

# Retail Pricing: A Low Cost Approach to Load Flexibility

PRESENTED BY

SANEM SERGICI, PH.D.

PRESENTED TO

ESIG 2024 FORECASTING  
AND MARKETS WORKSHOP

JUNE 12, 2024



There are various alternatives to standard volumetric rates, many of which are time-varying rates and are enabled by AMI

| Rate                                              | Definition                                                                                                                                                               |
|---------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1- Time-of-Use (TOU)</b>                       | 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 |
| <b>2- Critical Peak Pricing (CPP)</b>             | Customers pay higher prices during critical events when system costs are highest or when the power grid is severely stressed                                             |
| <b>3- Peak Time Rebates (PTR)</b>                 | Customers are paid for load reductions on critical days, estimated relative to a forecast of what the customer would have otherwise consumed (their “baseline”)          |
| <b>4- Variable Peak Pricing (VPP)</b>             | During alternative peak days, customers pay a rate that varies by day to reflect dynamic variations in the cost of electricity                                           |
| <b>5- Real-Time Pricing (RTP)</b>                 | Customers pay prices that vary by the hour to reflect the actual cost of electricity                                                                                     |
| <b>6- Two-part Real-Time Pricing (2-part RTP)</b> | Customer’s current rate applies to a baseline level of consumption. A second, marginal cost based, price applies to deviations from the baseline consumption             |
| <b>7- Three-part Rates (3-part Rates)</b>         | 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       |
| <b>8- Fixed Bill with Incentives</b>              | 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

# Different rate designs meet different rate design objectives

| Time-Varying 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                |

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

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

# Winter-peaking utility experience with TVPs has been limited historically, but is improving

|                           | Study Years | Form(s) of TVP    | Peak Price Ratio             | Peak Impact                                                                                                                         | Notes                                                                                                                                                                                                                                                                                                                                 |
|---------------------------|-------------|-------------------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BC Hydro                  | 2006-2008   | TOU, TOU/CPP      | TOU: 3-6<br>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<br>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<br>PTR: 7%-12% winter demand savings for opt-in, 5% for opt-out PTR<br>TOU/PTR: 1%-5% | Usage reductions were less significant in winter than summer, in part because approximately 60% of TOU participants have gas heating                                                                                                                                                                                                  |
| Hydro-Québec              | 2019-2021   | PTR, CPP          | 6.8 and 7.7                  | ~22% reduction in peak during winter period per event                                                                               | Offers both PTR and CPP options to accommodate the preferences of both risk-taking and risk-averse customers. Overall survey show that 60% + customers were satisfied with the rate offering.                                                                                                                                         |
| Nova Scotia Power         | 2021-2023   | TOU, CPP          | 1.96 and 10.76 (residential) | TOU: 10.1% (morning) and 8.8% (evening)<br>CPP: 27% (morning) and 29% (evening)                                                     | Residential TOU and CPP participants achieved greater load reductions during peaks that coincided with the highest Adjusted Net Load (ANL) hours compared to all other peak periods. CPP participants achieved significant reductions in electricity usage levels on event days throughout winter and, to a lesser extent, in summer. |

# U.S. Benchmark for the Residential and Commercial TVRs



According to 2022 EIA Form-861, **380 U.S. utilities offer at least one form of time-varying rate** to residential customers

- 347 offer Time-of-Use (TOU)
- 28 offer Critical Peak Pricing (CPP)
- 14 offer Peak Time Rebate (PTR)
- 7 offer Variable Peak Pricing (VPP)
- 33 offer Real-Time Pricing (RTP)

Altogether, **13.1 million customers** (or 9% of all residential customers) are enrolled on one of these time-varying rates

According to 2022 EIA Form-861, **580 U.S. utilities offer at least one TVP to their commercial customers**

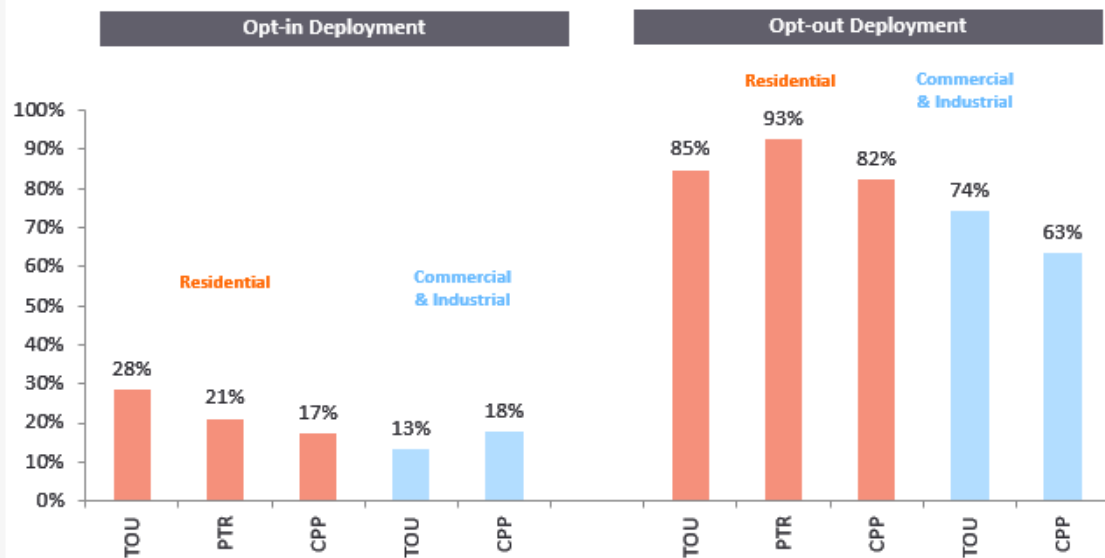
- 420 offer Time-of-Use (TOU)
- 42 offer Critical Peak Pricing (CPP)
- 12 offer Peak Time Rebate (PTR)
- 14 offer Variable Peak Pricing (VPP)
- 125 offer Real Time Pricing (RTP)

Altogether, **approximately 2 million customers** (12% of commercial customers served by these utilities) 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

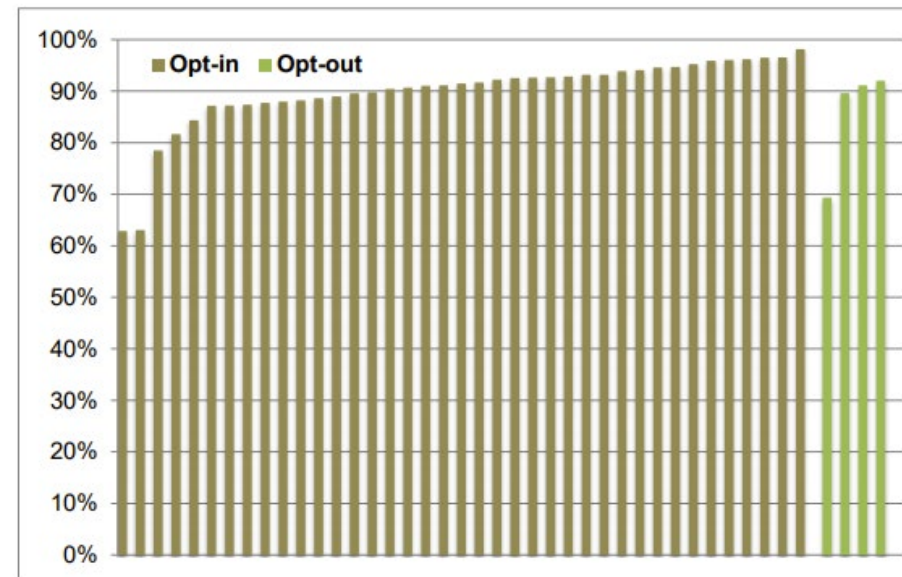
### Enrollment in Time-Varying Rates

(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

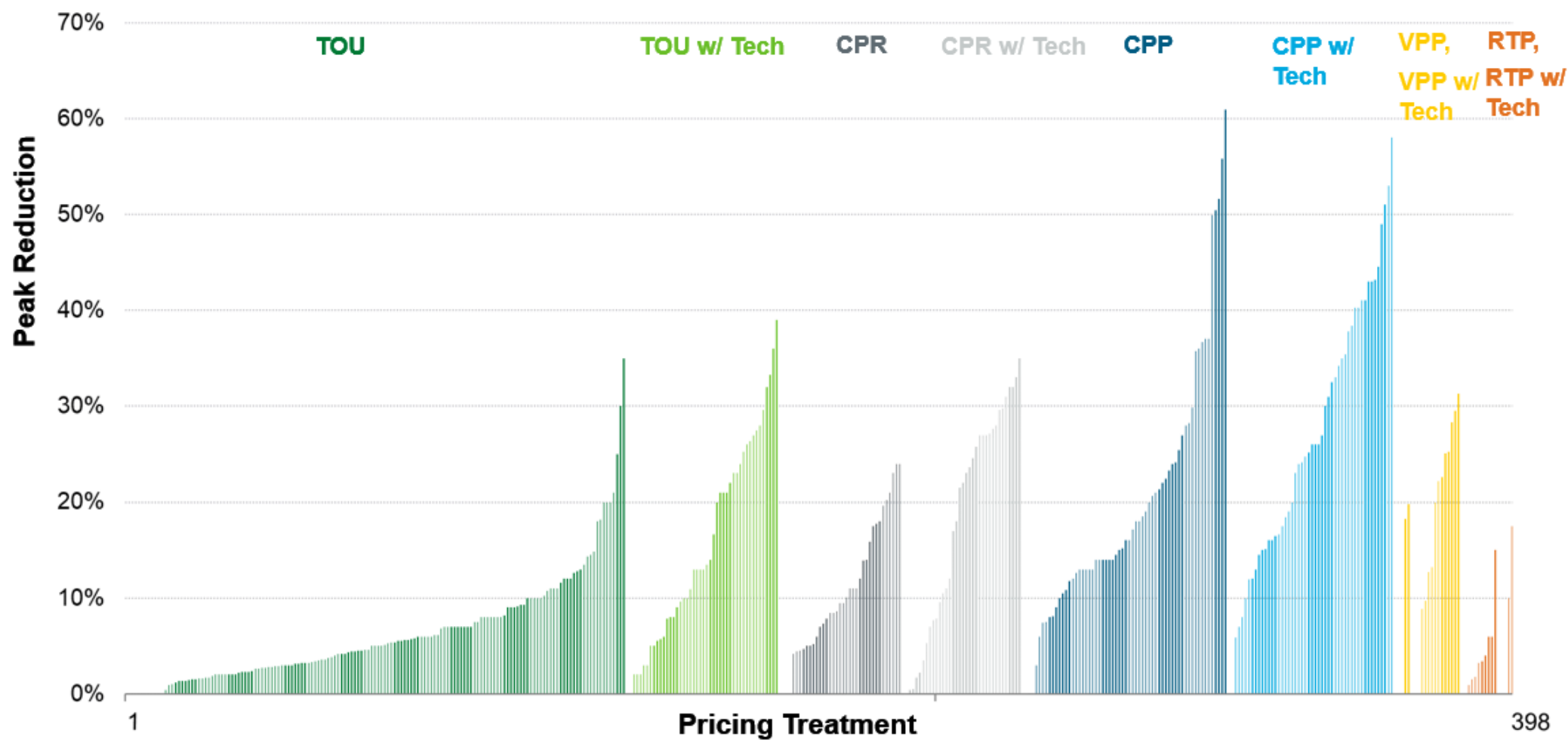


- A DOE Meta Study (\*) on 10 TVR pilots found that, while adoption and enrollment rates are lower under opt-in deployment compared to opt-out, retention is slightly higher

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

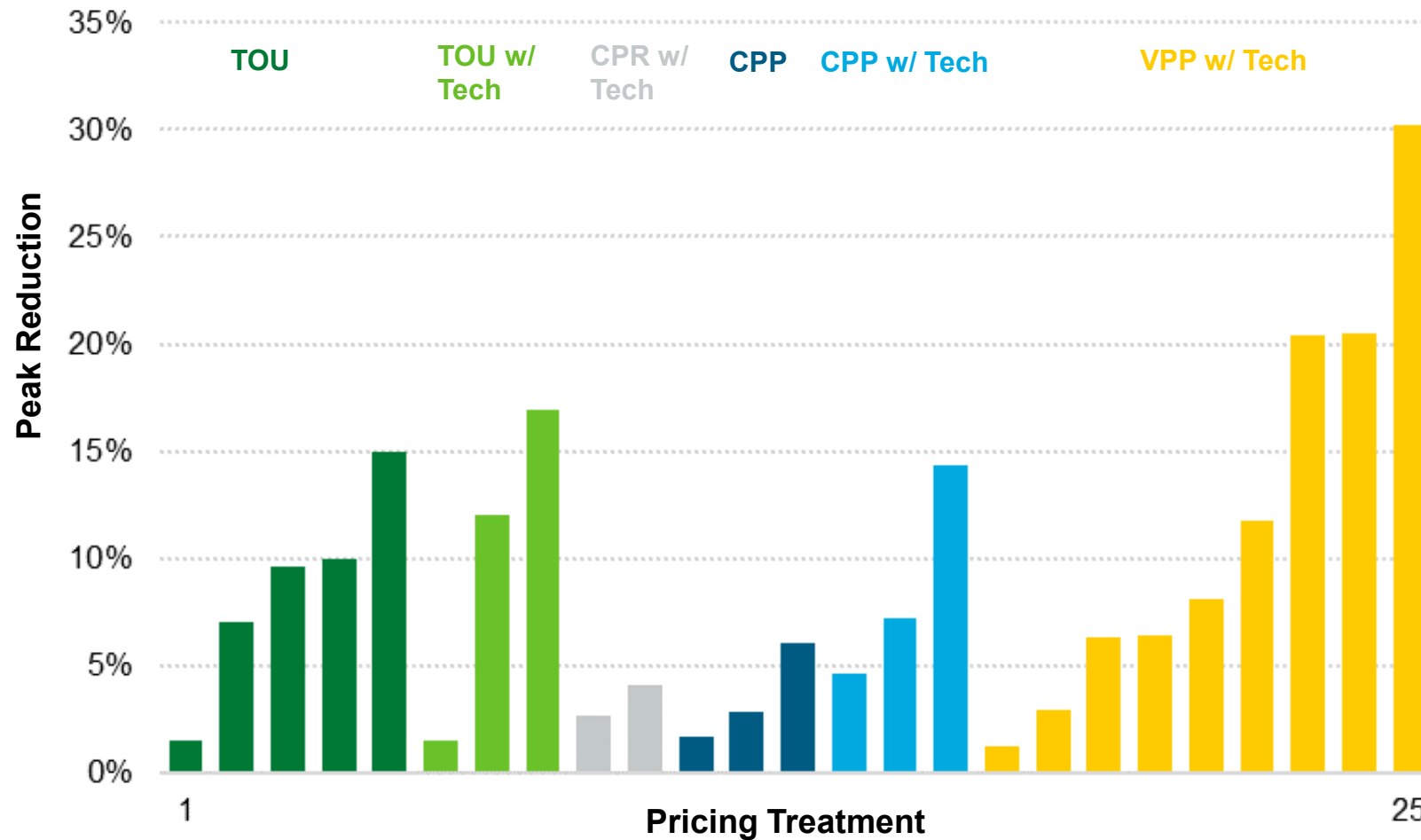
[https://www.energy.gov/sites/prod/files/2017/01/f34/CBS\\_Final\\_Program\\_Impact\\_Report\\_20161107.pdf](https://www.energy.gov/sites/prod/files/2017/01/f34/CBS_Final_Program_Impact_Report_20161107.pdf)

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



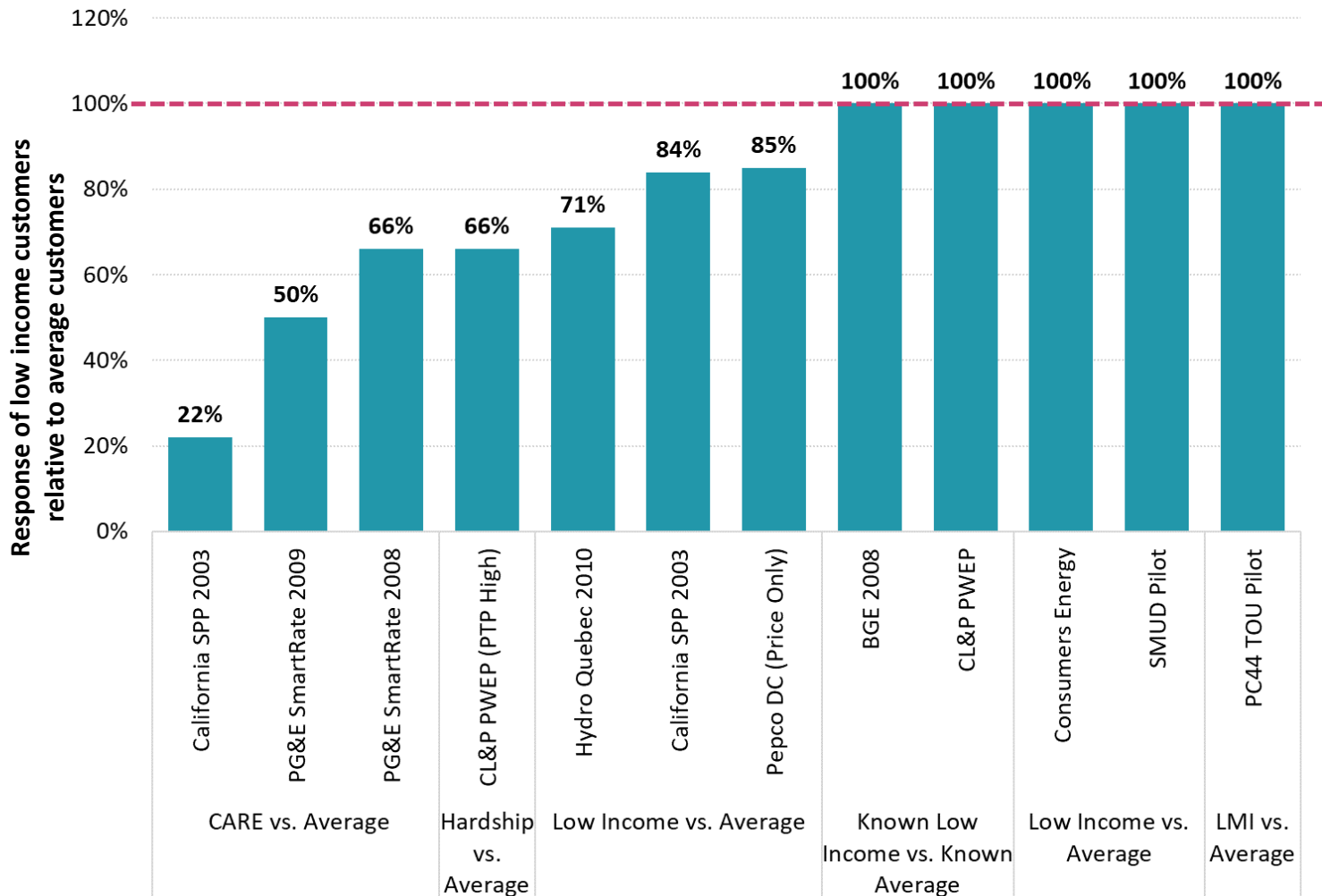
Source: Results from 79 pricing pilots and programs and 398 individual treatments in the Arcturus database.

## 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.

# 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

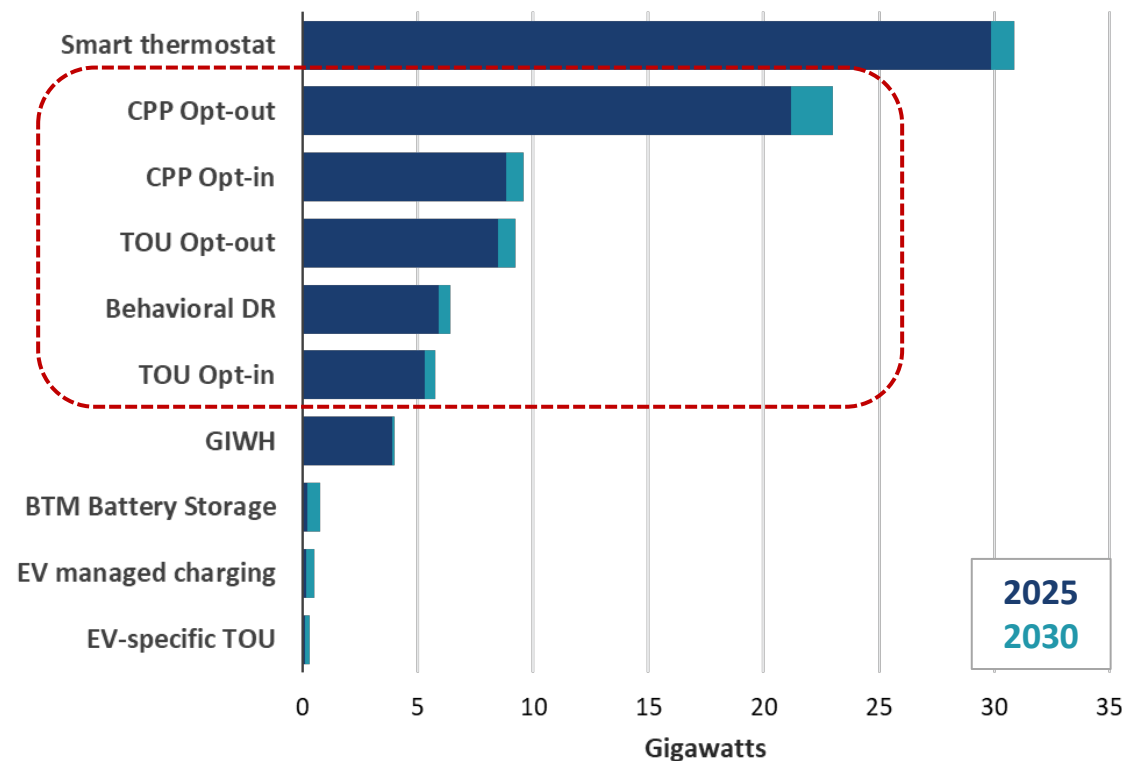
Several pilots included specific treatment groups for low and (sometimes low and moderate) income customers (i.e. Maryland PC44 TOU Pilot)

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

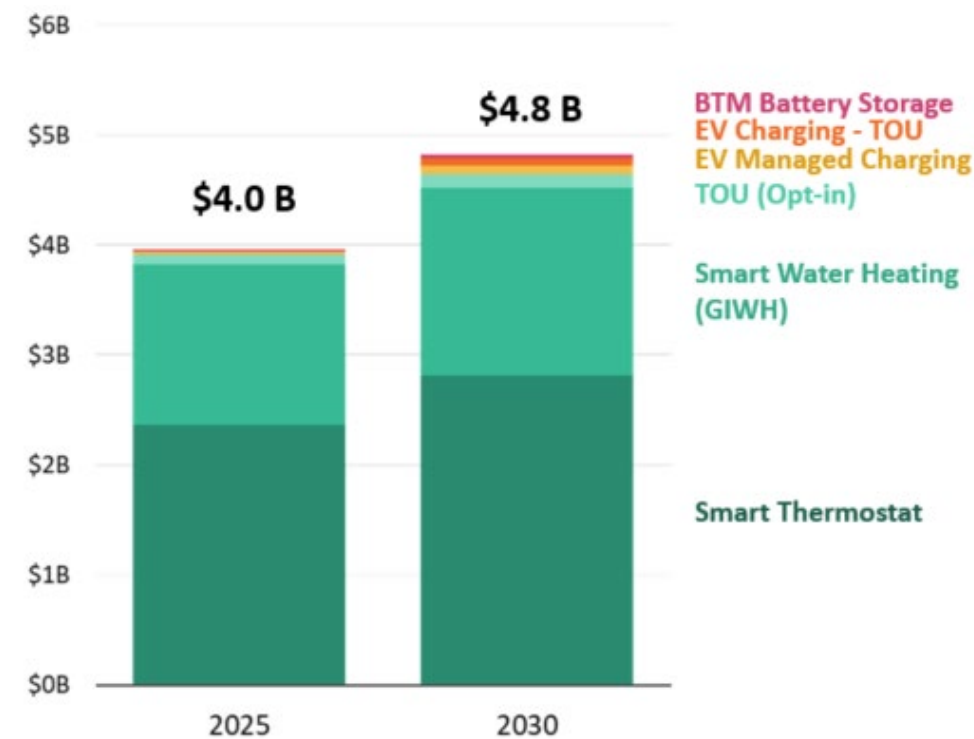
# Residential Load Flexibility Potential

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

System Peak Reduction Capability



Annual Value, by Program Type



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

# 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
- 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

# Clarity in the face of complexity

---

That's the Power of Economics™

