BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of Kansas City Power & Light Company's Request for Authority to Implement A General Rate Increase for Electric Service	)))	**Case No. ER-2018-0145**
In the Matter of KCP&L Greater Missouri Operations Company's Request for Authorization to Implement A General Rate Increase for Electric Service	))))	**Case No. ER-2018-0146**

NOTICE

COME NOW Evergy Metro, Inc. d/b/a Evergy Missouri Metro ("Evergy MO Metro") and Evergy Missouri West, Inc. d/b/a Evergy Missouri West ("Evergy MO West") (collectively, the "Company") [1] and respectfully state as follows to the Missouri Public Service Commission ("Commission"):

1. On September 25, 2018, the Company filed a *Non-Unanimous Stipulation and Agreement Concerning Rate Design Issues* ("Rate Design-TOU Stipulation") which included an agreement between the Company, Staff, the Office of the Public Counsel ("OPC"), Missouri Division of Energy ("DE"), and Renew Missouri Advocates ("Renew MO") (collectively, the "Signatories") on Time of Use ("TOU") rates.[2]

2. On October 31, 2018, the Commission issued its *Order Approving Stipulations and Agreements* ("Order") which approved the various settlements between the Signatories in these dockets, including the Rate Design-TOU Stipulation referenced above.

[1] Effective October 7, 2019, Every MO Metro adopted the service territory and tariffs of Kansas City Power & Light Company; and Evergy MO West adopted the service territory and tariffs of KCP&L Greater Missouri Operations Company.

[2] "When completed the Company will submit to the Commission the following documents on an ongoing basis: Customer research plan, business case for shadow billing, marketing and education plan, EM&V plan, Customer Feedback Mechanism, Customer Behavior Metrics, EM&V interim and final results and documentation shared at each stakeholder meeting." Rate Design-TOU Stipulation, Section 2.e., p. 6.

3. Pursuant to the provisions of the Rate Design-TOU Stipulation the Company is filing the attached, as identified below:

(i) **Exhibit A:** *Missouri West and Missouri Metro Residential Time of Use Plan Stakeholder Update* (presented on December 17, 2020); and

(ii) **Exhibit B**: *Evergy Missouri Residential Time of Use Rate Evaluation*, prepared by Guidehouse Inc.

WHEREFORE, the Company respectfully request the Commission take notice of the attached.

Respectfully submitted,

/s/ Robert J. Hack

Robert J. Hack, #36496
Roger W. Steiner, #39586
Evergy, Inc.
1200 Main Street
Kansas City, MO 64105
Phone: (816) 556-2791
Phone: (816) 556-2314
Fax: (816) 556-2787
rob.hack@evergy.com
roger.steiner@evergy.com

James M. Fischer, #27543
Fischer & Dority, P.C.
101 Madison Street—Suite 400
Jefferson City MO 65101
Phone: (573) 636-6758
Fax: (573) 636-0383
Jfischerpc@aol.com

ATTORNEYS FOR EVERGY MISSOURI METRO AND EVERGY MISSOURI WEST

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing have been mailed, hand-delivered, transmitted by facsimile or electronically mailed to all counsel of record this 17th day of December 2020.

Roger W. Steiner

Roger W. Steiner

Missouri West & Missouri Metro Residential Time of Use Plan

Stakeholder Update

December 17, 2020

evergy™

Agenda

- Safety Moment
- Process for follow up questions/material
- Enrollments and Channel Activity
- Interim EM&V Key Findings - Evergy
- Interim EM&V Report Review – Guidehouse
- Time of Use Rate Design Case Update
- Next Steps

Safety Moment

Safety Moment

- Holiday Safety Tips – Decorate Safely
  - Keep potentially poisonous plants – mistletoe, holly berries, Jerusalem cherry and amaryllis – away from children
  - If using an artificial tree, check that it is labeled “fire resistant”
  - Turn off all lights and decorations when you go to bed or leave the house

Follow Ups Process

Process for Follow Up Questions/Material

- To help ensure questions are addressed accurately, please remember for any follow up questions or requests coming out of this meeting that could not be answered and delivered within the construct of this meeting, please email the request(s) to **regulatory.affairs@evergy.com**.

Enrollments and Channel Activity

Enrollments and Channel Activity

All Active Enrollments as of 12/14/2020 **142%** to overall enrollment goal

State	Enrollment Type	Division	Source	Count	2020 Enrollment Goal	% to 2020 enrollment goal
Missouri	TOU	MO West (GMO)	CSR	248		
			CSS	2463		
				2711	1750	**155%**
		MO Metro (KCPLM)	CSR	186		
			CSS	2072		
				2258	1750	**129%**
State Total				4969	3500	**142%**

*High CSS enrollment % underscores the criticality of quality self-service tools, information and infrastructure.

Enrollment Channel Activity		
CSS	4535	91%
CSR	434	9%
Total	4969	100%

Enrollments began on October 1, 2019

Legend:
CSS = Customer Self Service (authenticated website)
CSR = Customer Service Representative (via phone or in person at Evergy Connect)

TOU EM&V Key Findings

Evaluation Year: October 2019-September 2020

MO West and Metro TOU EM&V Key Findings

- **Results** indicate that the TOU rate and associated program design has had the desired effect of reducing consumption during the on-peak period (4-8pm M-F) in both the summer and winter seasons and driving participant bill savings (on average).
- **Peak System Impacts –** TOU participants lowered their demand by 4-9% at system coincidence peak
- **Bill Impacts -** On average, participants are saving 3-10% annually depending on the tiered rate that they were on prior to enrolling. Summer bills see the greatest savings, approximately half of which are driven by **behavioral changes** while winter bills see an increase for those previously on the electric heating rate primarily driven by rate structure changes.
  - Average annual savings for res general customer - ranges from 5 to 10%
  - Average annual savings for res space heating customer - ranges from 3 to 6%
- **Enrollments –** Evergy exceeded stipulated enrollment targets within the evaluation year and is currently at 142% of the overall MO enrollment target.
- **Attrition** – Approximately 50% of the 700 total un-enrollments that occurred during the evaluation year were from customers moving.

TOU Interim EM&V Report Review

Evaluation Year: October 2019-September 2020

Guidehouse

Evergy Missouri Residential TOU Rate Evaluation

Interim Energy and Peak Demand Impacts for the Missouri Metro and West Jurisdictions

December 17, 2020

Agenda

Review interim impact results of the TOU rate study, from October 1, 2019 to September 30, 2020.

- Enrollment Summary
- Methodology
- Results

Enrollment Summary

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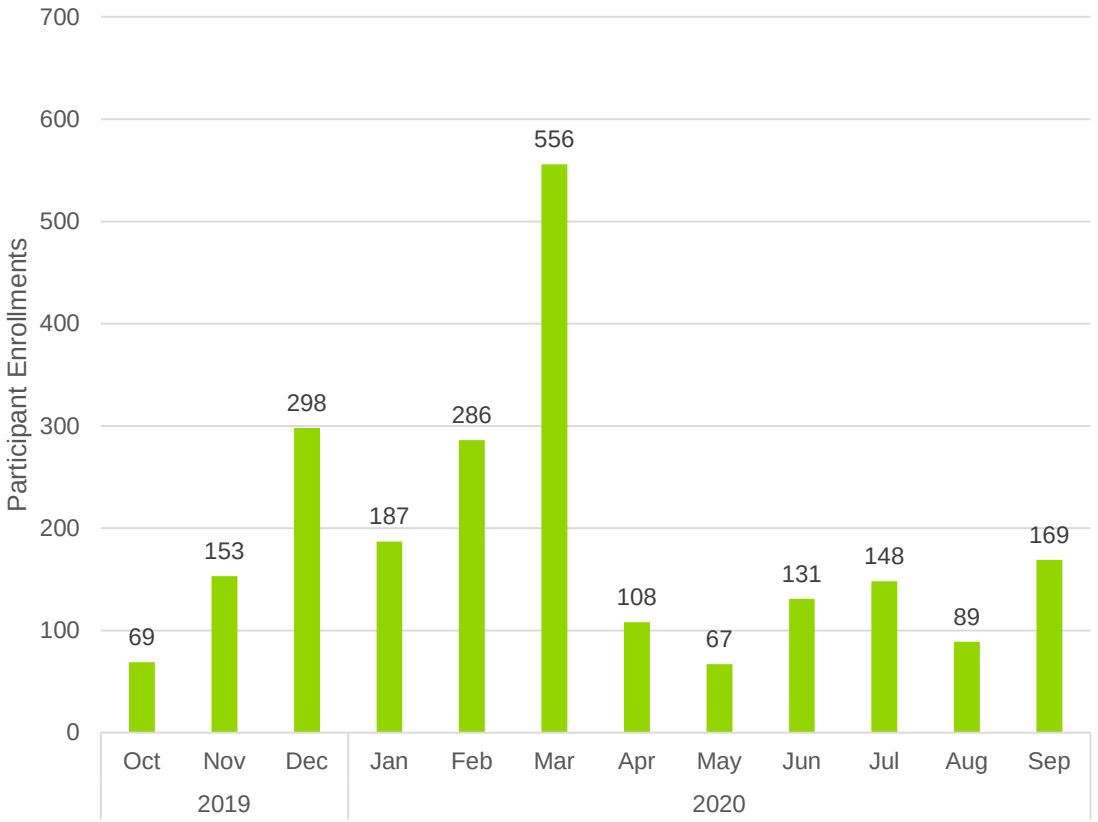
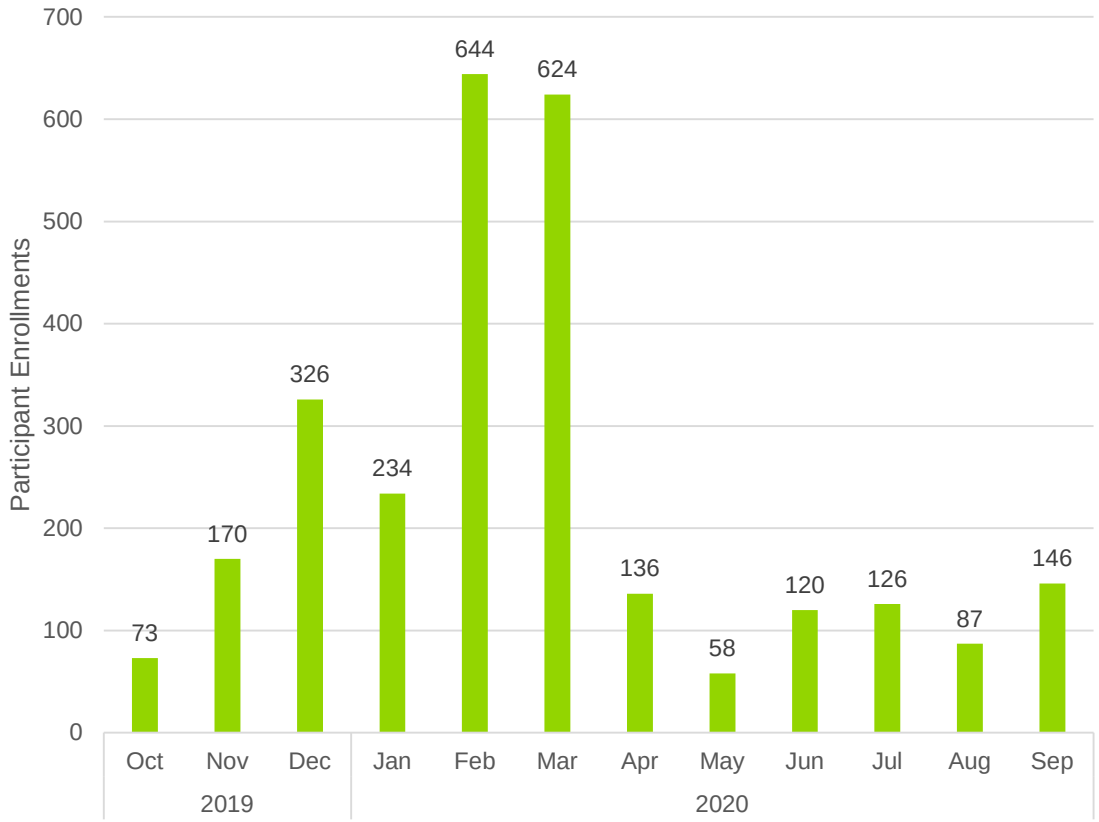
Enrollment Summary

General enrollment patterns are similar across the two jurisdictions. The interim analysis includes all customers enrolled between October 1, 2019 and September 30, 2020.*

Missouri Metro 2,261 Participants



Missouri West 2,744 Participants



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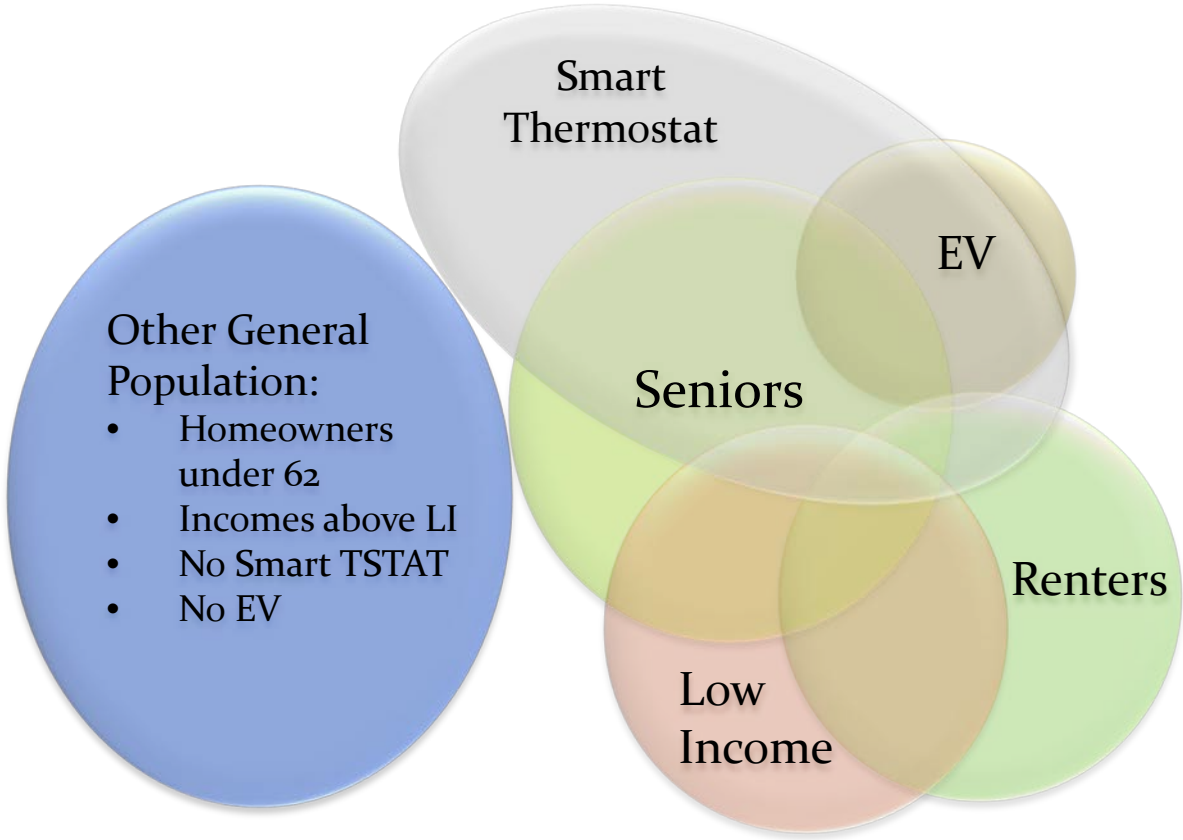
** Includes all customers who have enrolled, including those who may have un-enrolled at a later date.*

Customer Segmentation

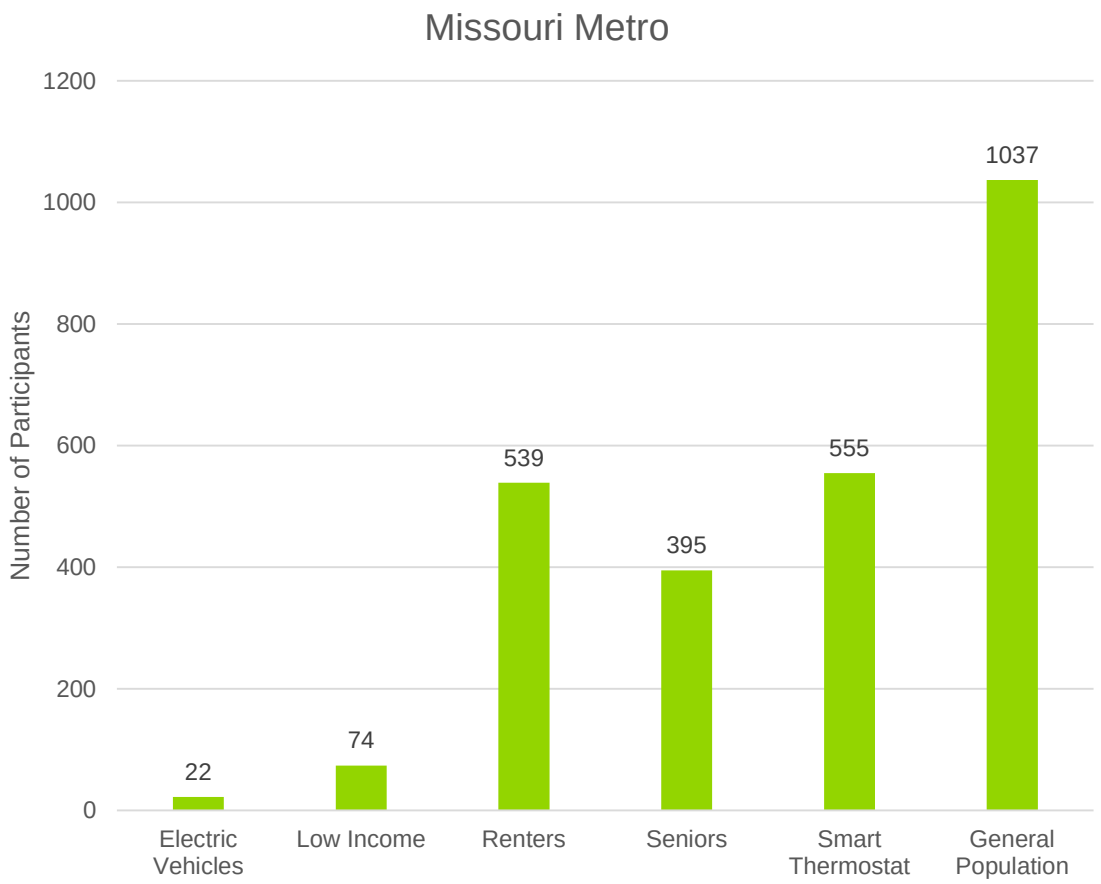
Individual customers represent a combination of characteristics and can provide insights into the impacts of more than one segment they represent.

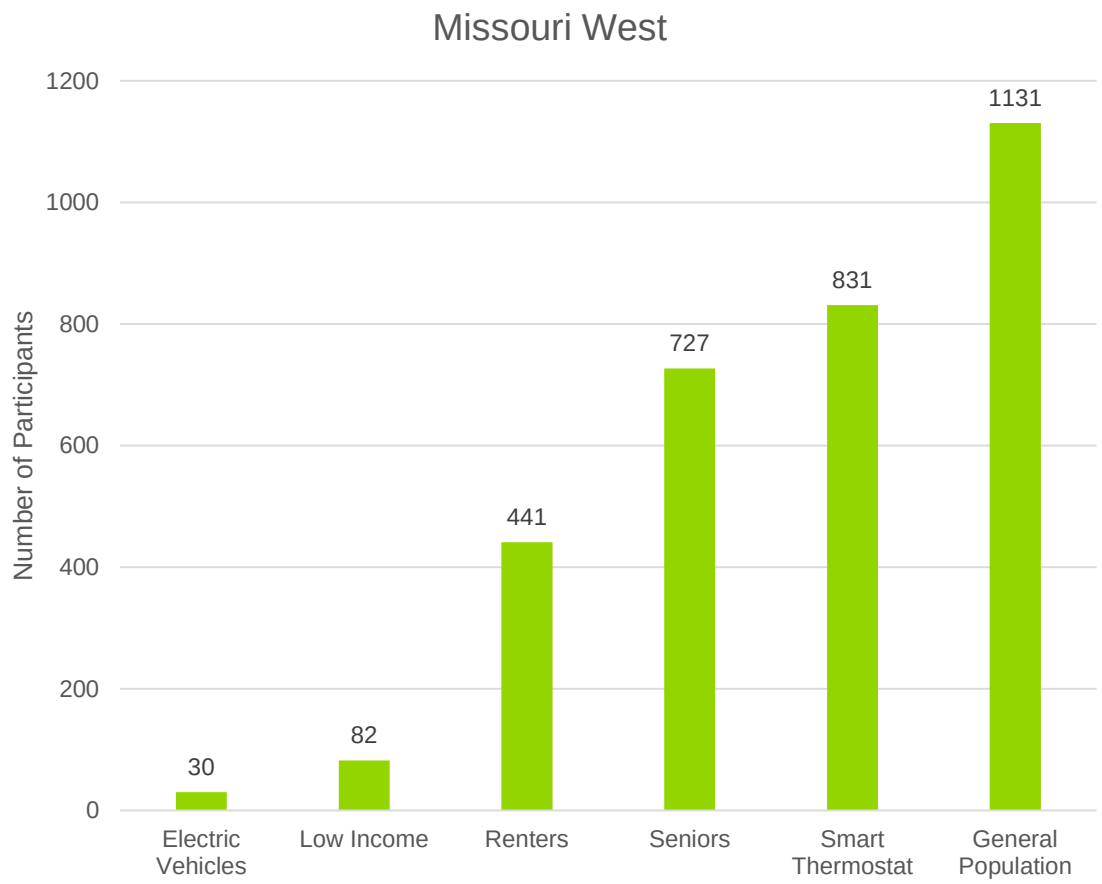
Low Income	•LIHEAP participants or customers that self-report LIHEAP eligibility in survey responses
Electric Vehicles	•Self-reported EV owners in survey responses or customers in EV program data
Smart Thermostat	•Participants in MEEIA 2 thermostat program or self-reported smart thermostat in survey responses
Seniors	•Self-reported at least one occupant over 62 in survey responses or identified as over 62 in 3rd party Axiom data
Renters	•Self-reported renter or identified as a renter in 3rd party Axiom data
General Population	•Customers that are not part of any other segment



Customer Segment Summary

Customers can be in more than one segment.* This includes only those customers who enrolled between October 1, 2019 and September 30, 2020.

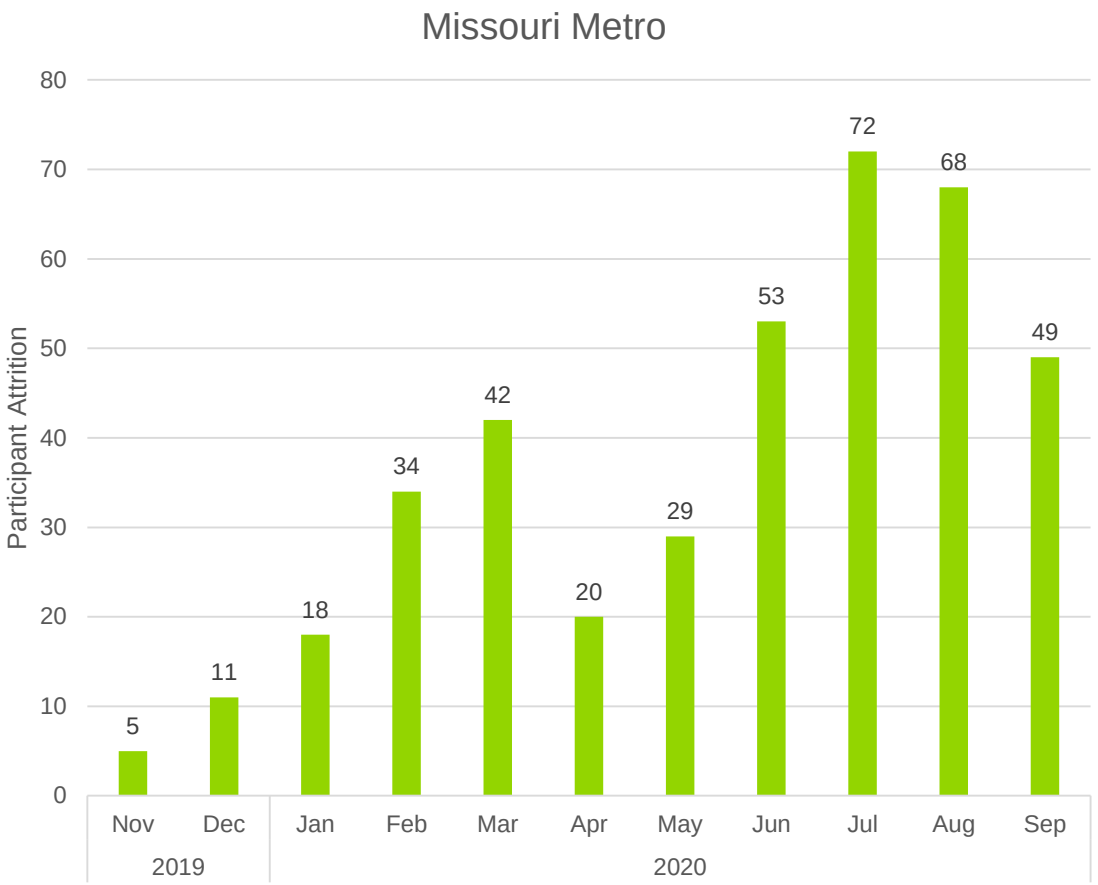


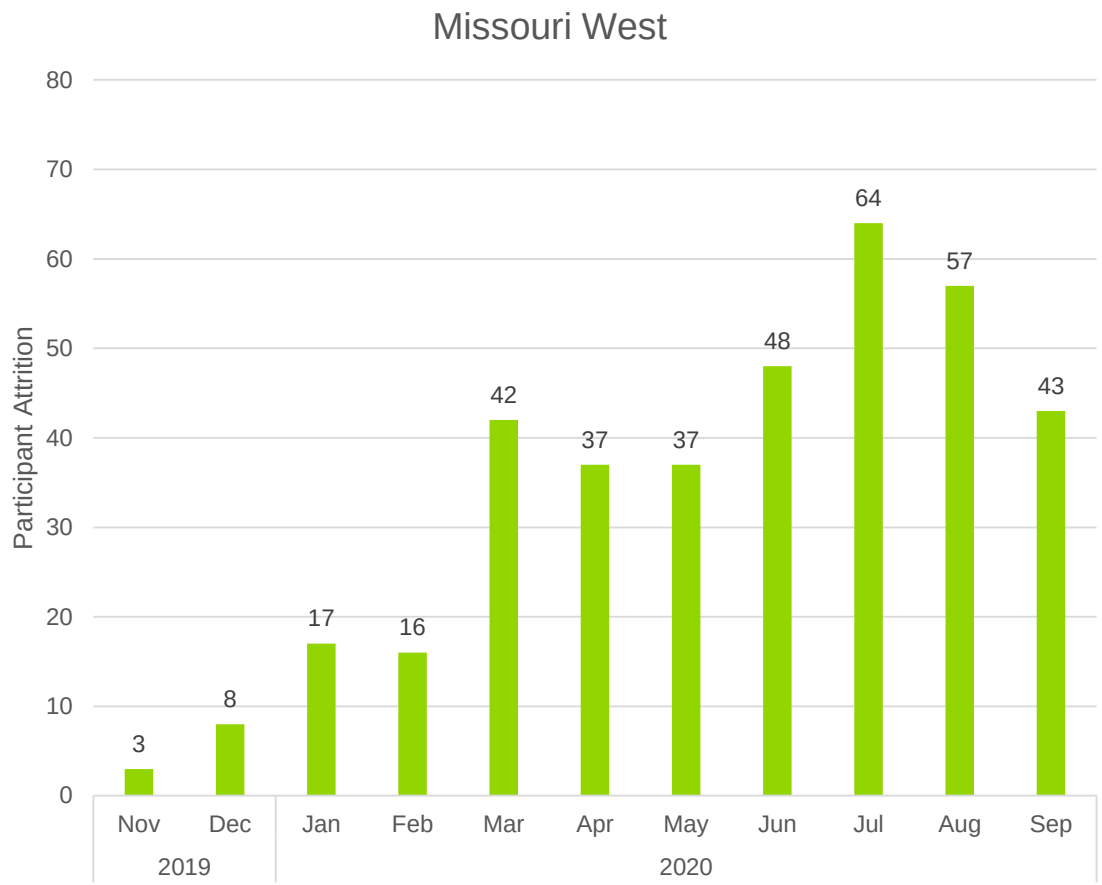


** Hence the total segment counts will be higher than the total number of participants who have enrolled.*

Attrition Summary I

General attrition patterns are similar across the two jurisdictions. The summary displays attrition that occurred between October 1, 2019 and September 30, 2020.

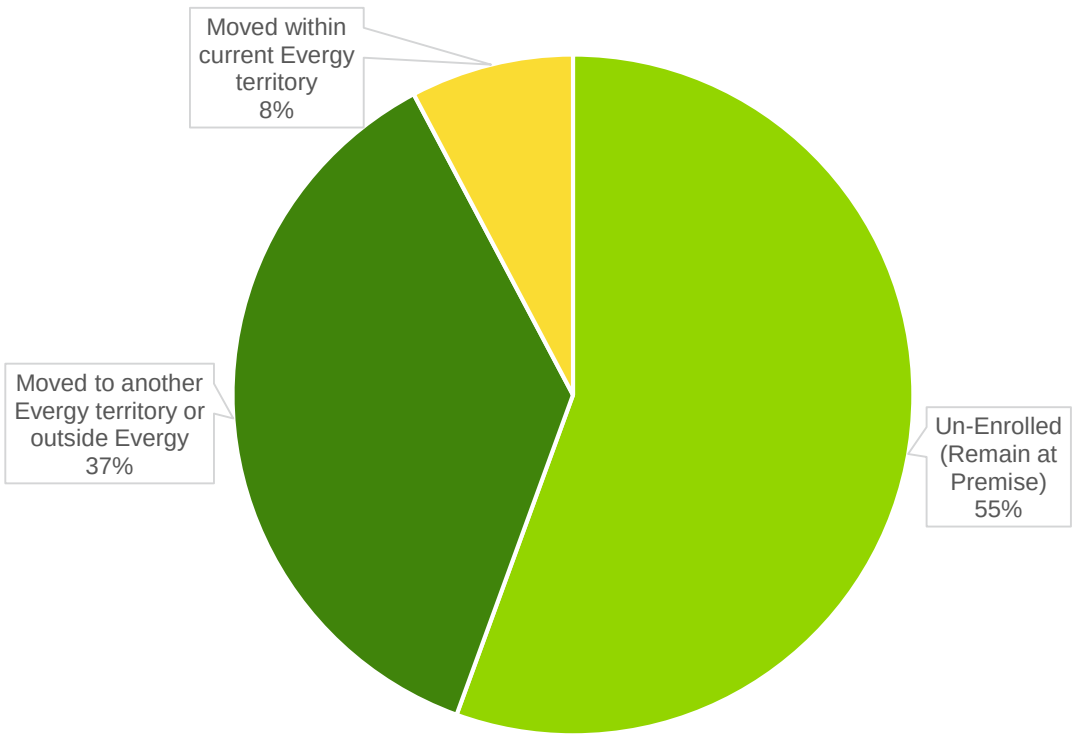




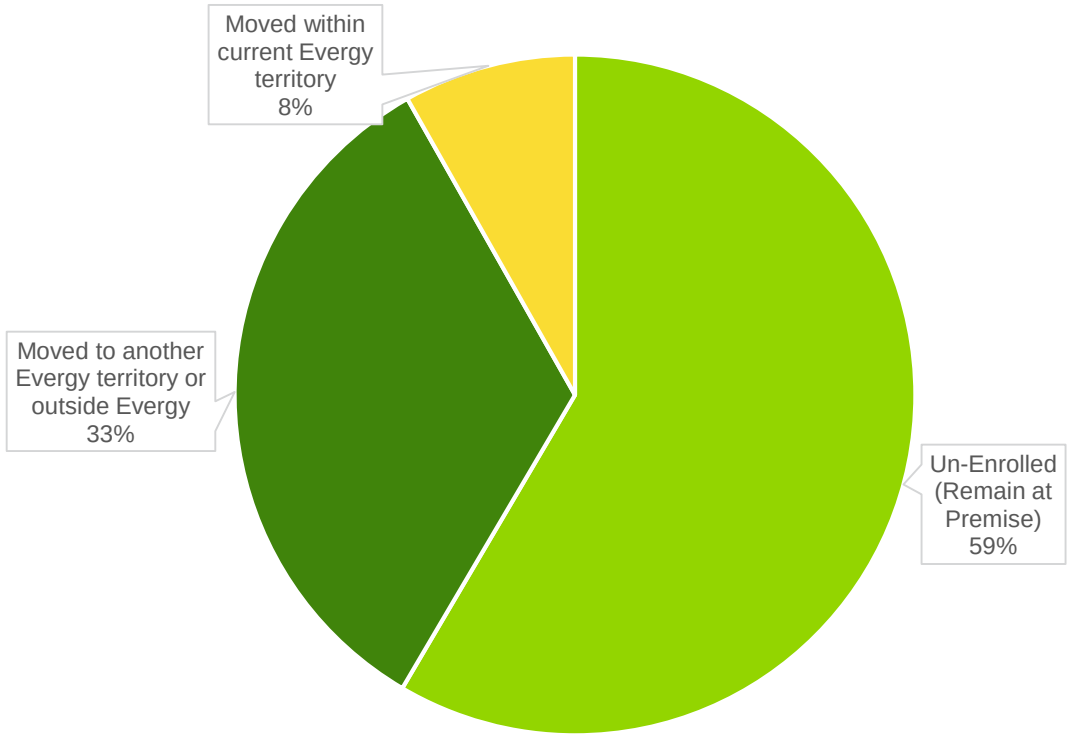
Attrition Summary II

The total attrition for the interim analysis are 401 and 372 customers for the Metro and West jurisdictions, respectively, approximately half of which is due to customers moving. This includes only those customers who enrolled between October 1, 2019 and September 30, 2020.

Missouri Metro



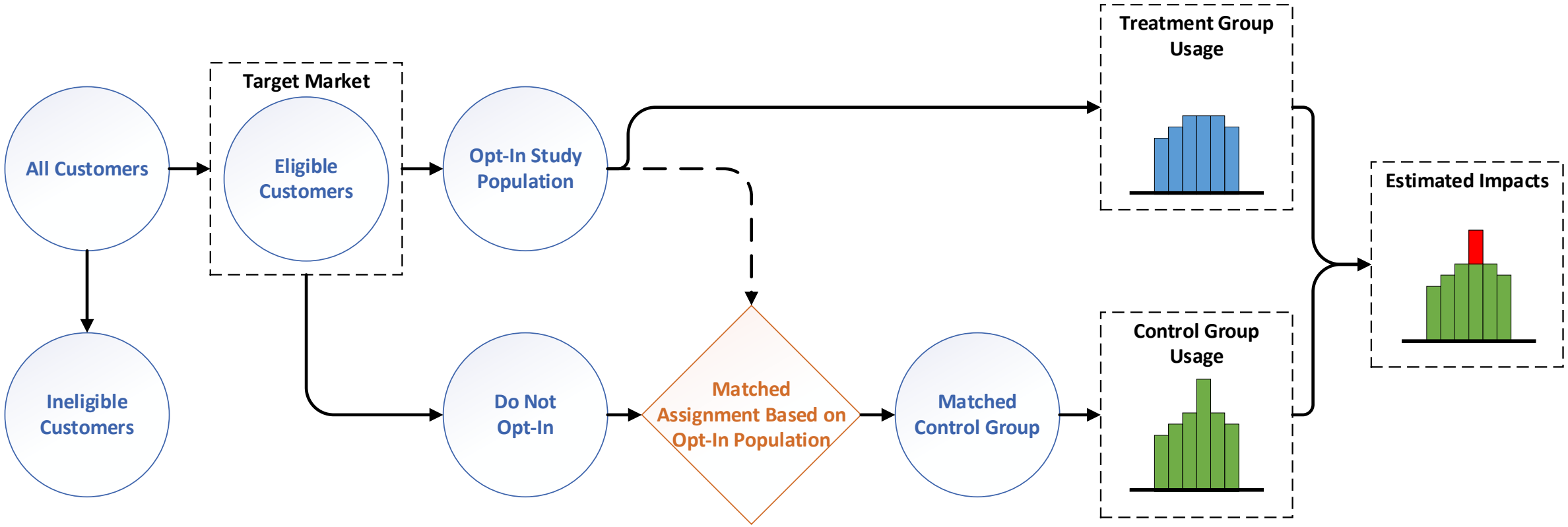
Missouri West



Methodology

Quasi-Experimental Design

Opt-In Recruitment with Quasi-Experimental Matched Control Group. For each participant, a matched control is selected based on pre-enrollment interval meter data.



Matching Approach

The purpose is to minimize any differences in consumption between the participants and controls by selecting non-participants whose pre-enrollment consumption is most similar to the participants.

Monthly Matching

- Narrow down the pool of non-participants with similar monthly consumption patterns
- Restrict pool of controls to be in the same jurisdiction as the participants

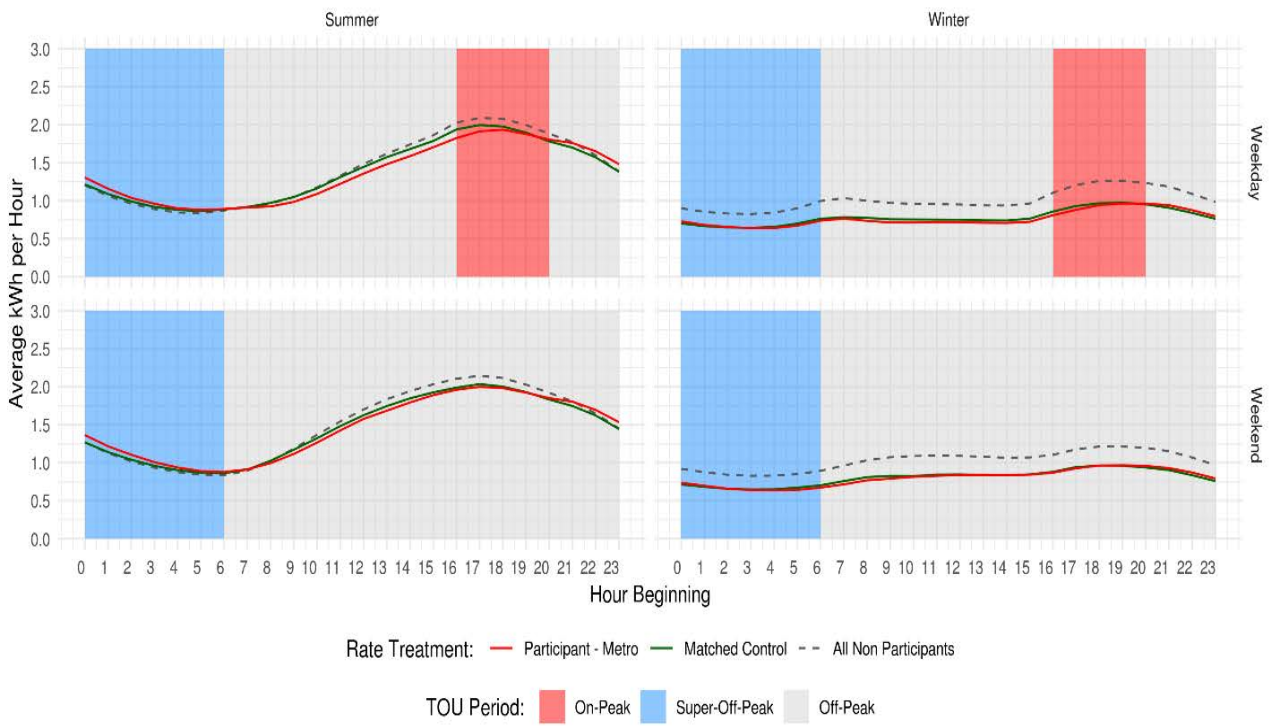
Hourly Matching

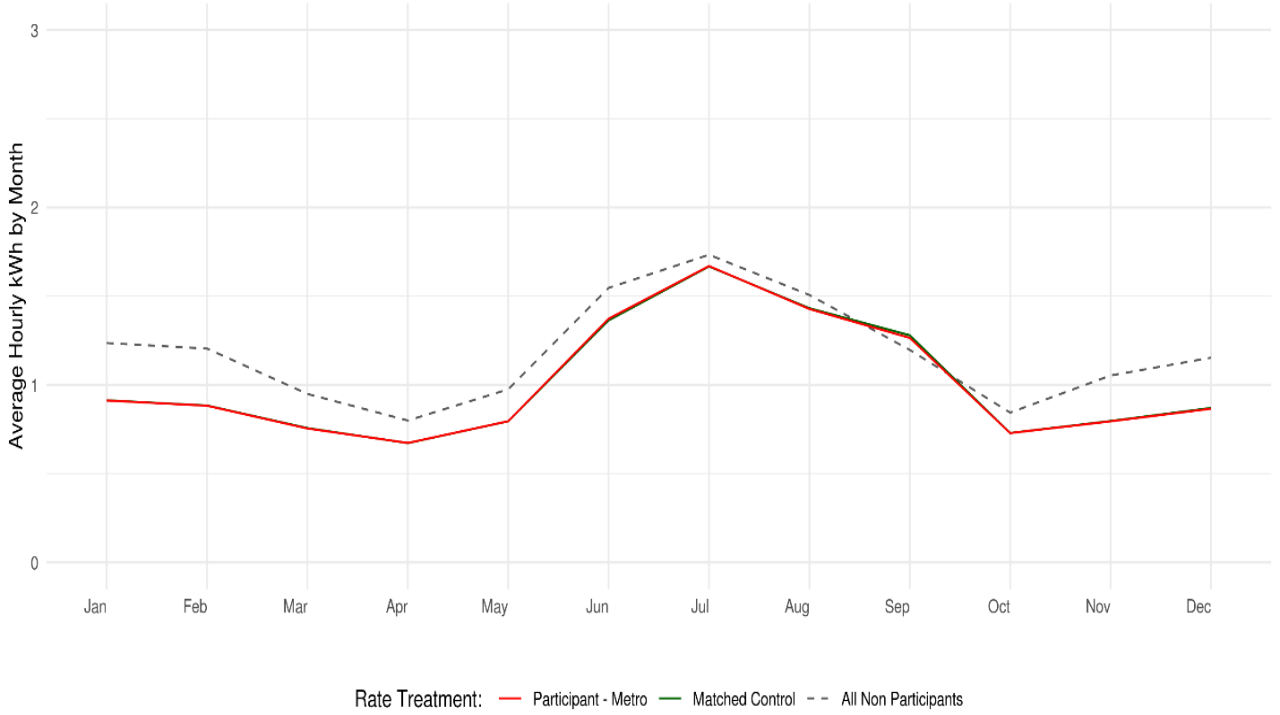
- Refine the pool of monthly matches for each participant
- Assign unique matched control for each participant based on hourly consumption profiles

- A pre-processing step for the regression analysis.
- In effect, the regression has less work to do to account for such differences.
- Any remaining differences will be accounted for by the regression model (LDV specification).
- Based on minimizing the Root Mean Squared Error (RMSE) of the Euclidean distance of energy consumption between the participant and the non-participant.
- Matching was conducted for the summer and winter seasons respectively as customers can have notably different patterns in the two seasons.

Matching Results – Missouri Metro

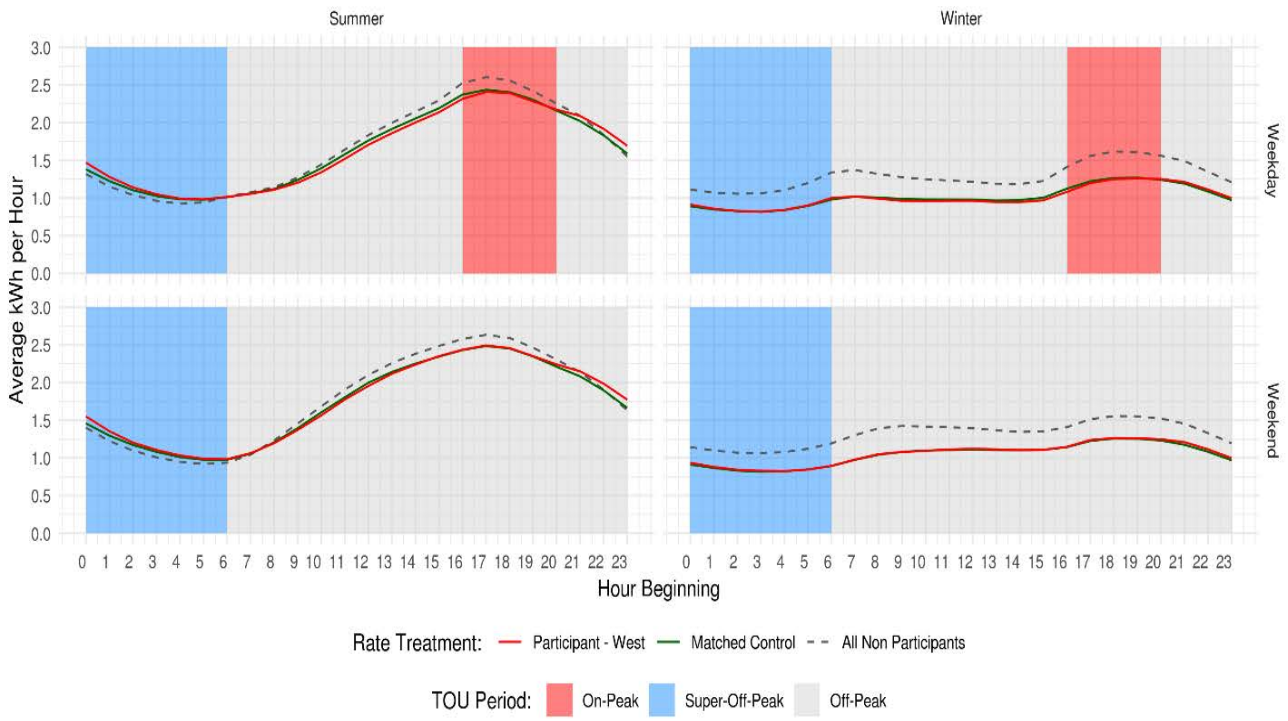
The monthly and hourly load profiles for the participants and the matched controls are very similar; better than the entire pool of non-participants, especially in the winter.

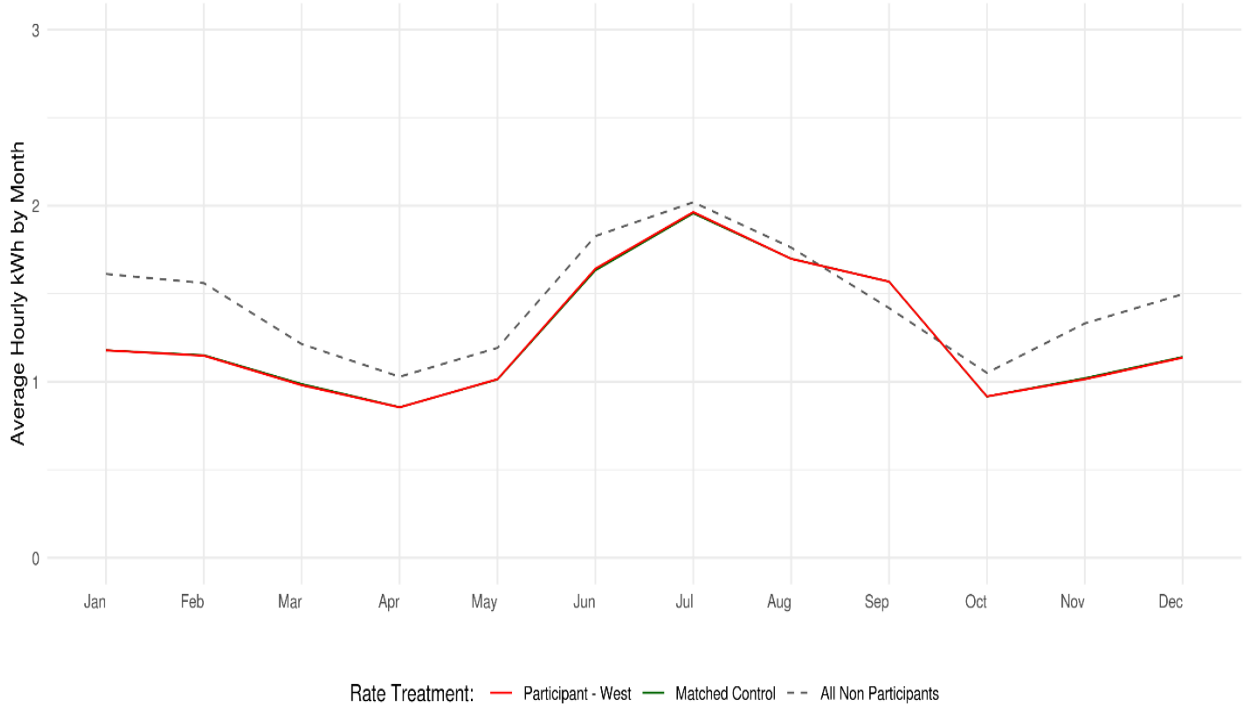




Matching Results – Missouri West

The monthly and hourly load profiles for the participants and the matched controls are very similar; better than the entire pool of non-participants, especially in the winter.





Model Specification – Energy Impacts

A Post Period* Regression model with the participants and matched controls was used. Separate regressions were run for each jurisdiction, season and customer segment.

$$kWh_{i,t} = \sum_n \alpha_n \cdot Participant_{i,t} \cdot TOU\_period_{n,i,t} + \sum_n \beta_n \cdot TOU\_period_{n,i,t} + \sum_w \chi_w \cdot WeekNum_{w,i,t} \cdot kWh\_Lag_{i,t} + \sum_w \sum_d \delta_{w,d} \cdot WeekNum_{w,i,t} \cdot DayOfWeek_{d,i,t} + \sum_w \sum_h \phi_w \cdot WeekNum_{w,i,t} \cdot Hour_{h,i,t} + \sum_w \gamma_w \cdot WeekNum_{w,i,t} \cdot HDH65_{i,t} + \sum_w \eta_w \cdot WeekNum_{w,i,t} \cdot HDH65buildup_{i,t} + \sum_w \iota_w \cdot WeekNum_{w,i,t} \cdot CDH65_{i,t} + \sum_w \varphi_w \cdot WeekNum_{w,i,t} \cdot CDH65\_buildup_{w,i,t} + \varepsilon_{i,t}$$

- Where:
  - I = index for customer
  - W = index for week of year
  - N = index for TOU period
  - T = index for year, month, day and hour
  - Participant: dummy variable to indicate whether a customer is a participant
  - TOU_Period: series of dummy variables taking the value of 1 if t = TOU period
  - WeekNum: series of dummy variables taking the value of 1 if t = TOU period
  - kWh_lag: average kWh consumption of the same hour in the same week of year in the pre-period by day type (weekday/weekend)
  - HDH65: heating degree hours measured at 65^0F
  - CDH65: cooling degree hours measured at 65^0F
  - HDH65_buildup: sum of the heating degree hours over the past 72 hours measured at 65^0F
  - CDH65_buildup: sum of the cooling degree hours over the past 72 hours measured at 65^0F
  - $\varepsilon_{i,t}$: error term

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** Post period refers to the period after which the TOU rates were applied, the study period.*

Model Specification – Peak Demand

A Post Period* Regression model with the participants and matched controls was used. Separate regressions were run for each jurisdiction, season and customer group.

$$kW_{i,t} = \alpha \cdot Participant_{i,t} + \sum_{m} \beta_m \cdot Month_{m,i,t} \cdot kW\_Lag_{m,i,t} + \sum_{m} \beta_m \cdot Month_{m,i,t} \cdot Monthly\_kWh_{i,t} +$$

$$\sum_{m} \gamma_w \cdot Month_{m,i,t} \cdot HDH65_{i,t} + \sum_{w} \iota_w \cdot Month_{m,i,t} \cdot CDH65_{i,t} + \varepsilon_{i,t}$$

- Where:
  - I = index for customer
  - M = index for month of year
  - T = index for year, month, day and hour
  - Participant: dummy variable to indicate whether a customer is a participant
  - Month: series of dummy variables taking the value of 1 if t = month
  - kW_lag: peak demand consumption in the same month of year in the pre-period by day type
  - HDH65: total heating degree hours for the month measured at 65^0F
  - CDH65: total cooling degree hours for the month measured at 65^0F
  - $\varepsilon_{i,t}$: error term

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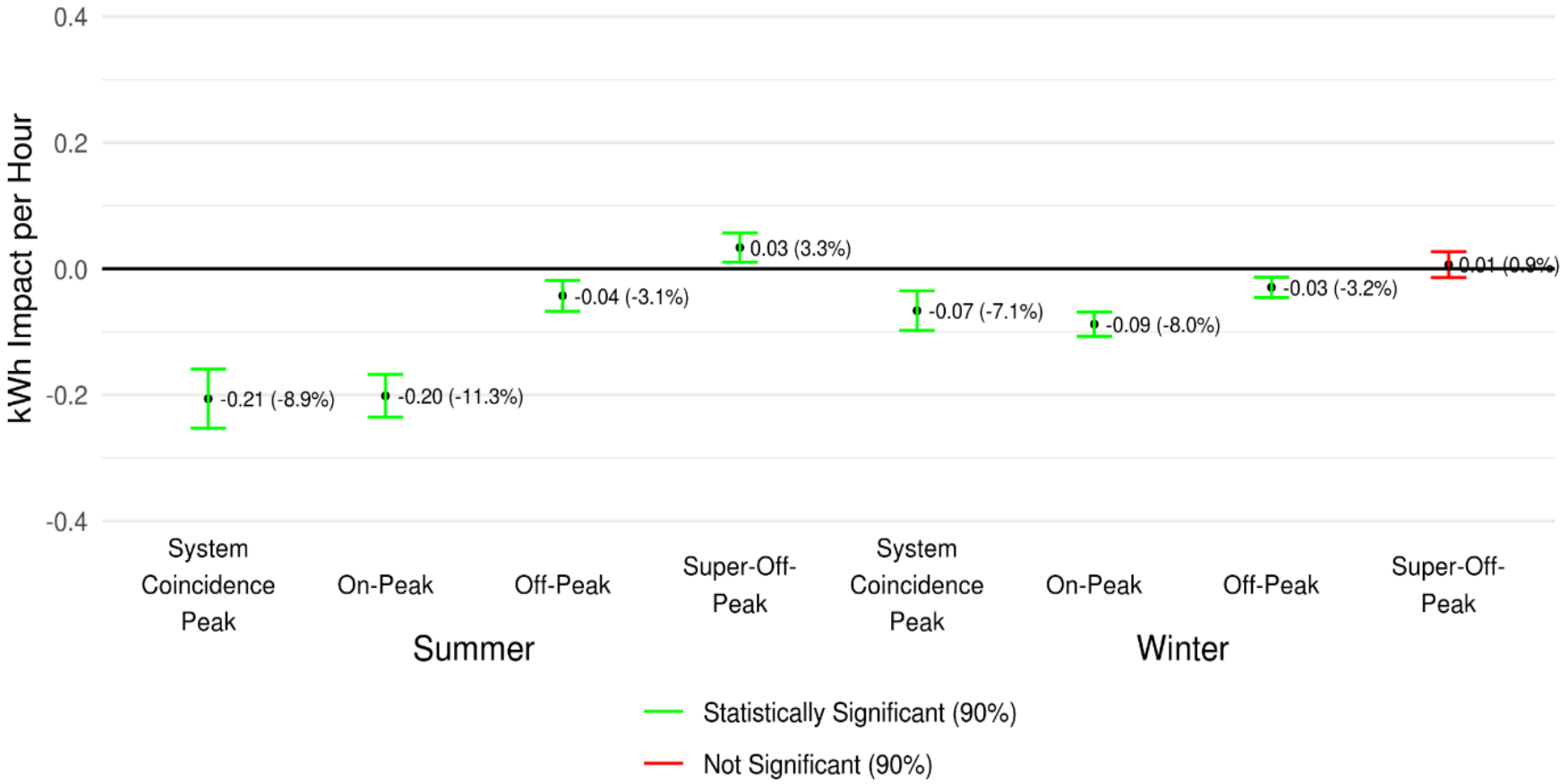
** Post period refers to the period after which the TOU rates were applied, the study period.*

Results

Impacts – All Missouri Metro Participants

Results indicate that the TOU rate has had the desired effect of reducing consumption during the on-peak period in both the summer and winter seasons.



- Summer kWh impacts higher than winter, but percent impact is closer
  - Summer consumption is higher than winter
- Summer system coincident peaks coincide with the on-peak period
  - Similar to on-peak impacts
- In some winter months, system coincident peak can occur in the morning during the off-peak period
  - Lower than on-peak impacts
- Monitor how results change as participation increases
  - confidence bands are not too wide

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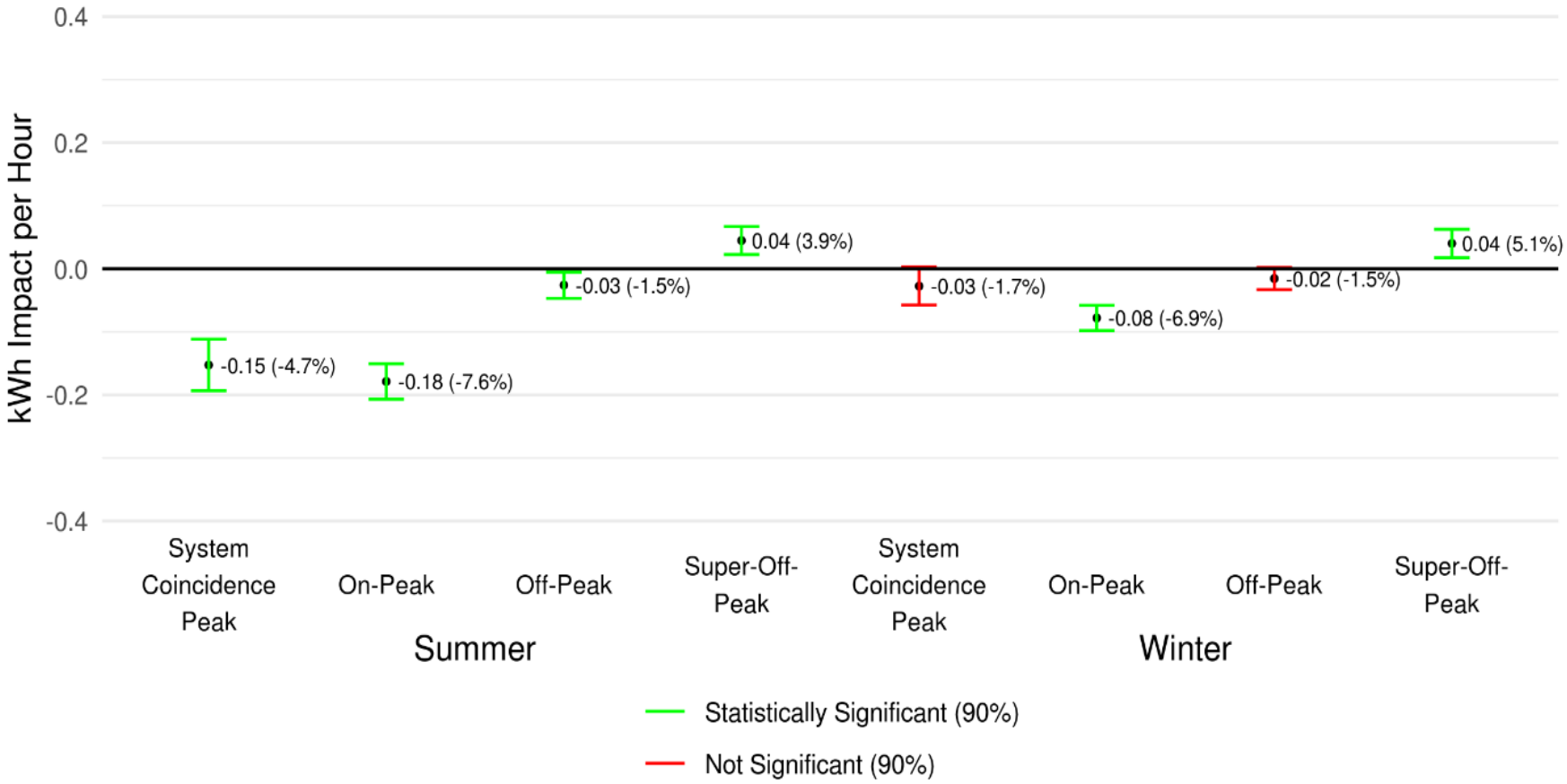
Impacts – All Missouri West Participants

Results indicate that the TOU rate has had the desired effect of reducing consumption during the on-peak period in both the summer and winter seasons.



- Summer kWh impacts higher than winter, but percent impact is closer
  - Summer consumption is higher than winter
- Summer system coincident peaks coincide with the on-peak period
  - Similar to on-peak impacts
- In some winter months, system coincident peak can occur in the morning during the off-peak period
  - Lower than on-peak impacts
- Monitor how results change as participation increases
  - confidence bands are not too wide

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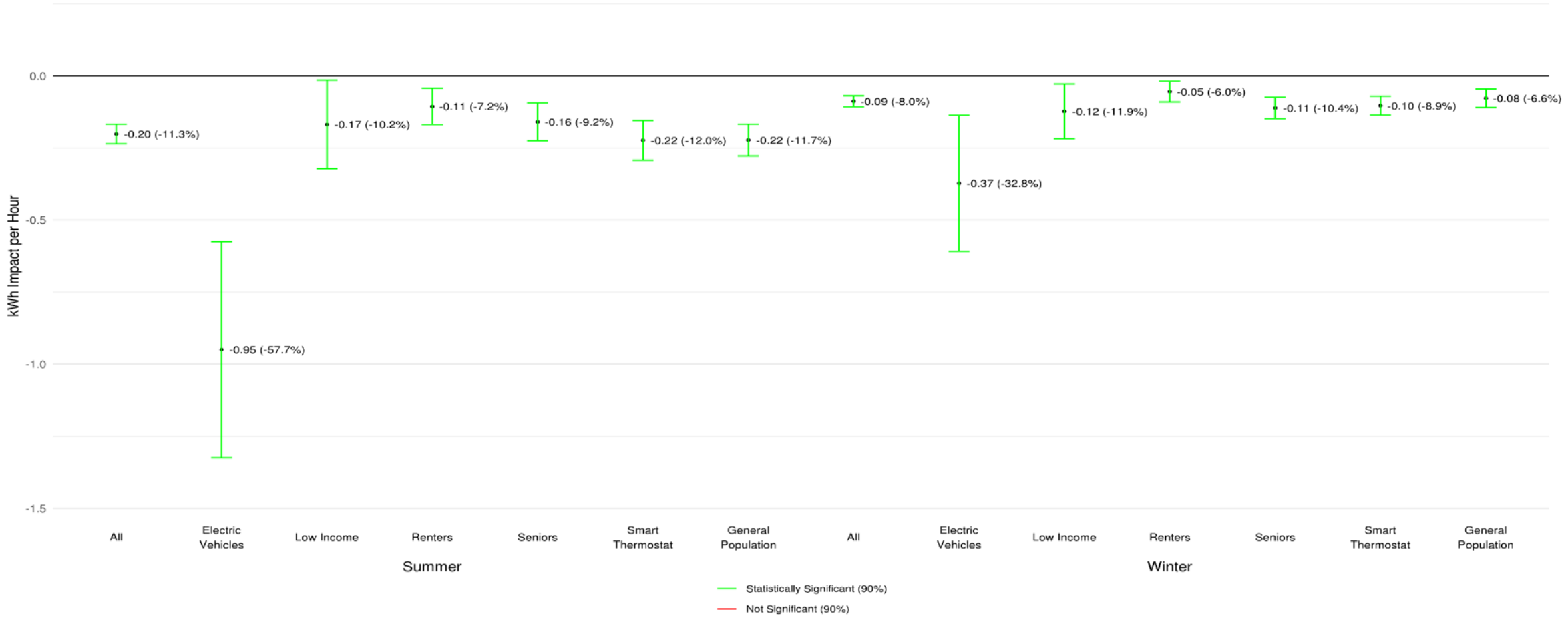
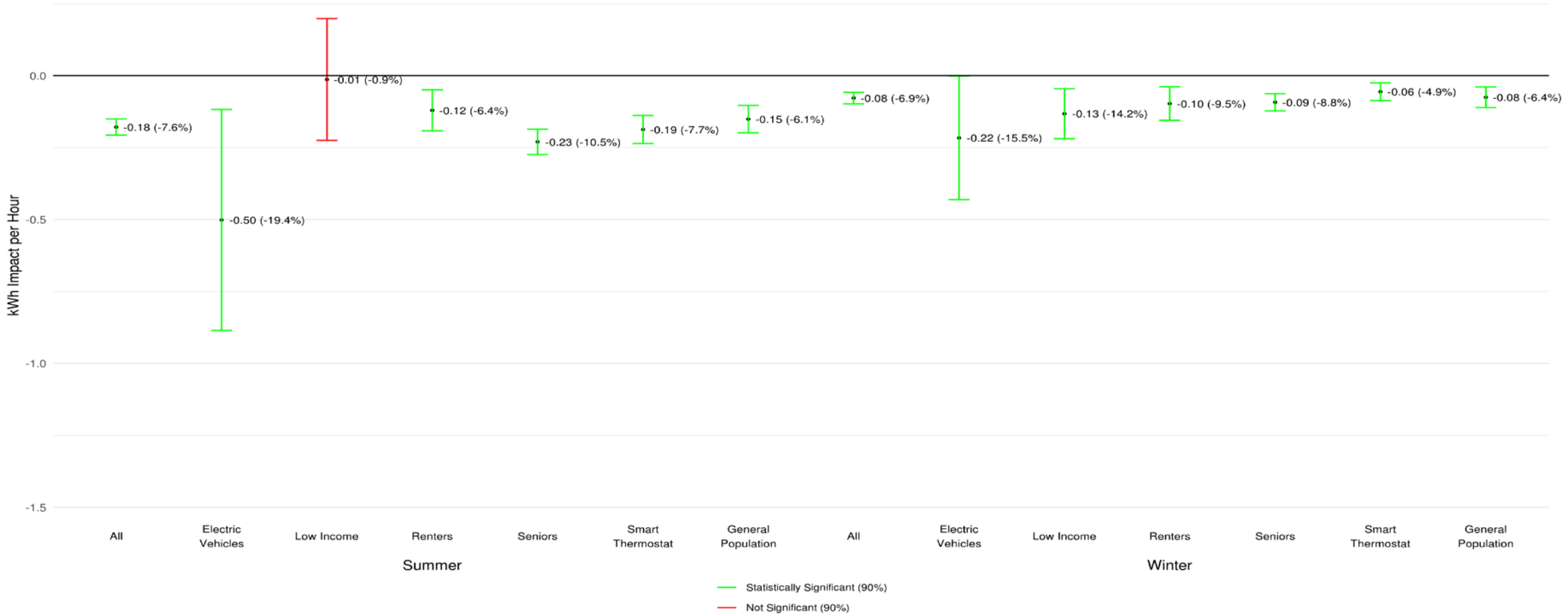
On-Peak Impacts by Segment – Missouri Metro

Impacts are relatively consistent across customer segments, while those with smaller sample sizes like Electric Vehicles & Low Income have wider confidence bands.



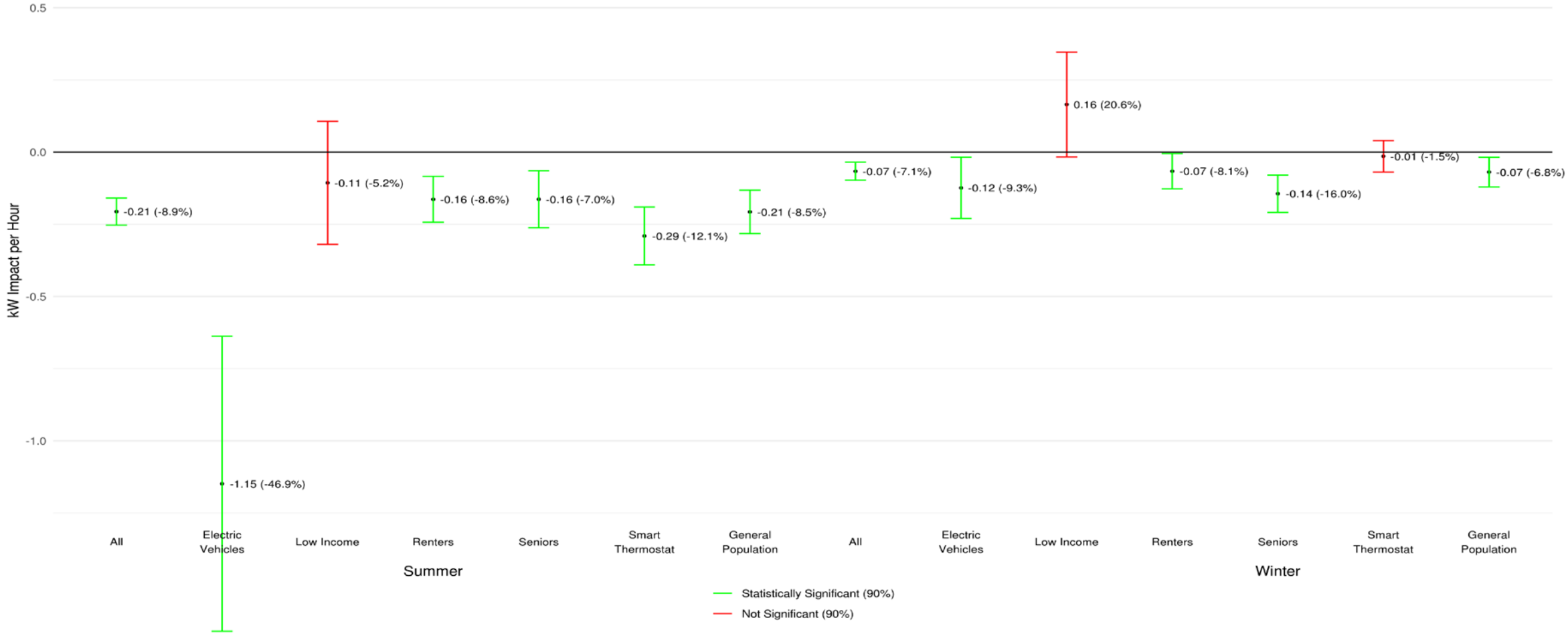
On-Peak Impacts by Segment – Missouri West

Impacts are relatively consistent across customer segments, while those with smaller sample sizes like Electric Vehicles & Low Income have wider confidence bands.



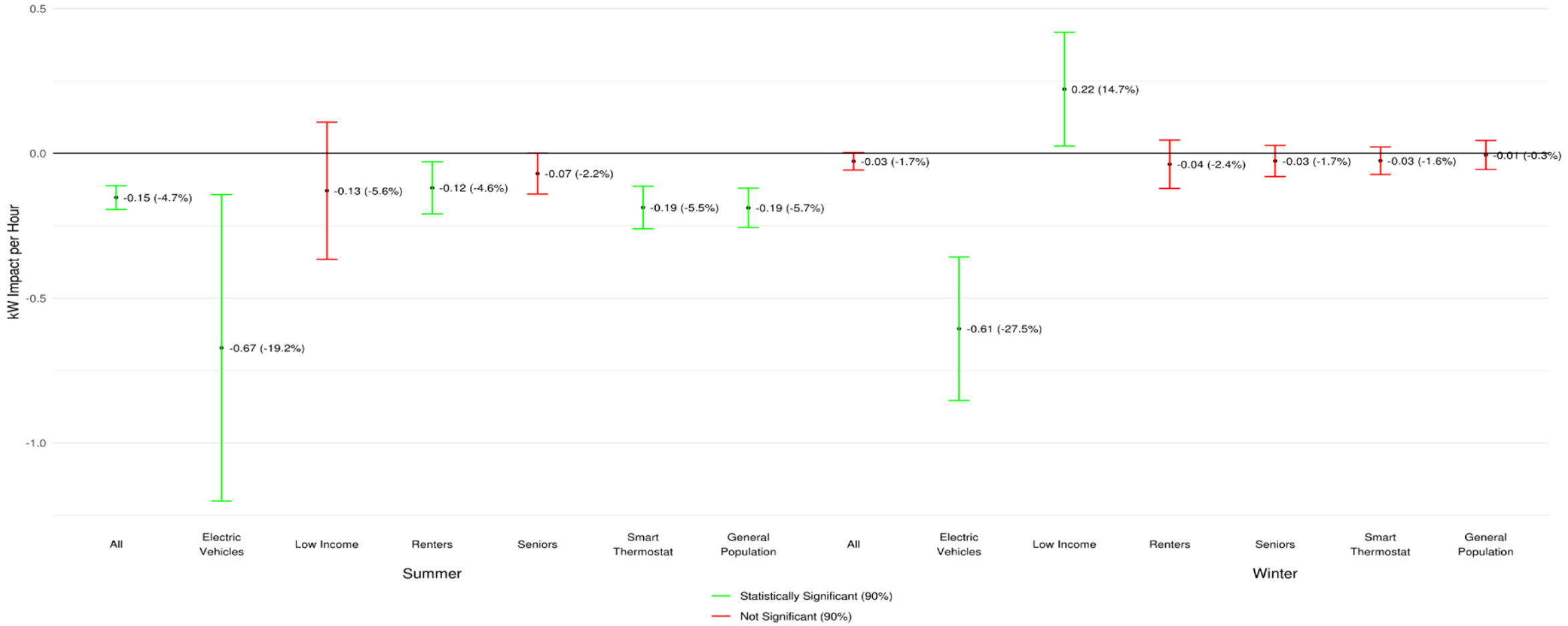
Peak Demand Impacts by Segment – Missouri Metro

Impacts are relatively consistent across customer segments while those with smaller sample sizes like Electric Vehicles & Low Income have wider confidence bands.



Peak Demand Impacts by Segment – Missouri West

Impacts are relatively consistent across customer segments while those with smaller sample sizes like Electric Vehicles & Low Income have wider confidence bands.



Review of TOU and Tiered Rates

Participants can be on either the general residential or residential space heating tiered rate prior to enrolling in the TOU rate pilot.

TOU Rates

Season	TOU Period	Metro Price ($/kWh)	West Price ($/kWh)	Time Period
Summer	On-Peak	0.32498	0.26577	4pm-8pm Weekdays, excl. holidays
	Off-Peak	0.10833	0.08859	All other hours
	Super-Off-Peak	0.05416	0.04429	12am-6am every day
Winter	On-Peak	0.26575	0.21629	4pm-8pm Weekdays, excl. holidays
	Off-Peak	0.10422	0.08727	All other hours
	Super-Off-Peak	0.04495	0.03667	12am-6am every day

- On-peak price is notably higher
  - Approx. 6X higher than super-off-peak
  - Approx. 3X higher than off peak
  - More than 2X higher than tiered prices
- Behavioral changes, i.e. reductions, during the on-peak period will have the greatest impacts
- TOU rates potentially advantageous in summer over general and space heating tiered rates
  - Off-peak and super-off-peak price is lower than tiered prices
  - May result in bill savings during these periods even without behavioral changes
- TOU rates potentially disadvantageous in winter over space heating tiered rates
  - Off-peak price higher than tiered price
  - May result in bill increase during these periods without behavioral changes
  - Space heating loads less flexible

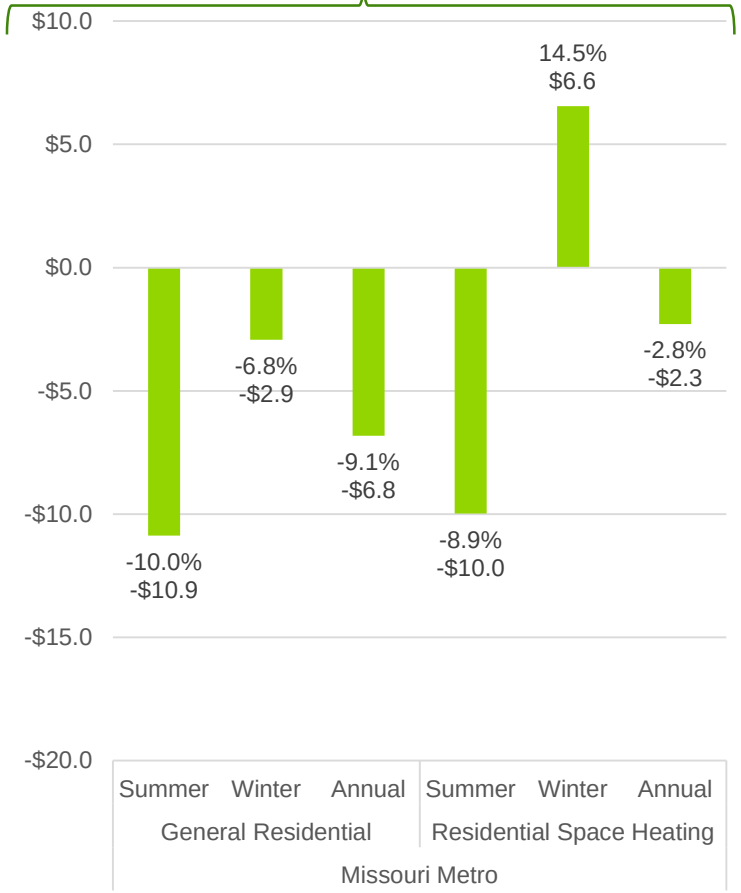
Tiered Rates

Season	Tier Structure	Metro General Res ($/kWh)	Metro Space Heating ($/kWh)	West General Res ($/kWh)	West Space Heating ($/kWh)
Summer	First 600 kWh	0.13511	0.13806	0.10938	0.11927
	Next 400 kWh	0.13511	0.13806	0.10938	0.11927
	Over 1000 kWh	0.14916	0.13806	0.11927	0.11927
Winter	First 600 kWh	0.12013	0.09703	0.09888	0.09888
	Next 400 kWh	0.07396	0.09703	0.07800	0.06035
	Over 1000 kWh	0.06561	0.06300	0.07800	0.05005

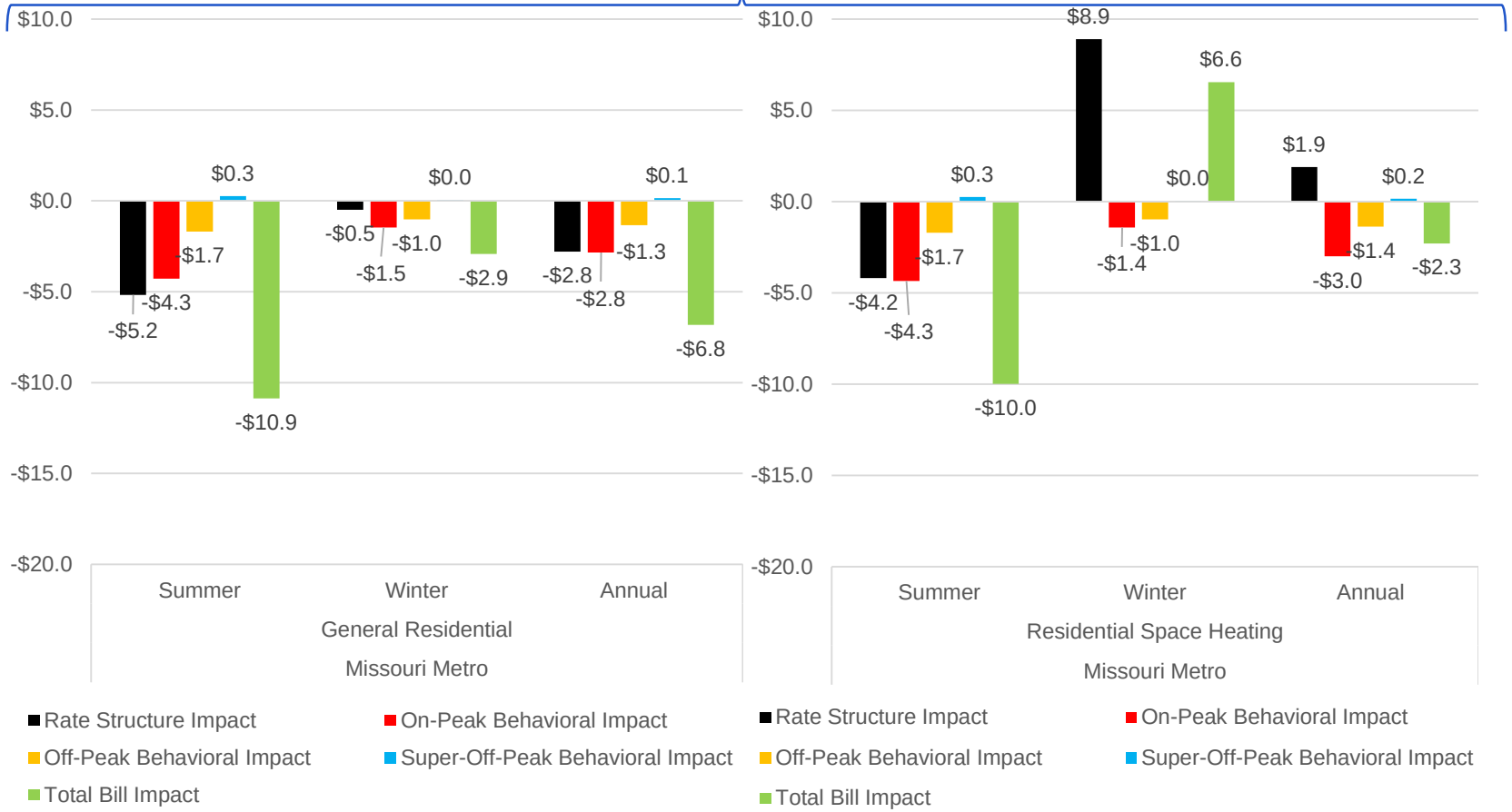
Bill Impacts – Missouri Metro

Summer bills see the greatest savings, approximately half of which are driven by behavioral changes while winter bills see an increase for those on the space heating rate primarily driven by rate structure changes.

Total Monthly Bill Impact



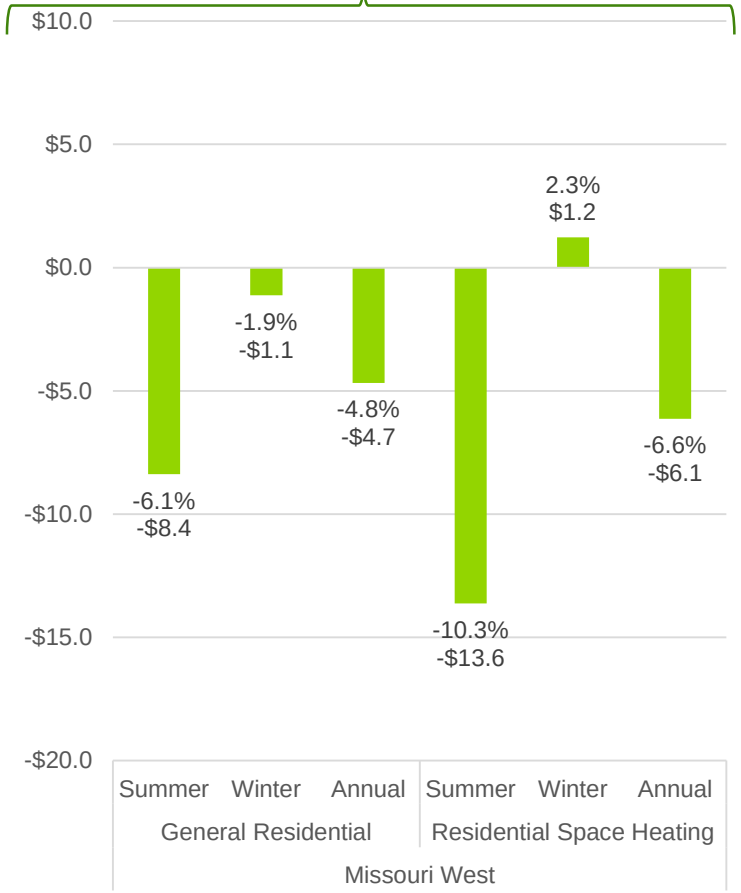
Composition of Bill Impact



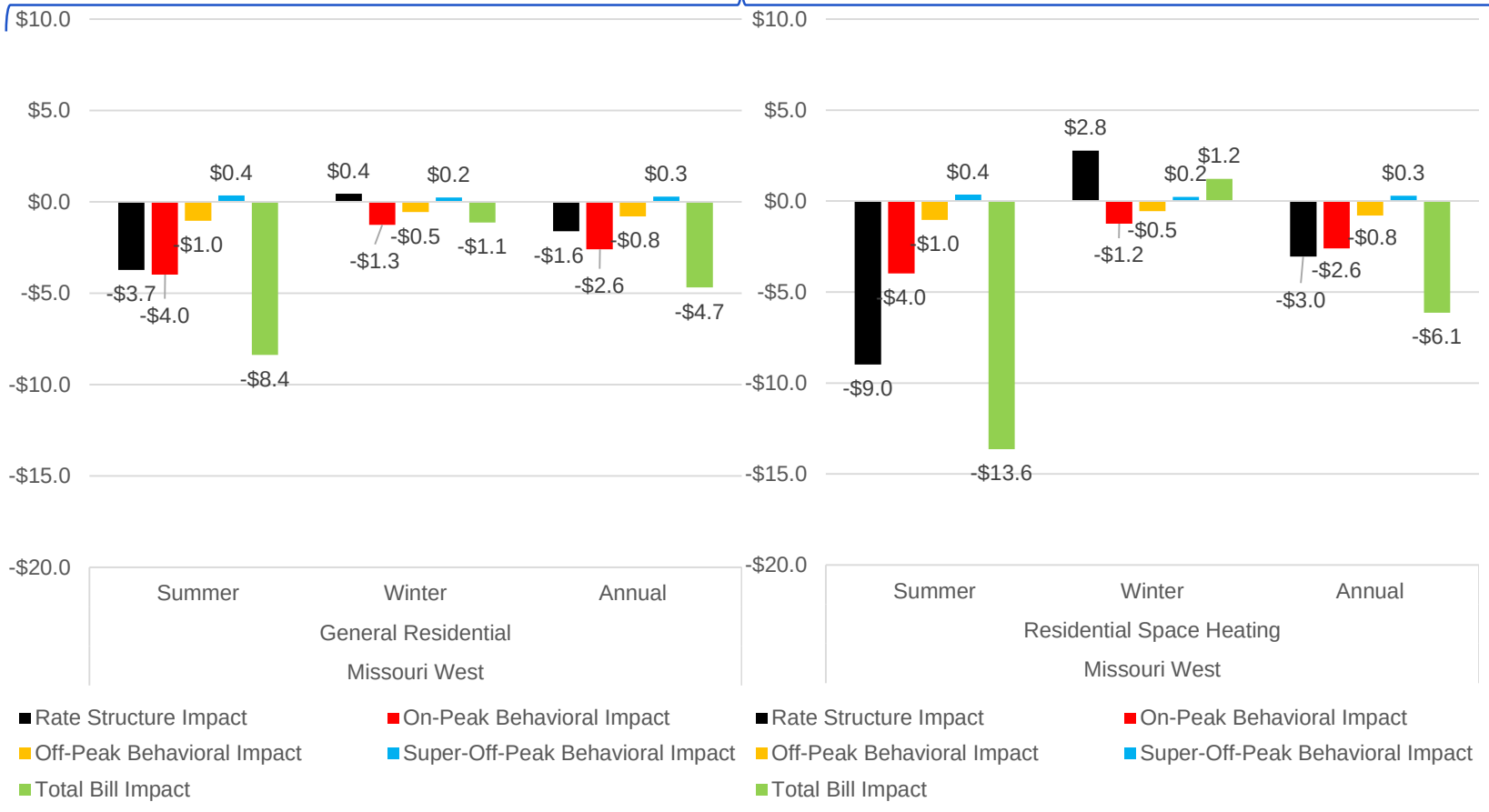
Bill Impacts – Missouri West

Summer bills see the greatest savings, approximately half of which are driven by behavioral changes while winter bills see an increase for those on the space heating rate primarily driven by rate structure changes.

Total Monthly Bill Impact

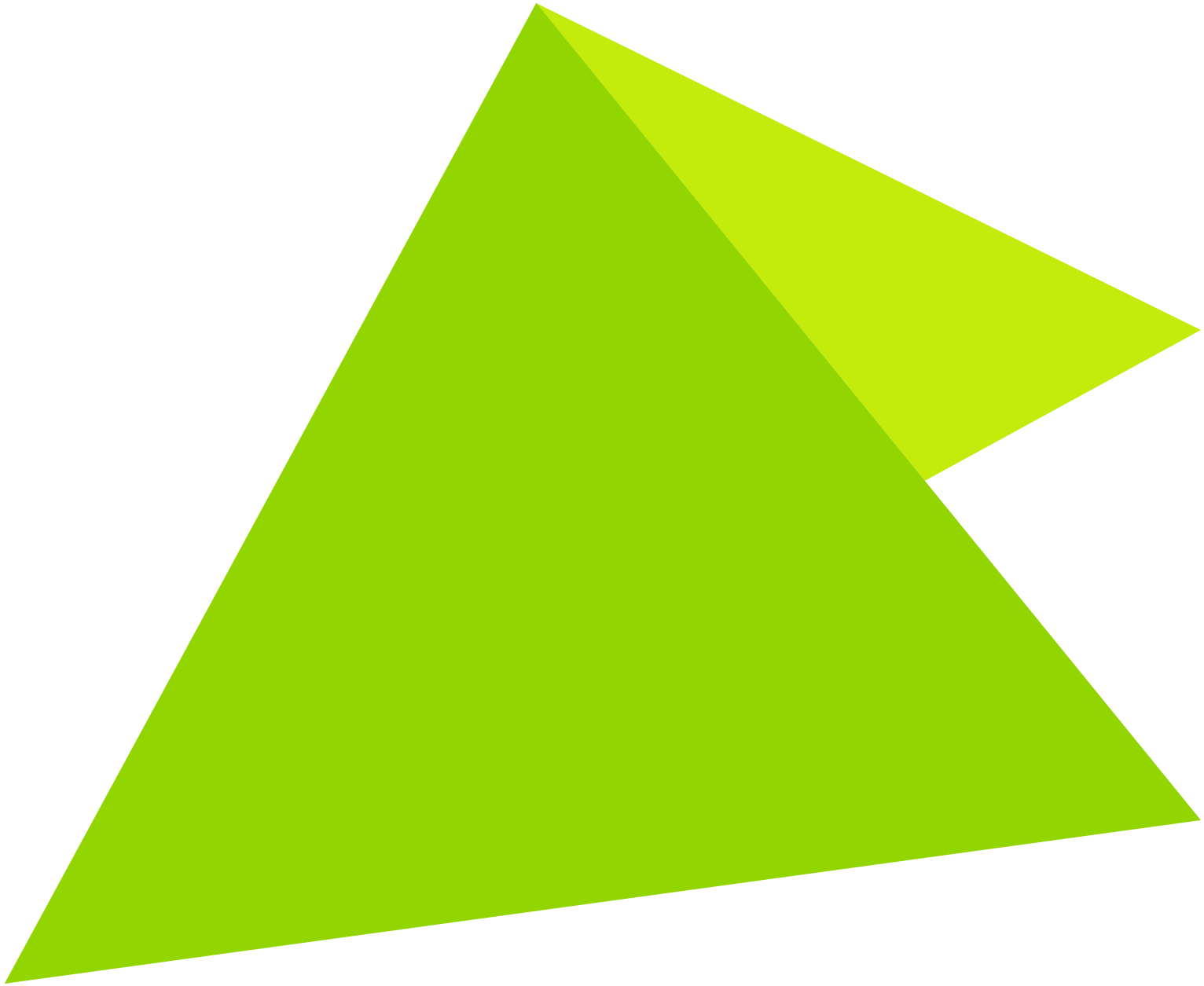


Composition of Bill Impact



Contact

Farhad Daruwala
Managing Consultant
farhad.daruwala@guidehouse.com
(647) 288-5225



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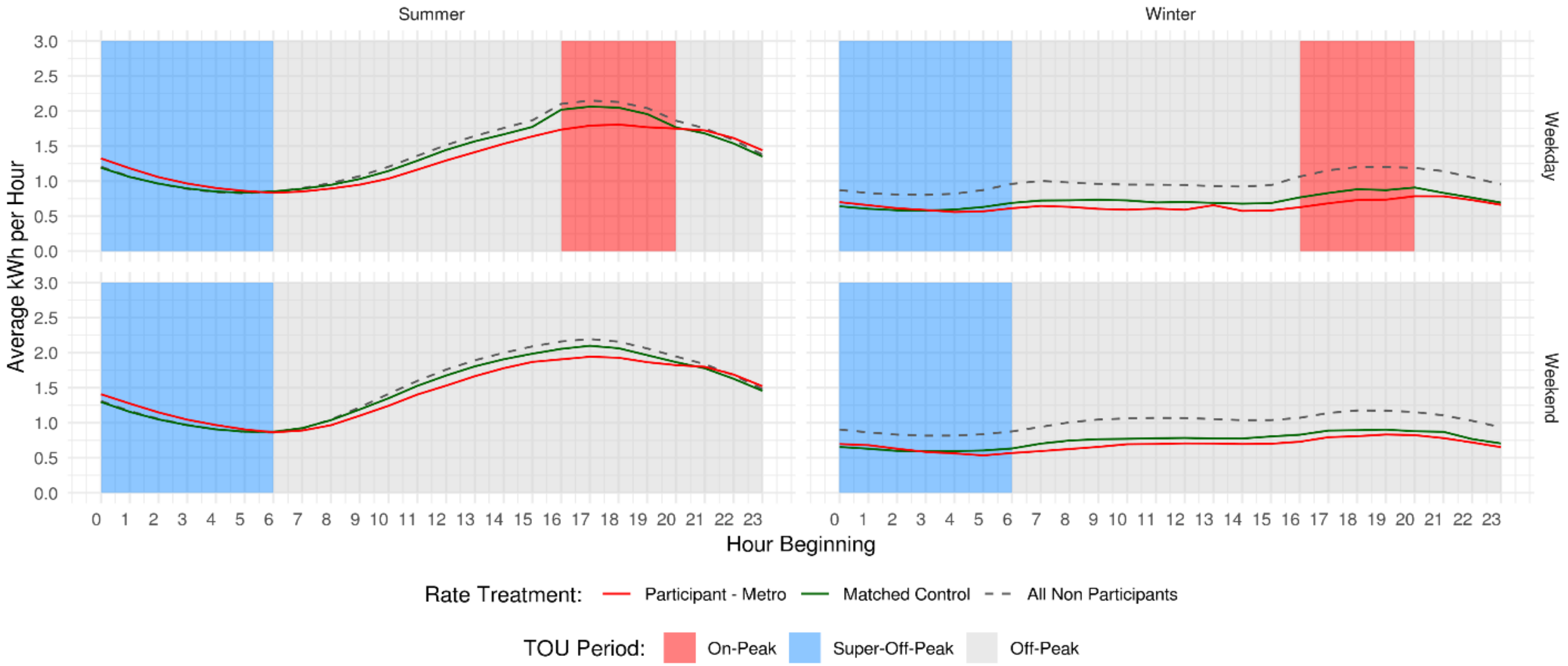
Post Period* Load Shapes – Missouri Metro

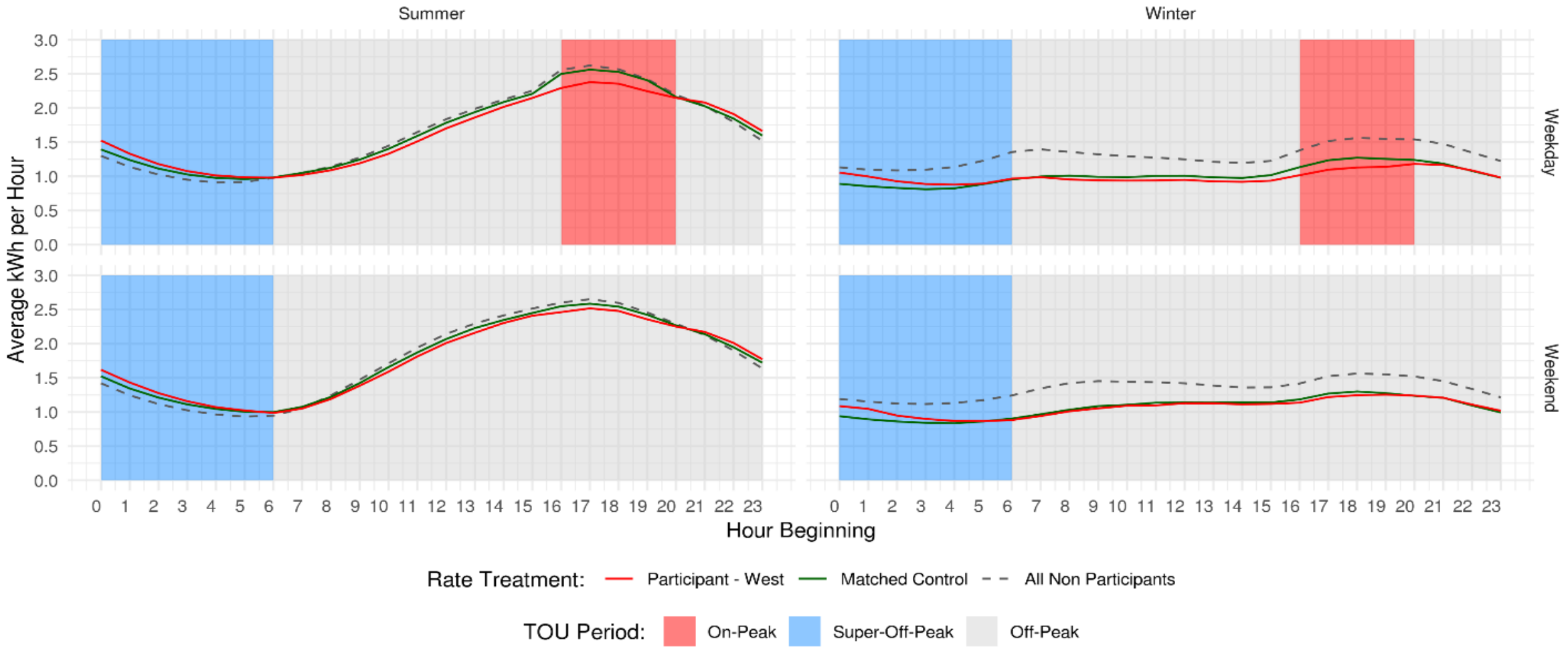
The load shapes corroborate the impact findings.



** Post period refers to the period after which the TOU rates were applied, the study period.*

Post Period* Load Shapes – Missouri West

The load shapes corroborate the impact findings.



** Post period refers to the period after which the TOU rates were applied, the study period.*

Questions or Comments

Time of Use Rate Design Case Update

Evergy Missouri Metro & Evergy Missouri West

Commission Order - TOU Rate Design Case Summarized

- By June 30, 2020, KCP&L will file a rate design case limited to TOU issues. For GMO, signatories further agree the September 20, 2016 Non-Unanimous Stipulation and Agreement in ER-2016-0156 will be expanded to include TOU, with the TOU rate design case to commence by June 30, 2020.
- KCP&L and GMO will submit a Residential TOU rate design in their next rate cases based on lessons learned from the TOU service.
- Company will complete an EM&V Report by December 31, 2021.

TOU Rate Design Case Timeline

- To allow for the utilization of learnings from the current TOU rate in the rate design case filing, the Company requested an extension for the TOU rate design case
- The MPSC approved the Company's request to extend time to file a rate design case to June 15, 2021
- In the Company's request for an extension, it offered the following timeline and milestone touch points until the June 15, 2021 filing date

Date	Description	
June 2020	Complete filing for extension to June 15, 2021	Complete
October 2020	Post-Summer checkpoint with parties including EM&V status discussion.	Complete
December 2020	Complete preliminary EM&V	Complete
December 2020	Meeting with parties to review preliminary EM&V results and plans for rate design	Dec 17
March 1, 2021	Preliminary rate design provided to the parties.	
April 2020	Dedicated meeting with parties to receive feedback and comments on preliminary rate design.	
April 15, 2021	60-day notice filed with the Commission opening the docket	
June 15, 2021	Complete rate design case filing	

Plan for TOU Rate Design

- Work Performed
  - Internal team development
  - Foundational work
    - Internal discussions
    - Surveys
    - Industry Sources
  - Consultants
    - Guidehouse
    - Brattle
- Key Learnings & Areas of focus
- Next steps – S&A

Questions or Comments

Next Steps

Next Steps

- **Overall**
  - Continue exceeding stipulated goals for both jurisdictions
  - Continue to monitor unenrollment numbers
  - Continue to look for process improvements, future learnings or changes needed
  - Continue working with Staff and Stakeholders on a TOU Rate Design study for summer 2021 in advance of next rate case filing to inform potential future offerings
  - Next Stakeholder update – Q1 2021

- **EM&V**
  - Continue data collection for final TOU EM&V in 2021

Evergy Missouri Residential Time of Use Rate Evaluation

Interim Impacts for Missouri Metro and West Jurisdictions

Prepared for:

Evergy Inc.

Submitted by:

Guidehouse Inc.
1375 Walnut Street, Suite 100
Boulder, CO 80302
navigant.com

Reference No.: 208441
December 10, 2020

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Disclaimer

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Executive Summary

Introduction

In 2019, Guidehouse Inc. (Guidehouse), formerly Navigant, was retained by Evergy Inc. (Evergy) to support Evergy's efforts to study residential Time of Use (TOU) rates in two jurisdictions in the state of Missouri, Metro and West, and provide independent evaluation services to verify the ex-post (historical) impacts of the TOU rates.

All residential customers in Evergy's service territory in Missouri are on a tiered rate structure. This means that they are charged a different set of prices based on whether or not their aggregate monthly consumption crosses various thresholds. In contrast, TOU rates place a premium, in terms of the price charged to customers, in certain hours of the day with the aim of aligning prices with cost causation and encouraging customers to reduce their consumption in those hours and shift it to other hours in the day that have a lower price point, e.g. shifting consumption from the on-peak to the super off-peak period.

Each jurisdiction has its own set of TOU rates as shown in Table 1 and while the price per kWh value for the TOU periods are different across the two jurisdictions, the price differentials across the TOU periods are almost identical. The on-peak to super off-peak price differential is the most notable with the on-peak price being approximately six times higher in both seasons. The on-peak to off-peak price differential is also notable with the on-peak price being three, and two and a half times higher in the summer and winter seasons, respectively.

Table 1. TOU Rate Structure

Season	TOU Period	Metro Price ($/kWh)	West Price ($/kWh)	Time Period
Summer	On-Peak	0.32498	0.26577	4pm-8pm Weekdays, excl. holidays
	Off-Peak	0.10833	0.08859	All other hours
	Super Off-Peak	0.05416	0.04429	12am-6am every day
Winter	On-Peak	0.26575	0.21629	4pm-8pm Weekdays, excl. holidays
	Off-Peak	0.10422	0.08727	All other hours
	Super Off-Peak	0.04495	0.03667	12am-6am every day

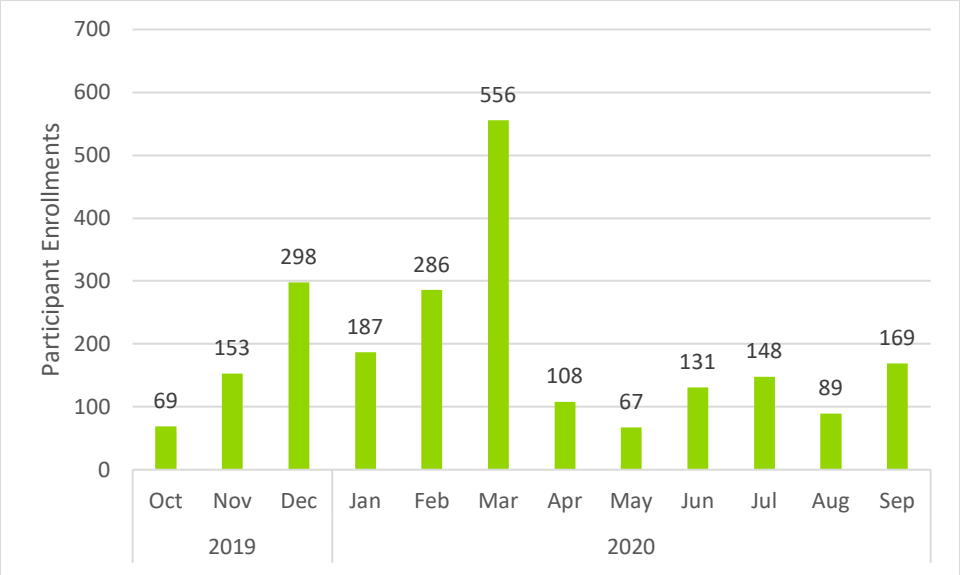
Source: Evergy Residential Rate Tariffs

The interim analysis includes all participants enrolled between October 1, 2019 and September 30, 2020. The total enrollments for the interim analysis are 2,261 customers and 2,744 customers for the Missouri Metro and West jurisdictions, respectively. Figure 1 and Figure 2

show the monthly participant enrollment for the Metro and West jurisdictions respectively with the general trend being very similar across the two jurisdictions.

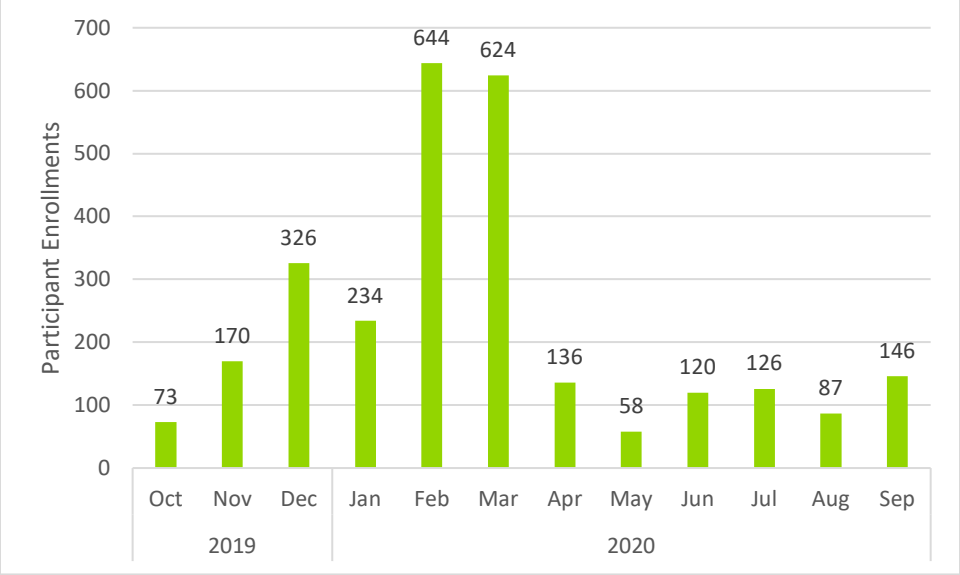
The majority of the enrollment occurred prior to April 2020 when Evergy launched the first significant phase of its marketing plan. Towards the beginning of April 2020, marketing efforts were reduced due to the onset of a global pandemic – COVID-19, however, efforts were increased again starting in June 2020.

Figure 1. Monthly Enrollment – Missouri Metro



Source: Guidehouse Analysis

Figure 2. Monthly Enrollment – Missouri West



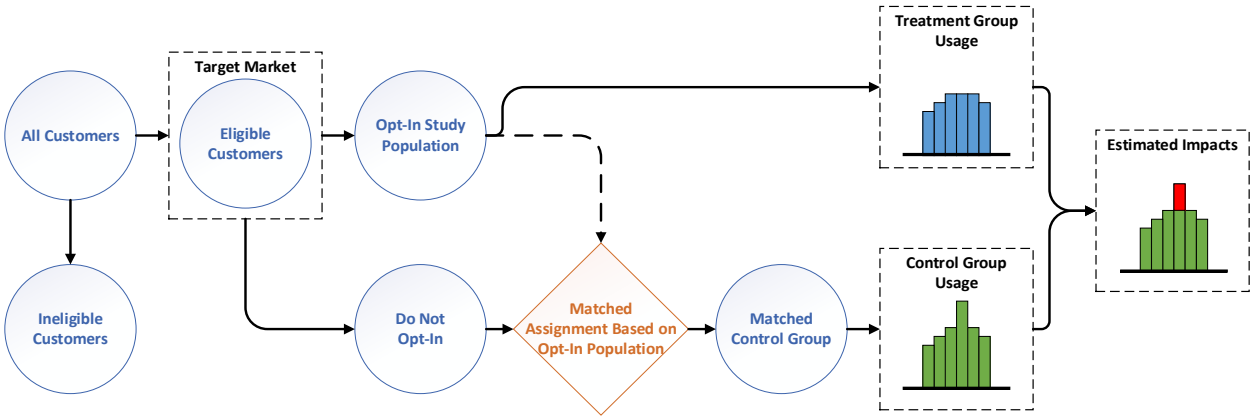
Source: Guidehouse Analysis

Methodology

Residential customers who are on the general residential rate or the residential space heating rate are eligible to opt-into the TOU rate. Customers were offered a choice to voluntarily opt-in to the TOU rate or to remain on their current tiered rate.

Guidehouse used an opt-in quasi-experimental design with matched controls as shown in Figure 3. This approach leverages historical interval metering data for participants to match them with a comparable non-participant that will serve as their control for the study period. In essence, we leverage observable characteristics to create an *'as-if or quasi Randomized Control Trial (RCT)'*. The selection of the matched controls is discussed in section 2.1.1.

Figure 3. Opt-In Quasi Experimental Design with Matched Controls



Source: Guidehouse Analysis

Results

TOU Rate Impacts

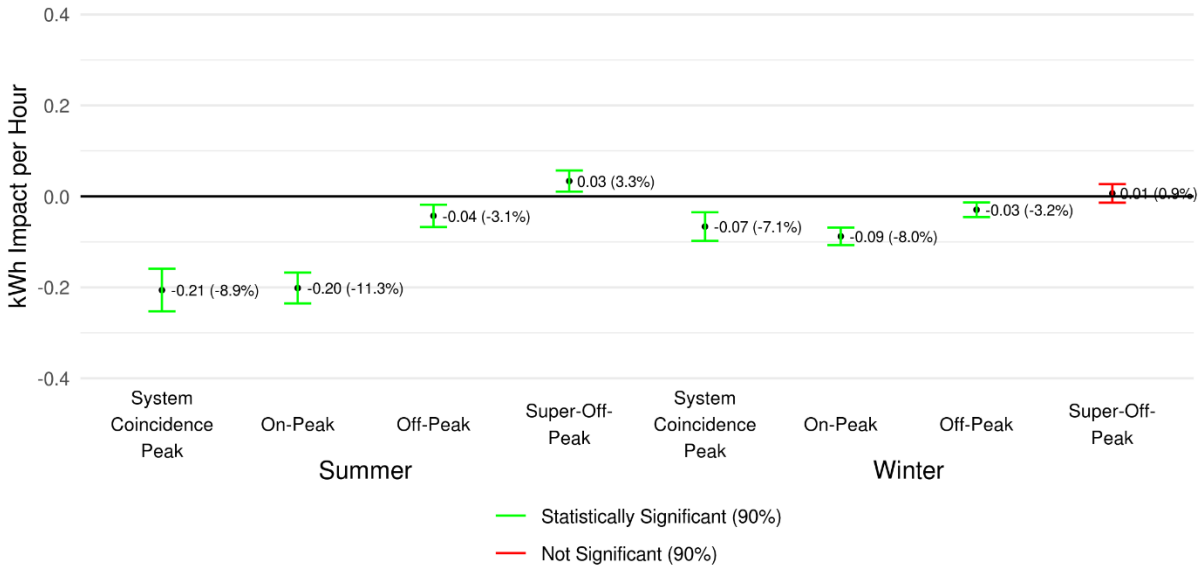
Figure 4 and Figure 5 present the TOU rate impacts for the Missouri Metro and West jurisdictions respectively. The impacts in both the summer and winter seasons are similar across the two jurisdictions with almost all of the impacts being statistically significant at the ninety percent confidence level, which indicates that participants in both jurisdictions did respond to the TOU prices by changing their consumption patterns.

The most notable savings in either season and jurisdiction occur during the on-peak periods as the price differential is the highest during these hours both in comparison to the other TOU periods as well as to the tiered rates (see section 1.2 for additional detail, Table 5 and Table 6). Furthermore, the on-peak period is four hours a day during weekdays, 4 to 8 pm, making it easier to shift consumption than if the on-peak period was longer.

The overall magnitude of the summer impacts, i.e. the kWh impacts, are greater than the winter impacts. However, the difference in the percent impact is closer which is mainly due to summer consumption being higher than the winter. Another potential contributing factor is that winter space heating loads may be less flexible as compared to summer space cooling loads.

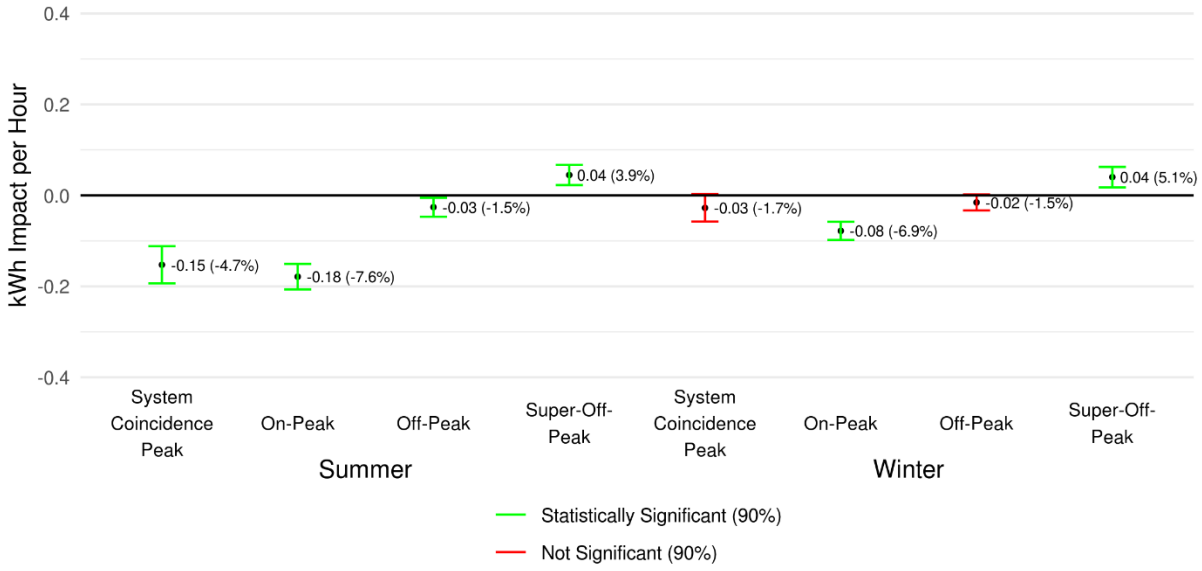
It remains to be seen how the impacts change as more participants are available for analysis, but the confidence bands around the interim impact estimates are reasonable, meaning that they are not too wide[1].

Figure 4. TOU Rate Impacts – Missouri Metro



Source: Guidehouse Analysis

Figure 5. TOU Rate Impacts – Missouri West



[1] For example, you do not see confidence bands stretch from -0.2 to -1.2 as then it would be difficult to draw reasonable conclusions.

Source: Guidehouse Analysis

During the off-peak period, we do see some impacts though the magnitude is much smaller than the on-peak period which is to be expected given that the off-peak price is much lower than the on-peak price. Given the low price offered during the super off-peak period, we see an increase in consumption as participants shift a portion of their consumption from the higher priced on-peak and off-peak periods to the super off-peak period.

During the summer season, the monthly system coincident peak demand impacts are very similar to those of the on-peak period impacts, but the winter system coincident peak demand impacts are lower than those of the on-peak period impacts.

In the summer, the system coincident peak hours always coincide with the on-peak hours during which we see the highest impacts and hence one would expect similar impacts in the summer system coincident peak. However, during some winter months the system coincident peak can occur in the early morning during the off-peak period, and hence one would expect lower system coincident peak impacts in the winter.

Bill Impacts

This compares the average participant's actual bill under the TOU rate compared to what it would have been under the tiered rate structure accounting for both the rate structure changes (i.e. tiered vs. TOU rates) as well as the associated behavioral changes. The impact estimates of the TOU rates for each jurisdiction, presented above, were used to determine what the average participant's consumption would have been in the absence of TOU rates, effectively adjusting for the change in behavior.

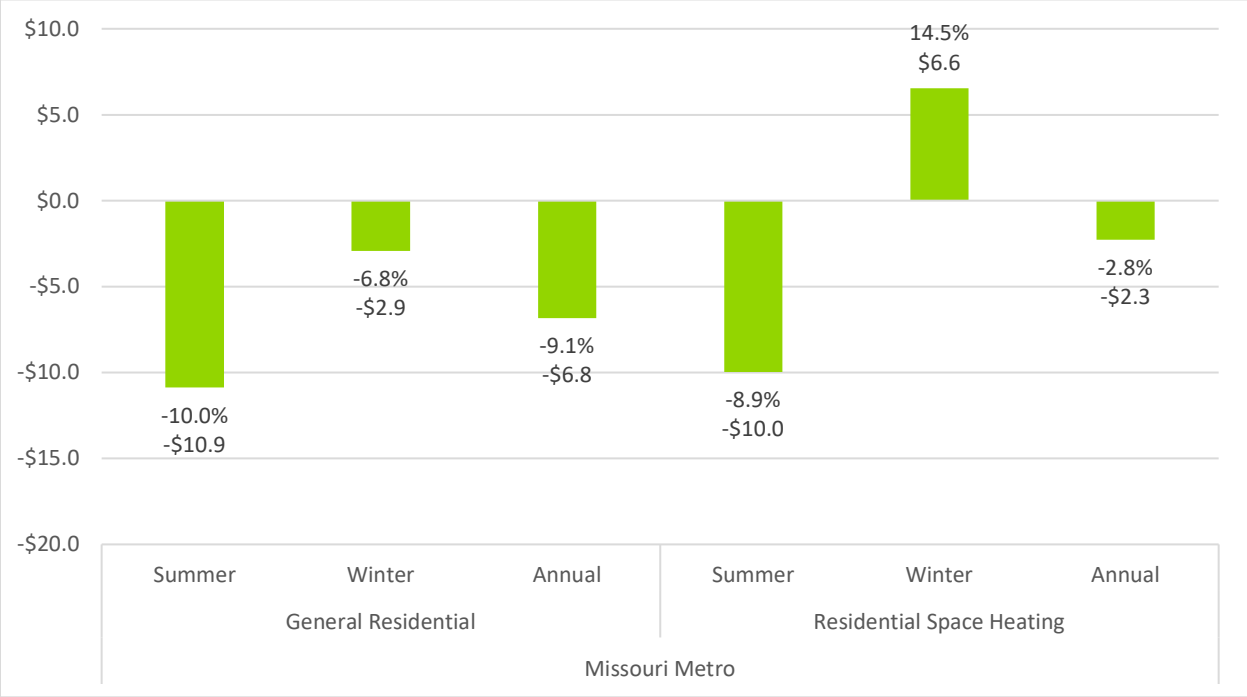
Figure 6 and Figure 7 present the total monthly bill impacts for each season as well as on an annual basis for the Metro and West jurisdictions respectively. Given that participants can be on one of two tiered rates prior to enrolling, we separate the bill impacts based on the tiered rates for each jurisdiction. The composition of these bill savings is discussed in section 3.2.2.

The average participant saves approximately six to ten percent on their bills during the summer season. During the winter months, the average general residential participant sees a slight decrease on their bills while the average residential space heating participant sees an increase. On an annual basis, we can see reductions ranging from three to ten percent depending on the tiered rate that an average participant was on prior to enrolling. This is primarily driven by the savings from the summer season. This pattern is consistent across both jurisdictions.

The aggregate level of consumption in the summer season is higher than the winter in both jurisdictions, and hence the associated kWh impacts are much higher as seen above. This means that more energy is shifted out of the on-peak periods in the summer than in the winter. Furthermore, space cooling loads are more flexible compared to space heating loads. Hence, we see a notable reduction ranging from six to ten percent in monthly summer bills.

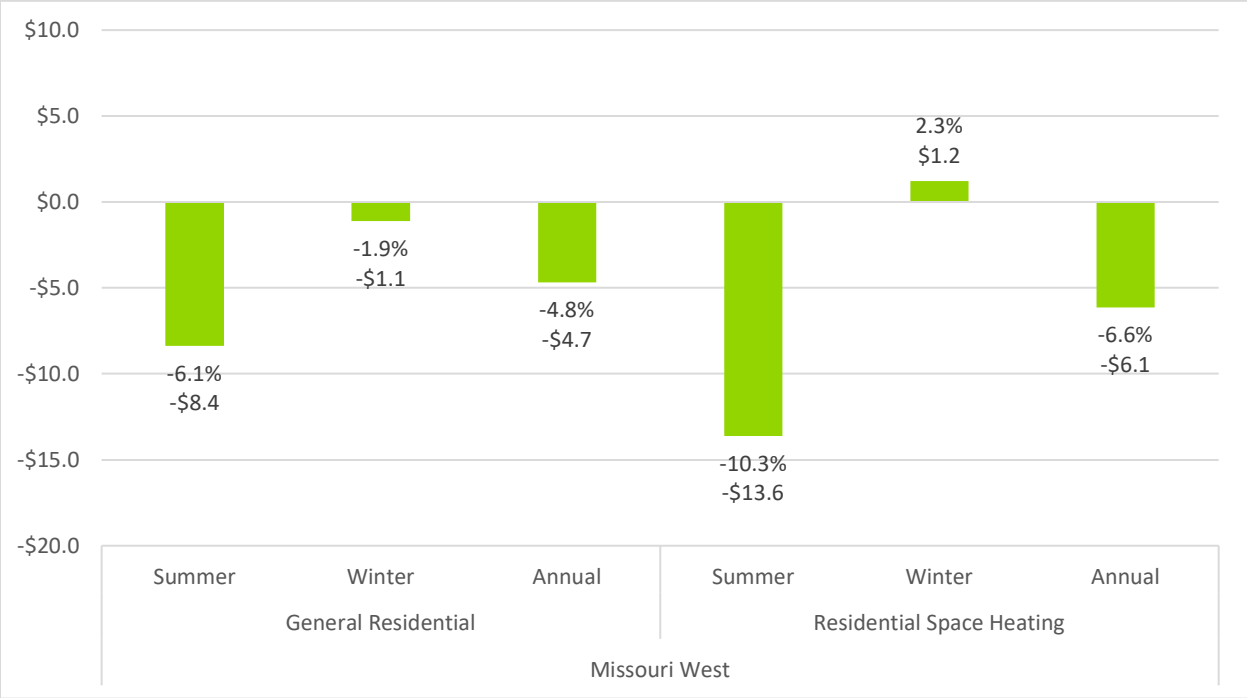
Given that the aggregate level of consumption in the winter is lower than the summer, the magnitude of the kWh impact is lower meaning less energy is shifted out of the on-peak period. For the average participant who was on the space heating rate prior to enrollment, the behavioral changes are not enough to offset the higher-priced TOU rates and hence we see a bill increase during the winter months.

Figure 6. Total Monthly Bill Impacts of TOU Rates – Missouri Metro



Source: Guidehouse Analysis

Figure 7. Total Monthly Bill Impacts of TOU Rates – Missouri West



Source: Guidehouse Analysis

Key Findings

TOU rates were studied in two jurisdictions within Evergy's service territory in the state of Missouri, Metro and West, using an opt-in quasi-experimental design with matched controls. Each jurisdiction has its own TOU rates. Residential customers who were on the general residential or the residential space heating rate were eligible to opt-into the TOU rate.

The key findings can be summarized as follows:

- The interim results indicate that participants in both jurisdictions did respond to the TOU prices by changing their consumption patterns in both seasons and the patterns are similar across the two jurisdictions.

- The summer kWh impacts are greater than the winter, but the percent impacts are closer due the summer consumption being much higher and winter space heating loads being less flexible as compared to space cooling loads.

- The system coincident peaks in the summer months occur during the on-peak period while in some winter months it can occur in the morning during the off-peak period and hence the summer / winter system coincident peaks are very similar / slightly lower to the on-peak impacts.

- Consistent with the energy and demand impacts, we see higher bill savings in the summer as compared to the winter and the summer savings are the primary drivers of the annual bill savings. Participants who were on the space heating tiered rate prior to enrolling in the TOU rate see a slight increase in their winter bills as compared to those participants who were on the general residential tiered rate.

- Approximately half of the summer bill savings for both rates and the winter bill increases for the space heating rate are driven by the rate structure change, i.e. moving from tiered to TOU rates. The breakdown of the total monthly bill impacts is discussed further in section 3.2.2.

1. Introduction

In 2019, Guidehouse Inc. (Guidehouse), formerly Navigant, was retained by Evergy Inc. (Evergy) to support Evergy's efforts to study residential Time of Use (TOU) rates in two jurisdictions in the state of Missouri, Metro and West. Guidehouse's services include independent evaluation services to verify the ex-post (historical) impacts of the TOU rates.

All residential customers in Evergy's service territory in Missouri are on a tiered rate structure. This means that they are charged a different set of prices based on whether or not their aggregate monthly consumption crosses various thresholds. Hence, the hour of the day in which a residential customer consumes energy does not have any bearing on their monthly electricity bill.

TOU rates place a premium, in terms of the price charged to customers, in certain hours of the day with the aim of aligning prices with cost causation and encouraging customers to reduce their consumption in those hours and shift it to other hours in the day that have a lower price point, e.g. shifting consumption from the on-peak to the super off-peak period. This helps improve grid stability by spreading the load across more hours of the day as opposed to having extremely high loads for a few hours that may have the potential to compromise system integrity.

The remainder of this chapter is divided into the following sections:

- **Study Overview** – provides an overview of the TOU rate study and the various customer segments that will be analyzed.
- **TOU Study Prices**– describes the TOU prices being tested and how they compare to the regular tiered rate structures.
- **Enrollment Summary** – provides a summary of the number of customers who have enrolled in the study thus far as well as unenrolled.
- **Evaluation Goals and Objectives** – describes the goals and objectives of the evaluation from a rate impact standpoint.

1.1 Study Overview

The TOU study was implemented in two jurisdictions of Evergy in the state of Missouri; i). Missouri Metro (formerly the Missouri jurisdiction of Kansas City Power & Light (KCP&L)) and ii). Missouri West (formerly KCP&L Greater Missouri Operations). Residential customers who are on the general residential rate or the residential space heating rate are eligible to enroll in the TOU rate. Each jurisdiction has its own set of TOU prices and is discussed further in section 1.2.

The analysis will focus on the jurisdictions as a whole but will also provide some additional insights with respect to various customer segments, i.e. subgroups of the participant population who have specific characteristics. The segment definitions are the same for both jurisdictions and Guidehouse used participant survey data in conjunction with 3rd party data to classify customers into the segments, see Table 2.

Table 2. Customer Segments

Customer Segment	Description
Low Income	Low Income Home Energy Assistance Program (LIHEAP) participants or that self-report LIHEAP eligibility in survey responses
Electric Vehicles	Self-reported Electric Vehicle (EV) owners in survey responses or in EV program data
Smart Thermostat	Participants in the Missouri Energy Efficiency Investment Act (MEEIA) 2 thermostat program or self-reported smart thermostat owners in survey responses
Seniors	Self-reported as seniors or at least one occupant over age 62 in survey responses or identified as over age 62 in 3rd party Axiom data[2]
Renters	Self-reported renter or identified as a renter in 3rd party Axiom data
General Population	Customers that cannot be classified within any other segments

Source: Guidehouse Analysis

The customer segments are based on various factors that influence a customer's perspective on energy. Individual customers usually represent a combination of characteristics, for example a customer may have an electric vehicle and a smart thermostat, meaning that the segments are not mutually exclusive. Hence, TOU participants can provide insights into the impacts of more than one segment they represent.

1.2 TOU Study Prices

The two jurisdictions have slightly different definitions of the seasons as described in Table 3. Table 4 describes the TOU prices for each jurisdiction. While the price per kWh value for the TOU periods are different across the two jurisdictions, the price differentials across the TOU periods are almost identical as seen in Table 5.

Table 3. Season Definition

Season	Metro Definition	West Definition
Summer	May 16 – September 15	June – September
Winter	September 16 – May 15	October – May

Source: Evergy

[2] Evergy provided the Axiom data that was used by Guidehouse.

Table 4. TOU Rate Structure

Season	TOU Period	Metro Price ($/kWh)	West Price ($/kWh)	Time Period
Summer	On-Peak	0.32498	0.26577	4pm-8pm Weekdays, excl. holidays
	Off-Peak	0.10833	0.08859	All other hours
	Super Off-Peak	0.05416	0.04429	12am-6am every day
Winter	On-Peak	0.26575	0.21629	4pm-8pm Weekdays, excl. holidays
	Off-Peak	0.10422	0.08727	All other hours
	Super Off-Peak	0.04495	0.03667	12am-6am every day

Source: Evergy Residential Rate Tarif

Table 5. Price Differentials Across TOU Periods

Differential	Season	Metro	West
On-Peak / Super Off-Peak	Summer	6.00	6.00
	Winter	5.91	5.90
On-Peak / Off-Peak	Summer	3.00	3.00
	Winter	2.55	2.48

Source: Guidehouse Analysis

As seen in Table 5, the on-peak to super off-peak price differential is the most notable with the on-peak price being approximately six times higher in both seasons. The on-peak to off-peak price differential is also notable with the on-peak price being three / two and a half times higher in the summer and winter seasons respectively.

For comparison purposes, Table 6 shows the residential tier pricing structure that customers are on prior to enrolling in the TOU rate. In both seasons, we can see that the on-peak price is more than double the average of the tiered prices. The off-peak price is approximately twenty percent lower while the super off-peak price is approximately half the average of the tiered prices.

Table 6. Residential Tiered Rate

Season	Tier Structure	Metro General Residential ($/kWh)	Metro Residential Space Heating ($/kWh)	West General Residential ($/kWh)	West Residential Space Heating ($/kWh)
Summer	First 600 kWh	0.13511	0.13806	0.10938	0.11927
	Next 400 kWh	0.13511	0.13806	0.10938	0.11927
	Over 1000 kWh	0.14916	0.13806	0.11927	0.11927
Winter	First 600 kWh	0.12013	0.09703	0.09888	0.09888
	Next 400 kWh	0.07396	0.09703	0.07800	0.06035
	Over 1000 kWh	0.06561	0.06300	0.07800	0.05005

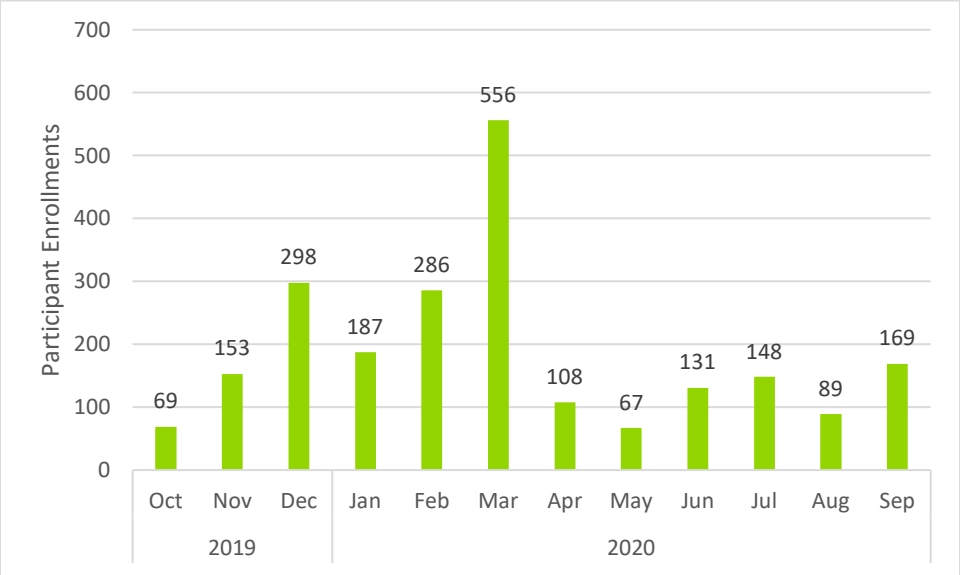
Source: Evergy Residential Rate Tarif

1.3 Enrollment Summary

The interim analysis includes all participants enrolled between October 1, 2019 and September 30, 2020. The total enrollments for the interim analysis are 2,261 customers and 2,744 customers for the Missouri Metro and West jurisdictions, respectively. Evergy has exceeded the stipulated enrollment goal of 1,750 per jurisdiction by the end of 2020.

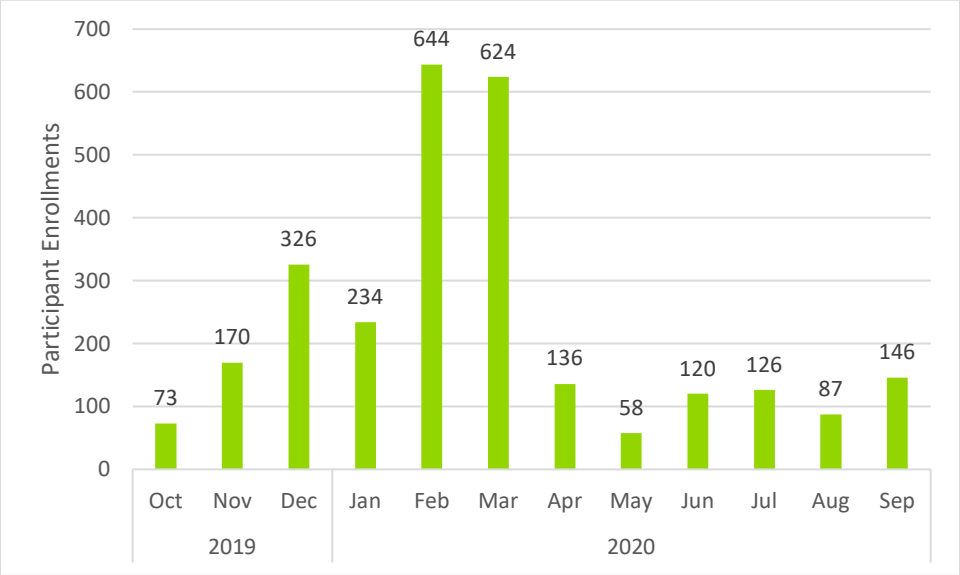
Figure 8 and Figure 9 show the monthly participant enrollment for the Metro and West jurisdictions respectively with the general trend being very similar across the two jurisdictions. The majority of the enrollment occurred prior to April 2020 when Evergy launched the first significant phase of its marketing plan. Towards the beginning of April 2020, marketing efforts were reduced due to the onset of a global pandemic – COVID-19, however, efforts were increased again starting in June 2020.

Figure 8. Monthly Enrollment – Missouri Metro



Source: Guidehouse Analysis

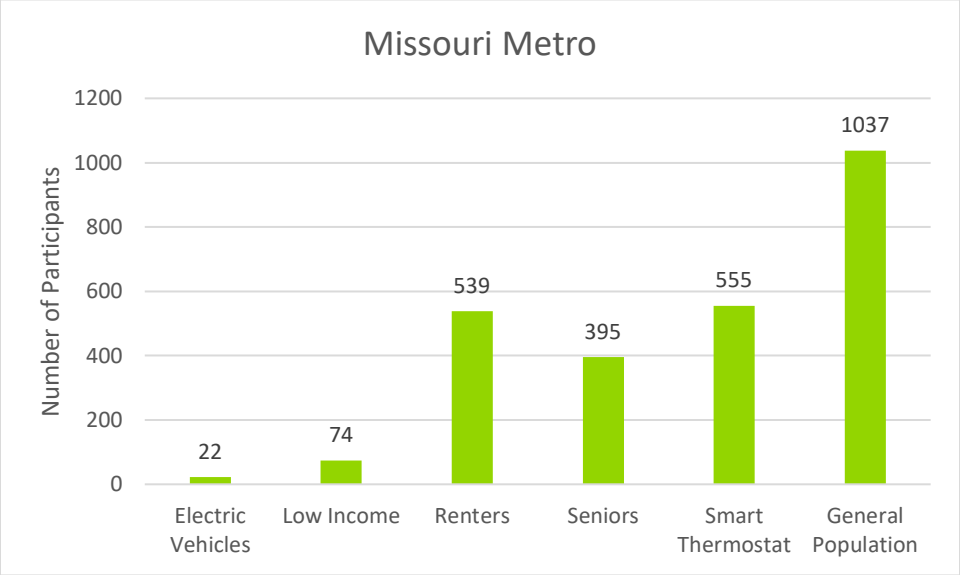
Figure 9. Monthly Enrollment – Missouri West



Source: Guidehouse Analysis

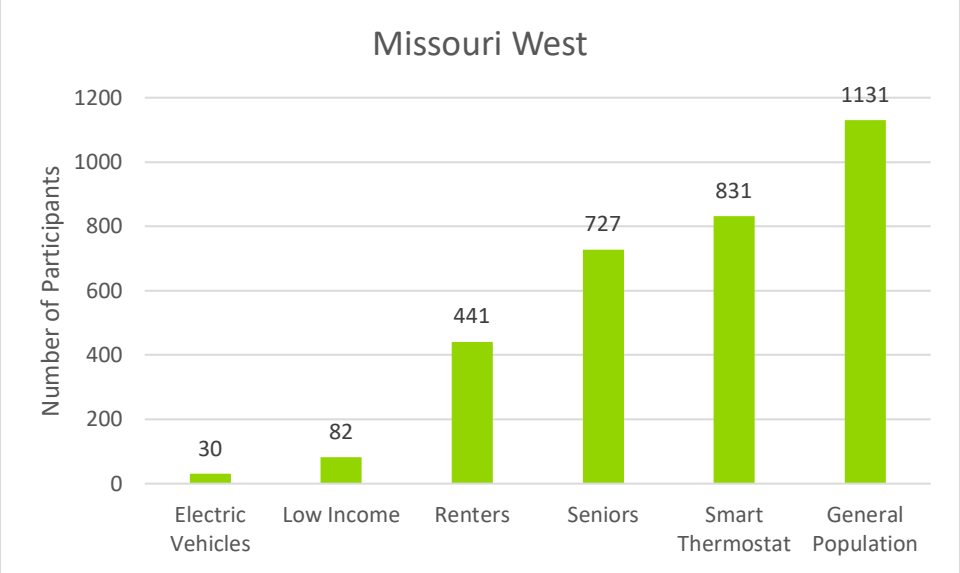
Figure 10 and Figure 11 show the enrollment by customer segment for the Metro and West jurisdictions respectively. As mentioned above, segment membership is not exclusive. Most participants fall into the general population segment with renters, seniors and smart thermostats having adequate representation. The electric vehicles and low-income segments have very few participants which will impact the confidence bands around the impact estimates and the results will need to be interpreted with caution.

Figure 10. Enrollment by Segment – Missouri Metro



Source: Guidehouse Analysis

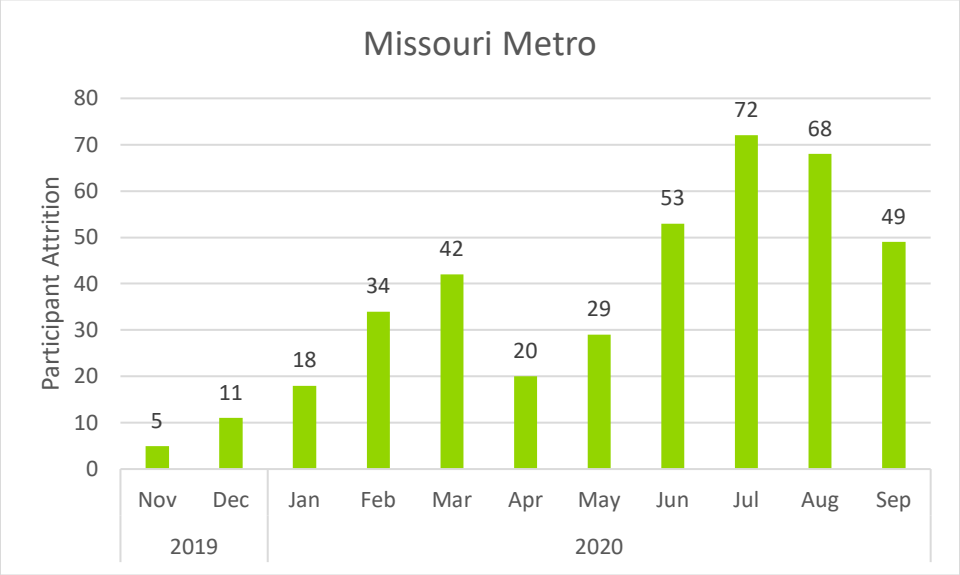
Figure 11. Enrollment by Segment – Missouri West



Source: Guidehouse Analysis

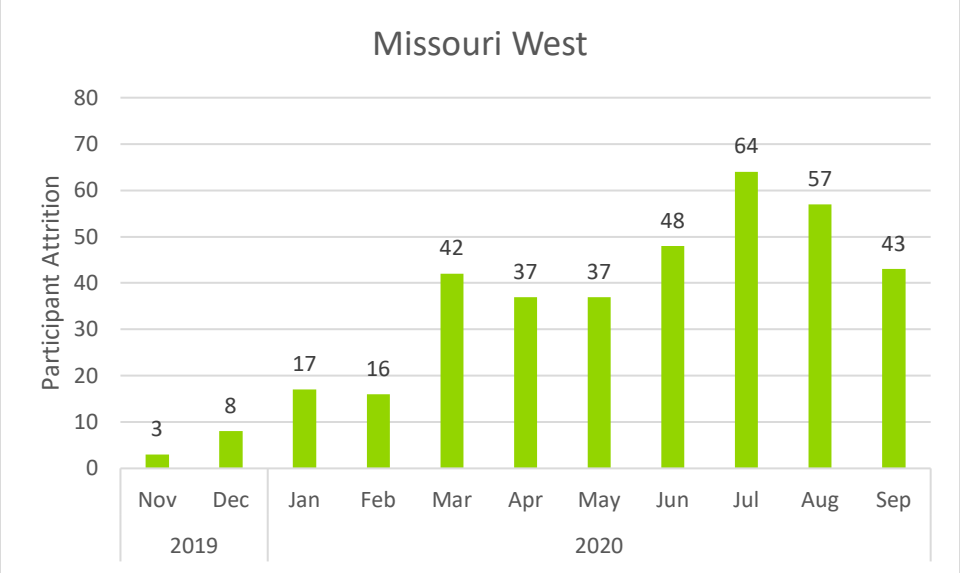
Figure 12 and Figure 13 show monthly participant attrition for the Metro and West jurisdictions respectively, with the trend across both jurisdictions being very similar. The total attrition is 401 and 372 customers for the Metro and West jurisdictions, respectively. Figure 14 and Figure 15 provide a breakdown of the reasons that caused attrition, for the Metro and West jurisdictions respectively, with the trends across the two jurisdictions being very similar. Approximately half of the attrition is due to participants moving from their current premise.

Figure 12. Participant Attrition – Missouri Metro



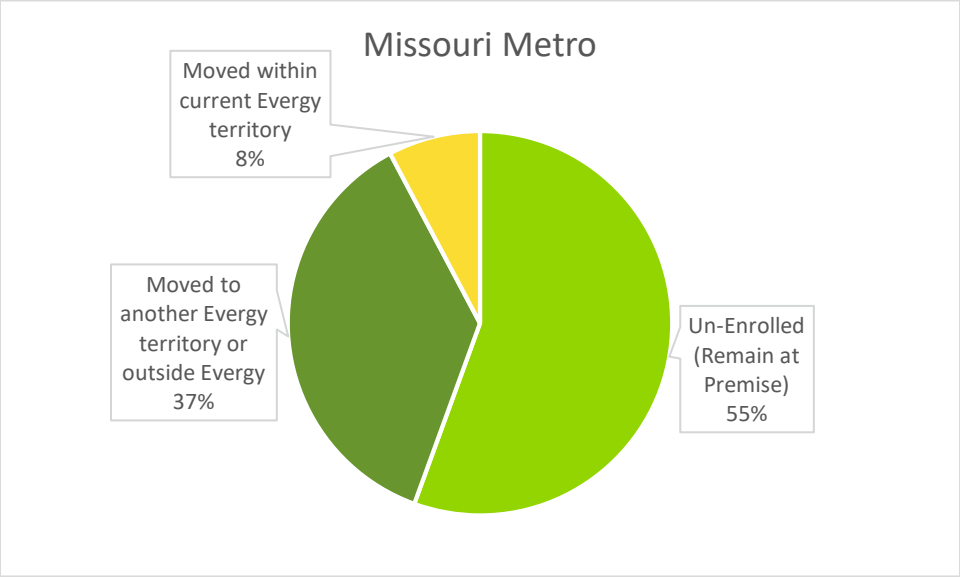
Source: Guidehouse Analysis

Figure 13. Participant Attrition – Missouri West



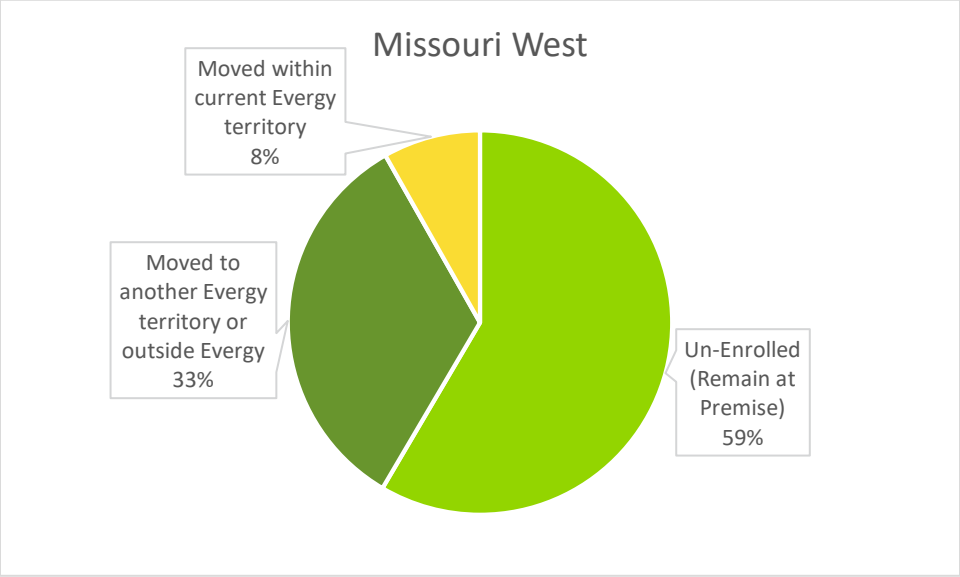
Source: Guidehouse Analysis

Figure 14. Attrition Reason – Missouri Metro



Source: Guidehouse Analysis

Figure 15. Attrition Reason – Missouri West



Source: Guidehouse Analysis

1.4 Evaluation Goals and Objectives

In accordance with the evaluation plan, Guidehouse estimated the Ex-Post Energy and Demand Impacts, i.e. the estimated impacts of historical pricing treatments, for the TOU rates across the two Missouri jurisdictions – Metro and West. The study period for this interim report comprises the one-year period from October 1, 2019 to September 30, 2020.

Key Objectives:

- Quantify the behavioral impacts of the TOU rate in terms of energy and peak demand, defined as the system coincident peak in each month,
- Assess how impacts vary across the customer segments in each jurisdiction, and
- Quantify the relative impacts of the TOU rate on customers' bills and the utility's revenue recovery.

The approach used to estimate the energy and demand impacts are discussed in chapter 2 and the associated findings in chapter 3.

2. Methodology

This chapter provides a high-level description of the approach used to conduct both rate evaluations. The remainder of this chapter is divided into the following sections:

- **Quasi-Experimental Design** – describes the experimental design used to quantify the behavioral impacts of the TOU rates
- **Estimating TOU Rate Impacts** – describes the econometric approach used to estimate the energy and demand impacts of the TOU rates

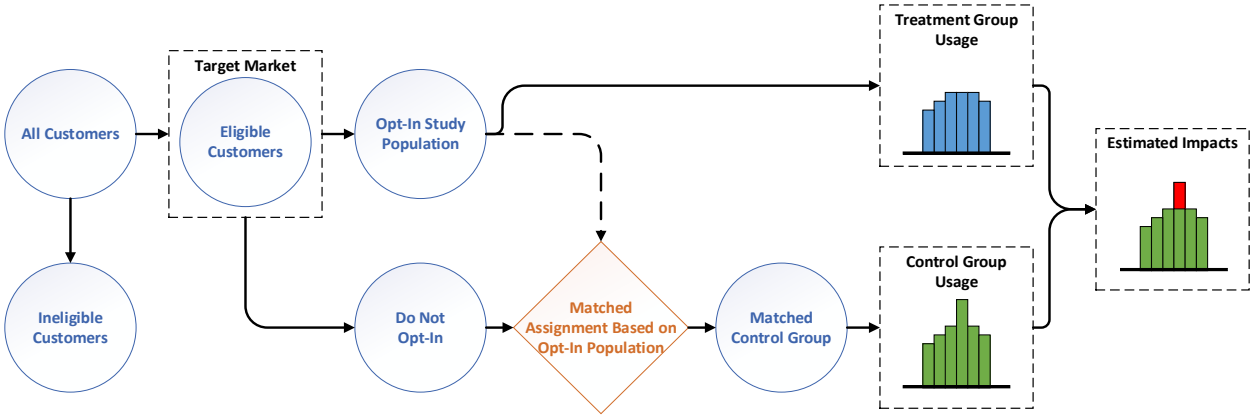
2.1 Quasi-Experimental Design

Residential customers who are on the general residential rate or the residential space heating rate are eligible to enroll in the TOU rate. Customers were offered a choice to voluntarily opt-in to the TOU rate or to remain on their current tiered rate. This enrollment approach is different from a default study, also known as an opt-out study, where customers are automatically placed on a new rate and must actively choose to unenroll or opt-out.

While this approach respects the customer's choice, any opt-in study can potentially result in self-selection bias meaning that it may attract those customers who are already more engaged in their electricity consumption patterns and think they can benefit from the TOU rate, i.e. they can shift consumption to the lower priced off-peak or super off-peak periods and/or reduce consumption thereby saving money on their electricity bill.

This approach, coupled with the relatively small sample sizes compared to the overall residential population, may potentially have implications for extrapolating the impacts to the broader population, but does not invalidate or compromise the study. This is because the behavioral changes observed in customers who opt-in to a rate may not necessarily mirror those for the entire residential population.

Figure 16. Opt-In Quasi Experimental Design with Matched Controls



Source: Guidehouse Analysis

Even a Randomized Control Trial (RCT), which effectively recruits customers and then denies a portion of customers the new rate so as to create the control group is subject to this challenge.[3] There were concerns that with an RCT denying customers the opportunity to enroll in the TOU rate, it would negatively impact customer perceptions.

Hence, Guidehouse used an opt-in quasi-experimental design with matched controls as shown in Figure 16. This approach leverages historical interval metering data for participants to match them with a comparable non-participant that will serve as their control for the study period. In essence, we leverage observable characteristics to create an *'as-if or quasi RCT'*. The selection of the matched controls is discussed in the sub-sections that follow.

2.1.1 Matching Analysis

The process of finding matched controls can be thought of as a pre-processing step for estimating the TOU rate impacts. This is because the act of selecting matched controls is aimed at reducing the variation in the data as we no longer include the entire residential population and balance the participant and control groups based on observable characteristics, namely pre-period consumption, which can potentially yield narrower confidence bands and more precise estimates.

A key aspect that must be kept in mind is that matching cannot be expected to yield a perfect matched control for every participant, meaning that consumption patterns won't be exactly the same. There are bound to be some minor differences in consumption patterns even during the matching period, but the key is that the patterns are similar.

The goal is to reduce the variation in the pre-period, i.e. the period prior to enrolling in the TOU rate, as much as possible, given the pool of non-participants, such that the regression has to do less *'work'* to control for these differences which would aid in yielding narrower confidence bands and more precise estimates. Any remaining differences will be controlled for by the regression model.

The process of finding a matched control for each participant was conducted in two phases:

- **Phase 1: Monthly Matching**

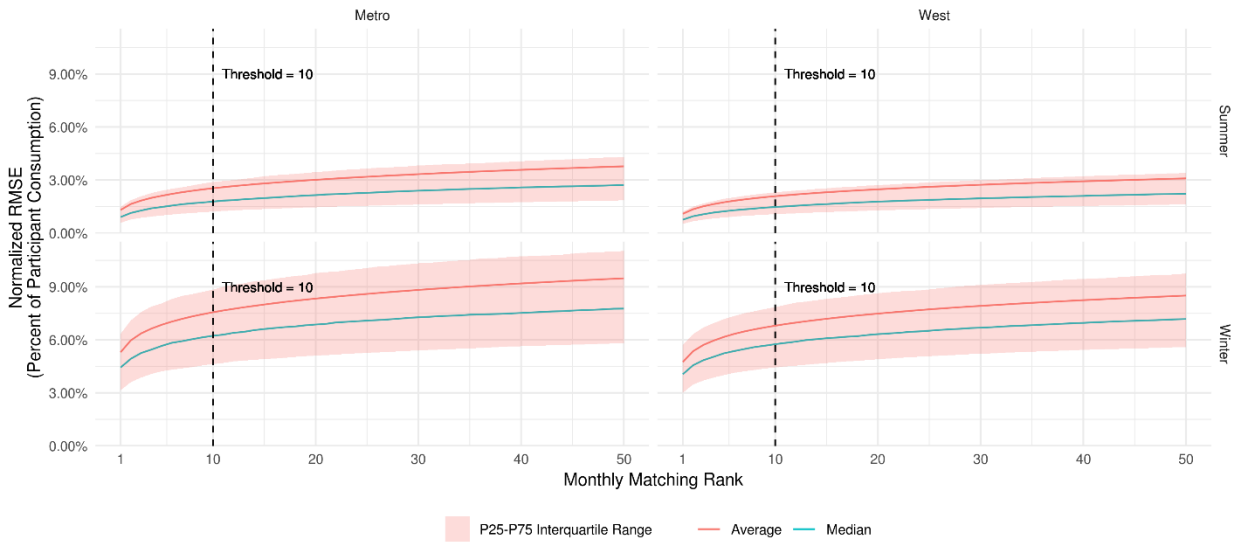
This phase can be thought of as a pre-processing step for the hourly matching. The goal of this phase is to narrow down the potential pool of controls for each participant for each season (as the summer and winter load profiles can vary) such that their monthly load profiles are similar.

Matching based on Euclidean (i.e. straight line) distance was conducted within each jurisdiction to select a subset of the top monthly matches for each participant for the summer and winter seasons respectively. The matching period used was the twelve-month period that immediately preceded the participant's enrollment month.

Figure 17 shows that the monthly distances (root mean squared error, RMSE) plateau quickly as you move further down the ranks allowing for the flexibility to have a reasonable threshold at which to narrow down the pool of controls for each participant for further refinement.

[3] RCTs eliminate self-selection bias conditional on expressing interest to participate.

Figure 17. Monthly Matches RMSE Distribution by Rank



Source: Guidehouse Analysis

There is no scientific algorithm to be applied in selecting the threshold for the top monthly matches but rather a determination based on a professional review of the distribution in Figure 17 to ensure a sufficient pool for the hourly matching.

The winter season has greater variance across the entire pool of non-participants that is most likely due to variations in space heating. The distributions are similar for both jurisdictions in both seasons and hence a threshold of the top ten monthly matches was selected as the threshold for both jurisdictions and seasons.

In summary, this first phase generates ten matches for each participant for each season, summer and winter respectively, within their own jurisdiction with similar monthly load profiles that can be passed to phase 2 for further refinement at the hourly level.

- **Phase 2: Hourly Matching**

Given that the impacts are estimated using an hourly regression model, it is important to ensure that the hourly load profiles are as close as possible. The top ten monthly matches for each participant (in each season) from phase one were used as inputs to select the matched control with the most similar hourly profile for each participant in each season. The matching period used was same as that used in phase 1.

For the purpose of hourly matching, the TOU buckets were defined as seen in Table 7. The weekend off-peak and super off-peak periods were separated from the weekday as the weekend load profiles are usually different from the weekday. The weights assigned to each period correspond to the number of hours they span in the week, i.e. they are the natural weights. Given that the TOU periods are same for both seasons, the same set of buckets and weights apply.

Table 7. Weights by TOU Period and Bucket

Day Type	TOU Period	Hours / Week	Total Hours / Week	Bucket	Period Weight
Weekday	On-Peak	20	168	1-On-Peak	12%
	Off-Peak	70	168	2-Off-Peak	42%
	Super Off-Peak	30	168	3-Super Off-Peak	18%
Weekend	Off-Peak	36	168	4-Off-Peak	21%
	Super Off-Peak	12	168	5-Super Off-Peak	7%

Source: Guidehouse Analysis

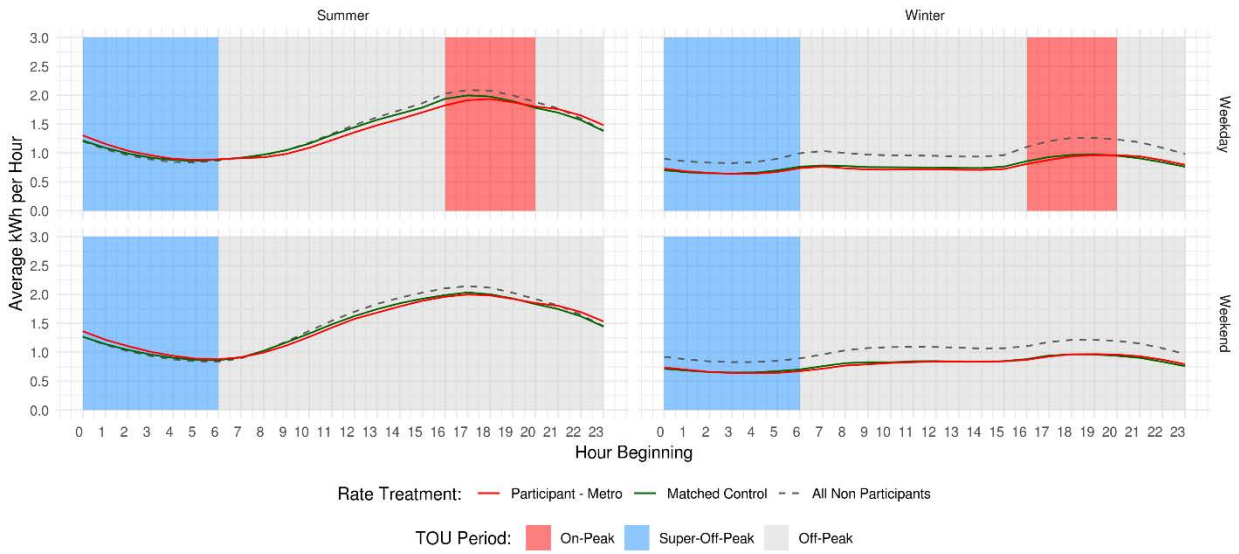
Conducting the hourly matching with a full twenty-four-hour load profile for the weekday vs. the weekend results in too many dimensions for each month to match on which can introduce a lot of noise thereby reducing the ability to produce a reliable match. However, using the TOU buckets provide a reasonable number of dimensions to match on providing a good set of matches. Effectively, for each month of each season we have five dimensions to match on for each participant, three for the weekday and two for the weekend.

2.1.2 Review of Matched Controls

The approach described above yielded a good set of matched controls for both jurisdictions in that the participant and matched control consumption profiles are very similar as seen in the figures below. The figures also demonstrate how the matched controls compare to the entire pool of all non-participants from which the controls are selected.

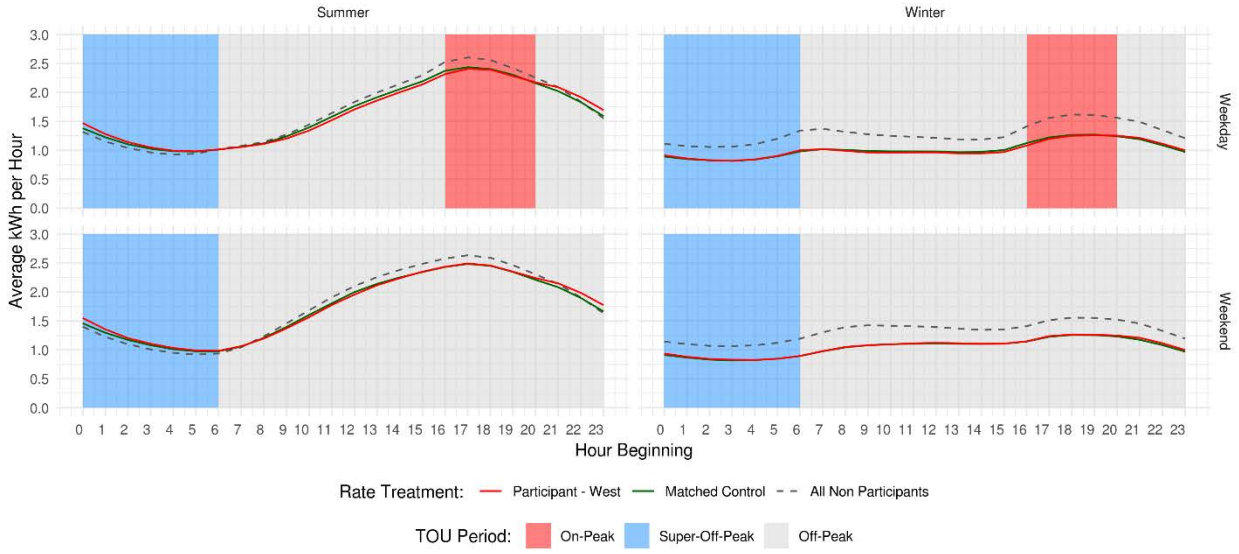
In general, the summer consumption is higher than the winter consumption which demonstrates the benefit of finding a separate matched control for the two seasons. The entire pool of all non-participants has a notably higher load profile, especially in the winter. Hence, we can conclude that the pre-processing step of finding a matched control was successful.

Figure 18. Matched Control Hourly Load Profiles – Missouri Metro



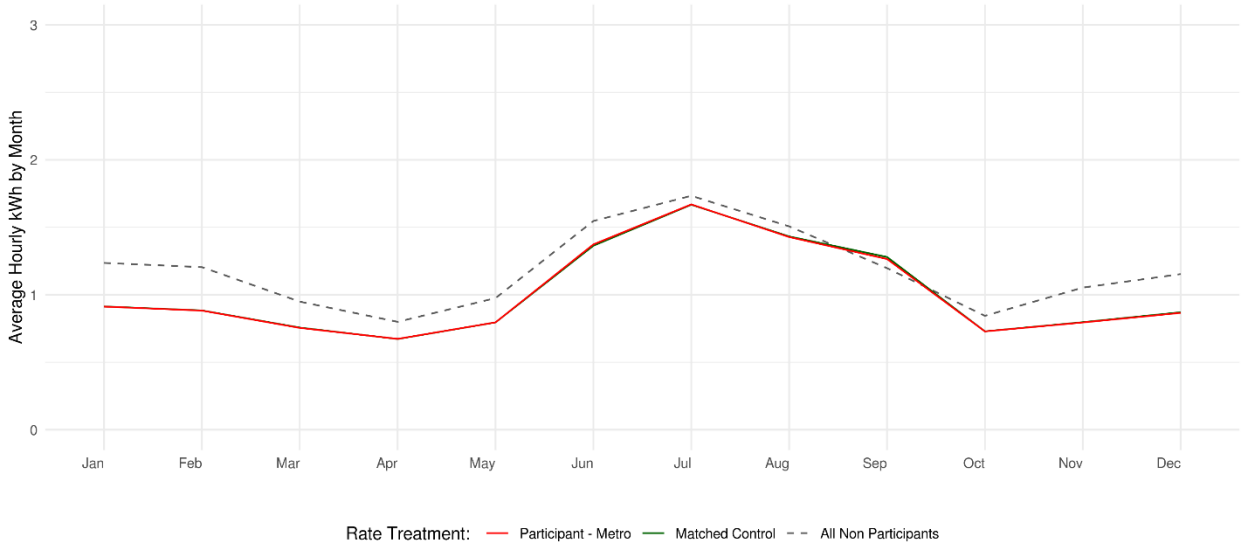
Source: Guidehouse Analysis

Figure 19. Matched Control Hourly Load Profiles – Missouri West



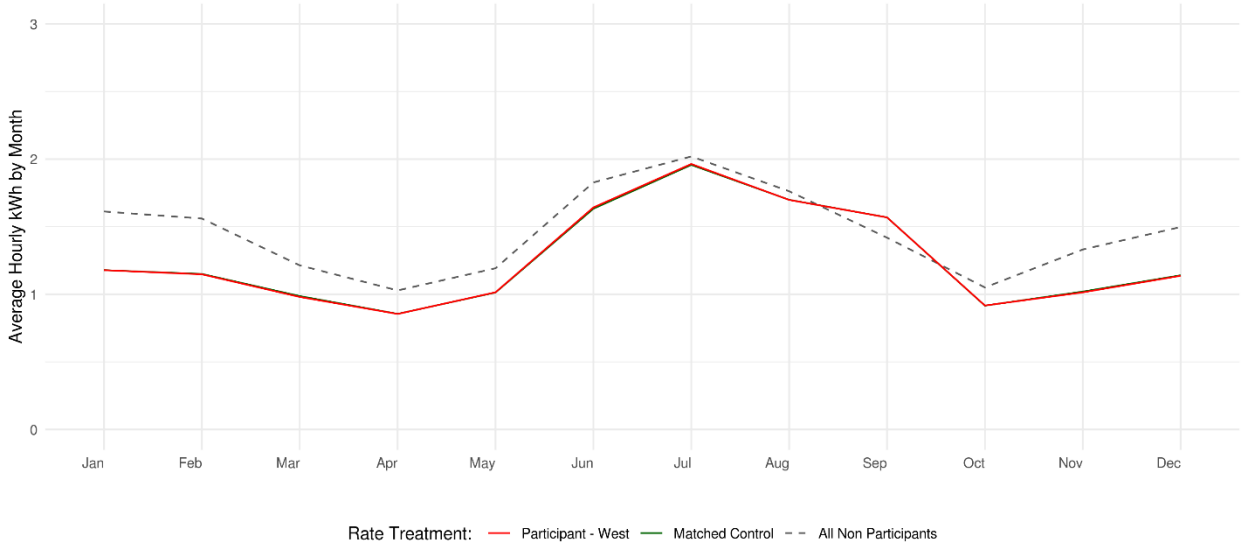
Source: Guidehouse Analysis

Figure 20. Matched Control Monthly Load Profiles – Missouri Metro



Source: Guidehouse Analysis

Figure 21. Matched Control Monthly Load Profiles – Missouri West



Source: Guidehouse Analysis

2.2 Estimating TOU Rate Impacts

This section describes the econometric approach to estimating the energy impacts by TOU period as well as the monthly system coincident peak demand impacts.

2.2.1 Energy Impacts Methodology

This section details the econometric approach adopted by Guidehouse to estimate energy impacts by TOU period. A post program lagged dependent variable model was applied to a panel dataset. The model effectively compares the hourly consumption in the post period, i.e. the period after enrolling in the TOU rate, for the participants and matched controls to estimate savings. Any remaining differences in usage prior to enrollment are controlled for via the lagged dependent variable. A separate regression was run for each jurisdiction and season, see Equation 1.

Equation 1. Energy Impacts Post Program Regression Model

$$\begin{aligned} kWh_{i,t} = & \sum_{n} \alpha_n \cdot Participant_{i,t} \cdot TOU\_period_{n,i,t} + \sum_{n} \beta_n \cdot TOU\_period_{n,i,t} + \\ & \sum_{w} \chi_w \cdot WeekNum_{w,i,t} \cdot kWh\_Lag_{i,t} + \\ & \sum_{w}\sum_{d} \delta_{w,d} \cdot WeekNum_{w,i,t} \cdot DayOfWeek_{d,i,t} + \sum_{w}\sum_{h} \phi_w \cdot WeekNum_{w,i,t} \cdot Hour_{h,i,t} + \\ & \sum_{w} \gamma_w \cdot WeekNum_{w,i,t} \cdot HDH65_{i,t} + \sum_{w} \eta_w \cdot WeekNum_{w,i,t} \cdot HDH65buildup_{i,t} + \\ & \sum_{w} \iota_w \cdot WeekNum_{w,i,t} \cdot CDH65_{i,t} + \sum_{w} \varphi_w \cdot WeekNum_{w,i,t} \cdot CDH65\_buildup_{w,i,t} + \varepsilon_{i,t} \end{aligned}$$

Source: Guidehouse Analysis

Table 8 provides a description of the model variables. The dependent variable is the hourly consumption in the post period analysis timeframe. The participant indicator variable is interacted, i.e. multiplied, with the TOU period to capture the changes in energy consumption in each TOU period.

The purpose of the other variables is to account for other factors that influence energy consumption behavior so as to obtain a clean estimate of the impact of the TOU rates on a customer's energy consumption patterns. The lag dependent variable controls for the pre-period consumption by week of the year providing greater flexibility to control for changes in consumption over time.

Table 8. Energy Impact Regression Model Variables

Variable	Description
i	Index to identify a particular customer
t	Index to identify the datetime stamp for the hourly observation
n	Index to identify the TOU period (on-peak, off-peak, super off-peak)

Variable	Description
w	Index to identify the week of the year
d	Index to identify the day of the week
h	Index to identify the hour of the day
$Participant_{i,t}$	Indicator variable that takes the value of one when the customer is a participant, zero otherwise
$TOU\_Period_{n,i,t}$	Indicator variable that takes the value of one when the TOU period = n, zero otherwise
$WeekNum_{w,i,t}$	Indicator variable that takes the value of one when the week of the year = w, zero otherwise
$kWh\_Lag_{i,t}$	Average energy consumption in the same week and hour, by weekday or weekend, in the pre-period (same timeframe used for matching)[4]
$DayOfWeek_{d,i,t}$	Indicator variable that takes the value of one when the day of the week = d, zero otherwise
$Hour_{h,i,t}$	Indicator variable that takes the value of one when the hour of the day = h, zero otherwise
$HDH65_{i,t}$	Heating degree hours measured at 65^0F
$CDH65_{i,t}$	Cooling degree hours measured at 65^0F
$HDH65\_buildup_{w,i,t}$	Sum of the heating degree hours over the past seventy-two hours measured at 65^0F
$CDH65\_buildup_{w,i,t}$	Sum of the cooling degree hours over the past seventy-two hours measured at 65^0F

Source: Guidehouse Analysis

2.2.2 Peak Demand Impacts Methodology

This section details the econometric approach adopted by Guidehouse to estimate the monthly system coincident peak demand impacts. Like the energy impacts, a post program lagged

[4] Guidehouse believes that a weekly average is a reasonable timeframe for the purpose of accounting for the prior year's energy consumption levels. This address the issue with variability that may arise in any particular hour in the previous year that may not be indicative of typical consumption patterns.

dependent variable model was applied to a panel dataset. The model effectively compares the monthly system coincident peak demand consumption in the post period for the participants and matched controls to estimate savings. Any remaining differences in usage prior to enrollment are controlled for via the lagged dependent variable. A separate regression was run for each jurisdiction and season, see Equation 2.

Equation 2. Peak Demand Impacts Post Program Regression Model

$$kW_{i,t} = \alpha \cdot Participant_{i,t} + \sum_{m} \beta_m \cdot Month_{m,i,t} \cdot kW\_Lag_{m,i,t} + \sum_{m} \beta_m \cdot Month_{m,i,t} \cdot Monthly\_kWh_{i,t} + \sum_{m} \gamma_w \cdot Month_{m,i,t} \cdot HDH65_{i,t} + \sum_{w} \iota_w \cdot Month_{m,i,t} \cdot CDH65_{i,t} + \varepsilon_{i,t}$$

Source: Guidehouse Analysis

Table 9 provides a description of the model variables. The dependent variable is the system coincident peak demand consumption for the month in the post period analysis timeframe. The participant indicator variable captures the changes in peak consumption that are driven by the TOU rate.

Like the energy impacts, the purpose of the other variables is to account for other factors that influence energy consumption behavior so as to obtain a clean estimate of the impact of the TOU rates on a customer's peak demand and the lag dependent variable controls for the pre-period peak demand by month of the year.

Table 9. Peak Demand Impact Regression Model Variables

Variable	Description
i	Index to identify a particular customer
t	Index to identify the month for the peak demand observation
m	Index to identify the month of the year
$Participant_{i,t}$	Indicator variable that takes the value of one when the customer is a participant, zero otherwise
$Month_{m,i,t}$	Indicator variable that takes the value of one when the month of the year = m , zero otherwise
$kW\_Lag_{i,t}$	Peak demand in the same month of the pre-period (same timeframe used for matching)
$HDH65_{i,t}$	Heating degree hours measured at 65^0F
$CDH65_{i,t}$	Cooling degree hours measured at 65^0F

Source: Guidehouse Analysis

3. Results

This chapter presents the results of the TOU rates on customer behavior, namely the associated impacts on energy and peak demand, and the associated bill impacts. As we interpret the various impacts of the TOU rates, the following key factors must be kept in mind:

- **The on-peak price differential in both seasons is the most notable** as discussed in section 1.2, being six times higher than the super off-peak price and approximately three times higher than the off-peak price and hence we would expect to see the highest impacts in this period.

- **It remains to be seen how the impacts change over the course of the second year** of the study as more customers enroll. However, the confidence bands around the interim impact estimates are reasonable, i.e. they are not too wide[5].

The remainder of this chapter is divided into the following sections:

- **TOU Rate Impacts** – presents the energy and monthly system coincident peak demand impacts of the TOU rate.

- **Bill Impacts** – presents the impacts that the TOU rates and the associated behavioral changes that customers have made has had on their electricity bills.

3.1 TOU Rate Impacts

Figure 22 and Figure 24 present the TOU rate impacts for the Missouri Metro and West jurisdictions respectively. The impacts in both seasons are similar across the two jurisdictions with almost all of the impacts being statistically significant at the ninety percent confidence level. The impacts can also be corroborated by comparing the load shapes of the participants and the matched controls as shown in Figure 23 and Figure 25 for the Missouri Metro and West jurisdictions respectively.

The results indicate that participants in both jurisdictions did respond to the TOU prices by changing their consumption patterns. Prior to enrolling in the TOU rate, participants were on a tiered rate structure. This means that the hour in which they consumed electricity did not affect their bill, only the total amount they consumed in a month.

As expected, the most notable savings in either season and jurisdiction occur during the on-peak periods as the price differential is the most notable during these hours both in comparison to the other TOU periods as well as to the tiered rate as mentioned in section 1.2, see Table 5 and Table 6. This is also evident from the post period load shapes shown in Figure 23 and Figure 25 as the gap between the participants and the matched controls is the largest during the on-peak period.

[5] For example, you do not see confidence bands stretch from -0.2 to -1.2 as then it would be difficult to draw reasonable conclusions.

The high priced on-peak period provides the incentive to shift consumption to the lower priced off-peak or super off-peak periods. Another contributing factor is that the on-peak period is four hours a day during weekdays, 4 to 8 pm, making it easier to shift consumption than if the on-peak period was longer.

The overall magnitude of the summer impacts, i.e. the kWh impacts, are greater than the winter impacts, however, the difference in the percent impact between the two seasons is closer. The winter months also include space heating loads which tend to be less flexible as compared to the summer space cooling loads.

The consumption during the summer months, especially during the on-peak period, is much higher than the winter. This was observed in the pre-period during the matching process as mentioned in section 2.1.2, see Figure 18 through Figure 21, and can also be seen in post period load shapes shown in Figure 23 and Figure 25.

During the off-peak period, we do see some impacts though the magnitude is much smaller than the on-peak period which is to be expected given that the off-peak price is much lower than the on-peak price. This off-peak price is still three / two and a half times higher than the super off-peak price in the summer and winter seasons respectively which may provide some incentive to shift consumption to the super off-peak period.

Given the low price offered during the super off-peak period when compared to the other TOU periods or the tiered rate structure, we see an increase in consumption as participants shift a portion of their consumption from the higher priced on-peak and off-peak periods to the super off-peak periods.

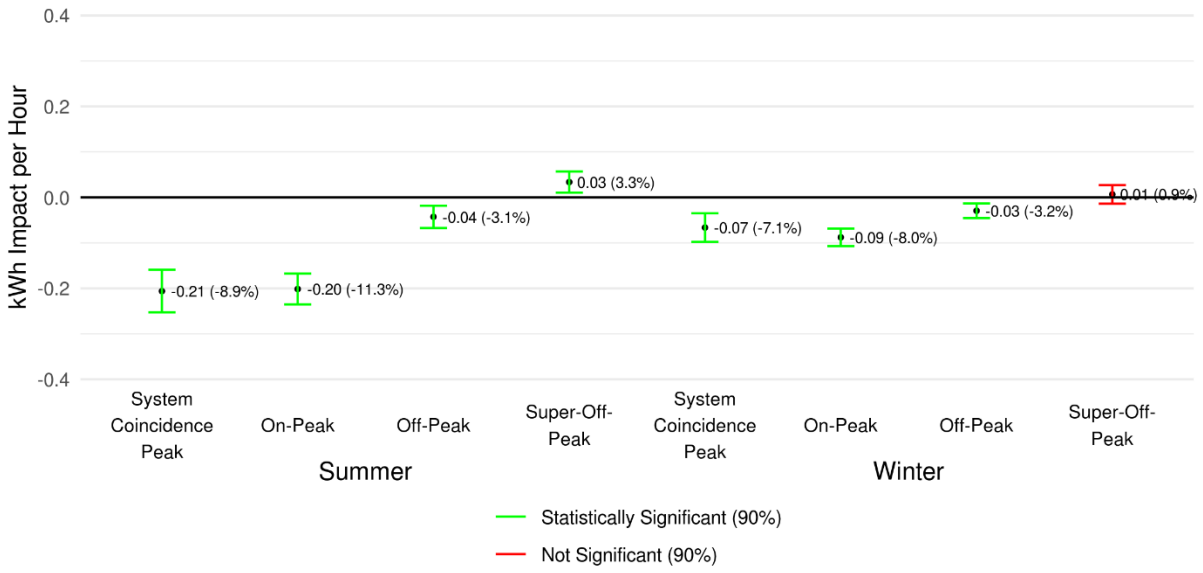
During the summer months, the system coincident peak demand impacts are very similar to those of the on-peak period impacts, but in the winter months the winter system coincident peak demand impacts are lower than those of the on-peak period impacts.

The system coincident peak hours in the summer months always coincide with the on-peak hours during which we see the highest impacts and hence one would expect similar impacts in the summer system coincident peak.

However, during some winter months the system coincident peak can occur in the early morning during the off-peak period, which can also see an increase in space heating loads. As noted above, the off-peak period impacts are lower than the on-peak impacts and hence one would expect lower system coincident peak impacts in the winter months.

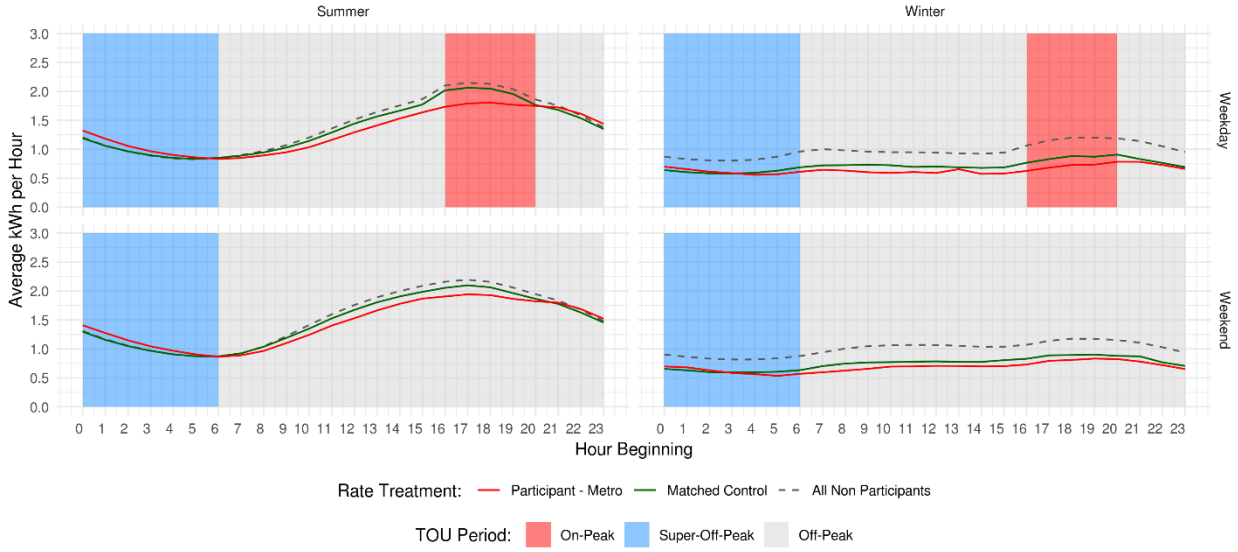
In summary, participants in both jurisdictions are responding to the TOU rates in both seasons by changing their consumption patterns. However, as mentioned at the start of this chapter, it remains to be seen how the impacts change as the study progresses into the second year and more participants are available for analysis.

Figure 22. TOU Rate Impacts – Missouri Metro



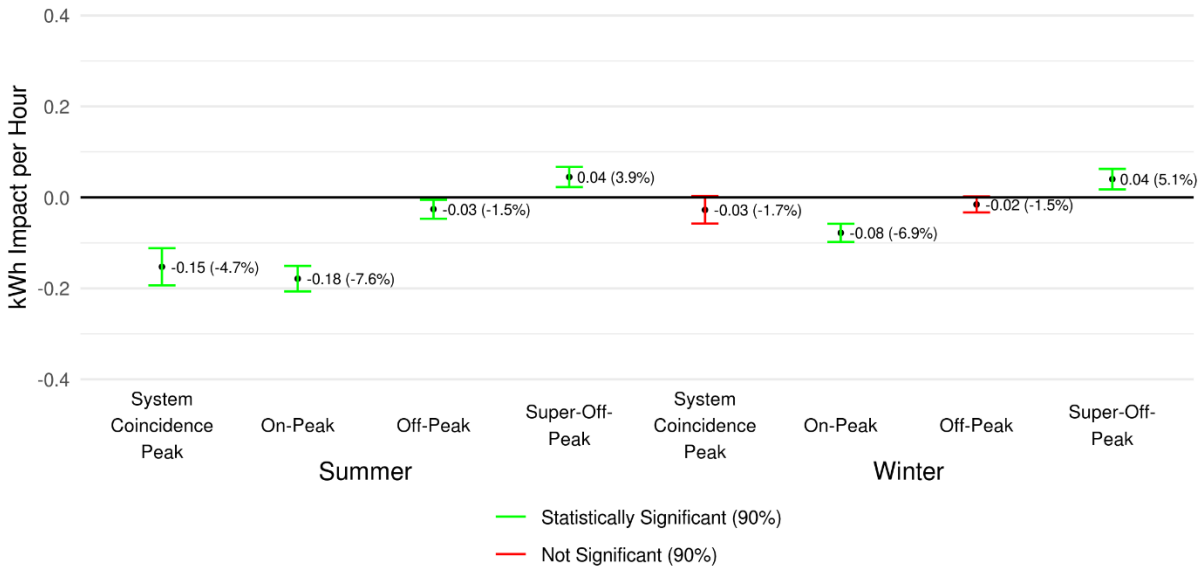
Source: Guidehouse Analysis

Figure 23. Post Period Load Shapes – Missouri Metro



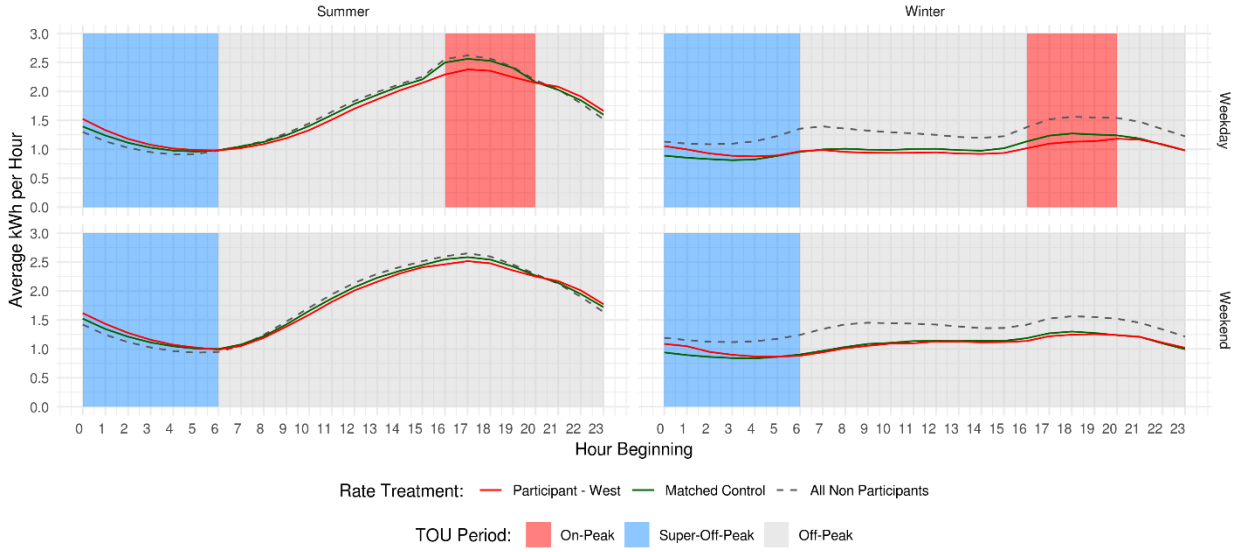
Source: Guidehouse Analysis

Figure 24. TOU Rate Impacts – Missouri West



Source: Guidehouse Analysis

Figure 25. Post Period Load Shapes – Missouri West



Source: Guidehouse Analysis

3.1.1 Impacts by Customer Segment

This section presents a summary of the impacts by customer segment with additional detail provided in Appendix A. Some individual segments, such as low income and electric vehicles, have much smaller sample sizes compared to others and the results should be interpreted with caution. The following figures present the on-peak and monthly system coincident peak demand impacts by each customer segment.

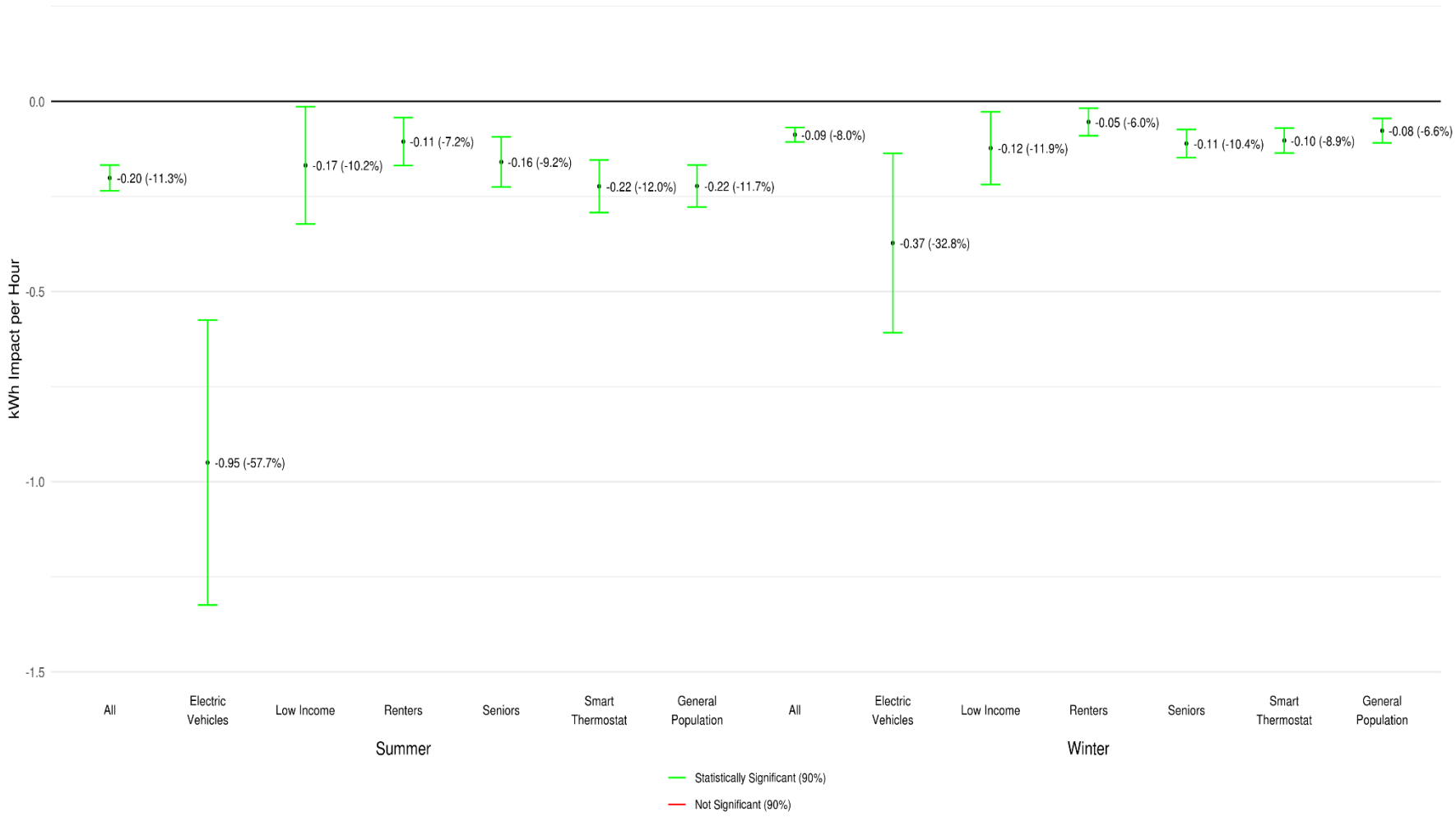
In general, the impacts at the segment level are similar to those of the entire jurisdiction for each season. The general population is the most similar which is to be expected as the majority of the participants in each jurisdiction belong to this segment. However, the confidence bands are slightly wider which can be attributed to the smaller sample sizes.

The seniors and renters' segments have similar but slightly lower impacts while smart thermostats have slightly higher impacts. Customers with smart thermostats may be more energy savvy as compared to other customers. Like the general population segment, the confidence bands are slightly wider for the other segments which can be attributed to the smaller sample sizes.

The electric vehicles segment has the highest impacts which are primarily driven by shifting vehicle charging to the super off-peak period. The super off-peak period provides the perfect opportunity for customers to charge their electric vehicles at a low cost.

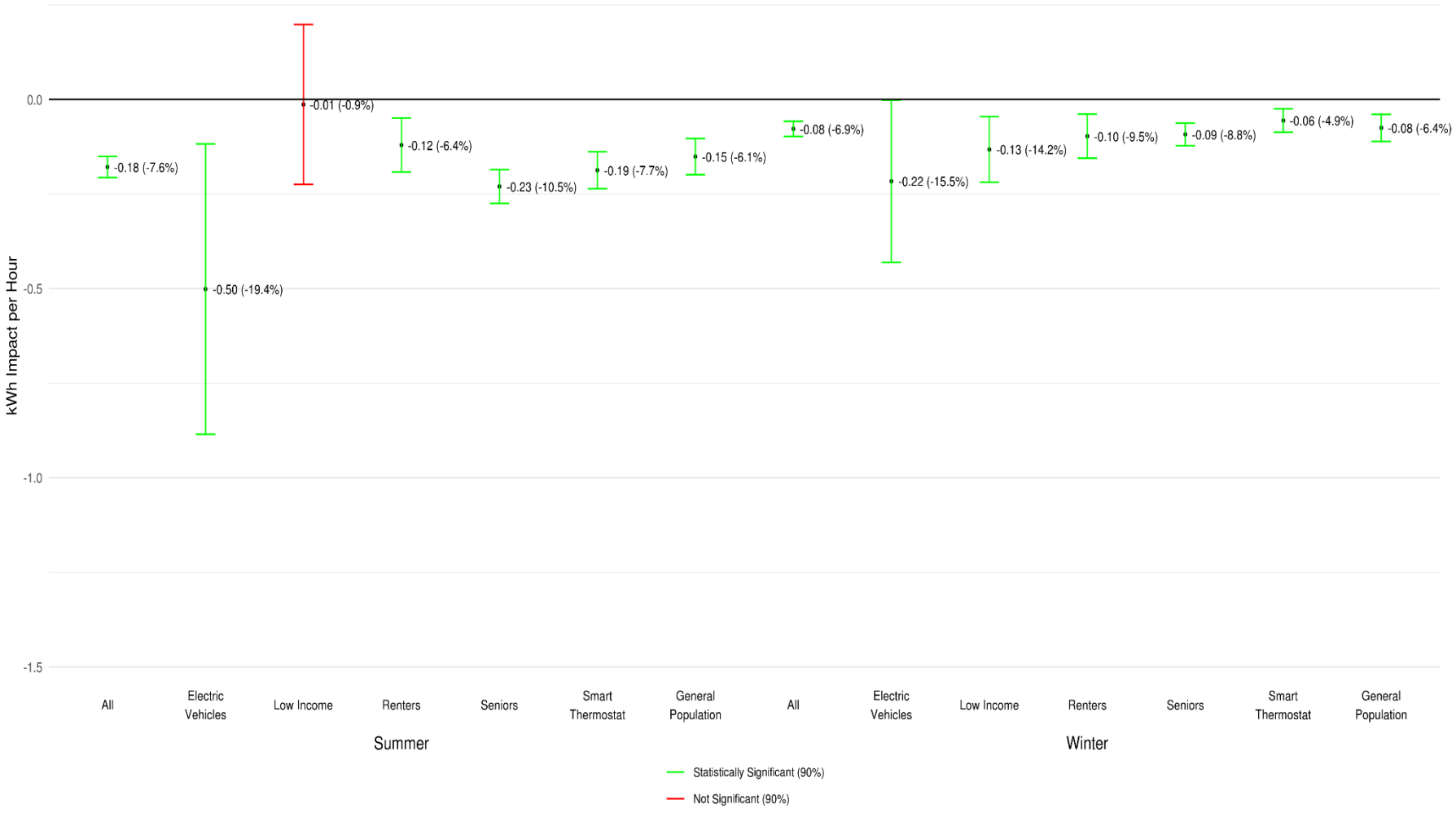
The low-income segment for the most part has statistically insignificant impacts, especially with regards to the monthly system coincident peak. This can be attributed to the small sample sizes as well as the fact that their aggregate levels of consumption are lower as compared to other segments and hence there would be less potential for further modifications to consumption patterns. However, in the metro jurisdiction, there does appear to be some statistically significant on-peak savings in the summer.

Figure 26. On-Peak Impacts by Segment – Missouri Metro



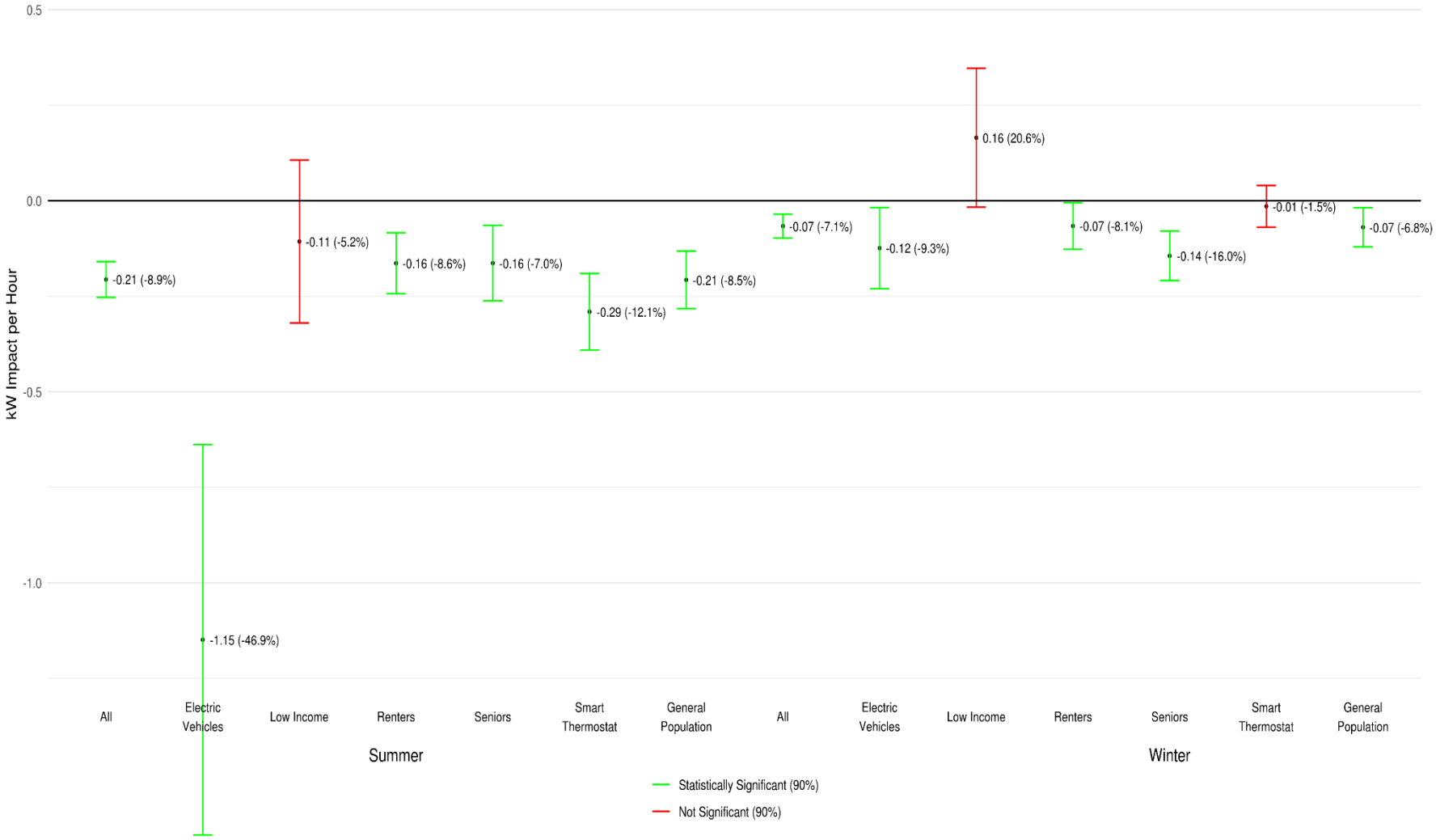
Source: Guidehouse Analysis

Figure 27. On-Peak Impacts by Segment – Missouri West



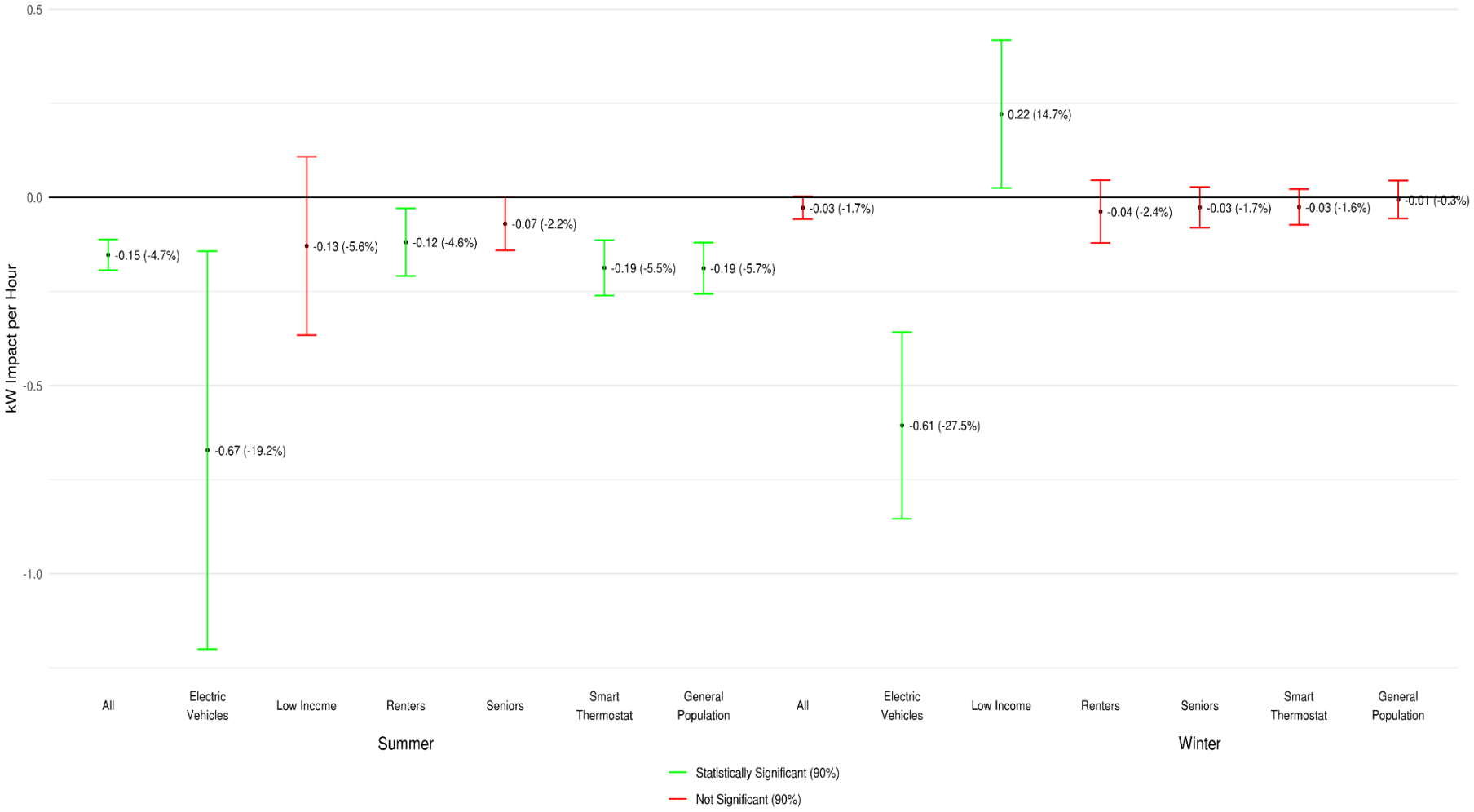
Source: Guidehouse Analysis

Figure 28. System Coincident Peak Demand Impacts by Segment – Missouri Metro



Source: Guidehouse Analysis

Figure 29. System Coincident Peak Demand Impacts by Segment – Missouri West



Source: Guidehouse Analysis

3.2 Bill Impacts

This section presents the impacts of the TOU rate on an average participant's electricity bill. Effectively, this compares the average participant's actual bill under the TOU rate compared to what it would have been under the tiered rate, accounting for both the rate structure changes (i.e. tiered vs. TOU rates) as well as the associated behavioral changes.

The impact estimates of the TOU rates for each jurisdiction, presented in section 3.1, were used to determine what consumption would have been in the absence of TOU rates, effectively adjusting for the change in behavior. This in conjunction with the applicable tier prices was used to determine what the average participants electricity bill would have been in absence of the TOU rate. This allows for the separation of rate structure and behavioral impacts.

Total monthly bill impacts are presented for each season as well as on an annual basis which have implications for the utility's revenue recovery. Prior to enrolling in the TOU rate, customers were either on the general residential or residential space heating rate, see Table 11.

During the summer months, the main difference in the general and space heating tiered rate structure is that the general price increases by approximately $0.01 for the final step – over 1000 kWh. This would result in a small bill increase for customers on the general residential rate that have high space cooling loads in the summer and their monthly consumption exceeds 1000 kWh. The residential space heating rate is simply a flat rate in the summer.

Table 10. Residential Tiered Rate

Season	Tier Structure	Metro General Residential ($/kWh)	Metro Residential Space Heating ($/kWh)	West General Residential ($/kWh)	West Residential Space Heating ($/kWh)
Summer	First 600 kWh	0.13511	0.13806	0.10938	0.11927
	Next 400 kWh	0.13511	0.13806	0.10938	0.11927
	Over 1000 kWh	0.14916	0.13806	0.11927	0.11927
Winter	First 600 kWh	0.12013	0.09703	0.09888	0.09888
	Next 400 kWh	0.07396	0.09703	0.07800	0.06035
	Over 1000 kWh	0.06561	0.06300	0.07800	0.05005

Source: Evergy Residential Rate Tariffs

Conversely in winter months, the both sets of tiered prices decreases with each step which would aid customers with electric space heating loads that have limited potential for shifting or reduction. However, the space heating rate does offer price advantages over the general residential rate as one would expect; for example, in the metro jurisdiction there is a notable

difference in the price paid for the first 600 kWh under the space heating rate as compared to the general residential rate.

As we move to a TOU rate structure, we see that the on-peak price is more than double any of the tiered rates in both the summer and winter. The off-peak rate is lower than the tiered rate in the summer but slightly higher than the second and third tier in the winter, especially for the space heating tiered rate. The super off-peak rate is lower than any tiered rate in any season.

Hence, customers with space cooling loads could potentially see additional benefits in the summer as opposed to customers with space heating loads in the winter who may see their bill increase from just switching to the TOU rate. The super off-peak period price is lower than any tiered rate structure.

A customer's aggregate level of consumption also plays a role in the overall bill impacts. Customers who have low levels of consumption typically have limited potential for further behavioral changes (shifting or reducing consumption) as compared to other customers who have higher levels of overall consumption. Hence, higher aggregate levels of consumption could potentially result in higher bill savings.

Table 11. TOU Rate Structure

Season	TOU Period	Metro Price ($/kWh)	West Price ($/kWh)	Time Period
Summer	On-Peak	0.32498	0.26577	4pm-8pm Weekdays, excl. holidays
	Off-Peak	0.10833	0.08859	All other hours
	Super Off-Peak	0.05416	0.04429	12am-6am every day
Winter	On-Peak	0.26575	0.21629	4pm-8pm Weekdays, excl. holidays
	Off-Peak	0.10422	0.08727	All other hours
	Super Off-Peak	0.04495	0.03667	12am-6am every day

Source: Evergy Residential Rate Tariffs

The subsections that follow present the total bill impacts at the monthly level and then provide a more detailed analysis of what comprises the total monthly bill savings. The bill impact calculations only consider the volumetric price of electricity and do not factor in fixed charges or rate riders.

3.2.1 Total Monthly Bill Impacts

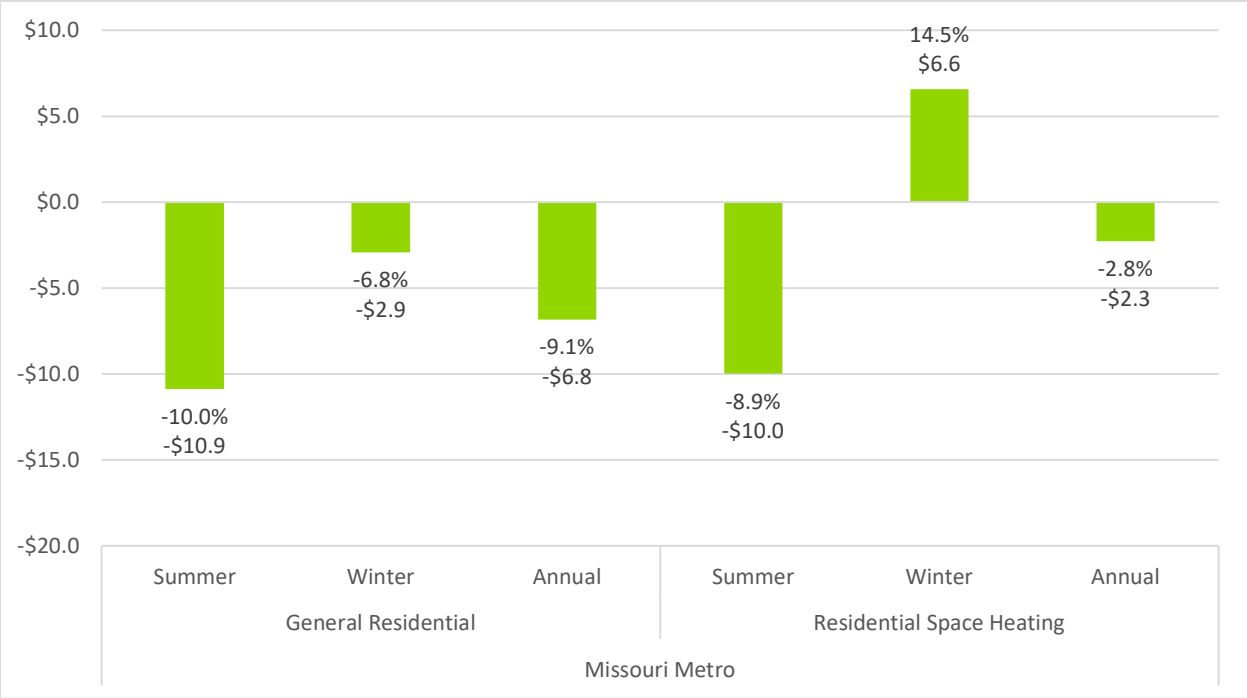
Figure 30 and Figure 31 present the monthly bill impacts on an average participant bill for each season as well as on an annual basis for the Metro and West jurisdictions respectively. Given that participants can be on one of two tiered rates prior to enrolling, we separate the bill impacts based on the tiered rates for each jurisdiction. The composition of these bill savings is discussed in section 3.2.2.

The average participant saves approximately six to ten percent on their bills during the summer season. During the winter months, the average general residential participant sees a slight decrease on their bills while the average residential space heating participant sees an increase. On an annual basis, we can see reductions ranging from three to ten percent depending on the tiered rate that an average participant was on prior to enrolling. This is primarily driven by the savings from the summer season. This pattern is consistent across both jurisdictions.

The aggregate level of consumption in the summer season is higher than the winter in both jurisdictions, and hence the associated kWh impacts are much higher as seen in section 3.1. This means that more energy is shifted out of the on-peak periods in the summer than in the winter. Furthermore, space cooling loads are more flexible compared to space heating loads. Hence, we see a notable reduction ranging from six to ten percent in monthly summer bills.

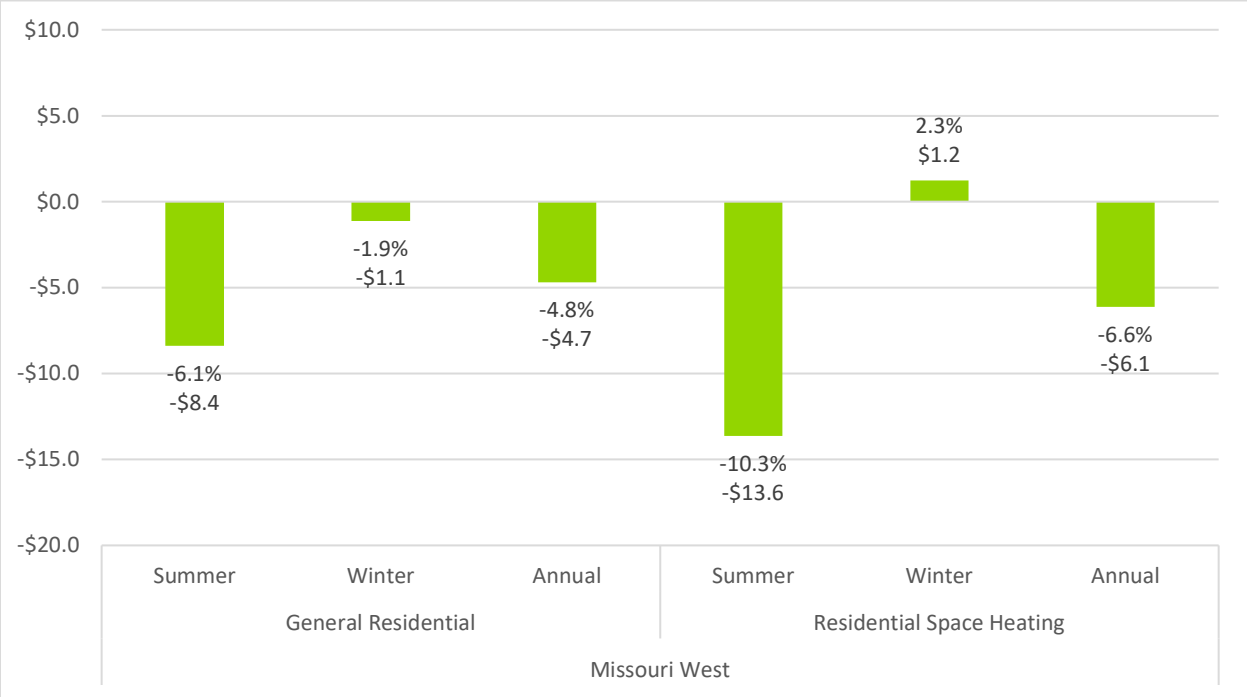
Given that the aggregate level of consumption in the winter is lower than the summer, the magnitude of the kWh impact is lower meaning less energy is shifted out of the on-peak period. For the average participant who was on the space heating rate prior to enrollment in the TOU rate, the behavioral changes are not enough to offset the higher-priced TOU rates and hence we see a bill increase during the winter months.

Figure 30. Total Monthly Bill Impacts of TOU Rates – Missouri Metro



Source: Guidehouse Analysis

Figure 31. Total Monthly Bill Impacts of TOU Rates – Missouri West



Source: Guidehouse Analysis

3.2.2 Composition of Bill Impacts

There are two key factors that determine the impact of TOU rates on a customer's bill:

1. **Rate Structure Impact**

This refers to changes in the rate structure, i.e. moving from a tiered rate that is based off total monthly consumption to a TOU rate that charges customers based on the hour of the day in which they consumed electricity. The tiered rate which a particular participant was on prior to enrolling in the TOU study will also determine the impact to their bill.

The rate structure impact focuses on what a customer's bill would have been under tiered rates but excludes any behavioral changes to determine whether the switch to a TOU rate structure on its own results in any bill savings or increases.

2. **Behavioral Impact**

This refers to the behavioral changes that the TOU rates induce, for example shifting consumption from the high priced on-peak period to the lower priced super off-peak period. The magnitude of changes in terms of kWh, see section 3.1, in each season will determine the impact on a customer's bill.

The total bill impacts presented in section 3.2.1 factor in both the rate structure and behavioral impacts. Figure 32 through Figure 35 present this breakdown of the rate structure and behavioral bill impacts for the Metro and West jurisdictions for both the general residential and residential space heating tier rates for the average participant.

During the summer, approximately half of the total bill savings are achieved due to the change in the rate structure in both jurisdictions for both the general residential and residential space heating rate. This is because the off-peak and super off-peak rates in the summer are lower than the tiered rates so even without any behavioral changes, customers save money during those periods.

During the winter months, the rate structure impact for the average participant on the general residential rate is practically negligible in both jurisdictions. However, for the average participant on the residential space heating rate, the structural impact accounts for the majority of the bill increase.

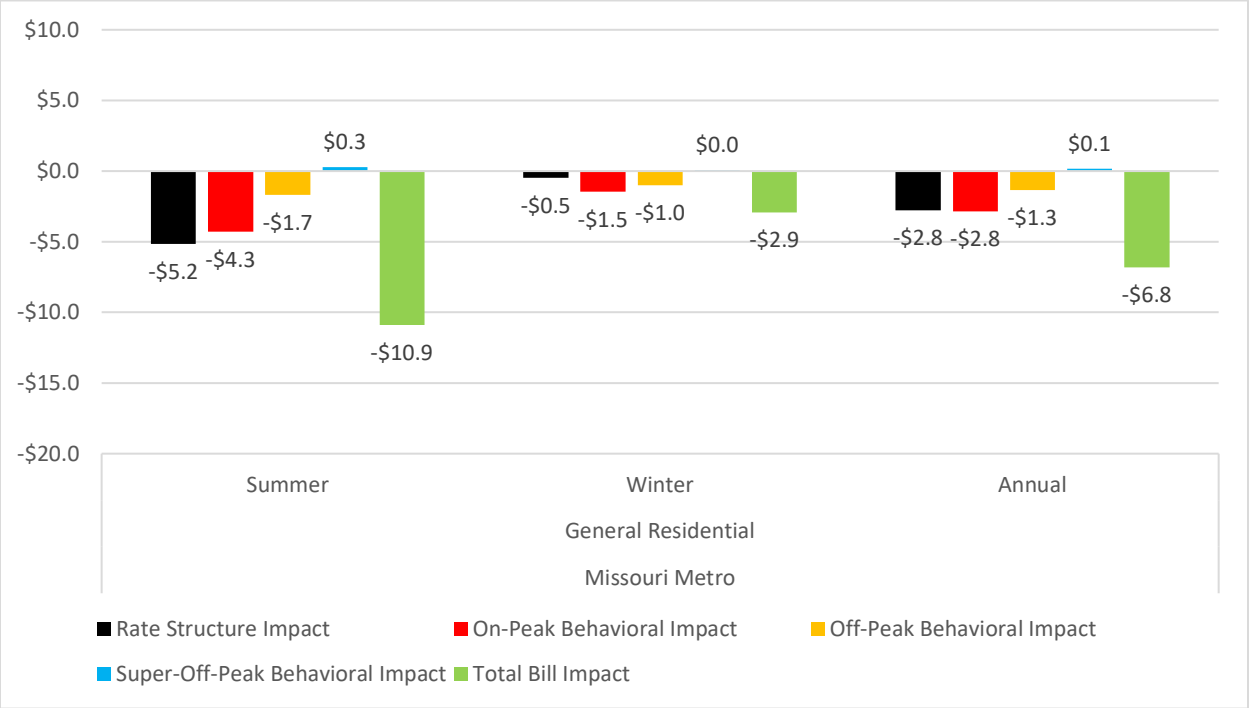
This is driven by the fact that the winter residential space heating rates are lower than the TOU on-peak and off-peak rates and the two periods together account for the majority of hours in a day / week. The higher the winter loads (that we assume are primarily driven by space heating) on the space heating rate, the higher the structural impact.

The remaining half of the bill impacts are due to behavioral impacts. We see that the on-peak periods account for the majority of the kWh impacts, which is consistent with their impacts being the highest as seen in section 3.1. We do see some savings in the off-peak period and a slight increase during the super off-peak period, which is consistent with smaller savings impacts during the off-peak period and a small increase in consumption during the super off-peak period.

In summary, the summer bills experience a notable reduction as both the structural impacts and behavioral impacts result in savings. The average TOU participant previously on the general residential rate sees modest bill savings during the winter driven mainly by behavioral changes. However, the average TOU participant previously on the residential space heating rate sees an increase on their winter bills that are driven primarily by structural changes which are high enough to offset any savings from the behavioral changes.

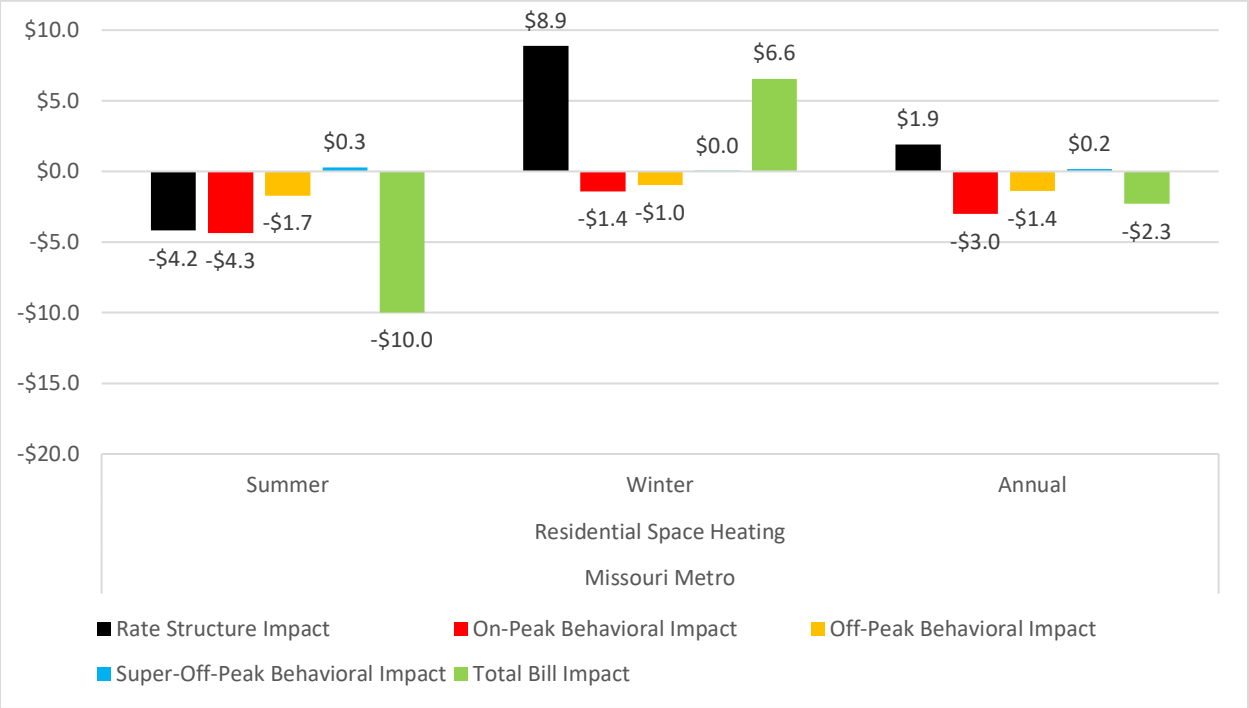
Hence, the average general residential customer has the potential to experience greater bill savings as compared to the average residential space heating customer especially if they have high space heating loads that are relatively inflexible. On an annual basis, the average participant in both jurisdictions, regardless of the tiered rate they were on prior to enrolling in the TOU rate, experience a decrease in their average monthly bill that is driven primarily by the summer savings.

Figure 32. Composition of Bill Impacts – Missouri Metro – General Residential



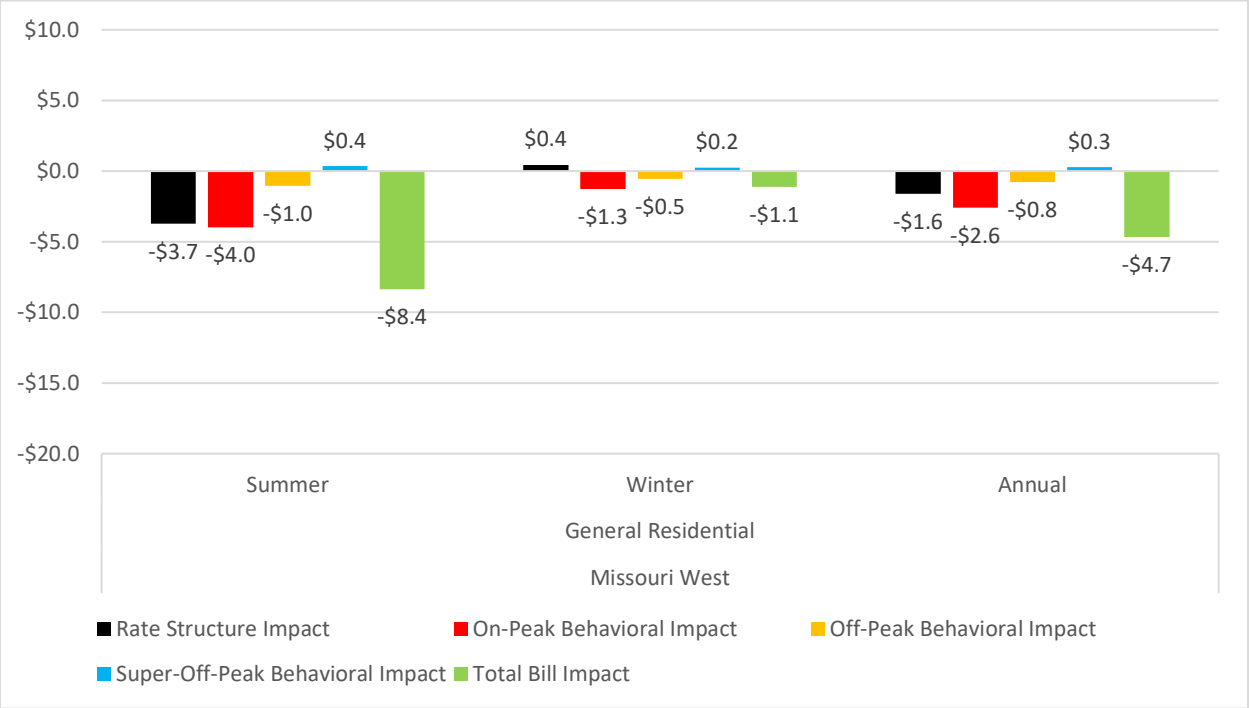
Source: Guidehouse Analysis

Figure 33. Composition of Bill Impacts – Missouri Metro – Residential Space Heating



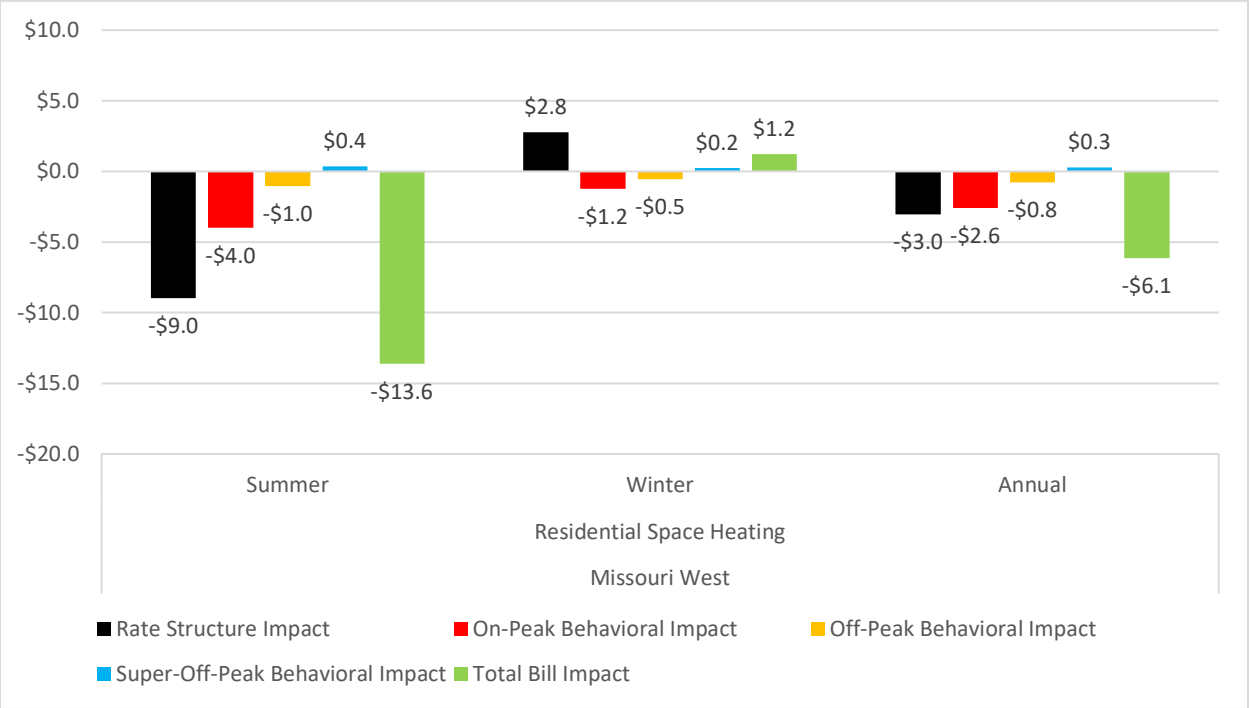
Source: Guidehouse Analysis

Figure 34. Composition of Bill Impacts – Missouri West – General Residential



Source: Guidehouse Analysis

Figure 35. Composition of Bill Impacts – Missouri West – Residential Space Heating



Source: Guidehouse Analysis

4. Conclusion

TOU rates were studied in two jurisdictions within Evergy's service territory in the state of Missouri, Metro and West jurisdictions, using an opt-in quasi-experimental design with matched controls. Each jurisdiction has its own TOU rates. Only residential customers who were on the general residential or the residential space heating rate were eligible to opt-into the TOU rate.

The interim analysis includes all participants enrolled between October 1, 2019 and September 30, 2020. The total enrollments for the interim analysis are 2,261 customers and 2,744 customers for the Missouri Metro and West jurisdictions, respectively. The overall sample sizes are relatively small, and it remains to be seen how the impacts change as more customers enroll over the course of the second year.

The interim results indicate that participants in both jurisdictions did respond to the TOU prices by changing their consumption patterns. The impacts in both seasons are similar across the two jurisdictions with almost all of the impacts being statistically significant at the ninety percent confidence level.

The overall magnitude of the summer impacts, i.e. the kWh impacts, are greater than the winter impacts but the difference in the percent impact between the two seasons is closer. This is driven by the fact that the summer consumption levels are higher than the winter and winter space heating loads tend to be less flexible as compared to the summer space cooling loads.

There are some impacts during the off-peak period though they are much smaller than the on-peak period which is to be expected given that the off-peak price is much lower than the on-peak price, while we see an increase in consumption during the super off-peak periods, which is to be expected since this is the lowest priced TOU period.

In the summer, the monthly system coincident peak demand occurs during the on-peak period and hence impacts are very similar to those of the on-peak period impacts. In the winter, the monthly system coincident peak demand can occur in the morning during the off-peak periods and hence the winter system coincident peak demand impacts are slightly lower than those of the on-peak period impacts.

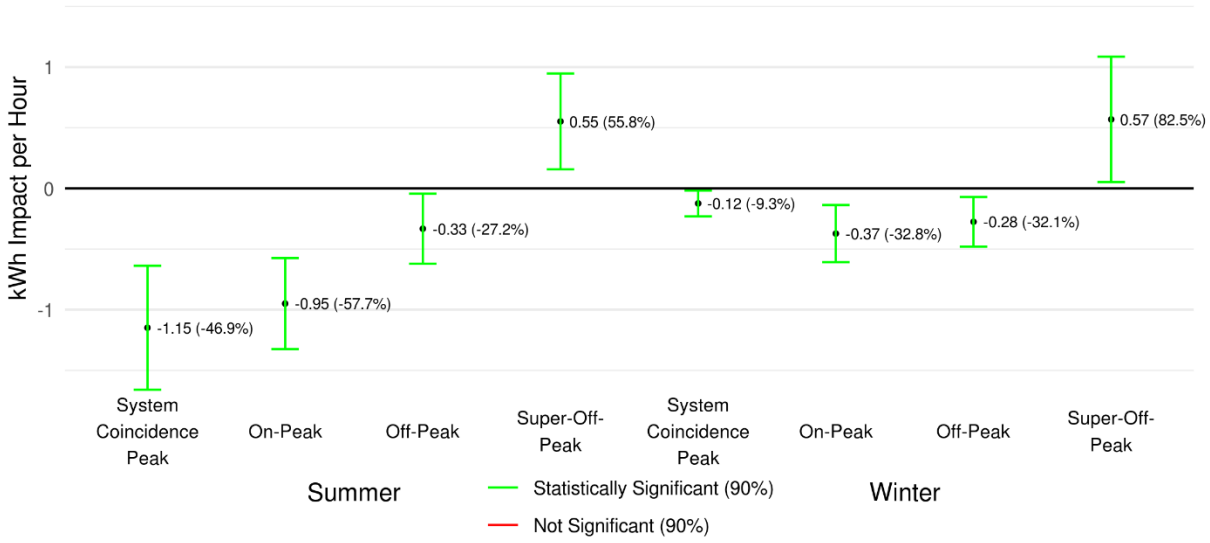
We see a similar pattern with the bill impacts wherein the summer bill savings are higher than the winter. However, approximately half or more of the summer bill savings are driven by rate structure changes and the other half by behavioral changes made by customers due to the TOU rate. The average TOU participant previously on the residential space heating rate sees an increase on their winter bills that are driven by structural changes as the behavioral changes are not enough to offset this increase.

Appendix A. TOU Rate Impacts by Segment

This appendix presents the impacts by each customer segment along with their study period load shapes. The explanations provided in section 3.1 are applicable. Some segments such as low income and most notably electric vehicles have small sample sizes and hence they have wider confidence bands meaning that the results should be interpreted with caution.

A.1 Electric Vehicles

Figure 36. Electric Vehicle TOU Rate Impacts – Missouri Metro

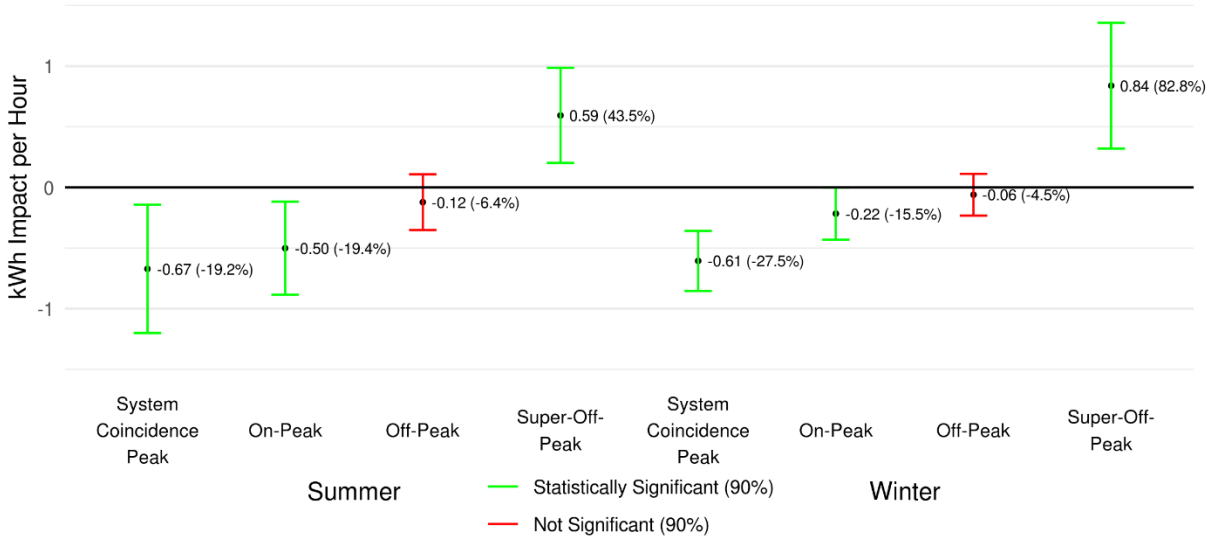


Source: Guidehouse Analysis

Figure 37. Electric Vehicle Post Period Load Shapes – Missouri Metro

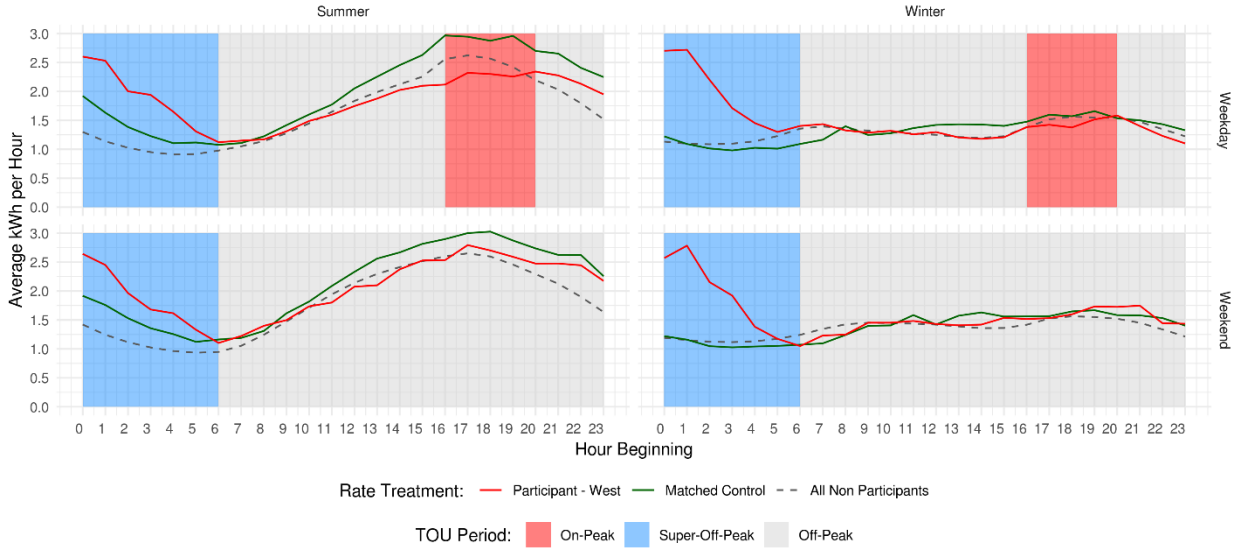
Source: Guidehouse Analysis

Figure 38. Electric Vehicle TOU Rate Impacts – Missouri West



Source: Guidehouse Analysis

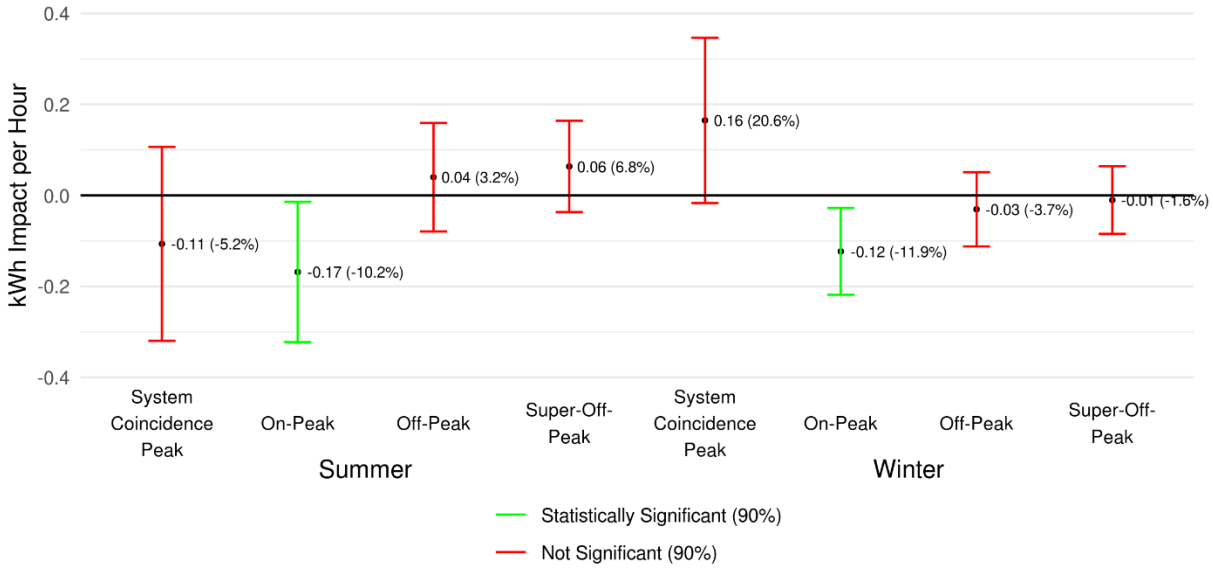
Figure 39. Electric Vehicle Post Period Load Shapes – Missouri West



Source: Guidehouse Analysis

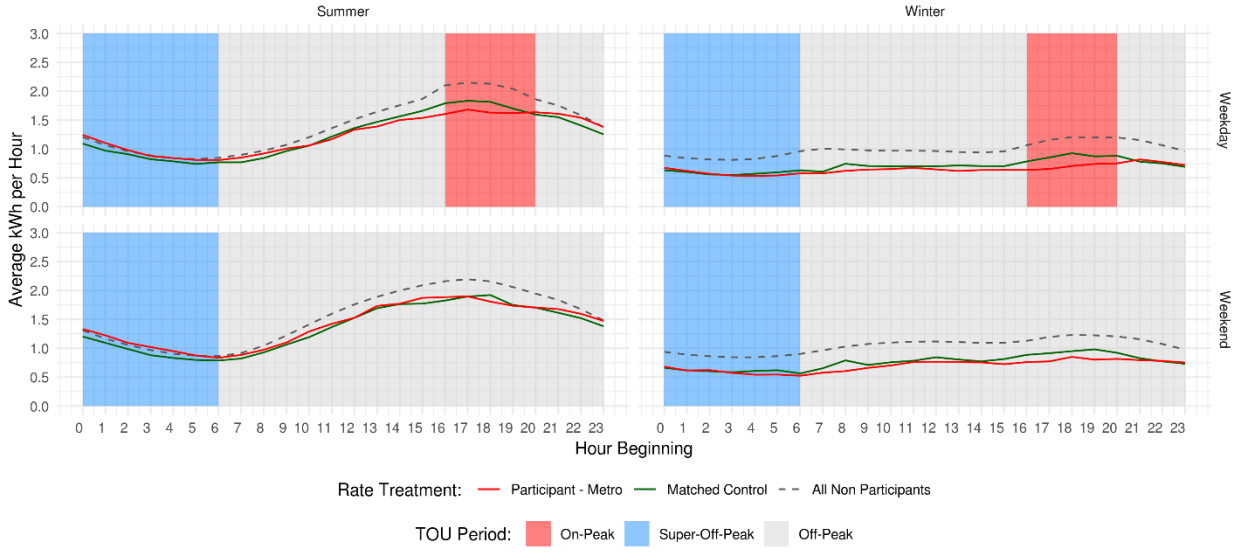
A.2 Low Income

Figure 40. Low Income TOU Rate Impacts – Missouri Metro



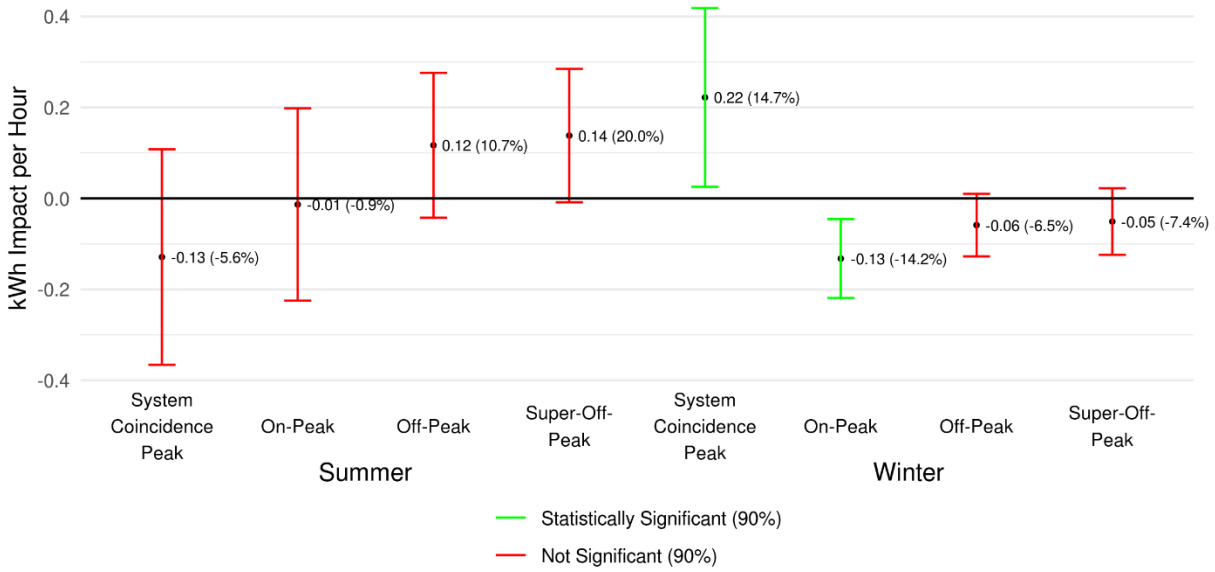
Source: Guidehouse Analysis

Figure 41. Low Income Post Period Load Shapes – Missouri Metro



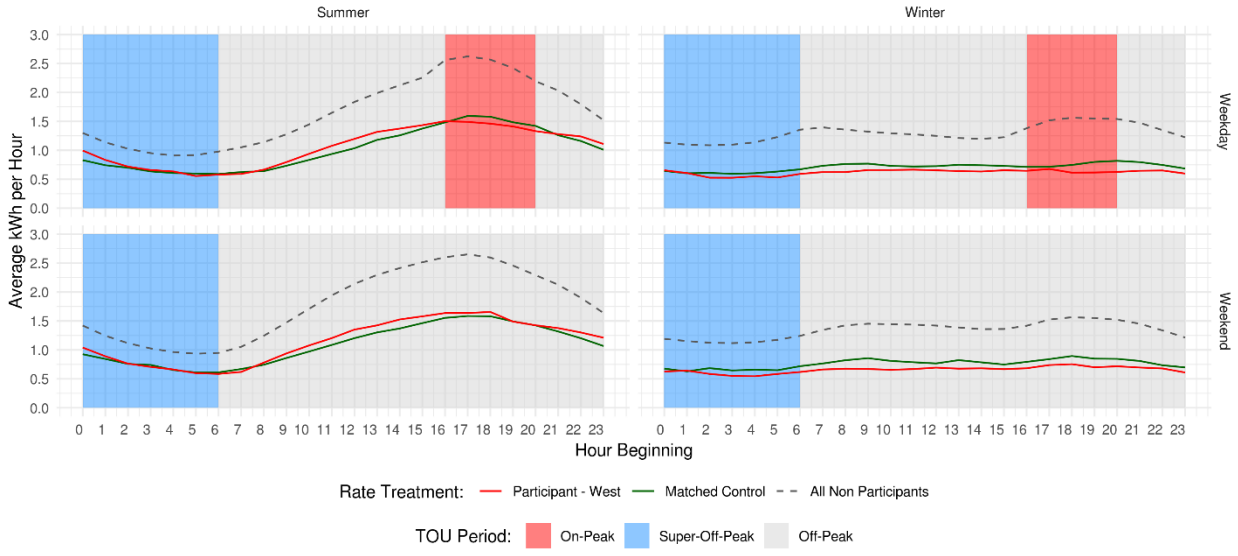
Source: Guidehouse Analysis

Figure 42. Low Income TOU Rate Impacts – Missouri West



Source: Guidehouse Analysis

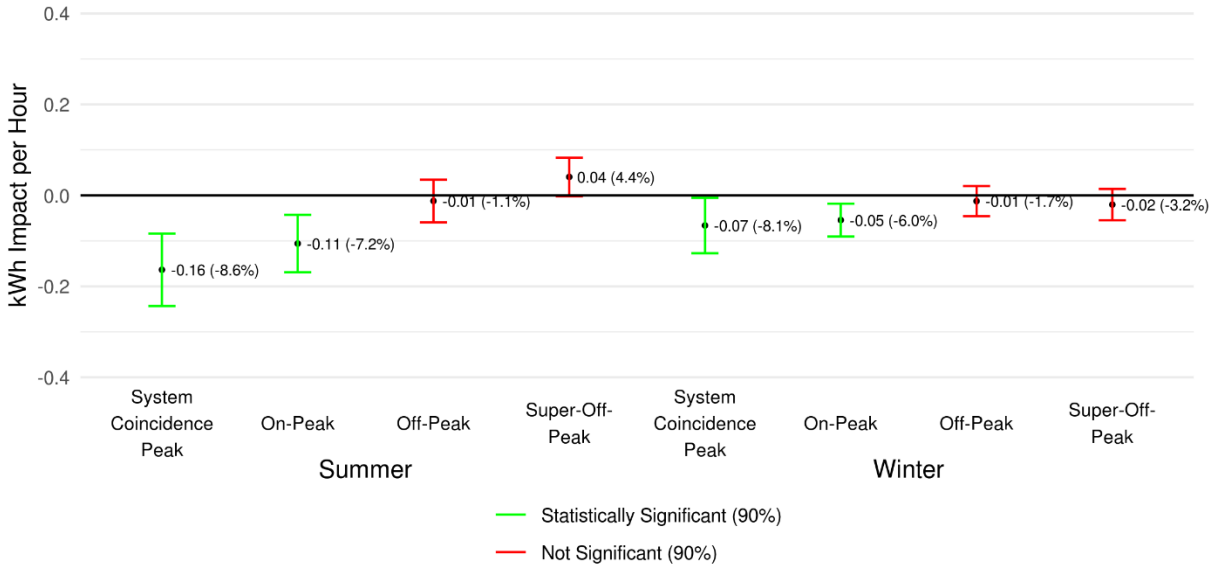
Figure 43. Low Income Post Period Load Shapes – Missouri West



Source: Guidehouse Analysis

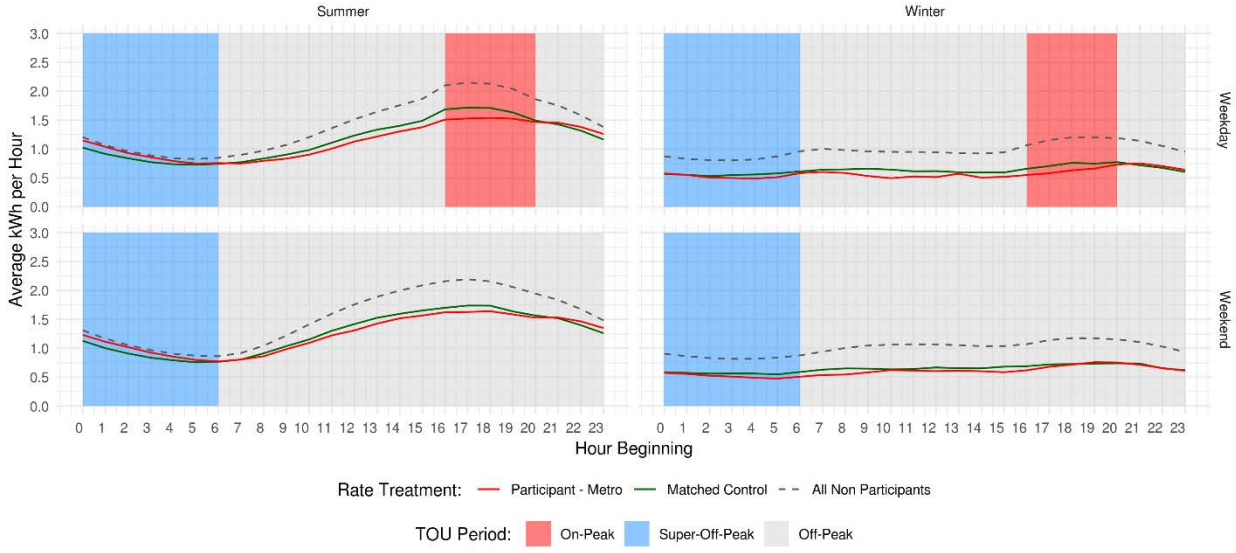
A.3 Renters

Figure 44. Renters TOU Rate Impacts – Missouri Metro



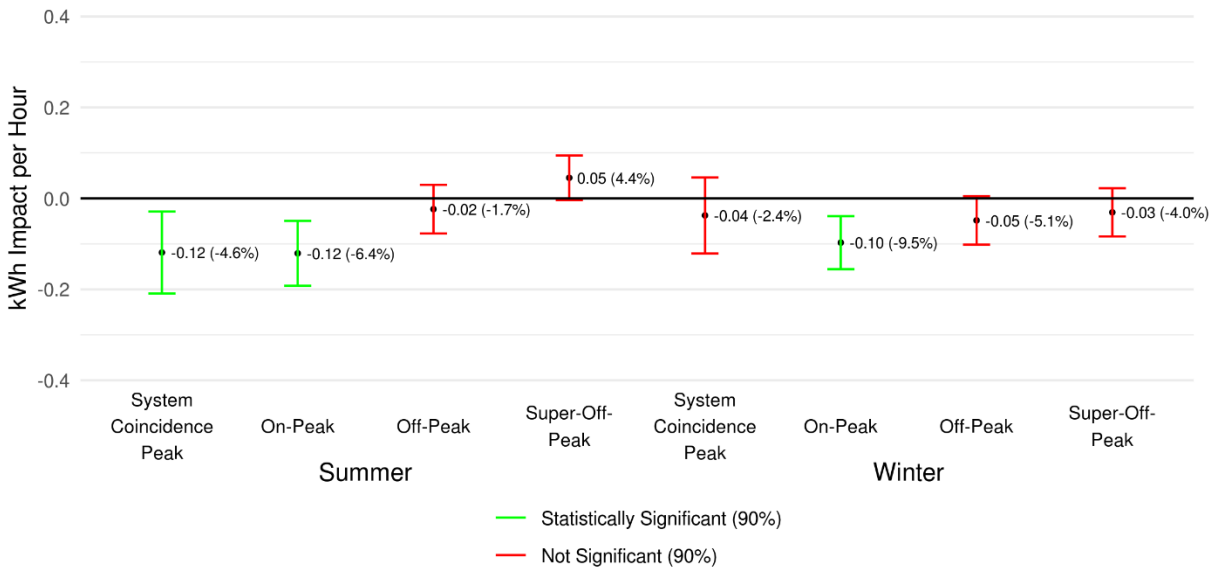
Source: Guidehouse Analysis

Figure 45. Renters Post Period Load Shapes – Missouri Metro



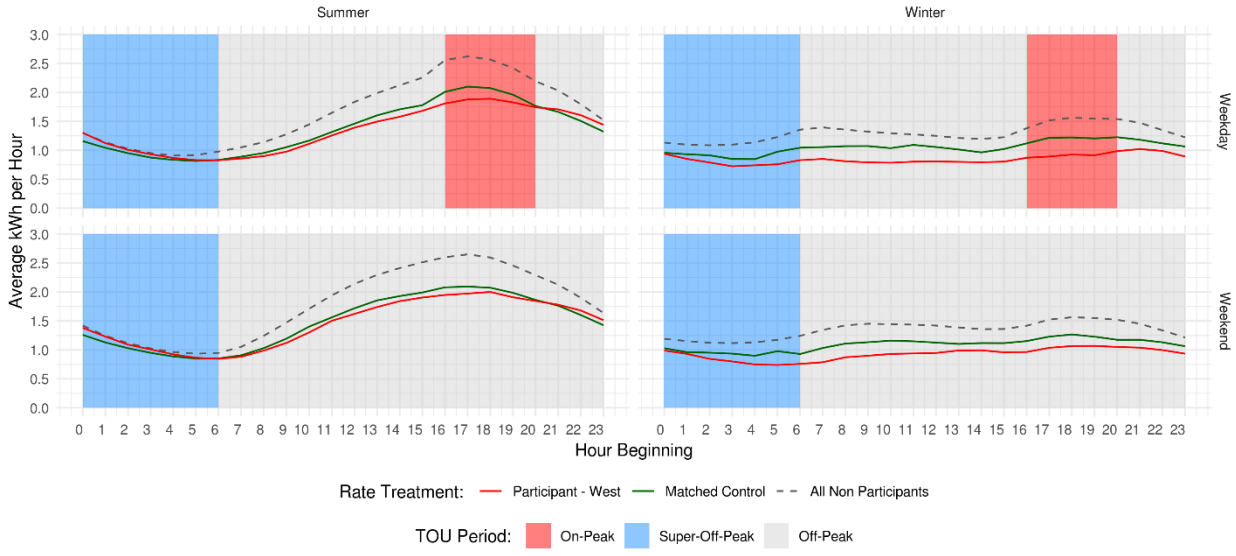
Source: Guidehouse Analysis

Figure 46. Renters TOU Rate Impacts – Missouri West



Source: Guidehouse Analysis

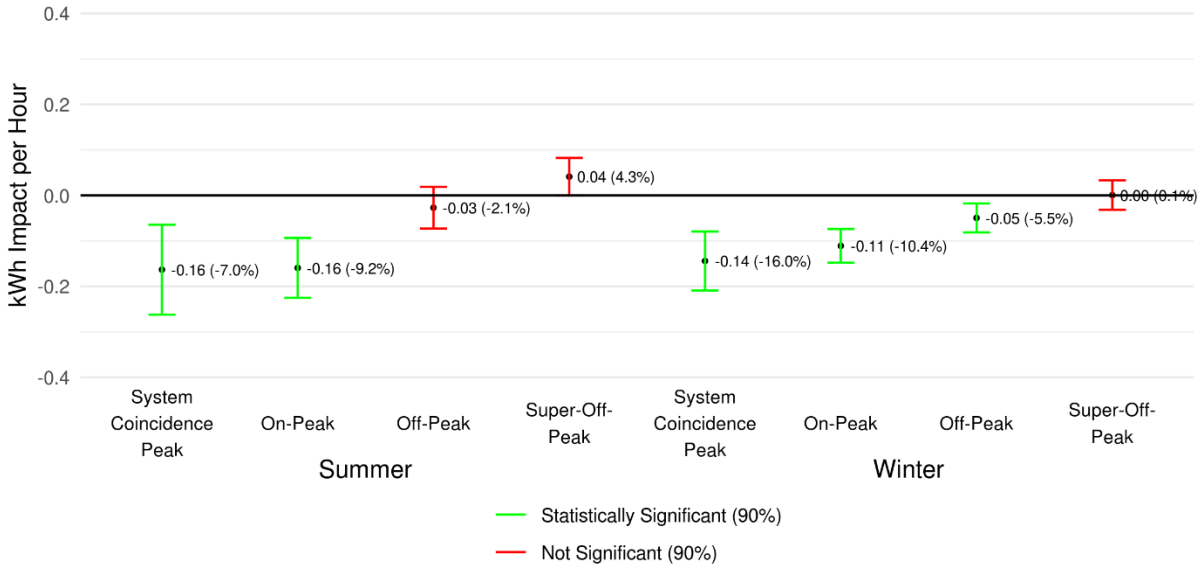
Figure 47. Renters Post Period Load Shapes – Missouri West



Source: Guidehouse Analysis

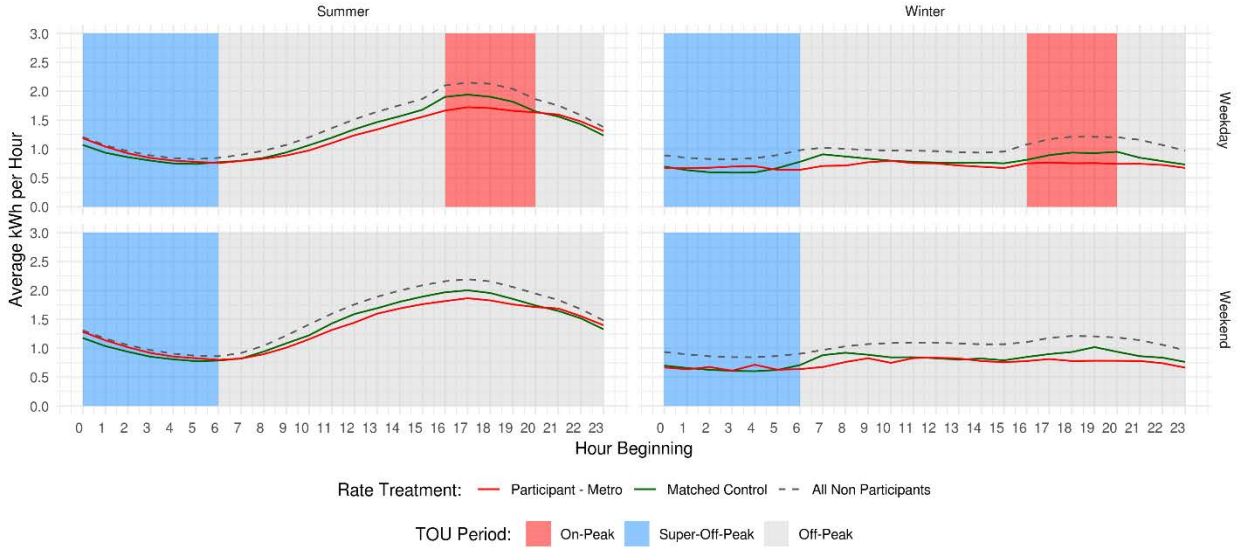
A.4 Seniors

Figure 48. Seniors TOU Rate Impacts – Missouri Metro



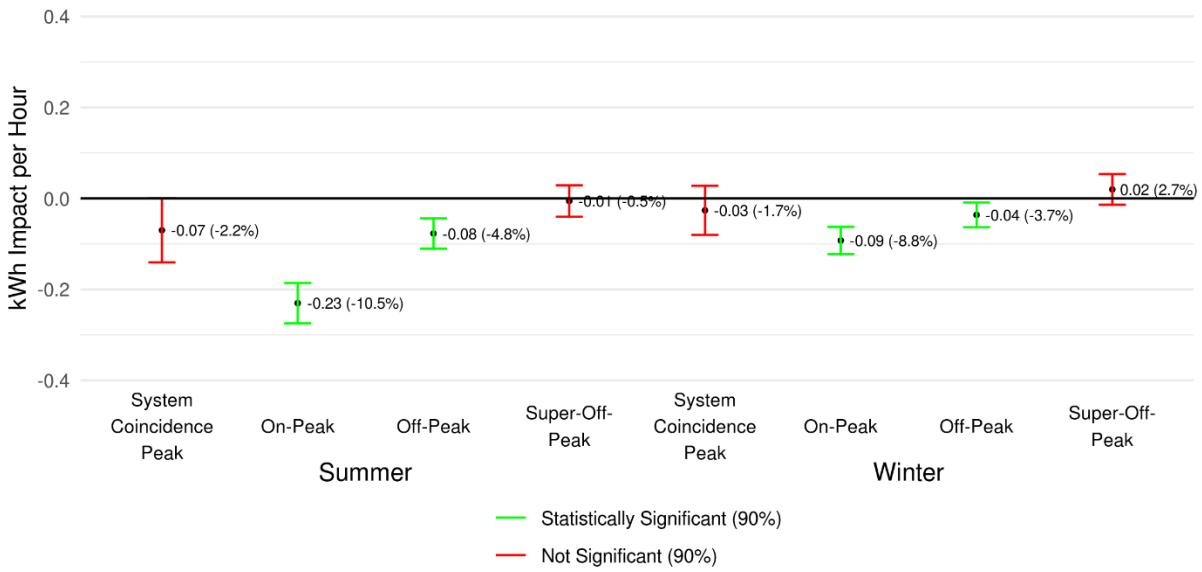
Source: Guidehouse Analysis

Figure 49. Seniors Post Period Load Shapes – Missouri Metro



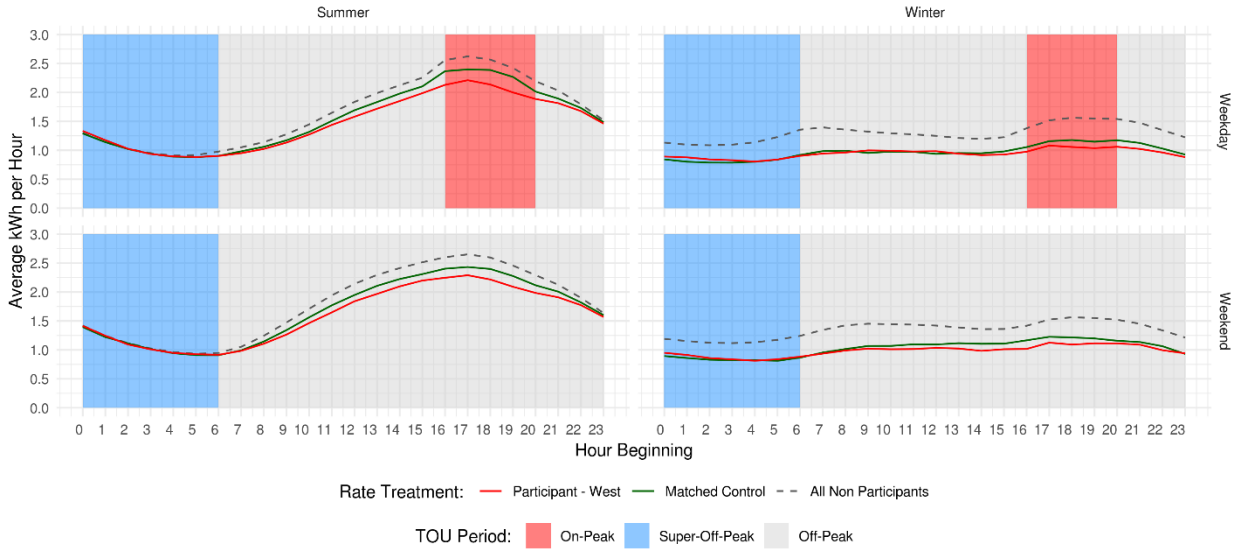
Source: Guidehouse Analysis

Figure 50. Seniors TOU Rate Impacts – Missouri West



Source: Guidehouse Analysis

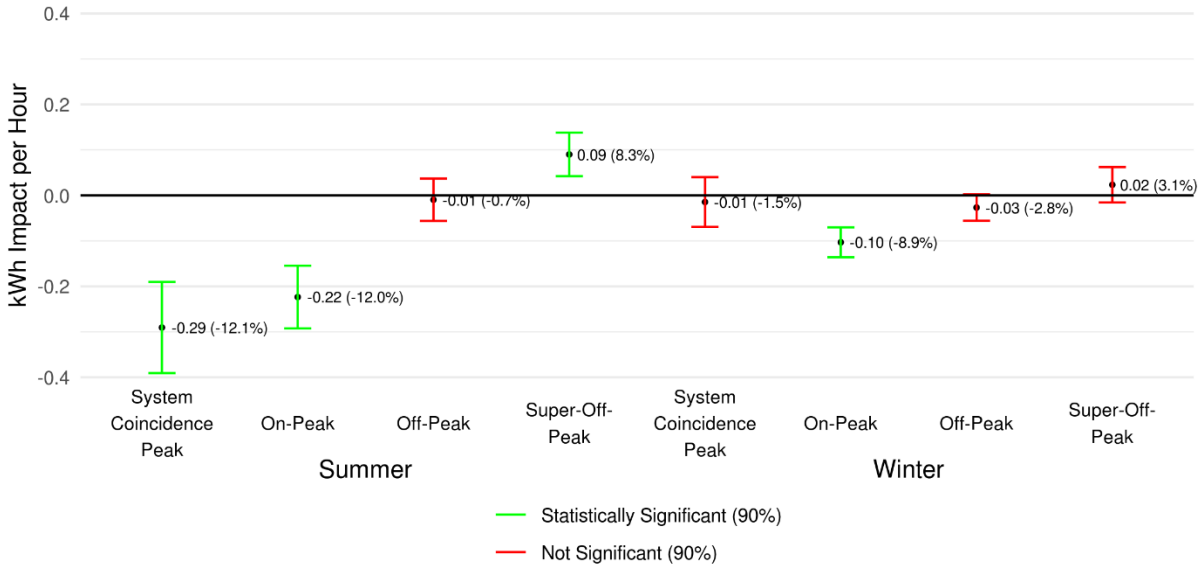
Figure 51. Seniors Post Period Load Shapes – Missouri West



Source: Guidehouse Analysis

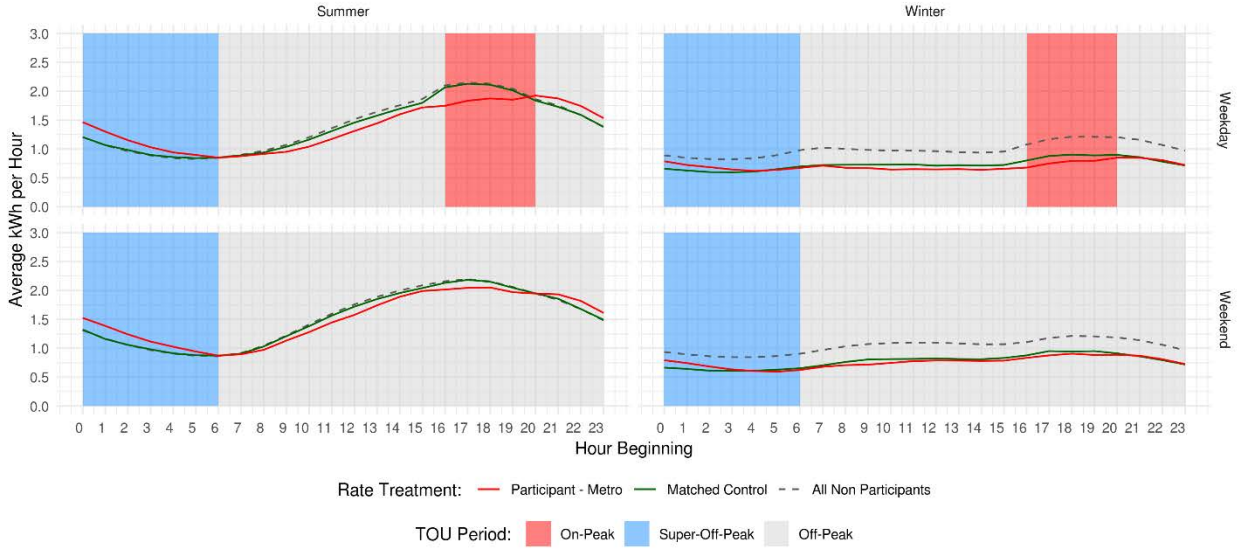
A.5 Smart Thermostats

Figure 52. Smart Thermostats TOU Rate Impacts – Missouri Metro



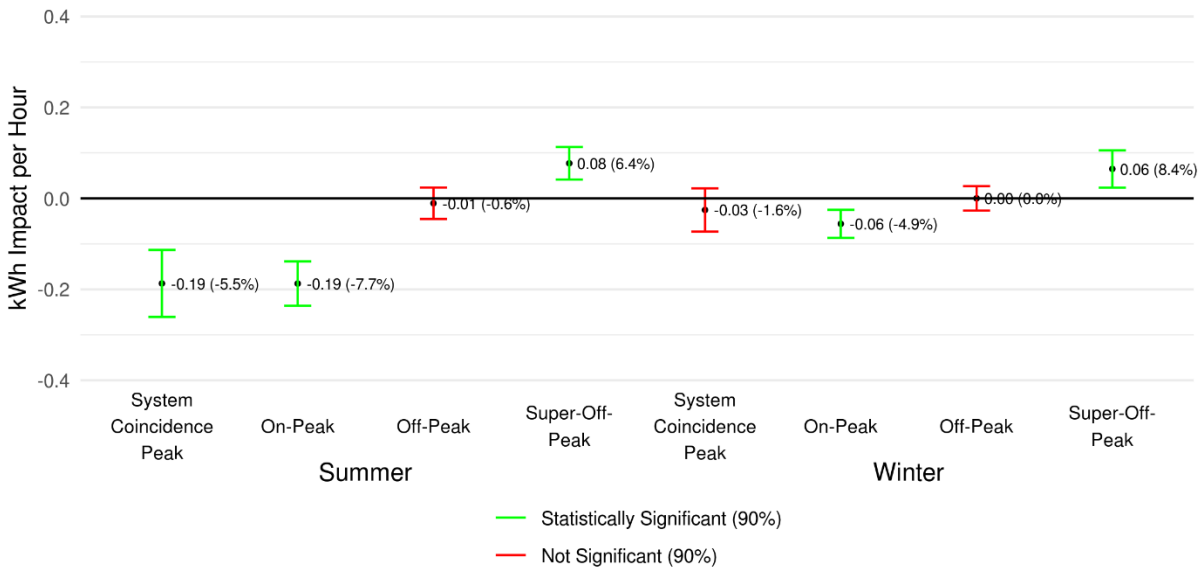
Source: Guidehouse Analysis

Figure 53. Smart Thermostats Post Period Load Shapes – Missouri Metro



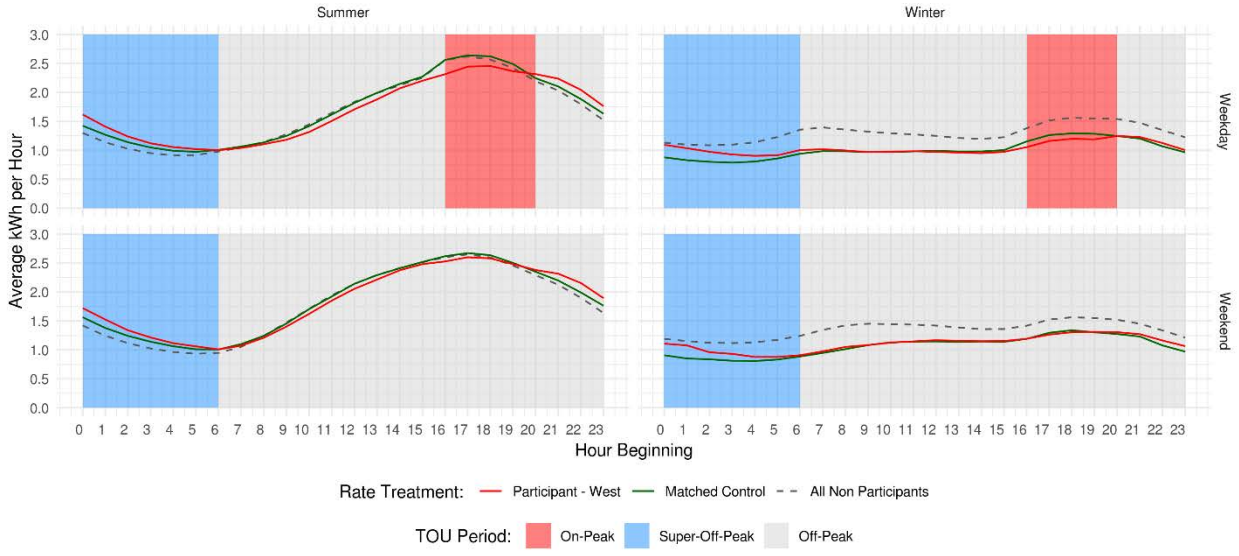
Source: Guidehouse Analysis

Figure 54. Smart Thermostats TOU Rate Impacts – Missouri West



Source: Guidehouse Analysis

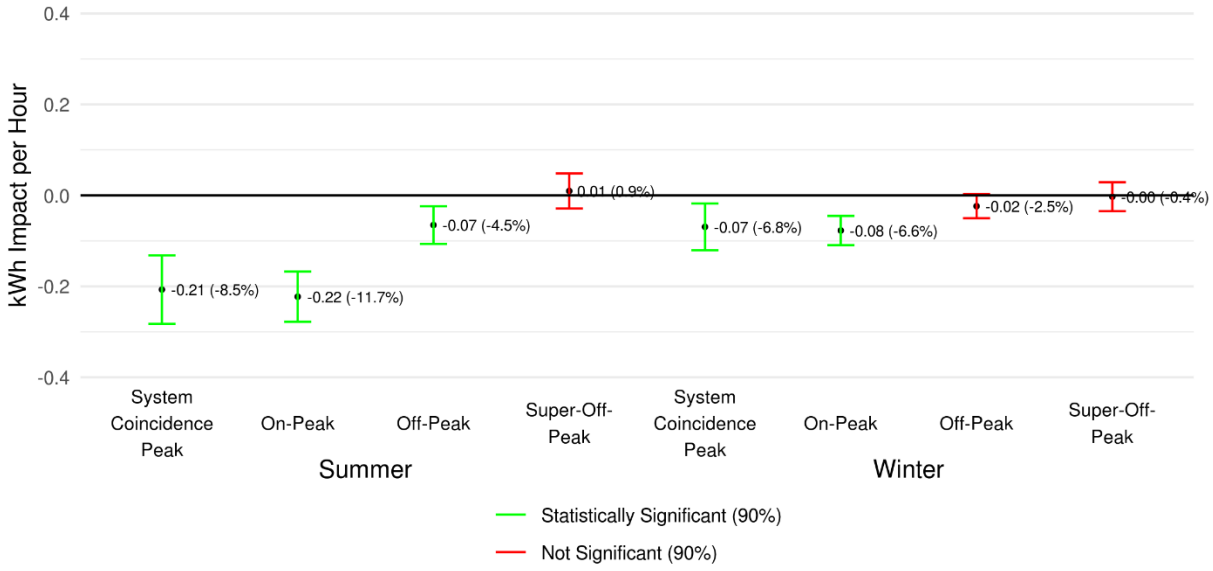
Figure 55. Smart Thermostats Post Period Load Shapes – Missouri West



Source: Guidehouse Analysis

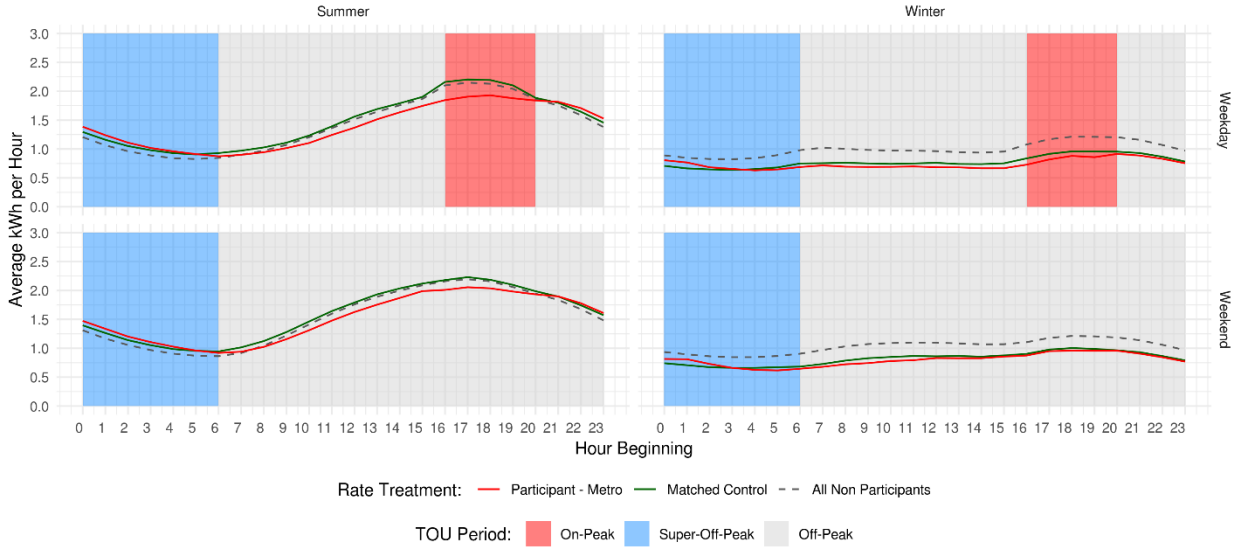
A.6 General Population

Figure 56. General Population TOU Rate Impacts – Missouri Metro



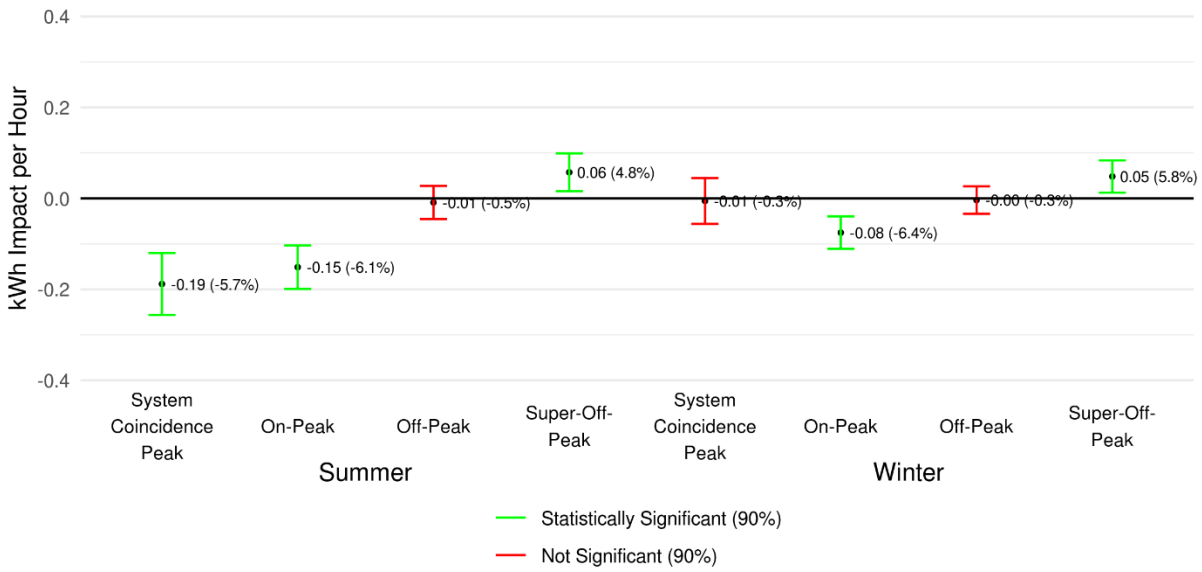
Source: Guidehouse Analysis

Figure 57. General Population Post Period Load Shapes – Missouri Metro



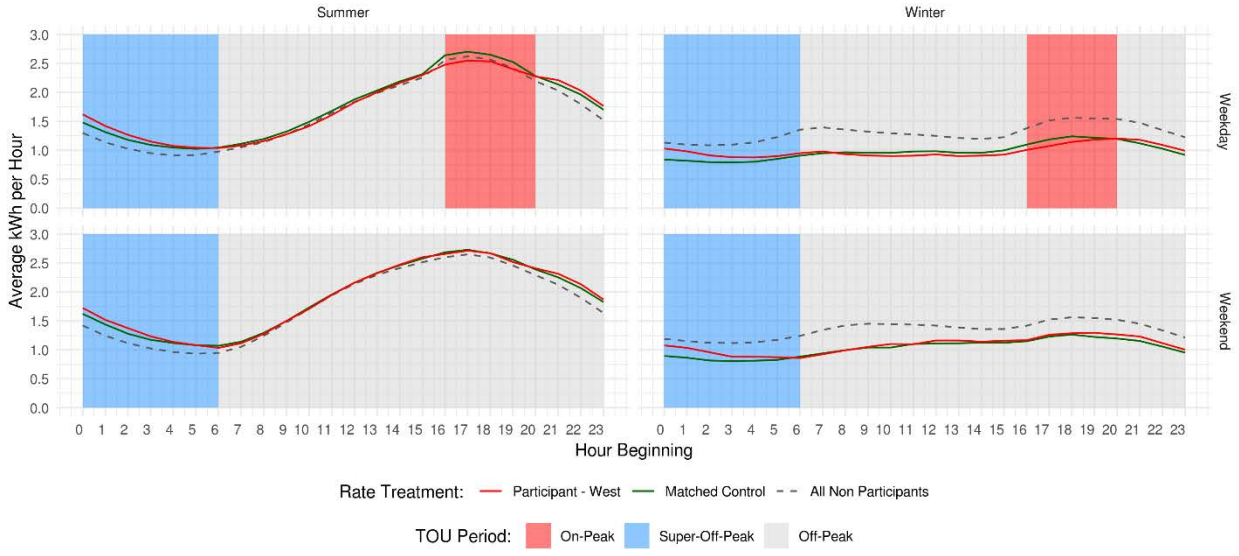
Source: Guidehouse Analysis

Figure 58. General Population TOU Rate Impacts – Missouri West



Source: Guidehouse Analysis

Figure 59. General Population Post Period Load Shapes – Missouri West



Source: Guidehouse Analysis