EXH. AF-5
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____**

FOURTH EXHIBIT (NONCONFIDENTIAL) TO THE PREFILED DIRECT TESTIMONY OF

AHMAD FARUQUI

ON BEHALF OF PUGET SOUND ENERGY

JANUARY 31, 2022

Time Varying Rates Pilot

Stakeholder Collaborative #2

PUGET SOUND ENERGY

August 6, 2021

Welcome, Introduction & Ground Rules

Moderator: Birud Jhaveri, PSE (Birud.Jhaveri@pse.com)
Speakers: Laura Troyani, PlanBeyond
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

PUGET SOUND ENERGY

Agenda

- Introduction – 1:00-1:15
- PlanBeyond Customer Focus Group Recap – 1:15-2:00
- Break – 2:00-2:05
- Brattle Rate Design Analysis – 2:05-3:00
- Break – 3:00-3:05
- Brattle Rate Design Recommendations and Discussion/Q&A – 3:05-4:00

Safety Moment

Time Varying Rates Focus Group Summary Findings

Puget Sound Energy | August 6, 2021

PlanBeyond

BACKGROUND & METHODOLOGY

BACKGROUND & OBJECTIVES

PSE is considering offering time-varying energy rate plans to their residential and business customers. However, as a new energy offering within the region, the organization needs to understand how well the idea of time varying energy rates appeals to a broad range of customers while also exploring how best to launch a pilot program that will have positive reception.

A focus group study was fielded to:

Understand how different customer groups think about time varying energy rates.

Explore how time varying rates may, or may not, impact electricity usage behaviors.

Test time varying rate product concepts to assess overall interest, appeal, and barriers to acceptance.

METHODOLOGY & SEGMENTS EXPLORED

RESIDENTIAL CUSTOMERS	Residents in PSE's electric service territory, segmented by household income.
EV OWNERS	Residents in PSE's electric service territory who currently own an electric vehicle.
BUSINESS OWNERS	Small business owners that have businesses with physical locations in PSE's electric service territory and that actively manage and/or monitor their electricity bills.

SUMMARY FINDINGS

GENERAL TIME VARYING RATE ATTITUDES

- Customers look at electricity bill information, but generally not kilowatt hours.
- Flat rate energy pricing is appealing for its predictability.
- Residents and business owners understand TVR plans but are unsure about their impact on bills and behaviors. However, low income residents like the savings opportunity.

TIME-OF-USE - RESIDENTIAL

- The structure of TOU plans is understood. The impact on bills is not.
- Low income residents identify savings opportunities as a strong advantage of the plan.
- Higher income residents are more concerned about household disruptions while lower income residents are more wary about actual bill implications.
- Low income residents are willing to make behavior adjustments to save money.
- A 3-hour evening peak is attractive to low, but not middle to high, income residents.
- A single morning peak creates TOU interest for middle + high income residents.
- The two peak plan is generally deemed inconvenient and possibly confusing.

TIME-OF-USE – SMALL & MEDIUM BUSINESS

- Receptiveness to TOU plans aligns 100% with a business's particular schedule.
- Business conditions make them unable to adjust energy usage.
- Peak window range has no impact on appeal.
- Morning peaks are only attractive to business owners with afternoon and evening hours.
- Two peak plans only work well for those with weekend and mid-day hours.

TIME-OF-USE – ELECTRIC VEHICLES

- EV owners are interested in a single peak TOU plan.
- Creating stronger peak and off peak extremes is not as attractive. It drives concerns about bill amounts.
- An off peak + super off peak TOU plan has appeal but bill implications are needed.
- Owners are open to using different electricity plans for EV and household needs.

CRITICAL PEAK PRICING - RESIDENTIAL

- Residents are concerned that CPP could lead to very high bills.
- Low income incomes residents see CPP as a major burden.
- Skepticism exists around event days and when they will be called.
- Receptiveness to event day quantity varies by income range.
- Year-wide event days are more palatable to higher income groups but not low income groups.

CRITICAL PEAK PRICING – SMALL & MEDIUM BUSINESS

- CPP’s lack of advance warning is unacceptable to SMB owners.
- Owners have very negative attitudes toward event days.

PEAK TIME REBATE - RESIDENTIAL

- PTR is highly liked by high and middle income residents.
- Low income residents are wary of PTR's unpredictability and actual savings potential.
- Event days only appeal to middle and high income residents.

PEAK TIME REBATE – SMALL & MEDIUM BUSINESS

- PTR holds no appeal for SMB owners.
- No single TVR plan is attractive for SMB owners.

PROGRAM ENABLEMENT

- There is an overall interest in real time energy tracking.
- Residents are open to receiving text notifications about unusual usage patterns or usage thresholds. SMB owners are more mixed about text message interest.
- Most digital channels—text, email, app notifications—are acceptable avenues to communicate event days.
- There is general awareness about smart thermostats but skepticism about giving PSE access to control thermostat levels.
- Smart thermostats can help with TVR adoption.
- SMB Owners and higher income residents are open to smart thermostat installation.

Questions?

Designing Time Varying Prices for PSE's TVR Pilot

PRESENTED BY

Ahmad Faruqui
Sanem Sergici
Long Lam
Megan Diehl

PRESENTED TO

Second Collaborative
Puget Sound Energy

AUGUST 6, 2021

Brattle

Objectives of Today's Meeting

- **Discuss the data-driven process that Brattle and PSE teams utilized to develop rate treatments to be tested in the TVR pilot**
- **Present proposed rate treatments for the TVR pilot and seek stakeholder input**

Today's meeting will <u>not</u> address the pilot design approach, sample size determination, and the EM&V approach. These topics will be the subject of 3rd Collaborative meeting

We will start by presenting the proposed rate designs for the TVR pilot and then explain how we developed all the decisions leading to these rate designs

Agenda

1- Proposed Rate Designs

2- Summary of TOU Rate Designs from Other Jurisdictions

3- Determining TVR Seasons

4- Determining TVR Peak and Off-peak Periods

5- Recap and Next Steps

1- Proposed Rate Designs

RATE DESIGNS

Overview

We designed multiple time-varying rates, using the embedded cost approach and a hybrid approach (that combines marginal costs with embedded costs) to determine the prices of the time-varying periods

These approaches support time-varying rates with substantial price differentials, which are in line with price ratios found in successful time-varying rate pilot programs

These are still "draft" rate designs and may be adjusted as needed based on:

- stakeholder input
- bill impact analysis to assess potential bill changes with these rates

We will present the residential rate designs today; small business rate design is still under progress

Proposed TVR Pilot Rate Treatments

- PSE is proposing to test **six different treatments** during its TVR pilot

Rate	Residential	Low Income	Small Business
TOU	X	X	N/A
TOU+PTR	X	X	X
EV TOU	X	N/A	?

- PSE is testing these rates on an **opt-in** basis because future roll-outs are also more likely to be opt-in
- **Low income customers** will be offered the same rates as the average residential customers, however they will also be offered “bill discounts” similar to discounts offered through the Low Income Discount Rates (currently in development)
- PSE is planning to offer a **whole-house TOU rate for the EV customers**. PSE will continue to explore EV-only metering options and may offer an EV-only TOU rate. Experience elsewhere has shown that EV customers are likely to be very responsive to TOU rates

RATE DESIGNS

High Level Rate Design Approach

- Start with PSE's 2021 embedded cost study results for the **Residential and Small Business classes**
- Use cost classification percentages for **Demand, Energy and Customer** related cost drivers for each of the **Generation, Transmission, Distribution and Customer** functions
- Design rates based on the embedded cost study results ("embedded cost method")
- Design rates by replacing generation cost allocation in the COS with marginal capacity and mid-C energy costs, but retaining all other allocations for T, D, and customer functions ("hybrid approach")
    - PSE does not have a marginal cost of service (MCOS) study so this is the closest we can come to a marginal cost approach

TOU Rate Design with Embedded Cost Method

We used revenue requirement for the **residential customer group** from the embedded COS study to determine total costs and cost classification percentages

- **Generation**: Demand component (24%) was allocated to the total kWh over the winter peak hours; Energy component was allocated to kWh in all hours
- **Transmission**: Demand (56%) was allocated to all peak kWh; Energy was allocated to kWh in all hours
- **Distribution**: Half of the Demand component (45%) was allocated to all peak kWh, and the other half (45%) to off peak kWh; Customer Charge was allocated to kWh in all hours
- **Customer charge**: residual that is not collected by the current monthly fixed charge ($7.49 per residential customer) is allocated across kWh in all hours.

The rate for a period is the sum of all costs allocated to that period. For example:

$$\textit{Peak Rate} = \textit{Generation}_{\textit{Peak}} + \textit{Transmission}_{\textit{Peak}} + \textit{Distribution}_{\textit{Peak}} + \textit{Customer Charge}_{\textit{Peak}}$$

TOU Design with a Hybrid Cost Method

We explored an alternative method for setting rates using marginal costs. PSE does nothave an MCOS study at this time, so we developed a hybrid cost approach that uses marginal costs for assessing marginal generation capacity and energy costs and embedded costs for transmission and distribution costs

1. Set winter and non-winter peak rate to reflect generation capacity, transmission, distribution, and energy costs

- Marginal generation capacity cost = $95/kW-yr (2021 IRP), allocated entirely to kWh in winter peak hours
- Marginal energy cost = Average Mid-C energy price in peak hours
- Transmission and distribution = Same as in embedded allocation methodology

2. Solve for the rate for other periods (winter and non-winter off-peak), ensuring revenue neutrality

- The remaining costs (net of revenue from peak hours and revenue from fixed charges) are allocated equally to both winter and non-winter off-peak kWh

Residential TOU Rate Design

		Current Rate	TOU (Embedded)	TOU (Hybrid)
Customer Charge	$/mo	$7.49	$7.49	$7.49
Current Rate				
<=600 kWh	$/kWh	0.09		
>600 kWh	$/kWh	0.11		
TOU Charges				
Winter				
On-Peak	$/kWh		$0.27	$0.30
Off-Peak	$/kWh		$0.06	$0.06
Super Off-Peak	$/kWh		-	-
Non-Winter				
On-Peak	$/kWh		$0.16	$0.16
Off-Peak	$/kWh		$0.06	$0.06
Super Off-Peak	$/kWh		-	-
Full Year				
Peak Time Rebate	$/kWh		-	-
On-Peak : Off-Peak Ratios				
Winter			4.2 : 1	5.2 : 1
Non-Winter			2.5 : 1	2.8 : 1
PTR:Off-Peak			-	-

- 4.2:1 price ratio in the Winter months
- 2.5:1 in the Non-winter months

Residential TOU + PTR Rate Design

- We assumed 15 winter peak events and 5 non-winter critical peak events
- We calculated the critical peak rate by allocating generation capacity cost ($95/kW-yr) with a 30% derate to account for DR availability
- Peak rate and off-peak rate are calculated in the same manner as in the TOU method

- For example: on an event day, if the CPP price is $1/kWh, and the retail rate is $0.10/kWh, the customer will pay $1/kWh
- In a PTR program, the customer's opportunity cost for consumption should be $1/kWh. The rate remains at $0.10/kWh, therefore the rebate should be $0.90/kWh
- We solve for the PTR similarly in our analysis

Residential TOU + PTR Rate Design

		Current Rate	TOU (Embedded)	TOU (Hybrid)	TOU + PTR
Customer Charge	$/mo	$7.49	$7.49	$7.49	$7.49
Current Rate					
<=600 kWh	$/kWh	0.09			
>600 kWh	$/kWh	0.11			
TOU Charges					
Winter					
On-Peak	$/kWh		$0.27	$0.30	$0.17
Off-Peak	$/kWh		$0.06	$0.06	$0.06
Super Off-Peak	$/kWh		-	-	-
Non-Winter					
On-Peak	$/kWh		$0.16	$0.16	$0.16
Off-Peak	$/kWh		$0.06	$0.06	$0.06
Super Off-Peak	$/kWh		-	-	-
Full Year					
Peak Time Rebate	$/kWh		-	-	$0.46
On-Peak : Off-Peak Ratios					
Winter			4.2 : 1	5.2 : 1	2.9 : 1
Non-Winter			2.5 : 1	2.8 : 1	2.7 : 1
PTR:Off-Peak			-	-	10.5 : 1

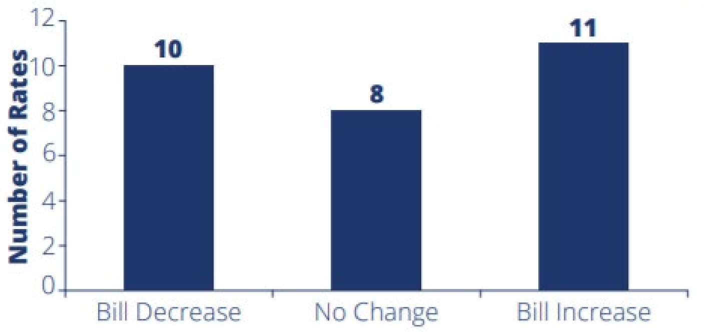
Note: the generation capacity of the TOU+PTR has been de-rated by 30%

- 2.9:1 P/OP ratio in the Winter
- 2.7: 1 in the Non-Winter
- 10.5: 1 during the event days

RATE DESIGNS

EV TOU Rate Design

- According to a SEPA report on EV TOU rates, only 27% of the surveyed rate designs were revenue neutral



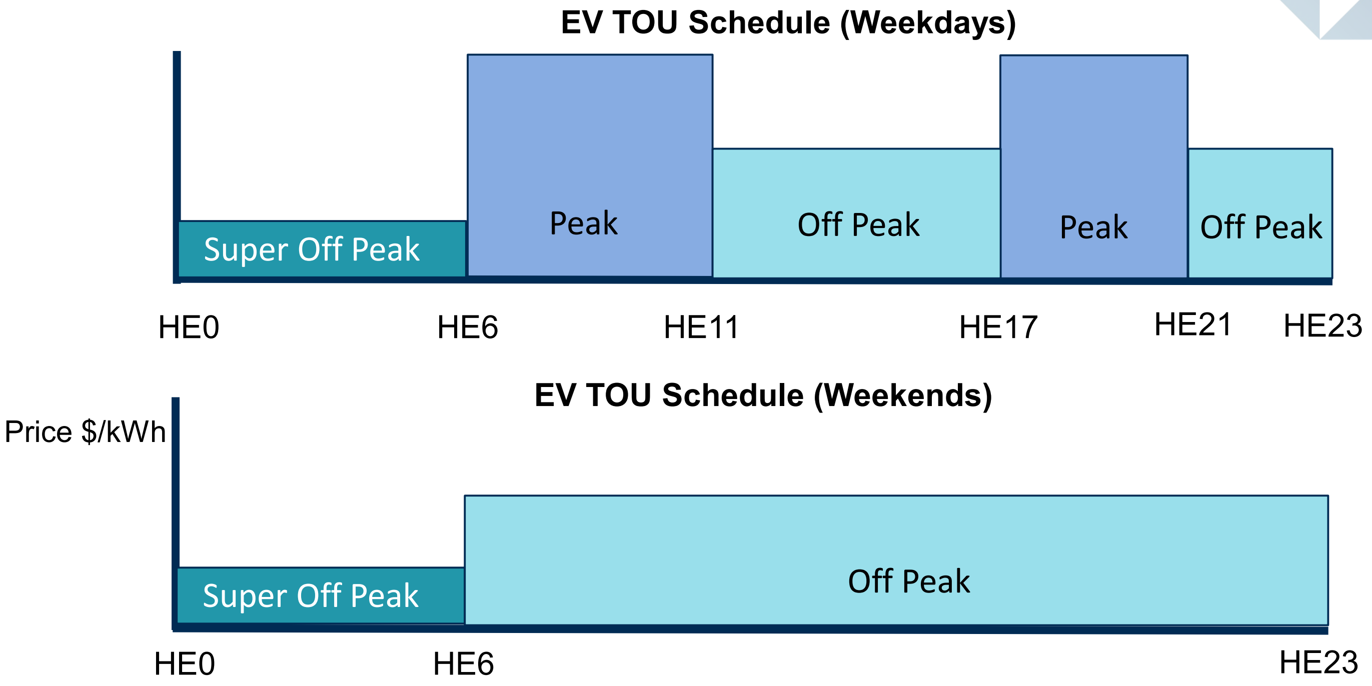
Source: Smart Electric Power Alliance & The Brattle Group, 2019

RATE DESIGNS

EV TOU Rate Design II

We designed the peak and off peak hours using the following conventions:

- Patterns mirror patterns of average weekday Mid-C prices
- Super off-peak occurs during night-time hours
- Morning peak window is extended from the TOU peak to mitigate any prominent "snapback"
- The evening peak window is followed by an off-peak window to avoid sudden surge
- Weekends involve only Super off-peak and Off-peak windows

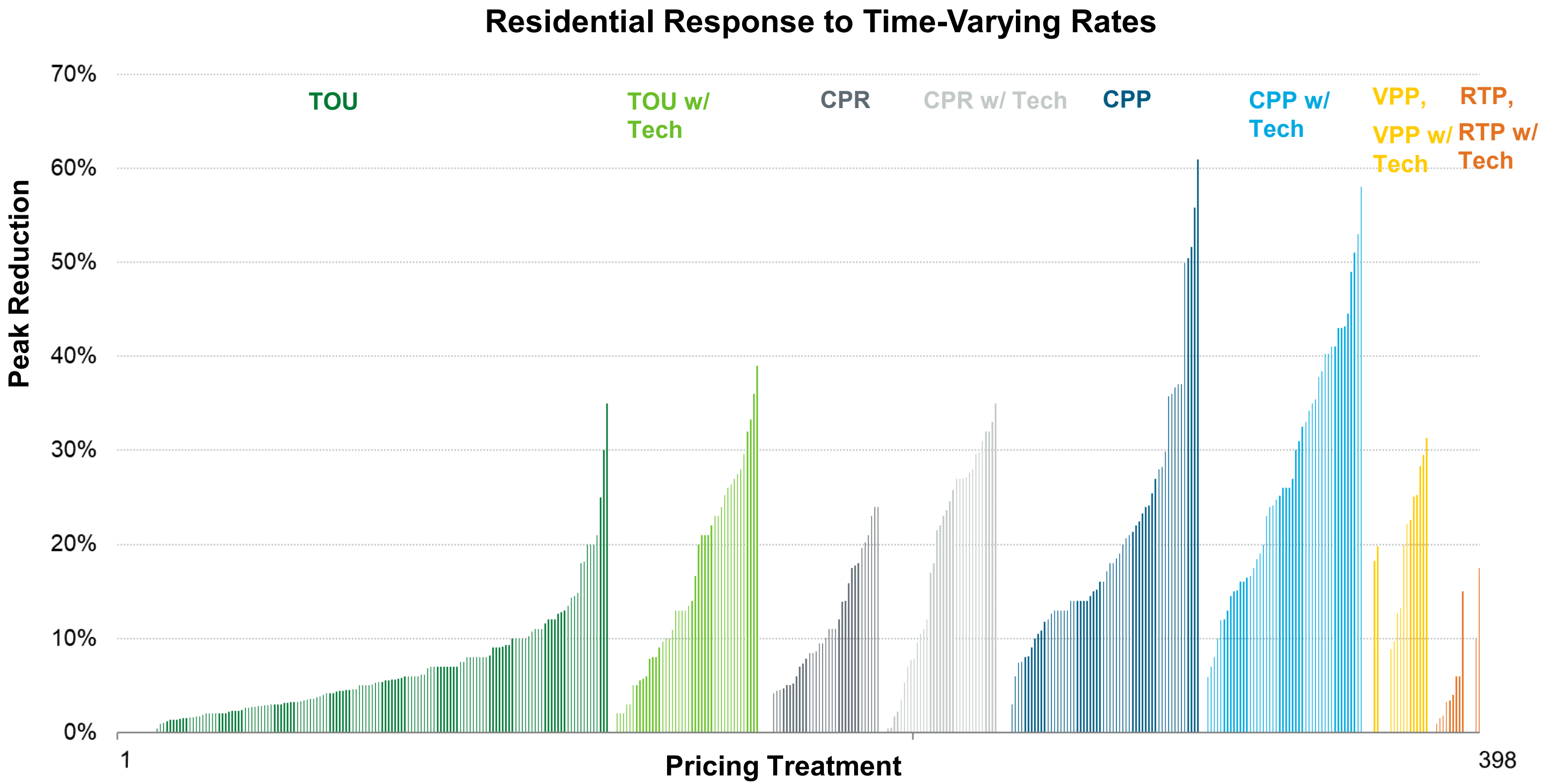


EV TOU Rate Design

		Current Rate	TOU (Embedded)	TOU (Hybrid)	TOU + PTR	EV TOU (Hybrid)
Customer Charge	$/mo	$7.49	$7.49	$7.49	$7.49	$7.49
Current Rate						
<=600 kWh	$/kWh	0.09				
>600 kWh	$/kWh	0.11				
TOU Charges						
Winter						
On-Peak	$/kWh		$0.27	$0.30	$0.17	$0.17
Off-Peak	$/kWh		$0.06	$0.06	$0.06	$0.08
Super Off-Peak	$/kWh		-	-	-	$0.04
Non-Winter						
On-Peak	$/kWh		$0.16	$0.16	$0.16	$0.15
Off-Peak	$/kWh		$0.06	$0.06	$0.06	$0.06
Super Off-Peak	$/kWh		-	-	-	$0.04
Full Year						
Peak Time Rebate	$/kWh		-	-	$0.46	-
On-Peak : Off-Peak Ratios						
Winter			4.2 : 1	5.2 : 1	2.9 : 1	4.0 : 1.8 : 1
Non-Winter			2.5 : 1	2.8 : 1	2.7 : 1	3.5 : 1.4 : 1
PTR:Off-Peak			-	-	10.5 : 1	-

- 4.0:1, Peak/Super OP ratio and 1.8:1 P/OP ratio in Winter
- 3.5:1, Peak/Super OP ratio and 1.4:1 P/OP ratio in Non-winter

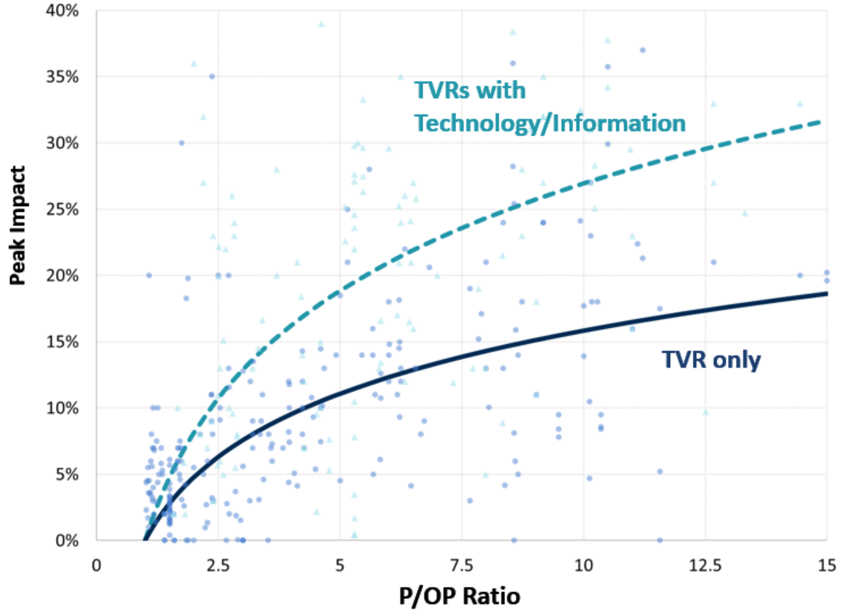
Residential TVR Peak Load Impacts from 398 Pricing Treatments



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

- Estimated peak impacts are based on regression analysis of 74 time-varying residential pilots with 387 treatments in the Arcturus database (see figure)
- "**Arc of Price Response**" shows that 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
- We used separate coefficients to estimate the impact for PTR and TOU rates, as the data implies lower responsiveness to PTR compared to TOU



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

ESTIMATING TVR LOAD IMPACTS

Estimated peak impacts from the draft TVRs

We have computed estimated impacts for the proposed TVRs using the Arc of Price Response

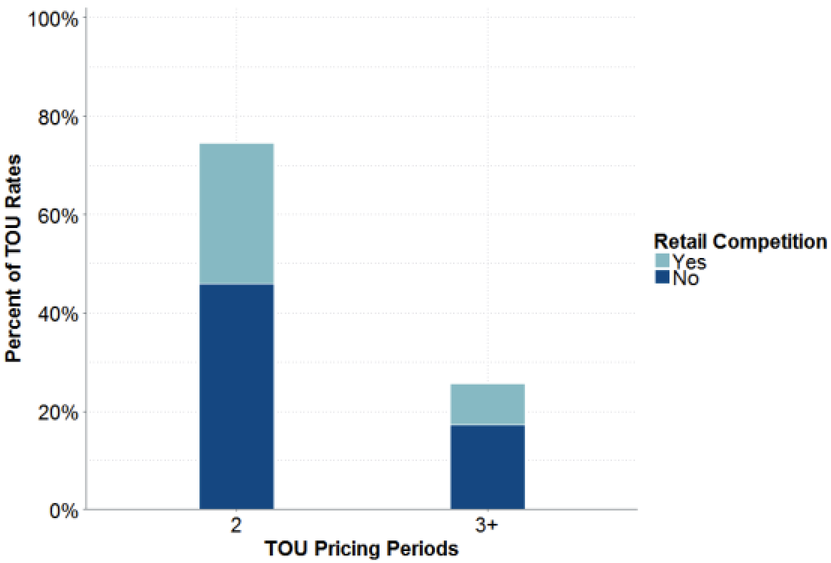
Rate	Season	Ratio *(P:OP)*	Estimated Peak Demand Reduction	50% Derate for Winter Peaking System
TOU (Embedded)	Winter	4.2:1	9.5%	4.8%
	Non-winter	2.5:1	6.1%	3%
TOU (Hybrid)	Winter	5.2:1	10.9%	5.5%
	Non-winter	2.8:1	6.8%	3.4%
TOU+PTR	Winter	2.9:1	7.1%	3.5%
	Non-Winter	2.7:1	7.3%	3.3%
	Event day	10.5:1	12.2%	6%

2- Summary of TOU Design Elements from Other Jurisdictions

INSIGHTS FROM TOU PROGRAMS

Number of Pricing Periods

NUMBER OF PRICING PERIODS IN TOU RATES

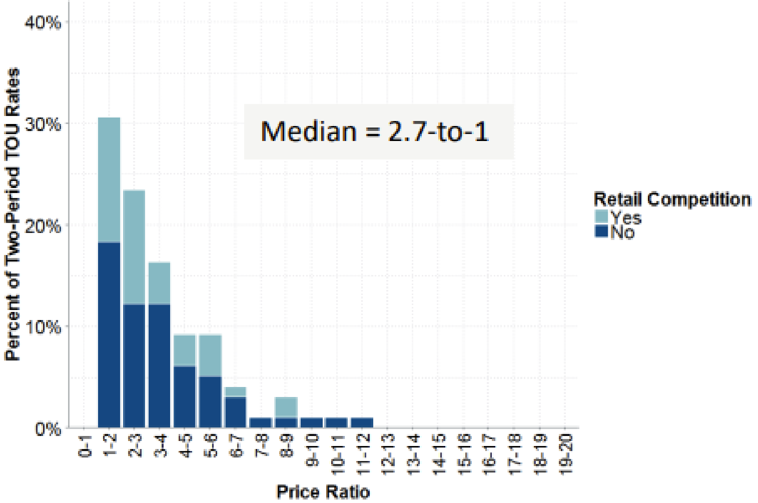


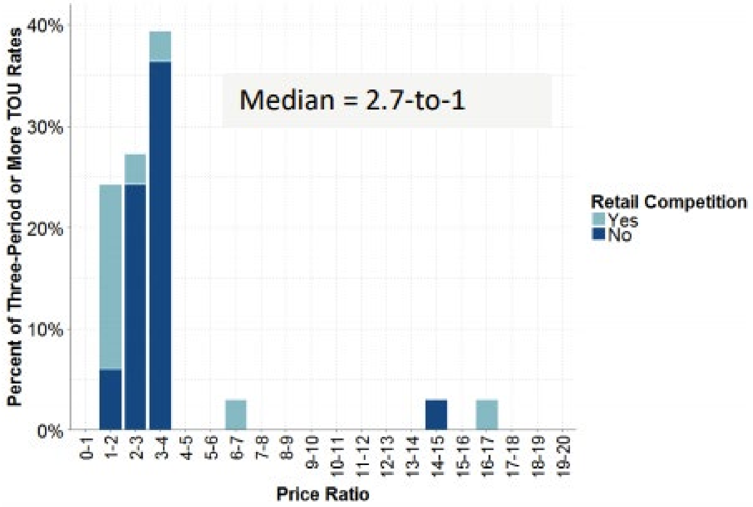
- According to 2018 EIA Form-861, **322 U.S. utilities offer at least one form of time-varying rate** to residential customers
- 303 of them offer Time-of-Use (TOU)
- We have analyzed data for IOUs only and found that 74% of all residential TOU rates have two periods
- Only two rates in the survey sample have more than three periods

Source : Brattle Analysis of OpenEI Utility Rates Database. Data shown for IOUs only.

INSIGHTS FROM TOU PROGRAMS

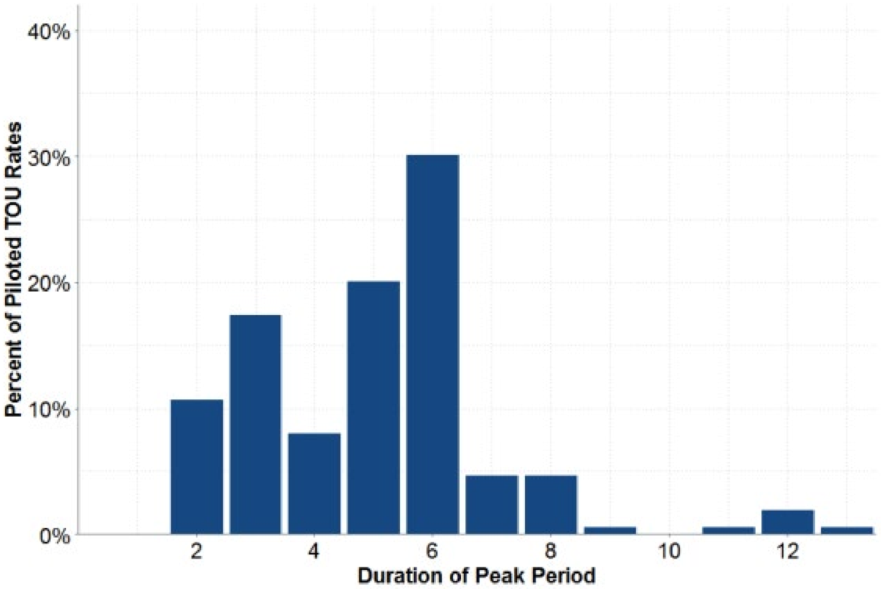
Price Ratio in 2-period and 3-period Rates





- Among the TOU rates, 71% have a price ratio of at least 2-to-1
- Price ratios shown are for the volumetric charge only. The strength of the price signal will be diluted to some degree by fixed charges and/or additional flat volumetric charges
- For 3-period rates, the ratio is between peak and super off-peak

Peak period duration



- Legacy TOU rates to have peak periods of 12 hours or longer
- Many of these older TOU rates have been offered for many years, but have very low enrollment rates. They are not actively marketed most of the time
- The **peak periods for newly designed TOU rates** (included those tested in the pilot data presented) typically **last for 6 or fewer hours**

Peak durations and price ratios from recent pilots

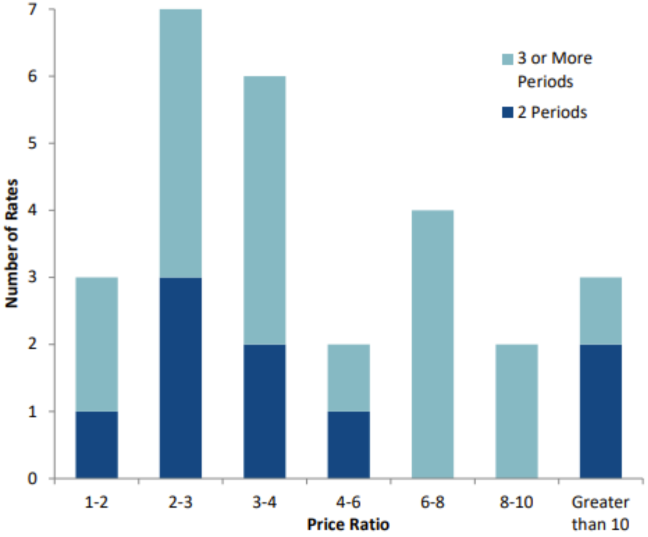
More recent TOU pilots, especially those testing all-in TOU rates (not just applicable to generation), have involved higher peak-to-off-peak price ratios

Year	Pilot	Peak Period	Price Ratio
2019-2021	**PC44 Maryland TOU Pilot**	Summer evening peak (5 hrs) Winter morning peak (3 hrs)	Range from 4:1 to 6:1 across the three utilities undertaking the pilot
2020	**Duke Energy North Carolina TVR Pilot (TOU+CPP treatment)**	Summer evening peak (6 hrs) Winter morning and evening peak (4+3 hours)	1.8: 1 for TOU only days 6:1 for CPP days
2021	**Evergy Missouri TOU Pilot**	Summer evening peak (4 hrs) Winter evening peak (4 hrs)	3:1 in the summer 6:1 in the winter
2021	**Ameren Missouri Opt-in TOU Deployment ("Smart Savers")**	Summer evening peak (5 hrs) Winter morning and evening peak (2+2 hrs)	5:1 in the summer 3.4:1 in the winter
2020	**Consumers Energy Default TOU Deployment**	Summer and Winter evening peak (5 hours)	1.5: 1 in the summer

INSIGHTS FROM TOU PROGRAMS

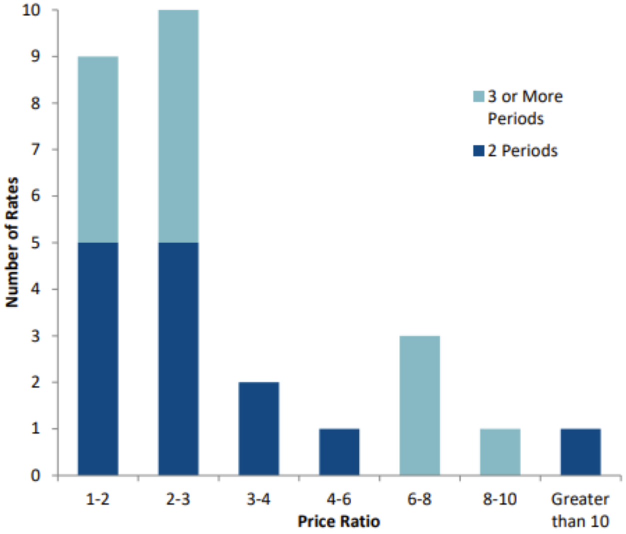
EV TOU Rates, Price Ratios

Summer Price Ratios (Peak Rate to Lowest Off-Peak Rate)



2 Period Median = 3.19
3 or More Period Median = 3.74

Winter Price Ratios (Peak Rate to Lowest Off-Peak Rate)



2 Period Median = 2.36
3 or More Period Median = 2.54

3- Determining TVR Seasons

There are several steps involved in designing time varying rates (TVRs)

- Step 1: Collect data on loads and costs by time period
- Step 2: Analyze data to identify pricing seasons and periods
- Step 3: Design rates
- Step 4: Estimate load impacts of the new rates
- Step 5: Estimate bill impacts of the new rates
- Step 6: Adjust rates if necessary
- Step 7: Finalize rates

Determining pricing seasons and peak windows

The definition of pricing seasons and peak and off-peak windows is an important element of the TVR design. An ideal peak window has the following attributes:

- Captures seasonal differences to the extent that noticeable changes in loads and costs exist across the year
- Captures the high load and/or high marginal cost hours
- Offers a reasonable opportunity for customers to change behavior; not too short (<4 hours) or too long (>6)

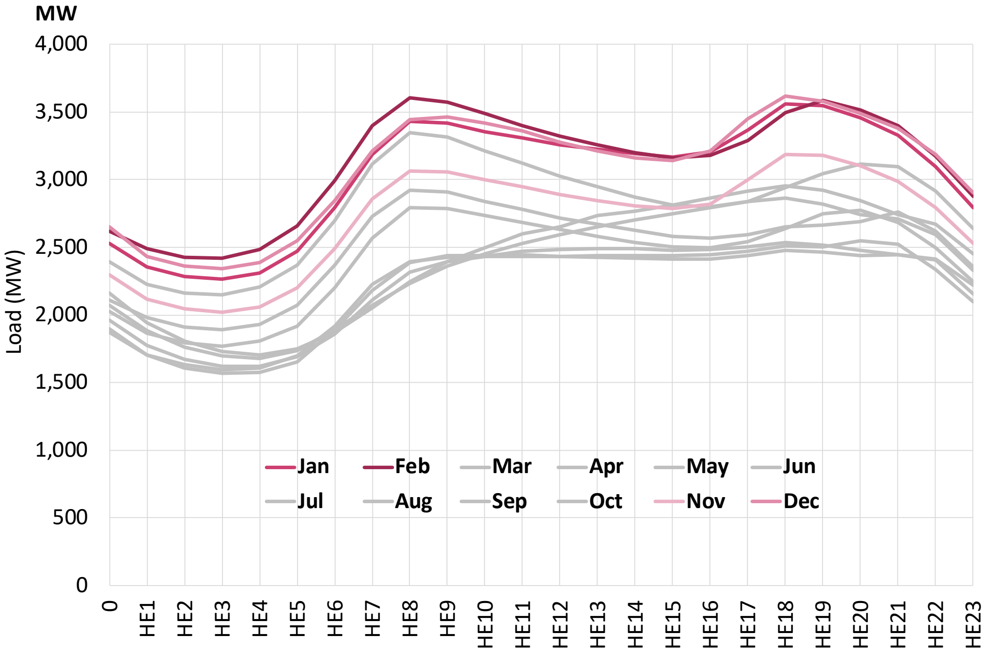
1. PSE hourly gross system load
2. Net system load data (after subtracting the non-dispatchable generation)
3. Mid-Columbia (Mid-C) wholesale prices

SEASON DEFINITION (GROSS LOAD ANALYSIS)

To identify peak windows throughout the year, we first examined seasonality in gross system load

Based on **2018 data** for PSE's typical weekday system load, we observed four distinct patterns

I. Winter: **January, February*, November, December** feature bimodal peaks, with a more pronounced *evening peak*



*February actually displays a more pronounced morning peak

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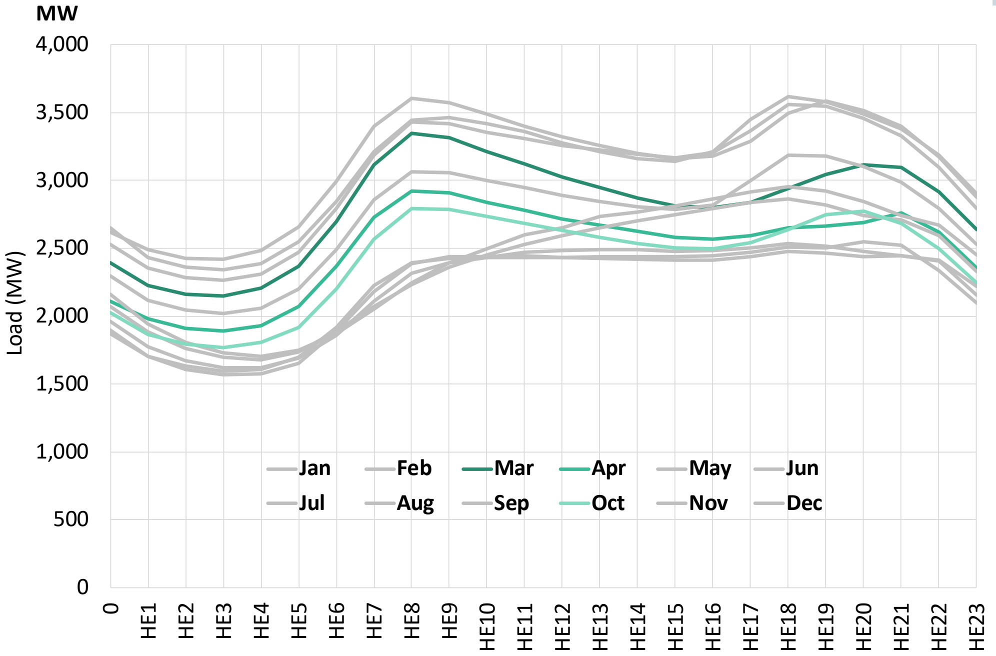
II. Spring & Fall: **March, April & October** feature bimodal peaks, with a more pronounced *morning peak*



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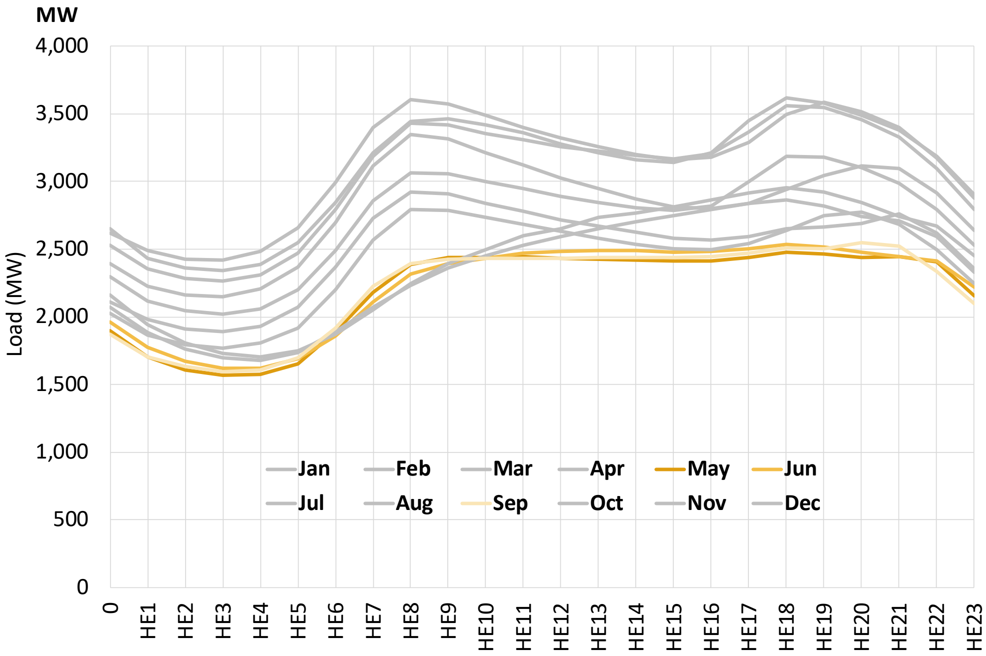
II. Spring & Fall: **March, April & October** feature bimodal peaks, with a more pronounced *morning peak*

III. Shoulder months: **May, June & September** feature mostly flat load during the day



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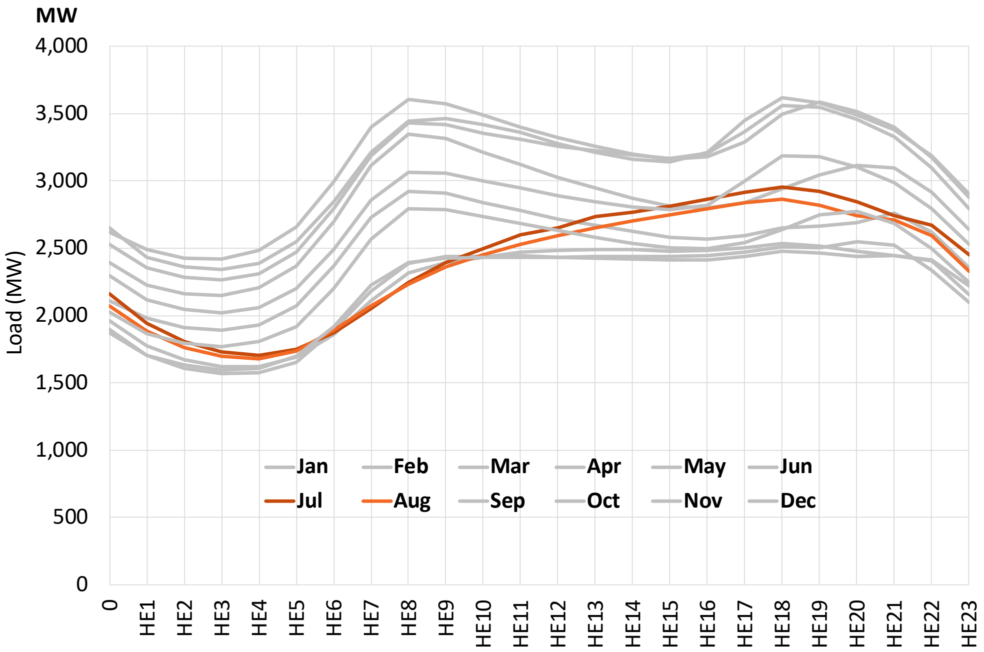
II. Spring & Fall: **March, April & October** feature bimodal peaks, with a more pronounced *morning peak*

III. Shoulder months: **May, June & September** feature mostly flat load during the day

IV. Summer: **July & August** feature evening peaks

2019 data shows the same four patterns

PSE's current winter season includes October-March



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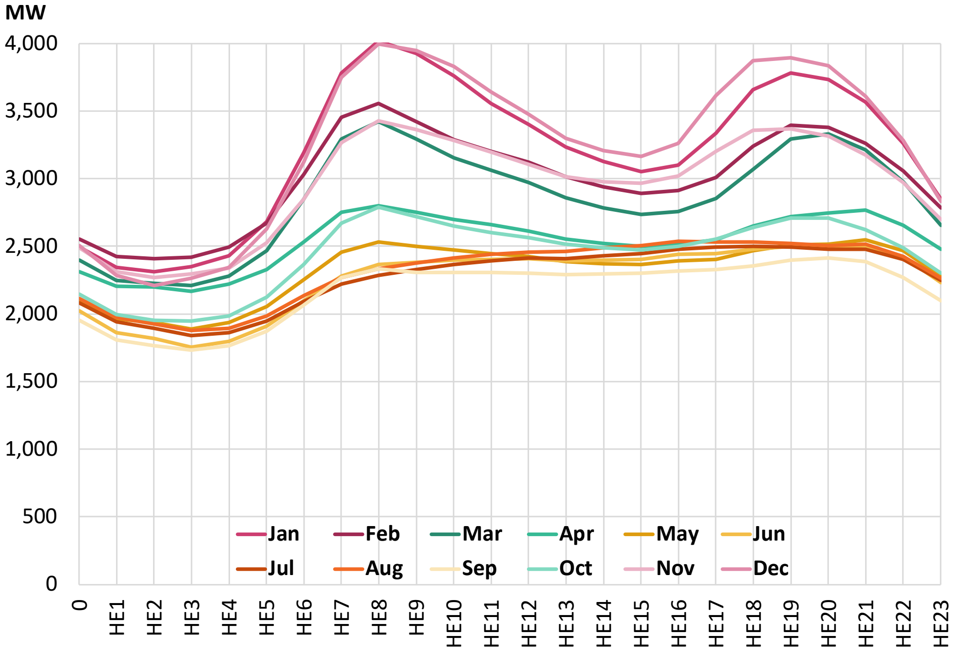
Forecasted system load shows a few small changes in 2025

2025 gross system load data confirms trends, with a few small differences

I. November-March stand out as the winter months. There’s a clear separation between these months and the rest of the year

II. The highest system load occurs in December (instead of February)

- *Data suggests that November-March may be a good candidate for “winter” if a shorter winter season is preferred*
- *April and October can be added to this grouping to create a longer winter period, especially if the TVRs will apply on during the winter*
- *Alternatively, Company may retain its current winter definition (October-March)*



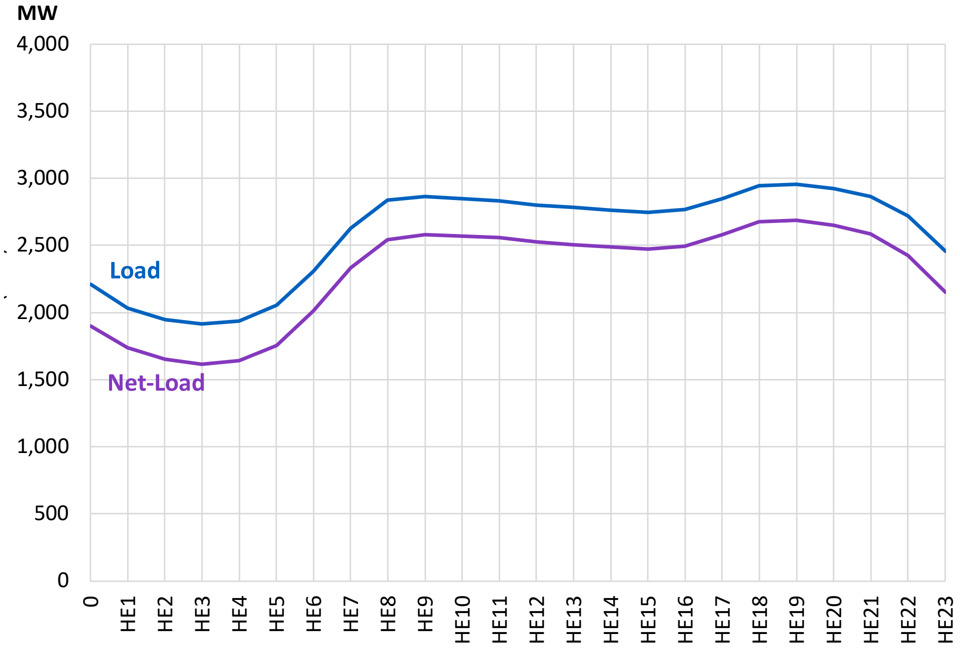
Net load is also important to analyze given the increasing penetration of non-dispatchable renewable resources

More recently, the system net load has become an important variable to evaluate for systems with high renewable deployment

- Reliability risk and marginal energy costs may correlate more strongly with *net load* than *gross load*

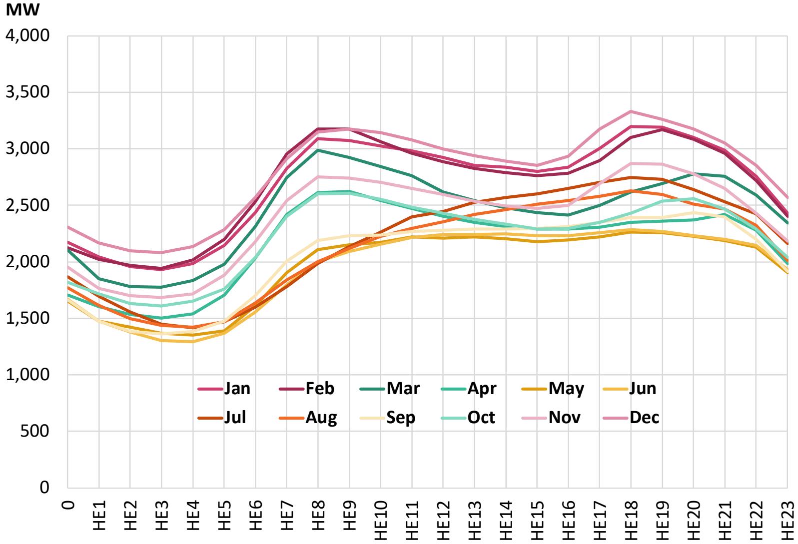
Net load is simply defined as gross load *minus* non-dispatchable energy

- *Net load = System Load – Non-Dispatchable Generation – Long-Term Purchase + Long-Term Sales*
- Non-dispatchable resources includes wind, solar, and (run-of-river) hydro power

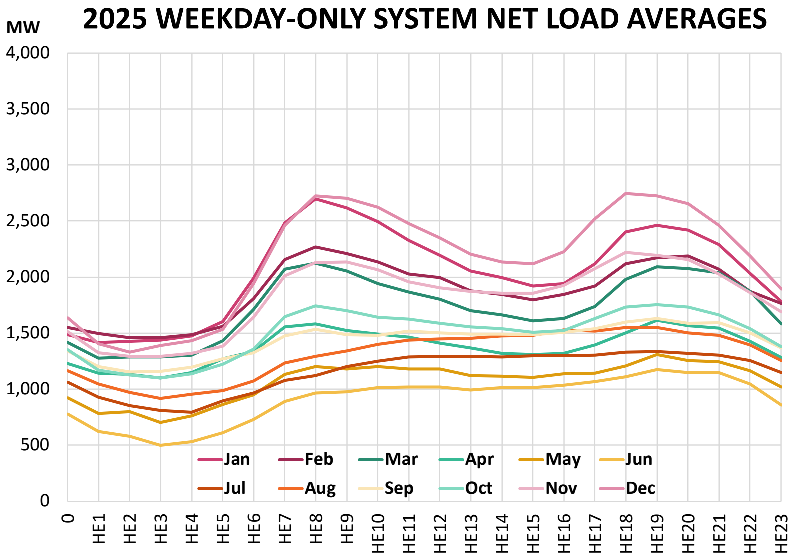


SEASON DEFINITION (NET LOAD ANALYSIS)

Analysis of net load in 2018 and 2025 confirms previously observed patterns



Note: Net load here does not include long-term purchase and sales



Note: Net load includes all hydro generation, and does not include long-term purchase and sales

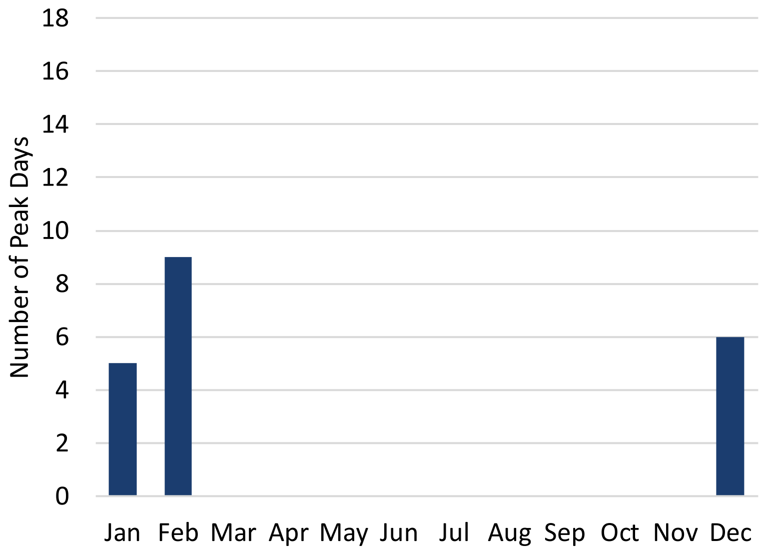
Similarly, **2018 and 2025 system net load** data shows three distinct patterns:

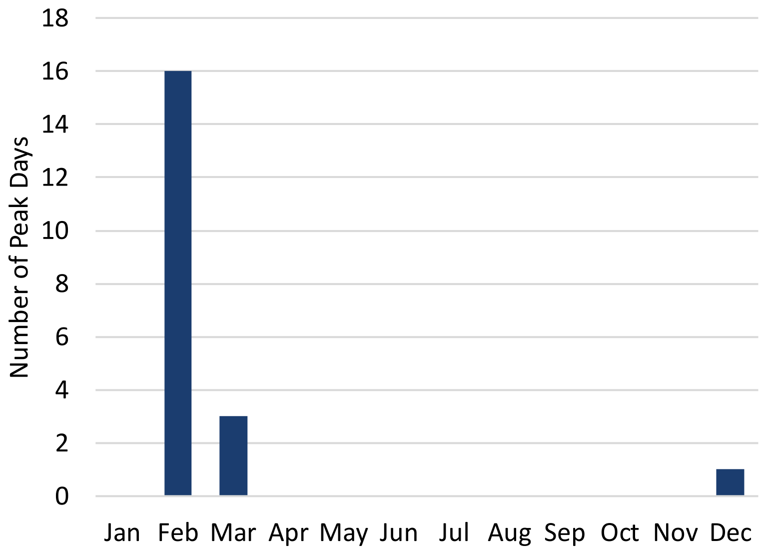
- November-March: pronounced double peaks in the morning and evening
- October and April: dual peak profile, but flatter peaks in 2025
- May-Sept: most flat loads during the day (although July and August have more pronounced evening peaks in 2018)

SEASON DEFINITION

All top 20 peak load days occurred in Winter in 2018 and 2019

Time varying rates would help manage the peak load in the winter months which is important from a distribution system capacity management perspective



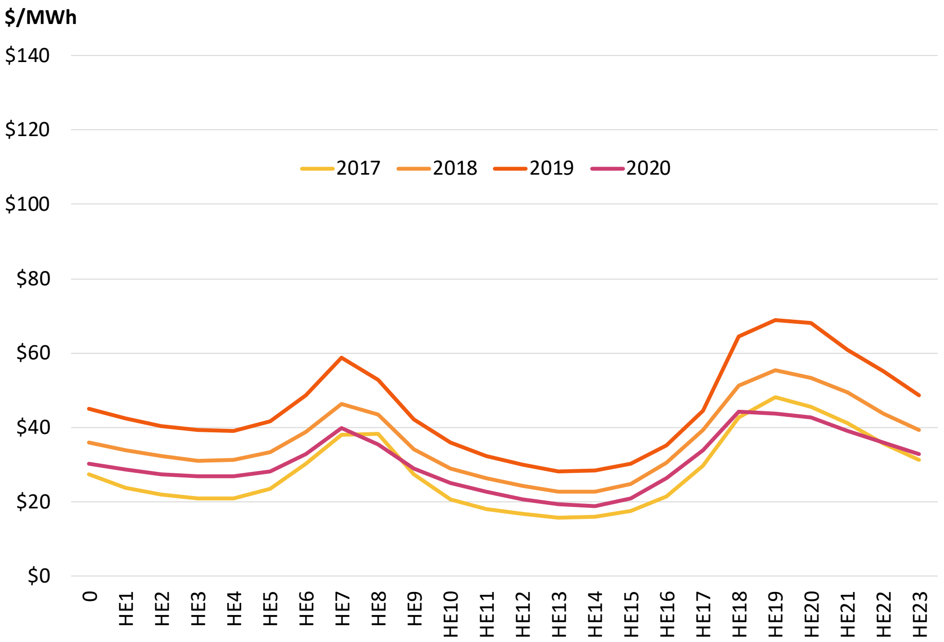


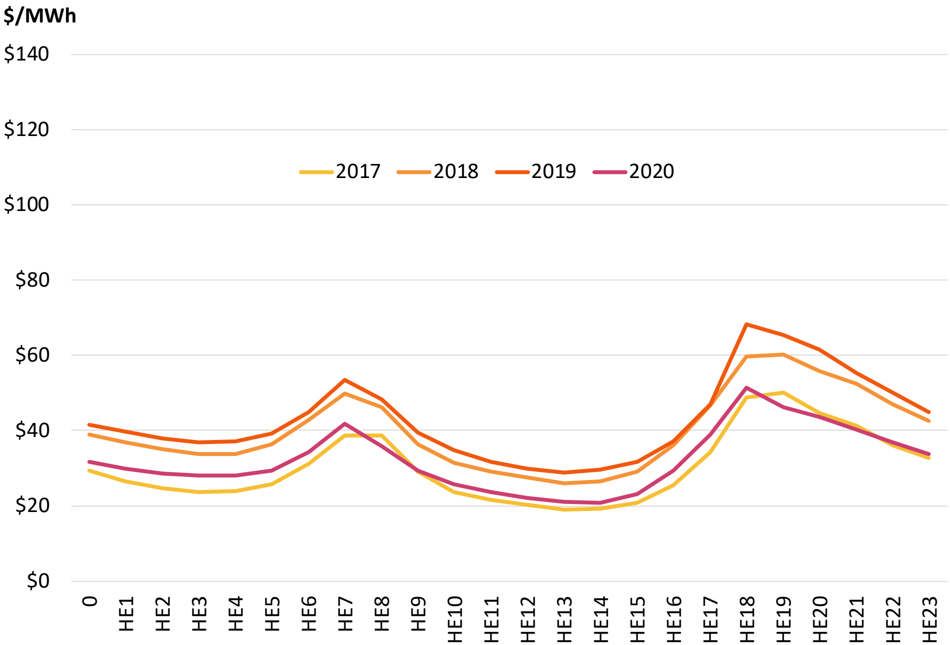
Note: Top 20 peak days = 20 separate days with highest loads

SEASON DEFINITION (MID-C PRICE ANALYSIS)

Mid-C average prices are generally low during Winter months

While all of the top 20 highest peak load days occur in the winter in both 2018 and 2019, none of the top 10 highest energy price days of the year are in the 2018 winter. (8/10 of the highest energy price days are in the 2019 winter due to the winter storm)

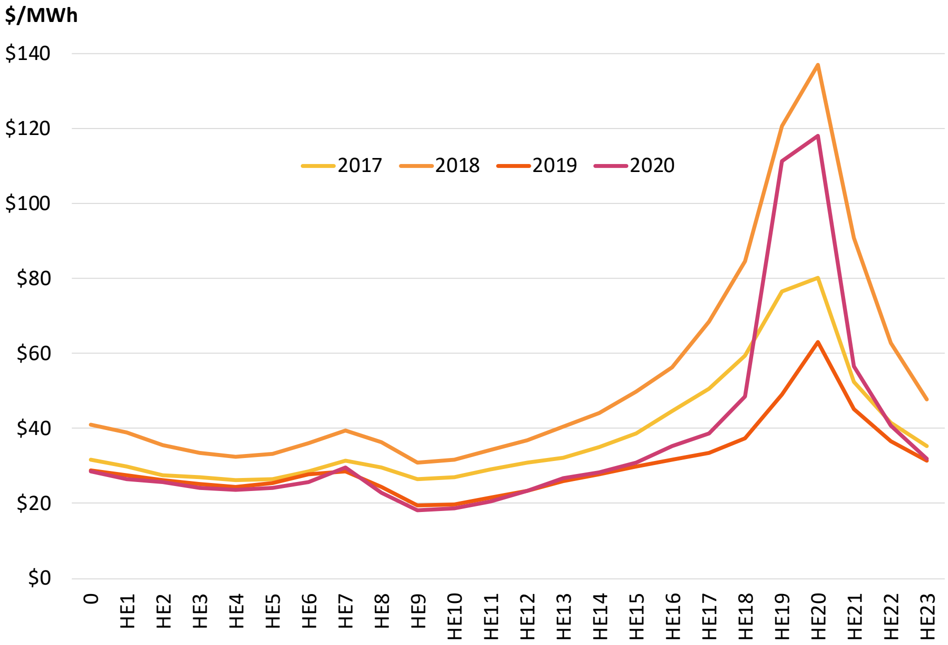


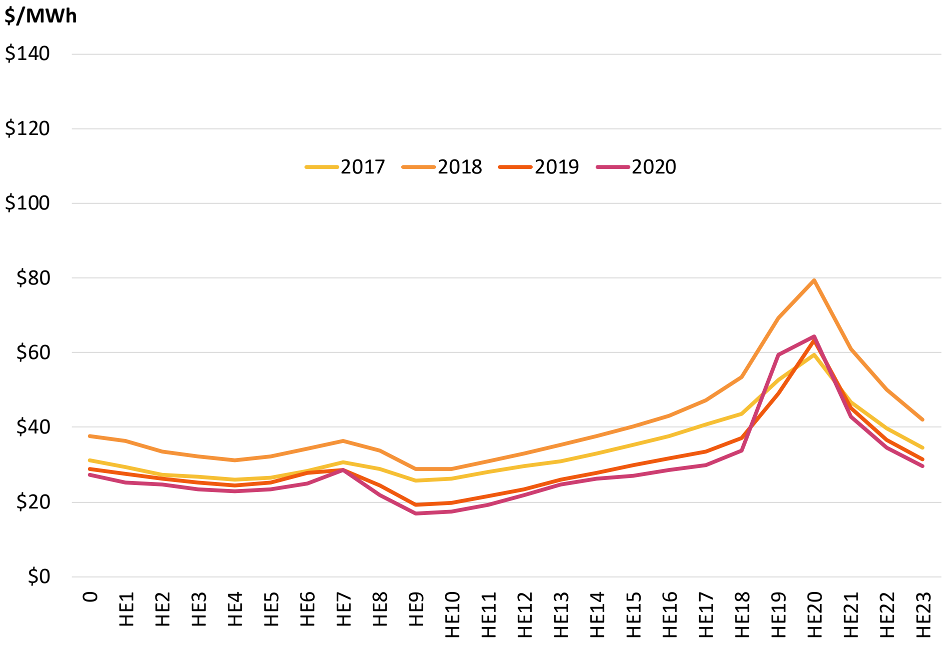


SEASON DEFINITION (MID-C PRICE ANALYSIS)

Mid-C prices can get quite high in July and August, mostly driven by a handful of high-price days

Price patterns highlight the importance of using TVR to manage higher peak energy costs in the summer months





Key Takeaways

- The dual-peak feature in winter months is evident across all three data sources
- Winter months have the highest gross system loads, confirming winter-peaking system
- While summer and shoulder months are relatively flat (or have slight evening peaks) based on the load profiles, Mid-C prices have recently been showing pronounced summer peak spikes
- This implies that there are system benefits to offering year-round TVRs
- While the recent trends in the data support November-March as the winter season, the Company decided to stay with its current winter season definition: October-March

4- Determining TVR Peak and Off-Peak Periods

Similar to the season definition, we applied a data-driven approach to determining pricing periods

Recalling the TVR pilot objectives presented in the 1st Collaborative Meeting, the TVRs will be developed to help minimize system costs

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.

This implies that TVRs will need to incentivize customers to: 1) reduce peak load 2) shift usage from high-cost to low-cost hours

Therefore, we analyze both the "load" and "price" data to determine the TVR periods

- First, we performed a "cluster analysis" to determine natural groupings of hours based on load similarity
- Next, we evaluated Mid-C prices and price patterns to gauge whether high-price hours correlate well with the high load hours

PRICING PERIOD DEFINITION

Cluster analysis applied to load data

Cluster analysis attempts to determine the natural groupings (or clusters) of observations, such that observations in the same group are as similar to each other as possible

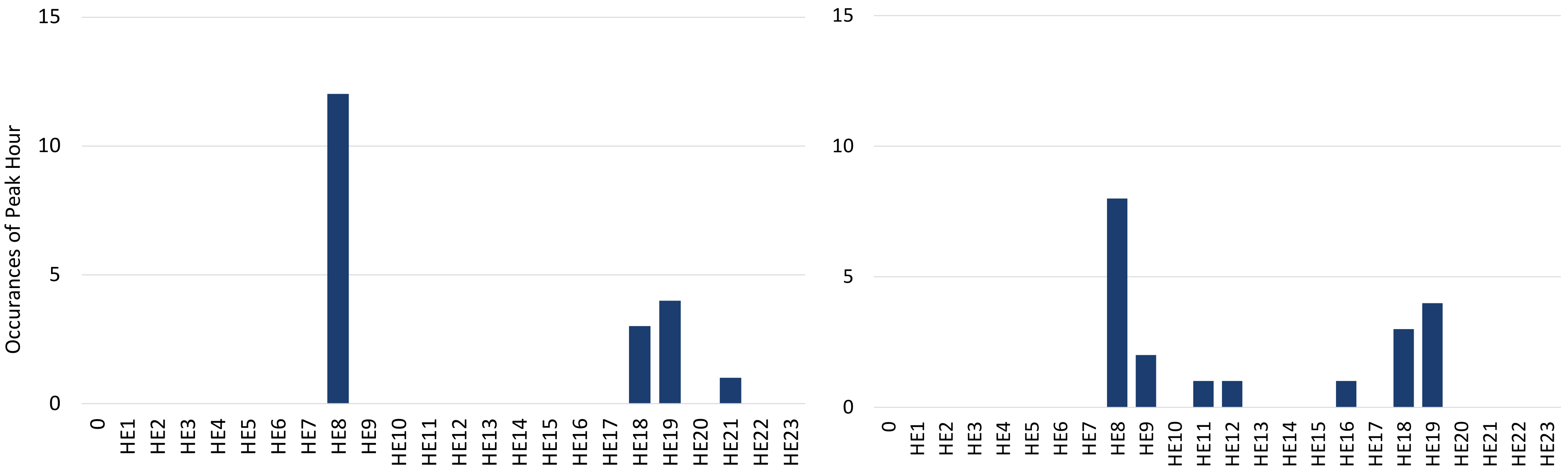
- Statistical analysis approach widely used in data analysis
- This approach allows us to more systematically identify similar hours (compared to a more simplistic visual approach)

We conducted cluster analysis on hourly system load (gross and net) and hourly system cost at both monthly and daily levels, for both winter and non-winter weekdays. We found that:

- Daily level clustering is more suitable for load analysis because it captures more variation
- Monthly level clustering is more appropriate for price analysis because daily data was highly volatile

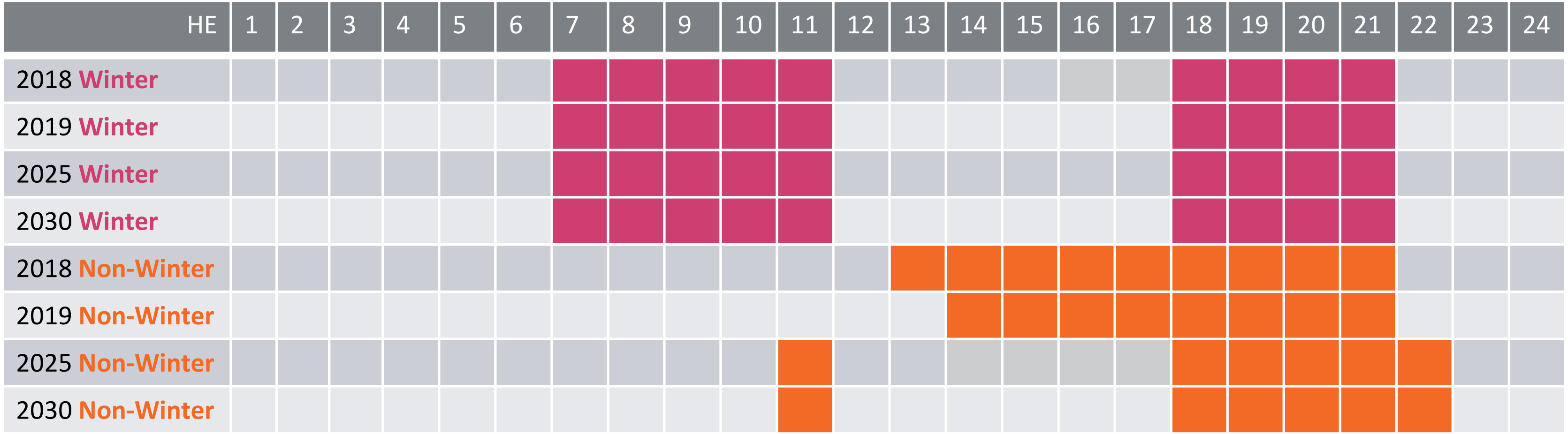
PRICING PERIOD DEFINITION

On the top 20 peak days, peak hours occurred between HE 8-12 and HE 16-21



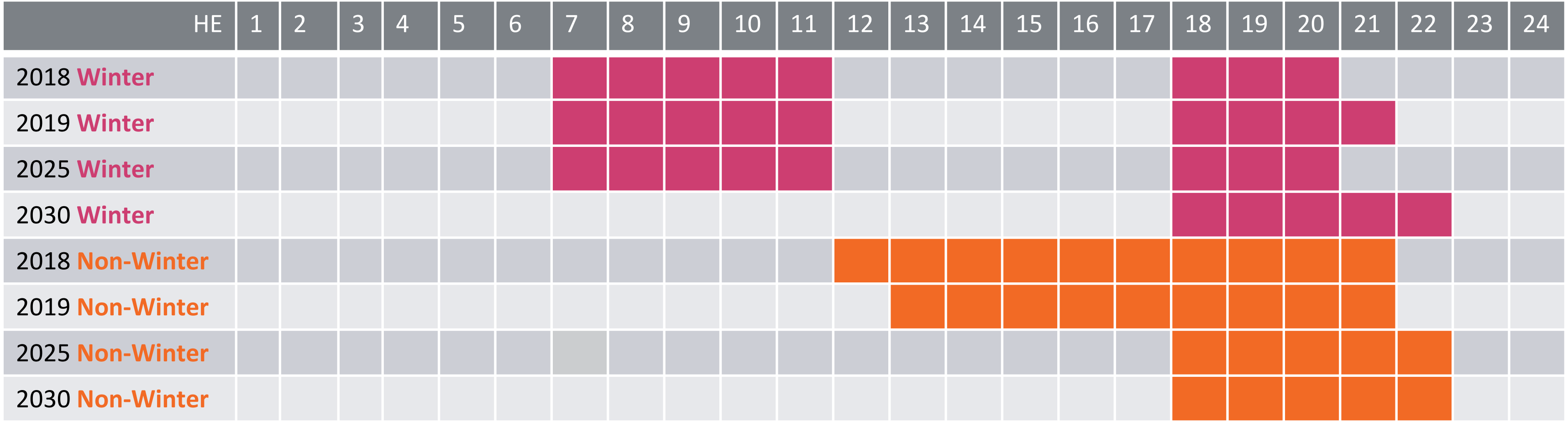
PRICING PERIOD DEFINITION

Daily Cluster Analysis, **Gross** System Load



PRICING PERIOD DEFINITION

Daily Cluster Analysis, **Net** System Load



PRICING PERIOD DEFINITION

Monthly Cluster Analysis, **Mid-C Prices**

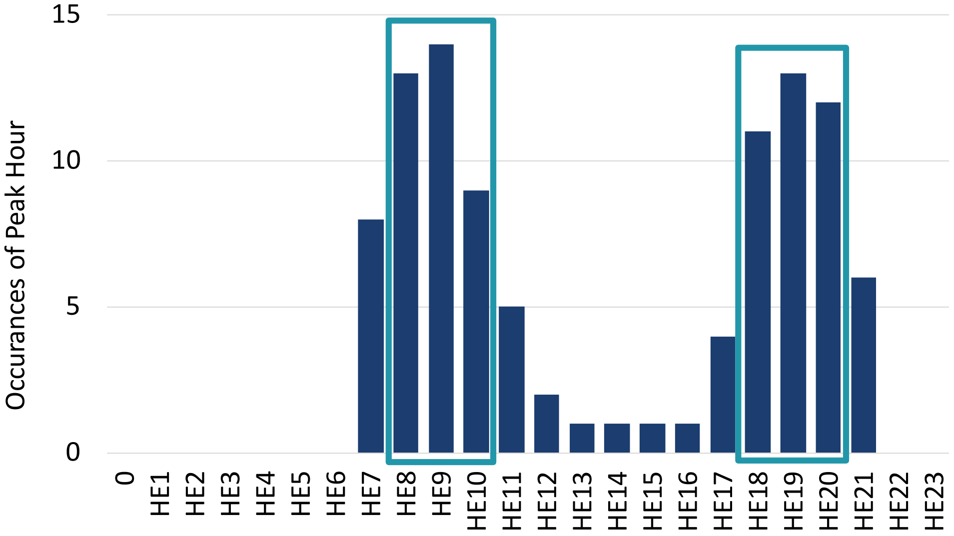
HE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
2018 Mid-C Winter																								
2019 Mid-C Winter																								
2018 Mid-C Non-Winter																								
2019 Mid-C Non-Winter																								

Cluster analysis implies a nine-hour peak (five morning and four evening hours)

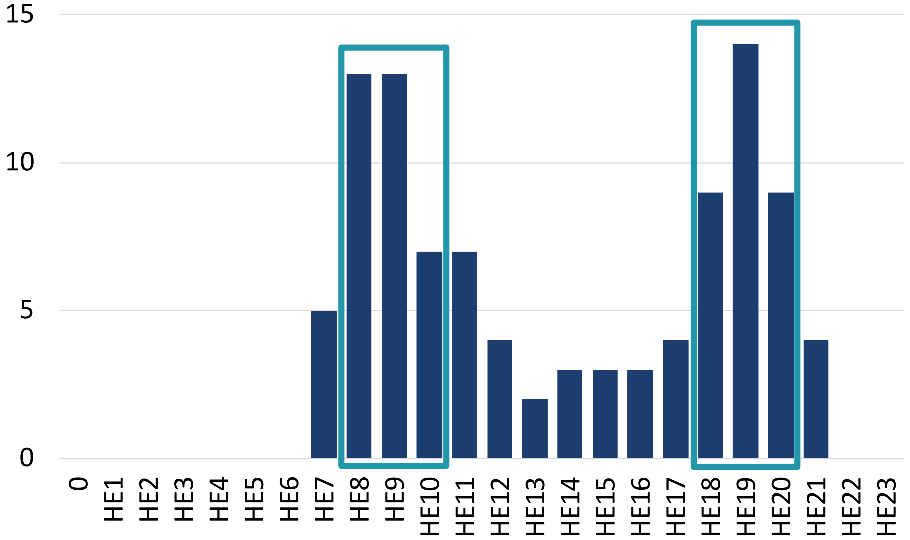
Analysis of gross load implies a five-hour morning peak **(HE 7-11)** and a four-hour evening peak **(HE 18-21)** in the winter

	Gross Load	Net Load	Mid-C
2018			
Winter	7-11, 18-21	7-11, 18-20	8, 18-22
Non-Winter	13-21	12-21	18-21
2019			
Winter	7-11, 18-21	7-11, 18-21	19-20
Non-Winter	14-21	13-21	19-21

Review of top 100 load hours help identify shorter peak windows: **HE 8-10 and HE 18-20**



2019 TOP 100 LOAD HOURS

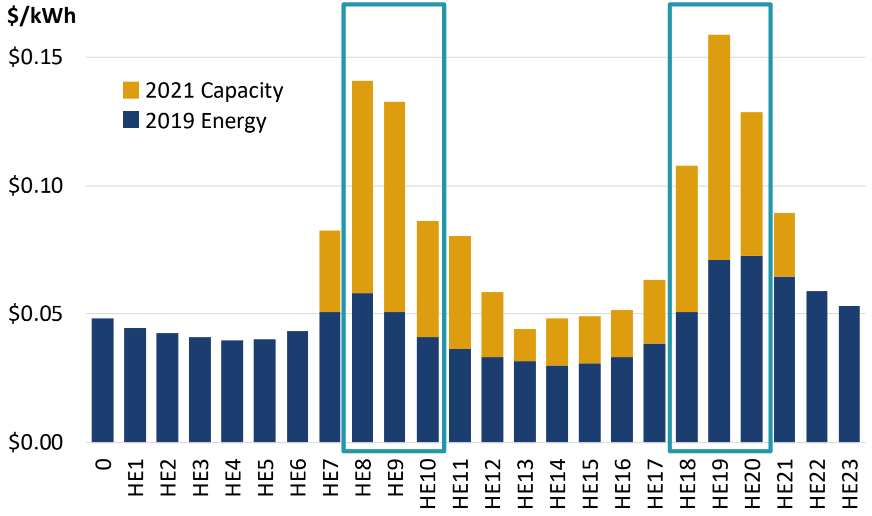


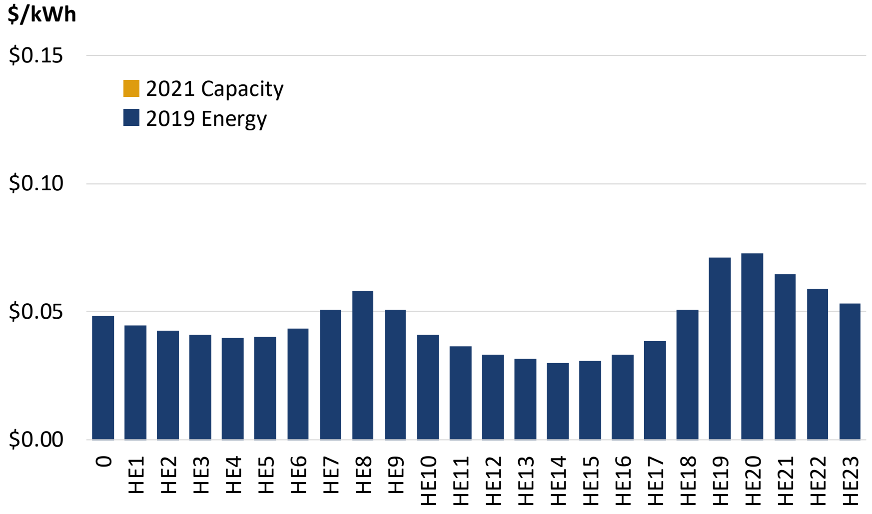
PRICING PERIOD DEFINITION

Spreading capacity costs over top 100 load hours and overlaying them on 2019 Mid-C prices help focus the peak windows

- Mid-C winter average prices present HE 7-9 and HE 19-21 as the peak windows in Winter, and HE 19-21 in the Non-Winter months
- However, when generation capacity costs are spread over the top 100 load hours in proportion to load in those hours, winter peak periods become **HE 8-10 and HE 18-20**

Marginal Energy & Capacity Costs (2019 Winter, Mid-C)





Key Takeaways

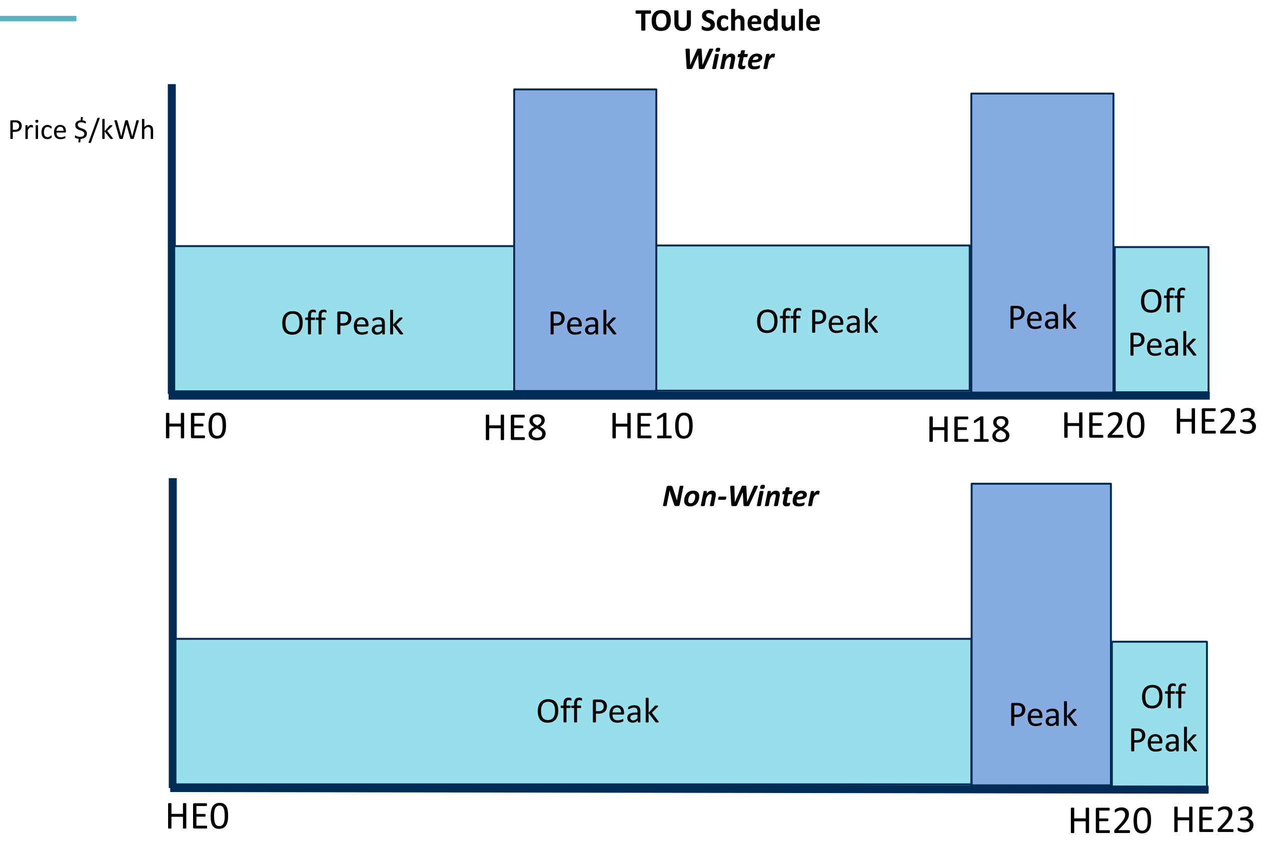
- Based on our cluster analysis of the load data and Mid-C price patterns, we propose the following pricing periods for the TVR Pilot

Season	Peak Period	Off-peak Period
Winter (October- March)	HE 8-10 and HE 18-20 on weekdays	All other hours, weekends and holidays
Non-Winter (April – September)	HE 18-20 on weekdays	All other hours, weekends and holidays

- While we could have included a few more hours to the peak periods in the winter months (based on trends in the data), we decided to keep the total peak hours to not more than six
- Similarly, while there is small increase in the Mid-C prices in the morning peak window during non-winter months, we propose that only the evening window is assigned as the peak
  - This might make the rate more appealing for the customers

PRICING PERIOD DEFINITION

Peak and Off-Peak Hours



Note: In one year there are 1,128 Peak hours (13%) and 7,632 Off Peak hours 87%)

5- Recap and Next Steps

TVR Pilot Design Recommendations

Question	Brattle and/or Company Recommendation	Rationale
1- Should TOU only rates be offered?	Yes, for Residential	Focus groups found that residential customers preferred the predictability of savings opportunities with TOU rates vs. callable events like CPP.
2- Should TOU+PTR rates be offered?	Yes, For Residential & Small Commercial	Can help reduce energy costs daily and during peak days; better customer engagement; mitigate free-rider problem that exists with simple PTR rate
3- Should TOU+PTR be offered just in the winter months (versus year-round)?	TOU+PTR rate should be offered year-round (same as TOU only)	Customers do not have to worry about changing their lifestyle over the year. Also increases their chances to save on a more diverse set of events.
4- Should CPP Rates be offered?	Recommendation is to offer PTRs instead of CPP. If EV-Only rates are viable, CPP may be considered	Focus groups were highly resistant to the prospect of CPP; customers may find the uncertainty too risky. Little support from stakeholders for this to be applied to most populations.
5- Will TOU rates be offered for EVs?	Yes. Baseline case includes Whole-house EV TOU rates; Company is exploring viability of EV-only rates	It is not certain whether separate EV metering will be viable in a full-scale deployment. Advantages to both approaches, whole-house is more inclusive within Sch. 7, while EV only could have more appeal.
6- Should TOU Carbon rates be offered?	No economic basis at this time	Current average carbon emissions profile is flat; and do not correlate with high-load or high-price hours.

TVR Pilot Design Recommendations (Cont.)

Question	Brattle and/or Company Recommendation	Rationale
7- Will the rates be paired with enabling technologies?	TVR pilot will not have a separate treatment for enabling technologies; Company will offer enabling technologies through EE/DR programs	It is likely rates will not be paired with PSE provided technology in a full scale roll-out; strongly prefer to pursue same strategy that would be used for a full-scale rollout.
8- How will the rates be deployed?	Opt-in will be the default for all treatment groups	Pursue same strategy that would be used for a full-scale rollout. Allows for increased customer choice. As EV and PTRs paired either with TOU or Whole-house TOU, opt-out is not being considered at this time.
9- Will the treatment customers be offered bill protection?	Recommendation is to not offer bill protection	Not likely to be available in a full-scale roll-out; low-income/underserved customers will be protected through low-income discounts/programs; bill protection for may dilute customer response to price signals.
10-Will the treatment customers be offered shadow bills during recruitment?	Recommendation is to offer generic typical bill impacts using multiple load use scenarios	Similar information may be offered in a full-scale roll-out; customer can opt-out if pilot is not suitable

Next Steps

- Revise proposed treatments and rate designs based on the stakeholder feedback
- Undertake bill impact analyses and modify rates, if necessary
- Undertake statistical power calculations to determine the pilot sample sizes
- Develop pilot design and recruitment approach
- Develop an Evaluation, Measurement, and Verification approach