Update on EPE's Time Varying Rate (TVR) Pilot

Advisory Group Meeting #3

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DECEMBER 19, 2023

Brattle

Objectives of Today's Meeting

- Review the draft rate designs that Brattle and EPE have developed after feedback from stakeholders in previous meetings
- Review bill impacts of the proposed rate designs
- Discuss the pilot design approach and sample size requirements

Contents

1- Proposed Rate Designs

TVR Options – Recap

- Based on input from stakeholders and internal deliberations, we propose to test **three different rate designs**
  - 2-period time-of-day (TOD) rate
  - 2-period TOD + demand charge
  - 2-period TOD + critical peak pricing (CPP)
    - *2-period TOD + CPP + enabling technology has the same rate*
- We propose to test **eight treatments**
  - Include residential and small general service classes
  - Also include low-income residential customers as a separate subgroup and offer TOD rates for this subgroup

Proposed Treatment Cells

Customer	2-period TOD	2-period TOD + demand charge	2-period TOD + CPP	2-period TOD + CPP + enabling technology
Residential Low-Income	✓			
Residential	✓	✓	✓	✓
Small General Service	✓	✓	✓	

Season and Pricing Period Definitions

- We followed a data-driven approach to determine the seasons and pricing periods for the TVR pilot, using data from:
  - EPE system load and class load profiles
  - EPE's embedded cost of service
  - Marginal energy costs (system lambda)

Season	Peak Period	Off-peak Period
Summer (June-September)	2-7 pm MDT (HE 15-19) on weekdays	All other hours
Winter (October-May)	--	All hours

- Key results
  - Seasons are aligned with the season definitions used in EPE's current rates for New Mexico
  - Monthly gross load system profiles show that these summer months have the **highest load**
  - Peak period captures the **five highest system cost hours** in the day based on the cost allocation profiles

Rate Design Overview

Consistent with rate design best practices and discussions with the EPE team and stakeholders, we aim to accomplish the following:

- Ensure that the rates are derived using a cost basis relying on the most recent embedded cost of service study (ECOSS) for New Mexico
- Ensure that the rate is revenue neutral to the ECOSS revenue requirement for each class
- Design rates to reflect the underlying structure of EPE's costs
  - EPE allocates costs to the **Generation, Transmission, Distribution, and Customer** functions
  - Each of the above functions is further classified into cost drivers, **Demand, Energy, and Customer**
  - We assign costs for each function to each season and pricing period based on defined cost drivers
- Adjust cost-based rates to improve ease of communication with customers and customer uptake

2-period TOD Rate

- Rate design considerations
  - Volumetric rates ($/kWh) are reflective of Generation, Transmission, Distribution costs in all periods based on cost drivers
  - Peak period results in a larger share of costs due to underlying cost drivers
  - Monthly customer charge is maintained at its current level
- Rates have strong price signals encouraging customers to shift load to off-peak periods
  - **4:1 Peak/Off-peak** for residential
  - **3:1 Peak/Off-peak** for small general service (SGS)

Residential

4 : 1 Summer Price Ratio

NM Residential		Proposed	Current IBR
Summer			
On-peak	$/kWh	0.28397	-
Off-peak	$/kWh	0.07099	-
Tier 1 (First 600 kWh)	$/kWh	-	0.06999
Tier 2 (Over 600 kWh)	$/kWh	-	0.10840
Winter			
Off-peak	$/kWh	0.03300	-
Flat	$/kWh	-	0.05782
Customer Charge			
Customer charge	$/cust/mo	7.00	7.00

SGS

3 : 1 Summer Price Ratio

NM SGS		Proposed	Current	
			Standard Rate	Alternative Rate
Summer				
On-peak	$/kWh	0.32694	-	-
Off-peak	$/kWh	0.10898	-	-
Demand Charge	$/kW	-	18.63	-
Energy Charge	$/kWh	-	0.03963	0.10941
Winter				
Off-peak	$/kWh	0.04049	-	-
Demand Charge	$/kW	-	13.93	-
Energy Charge	$/kWh	-	0.01152	0.07441
Customer Charge				
Customer charge	$/cust/mo	14.00	14.00	14.00

Notes: Summer = June 1 - September 30, Winter = all other months.

2-period TOD + CPP

- Rate design considerations
  - Critical Peak Price will be active during the 5-hour summer peak period for **20 event days** in summer
  - CPP rate presented in the table is the total effective rate during the CPP period
  - CPP period is assigned the majority of the marginal generation capacity costs, and reflects costs related to other functions such as transmission and distribution
  - Maintain a reasonably high CPP/off-peak and a meaningful peak/off-peak price ratio
- Rates have strong price signals encouraging customers to shift load to off-peak periods
  - **10:1 CPP/Off-peak** and **2:1 Peak/Off-peak** for residential
  - **8:1 CPP/Off-peak** and **2:1 Peak/Off-peak** for SGS

Residential

10 : 1 CPP Price Ratio and 2 : 1 Summer Price Ratio

NM Residential		Proposed	Current IBR
Summer			
Critical Peak	$/kWh	0.68098	-
On-peak	$/kWh	0.13620	-
Off-peak	$/kWh	0.06810	-
Tier 1 (First 600 kWh)	$/kWh	-	0.06999
Tier 2 (Over 600 kWh)	$/kWh	-	0.10840
Winter			
Off-peak	$/kWh	0.03412	-
Flat	$/kWh	-	0.05782
Customer Charge			
Customer charge	$/cust/mo	7.00	7.00

SGS

NM SGS		Proposed	Current	
			Standard Rate	Alternative Rate
Summer				
Critical Peak	$/kWh	0.79830		
On-peak	$/kWh	0.19957	-	-
Off-peak	$/kWh	0.09979	-	-
Demand Charge	$/kW	-	18.63	-
Energy Charge	$/kWh	-	0.03963	0.10941
Winter				
Off-peak	$/kWh	0.04171	-	-
Demand Charge	$/kW	-	13.93	-
Energy Charge	$/kWh	-	0.01152	0.07441
Customer Charge				
Customer charge	$/cust/mo	14.00	14.00	14.00

2-period TOD + Demand Charge

- Two components besides the fixed charge
  - **Volumetric TOD rate** featuring the same pricing windows as the pure TOD rate
  - **Demand charge** that applies only during the summer peak period
- Rate design considerations
  - Demand charge recovers a portion of generation demand and transmission costs in the peak period
  - Aim to recover less than 1/3 of the revenues from demand charge and the rest from volumetric and fixed charges on an annual basis
  - Maintain a meaningful peak/off-peak price ratio for the volumetric charge; currently **4:1 Peak/Off-peak**
  - Incorporate forgiveness elements to prevent bill hikes
    - Set monthly billing demand as the *average of the three highest* demands recorded in the peak period in a given month, as opposed to using the maximum demand
    - In one out of the four summer months, if the billing demand exceeds a certain threshold (e.g., demand implied by a 15% load factor), set billing demand at that threshold

Residential

4 : 1 Summer Price Ratio

NM Residential		Proposed	Current IBR
Summer			
Demand Charge	$/kW	4.38	-
On-peak	$/kWh	0.23408	-
Off-peak	$/kWh	0.05852	-
Tier 1 (First 600 kWh)	$/kWh	-	0.06999
Tier 2 (Over 600 kWh)	$/kWh	-	0.10840
Winter			
Off-peak	$/kWh	0.03187	-
Flat	$/kWh	-	0.05782
Customer Charge			
Customer charge	$/cust/mo	7.00	7.00

SGS

4 : 1 Summer Price Ratio

NM SGS		Proposed	Current	
			Standard Rate	Alternative Rate
Summer				
Demand Charge	$/kW	10.34		
On-peak	$/kWh	0.30269	-	-
Off-peak	$/kWh	0.07567	-	-
Demand Charge	$/kW	-	18.63	-
Energy Charge	$/kWh	-	0.03963	0.10941
Winter				
Off-peak	$/kWh	0.03791	-	-
Demand Charge	$/kW	-	13.93	-
Energy Charge	$/kWh	-	0.01152	0.07441
Customer Charge				
Customer charge	$/cust/mo	14.00	14.00	14.00

2- Bill Impacts

Bill Impact Analysis Overview

- Bill impact analysis helps inform the distribution of the bill impacts across the customer base, due to a rate design change

- For EPE's residential customers, when transitioning from the existing inclining block rate to TOD rates, the customer's bill change typically depends on the customers' **existing usage**, **rate difference**, **load shape**, and their **response**
  - Under a revenue neutral rate, there is no bill change for the class-average customer before any load response
  - Customers who currently consume proportionately less electricity during off-peak hours will experience bill savings under the new TOD rates (even if they don't change their load profile)
  - Customers who consume more electricity during peak hours will experience an bill increase
  - Most customers can lower their bills by shifting electricity usage away from peak periods

Approach

- Obtain hourly usage data from customers from EPE’s load research sample

- Using customer usage data, calculate and compare the monthly bills under:
  - The current rates
  - The proposed TVR *before* load response
  - The proposed TVR *after* load response

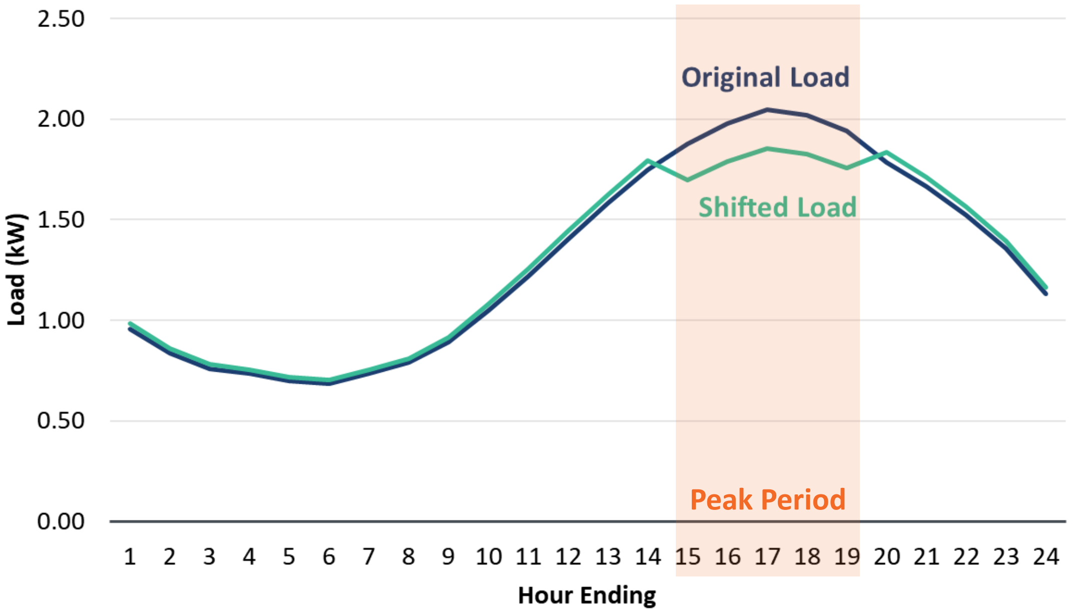
- Bill impact is computed as:

  Total annual bill under the new TVR rate

  minus

  Total annual bill under the current rate

Illustration of Load Response
Average Residential Customer on a Summer Weekday



Load Response Assumptions

- Assumptions for load response come from our Arcturus database, which contains pricing treatments from over 400 TVR pilots implemented all over the world
  - We assume that customers shift load from the peak (or critical peak) period to the off-peak
  - The assumed load response is a function of the peak/off-peak price ratio – Higher price ratio results in a greater load shift

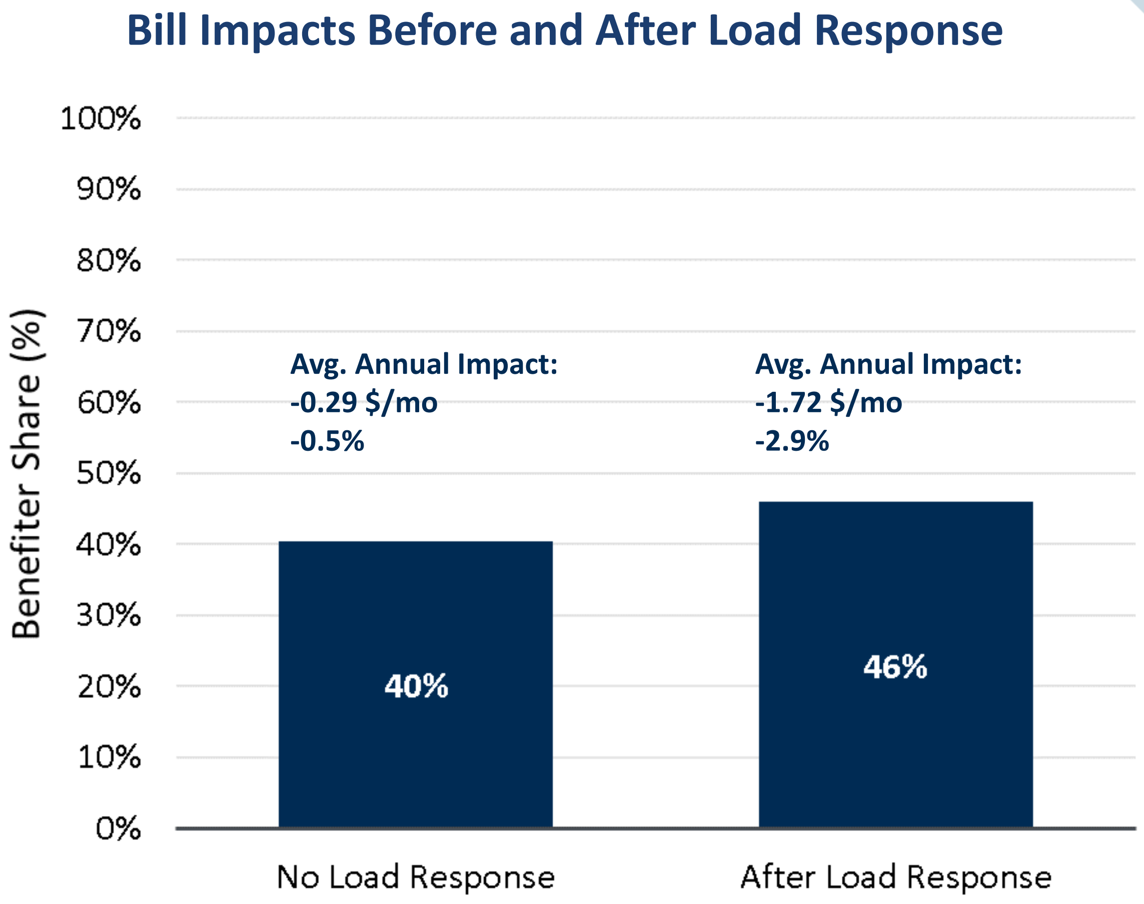
Load Response Assumptions – % Load shift

Rate	NM RES	NM SGS
2P TOD	9.2%	7.3%
2P TOD + CPP	19.5% CPP impact 5.9% Peak impact	17.6% CPP impact 5.9% Peak impact
2P TOD + Demand charge	9.2%	9.2%

Source: Dr. Sanem Sergici, Dr. Ahmad Faruqui, Sylvia Tang, "Do Customers Respond to Time-Varying Rates: A Preview of Arcturus 3.0", Brattle Working Paper. For the tech-enabled CPP treatment, we assume a 9.8% shift in load from peak to off-peak as enabling technologies can help improve load response even more, per evidence from the Arcturus database.

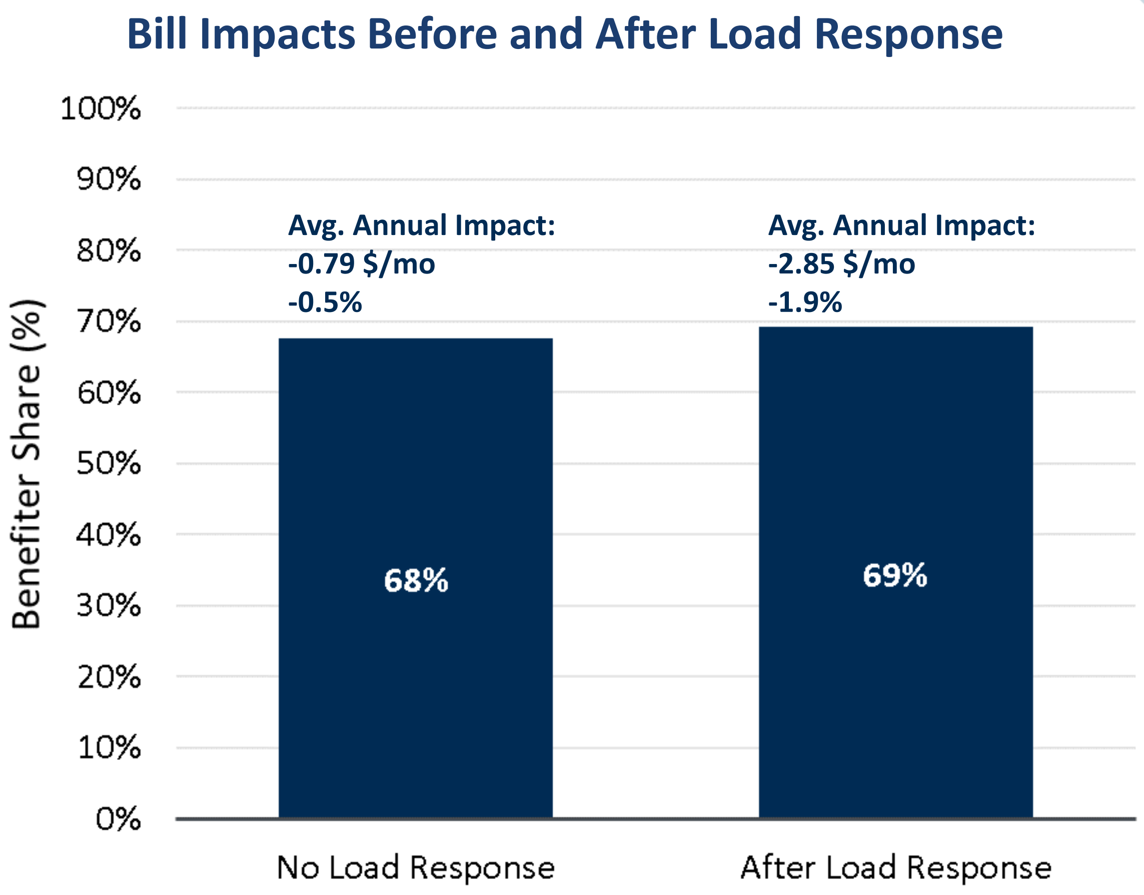
2-period TOD Rate - Residential Bill Impacts

- Before load response
  - **40%** of the population benefitting on the rate
  - Average customer sees modest annual bill reduction of ~**0.5%**
- After load response
  - **46%** of the population benefitting due to ~9% load shift from peak to off-peak
  - Average bill reduction is ~**3%**
- Key insights
  - Smaller customers tend to represent lower share of benefiters as they lose the lower rate from the current inclining block rate
  - Summer period exhibits bill increase for all customers, while the winter period exhibits savings for all customers
  - Customers with higher summer consumption will experience bill increases if not shifting load to off-peak



2-period TOD Rate – SGS Bill Impacts

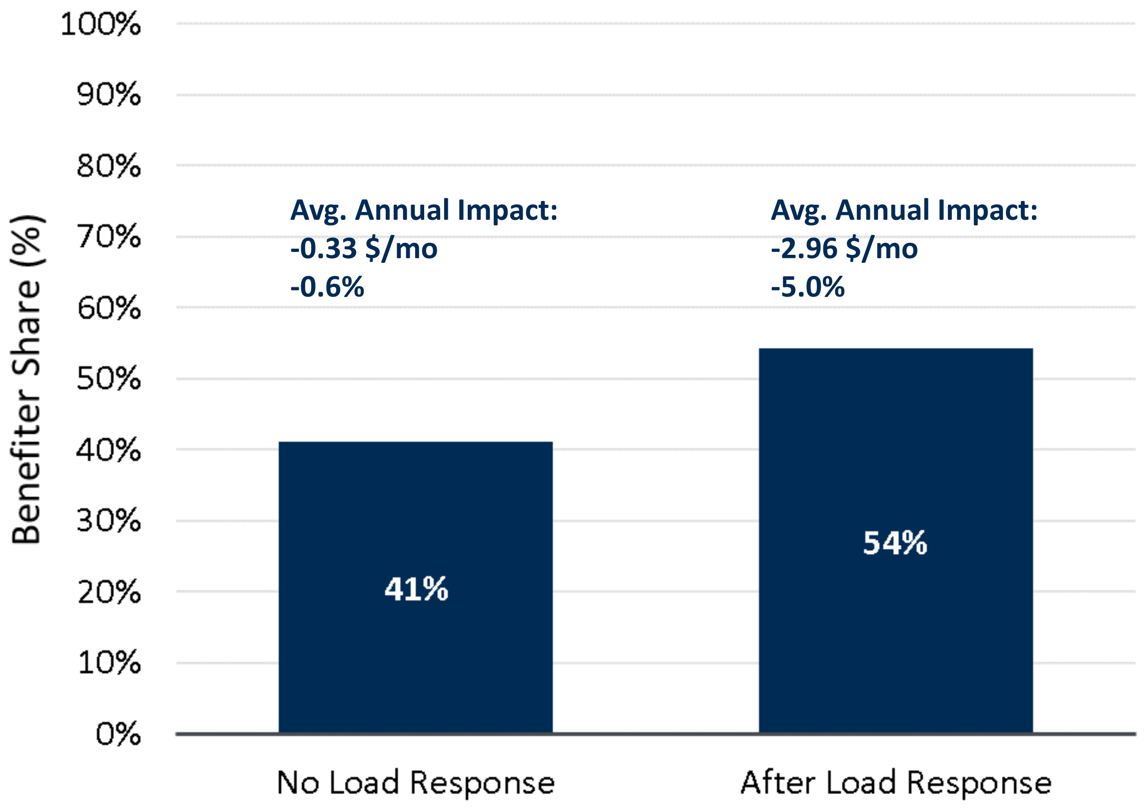
- Before load response
  - **68%** of the population benefitting on the rate
  - Average customer sees modest bill reduction of ~**0.5%**
- After load response
  - **69%** of the SGS population benefitting due to ~7% load shift from peak to off-peak
  - Average bill reduction is ~**2%**
- Key insights
  - Larger customers tend to see bill increases due to the existing tariff having extremely low seasonal volumetric rates
  - Smaller to medium sized customers with low summer consumption stand to benefit significantly on TOD



2-period TOD + CPP – Residential Bill Impacts

- The CPP is similar to the TOD structure, except with a higher critical peak on select days. As a result, bill impact trends are similar but stronger after the load shift
- Before load response
  - **41%** of the population benefitting on the rate
  - Average customer sees modest bill reduction of ~**0.6%**
- After load response
  - **54%** of the RES population benefitting due to ~20% load shift from CP to off-peak period and ~6% from peak to off-peak
  - Average bill reduction is ~**5%**
- Key insights
  - Trends here are very similar to TOD effects. Only difference is select summer days have an amplified critical peak price signal

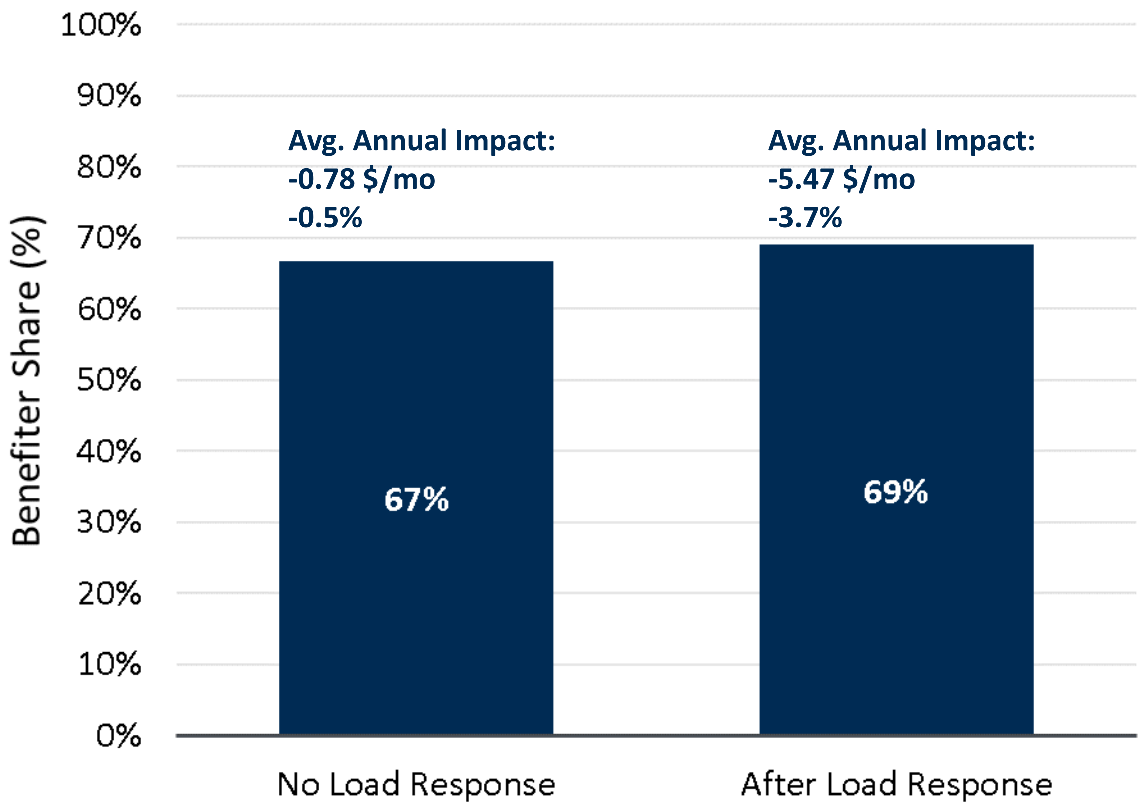
Bill Impacts Before and After Load Response



2-period TOD + CPP – SGS Bill Impacts

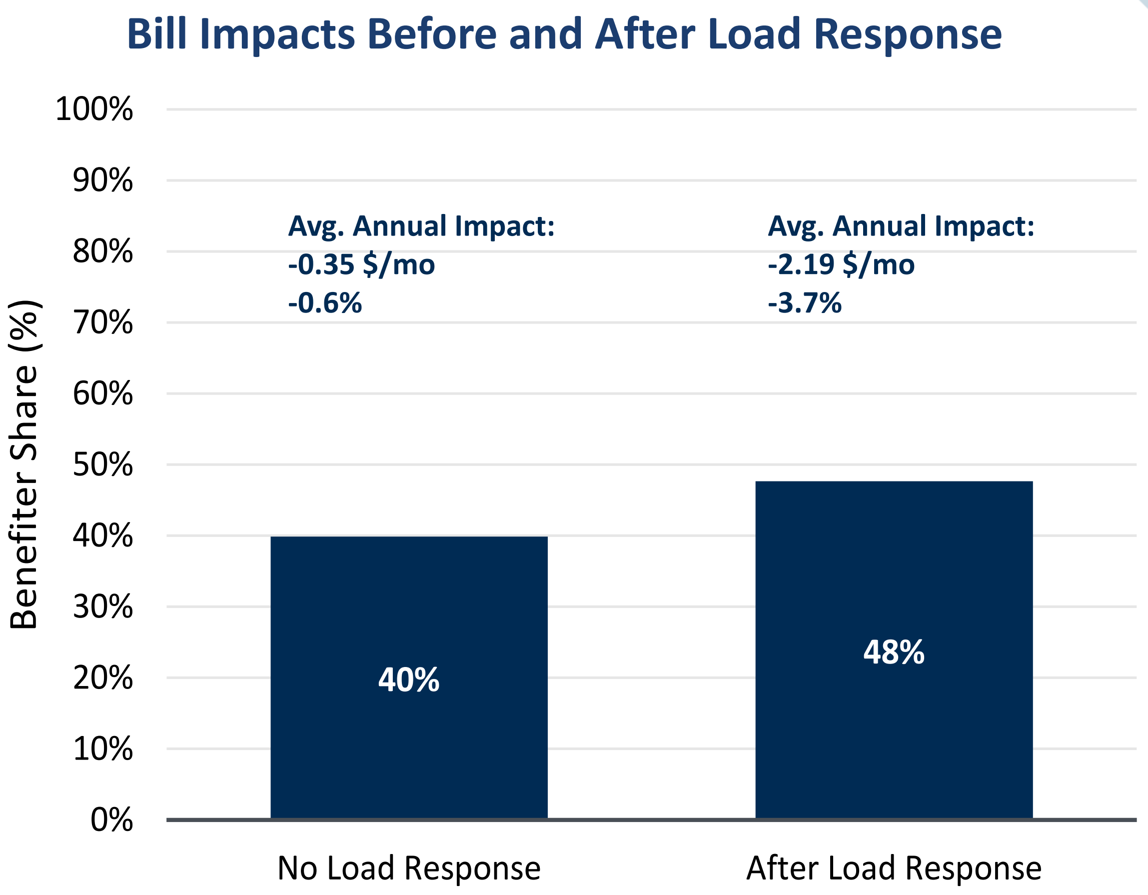
- The CPP is similar to the TOD structure, except with a higher critical peak on select days. As a result, bill impact trends are similar but stronger after the load shift
- Before load response
  - **67%** of the population benefitting on the rate
  - Average customer sees modest bill reduction of ~**0.5%**
- After load response
  - **69%** of the RES population benefitting due to ~18% load shift from CP to off-peak period and ~6% from peak to off-peak
  - Average bill reduction is ~**4%**
- Key insights
  - Trends here are very similar to TOD effects. Only difference is select summer days have an amplified critical peak price signal

Bill Impacts Before and After Load Response



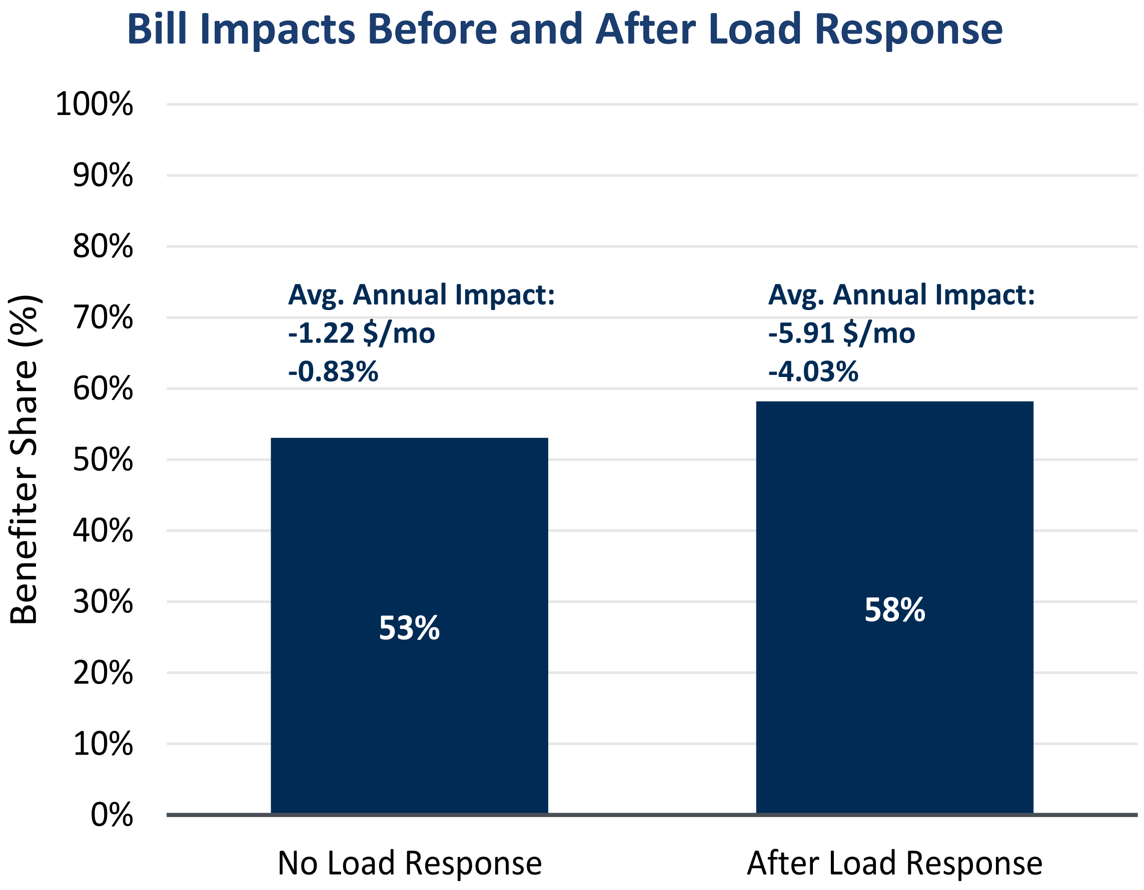
2-period TOD + Demand Charge – Residential Bill Impacts

- The Demand rate is similar to the TOD structure, except with a price associated with each customer's highest monthly demand. As a result, bill impact trends are similar but stronger after the load shift
- Before load response
  - **40%** of the population benefitting on the rate
  - Average customer sees modest bill reduction of ~**0.6%**
- After load response
  - **48%** of the RES population benefitting due to ~9% reduction in highest demand and ~9% from peak to off-peak
  - Average bill reduction is ~**4%**
- Key insights
  - Trends here are very similar to TOD effects.



2-period TOD + Demand Charge – SGS Bill Impacts

- The Demand rate is similar to the TOD structure, except with a price associated with each customer's highest monthly demand. As a result, bill impact trends are similar but stronger after the load shift
- Before load response
  - **53%** of the population benefitting on the rate
  - Average customer sees modest bill reduction of ~**0.83%**
- After load response
  - **58%** of the RES population benefitting due to ~9% reduction in highest demand and ~9% from peak to off-peak
  - Average bill reduction is ~**4%**
- Key insights
  - Smaller customers under this rate, despite having relatively low summer consumption, face a summer demand charge, which results in a smaller share of benefiters than the TOD or CPP. However, the rate still produces more benefiters than non-benefiters.



Bill Impact Conclusions

In this presentation we presented bill impact summaries for four classes across three rates for two scenarios – without and with price response

- Bill statistics presented are for the average class customer. Given the opt-in nature of the pilot, if more customers with favorable profiles participate, bill outcomes will be improved further
- Load response results in **more customers benefiting across the board**. Thus, messaging on load response is important
- While **RES class sees more non-benefiters** than benefiters, average customer bill sees a modest reduction. Load response under CPP results in more benefiters than other rates as customers can avoid significantly higher priced critical peak hours
- **Large share of SGS customers benefit** even without load response. This outcome is improved marginally with load response under TOD and CPP but markedly more for demand rates as smaller customers avoid higher peak period demand charges

% Share of Benefiters – With and Without Load Response

	Residential			Small General Service		
	2P-TOD	2P-TOD + CPP	2P-TOD + Demand	2P-TOD	2P-TOD + CPP	2P-TOD + Demand
No Load Response	40%	41%	40%	68%	67%	53%
With Load Response	**46%**	**54%**	**48%**	**69%**	**69%**	**58%**

3- Pilot Design Approach

Requirements for Designing a Scientifically Valid Pilot

- Clearly articulate pilot objectives
- Ensure **internal validity**, meaning a cause and effect relationship can be established between the treatment being tested (the TOD rate) in the pilot and the outcome of interest (change in peak usage)

  → Requires a robust control group and pre-treatment data

- Ensure **external validity**, meaning that the results from the pilot program can be extrapolated to the population of interest

  → Requires pilot recruitment to mimic potential wide scale deployment; can be ensured by selecting appropriate pilot design approach

- Determine sampling frame/eligible population for the pilot
- Undertake "**statistical power calculations**" to determine minimum size requirement for treatment and control groups to detect statistically significant impacts
- Incorporate attrition assumptions in the final sample sizes

Scientifically Valid Pilot Design Approaches (and control group strategy)

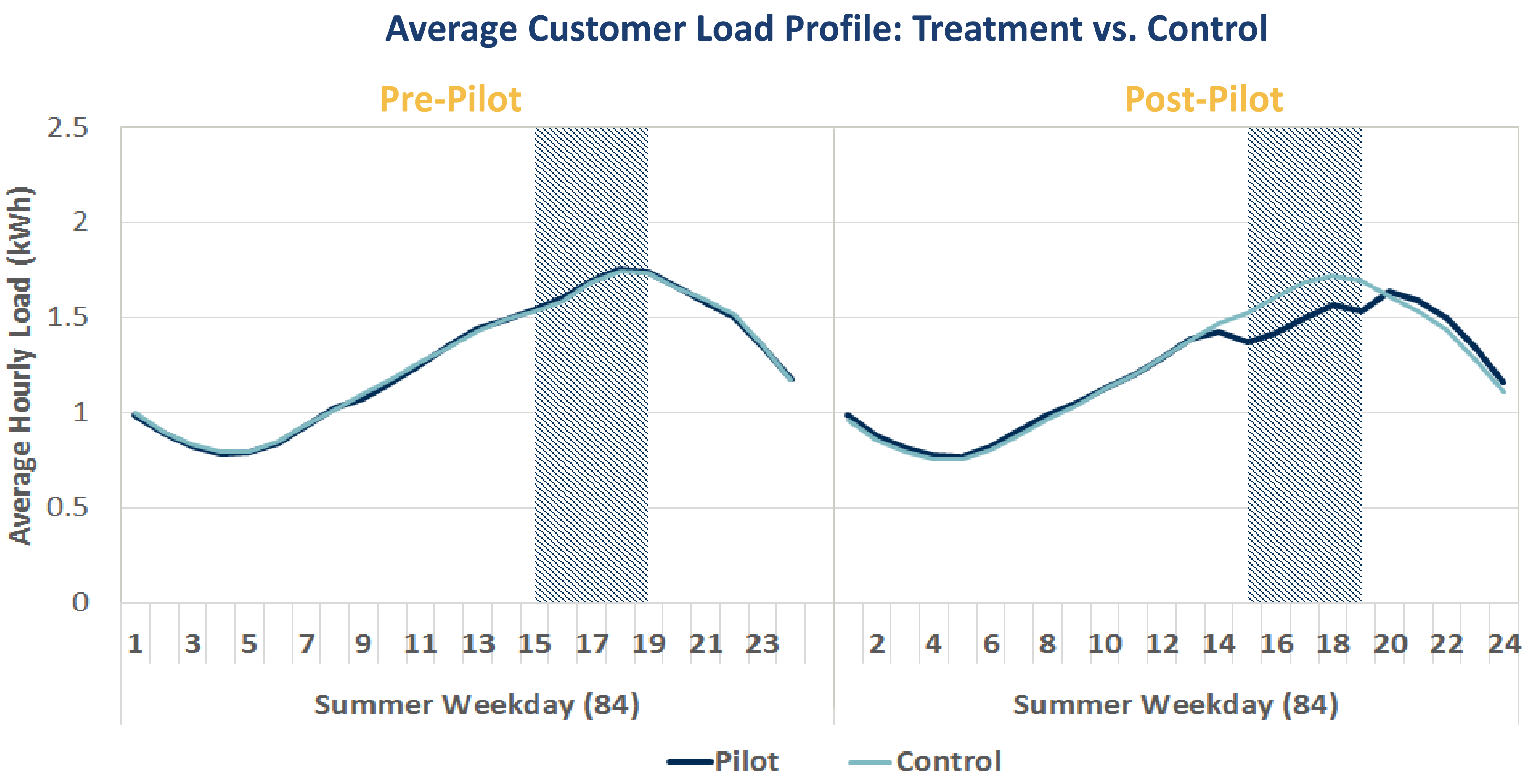
There are three widely accepted pilot design approaches:

Possible Pilot Design Approaches	Description and Pros/Cons
Randomized Controlled Trial ("RCT")	Involves a random assignment of the recruited customers into the treatment and control groups. While this is the most rigorous approach from a measurement perspective, it is rarely used by electric utilities due to a potentially adverse impact on customer satisfaction (as it would involve either "recruit-and-deny" or "recruit-and-delay" approaches for some portion of the recruited customers).
Randomized Encouragement Design ("RED")	Allows the researcher to construct a valid control group, maintaining the benefits of an RCT design by not negatively affecting the customer experience. However, it requires much larger sample sizes, relative to the RCT approach, in order to be able to detect a statistically significant impact. Large sample sizes increase pilot implementation costs.
Random Sampling with Matched Control Group	Involves recruiting treated customers from a randomly selected sample, and using regression analysis to identify and match customers from the rest of the population that are most similar to the treatment customers. This matched control group approach strikes a good balance between achieving statistically valid results and requiring a manageable level of pilot participants.

Source: Sergici *et al.*, *"Evaluation, Measurement and Verification Plan for the PC44 TOU Pilots," prepared for Maryland PC44 Rate Design Work Group, June 2018*

A statistically valid pilot design yields comparable treatment and control groups

This is an essential requirement in order to be able to attribute the difference between the two groups to the treatment impact



Note: The shaded regions indicate peak hours. Control group was constructed using a matching analysis

Recommended Design Approach for EPE's TVR Pilot

As required by the external validity principle, the recruitment of the treatment group should mimic the full-scale deployment of the TVRs

At this time, it seems that EPE's TVR broader deployment will be on an **opt-in** basis

Given this context, we considered three robust pilot design methods before proposing the pilot design approach for EPE:

- randomized controlled trial
- randomized encouragement design
- random sampling with matched controlled group

Assessing the pros and cons of each approach as well as the practical and budget implications of customer recruitment, we propose that the pilot is deployed using **"random sampling with matched controlled group"**

We discuss the implications of this approach for treatment group recruitment and control group selection in the next few slides

Treatment Group Recruitment Approach

Treatment group customers will be recruited from a randomly selected group of eligible customers (the rest of the eligible customers will be set aside for the control group design)

The random sample of eligible customers will be drawn from several recruitment waves, and customers in each wave will be sent recruitment materials and asked to participate in the pilot

- If a customer shows interest, they will be recruited for the pilot and asked to fill-in a pre-launch survey that confirms their eligibility and collects some socio-demographic data
- If a customer declines participation, they will be flagged as "declined to participate"
- The recruitment team will stay with the wave-based deployment until the recruitment targets/enrollment caps are reached
- Prior experience suggests that no more than 5% of customers who are contacted will join the pilot

The rest of the eligible customers will be used for designing the matched control group (discussed in the next slide)

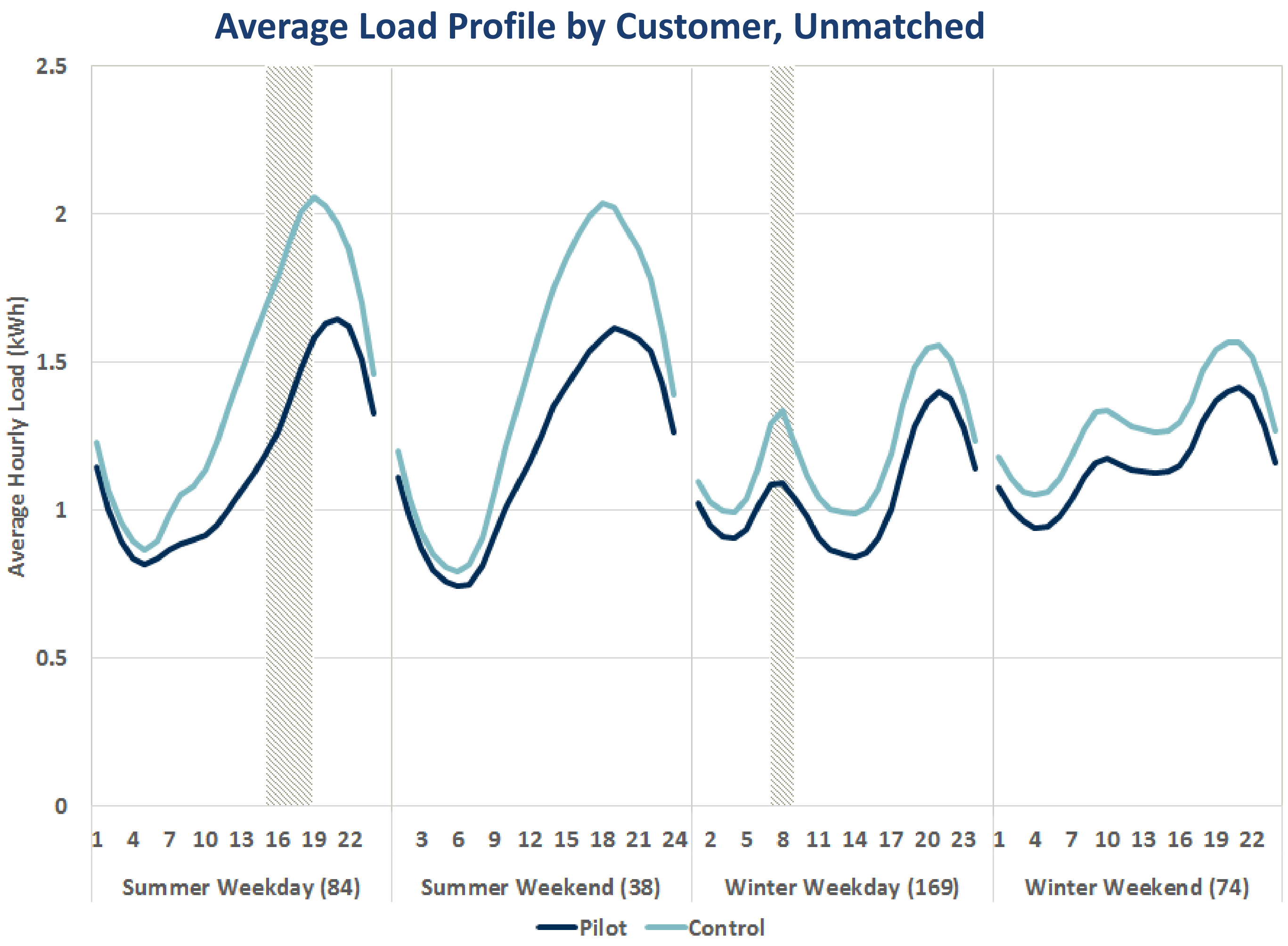
Control Group Design Approach

The control group will be chosen from the set-aside group of customers who were never approached for the pilot using the “propensity score matching” approach

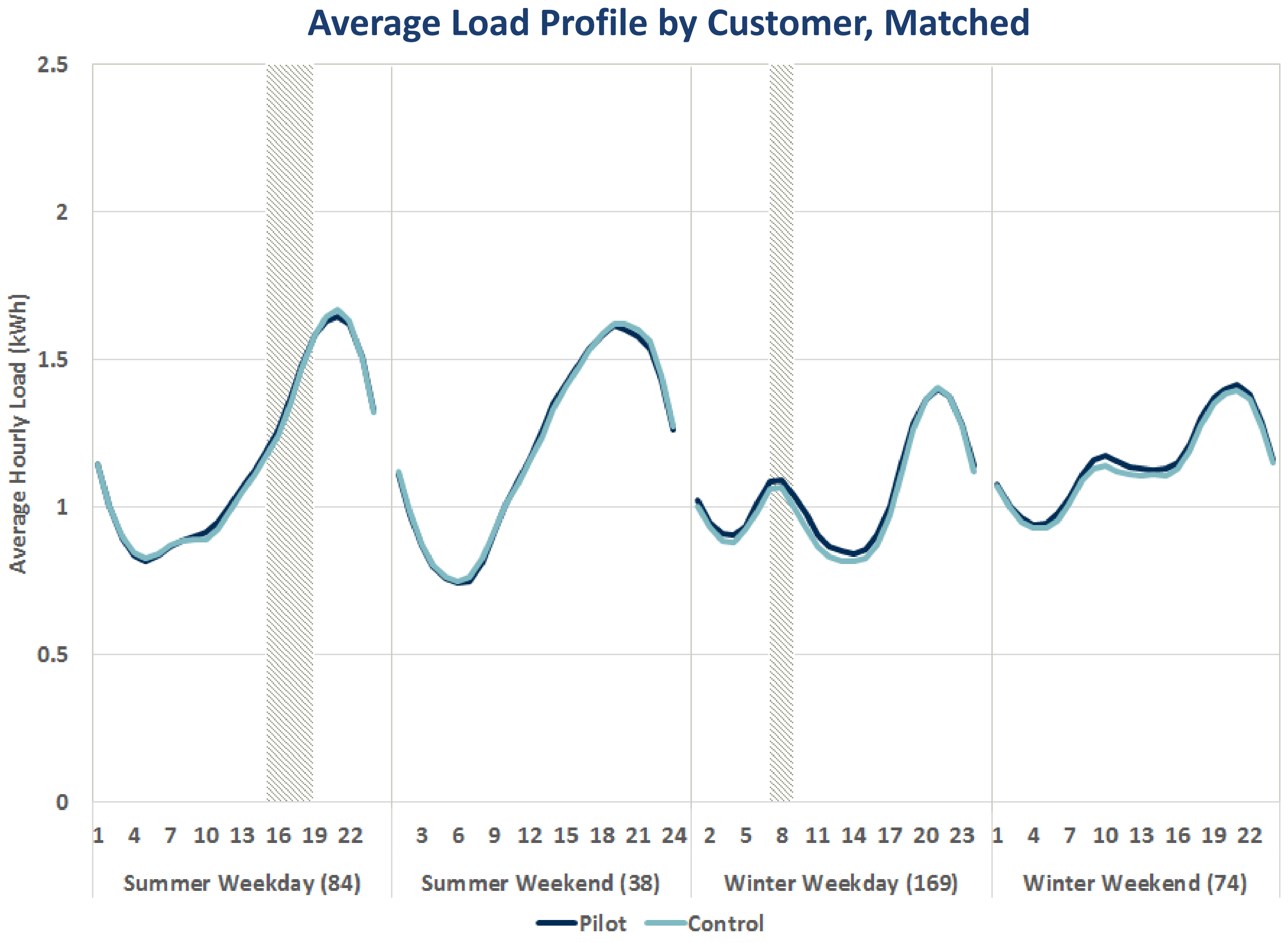
Propensity score matching is a widely-used statistical matching method in economics and other social sciences

- Uses statistical analysis to identify the variables that are most closely correlated with enrollment in the pilot
  - For example: individual customer peak demand, monthly usage, ratio of peak to off-peak usage; observable household-level data such as dwelling type, square footage, or socio-economic data; and geographic information, including zip code
- Using the results of that analysis, “predicts” the propensity score or probability of participation for both enrollees and control group
  - This propensity score can be thought of as the probability of a customer to opt-in to the pilot based on their observable characteristics, had they been approached to.
- For each participating customer, the unapproached customer whose propensity score is most similar to the treatment customer is placed in the control group

Treatment vs. Control groups (Before Matching)



Treatment vs. Control groups (After Matching)



Pilot Design Approaches Used in Other Pilots

Early pilots relied on random sampling with voluntary participation + randomly selected control groups

- California Statewide Pricing Pilot, 2003; Baltimore Gas and Electric Smart Energy Pricing Pilot, 2007)

Some of the more recent pilots used RCT and RED

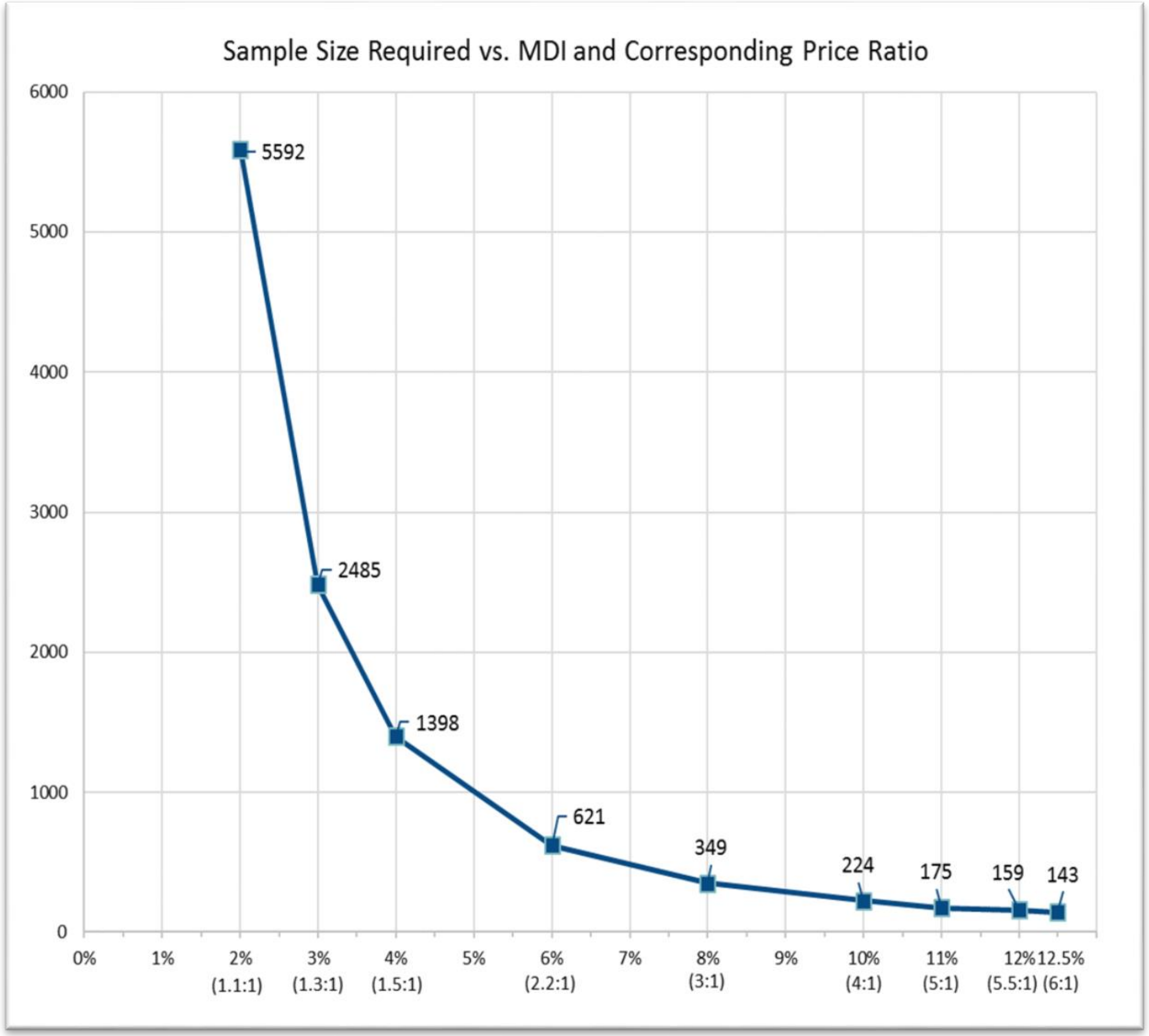
- SMUD SmartPricing Pilot, 2014; Ontario RPP Pilots, 2018

However, practical considerations (i.e., denying participation to the recruited customers in the RCT or large sample size requirements of RED) were not surmountable for other recent pilots. These pilots opted to use random sampling with matched control group

- PC44 TOU Pilot in Maryland, 2019; PowerPath DC Pepco Residential TOU Pilot, 2020; Alectra Advantage Power Pricing Pilot, 2017; Evergy Missouri 2021.

4- Sample Size Determination

Statistical power calculations are necessary to determine the sample size



Statistical power calculations are undertaken to ensure sample size is large enough to detect statistically significant impacts

- As the minimum detectable impact (MDI) increases (i.e. due to higher peak to offpeak ratio), sample size requirement decreases
- As the statistical power and statistical significance requirements increase, the sample size increases
- As the resolution of the analysis increases (i.e. hourly vs. monthly), sample size requirement decreases

Assumptions for Sample Size Calculations

We undertook statistical power calculations and calculated minimum sample size requirements to be able to estimate the impacts at acceptable statistical significance levels

- For our calculations, we targeted a minimum 80% statistical power, 5% statistical significance
- We calculated the sample sizes which will be large enough to detect the "minimum detectable impacts"
- For the LMI RES treatment cell, we assume a 25% derate to the peak demand reduction as a conservative estimate even though there is evidence from other jurisdictions that LMI customers respond just as much, if not more

Peak Demand Reduction Assumptions

Rate	Treatment Type	Ratio *(P:OP)*	Estimated Peak Demand Reduction
Residential TOD	All RES	4:1	9.2%
	LMI	4:1	6.9%
Residential TOD+CPP	Regular CPP	2:1	5.9%
	Tech Enabled CPP	2:1	9.8%
Residential Demand	All Res	4:1	9.2%
SGS TOD	All SGS	3:1	5.8%
SGS TOD+CPP		2:1	5.9%
SGS Demand		4:1	9.2%

Draft Sample Sizes

We calculated required sample sizes to be able to detect the customer price response given the statistical precision criteria. Next, we boosted the sample sizes by 15% to account for potential attrition over the two years of the pilot. We also calculated an approximate outreach sample assuming a 2% enrollment rate

Class	Treatment	Based on Statistical Power Calculations	Assuming 15% Attrition	Target Outreach Assuming 2% Enrollment
Residential	2-Period TOD	146	***170***	***8,500***
	2-Period TOD *(LMI Only)*	259	***300***	***15,000***
	2-Period TOD + CPP	355	***410***	***20,500***
	2-Period TOD + CPP *(Tech Enabled)*	129	***150***	***7,500***
	2-Period + Demand Charge	146	***170***	***8,500***
SGS	2-Period TOD	249	***290***	***14,500***
	2-Period TOD + CPP	381	***440***	***22,000***
	2-Period + Demand Charge	157	***180***	***9,000***

Total RES outreach target of 60K

Total SGS outreach target of 45.5K

5- Next Steps

Timeline

Meeting Schedule	July 2023 AMS PAG Meeting	Oct 2023 AMS PAG Meeting	Dec 2023 AMS PAG Meeting	Q1 2024
Meeting Scope	• Review pilot objectives and alternative rates • Discuss general pilot design approach	• Incorporate feedback on alternative rates and pilot treatment cells • Present proposed draft pilot treatment cells • Present analysis of EPE load and cost data to identify seasons and pricing periods for TVRs	• Present draft rates for pilot treatments • Present draft pilot parameters, including sample sizes, recruitment methods, control methodology • Seek stakeholder feedback	• Present final proposed pilot rates • Present final pilot design and implementation plan • File for regulatory approval