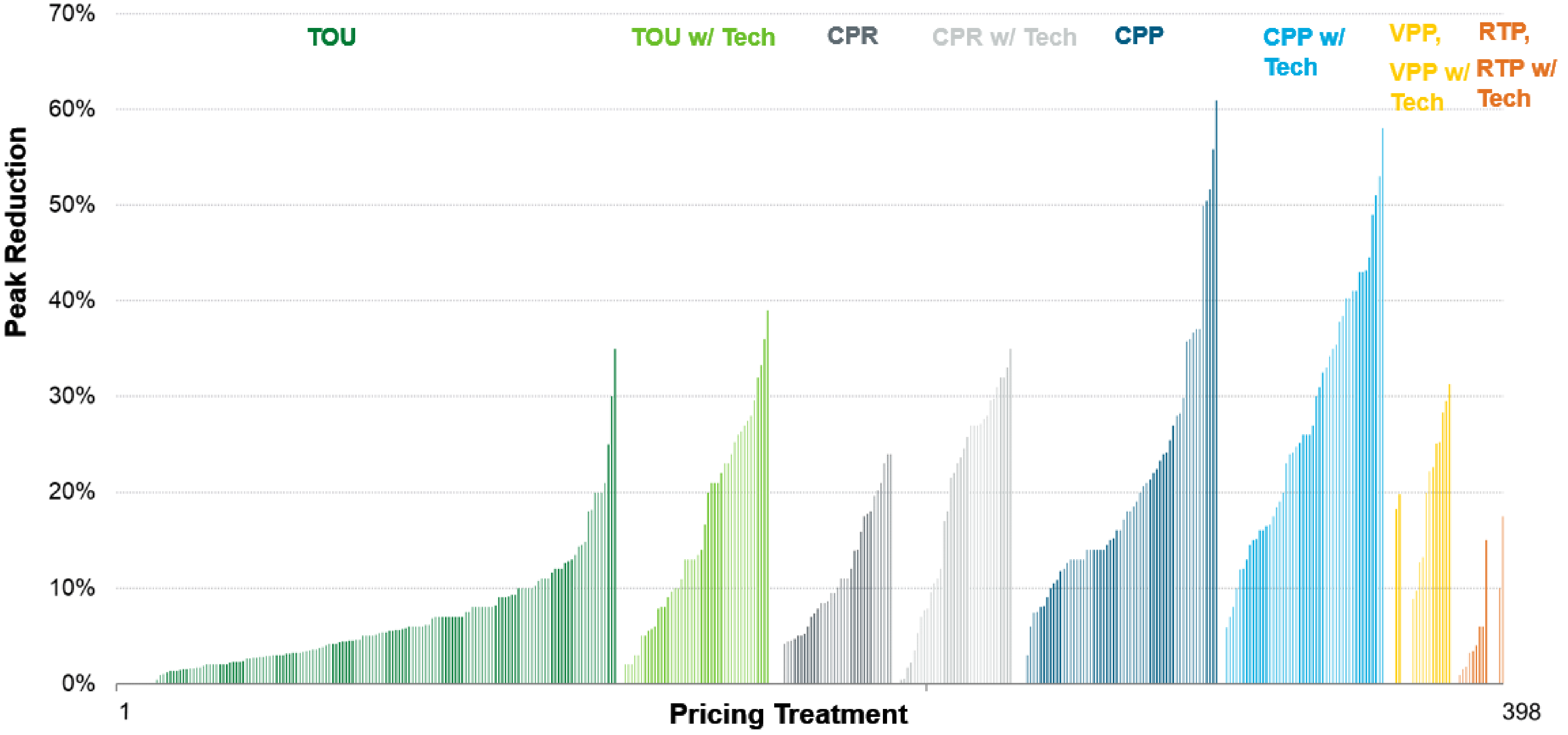


- A DOE Meta Study (*) on 10 TVR pilots found that, while adoption and enrollment rates are lower under opt-in deployment compared to opt-out, retention is slightly higher

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

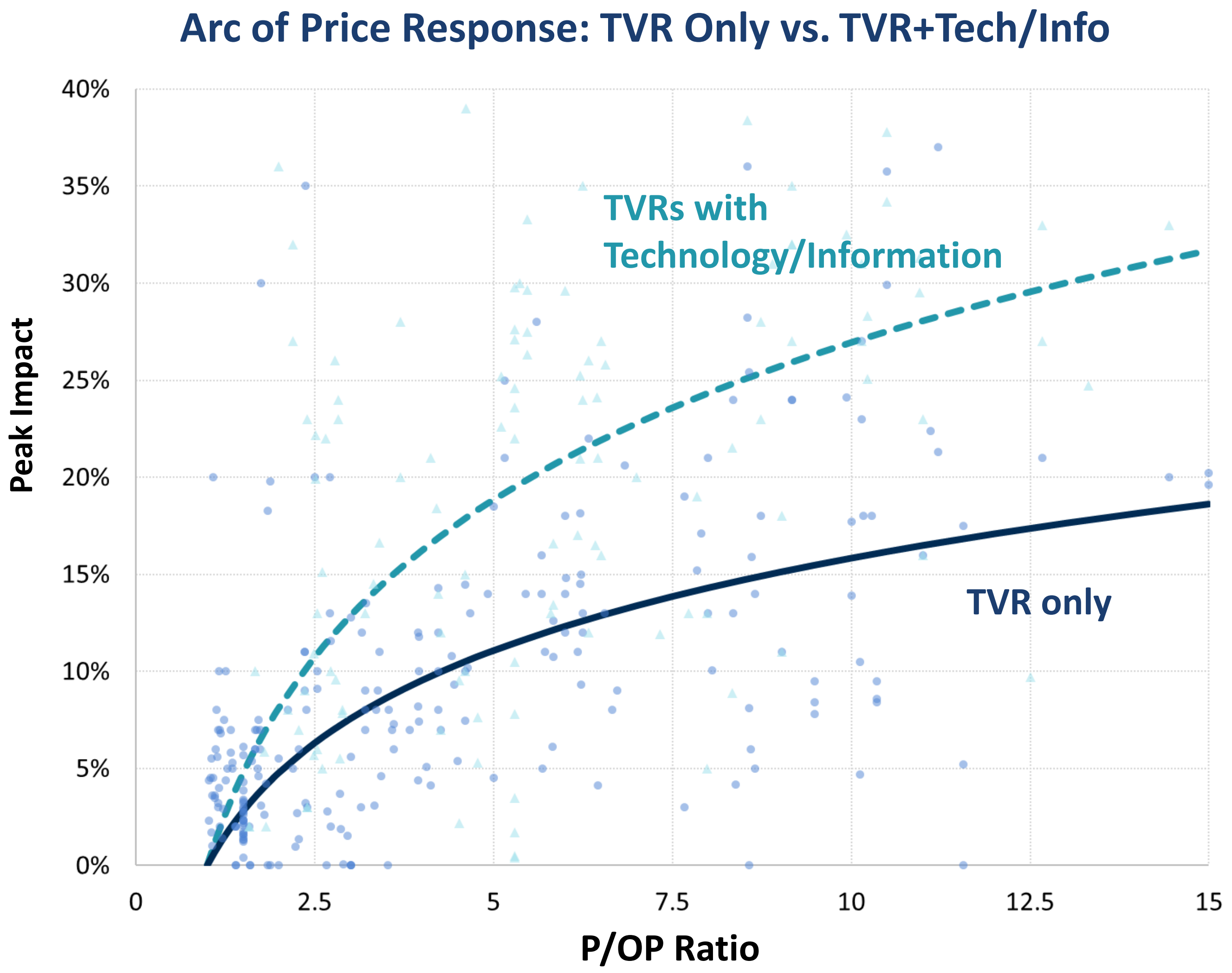
https://www.energy.gov/sites/prod/files/2017/01/f34/CBS_Final_Program_Impact_Report_20161107.pdf

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.

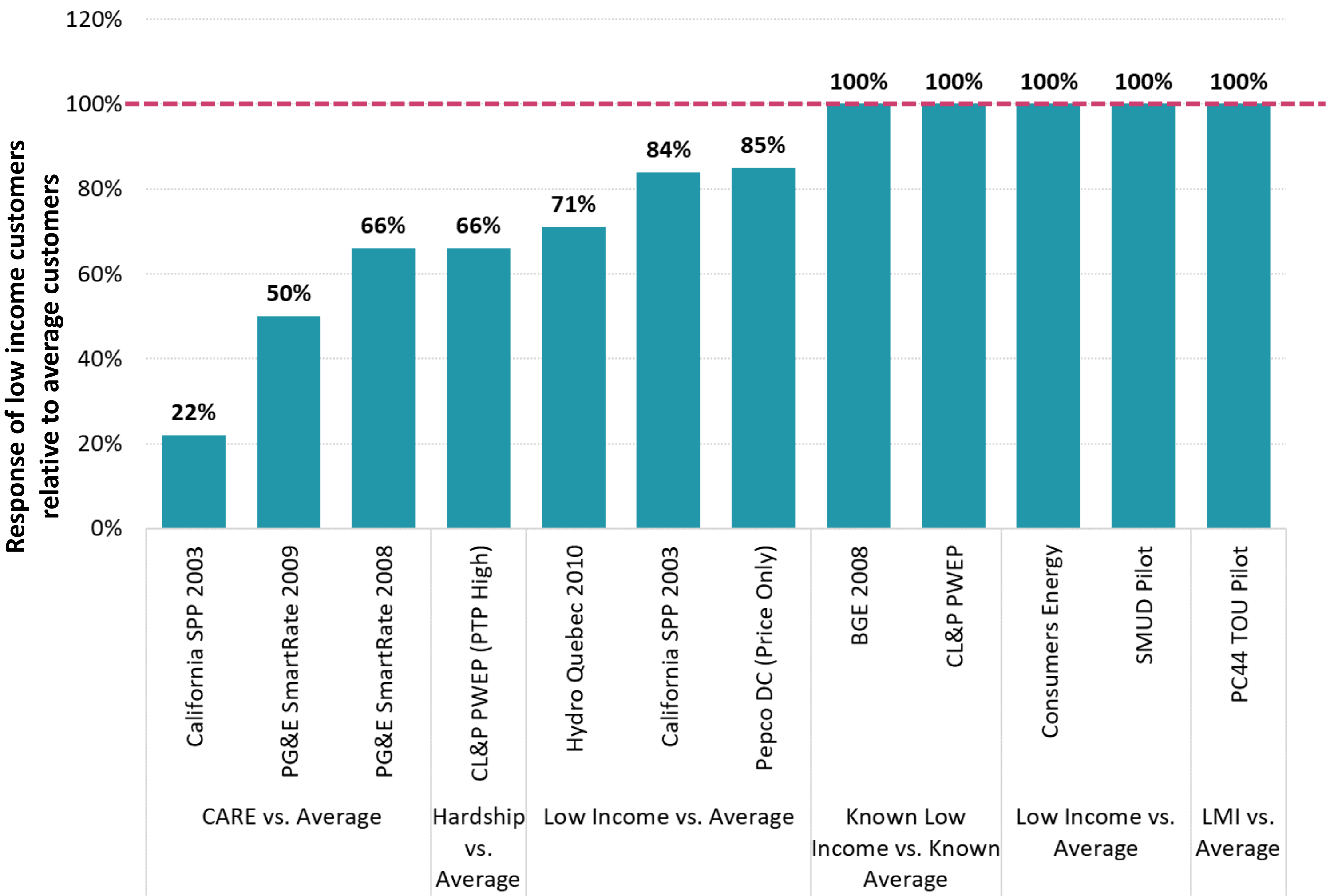
As the P/OP ratio increases, peak load impacts increase at a decreasing rate



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

- Using 387 treatments, we estimated a regression between Peak/Off-peak price ratios and peak impacts
- "**Arc of Price Response**" shows that the price responsiveness increases at a decreasing rate
- When TVRs are paired with enabling technologies and/or informational feedback, the peak impacts are higher than that of TVRs only

Low income customers respond to TVRs, in many cases as much as average customers



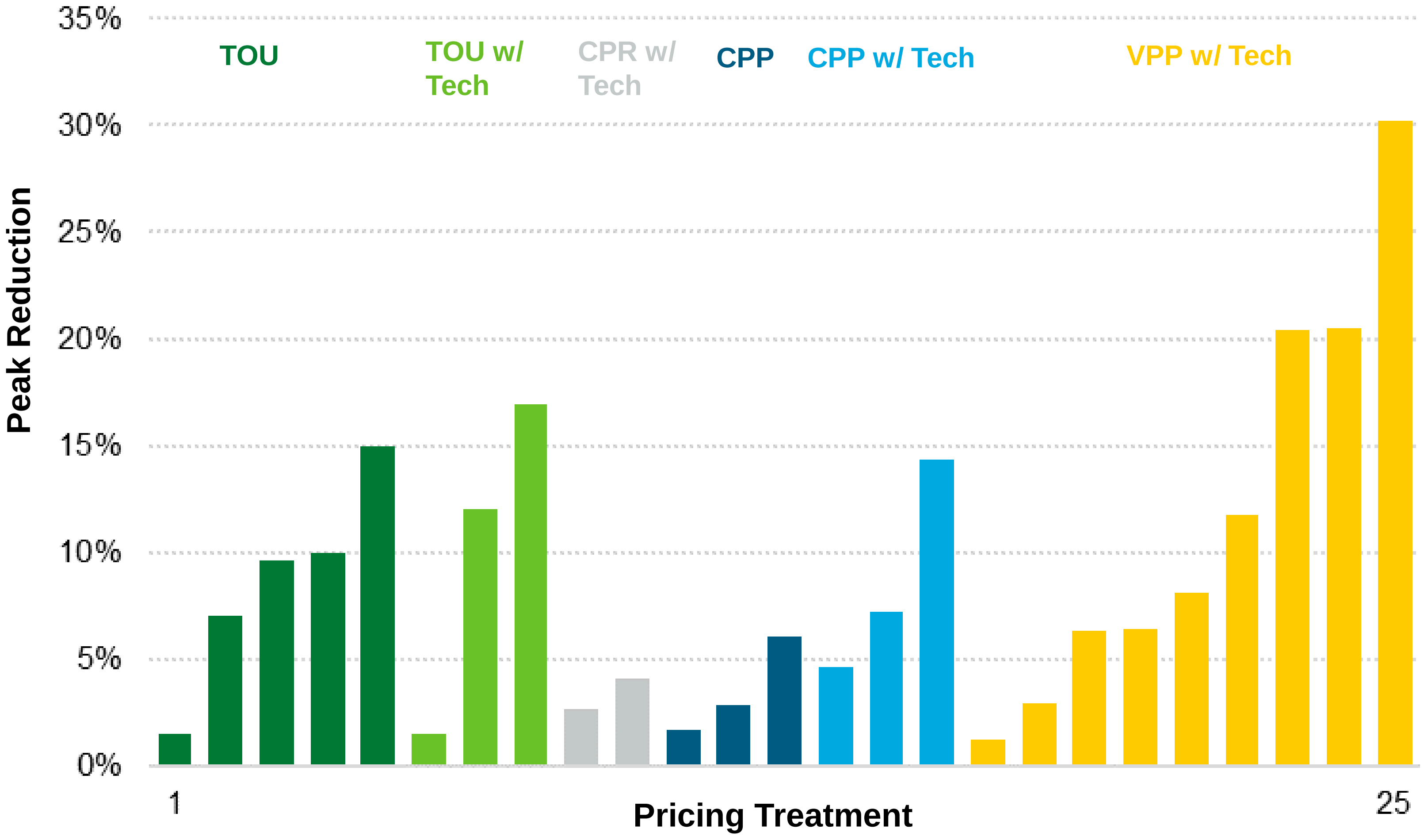
Notes: For the Pepco DC pilot, the average residential response excludes low income customers from RAD program. The average population for Hydro Quebec and Consumers Energy refers to specifically residential customers.

Whether the low income customers can respond to TVRs is a contentious question that come up in many stakeholder discussions

Several pilots included specific treatment groups for low and (sometimes low and moderate) income customers (i.e. Maryland PC44 TOU Pilot)

Evidence shows that low income customers do respond to the TVRs and in some cases as much as average customers on a percentage basis

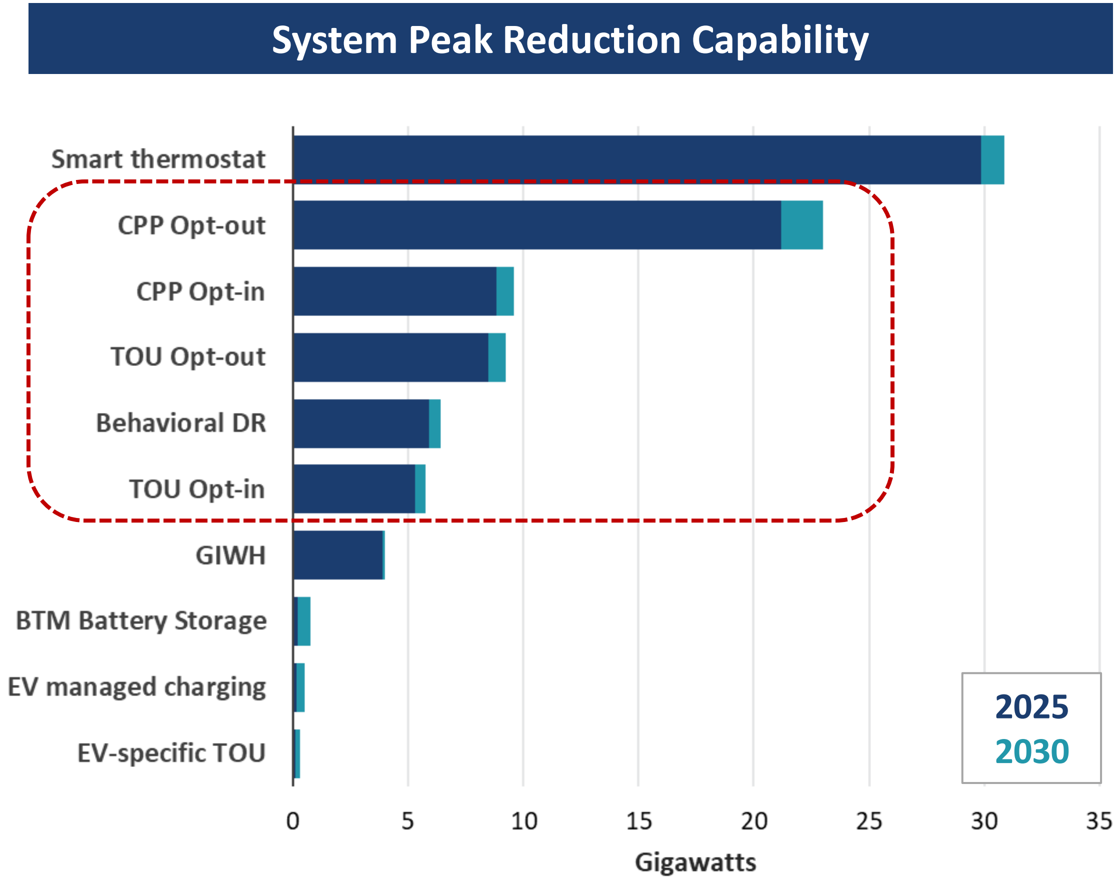
Small C&I customers were also shown to respond to TVRs but the evidence is more limited

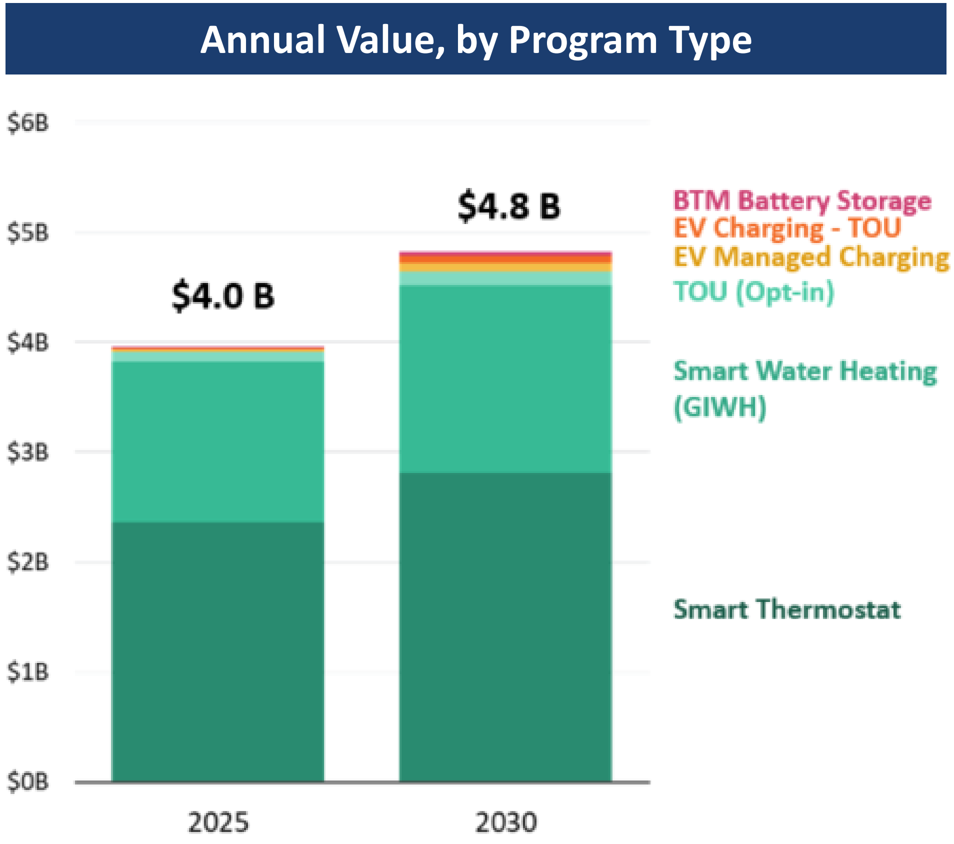


Source: Results from 4 pricing pilots and 25 individual treatments in these pilots. Con Edison's Innovative Pricing Pilot (2019-2020) was also reviewed but the small C&I impacts were not statistically significant.

Residential Load Flexibility Potential

While smart thermostats and water heaters lead to the largest value, time varying rates may provide a significant value based on the rate type and deployment approach





The potential estimates are based on achievable levels of adoption, but do not account for the cost-effectiveness of the options. Load flexibility value in nominal dollars.
Source: Brattle LoadFlex Model

Key lessons learned during the past two decades of TVR deployment

- Based on evidence from nearly 400 tests of TVRs, residential customers respond to TVRs by reducing their peak usage
- Price response is directly related to peak to off-peak price ratio, rather than the type of TVR being tested
- Residential customers are most price responsive as a % of peak usage compared to the small C&I customers
- Enabling technologies such as smart thermostats increase the load impacts by up to 100% based on the pilots that tested both
- Default rate offerings produce lower impacts per participant, but larger impacts in the aggregate (holding the rate design constant) due to the higher enrollment level
- While there is some evidence that TVRs may result in overall conservation, the evidence is not conclusive
- Most of the time-varying rates were piloted/offered in summer-peaking climates; the evidence for winter response is limited
- Understanding winter price response will become exceedingly important with heating electrification, and summer-peaking systems starting to switch to winter-peaking systems
- Rate coaching and frequent feedback offered with TVRs is expected to improve customer response and experience. Effectiveness of these programs are typically not evaluated.

Key lessons (cont'd)

Designing the rates	Marketing the rates	Inclusion of enabling technologies	Inclusion of behavioral messaging	Transition to new rates
• Rates should be cost-reflective to promote economic efficiency and equity. However, they should also be **customer focused** • Unless new rates have **savings opportunities**, customers will either not join or not alter their usage habits to respond. • Savings opportunities can be maximized by **discounting off-peak prices substantially** compared to the existing rate	• Most utilities offer time-varying rates but only a handful of customers are on them. Often, customers don't even know the rates exist **due to limited customer outreach** • Utilities can conduct focus groups to get insights on which design features appeal to customers. For further insights, conjoint analysis can be carried out with data gathered via online customer surveys	• Customer responses to time-varying rates can be facilitated and often magnified by including **smart thermostats** rapidly being acquired by customers. Other enabling technologies include **digitally-enabled appliances and home-energy controllers**	• Research has shown that **behavioral messaging** or **social norming** can boost response • This can be done through mailers, emails and text messages, which inform customers of how their change in usage compares with the response of peers on the same rate	• Many rollouts are abruptly handled, such that **customers are not prepared** for the arrival of the new rates, and customer service staff are not trained to answer customer questions • This can be avoided through **proper planning**

What comes next?

- We are rapidly nearing the important “**prices-to-devices**” breakthrough in which the devices respond to real-time prices based on the preprogrammed set-points reflecting customer preferences
  - As customers continue to adopt new technologies such as smart thermostats, smart water heaters, and EVs, opportunities to derive load flexibility resources from these technologies will increase
  - There are still some areas that need work, such as setting the load management standards like those recently initiated by California Energy Commission

- Even then there will still be customers who prefer to self-manage their consumption, and not to rely on devices or aggregators. Providing many options/choices will be key

- In the meantime, **TOU plus CPP rate** might be most suitable for the needs of most systems with increasing renewable penetration
  - The TOU element would enable **daily load shifting** from high-priced to low-priced hours (or high net load to low net load hours), while CPP elements would be activated on a select number of extreme days when **system capacity is constrained**
  - CPP events can be called to manage system peak needs, but they can also be called on a more localized level (i.e., covering a few substations) to **manage distribution system constraints**
  - Managing local constraints will be exceedingly important as EV adoption and building electrification initially clusters on certain parts of the distribution system and might benefit from more targeted load flexibility options

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