NAVIGANT
A Guidehouse Company

Residential Energy Time-of-Use (RE-TOU) Trial
Evaluation Report 2

Findings from October 2018 to July 2019

Prepared for:

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DISCLAIMER

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[1] On October 11, 2019, Guidehouse LLP completed its previously announced acquisition of Navigant Consulting Inc. In the months ahead, we will be working to integrate the Guidehouse and Navigant businesses. In furtherance of that effort, we recently renamed Navigant Consulting Inc. as Guidehouse Inc.

EXECUTIVE SUMMARY

Public Service Company of Colorado (Public Service) and the other Parties to the 2016 Settlement in Proceeding No. 16AL-0048E (Settlement) agreed to test two new voluntary residential time-varying rate schedules in Colorado:

1. Residential Energy Time-Of-Use Service Schedule (RE-TOU or TOU)
2. Residential Demand – Time Differentiated Rates Service Schedule (RD-TDR or TDR)

The intent of the Settlement is to provide an opportunity for: (1) adequate educational materials to be prepared; (2) testing the impact of the trial's RE-TOU rate differentials and pricing time periods; and (3) testing the trial's schedule RE-TOU rate with existing and new demand side management or energy efficiency tools. The Settlement Agreement approved the two rates (the TOU trial and the TDR pilot) for customers who volunteer to enroll and receive a bridge meter that allows for measurement and billing of customers' monthly electric usage on a 15-minute basis. Voluntary participants have the right to withdraw (or opt out) from the rate through the end of their sixth billing cycle. Per the Settlement, Public Service is expected to file an Advice Letter on December 2, 2019, which will include results from the RE-TOU trial. As specified in the Settlement, the Advice Letter is intended to inform whether the RE-TOU rate requires modification prior to implementing the final time-varied rate for all residential customers, whether the rate is working well as originally implemented, or whether it should be discontinued.

This Evaluation Report addresses Navigant's evaluation of the energy, system coincident peak demand, bill impacts, and customer experience from participation in the RE-TOU trial from October 2018 through July 2019.[2]

Key Takeaways. For customers within the sample, the evaluation identified significant reductions in peak-period consumption across most customer segments, with EV owners and customers with solar PV most able to reduce on-peak usage and reduce electric bills. *Summer and winter peak-period reductions for non-solar participants without EVs were 3.2% and 3.1%, respectively*. On an annual basis, consumption for non-solar participants without EVs increased by 0.6%.

Non-solar participants without EVs on the RE-TOU rate reduced summer on-peak consumption by close to 3%; annual consumption for these customers increased by 0.6%.

The customer research findings indicate that near the end of the trial, participants in the TOU rate plan tend to feel satisfied and comfortable with the rate plan and are likely to recommend it to friends and family. Specific customer research findings include:

- Most customers report that their bills are in line with or lower than expected (68%) and that they have more control over their bill (69%).
- A predominant majority of TOU rate plan participants are engaged in taking actions to shift their energy use away from the peak period, with only 7% of customers reporting they have not taken any actions. However, customer engagement in the most impactful behaviors—in particular,

[2] Navigant prepared Evaluation Report 1 to cover participation from June 2017 through September 2018. Navigant will prepare a final evaluation report in 2020 that covers participation from June 2017 through December 2019.

raising thermostat setpoints in summer— remains relatively low: only 26% of customers are turning off their AC during peak periods and 12% are changing their thermostat settings.

- Customers indicate that email notifications and the Public Service customer MyAccount website are the most popular informational resources provided by Public Service to educate customers about the rate plan.

Rate Structure. Table 1 presents the rate structure for RE-TOU, including the pricing periods, applicable prices during each period, and fixed charges. The prices under this plan are based on three periods and are referred to as off-peak, shoulder, and on-peak. The prices vary between summer and winter seasons,[3] but the hours for each period remain the same all year.

Table 1. RE-TOU Rate Structure[4]

RE-TOU	Off-Peak	Shoulder	On-Peak	Service and Facility Charge
Hours	9 p.m.-9 a.m.	9 a.m.-2 p.m., 6 p.m.-9 p.m. on Weekdays, 9 a.m.-9 p.m. Weekends	2 p.m.-6 p.m. on Weekdays	
Summer	$0.08/kWh	$0.13/kWh	$0.18/kWh	$5.41
Winter	$0.08/kWh	$0.10/kWh	$0.14/kWh	$5.41

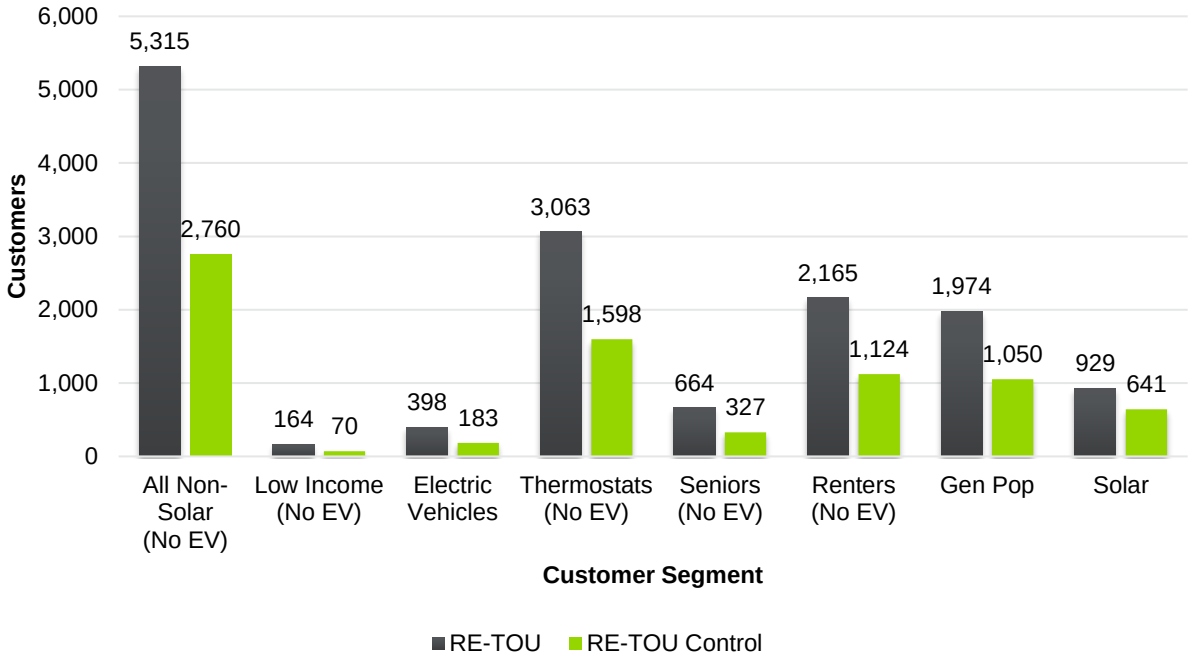
Enrollment Summary. Recruitment for the RE-TOU trial began in March 2017. Public Service implemented a variety of marketing tactics to increase awareness and enrollments in the trial rate, resulting in nearly 12,000 enrolled customers—including the one-third who were randomly assigned to be in a control group. There was a total of 7,927 participants over the course of the trial and 6,642 participants that were in the trial at any point during the evaluation year[5]. Figure 1 shows the number of participants and control group customers by customer segment for the evaluation reporting period including overlap.

[3] Costs are rounded and included appropriate adjustments. The summer season includes June, July, August, and September. The winter season includes January, February, March, April, May, October, November, and December.

[4] Rates include riders (that are periodically updated) and are rounded to the nearest cent.

[5] Evaluation year is October 1, 2018 through July 31, 2019.

Figure 1. RE-TOU Enrollment – Including Overlap (Evaluation Year Participants)



Impact Findings

The evaluation team estimated changes in the energy consumption of customers on the RE-TOU rate through a series of regression models, the findings from which were subsequently combined with the TOU rate structure to estimate bill impacts. Navigant's evaluation team performed the impact analysis across all customer segments and estimated the impacts both in aggregate (for all non-solar customers without EVs) and broken out by customer segment (including the solar and EV customer segments).

Table 2 summarizes the impact analysis findings for participant **non-solar customers without EVs**, who in aggregate produced significant reductions in consumption during the on-peak hours (3.2% reductions in summer months and 3.1% in winter months). Changes in annual energy consumption were minimal with a 0.6% increase. For the average non-solar participant without an EV, these impacts in combination with the RE-TOU rate structure yield an increase in summer bills and a decrease in winter bills, which net out to a 2.2% increase in the average annual cost of electricity.

Table 2. Impact Analysis Key Findings for Non-Solar Customers without EVs[6]

Season	Average System Coincident Peak Hour Impact		Average Hourly On-Peak Consumption Impact		Average Monthly Consumption Impact		Average Monthly Bill Impact	
Summer Months	-0.05 kWh	-3.0%	-0.04 kWh	-3.2%	8.3 kWh	1.2%	$3.67	4.4%
Winter Months	0.004 kWh	0.2%	-0.02 kWh	-3.1%	1.6 kWh	0.3%	-$1.08	-1.8%
October 2018 to July 2019	N/A				3.8 kWh *45.8 kWh annually*	0.6%	$1.51 *$18.07 annually*	2.2%

The ability of most home charging equipment to schedule vehicle charging enables **customers with EVs** to shift a large load and respond to the rate in a manner that is different than for other customers. Table 3 summarizes the impact analysis findings for non-solar customers with EVs, who in aggregate produced significant reductions in consumption during the on-peak hours (13.3% on-peak reductions in summer months and 19.5% in winter months). Energy consumption increased slightly (0.5%) during the summer and decreased during the winter (-2.2%) leading to an annual decrease in consumption of -1.2%. For the average non-solar participant with an EV, these impacts yield a decrease in both summer and winter bills, yielding a 7.3% decrease in the average annual cost of electricity.

Table 3. Impact Analysis Key Findings for Non-Solar Customers with Electric Vehicles

Season	Average System Coincident Peak Hour Impact		Average Hourly On-Peak Consumption Impact		Average Monthly Consumption Impact		Average Monthly Bill Impact	
Summer Months	-0.23 kWh	-12.0%	-0.22 kWh	-13.3%	5.3 kWh	0.5%	-$10.49	-7.4%
Winter Months	-0.34 kWh	-18.2%	-0.23 kWh	-19.5%	-21.4 kWh	-2.2%	-$7.26	-7.1%
October 2018 to July 2019	n/a				-12.5 kWh *-149.7 kWh annually*	-1.2%	-$8.34 *-$100.09 annually*	-7.3%

Within the trial, the financial motivations and characteristics[7] of **customers with solar**—and the resulting changes in consumption from the RE-TOU rate—are different than for customers without solar. Consequently, the analysis of their impacts has been separated from non-solar customers and are as shown in Table 4. Customers with solar achieve nearly a 30% reduction in summer on-peak consumption and a 13% reduction in annual electric bills compared to a matched control group.

[6] These average calculations are based on point estimates of the energy impacts by TOU rate period. The shoulder period point estimate is not statistically different from zero.

[7] Sampled customers with solar generally live in larger homes (66% in homes greater than 2,000 square feet) with large electric loads that can be shifted (23% own electric vehicles and 87% have smart thermostats connected to central air conditioning). This provides a greater opportunity to shift consumption than the average non-solar customer that live in relatively smaller homes (27% in homes greater than 2,000 square feet) and have smaller loads that can be shifted (5% own electric vehicles and 59% have smart thermostats connected to central air conditioning).

Table 4. Impact Analysis Key Findings for Solar Customers

Season	Average System Coincident Peak Hour Impact		Average Hourly On-Peak Consumption Impact		Average Monthly Consumption Impact (Gross Consumption)		Average Monthly Bill Impact (Net Consumption)	
Summer Months	-0.61 kWh	-38.4%	-0.36 kWh	-29.9%	-41.3 kWh	-5.7%	-$14.19	-45.5%
Winter Months	-0.10 kWh	-5.0%	-0.09 kWh	-15.1%	74.8 kWh	13.5%	-$7.52	1.7%
October 2018 to July 2019	N/A				36.1 kWh *433.0 kWh annually*	5.9%	-$10.77 *-$129.28 annually*	-13.0%

On-peak Impacts. Reductions in energy consumption from the on-peak period of the RE-TOU rate hold the greatest potential value to participants and customers alike, and higher on-peak prices relative to the R rate provides the greatest financial incentive for participants to reduce their usage. Key observations from the peak period impact analysis are as follows (see Figure 2 and Figure 3):

- Excluding renters, each segment has relatively consistent impacts to their on-peak consumption across both seasons.
- Reductions in average on-peak consumption are less in the winter than in the summer. This is likely due to participants reducing on-peak air conditioning loads during the summer and having less overall electricity use to manage in the winter.
- Electric vehicle customers reduce on-peak consumption by more than twice that of any other segment. Most likely due to shifting vehicle charging away from on-peak hours.
- Low income customers have the smallest impact estimates during the summer and are the only segment without a statistically significant reduction in on-peak consumption during either season. This may be due to low income customers being held harmless from bill increases and were not motivated by the possibility of paying a higher bill.

Figure 2. Summer On-Peak Consumption Impact

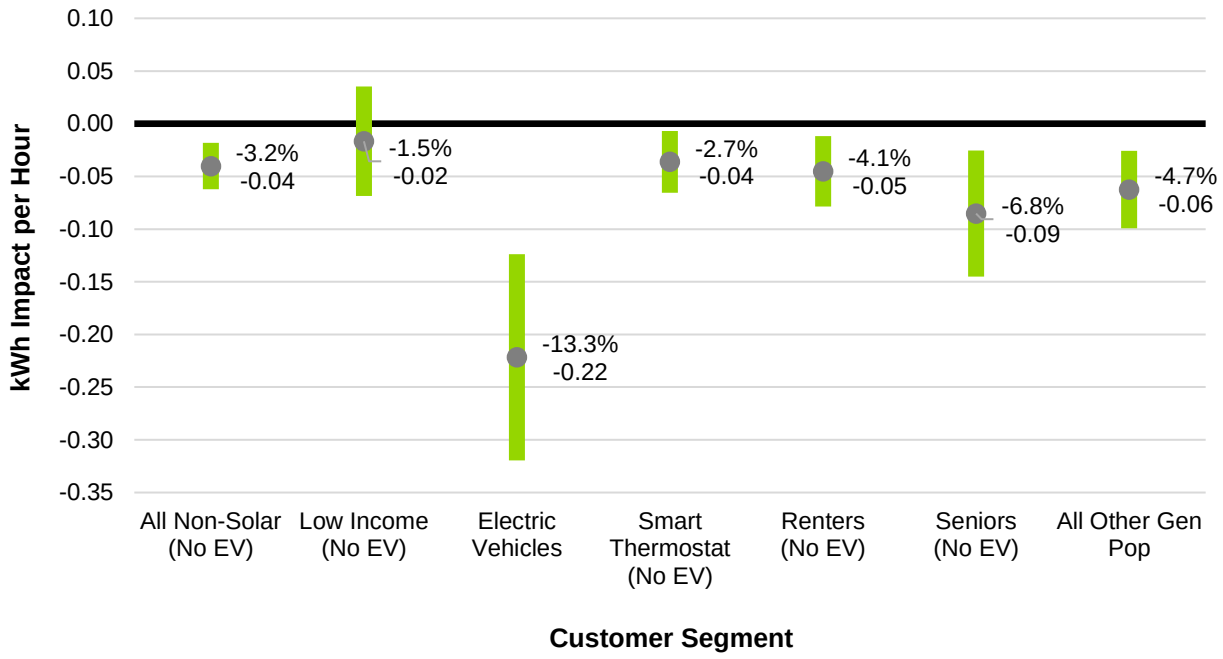
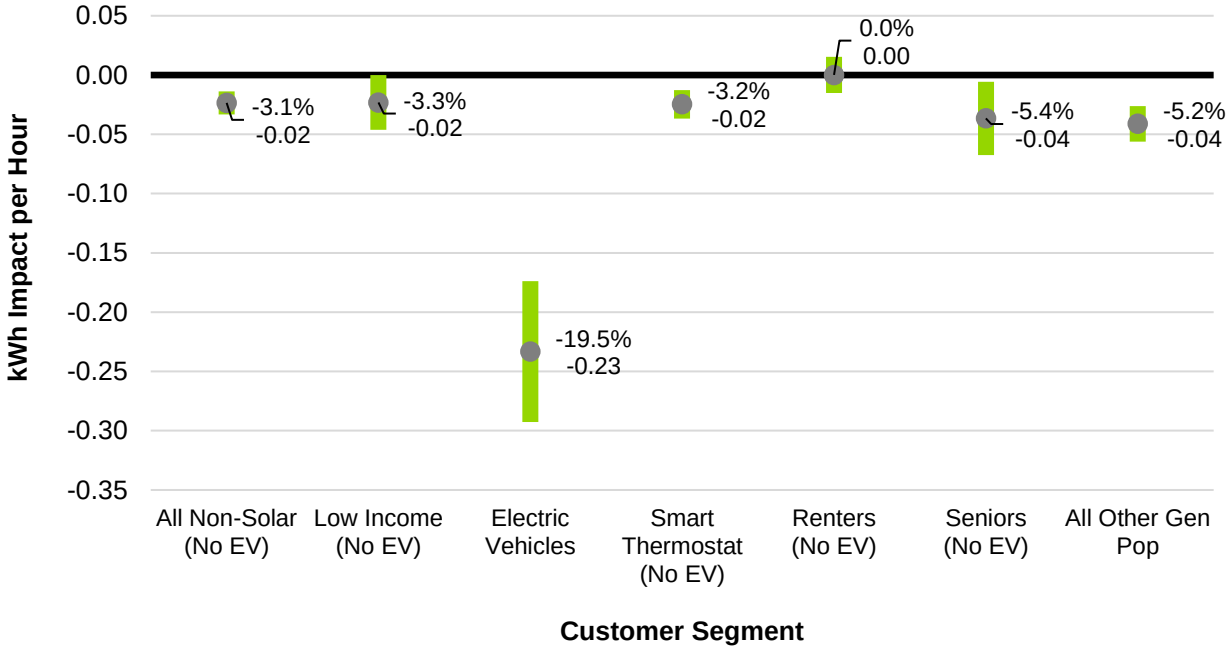


Figure 3. Winter On-Peak Consumption Impact



Energy Consumption Impacts. Many participants on RE-TOU responded to the rate structure by changing their usage in each of the pricing periods. For the shoulder period impact analysis, the period was divided into three parts (morning shoulder, evening shoulder, and weekend shoulder) to identify how customers' responses to the shoulder period varied based on the part of day or type of day in the shoulder period. Key observations from the energy consumption impact analysis are as follows:

- Across both seasons, participants appear to be reducing consumption during the morning shoulder and on-peak hours while increasing consumption during the evening shoulder, weekend shoulder, and off-peak hours.
- Impacts within the shoulder period vary depending on whether the hours fall before in on-peak period (reduced consumption) or during the evening/weekend (increased consumption).
- Participants have a statistically insignificant reduction in system coincident peak consumption during the summer. This is most likely due to system coincident peak hours occurring during on-peak hours. Winter system coincident peak hours occasionally occur in the evening shoulder hours, so that may be the reason for participants not reducing consumption that is coincident with the winter system coincident peak hours.

Figure 4. Summer RE-TOU Energy Consumption Impacts - All Non-Solar (No EV)

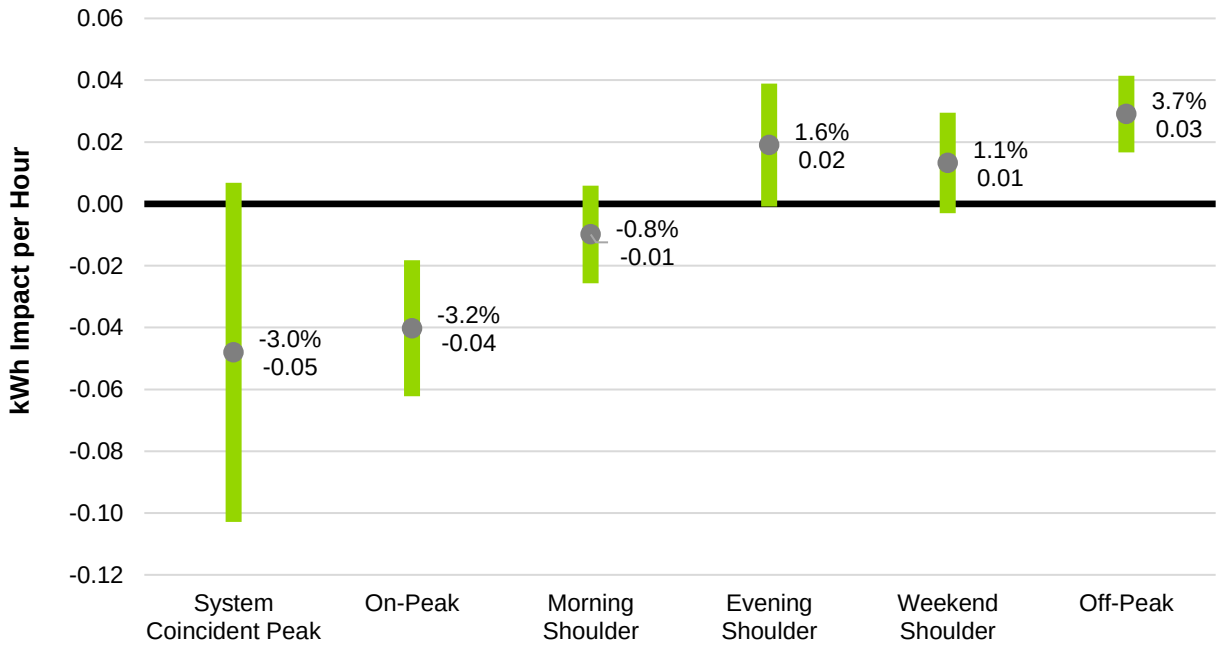
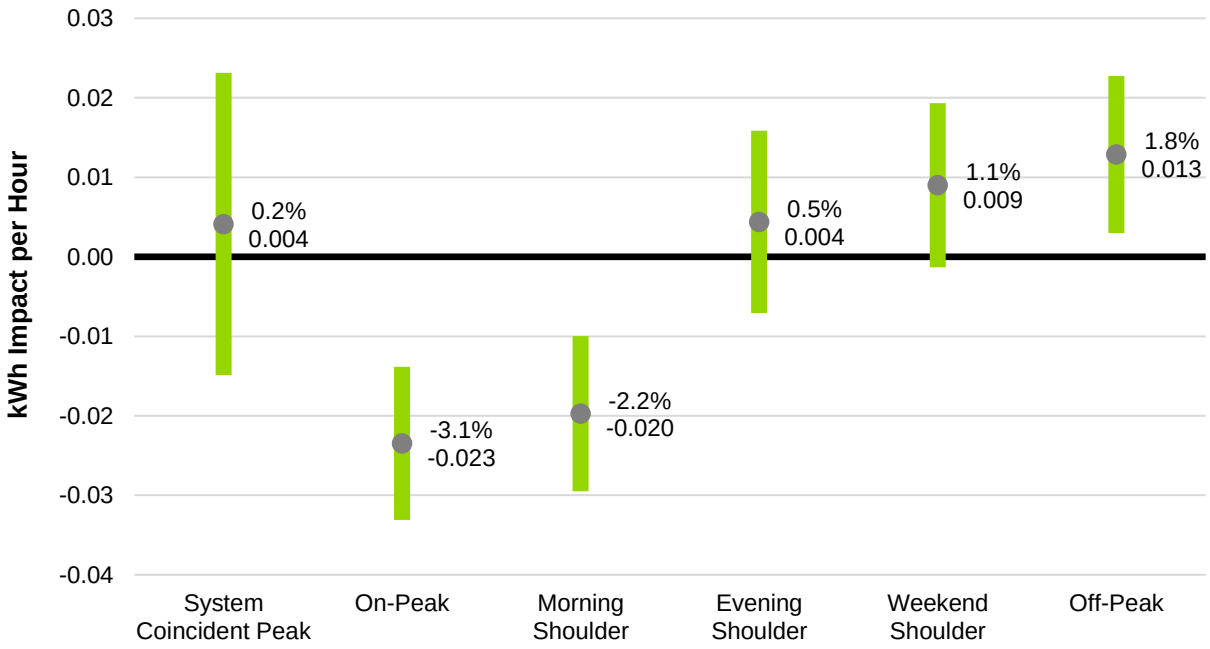


Figure 5. Winter RE-TOU Energy Consumption Impacts – All Non-Solar (No EV)

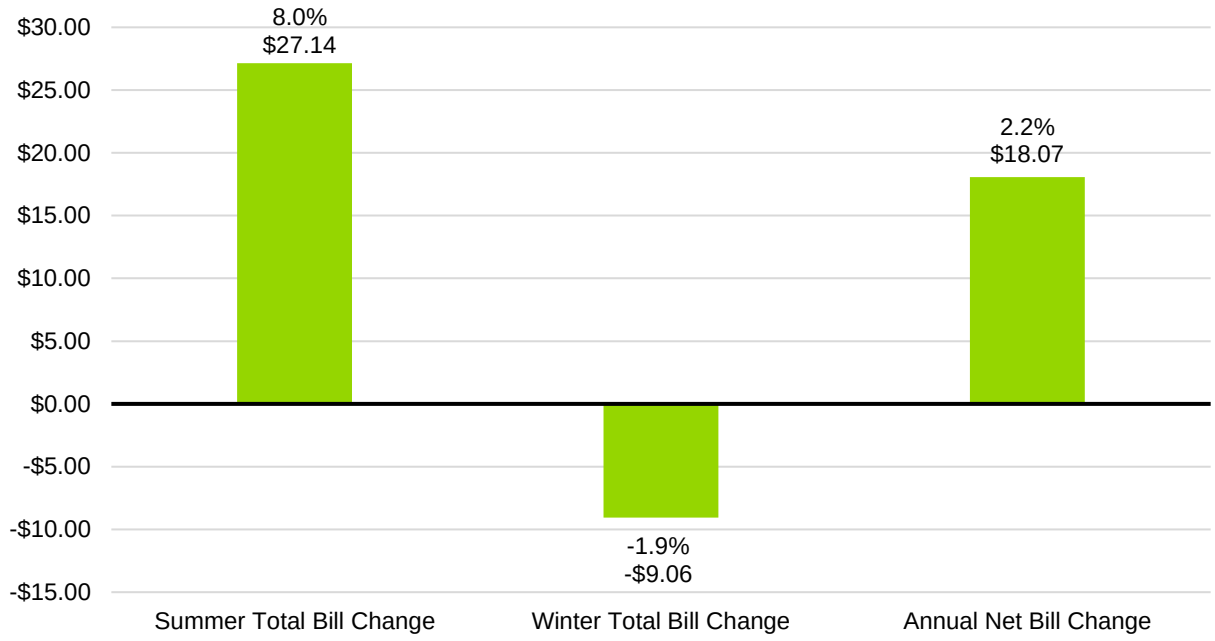


Bill impacts. Estimates of the impacts on consumption in each rate period were combined with the applicable prices to estimate the impact on the average participant's bill relative to what it would have been on the default residential (R) rate. These estimates account for both the change in rate structure[8] and the estimated change in consumption. As shown in Figure 6, the cumulative annual bill for the average non-solar (no EV) RE-TOU participant increases by 2.2% or $18.07. Bill increases during the summer are partially offset by winter bill decreases and the outcome is close to being revenue neutral for the average customer's usage (716 kWh average summer monthly usage and 563 kWh average winter monthly usage).

Bill impacts are based on the average consumption of participants in the trial and are not the average of individual participant bill impacts. This is due to the behavioral impact estimates being an average across all participants and those impacts do not reflect the exact behavior of any individual participant. Bill impacts should not be broadly interpreted as a measure of revenue neutrality since they are based on a bill calculation with the average consumption of participants and do not represent the cumulative distribution of bill impacts across all participants. RE-TOU rate design was based on load research data that differs from the average consumption and load profile of customers that self-selected to participate in the trial. Deviations from revenue neutrality within the trial can be attributed to those differences.

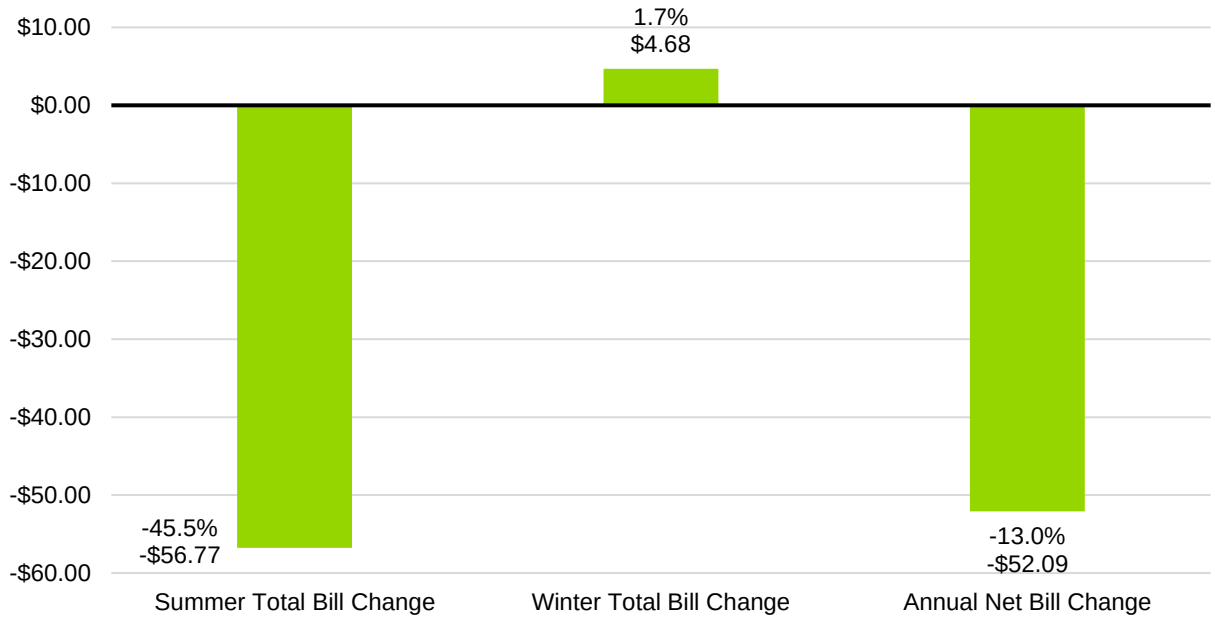
[8] See Section 3.3 for further details on the rate structure.

Figure 6. RE-TOU Bill Impacts by Season and Annual – Non-Solar (No EV)



In contrast to the modest bill impact for non-solar customers, Figure 7 shows a summer bill reduction of $56.77, a winter bill increase of $4.68, and an annual bill reduction of $52.09, or 13.0% for the average RE-TOU participant with solar. This is partially a result of an increase in the value of energy produced by solar during the shoulder and on-peak periods relative to R. The average customer has 261 kWh of net monthly usage with 463 kWh of monthly solar production during the summer and 293 kWh of net monthly usage with 260 kWh of monthly solar production during the winter.

Figure 7. RE-TOU Bill Impacts by Season and Annual – Solar



Customer Research Findings

Evaluation of customer participation in the RE-TOU trial rate over the last year consisted of two elements:

- **Participant surveys** throughout the trial rate period.
- **An analysis of participants who withdraw from the TOU rate** and switch back to the R rate.

Navigant conducted an online survey[9] with residential TOU participants near the conclusion of the TOU trial. The Wave 3 survey had several goals:

- Gain understanding of customer experience, perceptions, and satisfaction
- Measure customer understanding and change in understanding
- Measure customer behaviors and change in behaviors

Key takeaways from the Wave 3 survey include the following:

- **Customer satisfaction is high and perceptions are positive**. Eighty-four percent of customers say they are likely to recommend the TOU rate to family/friends and 65% indicate a "high likelihood" of recommending the plan. Most customers report that their bills are in line with or lower than expected (68%) and that they have more control over their bill (69%).
- **Customer knowledge appears to increase with experience**. A large majority of customers (87%) report at least a basic understanding of the bill, while the proportion of customers with a "fairly complete" or "complete" understanding has increased from 34% in the post-enrollment survey to 49% in the Wave 3 survey.
- **Nearly all customers are changing some behaviors; however, customers' behavioral responses leave opportunities for enhanced savings**. Most customers are shifting appliance use (>90%), and some are turning off their AC during peak periods (26%) or changing thermostat settings (12%); however, the difference in average reported temperature setting during peak and shoulder periods is less than 1 degree.

Navigant also analyzed the demographic characteristics and consumption level of participants that withdrew from the TOU rate. This analysis provided the following insights:

- **There was no single month, season, or event that caused a significant increase in participant attrition.** Attrition levels consistently varied above or below 100 per month for most of the trial.
- **The amount of monthly consumption does not appear to have influenced the decision to leave the TOU rate.** The percentage of participants that dropped out for a reason other than moving (e.g., did not think they could save money) varied between 7% and 8% across all electricity usage levels.

[9] Appendix C provides the full survey. Navigant issued the Wave 3 survey in August 2019. Navigant obtained 1,894 survey completes for an overall response rate of 36%.

1. INTRODUCTION

Public Service and the other Parties to the 2016 Settlement in Proceeding No. 16AL-0048E (Settlement) agreed to test two new voluntary residential time-varying rate schedules in Colorado:

1. Residential Energy Time-Of-Use Service Schedule (RE-TOU or TOU)
2. Residential Demand – Time Differentiated Rates Service Schedule (RD-TDR or TDR)

The intent of the Settlement is to provide an opportunity for: (1) adequate educational materials to be prepared; (2) testing the impact of the trial's RE-TOU rate differentials and pricing time periods; and (3) testing the trial's schedule RE-TOU rate with existing and new demand side management or energy efficiency tools.

The Settlement Agreement approved the two rates (the TOU trial and the TDR pilot) for customers who volunteer to enroll and receive a bridge meter that allows for measurement and billing of customers' monthly electric usage on a 15-minute basis. Voluntary participants have the right to withdraw (or opt out) from the rate through the end of their sixth billing cycle. Low income customers are included in the trial but are subject to a hold harmless provision where participants pay the lower of their monthly bills determined under the Schedule Residential rate (R rate) or the applicable trial rate.

Per the Settlement Agreement, Public Service is expected to file an Advice Letter on December 2, 2019, which will include results from the RE-TOU trial. As specified in the Settlement, the Advice Letter is intended to inform the following details regarding the RE-TOU rate:

- Whether the rate requires modification prior to implementing the final time-varied rate for all residential customers;
- Whether the rate is working well as originally implemented; and
- Whether it should be discontinued.

This Evaluation Report addresses Navigant's evaluation of the energy and bill impacts and of customer experience from participation only in the RE-TOU trial rate,[10] from October 2018 through July 2019.[11] Navigant prepared the first evaluation report from the earliest recruitment in March 2017 through September 2018. Navigant will prepare a Final Evaluation Report covering all study participants through December 2019.

1.1 Goals of the Study

Consistent with the Study and Evaluation Plan (the Evaluation Plan) filed by Public Service on November 15, 2016, the overarching goals of this evaluation include the following:

- Quantify the relative impacts of the RE-TOU rate on customers' bills compared to the current R rate

[10] In accordance with the RE-TOU and RD-TDR Measurement & Verification Scope of Work, Navigant's evaluation comprises two separate studies and reports; the evaluation does not compare the two tested rates.

[11] Due to the reporting timeline, meter data for 2019 had to be cut off at the end of July. Meters are read once per month on dates that vary across all participants, so complete data for a month is available 4-6 weeks after the end of a month. This required August and September to be cut from the 2019 Summer season.

- Assess how various customer groups within the residential class change their consumption behavior in response to the proposed rates to understand how their energy use and peak consumption change, particularly during summer peak periods
- Understand with statistical significance how these rates affect targeted population segments; specifically, low income, seniors (65 years of age or older), renters in multifamily buildings, and those with end-use technologies such as solar, EVs, and smart thermostats
- Determine participating customer demographics, major household appliances, energy use patterns and other behavioral changes, and technologies adopted to help reduce or shift energy use/bill costs and how these characteristics potentially impact the efficacy of the trial and pilot rates

This report describes the results of Navigant's evaluation through July 2019. It summarizes impact results for participants' energy consumption, bill impacts, and includes customer research survey findings, as described in Table 1-1.

Table 1-1. Evaluation Report 2 Research Objectives

Research Area	Objectives
Impact Analysis	• Energy consumption impacts, including overall on-peak consumption impacts and system coincident peak consumption impacts • Bill impacts, including aggregate seasonal bill impacts
Customer Research	• Participant engagement, experience, and satisfaction • Participant behaviors and change in behaviors • Participant understanding and change in understanding

1.2 Rate Structure

Table 1-2 presents the rate structure for RE-TOU, including the pricing periods, applicable prices during each period, and fixed charges. The prices under this rate are based on three periods and are referred to as off-peak, shoulder, and on-peak. The prices vary between summer and winter seasons,[12] but the hours for each period remain the same all year. This contrasts with the rate structure for R where summer is an inclining block structure (first 500 kWh of consumption is $0.10/kWh and $0.14/kWh for consumption over 500 kWh) and a flat rate during the winter ($0.10/kWh).

[12] Costs are rounded and included appropriate adjustments. The summer season includes June, July, August, and September. The winter season includes January, February, March, April, May, October, November, and December.

Table 1-2. RE-TOU Rate Structure

RE-TOU	Off-Peak	Shoulder	On-Peak	Service and Facility Charge
Hours	9 p.m.–9 a.m.	9 a.m.-2 p.m., 6 p.m.-9 p.m. on weekdays, 9 a.m.-9 p.m. on weekends	2 p.m.-6 p.m. on weekdays	
Summer	$0.08/kWh	$0.13/kWh	$0.18/kWh	$5.41
Winter	$0.08/kWh	$0.10/kWh	$0.14/kWh	$5.41

1.3 Enrollment Summary

Recruitment for the RE-TOU trial began in March 2017 and continued through summer 2019. Public Service implemented a variety of marketing tactics to increase awareness and enrollment in the trial, including but not limited to: direct mail, email, digital advertising, bill inserts, new mover outreach, and social media. Public Service tested numerous tactics and compared outcomes against industry and utility benchmarks to identify effective strategies for increasing enrollment. As of summer 2019, over 12,000 customers had enrolled, had participated in the trial for any amount of time, and were included in the evaluation of the trial—including the one-third of enrollees who were randomly assigned to be in a control group. There was a total of 7,927 participants over the course of the trial and 6,642 participants that were in the trial at any point during the evaluation year[13]. Figure 1-1. shows the number of participants and control group customers by customer segment that participated between October 1, 2018 and July 31, 2019. The report's impact analysis findings represent the data from those customers. Due to rolling enrollment and attrition, the number of participants varied throughout the evaluation period. Figure 1-2. shows the number of participants who moved or opted out and the number of control group customers who moved at any point during the trial.

[13] Evaluation year is October 1, 2018 through July 31, 2019.

Figure 1-1. RE-TOU Participation

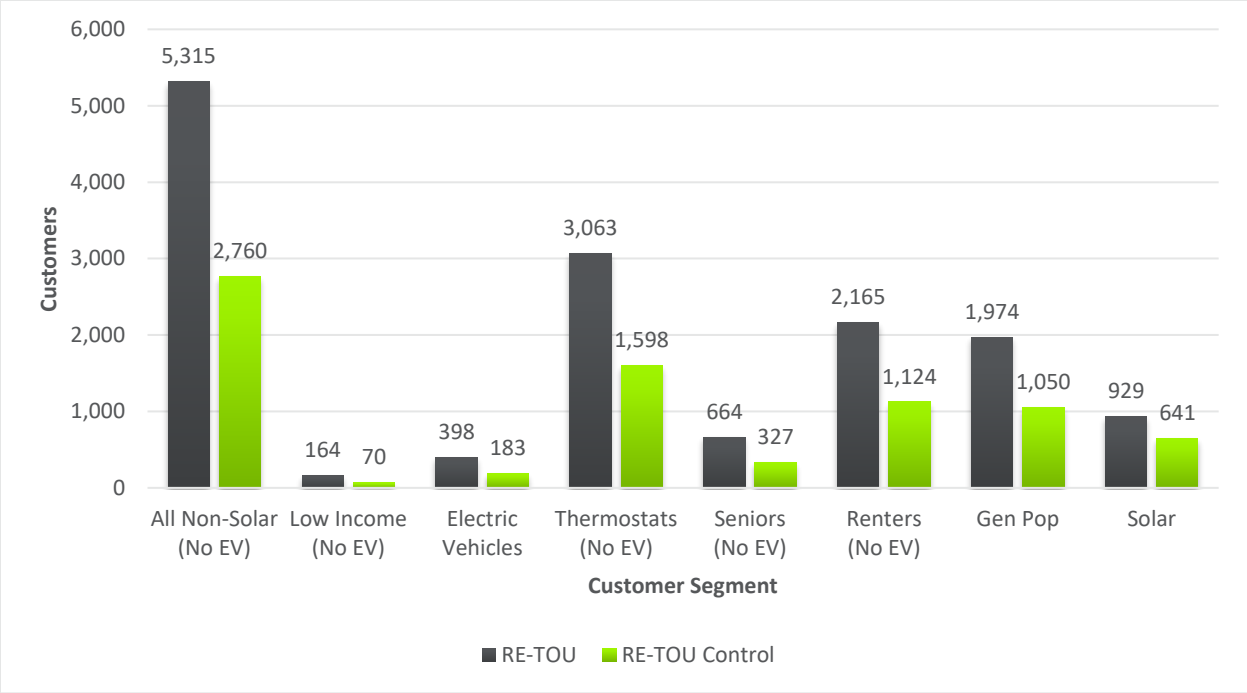
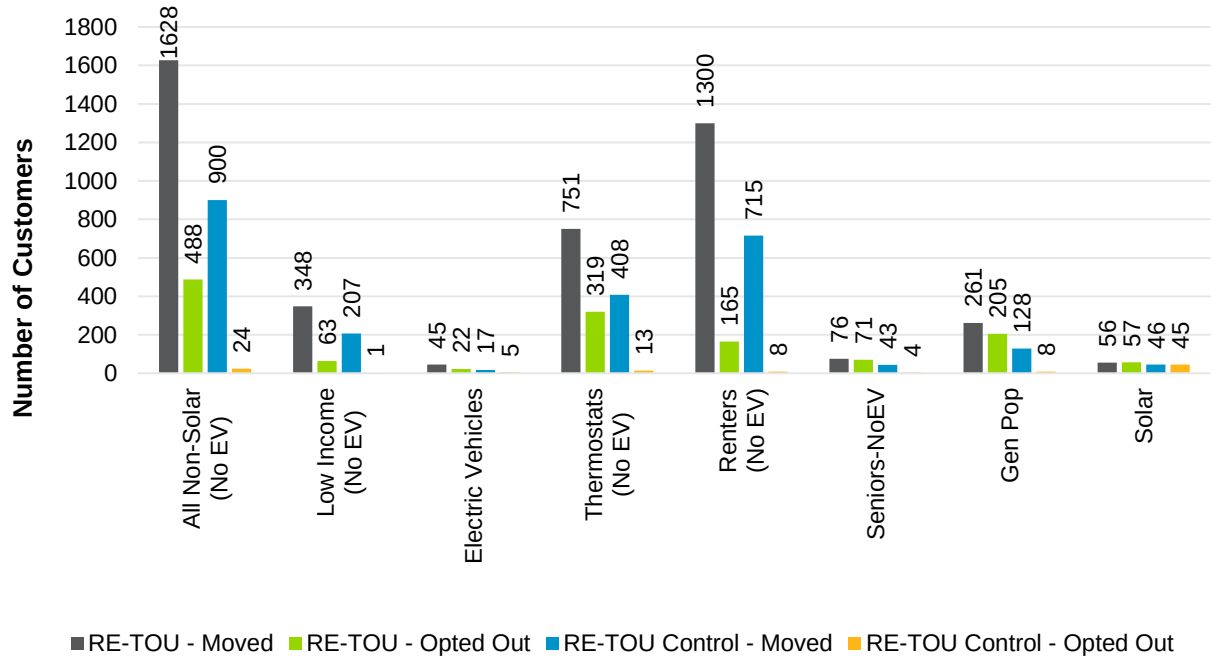


Figure 1-2. RE-TOU Attrition



1.4 Intake Survey Data

Public Service collected essential customer information during the enrollment process from all customers volunteering for the TOU trial using an intake survey.[14] The survey included customer contact information, household characteristics, appliance and technology saturation, behavioral characteristics, and demographics. This information was used to identify the applicable customer segment for each customer enrolled and to provide customer characteristics for use in the impact analysis. A copy of the Customer Intake Survey is included in Appendix D.

The remainder of this evaluation report reviews the methods and findings, organized as follows:

Section 2: **Methodology** addressing the experiment design, impact analysis, and customer research

Section 3: **Impact analysis** findings

Section 4: **Customer research** findings

[14] This did not include the control group customers with solar since the controls were matched from non-participants that did not go through the enrollment process.

2. METHODOLOGY

The methods employed for this RE-TOU rate trial evaluation trace back to the measurement and verification plan upon which the study is based. The plan encompasses sample design, identification of test versus control groups, and the data sources used to inform them. The methods related to the actual evaluation activities pertain to impact analysis and customer research. Each of these elements are described below, organized as follows:

- Experimental Design and Sample Management
- Impact Analysis Methods
- Customer Research Methods

2.1 Experimental Design and Sample Management

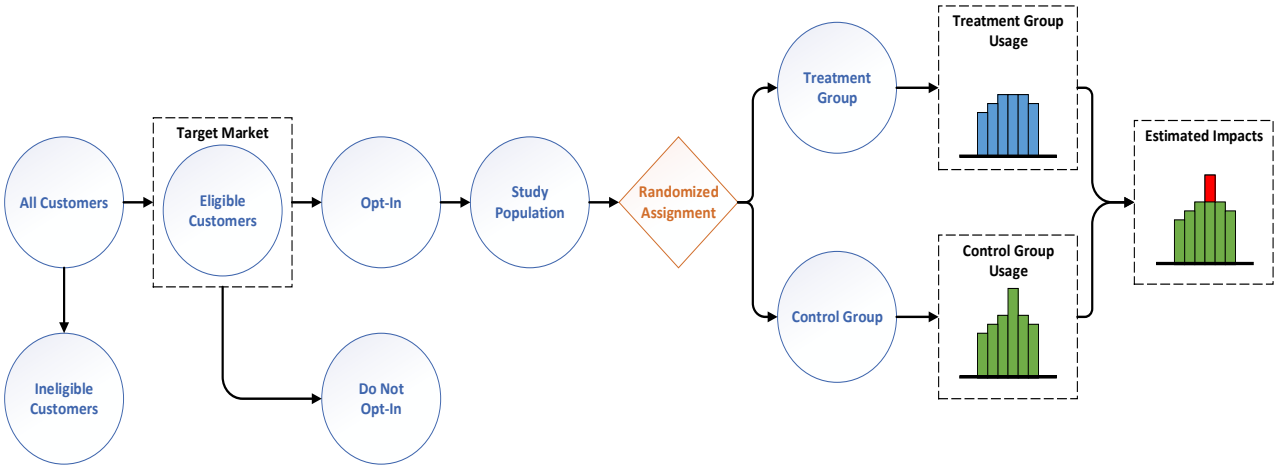
This section identifies the experimental design upon which the RE-TOU trial is based and it describes various elements of the evaluation approach and data, including:

- Sample Design
- Randomized Control Trial (RCT) Validation
- Matched Solar Control Group

RCTs are the gold standard for estimating treatment effects.[15] For customers without solar, an opt-in RCT was implemented for the RE-TOU trial (illustrated in Figure 2-1). This approach began with the identification of a target market of eligible customers. In this case, residential customers on the default R rate were the target market. Then those customers were recruited to opt-in to the rate of their choosing study and become part of the study population. After a customer had enrolled in the study, two-thirds were randomly assigned to be in the treatment group (on the RE-TOU rate) and one-third was randomly assigned to the control group (remaining on the R rate). Customers receiving their time-varying (RE-TOU) rate and those that were chosen to be on the control group received a new bridge meter so that consumption data could be captured.

[15] Donald B. Rubin, "The Design Versus the Analysis of Observational Studies for Causal Effects: Parallels with the Design of Randomized Trials," Statistics in Medicine 26(1): 20-37 (2007).

Figure 2-1. Opt-In RCT Experimental Design



Source: Adapted from US DOE Uniform Methods Project.

Ideally, the outcome of an RCT is a balanced sample where there are no observable or unobservable differences, or invariable characteristics, between the treatment and control groups during the pre-enrollment period.[16] However, from a practical standpoint, there are inevitably impediments to drawing perfect random samples as they would require a perfectly defined population and a perfect sampling frame. In the RE-TOU trial, imbalances occurred due to customers with unique characteristics (e.g., extremely high consumption) being randomly assigned to the treatment or control group without a similar customer in the opposing group. A verification of the RCT identified these imbalances and addressed them through the removal of outliers or the inclusion of variables in regression analysis to control for differences in observable characteristics.

Solar customers were not subject to the random assignments of the RCT and all interested customers would be placed on the RE-TOU rate. Solar participants were matched to non-participating solar customers based on PV system size and pre-enrollment energy usage. This approach created a matched control group for which the distribution of the independent variables (or covariates) used in regression analysis for solar customers is almost identical to that of the treatment group in the pre-enrollment timeframe. This approach is like an RCT because the two groups look as if they were formed by random assignment.

2.1.1 Sample Design

To understand how the rate impacts specific population segments, customers were actively recruited and identified as being part of the following segments:[17]

- Low income
- Solar
- Electric vehicles

[16] An RCT also has the benefit of minimizing self-selection bias as customers are randomly assigned to either the treatment or control group.

[17] All segments were self-reported except for low income (income qualified) and solar.

- Smart thermostats
- Renters
- Senior citizens (65 years of age or older)
- All others[18]

In the Evaluation Plan, the assignment of segments was based on a hierarchy[19] where customers were exclusively assigned to the highest priority[20] applicable segment. This approach reduced the number of customers that were assigned to segments lower in the hierarchy. For the impact analysis, Navigant allocated customers to all relevant segments that they represent based on information collected from the enrollment survey. This increased the number of customers included in the impact analysis for the segments lower in the hierarchy (e.g., renters, seniors). This potentially improves the external validity of impact estimates due to the inclusion of a range of overlapping characteristics that may more closely reflect the overall population with the specified characteristic.

2.1.2 RCT Validation

As previously mentioned, there are always impediments to drawing perfect, completely random samples. Validating the randomization of RCT assignments was an important step to ensure the validity of subsequent analysis. Navigant compared the energy usage and observable characteristics of the treatment and control groups during the period prior to the start of the trial to accomplish the RCT validation. This analysis identified minor imbalances due to high usage and low usage outliers that were subsequently excluded from the impact analysis. Pre-enrollment consumption data was not available for participants that enrolled in the study when starting electric service, so the RCT validation analysis identified outliers in the post-enrollment consumption data as an alternative approach to identifying imbalances in the level of monthly consumption between treatment and control groups.

2.1.3 Matched Solar Control Group

Navigant developed a matched control group for participants with rooftop solar based on PV system size and pre-enrollment energy usage. The purpose of the matched control group was to provide insight on what the counterfactual consumption would have been for the participants had they not enrolled in the trial against which energy and peak consumption savings can be measured.

Figure 2-2. illustrates the solar customer matching process. The goal of the matching process was to select a solar non-participant with a similar consumption pattern prior to enrollment. The matching was carried out in two stages using consumption data for two different time frames to ensure accuracy and consistency over time:

1. One-year period beginning 15 months prior to enrollment up to 3 months prior to enrollment to determine which control group customers track each participants usage

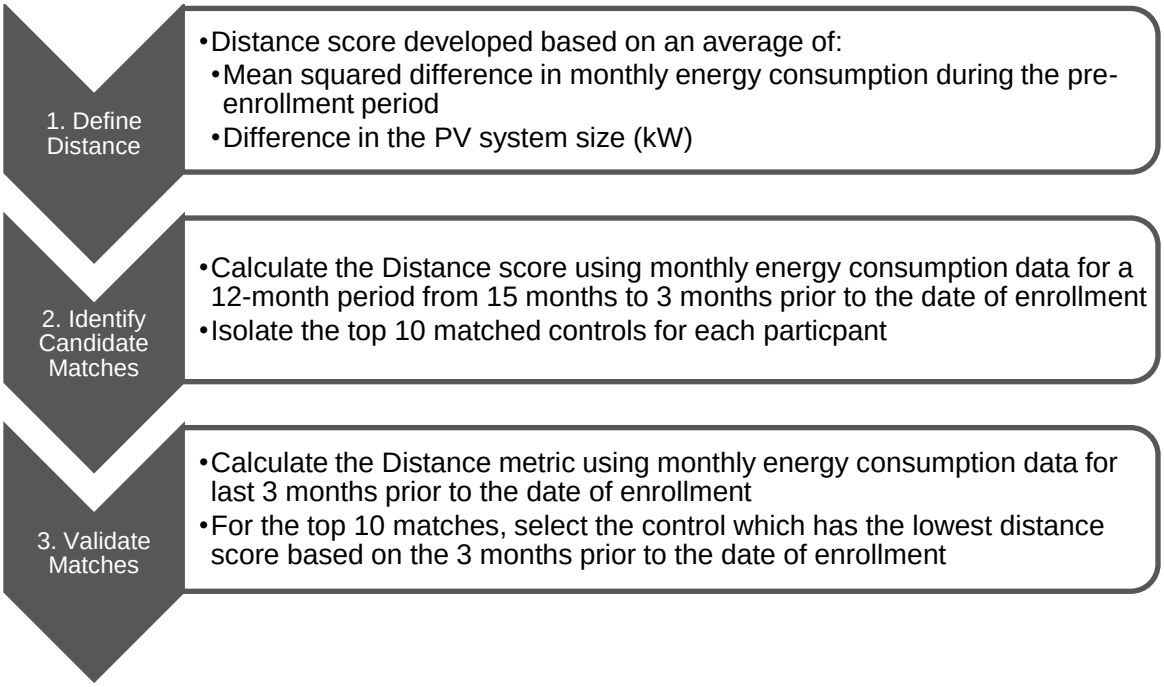
[18] The all others segment included customers that did not fall into the other segments and represented the absence of those characteristics.

[19] The hierarchy is as follows: (i) solar, (ii) low income, (iii) EVs, (iv) smart thermostats, (v) renters, (vi) seniors, (vii) general population.

[20] For non-solar customers, the sample plan hierarchy was in the following order from highest to lowest: low income, electric vehicles, smart thermostats, renters, senior citizens, and all others.

2. Three-month period beginning 3 months prior to enrollment up to the date of enrollment to see which of the top 10 matches are most consistent over time.

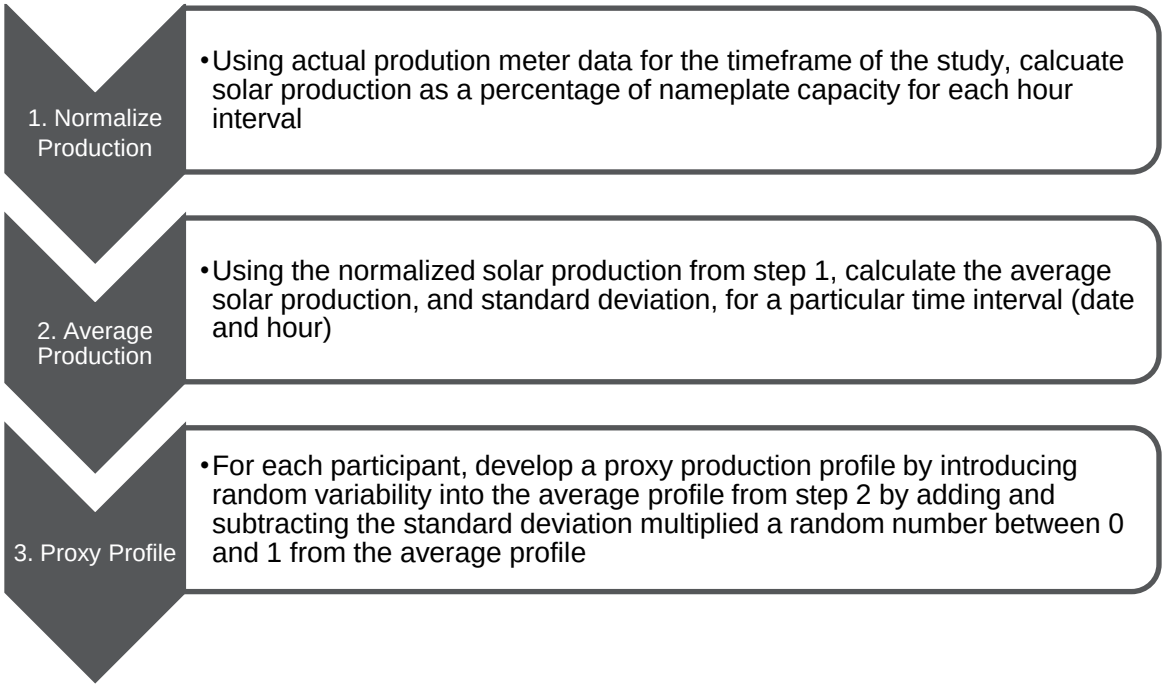
Figure 2-2. Solar Customer Matching Process



Source: Navigant

A deeper examination into the solar customers revealed that some customers were missing production meter data, which is required to determine the customer's total gross consumption. Further discussions with the Public Service project team revealed that these were legacy solar customers who had installed solar panels prior to January 1, 2015 and were not required to have a production meter. To keep these customers in the analysis, Navigant developed proxy production profiles using available production meter data from the remaining customers. Figure 2-3. illustrates the process Navigant deployed to develop the proxy solar production profile.

Figure 2-3. Proxy Solar Production Profile Process



Source: Navigant

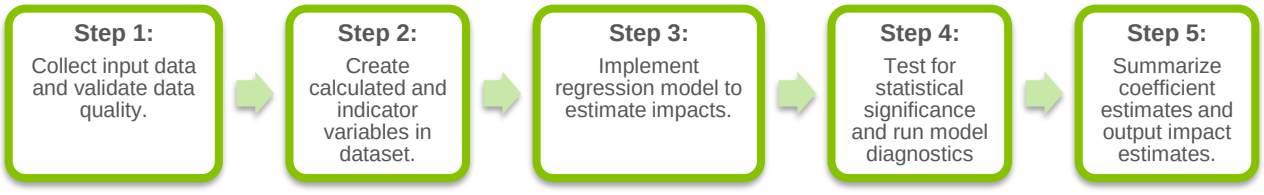
2.2 Impact Analysis Methods

To understand the changes in consumption of customers on the RE-TOU rate, a series of regression models were used to identify impacts and provide insights into changes in customer usage behavior. Those changes in usage behavior were combined with the TOU rate structure to estimate bill impacts. Two separate models were run to assess impacts on the following:

- Kilowatt-hours, consumption impacts (on-peak, shoulder, and off-peak periods)
- Kilowatt-hours, system coincident peak hour consumption impacts

Figure 2-4 shows the impact analysis process Navigant followed.

Figure 2-4. Impact Analysis Process



This process began (Step 1) with the collection and validation of all data necessary for the regression analysis to ensure that that the output of the analysis is not affected by missing data, erroneous values, or

outliers.[21] After consolidating and validating all available information, indicator variables were defined and appended to the dataset (Step 2). The indicator variables were used to identify assigned rates, pricing periods, enrollment status, customer segments, and temporal factors. After the necessary variables were appended to the dataset, a series of regression models were run (Step 3) and tested for statistical significance/robustness (Step 4). Finally, the coefficient estimates were summarized (Step 5) to provide impact estimates and output for further analysis and reporting.

The remainder of this section describes the regression models used to estimate the average peak consumption and energy impacts.

2.2.1 Peak Impacts Methodology

This section presents the regression models used for the non-solar and solar customers. The fundamental approach used for both groups is the same in principle; however, there are subtle differences in the exact variables used to achieve the outcome. This is driven by the fact that a matched control group was used for the solar customers and—since they did not partake in the recruit and deny RCT structure—they did not fill out an enrollment survey. Hence, the various household characteristics that were obtained from the intake surveys were not available for solar control group customers.

2.2.1.1 Non-Solar

An individual customer's peak consumption need not necessarily be coincident with that of system peak hour. A separate model was estimated using only the system coincident peak hours. By separately modeling the system peak hours, the model will provide insights into how the evaluated rates impact consumption during the conditions that result in system peak demands (daily and annual peak hours).

Equation 2-1. Non-Solar Peak Consumption Impact Regression Equation

$$kWh_{i,t} = \beta_1 * Participant_{i,t} + \beta_2 * Monthly\ kWh_{i,t} + \beta_3 * Work\ from\ Home_{i,t} + \beta_4 * Home\ Type_{i,t} + \beta_5 * OwnRent_{i,t} + \beta_6 * \sum Month_{i,t} + \varepsilon_{i,t}$$

The dependent variable is the individual customer's consumption during the system coincident peak hour. The participant indicator variable is intended to capture the differences in consumption patterns for the participants during the system coincident peak hours compared to the control group. The other variables are meant to control for the individual customer's specific characteristics.

[21] Outliers were identified through a statistical analysis of each variable. Observations that are found to be outside the reasonable range of values for the population that is to be represented were flagged as outliers and removed from the regression analysis.

Table 2-1. Non-Solar System Coincident Peak Consumption Model Regression Variables

Variable	Definition
$kWh_{i,t}$	kWh consumption of customer *i* during system coincident peak hour in month *t*
$Participant_{i,t}$	Indicator variable that takes on a value of one when customer *i* is a participant on the designated rate
$Monthly\ kWh_{i,t}$	Total monthly consumption for customer *i* during month *t*
$Work\ from\ Home_{i,t}$	Indicator variable that takes on a value of one when customer *i* is working from home
$Home\ Type_{i,t}$	A series of indicator variables that take on a value of one when customer *i* has that home type
$OwnRent_{i,t}$	A series of indicator variables that take on a value of one when customer *i* either owns or rents their current residence
$Month_{i,t}$	A series of indicator variables that take on a value of one when customer *i*'s consumption is for month *t*
$\varepsilon_{i,t}$	Error for participant *i* in month *t*

2.2.1.2 Solar

The fundamental methodology for solar customers is the same as for non-solar customers. The main difference is that the other household characteristics (work from home, home type, and own/rent) are replaced by the nameplate capacity.

Equation 2-2. Solar Customer Peak Consumption Impact Regression Equation

$$kWh_{i,t} = \beta_1 * Participant_{i,t} + \beta_2 * Monthly\ kWh_{i,t} + \beta_3 * Solar\ Nameplate\ Capacity_{i,t} + \beta_4 * \sum Month_{i,t} + \varepsilon_{i,t}$$

The dependent variable is the individual consumption during the system coincident peak hour. The participant indicator variable is intended to capture the differences in consumption patterns for the participants during the system coincident peak hours compared to the control group. The nameplate variable is meant to control for the individual specific characteristics of the solar PV system.

Table 2-2. Solar System Coincident Peak Consumption Model Regression Variables

Variable	Definition
$kWh_{i,t}$	Total gross kWh consumption of customer *i* during system coincident peak hour in month *t*
$Participant_{i,t}$	Indicator variable that takes on a value of one when customer *i* is a participant on the designated rate
$Monthly\ kWh_{i,t}$	Total gross monthly consumption for customer *i* during month *t*
$Solar\ Nameplate\ Capacity_{i,t}$	Solar PV nameplate capacity for customer *i*
$Month_{i,t}$	A series of indicator variables that take on a value of one when customer *i*'s consumption is for month *t*
$\varepsilon_{i,t}$	Error for participant *i* in month *t*

2.2.2 Energy Consumption Impacts Methodology

Like the on-peak impacts, the fundamental approach used for the energy consumption impacts of solar and non-solar customers is the same in principle; however, there are differences in the exact variables used to achieve the outcome due to a matched control group being used for the solar control customers. Since they did not partake in the recruit and deny RCT structure, they did not fill out an enrollment survey and the various household characteristics that were used for the non-solar regressions were not available for solar control group customers.

2.2.2.1 Non-Solar

The approach is to estimate:

1. The overall conservation of energy, and
2. Shifts in energy consumption from peak periods to off-peak or shoulder periods.

Equation 2-3. Non-Solar Energy Impact Regression Equation

$$kWh_{i,t} = \beta_0 \cdot \sum_{j=1}^{24} Hr_j + \beta_1 \cdot Weekday + \beta_2 \cdot Participant \cdot OnPeak + \beta_3 \cdot Participant \cdot ShoulderMorn + \beta_4 \cdot Participant \cdot ShoulderEve + \beta_5 \cdot Participant \cdot ShoulderWeekend + \beta_6 \cdot Participant \cdot OffPeak + \beta_7 \cdot OnPeak + \beta_8 \cdot ShoulderMorn + \beta_9 \cdot ShoulderEve + \beta_{10} \cdot ShoulderWeekend + \beta_{11} \cdot CDH65 + \beta_{12} \cdot Education + \beta_{13} \cdot WorkFromHome + \beta_{14} \cdot HomeType + \beta_{15} \cdot Sqft + \beta_{16} \cdot \mathrm{Re}\,ntOwn + \beta_{17} \cdot OccupantsUnder10 + \beta_{18} \cdot Occupants11to18 + \beta_{19} \cdot Occupants19to30 + \beta_{20} \cdot Occupants31to61 + \beta_{21} \cdot OccupantsOver62 + \beta_{22} \cdot SeasonPeakDemand + \varepsilon$$

The dependent variable is the hourly consumption for each datetime (day and hour combination) period in the analysis timeframe. The participant indicator variable interacted (multiplied) with the TOU period indicator variables are intended to capture the shifts in energy consumption patterns for the participants during each of the respective TOU time periods compared to the control group. The other variables are meant to account for the impacts of weather on consumption and control for the individual specific characteristics.

Table 2-3. Non-Solar Energy Model Regression Variables

Variable	Definition
$kWh_{i,t}$	kWh consumption of customer *i* during time period (day and hour combination) *t*
$Participant_{i,t}$	Indicator variable that takes on a value of one when customer *i* is a participant on the designated rate
$Time\ of\ Use\ Periods_{i,t}$	Indicator variable that takes on a value of one when the time period is within the respective TOU period—peak, shoulder morning / evening, off-peak
$HDH\ or\ CDH65_{i,t}$	The cooling or heating degree hours using a threshold of 65^0F
$Work\ from\ Home_{i,t}$	Indicator variable that takes on a value of one when customer *i* is working from home
$Home\ Type_{i,t}$	A series of indicator variables that take on a value of one when customer *i* has that home type
$OwnRent_{i,t}$	A series of indicator variables that take on a value of one when customer *i* either owns or rents their current residence
$Number\ of\ Occupants_{i,t}$	A series of variables that count the number of occupants in various age brackets in customer *i*'s home
$SeasonPeakDemand_{i,t}$	The maximum hourly consumption for customer *i* at any point during the season, Summer or Winter.
$\varepsilon_{i,t}$	Error for customer *i* in month *t*

2.2.2.2 Solar

The twofold objective and fundamental methodology for solar customers is the same as for non-solar customers. The main difference is that the other household characteristics (work from home, home type, and own/rent) are replaced by the nameplate capacity.

Equation 2-4. Solar Energy Impact Regression Equation

$$kWh_{i,t} = \beta_0 \cdot \sum_{j=1}^{24} Hr_j + \beta_1 \cdot Weekday + \beta_2 \cdot Participant \cdot OnPeak + \beta_3 \cdot Participant \cdot ShoulderMorn + \beta_4 \cdot Participant \cdot ShoulderEve$$
$$+\beta_5 \cdot Participant \cdot ShoulderWeekend + \beta_6 \cdot Participant \cdot OffPeak + \beta_7 \cdot OnPeak + \beta_8 \cdot ShoulderMorn$$
$$+\beta_9 \cdot ShoulderEve + \beta_{10} \cdot ShoulderWeekend + \beta_{11} \cdot CDH\,65 + \beta_{12} \cdot SolarNameplate + \varepsilon$$

The dependent variable is the hourly consumption for each datetime (day and hour combination) period in the analysis timeframe. The participant indicator variable interacted (multiplied) with the TOU period indicator variables are intended to capture the shifts in energy consumption patterns for the participants during each of the respective TOU time periods compared to the control group. The nameplate variable is meant to control for the individual specific characteristics of the solar PV system.

Table 2-4. Solar Energy Model Regression Variables

Variable	Definition
$kWh_{i,t}$	Total gross kWh consumption of customer *i* during time period (day and hour combination) *t*
$Participant_{i,t}$	Indicator variable that takes on a value of one when customer *i* is a participant on the designated rate
$Time\ of\ Use\ Periods_{i,t}$	Indicator variable that takes on a value of one when the time period is within the respective TOU period—peak, shoulder morning/evening, off-peak
$HDH\ or\ CDH65_{i,t}$	The cooling or heating degree hours using a threshold of 65^0F
$Solar\ Nameplate\ Capacity_{i,t}$	Solar PV nameplate capacity for customer *i*
$\varepsilon_{i,t}$	Error for customer *i* in month *t*

2.3 Customer Research Methods

Evaluation of customer participation in the RE-TOU trial consisted of two elements:

- **Participant surveys** throughout the trial rate period
- **An analysis of participants who withdraw from the TOU rate** and switch back to the R rate.

2.3.1 Participant Survey Research

Navigant conducted four survey efforts across the RE-TOU trial period. The varying objectives of each survey effort are identified in Table 2-5. Wave 1 refers to post-enrollment surveys fielded every few months as new customers enrolled. Wave 2 surveys were fielded in two rounds shortly following a customer's first cooling season, in fall of either 2017 or 2018 depending on the time of enrollment. The Wave 3 survey was conducted online in August 2019 toward the conclusion of the trial. Dropout survey respondents are participants who enrolled in the new rate and subsequently opted out.

The results of the Wave 1 survey, Wave 2 survey, and dropout surveys are described in Navigant's Evaluation Report 1. This report describes findings from the Wave 3 survey.

Table 2-5. Participant Research Surveys Conducted to Date

Wave No.	Survey	Objectives
1	Post-Enrollment Survey	• Marketing effectiveness • Participant understanding • Enrollment experience
2	Post First Cooling Season Survey	• Understanding of bill • Behavior changes • Motivations and perceived success in achieving goals • Support for hypothetical changes to the TOU rate
N/A	Dropout Survey	• Reasons for dropping out • Behavior changes • Recommendations
3	End of Trial Survey	• Participant engagement, experience, and satisfaction • Participant behaviors and change in behaviors • Participant understanding and change in understanding

Each of the four survey efforts conducted to date are described in more detail below.[22]

2.3.1.1 Wave 1 – Post-Enrollment Survey

Navigant conducted seven rounds of the post-enrollment survey[23] with residential TOU participants shortly after enrollment in the TOU trial (i.e., Wave 1 survey). The purpose of the Wave 1 survey was to:

1. Gather key data about TOU participants near the time of enrollment including reasons for enrolling, perceptions, expectations, and baseline behavior
2. Assess the effectiveness of marketing and messaging of the TOU rate
3. Measure customer understanding of the rate components
4. Assess customer experience with the enrollment process

Navigant issued seven rounds of the Wave 1 survey, from July 2017 through June 2018, to gather information about customer understanding and enrollment experience prior to significant exposure to the new rate. Survey eligibility was limited to those TOU rate participants who had enrolled during the 5-week period prior to the survey, and all eligible participants were invited to take the survey. In all, 2,492 participants were invited to take the Wave 1 survey and Navigant obtained 1,196 survey completes for an overall response rate of 48%.

[22] Navigant offered incentives to increase participation in the customer surveys. Navigant offered a 'reciprocity incentive' for rounds 1-3 of the Wave 1 survey. The reciprocity incentive involved offering a $5 gift card as a gift, with no requirement for completion of the survey. For the remaining rounds of Wave 1 survey and for all rounds of the Wave 2 and Dropout survey, Navigant implemented a 'sweepstakes incentive' where completion of the survey entered customers into a drawing where a pre-defined number of respondents were randomly selected to be awarded a monetary prize in the form of a gift card.

[23] Appendix A provides the full survey.

2.3.1.2 Wave 2 – Post-First Cooling-Season Survey

The Wave 2 survey was an online survey designed to gather information about customer perceptions and experiences following participants' first summer of enrollment in the TOU rate. The primary topics explored by this survey include:

- How well participants understand their bill
- Changes in energy use behaviors since signing up for the TOU rate
- Customer success in achieving enrollment goals
- Customer perceptions and support for hypothetical changes to the TOU rate

Survey data were collected by means of two separate rounds of the Wave 2 survey. The overall response rate for both rounds of the Wave 2 survey was 34%, with 1,252 participants completing the Wave 2 survey.

2.3.1.3 Dropout Survey

The dropout survey was an online survey designed to gather insights and recommendations from customers who dropped out of the TOU pricing plan.

The primary topics explored by this survey include:

- Reasons for leaving the plan
- The level of customer engagement and behavior change while on the plan
- The degree to which customers made use of informational resources before leaving the plan
- Customer recommendations for changing the plan

Survey data were collected by means of three separate rounds of the dropout survey. The dropout survey was fielded periodically with the goal of gathering insights in a timely manner following the customers' decision to leave the TOU rate. A total of 383 customers participated in the dropout survey for an overall response rate of 28%.

2.3.1.4 Wave 3 – End of Trial Survey

The Wave 3 survey was an online survey designed to gather information about customer perceptions and experiences towards the end of the TOU trial period. The primary topics explored by this survey include:

- Participant engagement, experience, and satisfaction
- Participant behaviors and change in behaviors
- Participant understanding and change in understanding

Survey data were collected online through the Wave 3 survey in August 2019. The overall response rate of the Wave 3 survey was 36%, with 1,894 TOU participants completing the Wave 3 survey.

3. IMPACT ANALYSIS

The evaluation estimated changes in the energy consumption of customers on the RE-TOU rate through a series of regression models (see Section 2.2 for details), the findings from which were subsequently combined with the TOU rate structure to estimate bill impacts. The evaluation team performed the impact analysis across all customers segments and estimated the impacts both in aggregate (for all non-solar customers) as well as broken out by customer segment (including the solar customer segment).

Additionally, electric vehicle owners were excluded from each of the other non-solar customer segments due to the large impact of shifting electric vehicle charging. This provided a more externally applicable impact estimate for those customer segments due to the relatively low proportion of customers that currently own electric vehicles. In each segment, the exclusion of electric vehicle owners reduced the on-peak and off-peak impacts due to the absence of electric vehicle charging loads that can be shifted to off-peak hours using timer functions provided by charging equipment.

Table 3-1 provides a summary of the impact analysis findings for **non-solar customers without electric vehicles**, who in aggregate produced significant reductions in consumption during the on-peak and system coincident peak hours (3.2% reductions in summer months and 3.1% in winter months). Changes in annual energy consumption were virtually non-existent and in fact increased by 0.6%. For the average non-solar participant without an electric vehicle, combined with the RE-TOU rate structure these impacts yield an increase in summer bills and a decrease in winter bills, which net out to a 2.2% increase in the average annual cost of electricity.

Table 3-1. Impact Analysis Key Findings for Non-Solar Customers without Electric Vehicles

Season	Average System Coincident Peak Hour Impact		Average Hourly On-Peak Consumption Impact		Average Monthly Consumption Impact		Average Monthly Bill Impact	
Summer Months	-0.05 kWh	-3.0%	-0.04 kWh	-3.2%	8.3 kWh	1.2%	$3.67	4.4%
Winter Months	0.004 kWh	0.2%	-0.02 kWh	-3.1%	1.6 kWh	0.3%	-$1.08	-1.8%
October 2018 to July 2019	N/A				3.8 kWh *45.8 kWh annually*	0.6%	$1.51 *$18.07 annually*	2.2%

The ability to schedule vehicle charging with most home charging equipment enables **customers with electric vehicles** to shift a large load and respond to the rate in a manner that is different than all other customers. Table 3-2 provides a summary of the impact analysis findings for non-solar customers with electric vehicles, who in aggregate produced significant reductions in consumption during the on-peak and system coincident peak hours (13.3% on-peak reductions in summer months and 19.5% in winter months). Energy consumption increased slightly (0.5%) during the summer and decreased during the winter (2.2%) leading to an annual decrease in consumption of 1.2%. For the average non-solar participant with an electric vehicle, these impacts in combination with the RE-TOU rate structure yield a decrease in summer and winter bills, which yield a 7.3% decrease in the average annual cost of electricity.

Table 3-2. Impact Analysis Key Findings for Non-Solar Customers with Electric Vehicles

Season	Average System Coincident Peak Hour Impact		Average Hourly On-Peak Consumption Impact		Average Monthly Consumption Impact		Average Monthly Bill Impact	
Summer Months	-0.23 kWh	-12.0%	-0.22 kWh	-13.3%	5.3 kWh	0.5%	-$10.49	-7.4%
Winter Months	-0.34 kWh	-18.2%	-0.23 kWh	-19.5%	-21.4 kWh	-2.2%	-$7.26	-7.1%
October 2018 to July 2019	N/A				-12.5 kWh *-149.7 kWh annually*	-1.2%	-$8.34 *-$100.09 annually*	-7.3%

The financial motivations and characteristics[24] of **customers with solar**—and the resulting changes in consumption from the RE-TOU rate—are different than customers without solar. Consequently, the analysis of their impacts has been separated. Changes in the value of solar production on RE-TOU and the desire to maximize the ROI in solar provide these customers with additional incentives that accompany the RE-TOU rate. Including solar customers with the non-solar customers in the impact analysis would provide a misleading estimate of the aggregate impacts across all customer segments. Key impact analysis findings for customers with solar are shown below in Table 3-3.

Table 3-3. Impact Analysis Key Findings for Solar Customers

Season	Average System Coincident Peak Hour Impact		Average Hourly On-Peak Consumption Impact		Average Monthly Consumption Impact (Gross Consumption)		Average Monthly Bill Impact (Net Consumption)	
Summer Months	-0.61 kWh	-38.4%	-0.36 kWh	-29.9%	-41.3 kWh	-5.7%	-$14.19	-45.5%
Winter Months	-0.10 kWh	-5.0%	-0.09 kWh	-15.1%	74.8 kWh	13.5%	-$7.52	1.7%
October 2018 to July 2019	N/A				36.1 kWh *433.0 kWh annually*	5.9%	-$10.77 *-$129.28 annually*	-13.0%

In the impact figures presented in this report, the point estimates are represented by the grey dot and the 80% confidence intervals are represented by the green bars.

3.1 Peak Impacts

For RE-TOU participants, the average change in consumption was estimated for the on-peak period and separately for the system coincident peak hours. The system coincident peak hours are the single hour

[24] Customers with solar generally live in larger homes (66% in homes greater than 2,000 square feet) with large electric loads that can be shifted (23% own electric vehicles and 87% have smart thermostats connected to central air conditioning). This provides a greater opportunity to shift consumption than the average non-solar customer that live in relatively smaller homes (27% in homes greater than 2,000 square feet) and have smaller loads that can be shifted (5% own electric vehicles and 59% have smart thermostats connected to central air conditioning).

with the highest demand for Public Service's system during each month. These impact estimates address the times when the price or system demand is the highest.

3.1.1 Seasonal On-Peak Impacts

The on-peak period of the RE-TOU rate provides the greatest financial incentive for participants to reduce their consumption of energy. Figure 3-1. and Figure 3-2. provide the average summer and winter consumption impacts for each customer segment during on-peak hours, with non-solar customers without electric vehicles achieving a 3.2% reduction in on-peak consumption. Details on the impact analysis methodology and regression model specifications can be found in Section 2.2. The following are key observations:

- Except for renters, each segment has relatively consistent impacts to their on-peak consumption across both seasons.
- Electric vehicle customers reduce on-peak consumption by more than twice that of any other segment. This is most likely due to shifting vehicle charging away from on-peak hours.
- Low income customers have the smallest impact estimates during the summer and are the only segment without a statistically significant reduction in on-peak consumption during either season.

Figure 3-1. Summer On-Peak Consumption Impact

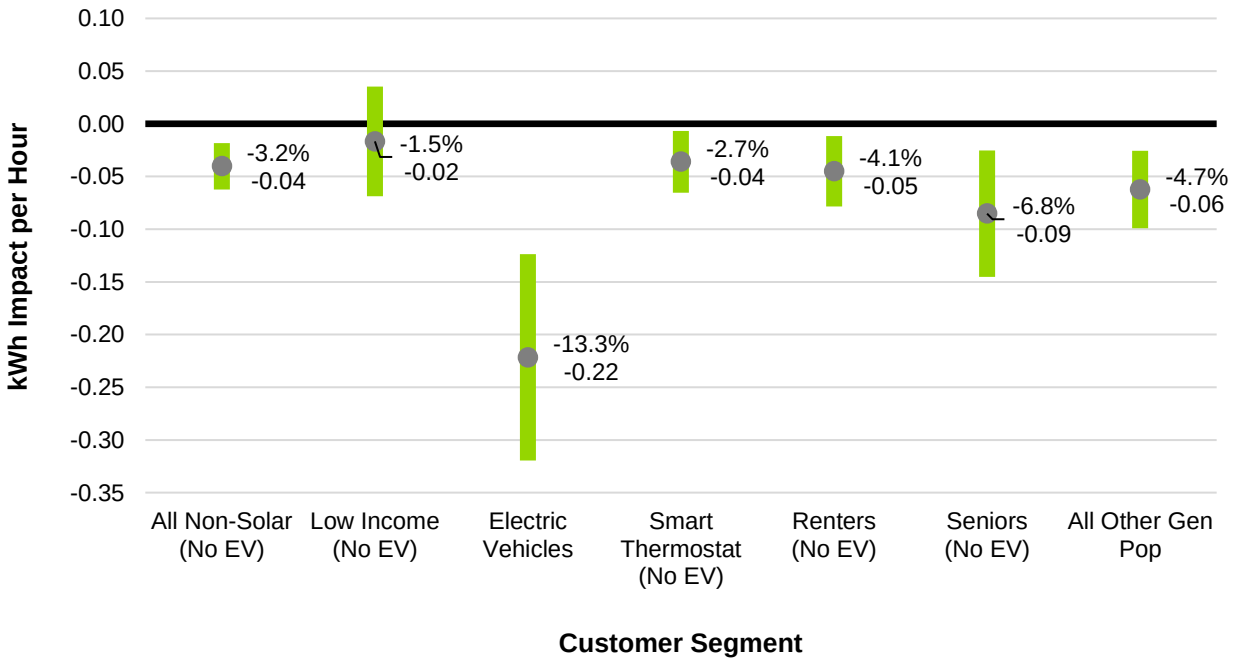
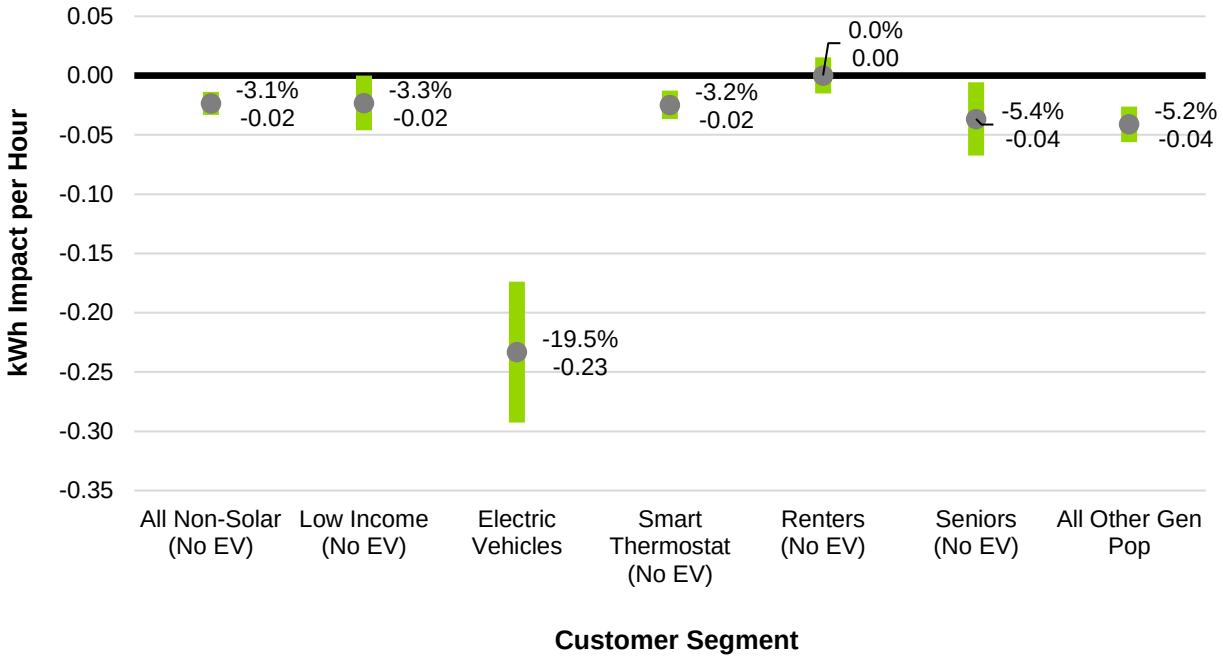


Figure 3-2. Winter On-Peak Consumption Impact



3.1.2 Seasonal System Coincident Peak Consumption Impacts

System coincident peak consumption impacts are the average reduction in consumption that happened during the system's peak hour each month. In most months, the system coincident peak hour was during the on-peak period. However, some of the winter season's peak hours occurred during the weekday evening shoulder period. Figure 3-3. and Figure 3-4. provide the average summer and winter on-peak impacts for each customer segment. Details on the impact analysis methodology and regression model specifications can be found in Section 2.2. The following are key observations:

- Participants mostly have a statistically insignificant reduction in system coincident peak consumption during the summer. Most likely due to system coincident peak hours occurring during on-peak hours.
- Participants mostly have a statistically insignificant change in coincident peak consumption during the winter. Winter system coincident peak hours occasionally occur in the evening shoulder hours, so that may be the reason for participants not reducing consumption that is coincident with the winter system coincident peak hours.

Figure 3-3. Summer RE-TOU System Coincident Peak Impact

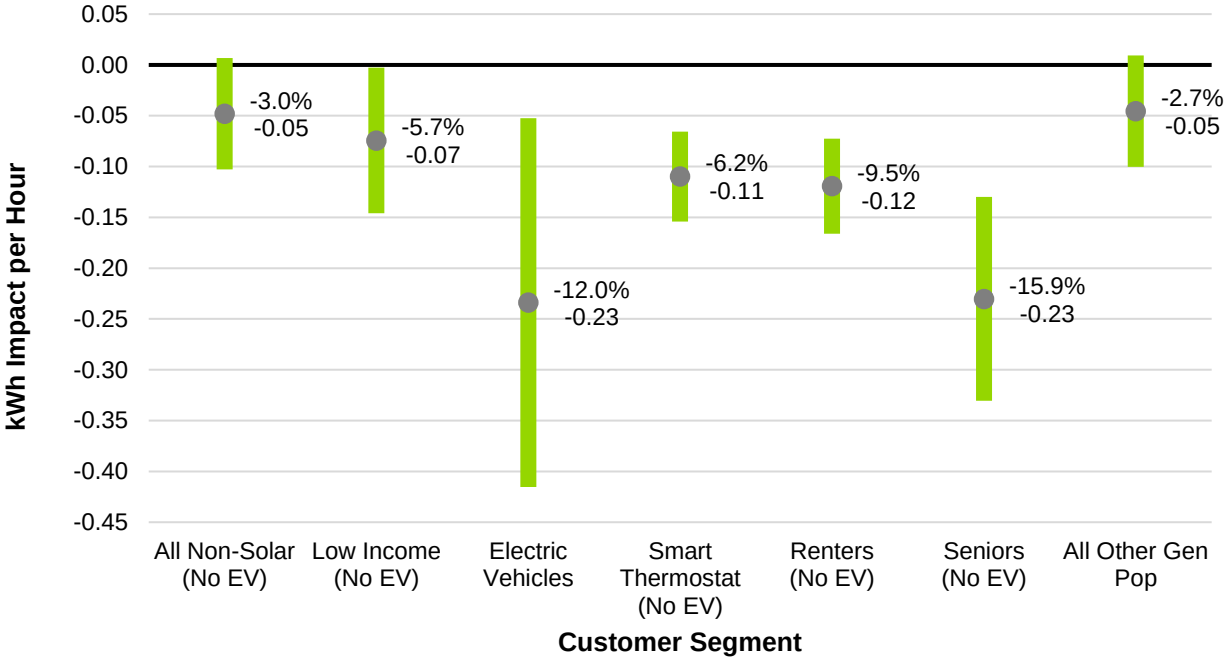
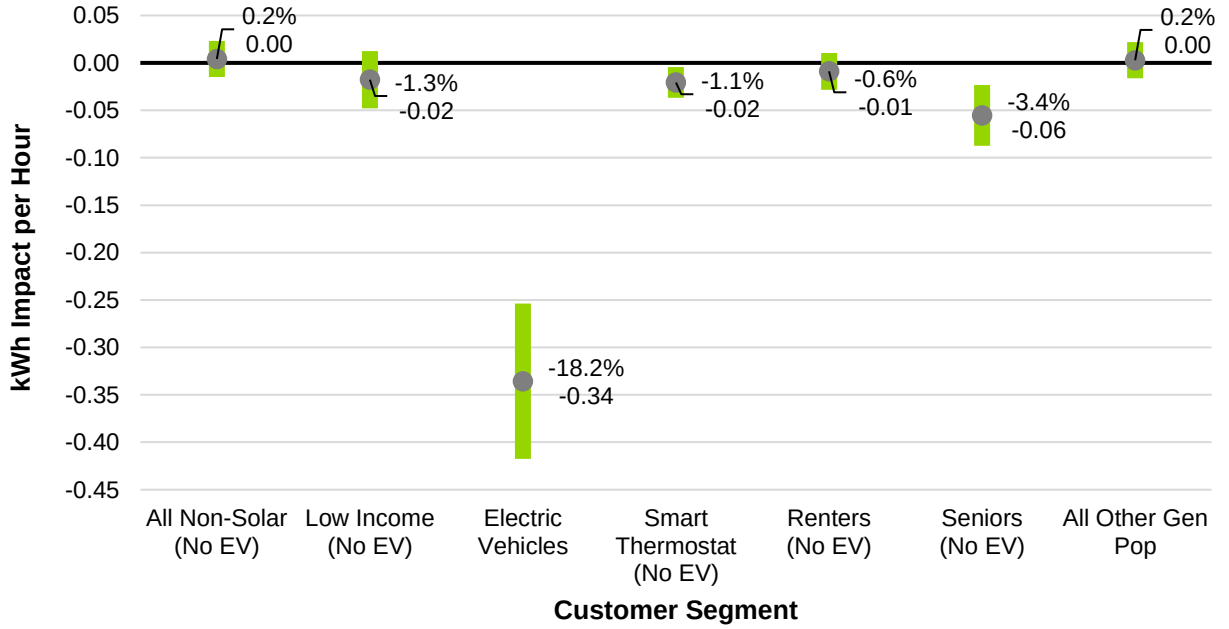


Figure 3-4. Winter RE-TOU System Coincident Peak Impact



3.2 Energy Consumption Impacts

Many participants on RE-TOU responded to the rate structure by changing their usage in each of the pricing periods. These changes in usage vary in statistical significance, but both solar and non-solar participants are responding to the price signals in aggregate.

For the shoulder period impact analysis, the period was divided into three parts (morning shoulder, evening shoulder, and weekend shoulder) to identify how customers' responses to the shoulder period varied based on the part of day or type of day in the shoulder period. The morning shoulder consists of the shoulder period hours that occurred prior to the on-peak period on weekdays (9 a.m.-2 p.m.), the evening shoulder consists of the shoulder period hours that occurred after the on-peak period on weekdays (6 p.m.-9 p.m.), and the weekend shoulder consists of the shoulder period hours on weekends (9 a.m.-9 p.m.).

Figure 3-5 and Figure 3-6 provide the average summer and winter energy consumption impacts by rate period for **non-solar participants.** Details on the energy consumption impact analysis methodology and regression model specifications can be found in Section 2.2. The following are key observations:

- Across both seasons, participants appear to be reducing consumption during the morning shoulder and on-peak hours while increasing consumption during the evening shoulder, weekend shoulder, and off-peak hours.
- Impacts within the shoulder period vary depending on whether the hours fall before in on-peak period (reduced consumption) or during the evening/weekend (increased consumption).

Figure 3-5. Summer RE-TOU Energy Consumption Impacts – All Non-Solar (No EV)

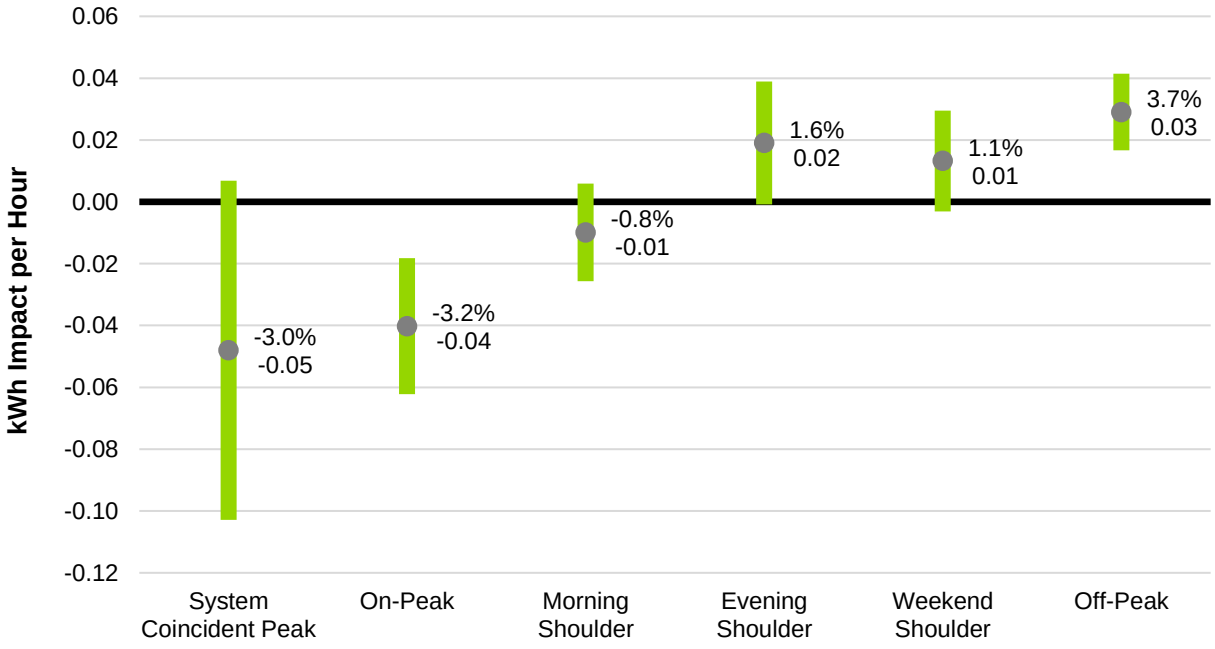


Figure 3-6. Winter RE-TOU Energy Consumption Impacts – All Non-Solar (No EV)

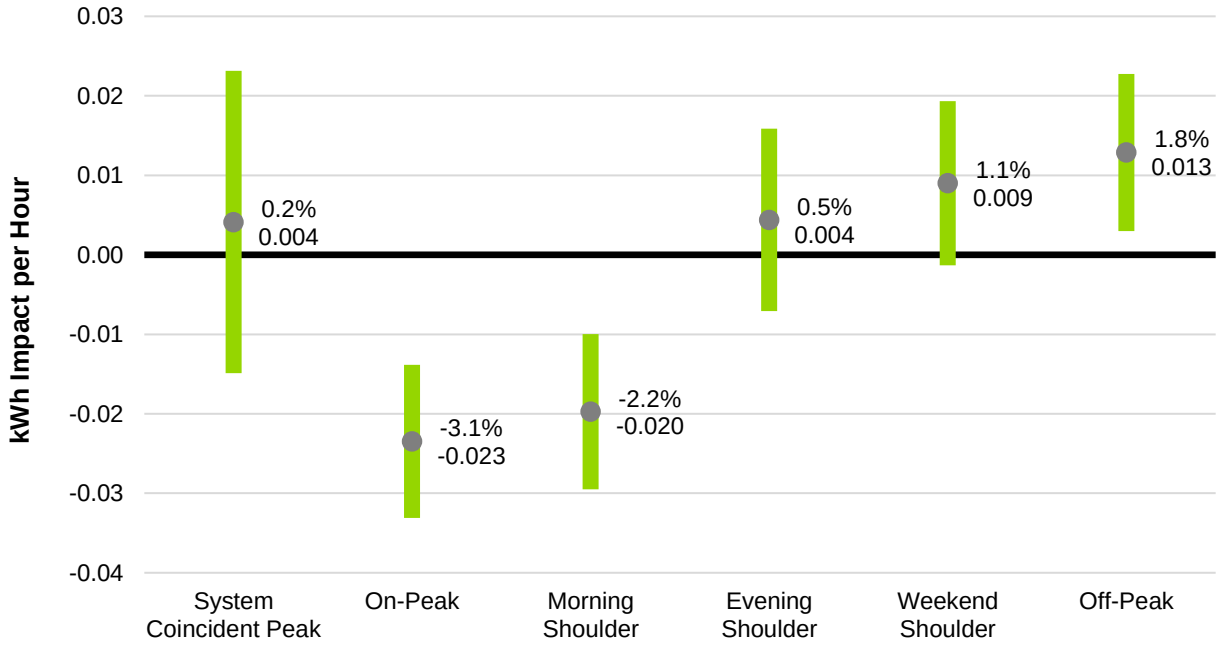


Figure 3-7. and Figure 3-8. provide the average summer and winter energy consumption impacts by rate period for solar participants. Details on the energy consumption impact analysis methodology and regression model specifications can be found in Section 2.2. The following are key observations:

- During the summer, solar customers are reducing consumption during the on-peak and shoulder periods. Increases in consumption during the off-peak period are statistically different than zero, but it appears that there is more conservation of energy than shifting consumption between rate periods.
- During the winter, solar customers are reducing consumption during the on-peak period and increasing consumption during the shoulder and off-peak period. The impacts during the shoulder period are only statistically different than zero during the weekday evening and weekend parts of the shoulder period.

Figure 3-7. Summer RE-TOU Energy Consumption Impacts - Solar

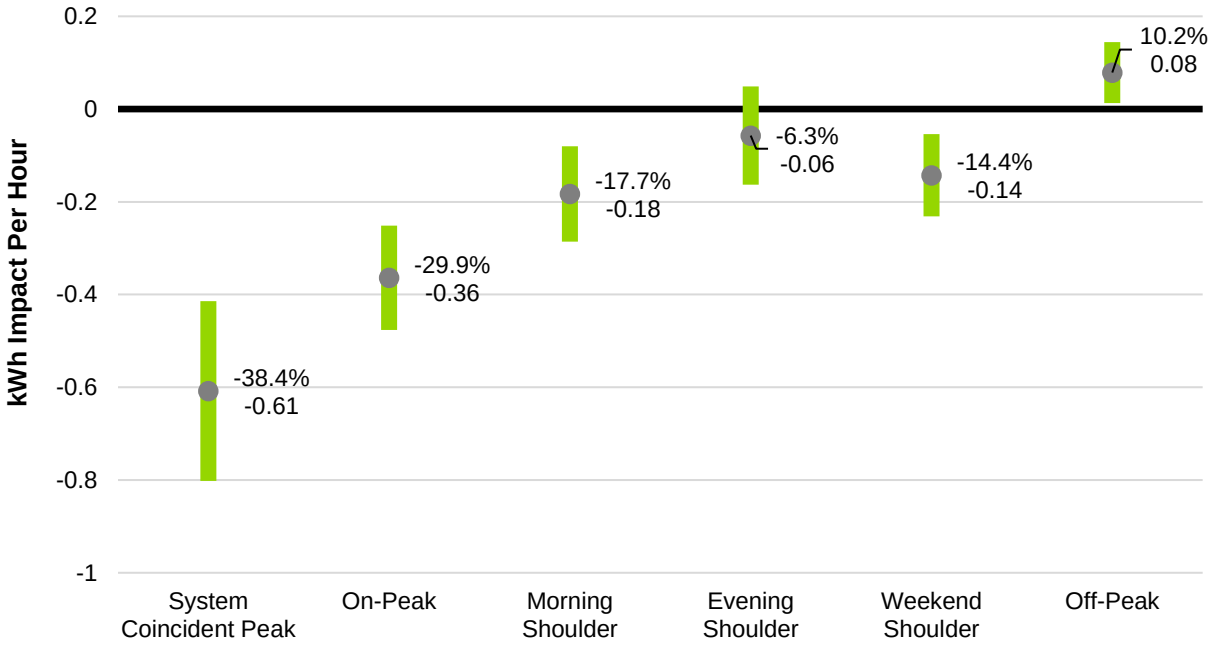


Figure 3-8. Winter RE-TOU Energy Consumption Impacts - Solar

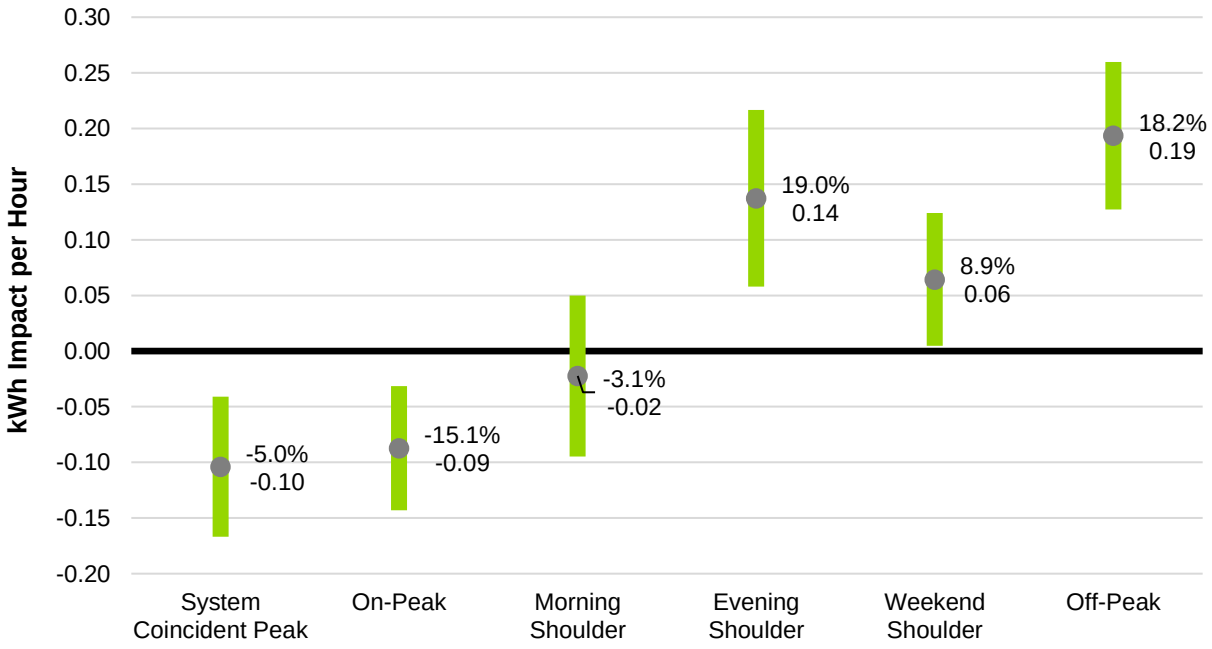


Table 3-4 and Table 3-5 provide the average impact on total monthly energy consumption during the summer and winter. The monthly consumption has been normalized to represent a month with 30 days (22 weekdays and eight weekend days). The impact on monthly consumption has been calculated by

multiplying the average hourly impact for each rate period by the number of hours in the normalized month for each rate period. The following are key observations:

- Seniors, general population, and solar are reducing their monthly consumption during the summer.
- Low income, electric vehicles, and the general population are reducing their monthly consumption during the winter.
- The electric vehicle segment has the highest monthly consumption year-round.

Table 3-4. Summer RE-TOU Monthly Consumption Impacts

Segment	Average Normalized Monthly Consumption Pre-Enrollment	Average Normalized Monthly Consumption Post-Enrollment	Average Normalized Monthly Consumption Impact (kWh)	Average Normalized Monthly Consumption Impact (%)
All Non-Solar (No EV)	707.5	715.8	8.3	1.2%
Low Income (No EV)	630.1	637.3	7.2	1.1%
Electric Vehicles	1100.8	1106.2	5.3	0.5%
Smart Thermostat (No EV)	752.2	764.7	12.6	1.7%
Renters (No EV)	639.1	643.5	4.4	0.7%
Seniors (No EV)	644.0	641.7	-2.3	-0.4%
Gen Pop	741.2	738.9	-2.2	-0.3%
Solar (Gross)	723.6	682.3	-41.3	-5.7%

Table 3-5. Winter RE-TOU Monthly Consumption Impacts

Segment	Average Normalized Monthly Consumption Pre-Enrollment	Average Normalized Monthly Consumption Post-Enrollment	Average Normalized Monthly Consumption Impact (kWh)	Average Normalized Monthly Consumption Impact (%)
All Non-Solar (No EV)	561.2	562.7	1.6	0.3%
Low Income (No EV)	519.4	508.0	-11.4	-2.2%
Electric Vehicles	974.8	953.4	-21.4	-2.2%
Smart Thermostat (No EV)	577.9	578.4	0.5	0.1%
Renters (No EV)	478.8	486.4	7.6	1.6%
Seniors (No EV)	482.3	486.4	4.1	0.8%
Gen Pop	598.4	591.9	-6.5	-1.1%
Solar (Gross)	554.5	629.3	74.8	13.5%

3.2.1 Energy Consumption Impacts by Segment

The following charts include the summer energy consumption impacts by rate period for each customer segment. Generally, customer segment level impact estimates have wider confidence intervals than the broader non-solar analysis that includes these segments. This is partially due to the sample sizes of each segment. See Figure 3-9 for the number of participants and control group customers within each segment for this analysis.

3.2.1.1 Low Income (No EV) Consumption Impacts

Figure 3-9. Summer RE-TOU Energy Consumption Impacts – Low Income

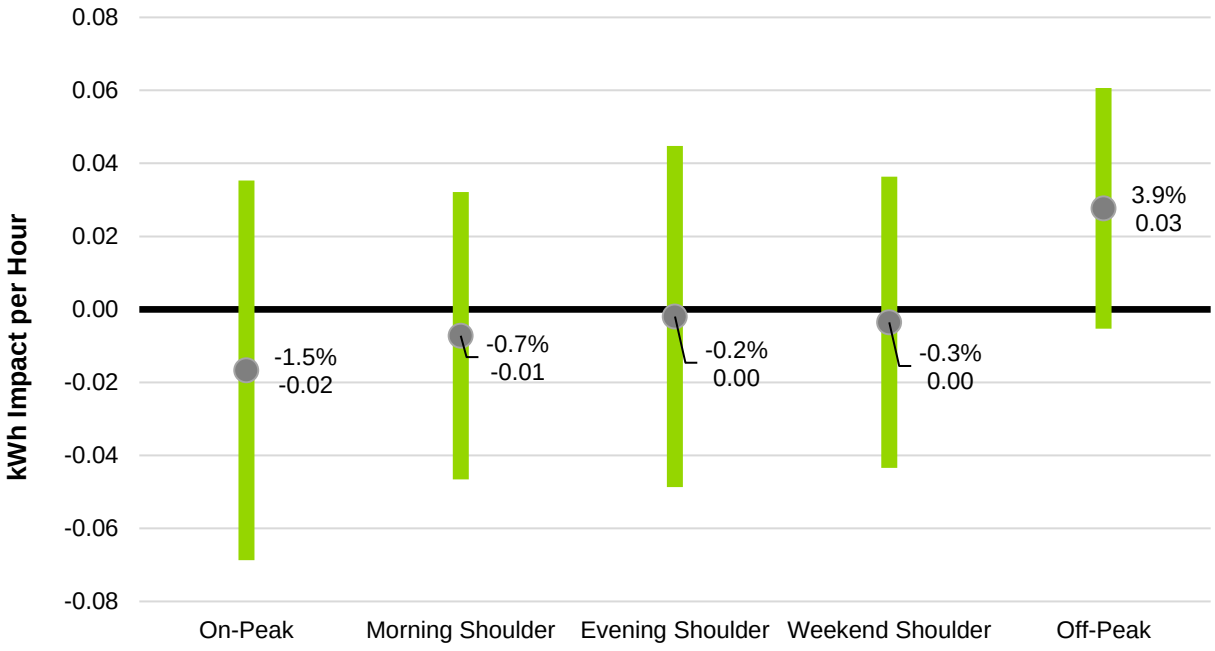
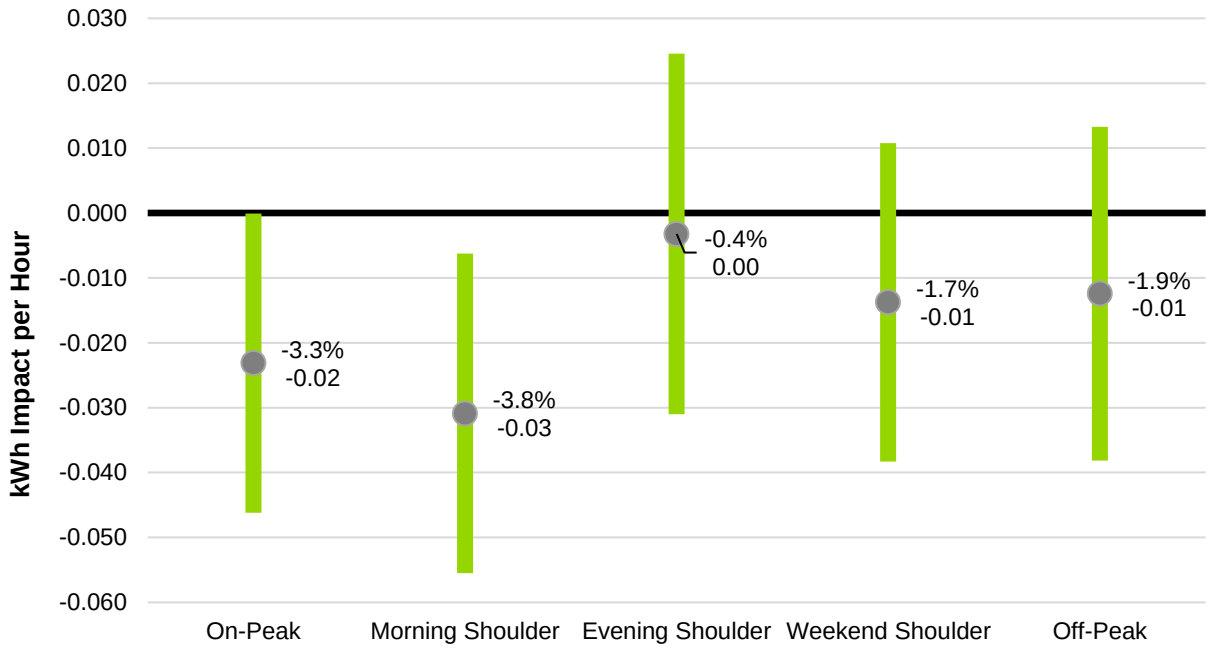


Figure 3-10. Winter RE-TOU Energy Consumption Impacts – Low Income



3.2.1.2 Electric Vehicles Consumption Impacts

Figure 3-11. Summer RE-TOU Energy Consumption Impacts – Electric Vehicles

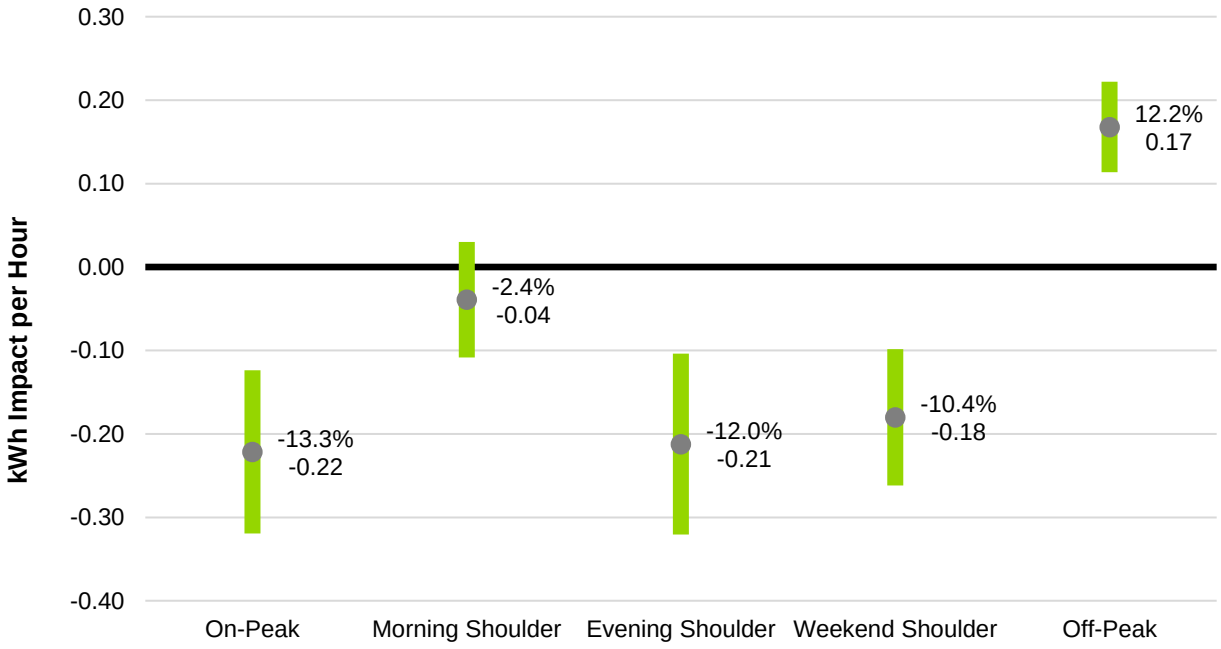
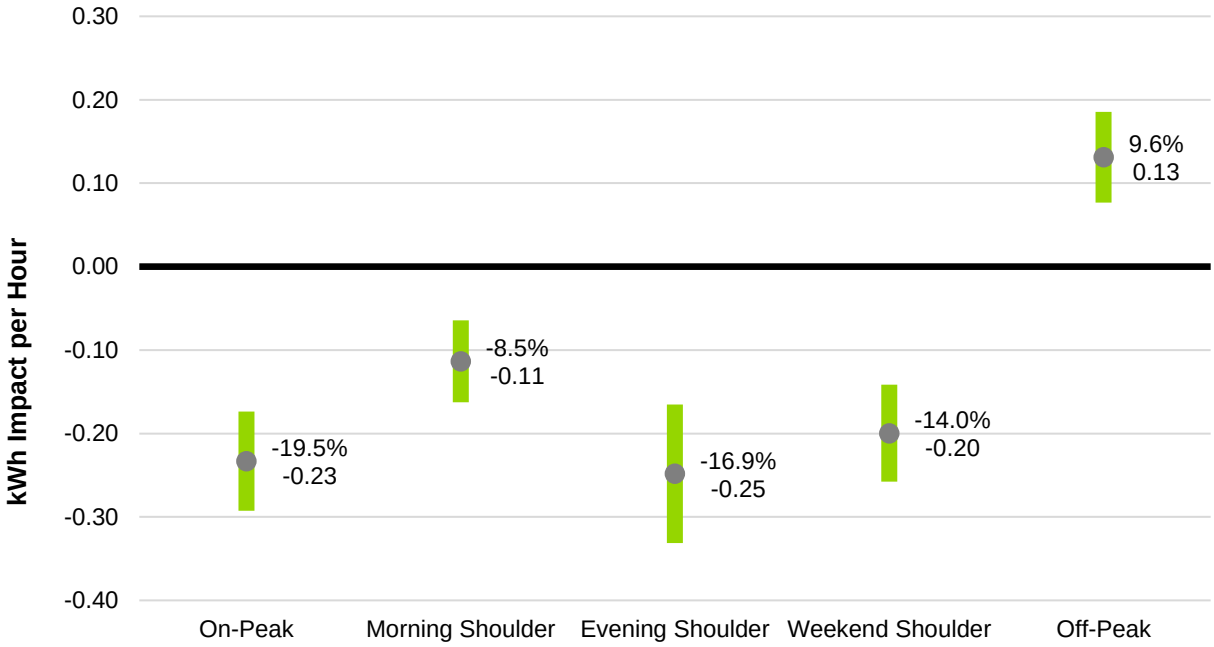


Figure 3-12. Winter RE-TOU Energy Consumption Impacts – Electric Vehicles



3.2.1.3 Smart Thermostat (No EV) Consumption Impacts

Figure 3-13. Summer RE-TOU Energy Consumption Impacts – Smart Thermostats

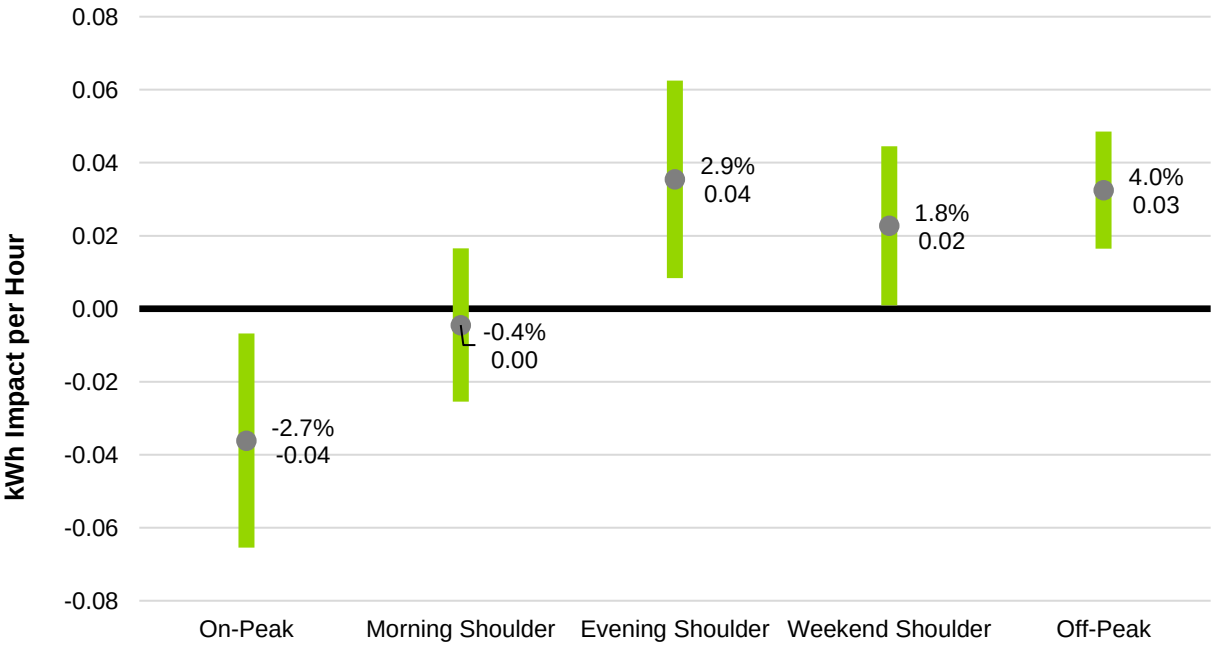
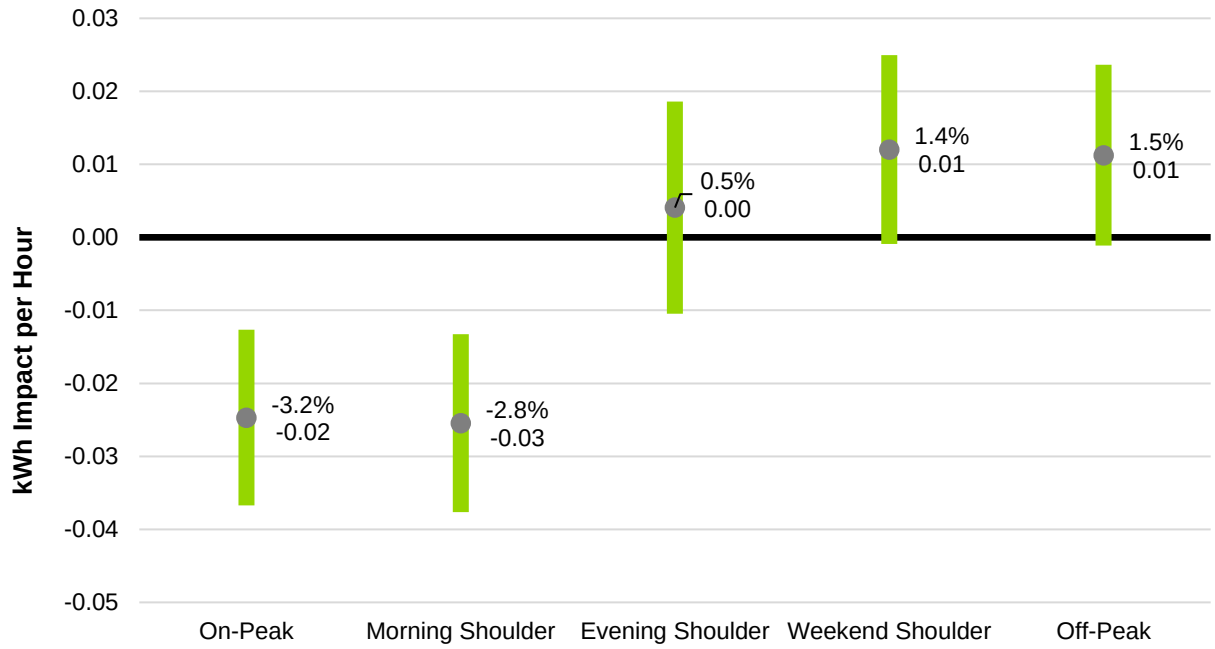


Figure 3-14. Winter RE-TOU Energy Consumption Impacts – Smart Thermostats



3.2.1.4 Renters (No EV) Consumption Impacts

Figure 3-15. Summer RE-TOU Energy Consumption Impacts – Renters

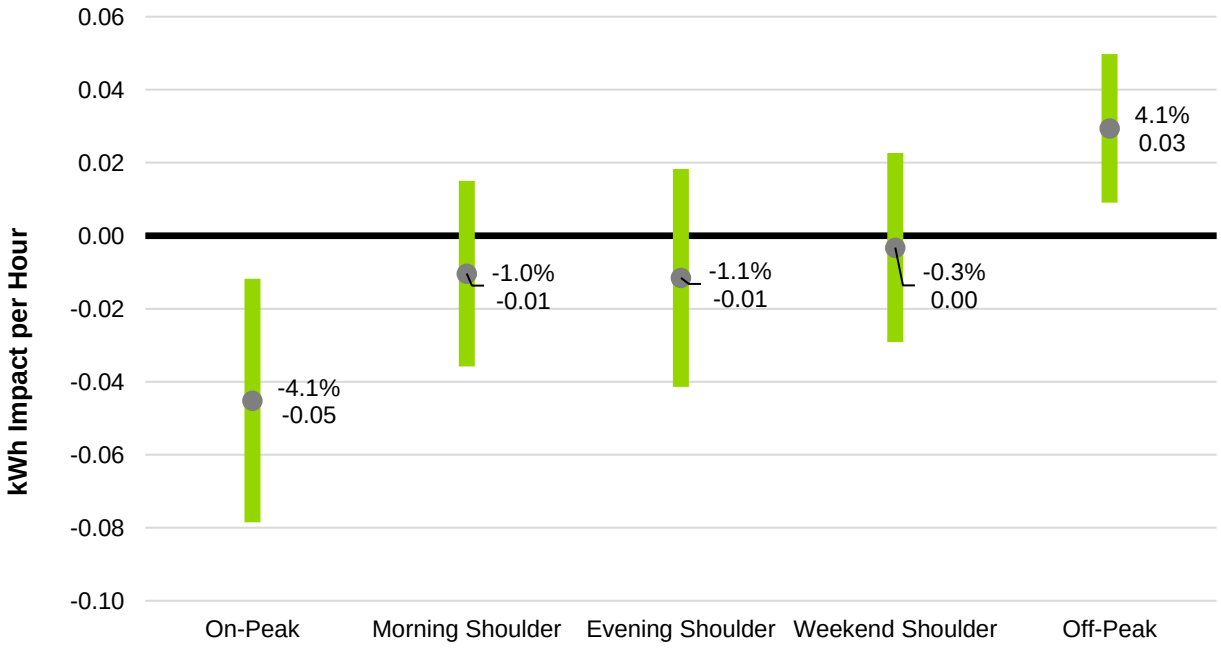
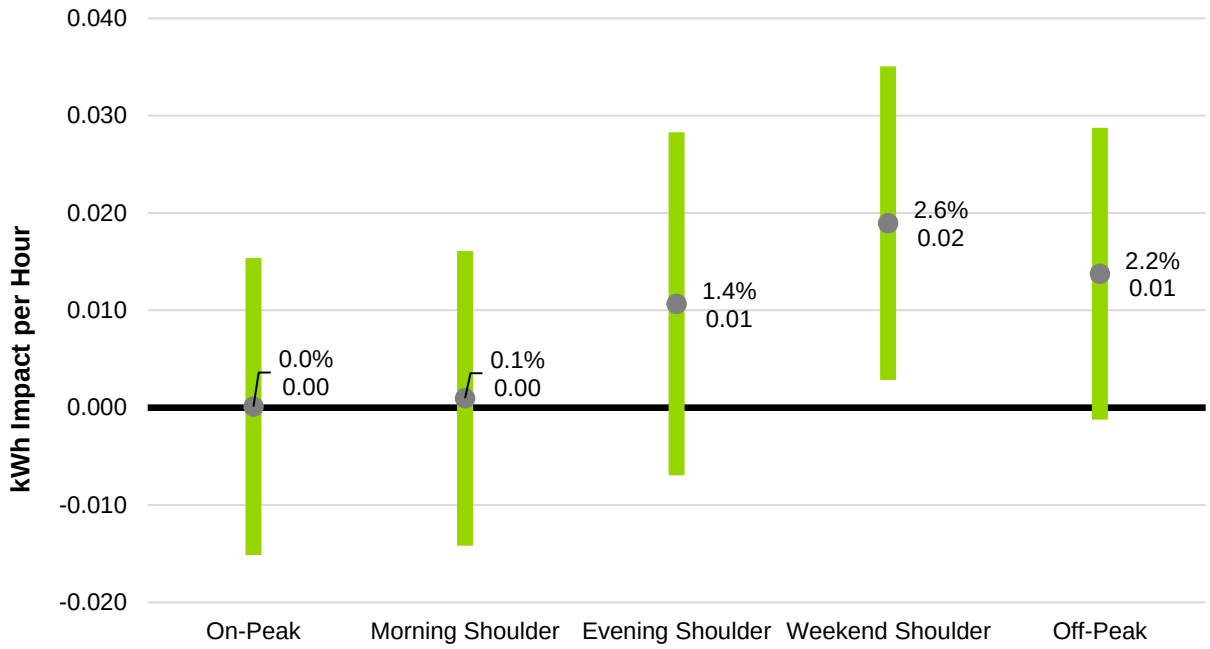


Figure 3-16. Winter RE-TOU Energy Consumption Impacts – Renters



3.2.1.5 Seniors (No EV) Consumption Impacts

Figure 3-17. Summer RE-TOU Energy Consumption Impacts – Seniors

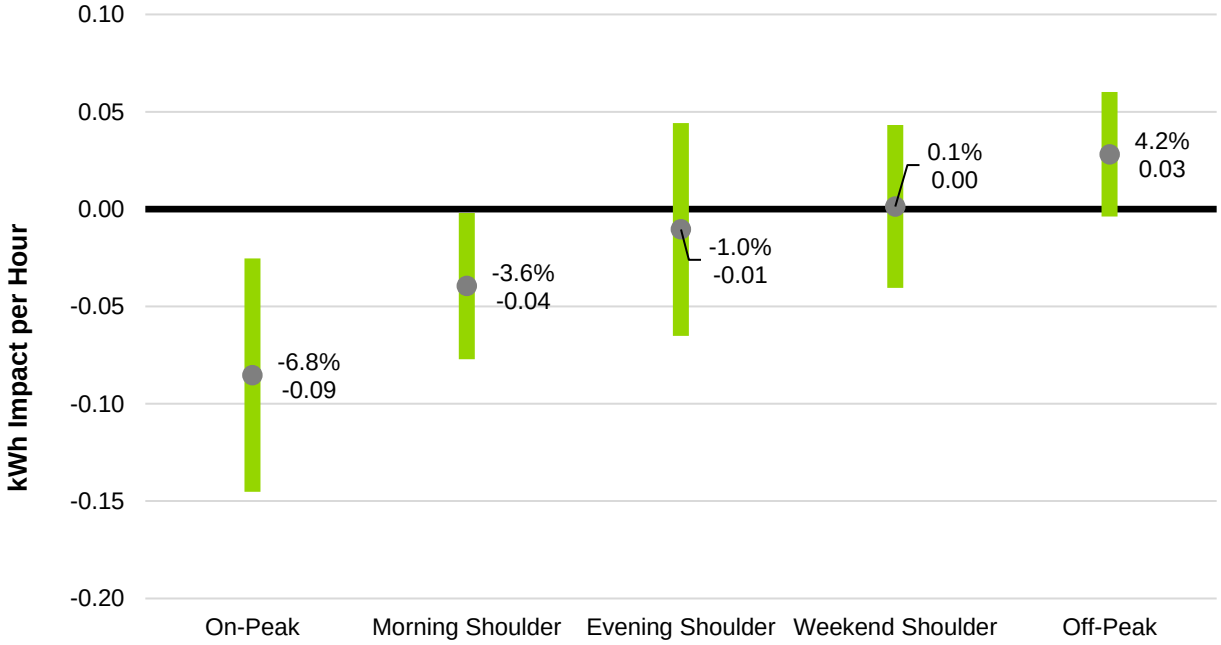
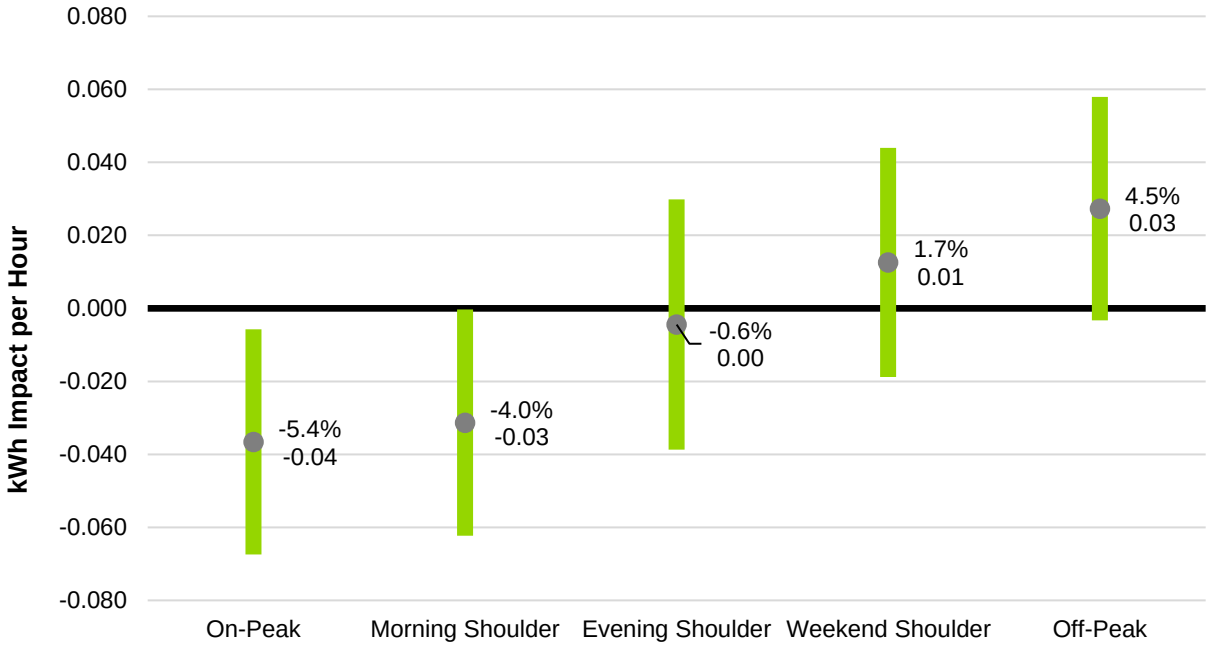


Figure 3-18. Winter RE-TOU Energy Consumption Impacts – Seniors



3.2.1.6 General Population Consumption Impacts

Figure 3-19. Summer RE-TOU Energy Consumption Impacts – General Population

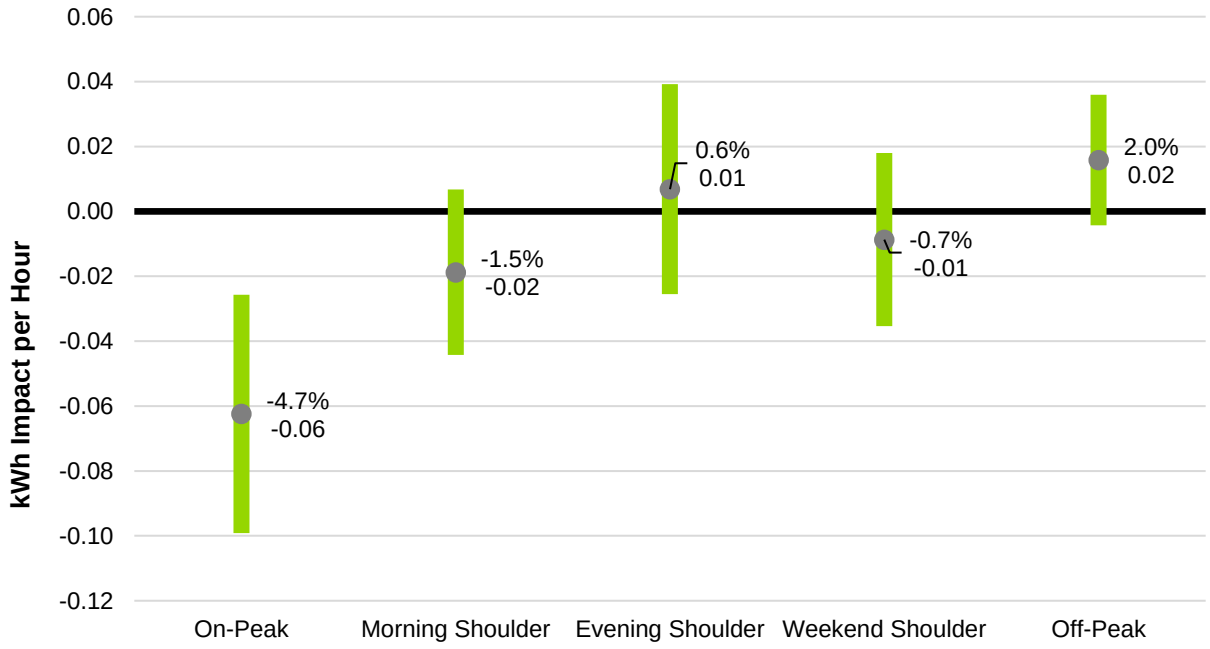
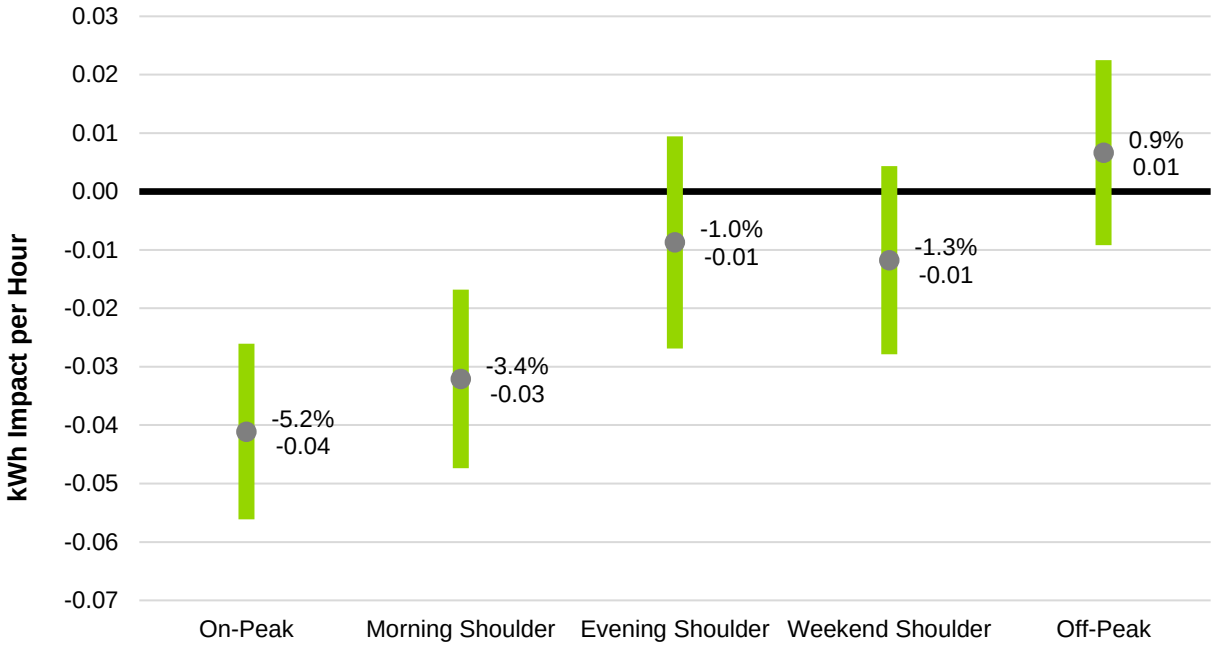


Figure 3-20. Winter RE-TOU Energy Consumption Impacts – General Population



3.2.1.7 Solar Gross Consumption Impacts

Figure 3-21. Summer RE-TOU Energy Consumption Impacts – Solar

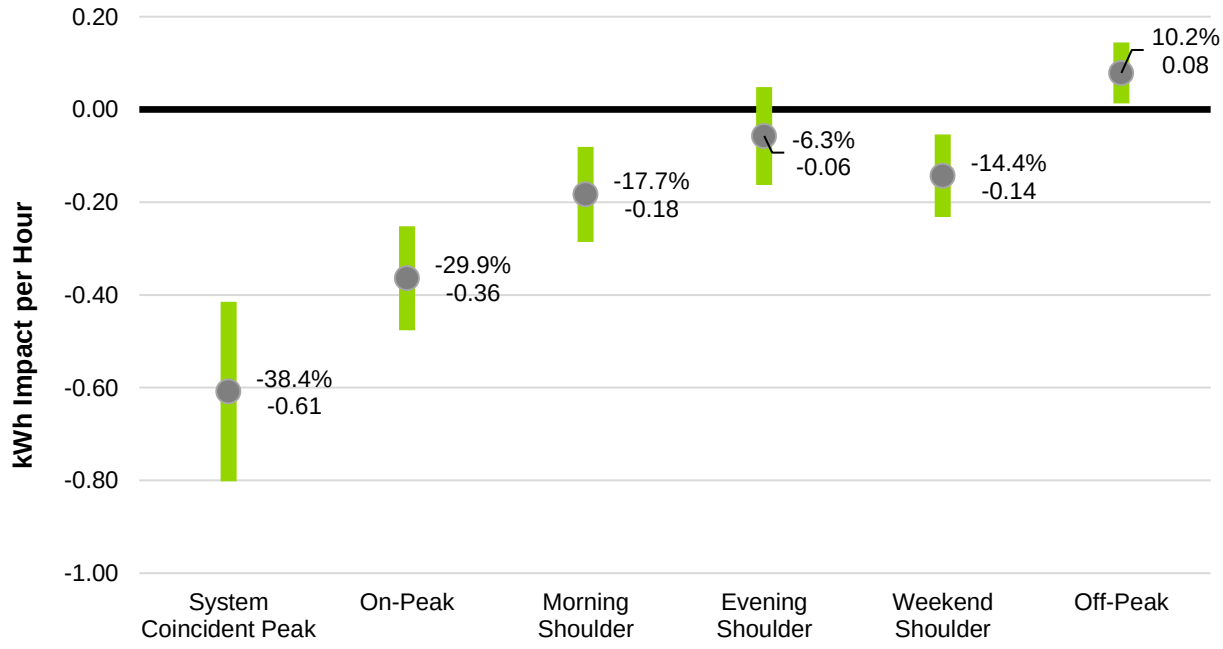
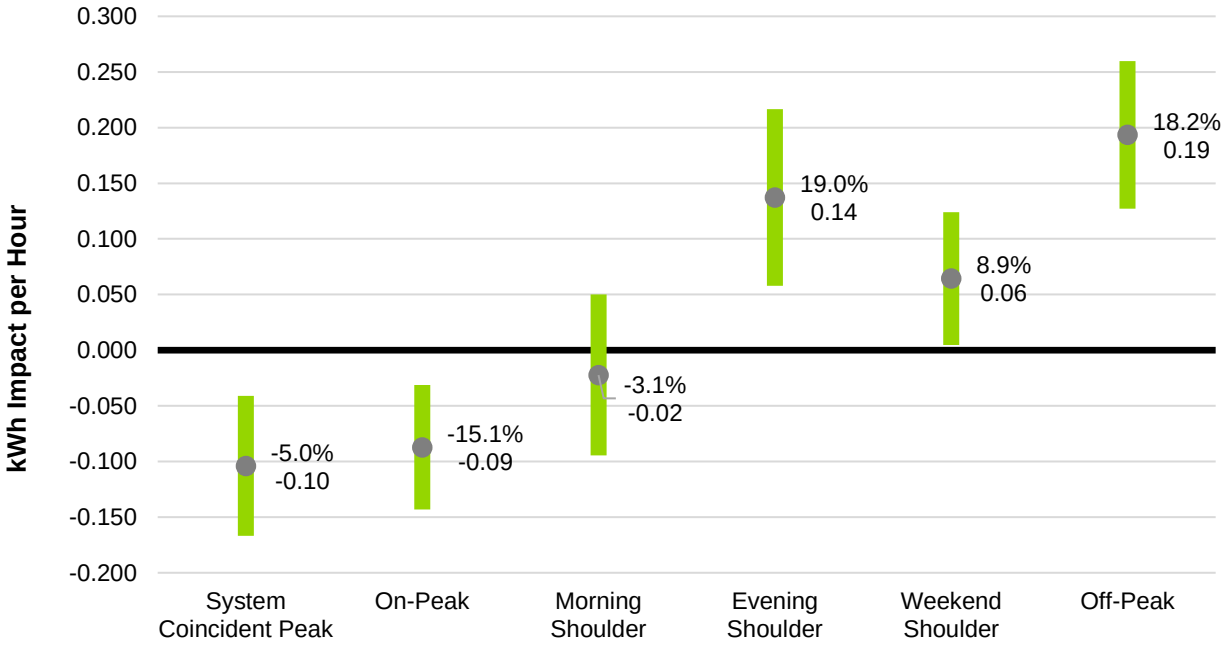


Figure 3-22. Winter RE-TOU Energy Consumption Impacts – Solar



3.3 Bill Impacts

Estimates of the impacts on consumption in each rate period were combined with the applicable prices to estimate the impact on the average participant's bill relative to what it would have been on the R rate, accounting for both the change in rate structure and the estimated change in consumption behavior. Consumption impacts and prices vary between the summer and winter seasons, so the average monthly impact was calculated for each season independently. Monthly bill impacts for each season were combined and annualized to estimate the cumulative annual impact on the average customer's bill and the Company's revenue collections.

As shown in Table 3-7 and Table 3-8, participants on RE-TOU transitioned from an inclining block rate during the summer (Tier I and Tier II) and a flat rate in the winter to a time-varying rate year-round with seasonal differences. A key aspect of this transition is how a customer's level of consumption is related to the RE-TOU bill impact during the summer. It is difficult for customers with less than 500 kWh of monthly consumption to save on RE-TOU during the summer since only the off-peak period has a price lower than the first 500 kWh of consumption on R ($0.08 versus $0.10 per kWh). A customer's ability to reduce their bill during the summer on RE-TOU increases when they have more consumption that would have been more than 500 kWh on R and billed at the higher block's rate on R. This is an important distinction as the average bill impacts were calculated for the summer but vary based on a customer's level of consumption. This phenomenon does not persist in the winter due to a constant price for all consumption on R.

Bill impacts are based on the average consumption of participants in the trial and are not the average of individual participant bill impacts. This is due to the behavioral impact estimates being an average across all participants and those impacts do not reflect the exact behavior of any individual participant. Bill impacts should not be broadly interpreted as a measure of revenue neutrality since they are based on a

bill calculation with the average consumption of participants and do not represent the cumulative distribution of bill impacts across all participants. RE-TOU rate design was based on load research data[25] that differs from the average consumption and load profile of customers that self-selected to participate in the trial. Deviations from revenue neutrality within the trial can be attributed to the differences shown in Table 3-6.

Table 3-6. RE-TOU Rate Design Assumptions vs Participant Usage

	Xcel Baseline Rate Design Assumptions	Trial Participants	Difference
Annual Avg Monthly Consumption	629.0 kWh	609.9 kWh	-19.0 kWh
Annual Consumption Allocation - Summer	718.5 kWh	707.5 kWh	-11.0 kWh
Annual Consumption Allocation - Winter	584.2 kWh	561.2 kWh	-23.1 kWh
Summer Energy Consumption Allocation by Rate Period			
On-Peak	15.6%	15.5%	-0.05%
Shoulder	44.9%	47.2%	2.3%
Off-Peak	39.5%	37.2%	-2.3%
Winter Energy Consumption Allocation by Rate Period			
On-Peak	11.8%	11.7%	-0.2%
Shoulder	41.9%	44.0%	2.1%
Off-Peak	46.3%	44.3%	-2.0%

Table 3-7. RE-TOU Rate Structure

RE-TOU	Off-Peak	Shoulder	On-Peak	Service and Facility Charge
Hours	9 p.m. -9 a.m.	9 a.m.-2 p.m., 6 p.m.-9 p.m. on Weekdays, 9 a.m.-9 p.m. Weekends	2 p.m.-6 p.m. on Weekdays	
Summer	$0.08/kWh	$0.13/kWh	$0.18/kWh	$5.41
Winter	$0.08/kWh	$0.10/kWh	$0.14/kWh	$5.41

Table 3-8. R Rate Structure

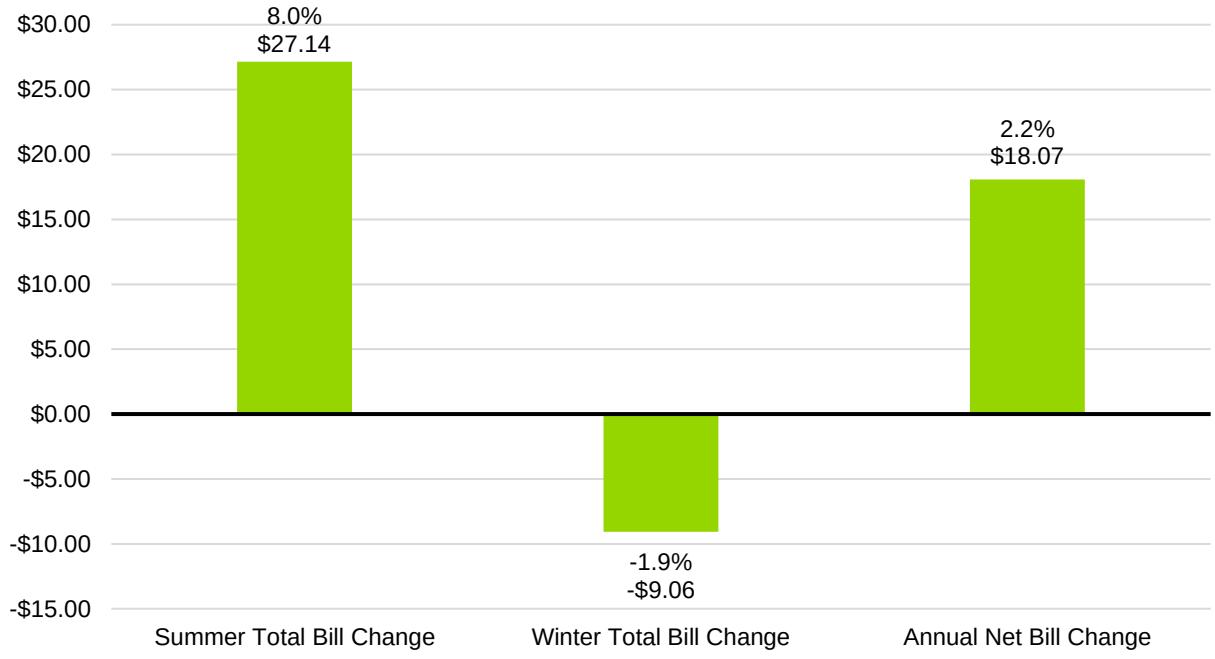
R	First 500 kWh of Consumption (Tier I)	Consumption Over 500 kWh (Tier II)	Service and Facility Charge
Summer	$0.10/kWh	$0.14/kWh	$5.41
Winter	$0.10/kWh	$0.10/kWh	$5.41

[25] Public Service primarily relied on residential load shape data from its load research data, which consists of interval meter data for less than 500 customers.

3.3.1 Aggregate Seasonal Bill Impacts

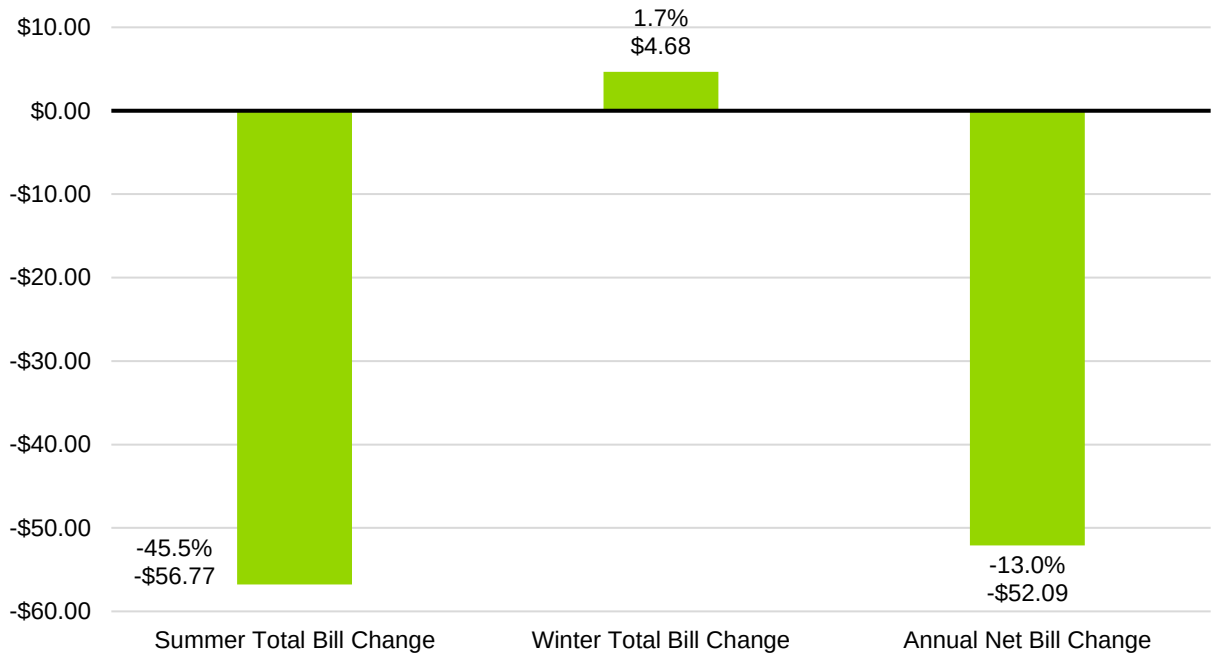
As shown in Figure 3-23, the cumulative annual bill for the average non-solar (no EV) RE-TOU participant increases by 2.2% or $18.07. Bill increases during the summer are partially offset by winter bill decreases, and the outcome is close to being revenue neutral for the average customer's usage (716 kWh average summer monthly usage and 563 kWh average winter monthly usage).

Figure 3-23. RE-TOU Bill Impacts by Season and Annual – Non-Solar (No EV)



In contrast to the modest bill impact for non-solar customers, Figure 3-24 shows a summer bill reduction of $56.77, winter bill increase of $4.68, and an annual bill reduction of $52.09, or 13.0% for the average RE-TOU participant with solar. This is partially a result of an increase in the value of energy produced by solar during the shoulder and on-peak periods relative to R. The average customer has 261 kWh of net monthly usage with 463 kWh of monthly solar production during the summer and 293 kWh of net monthly usage with 260 kWh of monthly solar production during the winter.

Figure 3-24. RE-TOU Bill Impacts by Season and Annual – Solar



3.3.2 Composition of Bill Impact

There are two main factors that determine the impact of RE-TOU on a customer's bill:

- **Rate structure change.** Customers with higher usage are more likely to benefit from the transition from the inclining block rate of the R rate to the RE-TOU rate structure. This is due to higher usage customers previously having more usage billed on the higher tier of the R rate than lower usage customers, meaning they would have paid a higher average price per kilowatt-hour on R. By moving to the RE-TOU rate, these high usage customers are more likely to see bill reductions even in the absence of any changes in usage patterns.
- **Change in usage patterns/behavior.** Changes in the time of day that a customer uses energy will have an impact on the bill, depending on the magnitude of the changes across the various rate periods. By decreasing usage during the on-peak and shoulder periods or shifting usage to the off-peak period, RE-TOU participants contributed to reducing their bill. Similarly, any reduction in total usage—even with the same relative usage patterns over time—will reduce the customer's bill.

The net of the structural bill impact and the impact from behavior changes constitutes the monthly bill impact for a RE-TOU participant.

Figure 3-25 and Figure 3-26 show the breakdown of how the rate structure change and behavior impacts contribute to the average monthly bill impact during the summer and winter for non-solar customers. The summer bill impact is mostly driven by the rate structure change increasing the average customer's bill while changes in usage behavior offsets a portion of the bill increase. Conversely, the winter bill impact is mostly driven by the rate structure change decreasing the average customer's bill with changes in usage behavior slightly offsetting some of the decrease due to an increase in off-peak consumption.

Figure 3-25. RE-TOU Summer Monthly Bill Impact – All Non-Solar (No EV)

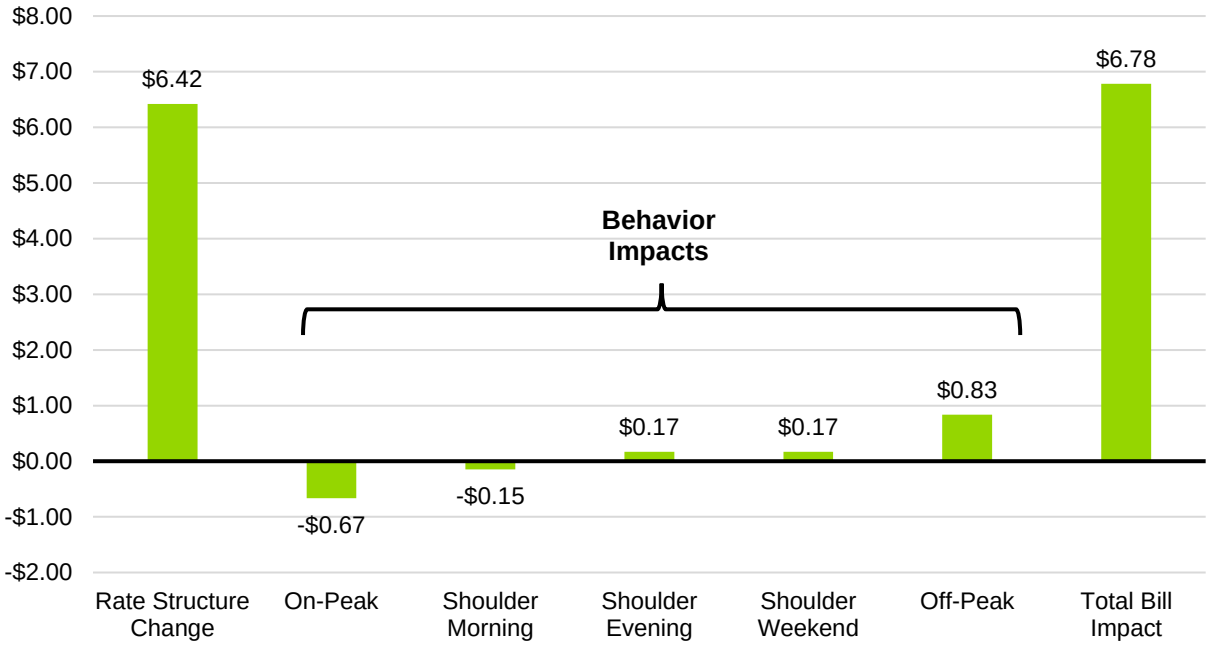


Figure 3-26. RE-TOU Winter Monthly Bill Impact - All Non-Solar (No EV)

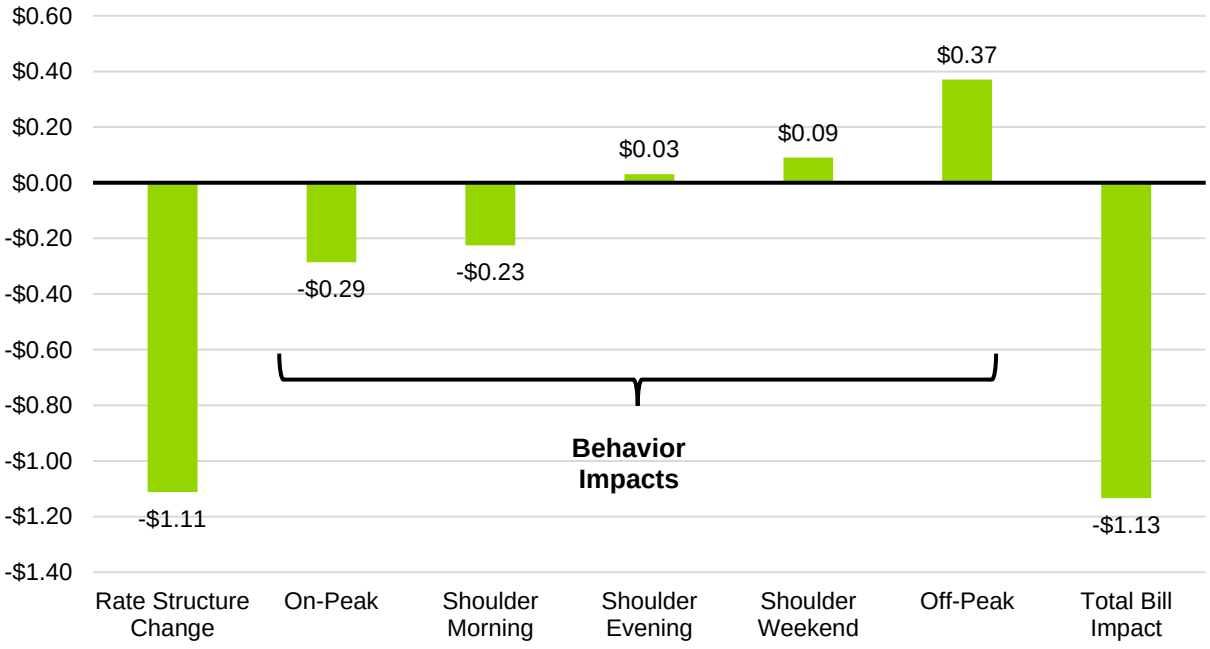


Figure 3-27 and Figure 3-28 show the breakdown of how the rate structure change and behavior impacts contribute to the average monthly bill impact during the summer and winter for solar customers. The bill impacts in both seasons are driven by the rate structure change decreasing the average customer's bill along with changes in usage behavior providing further bill decreases. Solar production during the

shoulder and on-peak periods is monetized at a higher value on RE-TOU than on R. The increased value of solar production outweighs the bill increases that would occur for a non-solar customer with similar net usage.

Figure 3-27. RE-TOU Summer Monthly Bill Impact - Solar

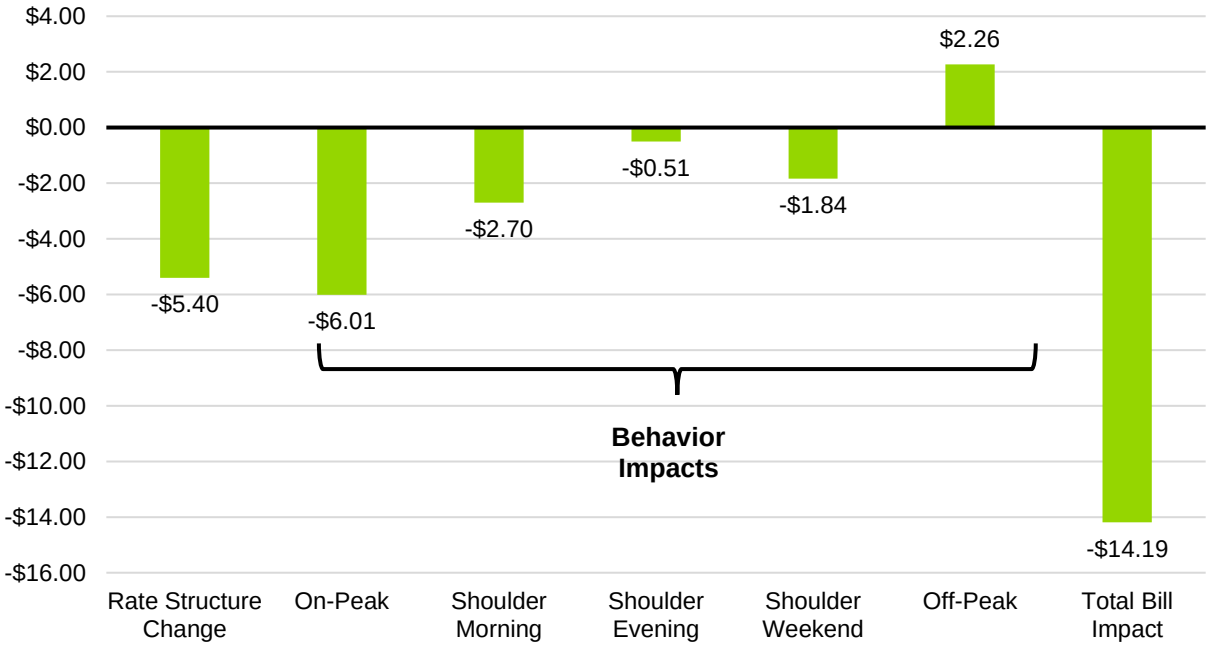
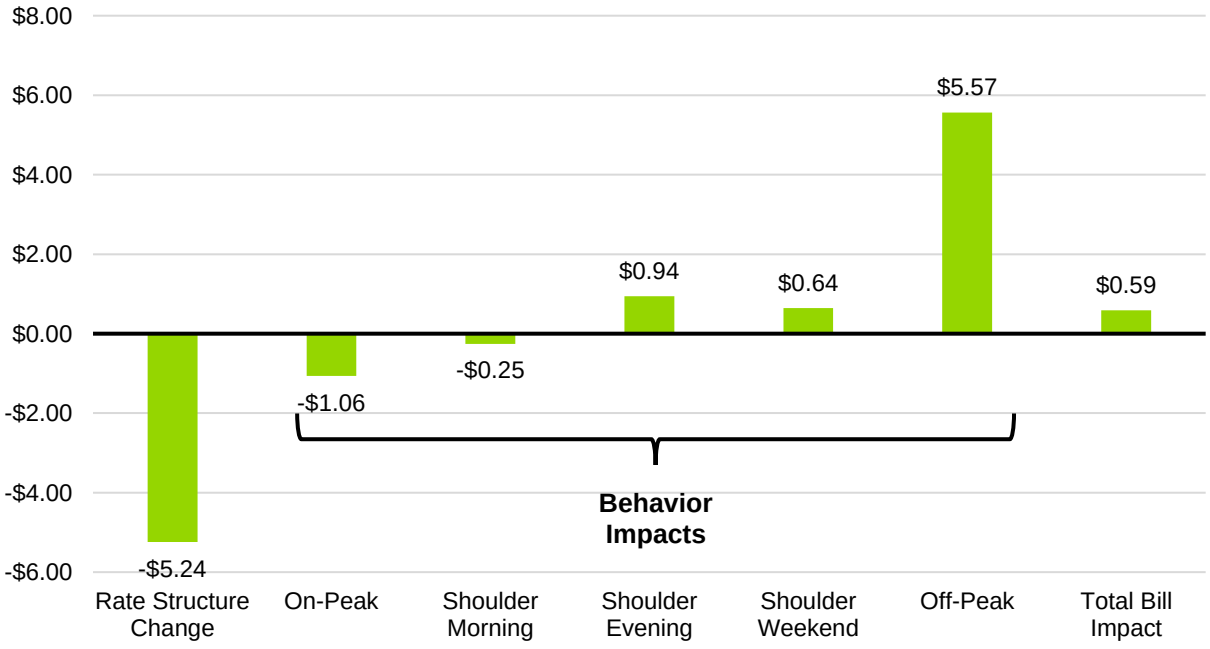


Figure 3-28. RE-TOU Winter Monthly Bill Impact - Solar



4. CUSTOMER RESEARCH

Navigant's customer research consisted primarily of four online participant survey efforts, supplemented by a statistical analysis of customers who withdraw from the rate and switch back to the R rate. The four surveys were conducted during unique periods of customers' participation in the trial (Table 4-1). The results of the first three efforts are described in Navigant's Evaluation Report 1; this report describes results from the fourth and final survey effort, the Wave 3 survey.

Table 4-1. Participant Research Surveys

Survey Timing/Trigger	Objectives/Focus
Wave 1 Survey Post-enrollment	Focusing on participant demographics, marketing and understanding of the rate, and the enrollment experience
Wave 2 Survey After customer's first cooling season	Addressing understanding of the new bill, behavior changes, perceived success in achieving goals, and suggested changes to the TOU rate
Drop-out Survey Upon withdrawing from the RE-TOU rate	Similar to the post-cooling-season survey, but also addressing reasons for dropping out and recommendations for a future alternative to the standard rate
Wave 3 Survey End of trial survey	Assessing customer engagement, experience, and satisfaction; customer behaviors and change in behaviors; customer understanding and change in understanding over the trial period

Synopsis of Wave 3 customer research takeaways. The customer research findings indicate that near the end of the trial, participants in the TOU rate plan tend to feel satisfied and comfortable with the rate plan and are likely to recommend it to friends and family. Customers indicate that they are using several of the informational resources provided by Public Service to learn more about the rate plan. Among these, information provided via email and MyAccount are the most popular, while stickers and the information on the Public Service website are valued by a subset of customers. Most customers indicate they are happy with the frequency of communications, although 25% would like more frequent communications. A predominant majority of TOU rate plan participants are engaged in taking actions to shift their energy use with only 7% of customers reporting they have not taken any actions. Notably, however, customer engagement in the most impactful behaviors remains relatively low, providing an opportunity for additional energy savings. Enhanced education and outreach efforts may help participants focus their efforts on the most impactful behaviors.

4.1 Participant Experience

Navigant conducted an online survey[26] with residential TOU participants near the conclusion of the TOU trial. The Wave 3 survey had several goals:

- Gain understanding of customer experience, perceptions, and satisfaction

[26] Appendix C provides the full survey.

- Measure customer understanding and change in understanding
- Measure customer behaviors and change in behaviors

Navigant issued the Wave 3 survey in August 2019. Navigant obtained 1,894 survey completes for an overall response rate of 36%.

Key takeaways from the Wave 3 survey include the following:

- **Customer satisfaction is high and perceptions are positive**. Eighty-four percent of customers say they are likely to recommend the TOU rate to family/friends and 65% indicate a "high likelihood" of recommending the plan. Most customers report that their bills are in line with or lower than expected (68%) and that they have more control over their bill (69%).
- **Customer knowledge appears to increase with experience**. A large majority of customers (87%) report at least a basic understanding of the bill, while the proportion of customers with a "fairly complete" or "complete" understanding has increased from 34% in the post-enrollment survey to 49% in the Wave 3 survey.
- **Nearly all customers are changing some behaviors; however, customers' behavioral responses leave opportunities for enhanced savings**. Most customers are shifting appliance use (>90%), and some are turning off their AC during peak periods (26%) or changing thermostat settings (12%); however, the difference in average reported temperature setting during peak and shoulder periods is less than 1 degree.

The remainder of this discussion addresses key findings for the following topics:

- Customer experience, perceptions, and satisfaction
- Customer understanding and change in understanding
- Customer behaviors and change in behaviors

4.1.1 Experience, Perceptions, and Satisfaction

Customers enrolled in the TOU rate plan are motivated to change behaviors, engaged in learning, and satisfied with their experience. Customers report that potential bill savings are the biggest motivator for changing their behaviors under the TOU rate plan. Earlier surveys found that this primary motivator is part of a broader set of motivations (such as environmental concerns) that guide customers to enroll in the TOU rate and to change energy use behaviors.[27] Survey findings also show that customers are engaged in actions to become more knowledgeable about the rate plan. Customer learning includes taking time to review energy bills as well as making use of Public Service's informational resources. Information resources received via emails and MyAccount were accessed by the largest proportion of customers and found to be helpful by most customers.

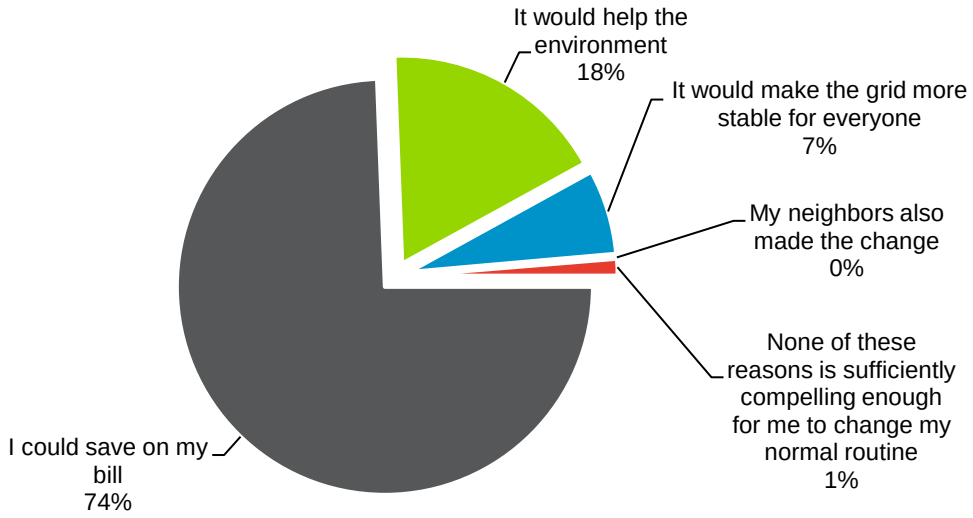
Survey research also suggests that the use of facilitating technologies is playing an important role in the customer experience. For example, compared to earlier surveys, customers are more likely to use technologies that facilitate their efforts to reduce peak electricity consumption, such as smart or programmable thermostats. Finally, customers are largely satisfied with their experience on the TOU rate plan, indicating that the plan has helped them gain more control over their bill. The positive experience of

[27] Findings and results from earlier surveys, including the Wave 1 and Wave 2 surveys, are described in Evaluation Report 1.

most customers is reflected in the high proportion of customers (84%) who are likely to recommend the plan to friends and family.

Customer Motivations for Changing Behaviors: When asked to select the single factor that is most compelling for changing their normal routine (i.e., shifting energy use behaviors), most customers (74%) report potential bill savings as the most compelling motivation. The second most compelling reason is helping the environment (18%). In earlier surveys where customers could identify multiple factors that motivated them to enroll, the proportion of customers selecting environmental concerns was similar to that of bill savings.

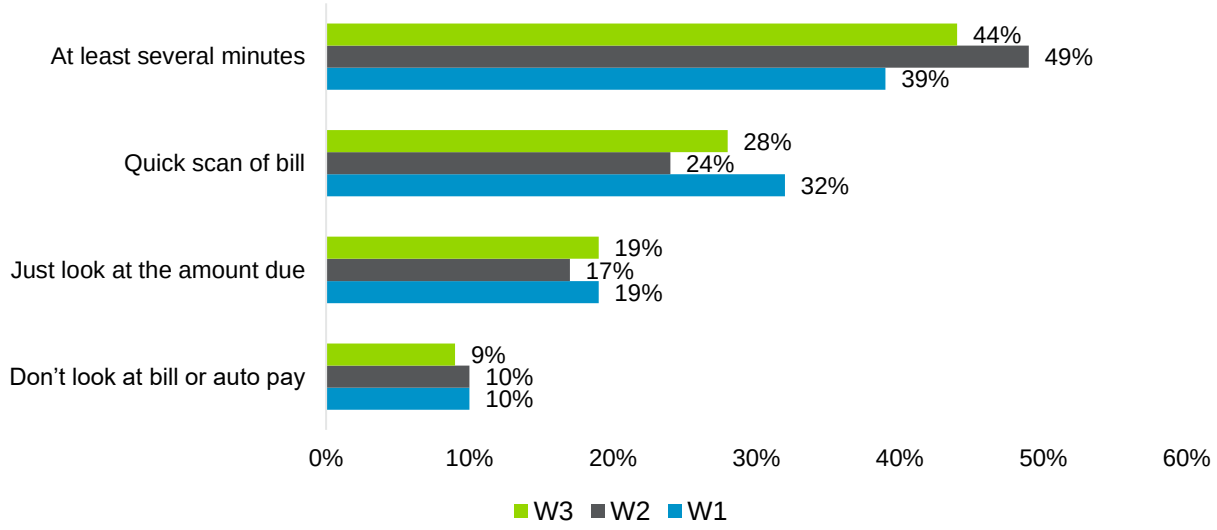
Figure 4-1. RE-TOU Behavior Change Motivations (n=1,868)



Q8 Which one of the following factors do you find most compelling as a reason for changing your normal routine on the Time of Use pricing plan? (select one)
Source: Navigant analysis of online survey data

Customer Attention to Electricity Bill: At the end of the trial, nearly half of customers (44%) report spending at least several minutes with their bill, while 28% scan the bill and 19% only look at the amount due. Nine percent of customers indicate that they either use auto pay or simply do not review their bill before paying. These results are shown in Figure 4-2

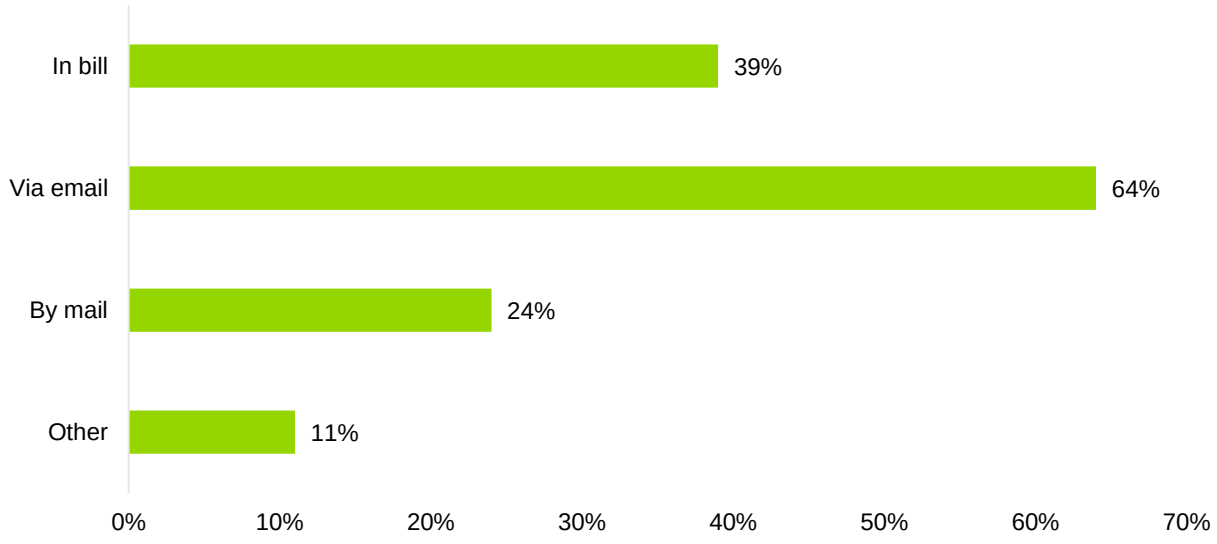
Figure 4-2. RE-TOU Time Spent Reviewing Bill (n=1,872)



Q3 Which of the following statements best describes your typical response to your electricity bill since joining the Time of Use pricing plan?
Source: Navigant analysis of online survey data

Awareness of Pricing Plan Communications: Public Service provided customers with pricing plan information using several different channels including the customers' electricity bill, via email, and by regular mail. When asked to recall the channels through which they had received pricing plan information, customers are most likely to recall emailed resources (64%). As shown in Figure 4-3, less than half of customers recall receiving information in their bill (39%) or by mail (24%).

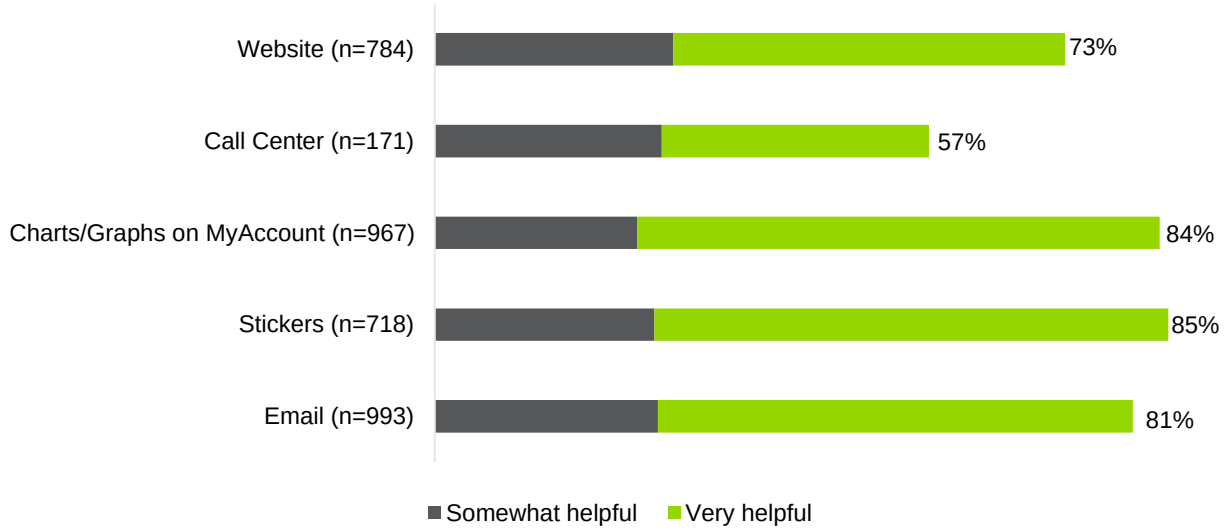
Figure 4-3. RE-TOU Awareness of Receiving Information by Source (n=1,889)



Q33 Please indicate whether you recall receiving information about the Time of Use pricing plan by means of any of the following methods.
Source: Navigant analysis of online survey data

Helpfulness of Education and Outreach Resources: Among customers who indicated that they used the following resources, more than 80% of customers find MyAccount, email, and stickers to be to be either “very helpful” or “somewhat helpful” for understanding the pricing plan. Seventy-three percent of customers who use the website find it helpful, and 57% of customers who use the call center find it helpful.

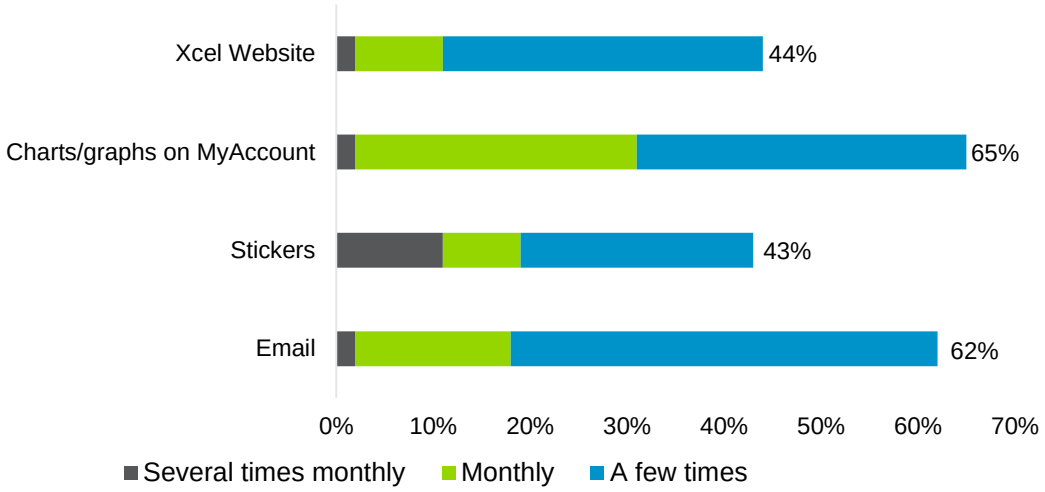
Figure 4-4. RE-TOU Percent Respondents Rating the Following Resources as Helpful



Q35 On a scale of 0 to 10 where 10 is “very helpful" and 0 is “very unhelpful”, please use the slider bars below to indicate how helpful the following information resources have been in your understanding of the Time of Use pricing plan.
Source: Navigant analysis of online survey data

Frequency of Referencing Public Service Resources: More than half of customers report repeated use of both the charts and graphs on MyAccount (65%) as well as information provided in emails from Public Service (62%). Forty-four percent of customers also report having used the Public Service website on a recurring basis, while 43% of customers report recurring use of rate plan stickers.

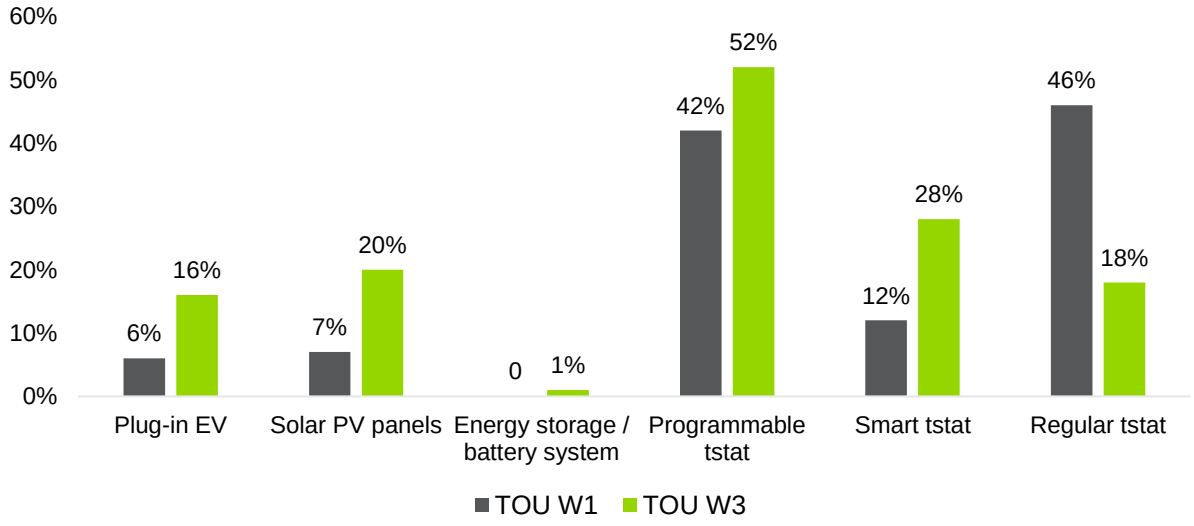
Figure 4-5. RE-TOU Resource Access Rate (n=1,889)



Q36 Since joining the Time of Use pricing plan, how often have you referenced each of the following resources
Source: Navigant analysis of online survey data

Technology Saturation: Consistent with findings from the enrollment survey, approximately two-thirds of participants in the Wave 3 survey report having central air conditioning systems. As shown in Figure 4-6, 52% of participants report having programmable thermostat near the end of the Trial. These findings indicate that the prevalence of smart and programmable thermostats is greater at the end of the trial than in the immediate post-enrollment period. Similarly, the proportion of customers with solar panels increased from 7% at post-enrollment to 20% at the end of the trial, while the proportion of customers with plug-in electric vehicles increased from 6% to 16%. Only 1% of customers report having energy storage systems.

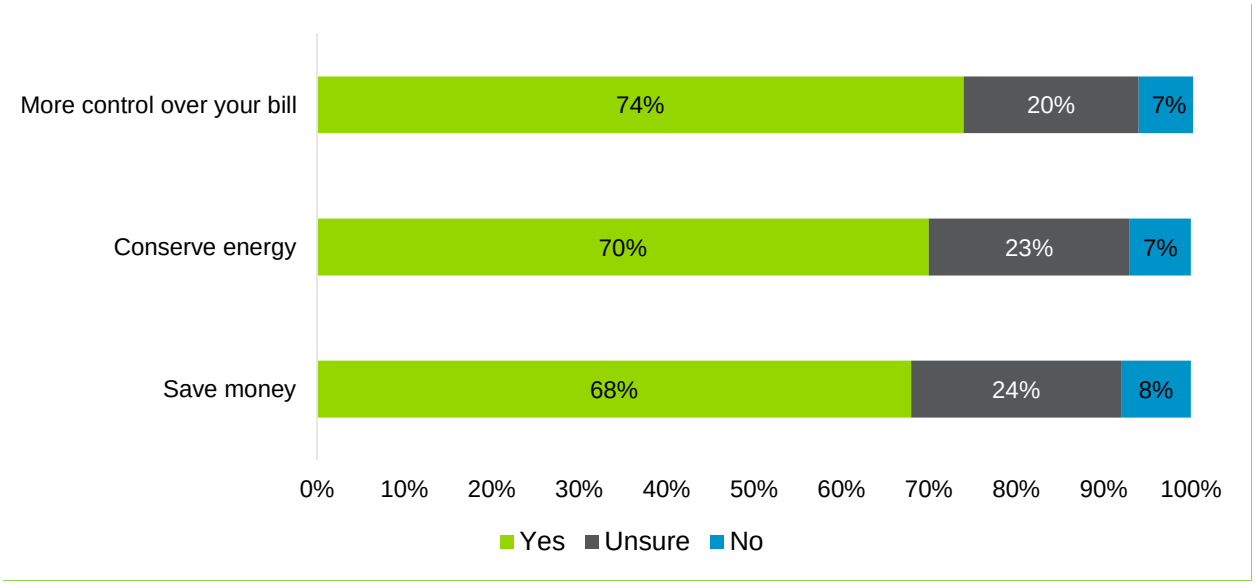
Figure 4-6. RE-TOU Technology Saturation Rates (n=1,889)



Q18 Please indicate which of the following technologies you currently own and/or have installed in your home. (Select all that apply.)
Source: Navigant analysis of online survey data

Perceived Benefits of Rate Plan: Wave 3 survey findings indicate that most customers on the TOU rate plan believe that the plan has given them more control over their bill (74%), helped them conserve energy (70%), and helped them save money (68%). As shown in Figure 4-7, less than 10% of customers believe that the plan has not helped them to achieve these ends while the remainder of customers are unsure.

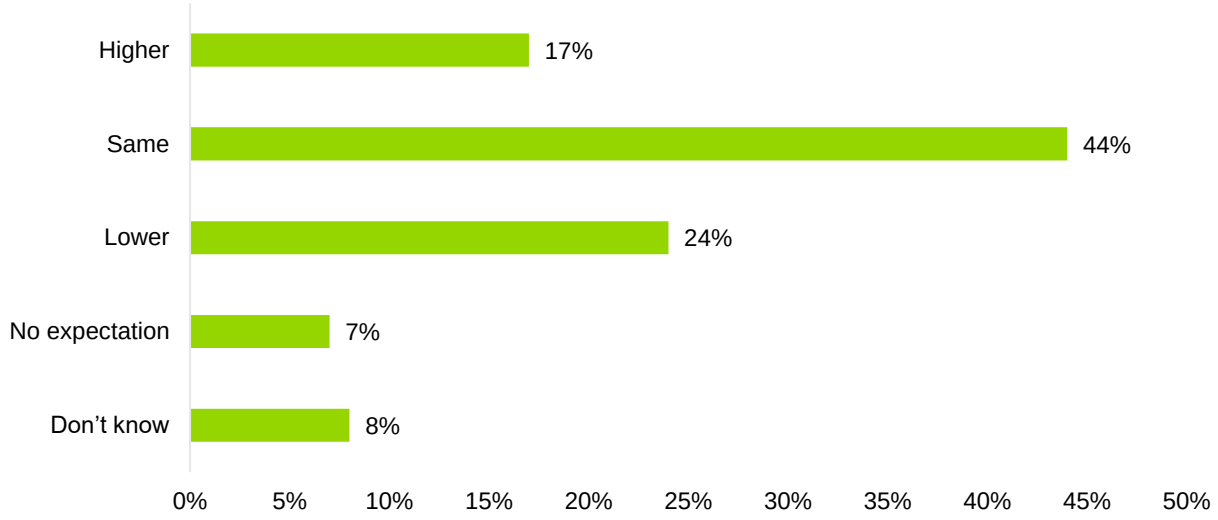
Figure 4-7. RE-TOU Perceived Benefits of the TOU Pricing Plan (n=1,894)



Q9 Has your participation in the Time of Use pricing plan helped you a) achieve more control over your electricity bill? b) conserve energy? c) save money on your electricity bill?
Source: Navigant analysis of online survey data

Bill Expectations and Experiences: When asked whether bills on the TOU rate plan were higher, lower, or in line with what they were expecting, most customers (68%) report that bills were either the same (44%) or lower (24%) than expected. Only 17% of customers report higher than expected bills, while 7% did not have expectations.

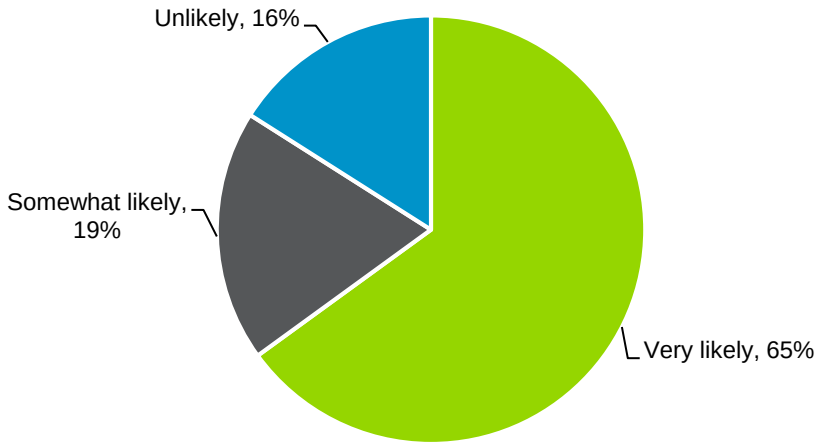
Figure 4-8. RE-TOU Bill Expectations (n=1,889)



Q32 Since enrolling in the Time of Use pricing plan, have your household's electricity bills been higher than expected, lower than expected, or about the same as you expected?
Source: Navigant analysis of online survey data

Likelihood to Recommend the TOU Rate Plan: Customer satisfaction with the rate plan was measured by asking participants to indicate how likely they would be to recommend the pricing plan to friends and family. Wave 3 results (shown in Figure 4-9.) indicate that 84% of customers are likely to recommend the plan (65% of customers are "very likely" to recommend the plan while 19% are "somewhat likely"). Compared to Wave 2 survey findings, a larger proportion of Wave 3 respondents indicated they are "very likely" to recommend the plan (44% in Wave 2 after the first summer of participation in the pricing plan).

Figure 4-9. RE-TOU Likelihood of Recommending the TOU Rate (n=1,894)



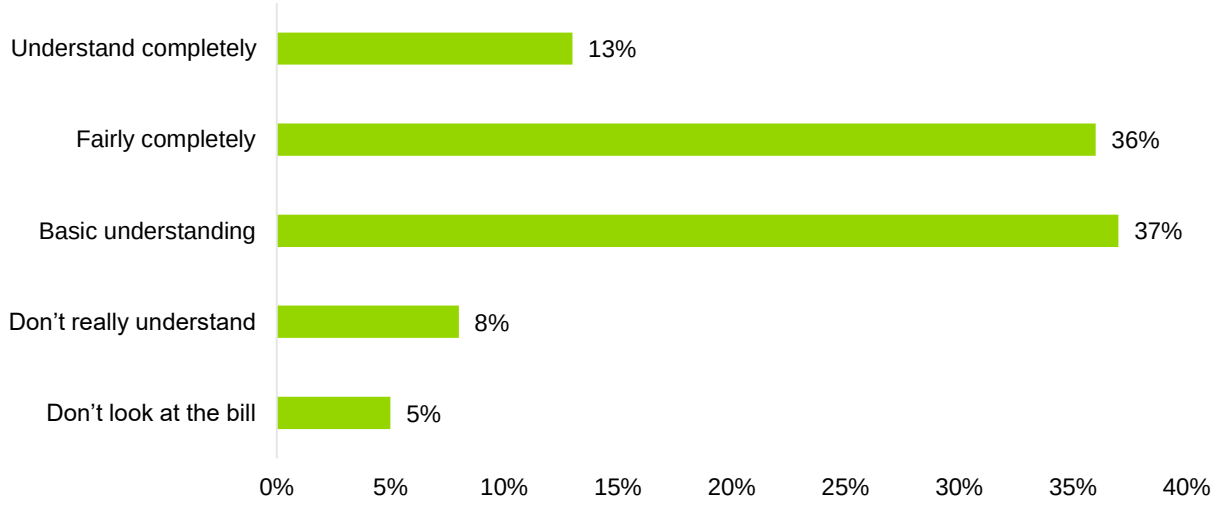
Q7 On a scale of 0 to 10, where 10 is "extremely likely" and 0 is "not at all likely", how likely are you to recommend the Time of Use pricing plan to friends or family? (Drag the slider bar left or right to indicate your answer.)
Source: Navigant analysis of online survey data

4.1.2 Customer Understanding

At the end of the trial, participants in the TOU rate plan report an enhanced understanding of their TOU electricity bill and show an improved understanding of the rate plan. These results are consistent with the expectation that longer periods of experience and engagement with the plan will bolster customers' familiarity with both the information presented in the bill as well as the essential elements of the rate design.

Understanding the Bill: As shown in Figure 4-10, nearly half of customers (49%) reported a fairly complete or complete understanding of the TOU electricity bill, while 37% indicated they had at least a basic understanding of the bill. Only 8% indicated that they do not understand the bill, while 5% indicated that they typically don't look at the bill.

Figure 4-10. RE-TOU Wave 3 Understanding of Energy Bill (n=1,894)

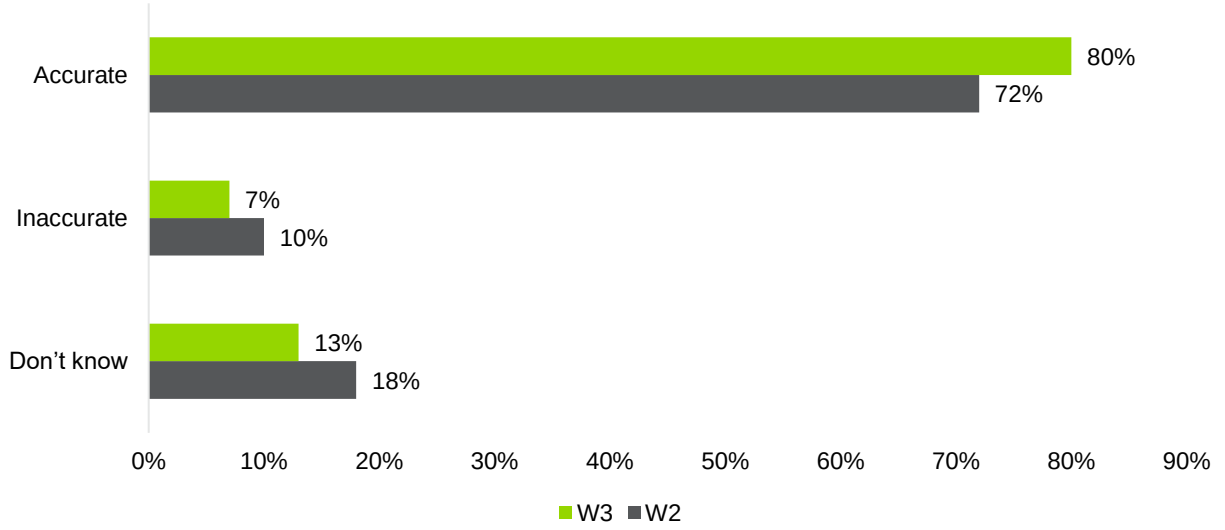


Q4 How well do you understand the electricity bills you have been receiving since you enrolled in the Time of Use pricing plan?
Source: Navigant analysis of online survey data

Understanding the Rate Design: Customer understanding of the rate was measured by asking customers whether the rate plan had three prices for electricity on nonholiday weekdays. As shown in Figure 4-11, at the end of the trial, 80% of customers correctly understood that there are three prices for electricity on nonholiday weekdays. This represents an increase over findings from the Wave 2 survey in which 72% of respondents correctly answered the question.[28]

[28] The Wave 2 survey was fielded in the fall of 2017 and 2018 to collect data following customers' first summer of enrollment. The results are described in Evaluation Report 1.

Figure 4-11. RE-TOU Price Plan Understanding (n=1,894)



Participant reported accuracy of the following statement: "Under the TOU pricing plan, there are three different prices for electricity on any given weekday (unless it is a holiday)"
Source: Navigant analysis of online survey data

4.1.3 Behavior and Behavior Change

Customers are changing their behavior to reduce peak time electricity use. Survey results show that nearly all participants in the TOU rate plan (93%) have made changes in when or how they are using electricity. Among the most prevalent actions, customers are reducing their use of dishwashers, electric dryers, and other appliances during peak. Customers are also shifting their use of air conditioning; however, shifts in air conditioning use appear to be less popular. For example, 80% of respondents indicated they "rarely" or "never" use their dishwasher during peak, and only 33% of respondents indicated that they "rarely" or "never" use their air conditioning during the same period.

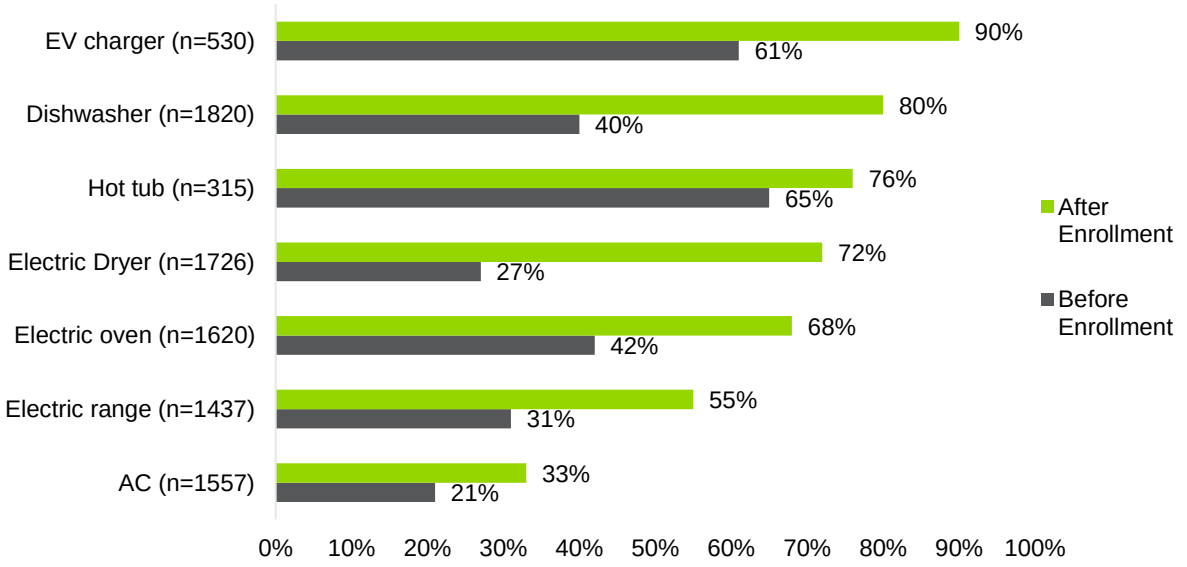
Customers who continue to use air conditioning during peak report that they are increasing the thermostat setting during those hours. Interestingly, however, survey data indicates that the average difference in thermostat settings between weekday peak and shoulder periods is less than 1 degree and 41% of TOU participants indicate that they do not vary the temperature settings during the day with most using a setting under 78 degrees.

These findings suggest that the largest opportunities for peak energy savings have barely been tapped by most TOU participants. What remains unclear is the reason(s) why. Does the limited customer engagement around changes in air conditioning settings and AC use reflect a lack of information and understanding? Are customers more concerned with thermal comfort than energy savings? Are customers correctly or incorrectly using smart and programmable thermostats and what myths or misperceptions might be shaping inefficient practices? Are household dynamics between multiple household occupants serving as a barrier to desired changes in air conditioning use? Or are there other challenges that customers are encountering when attempting to shift air conditioning use? These questions reveal the potential value of a more detailed analysis of air conditioning use patterns,

household dynamics, and customer perceptions that could help inform and improve outreach and education efforts.

Appliance and AC Use During Peak: Customers were asked how frequently they run specific appliances during peak, both prior to enrollment and after enrollment in the TOU rate plan. Figure 4-12 shows the percentage of customers who "rarely" or "never" use their appliances during peak hours. The findings indicate that most customers have shown a large shift in their use of dishwashers, electric dryers, and other appliances during peak. For example, while only 27% of customers "rarely" or "never" used their electric dryer during peak prior to enrolling, 72% were unlikely to use their dryer during peak after enrolling. The shift away from using air conditioning during peak was notably smaller moving from 21% before enrollment to 33% after enrollment.

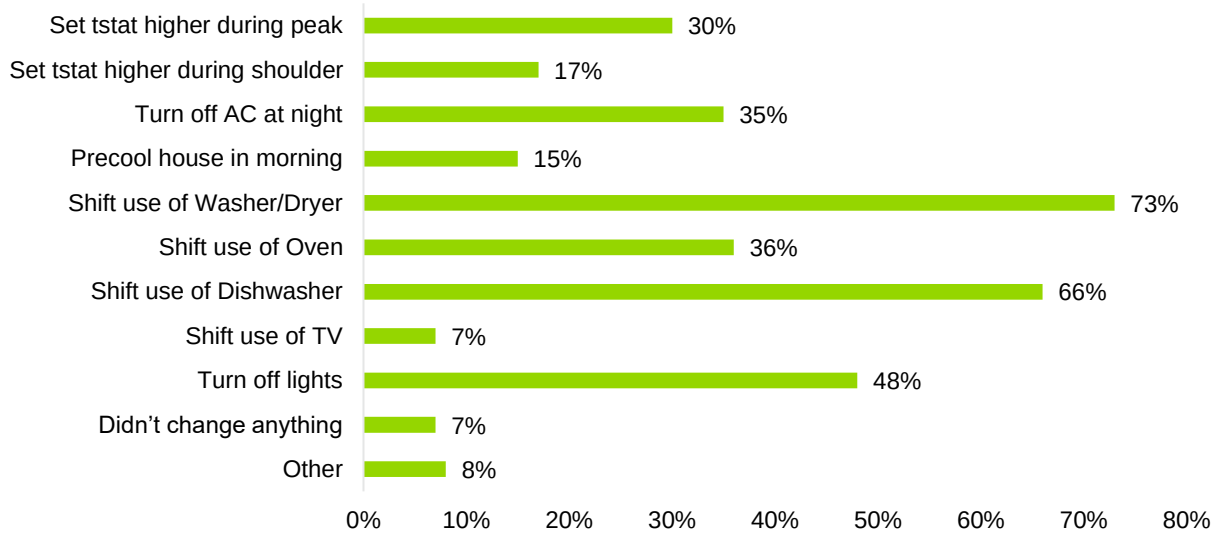
Figure 4-12. RE-TOU Customers Rarely or Never Using Appliances and AC During Peak



Q11 Before/Q13 After enrolling in the Time of Use pricing plan, how frequently have you run the following appliances during the hours of 2pm to 6pm during the summer months (June – Sept)?
Source: Navigant analysis of online survey data

Self-Reported Changes in Peak Period Appliance and AC Use: When customers were asked to indicate which new behaviors, they adopted after enrollment to reduce consumption during peak, the findings align with those reported above. Most customers shifted use of their washer, dryer, and dishwasher. In addition, nearly half of customers (48%) reported turning off lights. Changes in air conditioning behaviors were not as common. Roughly one-third of customers (35%) are turning off their AC at night and 30% are setting their thermostat to higher temperatures during peak. Only a small percentage of customers are setting their thermostat higher during shoulder periods (17%) or precooling their house in the morning (15%).

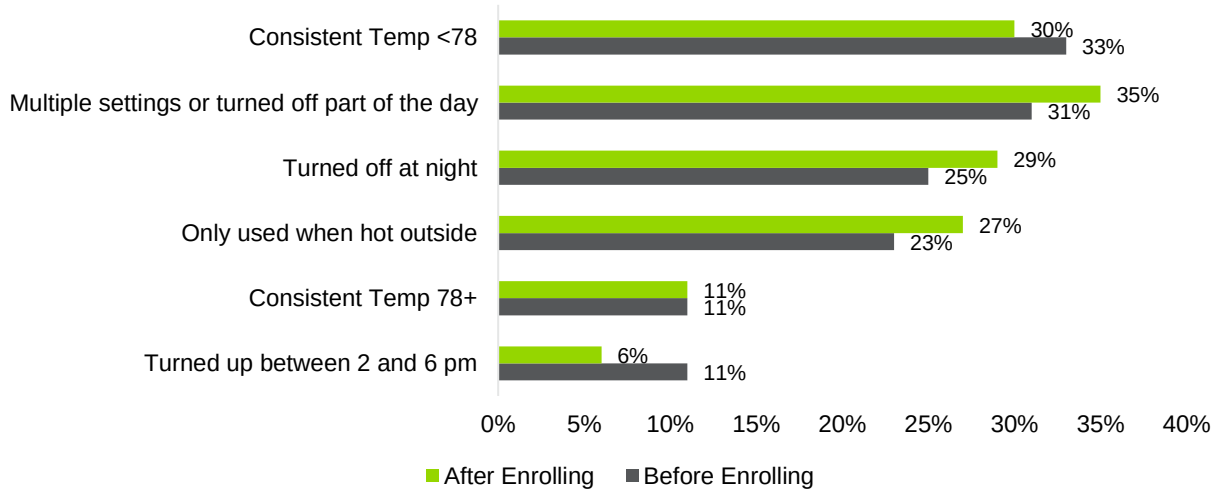
Figure 4-13. RE-TOU New Behavior After Enrollment (n=1,889)



Q16 Please indicate which of the following actions you or others in your household started doing (during the months June-Sept) after you signed up for the Time of Use pricing plan. Please select all that apply:
Source: Navigant analysis of online survey data

Air Conditioning Use Strategies: When asked about air conditioning use patterns during the past summer, 41% of customers indicated that they set a consistent temperature throughout the day. Of these customers, most set their thermostat to a setpoint under 78 degrees (the EPA recommended setpoint for air conditioning). As shown in Figure 4-14, about one-third of customers indicated using multiple temperature settings throughout the day, while 27% reported limiting their air conditioning use to times when it was really hot outside.

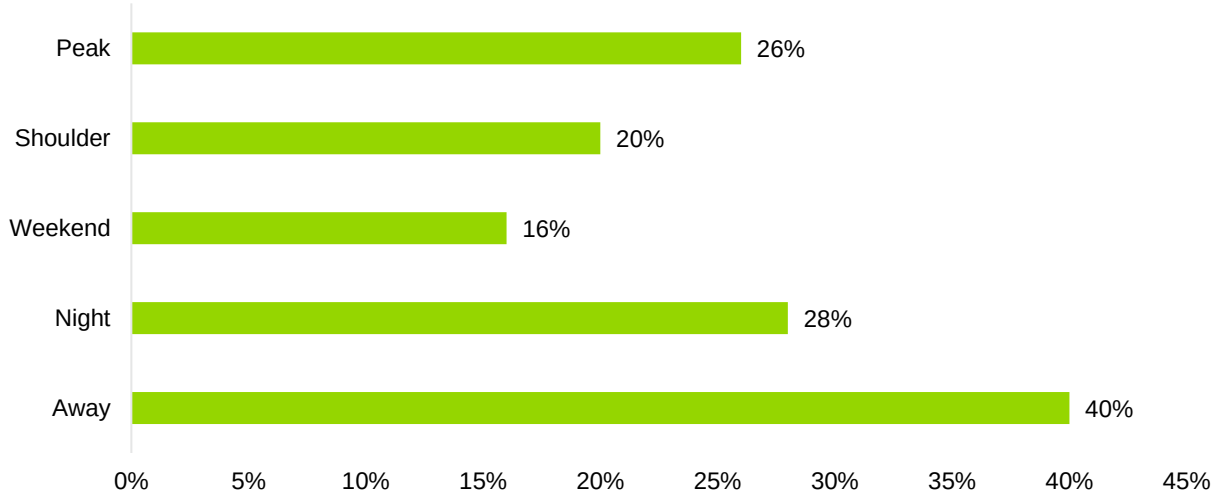
Figure 4-14. RE-TOU AC Usage (n=1,389)



Q12 Before/ Q14 After signing up for the Time of Use pricing plan, how would you describe the typical air conditioning settings in your home during the summer months (June – Sept)? Please select all that apply:
Source: Navigant analysis of online survey data

Use of Air Conditioning and Temperature Settings: As shown in Figure 4-15, customers are most likely to turn off their air conditioning when they are away from their home (40%). Approximately one-quarter of customers with air conditioning turn it off during peak hours and 28% turn it off at night. Weekends and shoulder periods are the times when customers are least likely to turn off their AC. A review of self-reported temperature settings indicates that while the temperature settings are higher during peak periods when compared to any other time period, the difference between shoulder and peak is less than 1 degree, on average. Also, the average temperature setting when away from home (for those customers who don't turn the AC off entirely) is roughly 77 degrees—a setting that is still 1 degree below the EPA-recommended temperature setting for AC use.

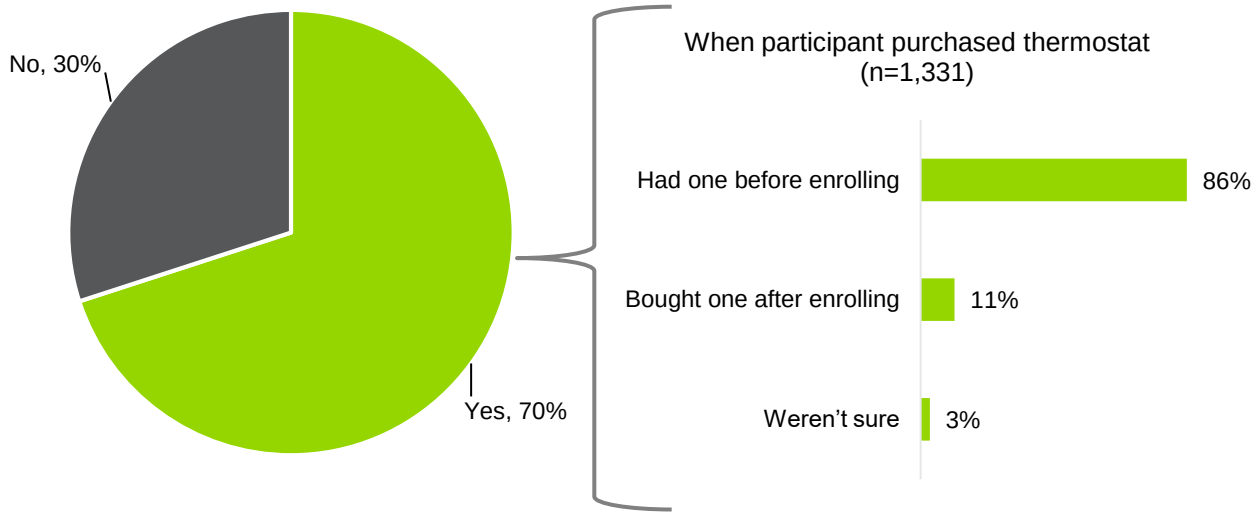
Figure 4-15. RE-TOU AC Restraint (n=1,220)



Q10 During this past summer, what temperature did you typically set your thermostat to when running your air conditioner...
Source: Navigant analysis of online survey data

Thermostat Saturation and Use: Nearly three-quarters of customers have either a smart or programmable thermostat in their home. These thermostats provide customers with an enhanced opportunity to manage cooling demand during peak periods. Most customers (86%) had their smart/programmable thermostat prior to enrolling in the trial; however, 11% purchased one after enrolling. Eighty percent of respondents with a smart/programmable thermostat reported that their thermostat is programmed. Among those respondents who had not programmed or reprogrammed their thermostat after enrolling, 42% said they would be interested in having Public Service program/optimize their thermostat settings.

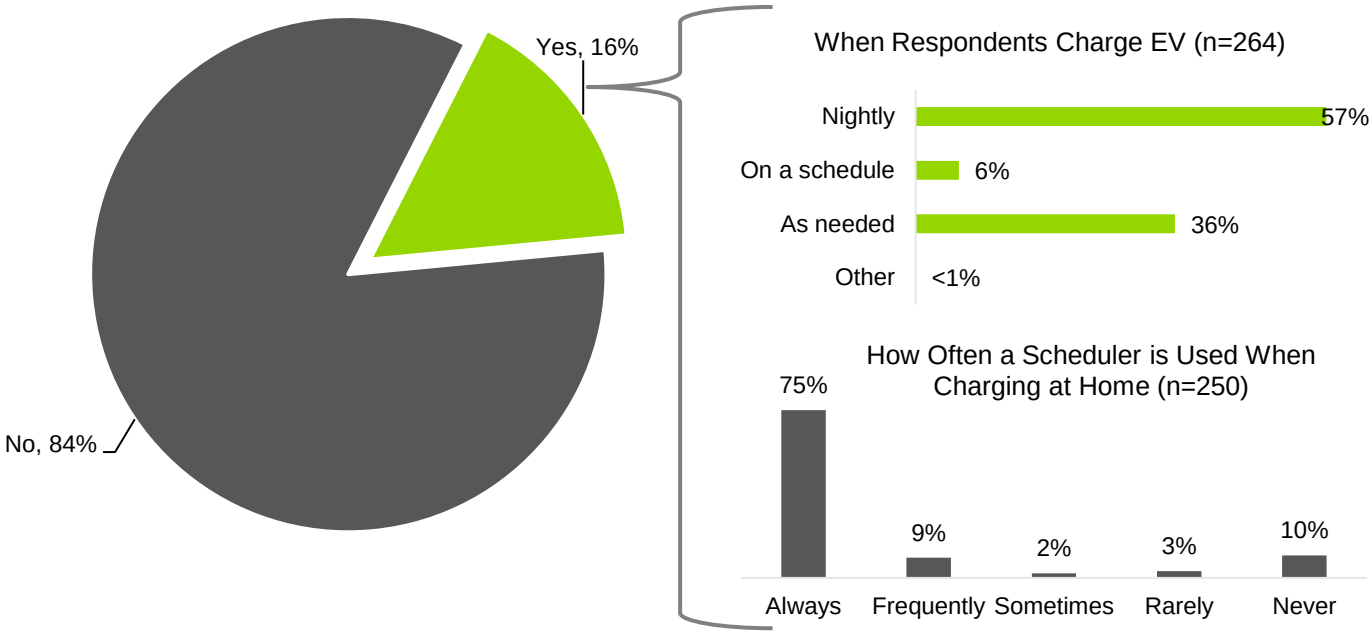
Figure 4-16. RE-TOU Smart Thermostat Penetration (n=1,889)



Q18 Please indicate which of the following technologies you currently own and/or have installed in your home. (Select all that apply.)
Q19a Did you have a programmable or smart thermostat in your home before enrolling in the Time of Use pricing plan or did you buy it after enrolling?
Source: Navigant analysis of online survey data

Plug-in Electric Vehicle (PEV) Saturation and Use: The proportion of survey respondents who own or lease a PEV grew from 6% in the Wave 1 post-enrollment survey to 16% (303 customers) in the Wave 3 survey. Most respondents (57%) report that they typically charge their PEV on a nightly basis, while 36% indicate that they charge when needed and 6% charge their PEV on a schedule. Nearly all respondents charge their PEVs at home (99.5%) and the majority either charge nightly (37%) or one to three times per week (49%). Roughly 32% charge at a public charging station and 17% of customers charge their vehicle at work. Three-quarters of respondents reported that they "always" use a scheduler when charging at home, while 10% reported that they never use a scheduler.

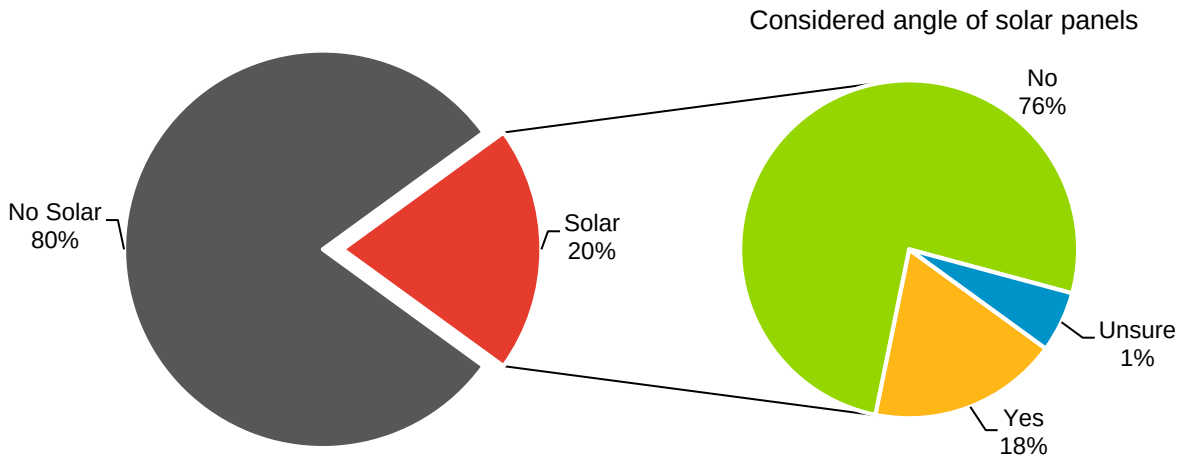
Figure 4-17. RE-TOU EV Penetration (n=1,889)



Q18 Please indicate which of the following technologies you currently own and/or have installed in your home. (Select all that apply.)
Q29 How would you describe your typical charging patterns? I typically charge my electric vehicle…
Q28 When charging your car at home, how often do you typically use the scheduler function in your vehicle or on the charger to set the start and end time for the charging session?
Source: Navigant analysis of online survey data

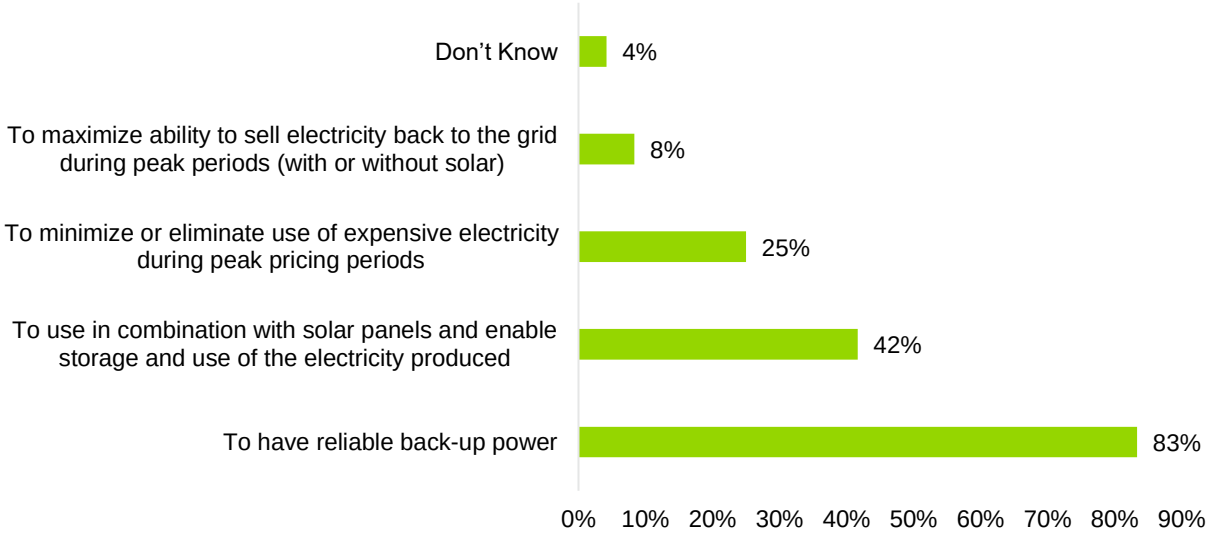
Solar and Storage: A total of 379 TOU respondents have solar PV. Most of these customers (80%) indicated that they were not encouraged to enroll in the TOU plan by their solar installers. When deciding whether to enroll in the TOU plan, 76% of solar customers did not consider the orientation of their solar panels, 18% did consider the orientation, and 6% were unsure. Battery storage was relatively uncommon among respondents. Only 24 TOU respondents had battery storage. Of these, most (83%) purchased a battery for reliable backup power, while 42% wanted to use it in combination with solar panels to enable their ability to store and use the electricity that they produce. Twenty-five percent of storage respondents indicated that they purchased the storage system to minimize or eliminate their need to use expensive electricity during peak pricing periods.

Figure 4-18. RE-TOU Solar Penetration (n=1,889)



Q18 Please indicate which of the following technologies you currently own and/or have installed in your home. (Select all that apply.)
Q30b Did you consider the orientation of the solar panels when deciding to enroll in the Time of Use pricing plan?
Source: Navigant analysis of online survey data

Figure 4-19. RE-TOU Battery Primary Purchase Motivations (n=24)



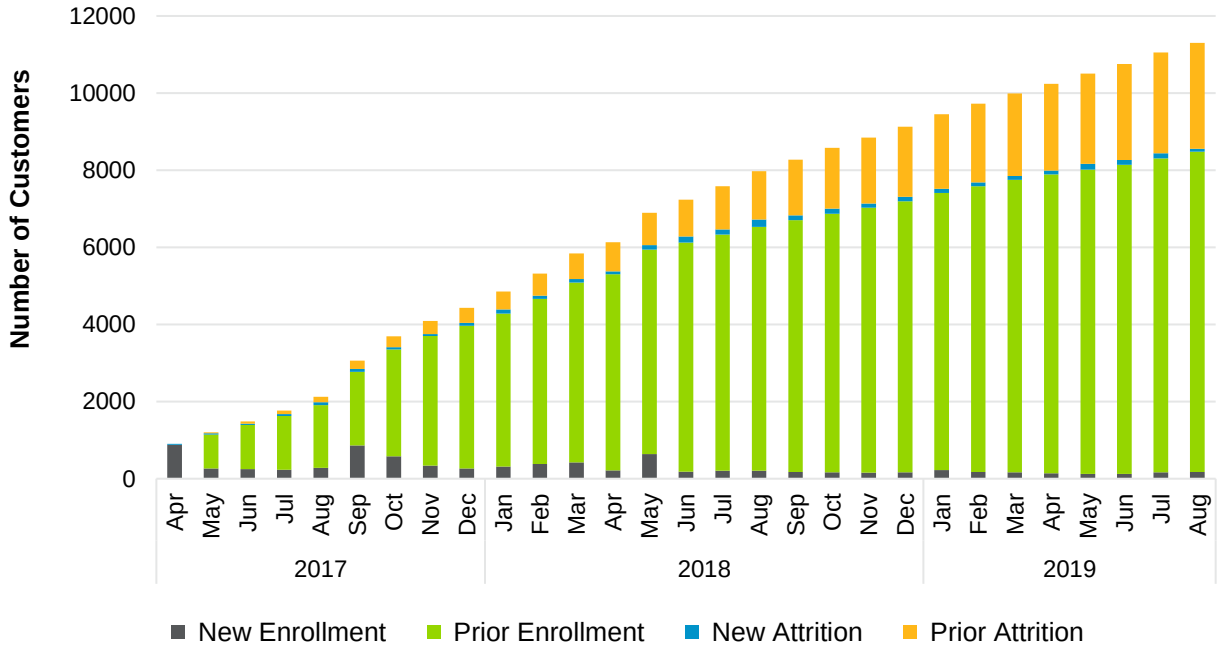
Q31 What were the two most important factors that motivated you to get battery storage for your home? Select two.
Source: Navigant analysis of online survey data

4.2 Participant Dropout Analysis

The evaluation of customer retention and dropouts consists of an analysis of the decision to leave the TOU rate, either due to moving or switching back to the R rate. Illustrated in Figure 4-20, there were a few months with larger amounts of enrollment due to marketing efforts (April 2017, September 2017, and May

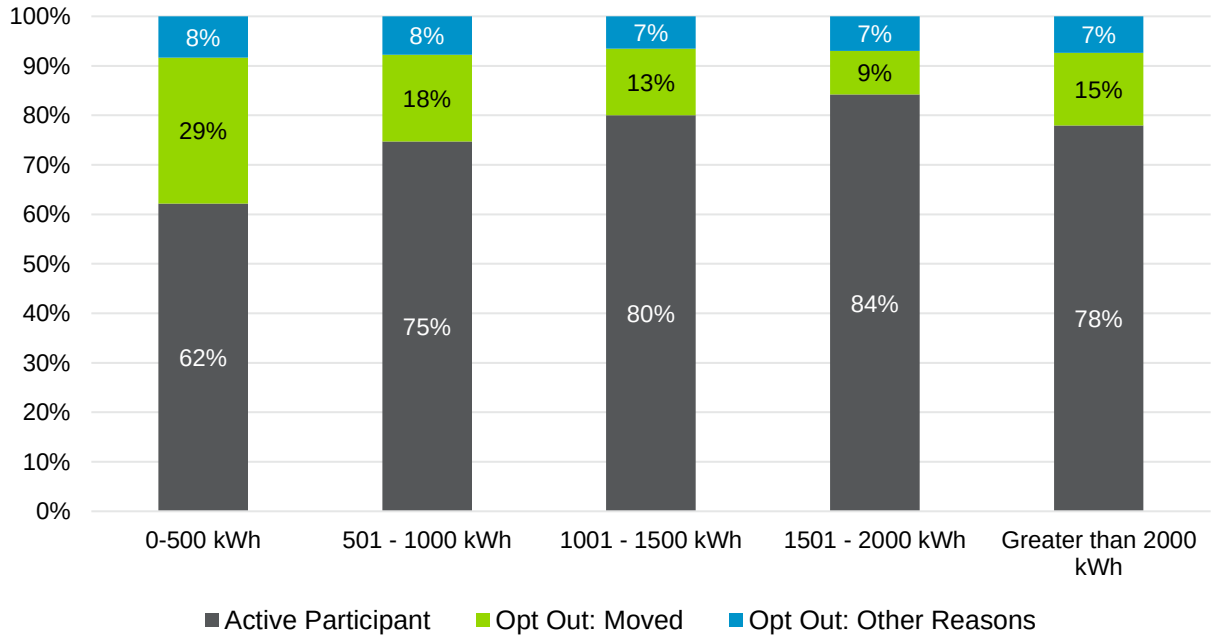
2018) and a steady level of enrollment in other months. Despite the ebb and flow of enrollment, there were no single months with a large amount of attrition. Attrition levels varied above or below 100 per month for most of the trial. This indicates that there was no single event (i.e., extreme weather, etc.) that caused participants to leave the trial.

Figure 4-20. Monthly RE-TOU Participant Enrollment and Attrition



Another factor that could influence a participant's decision to remain in the TOU trial is their level of consumption. As shown in Figure 4-21, the percentage of participants the dropped out for a reason other than moving (i.e., did not think they could save money, etc.) was consistent across usage level and ranged between 7% and 8%. The biggest difference was the frequency of low usage participants moving out at twice the frequency of higher consumption participants. This is mainly due to lower consumption participants being renters and it is not uncommon for renters to move more often than home owners. Participants with less than 500 kWh of monthly consumption accounted for 54% of all TOU participants, so the frequency of participants moving accounted for nearly 75% of all TOU attrition.

Figure 4-21. RE-TOU Participation and Attrition by Average Monthly Consumption Level



As shown by Figure 4-22 and Figure 4-23, participant demographics do not appear to have directly influenced the decision to drop out of the TOU trial. There are differences in the frequency of moving across demographic categories, but it is not uncommon for younger or less affluent households to move more often.

Figure 4-22. RE-TOU Attrition by Customer Age

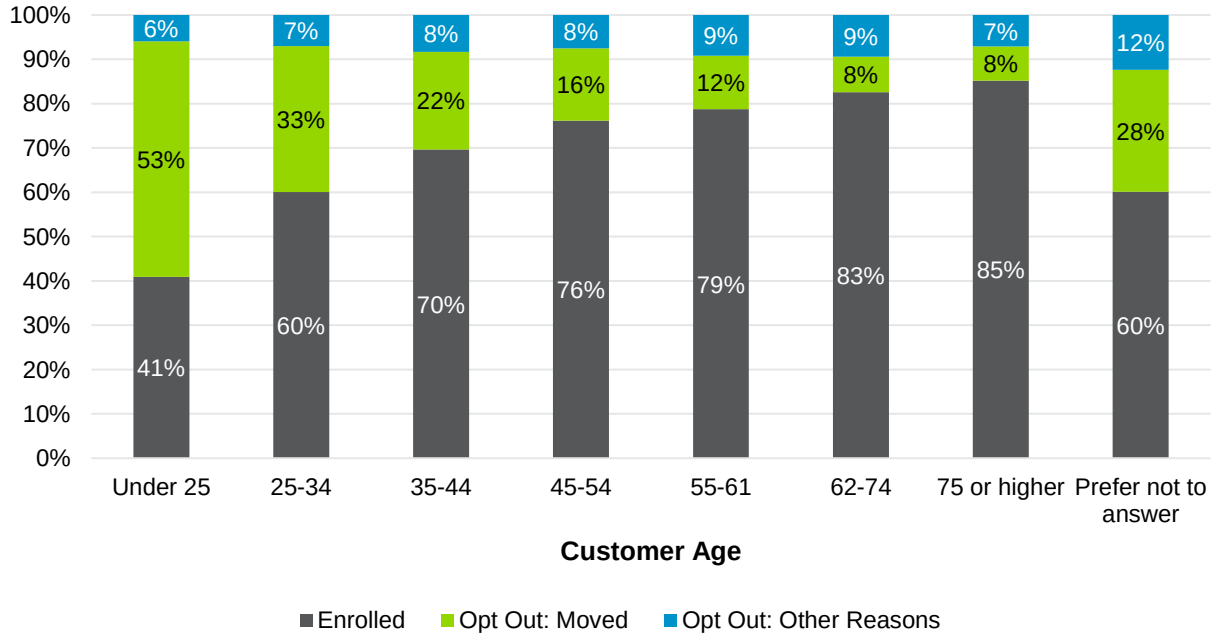
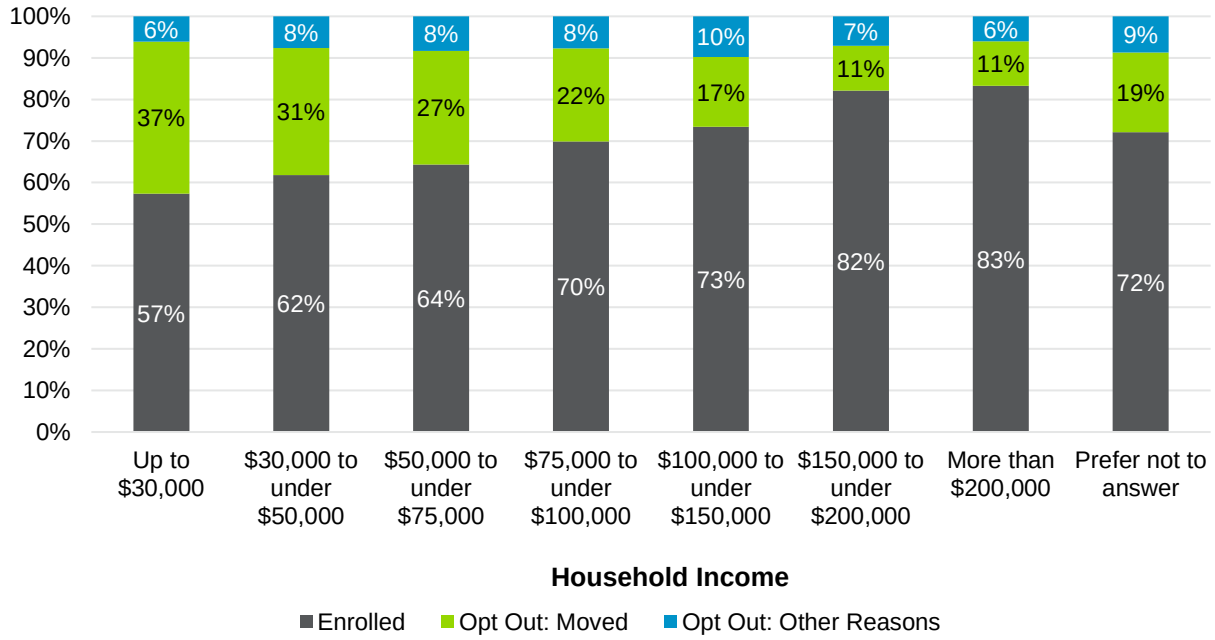


Figure 4-23. RE-TOU Attrition by Household Income



APPENDIX A. LOAD SHAPES BY SEGMENT

A.1 Low Income (No EV)

Figure A-1. Low Income – Summer, Weekdays

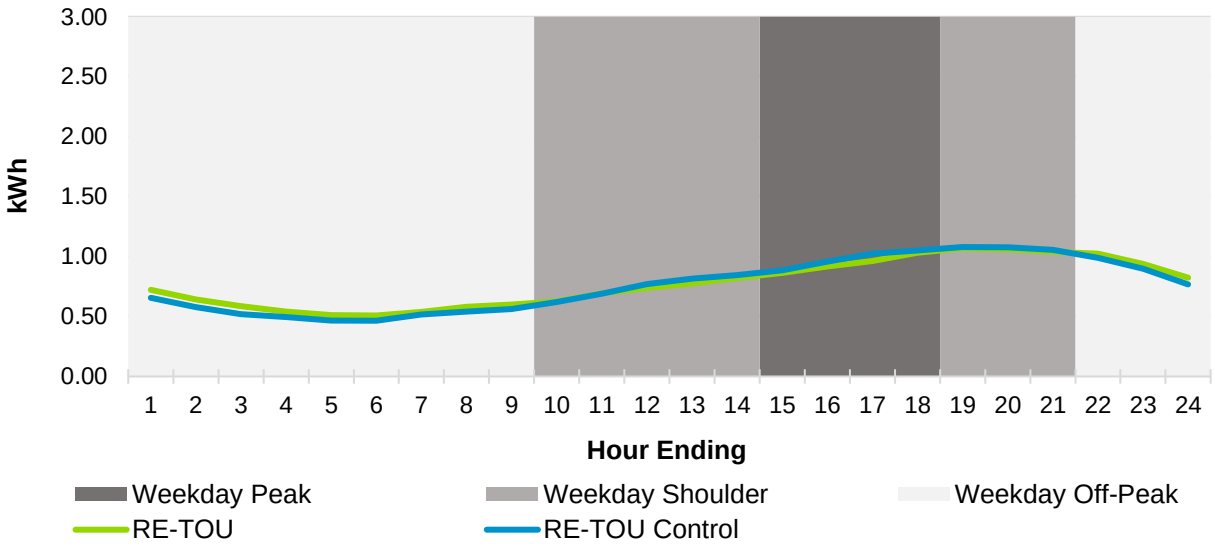


Figure A-2. Low Income – Summer, Weekends

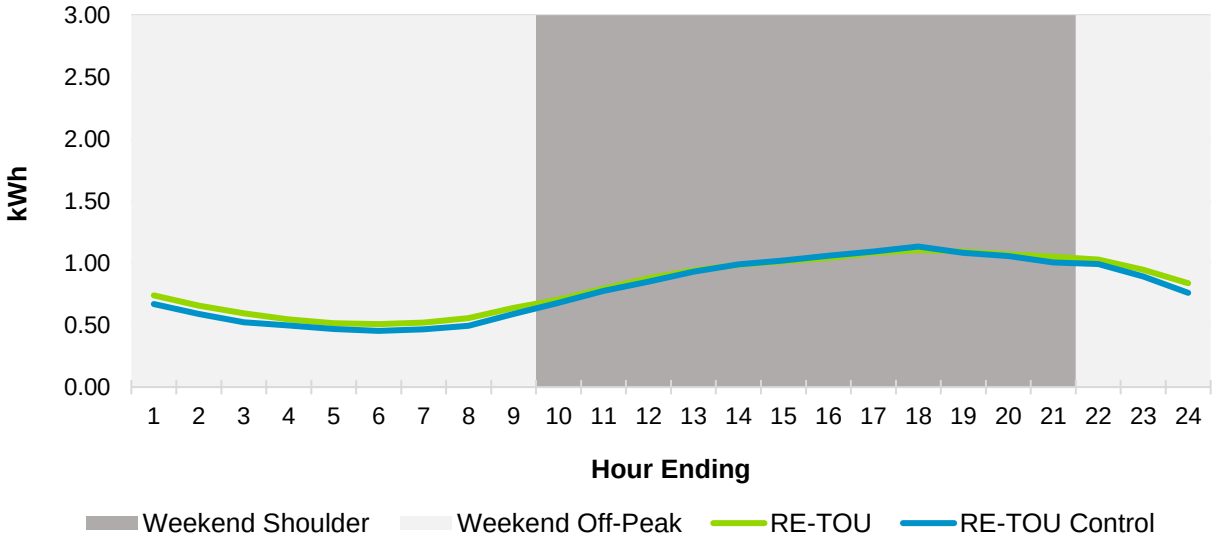


Figure A-3. Low Income – Winter, Weekdays

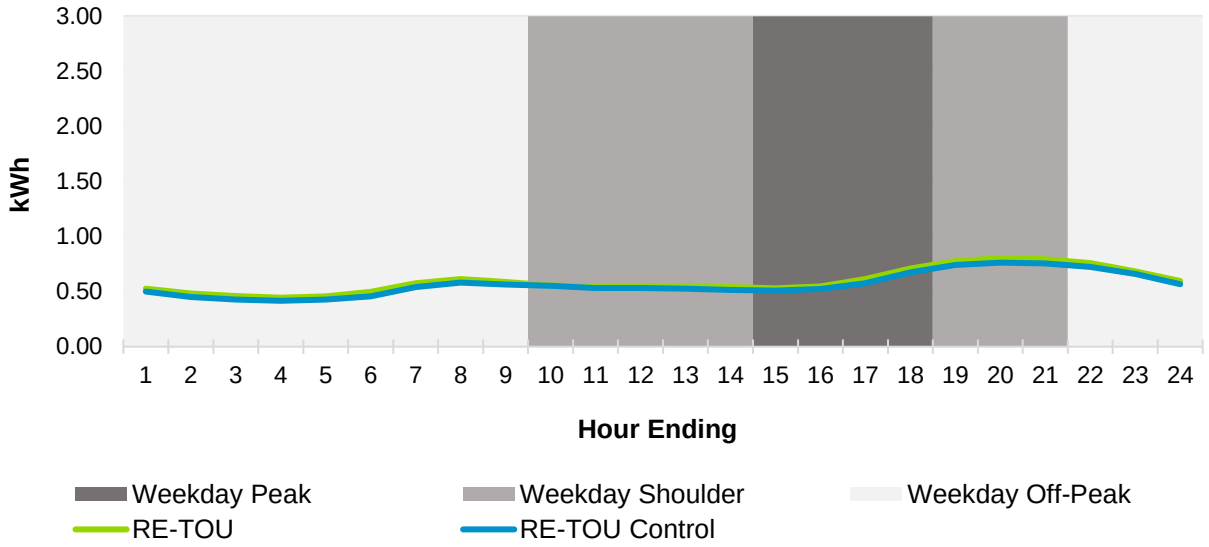
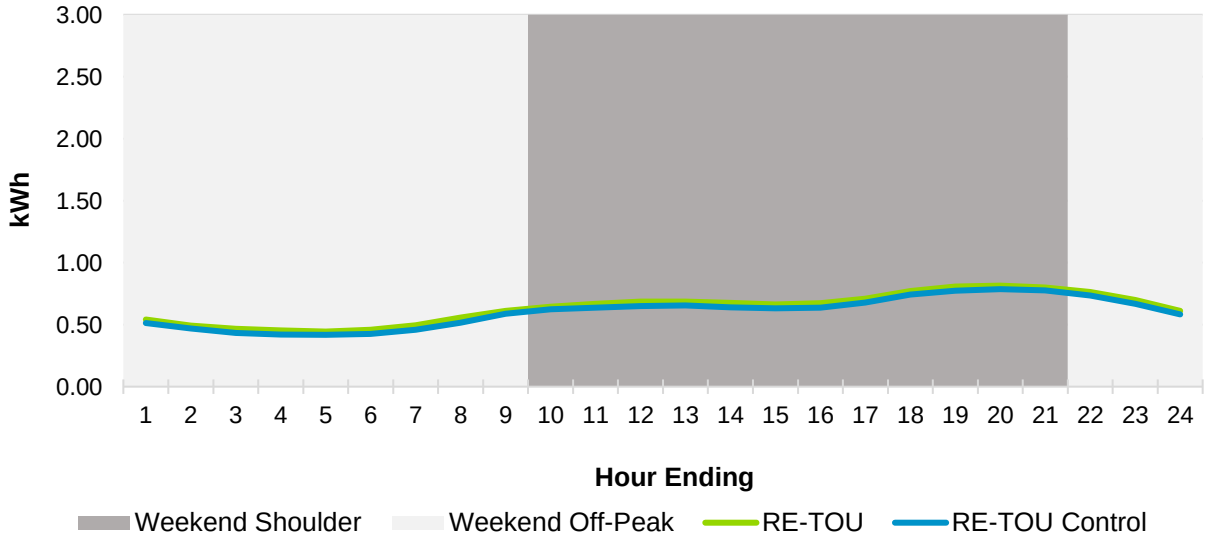


Figure A-4. Low Income – Winter, Weekends



A.2 Electric Vehicles

Figure A-5. Electric Vehicles – Summer, Weekdays

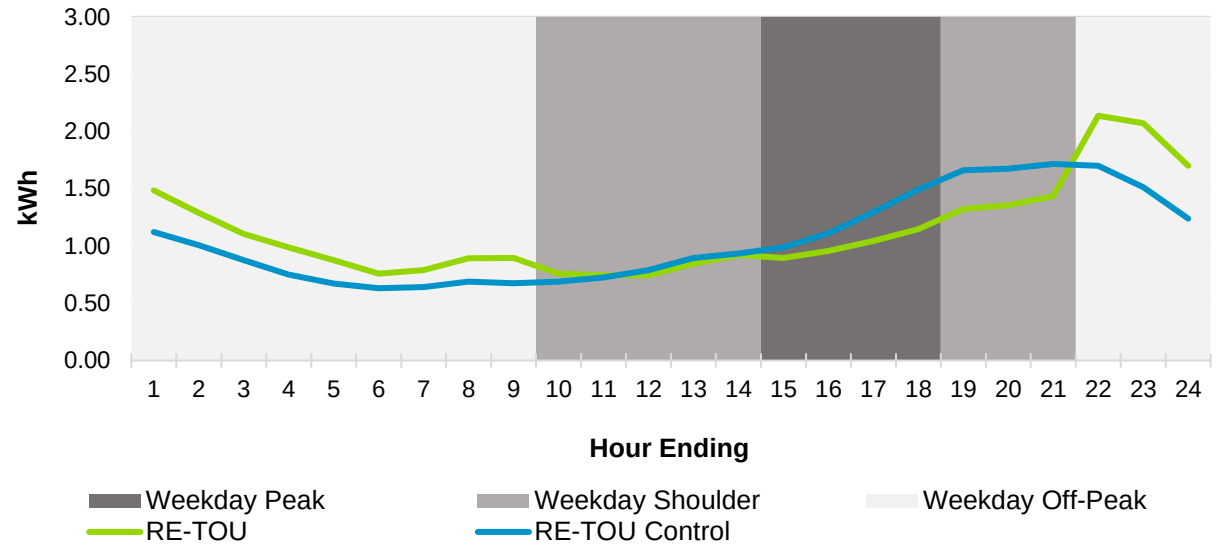


Figure A-6. Electric Vehicles – Summer, Weekends

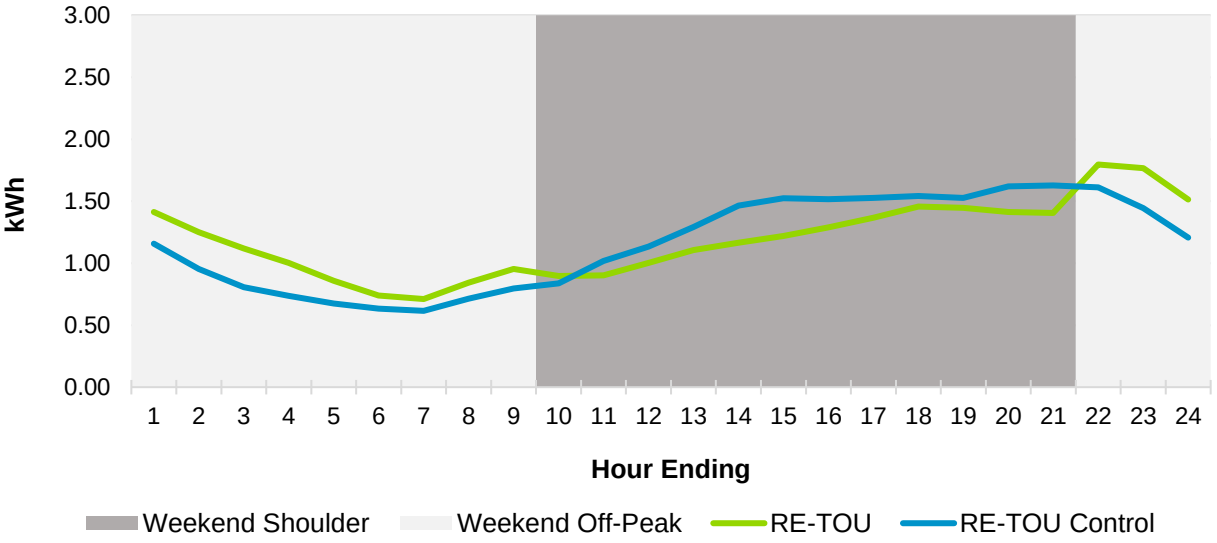


Figure A-7. Electric Vehicles – Winter, Weekdays

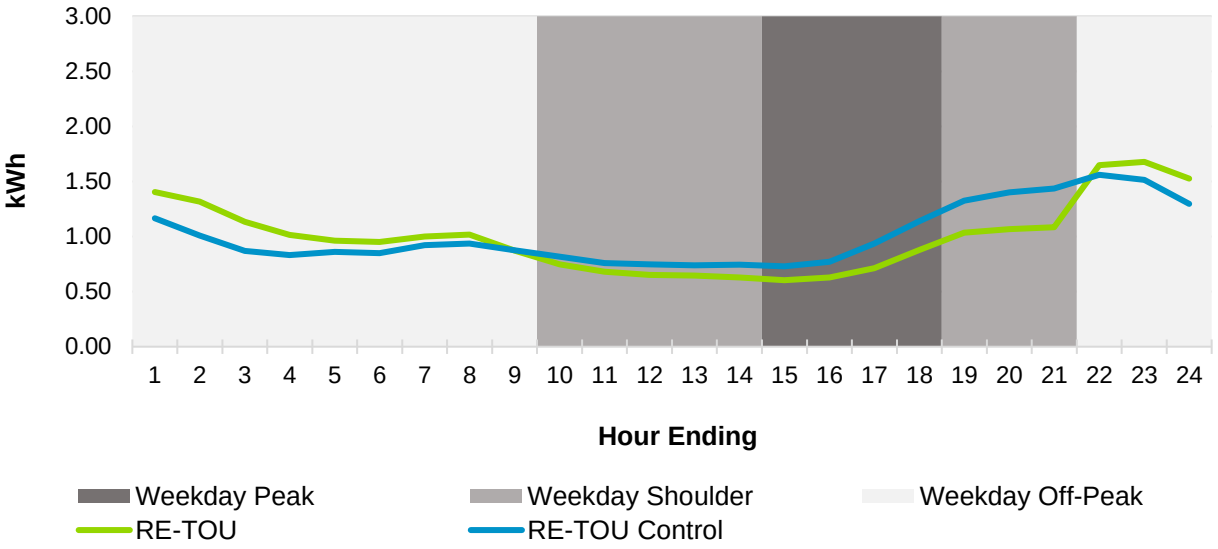
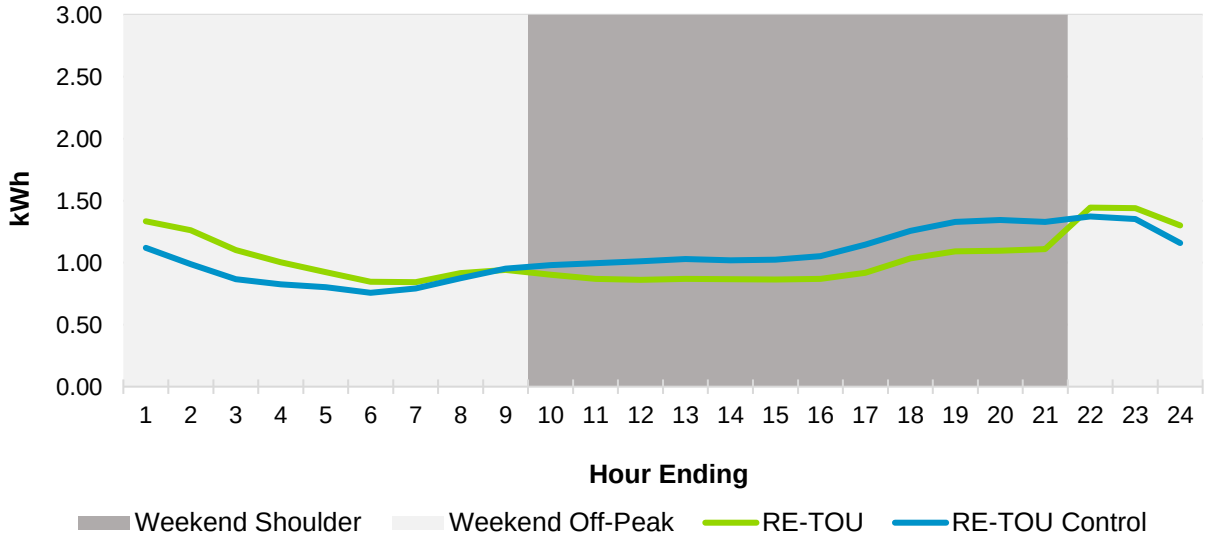


Figure A-8. Electric Vehicles – Winter, Weekends



A.3 Smart Thermostats (No EV)

Figure A-9. Smart Thermostats – Summer, Weekdays

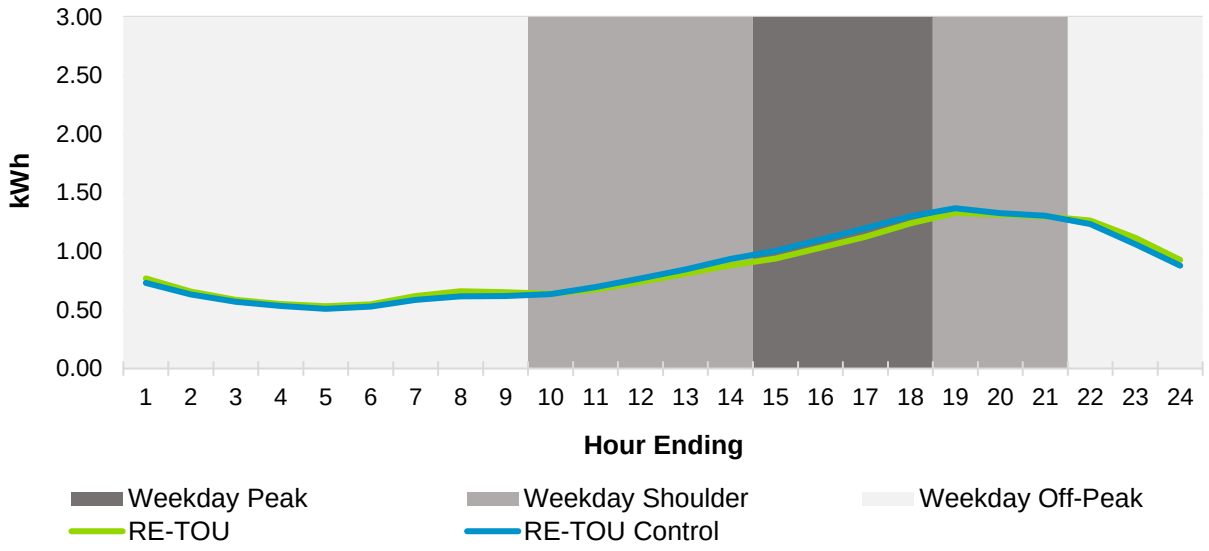


Figure A-10. Smart Thermostats – Summer, Weekends

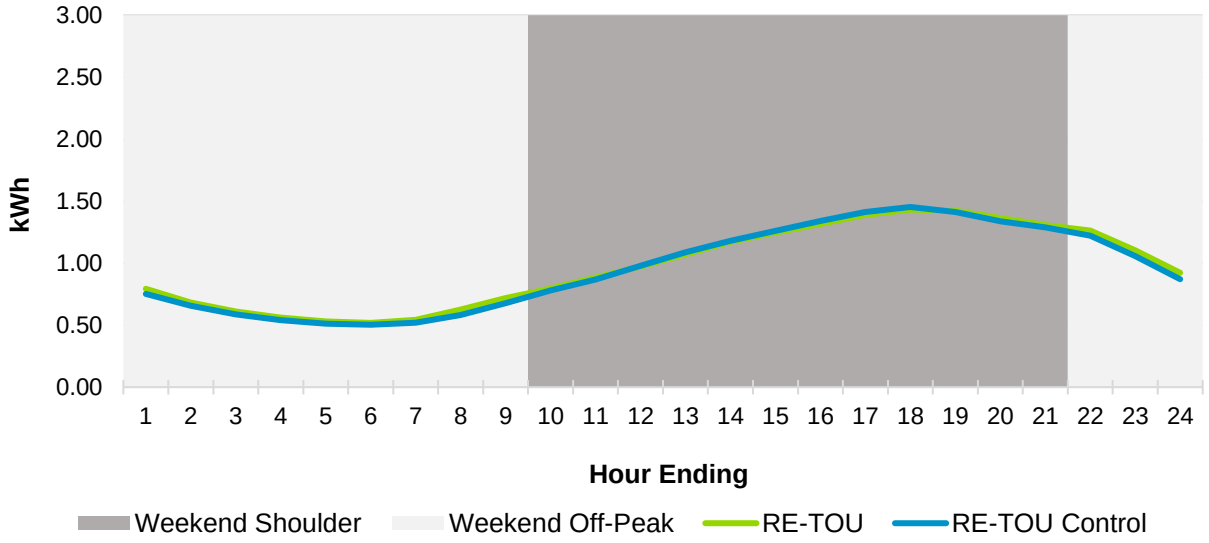


Figure A-11. Smart Thermostats – Winter, Weekdays

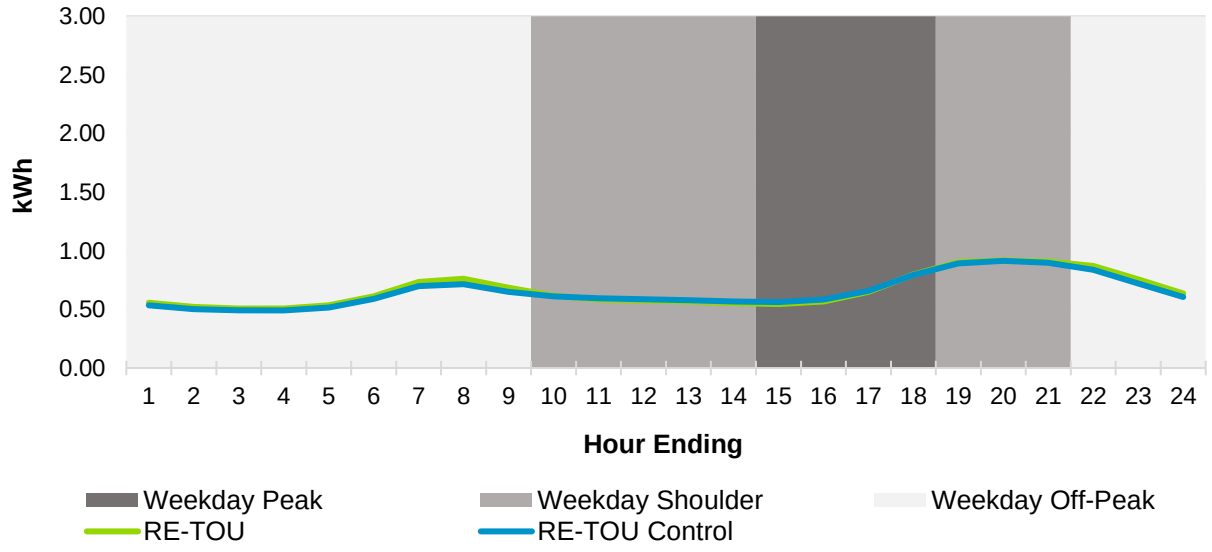
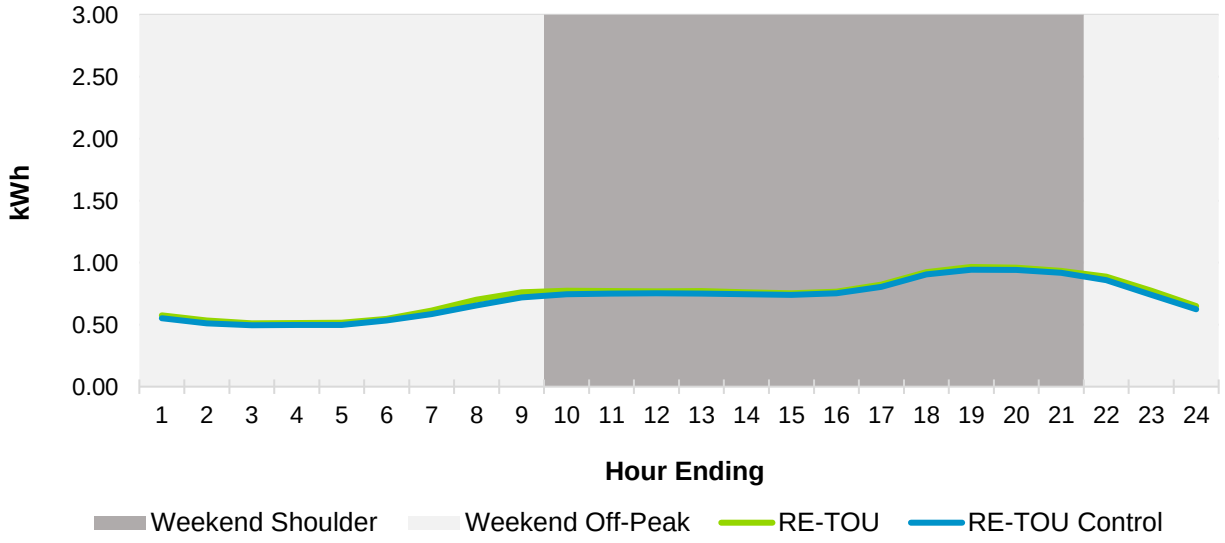


Figure A-12. Smart Thermostats – Winter, Weekends



A.4 Renters (No EV)

Figure A-13. Renters – Summer, Weekdays

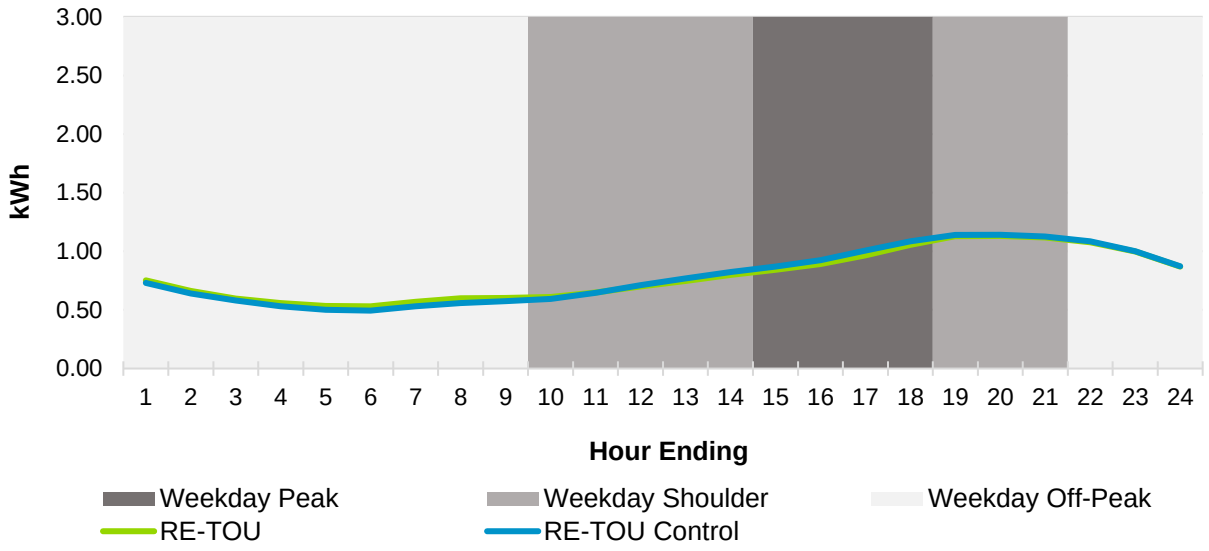


Figure A-14. Renters – Summer, Weekends

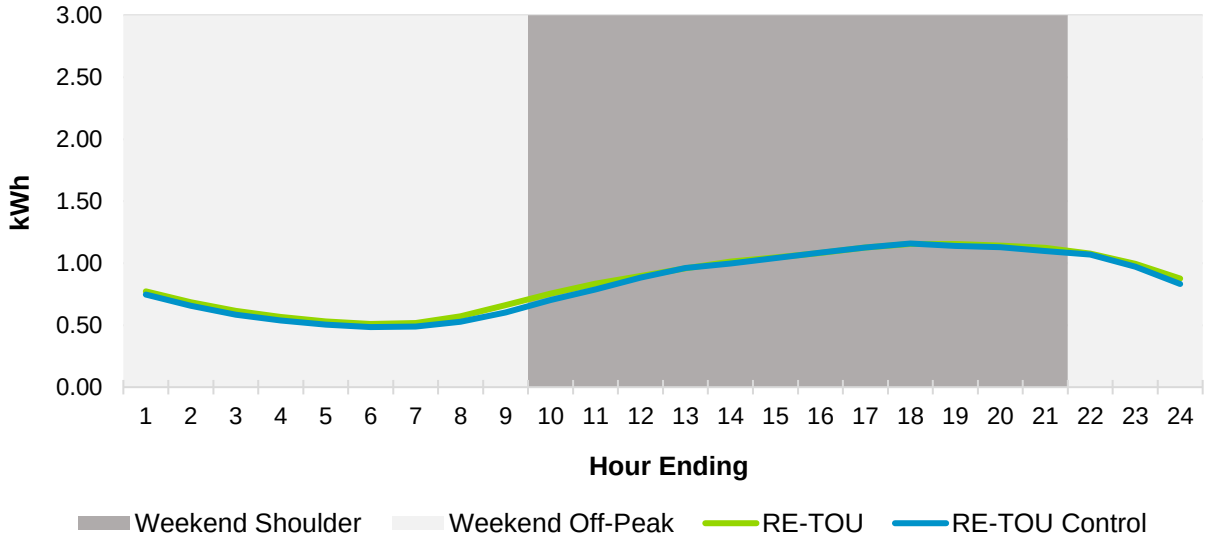


Figure A-15. Renters – Winter, Weekdays

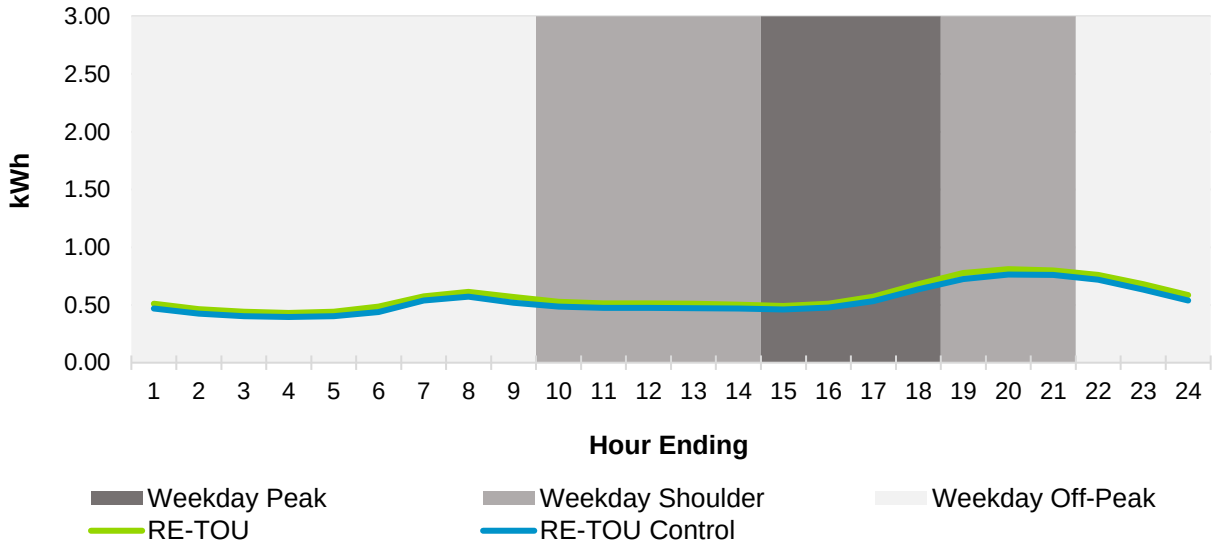
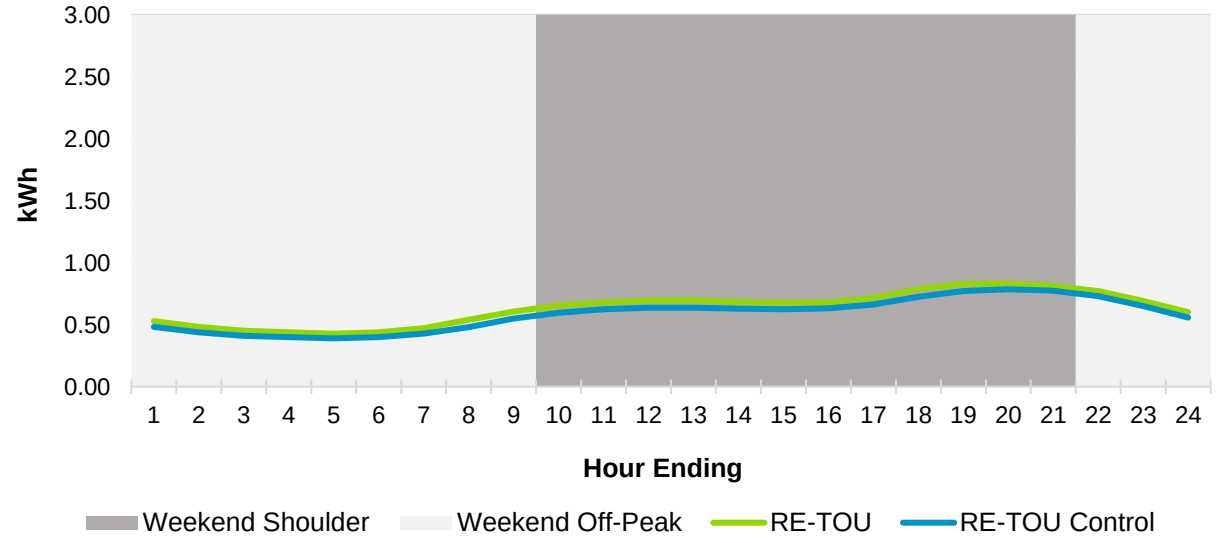


Figure A-16. Renters – Winter, Weekends



A.5 Seniors (No EV)

Figure A-17. Seniors – Summer, Weekdays

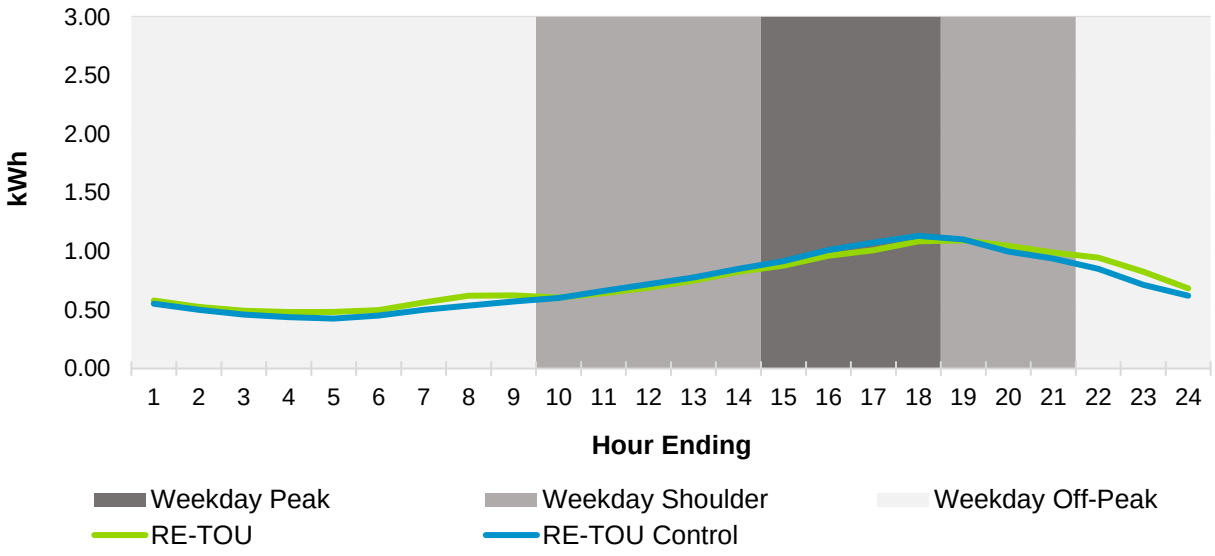


Figure A-18. Seniors – Summer, Weekends

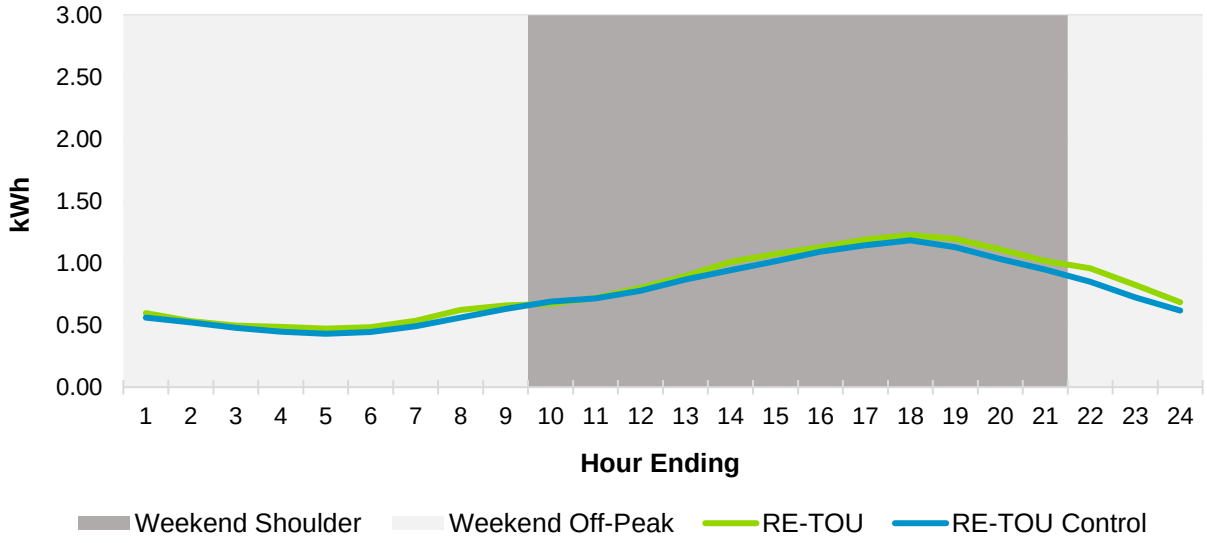


Figure A-19. Seniors – Winter, Weekdays

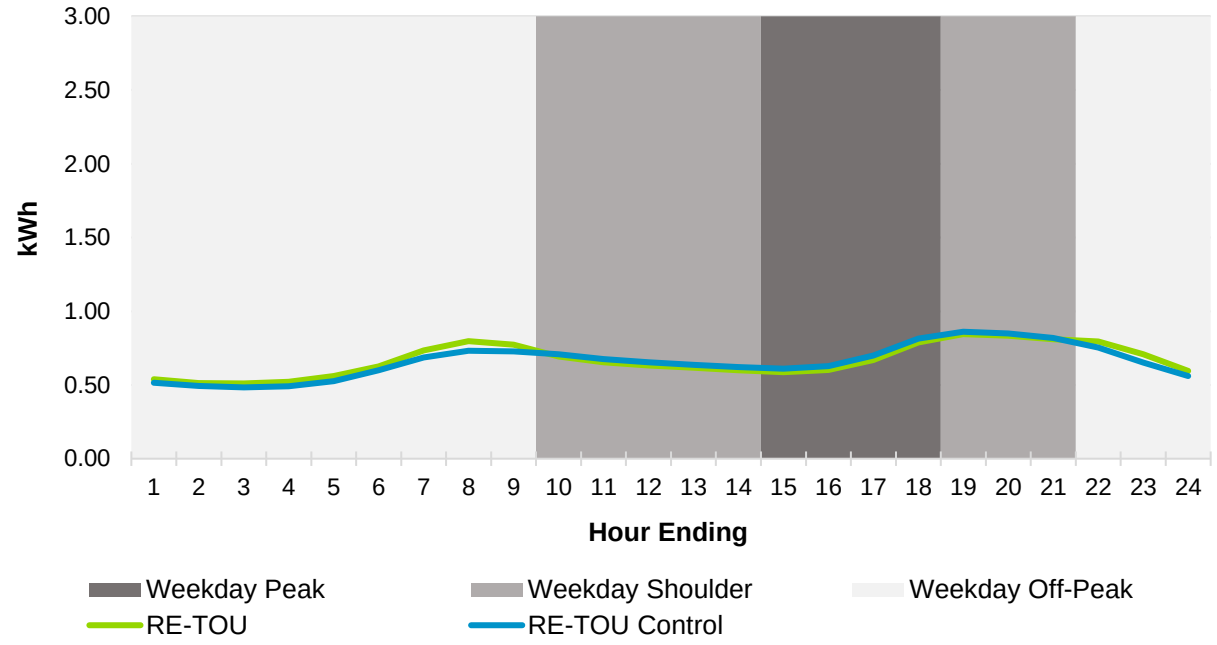
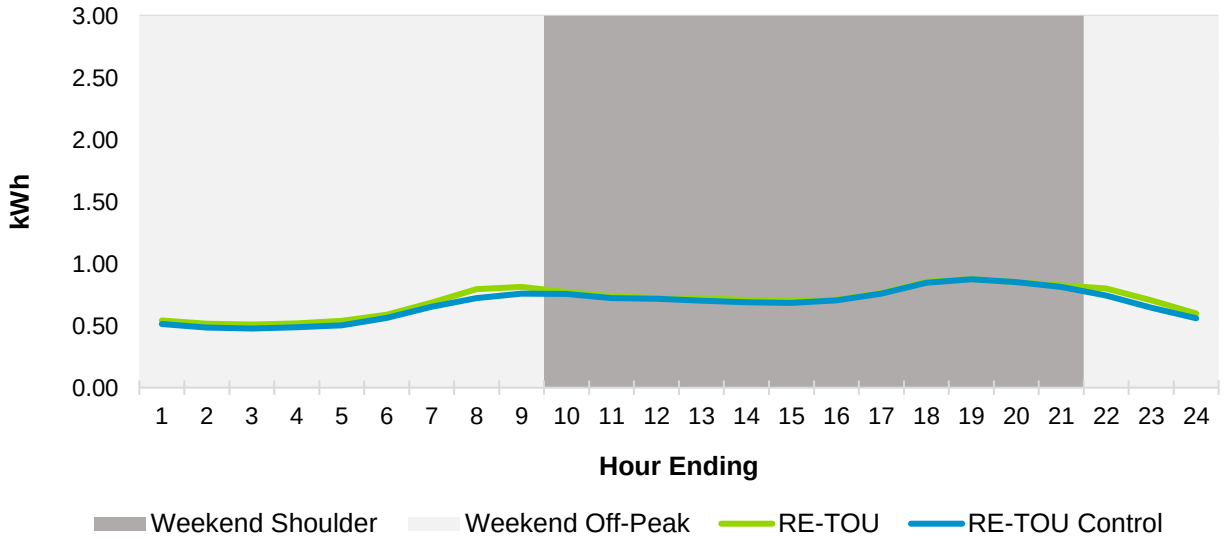


Figure A-20. Seniors – Winter, Weekends



A.6 General Population

Figure A-21. General Population – Summer, Weekdays

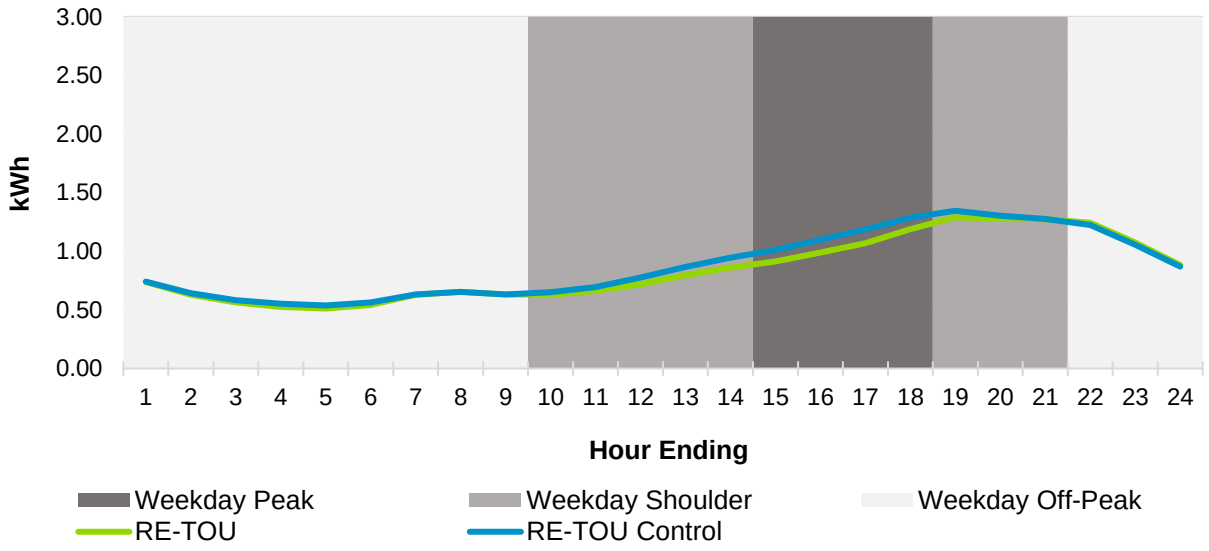


Figure A-22. General Population – Summer, Weekends

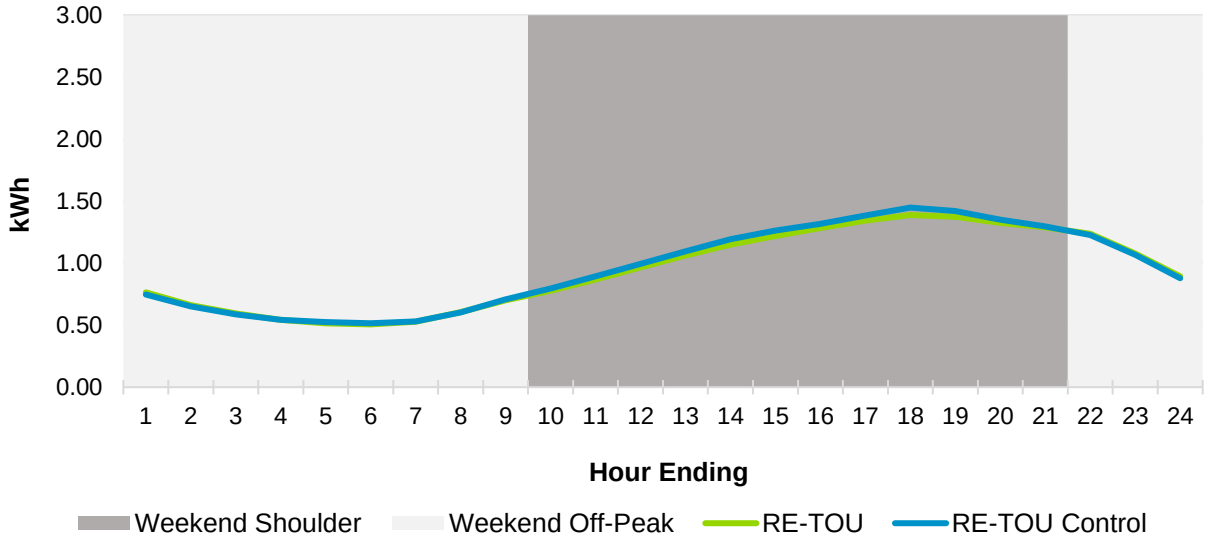


Figure A-23. General Population – Winter, Weekdays

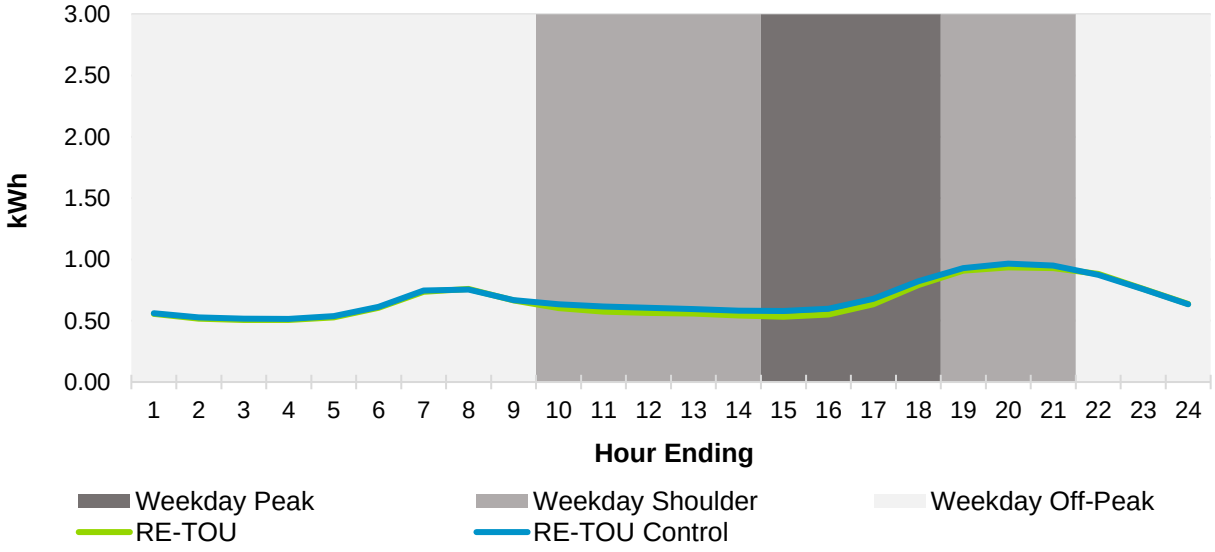
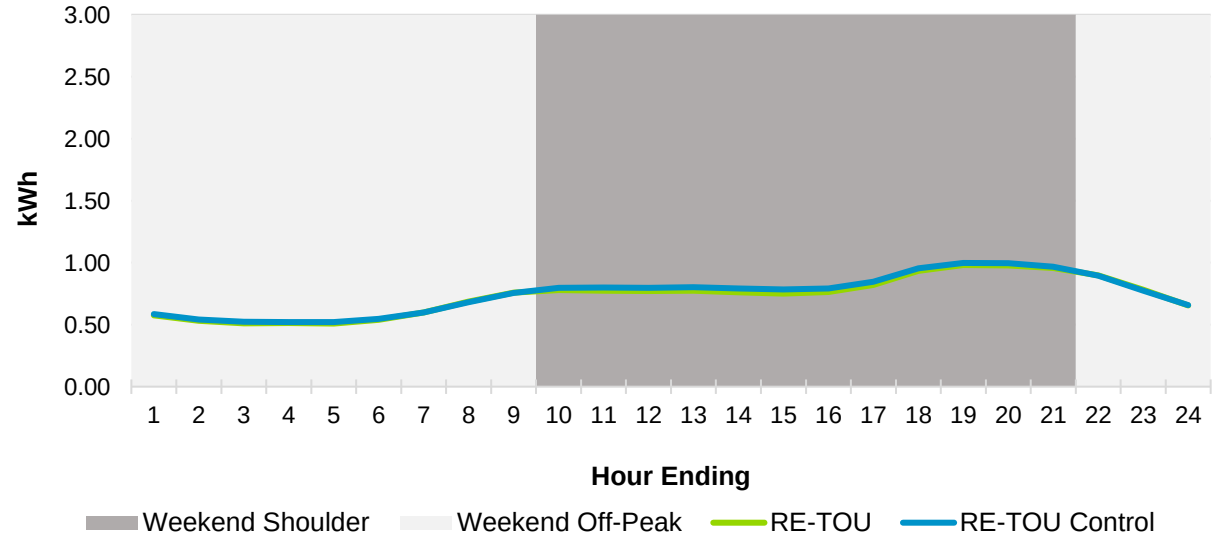


Figure A-24. General Population – Winter, Weekends



A.7 Solar

Figure A-25. Solar – Summer, Weekdays - Gross Consumption

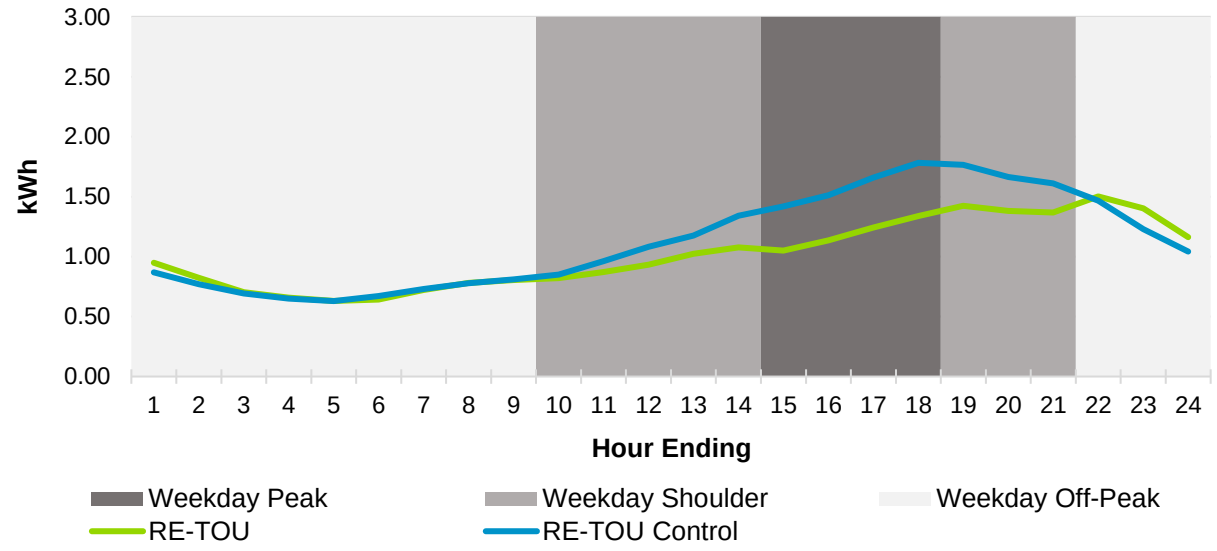


Figure A-26.Solar – Summer, Weekends - Gross Consumption

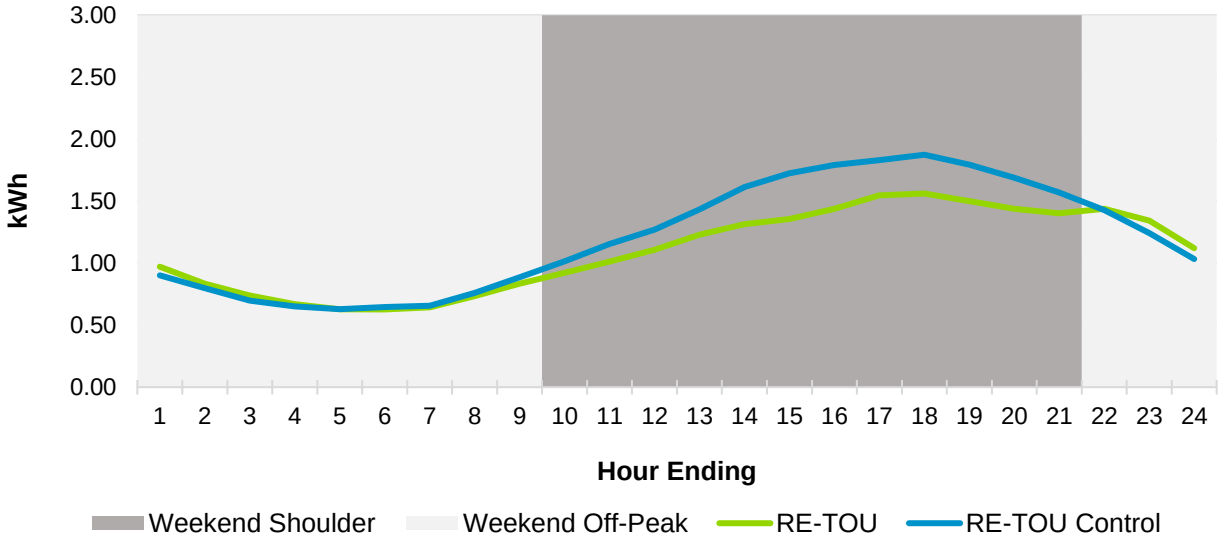


Figure A-27. Solar – Winter, Weekdays - Gross Consumption

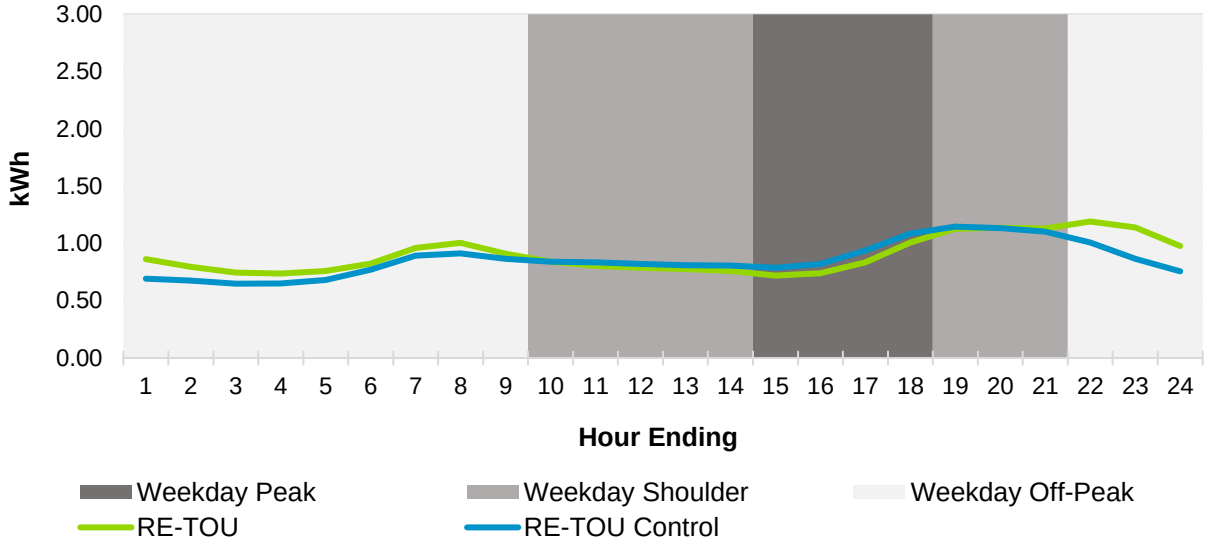
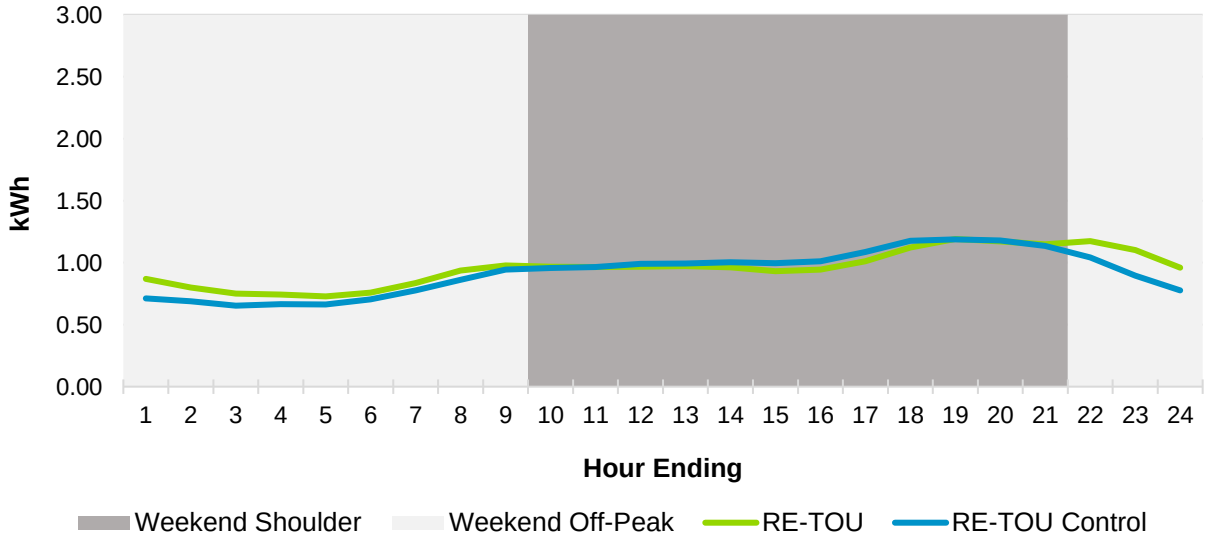


Figure A-28. Solar – Winter, Weekends - Gross Consumption



APPENDIX B. BILL IMPACTS BY SEGMENT AND SEASON

B.1 Low Income (No EV)

Figure B-1. Low Income - Summer – Monthly TOU Bill Impact

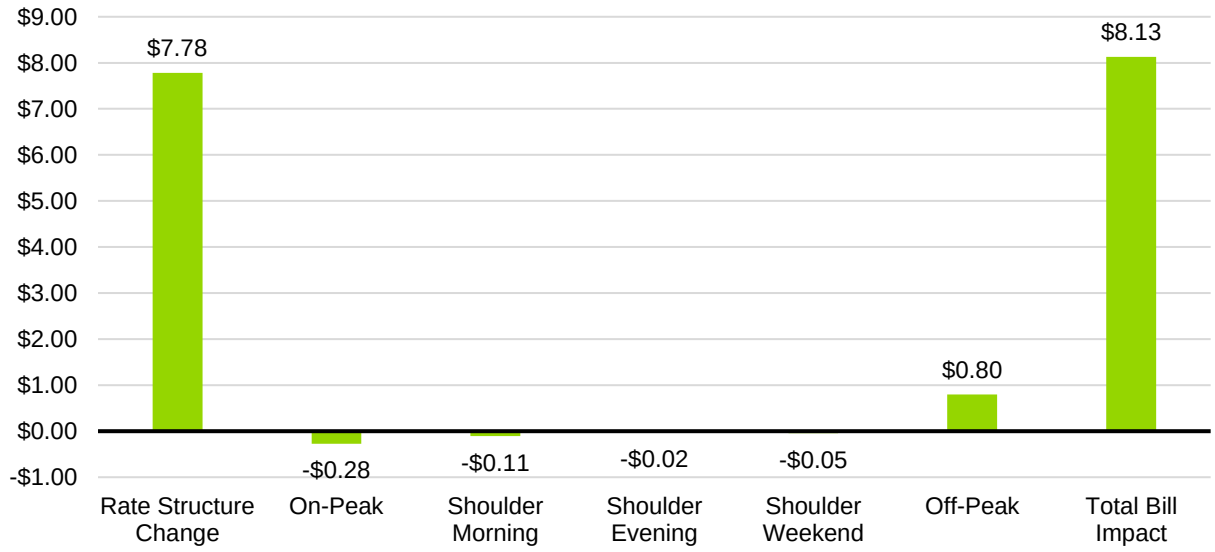


Figure B-2. Low Income - Winter – Monthly TOU Bill Impact

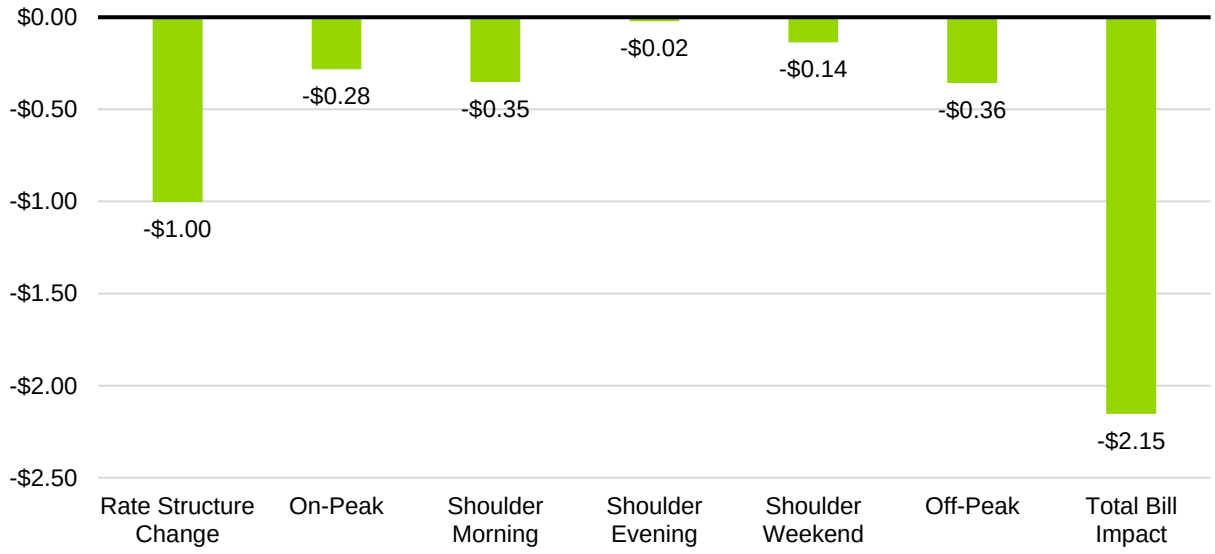
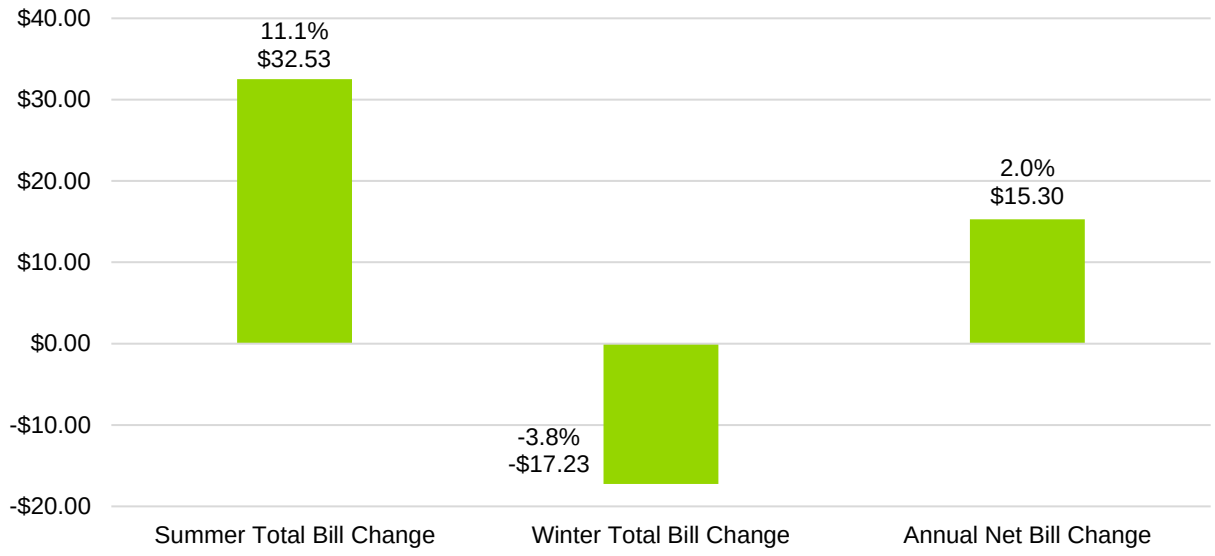


Figure B-3. Low Income – Total – Monthly TOU Bill Impact



B.2 Electric Vehicles

Figure B-4. Electric Vehicles - Summer – Monthly TOU Bill Impact

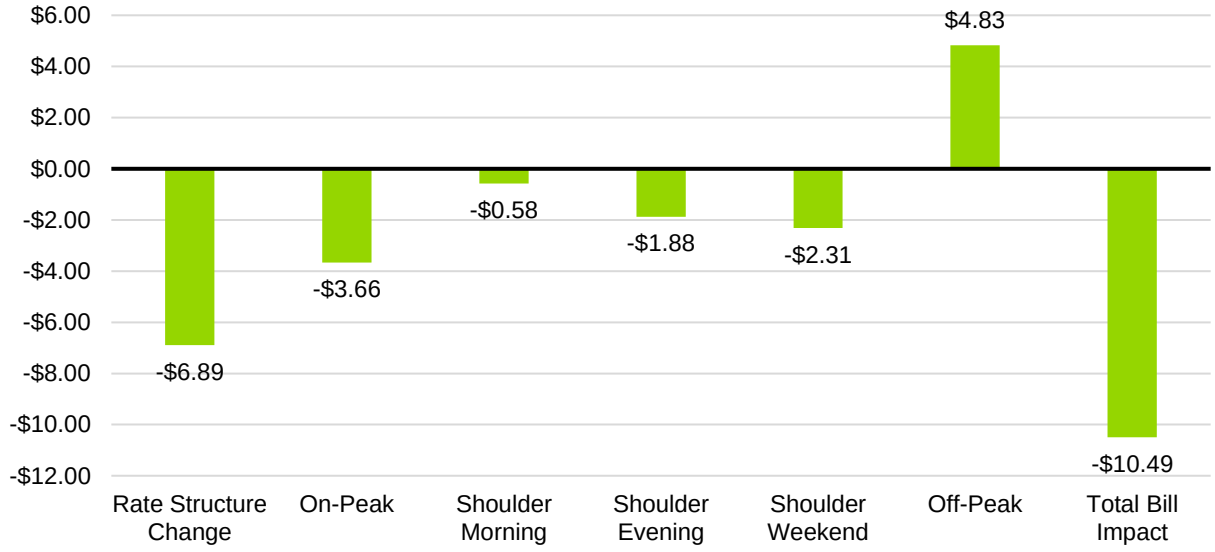
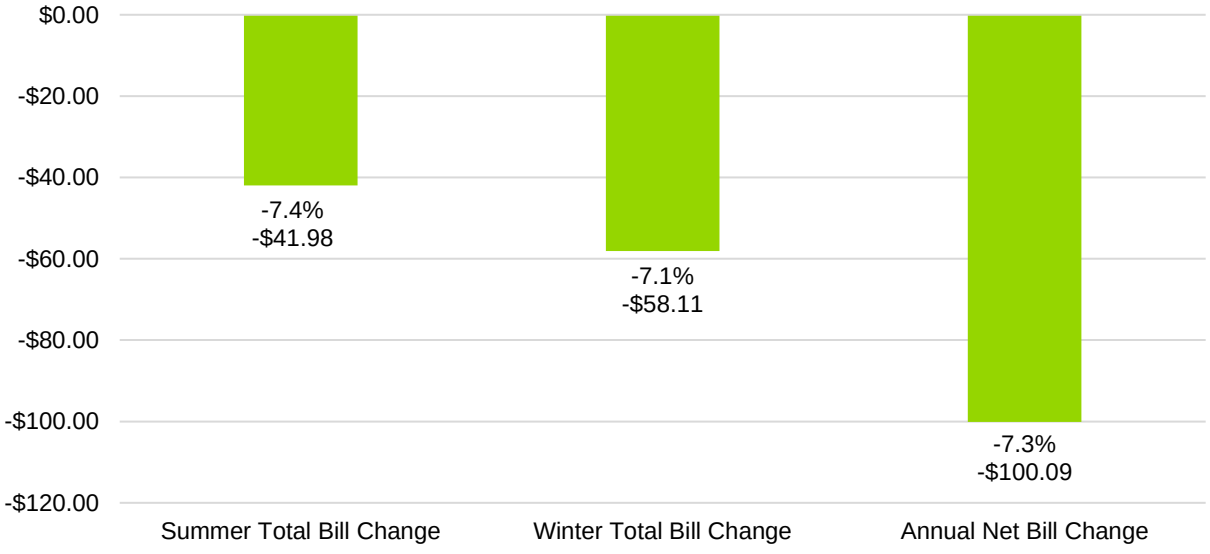


Figure B-5. Electric Vehicles - Winter – Monthly TOU Bill Impact

Figure B-6. Electric Vehicles – Total – Monthly TOU Bill Impact



B.3 Smart Thermostats (No EV)

Figure B-7. Smart Thermostats - Summer – Monthly TOU Bill Impact

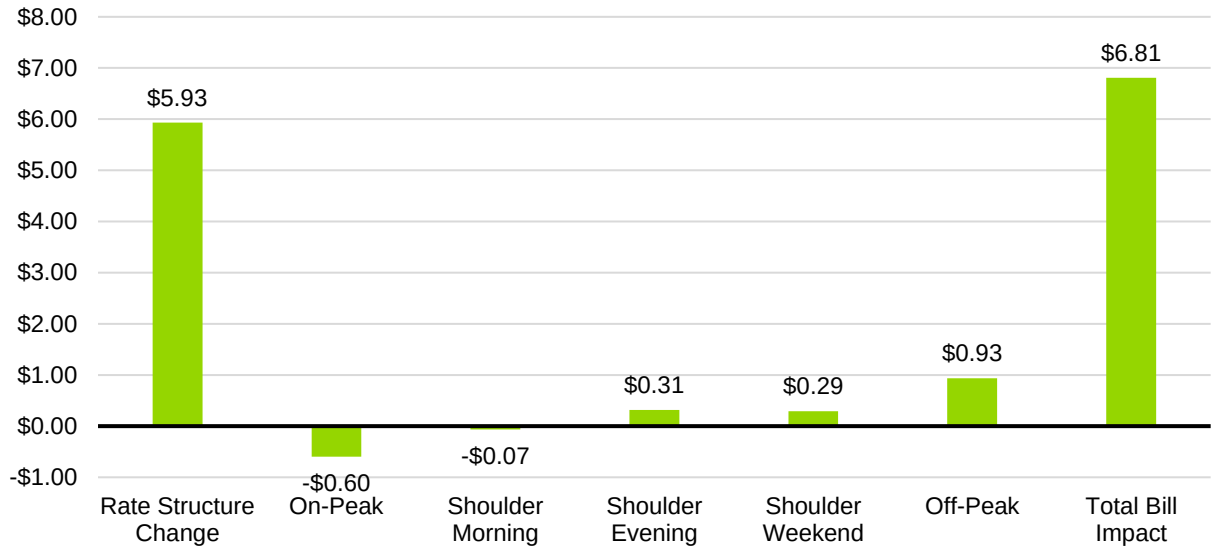
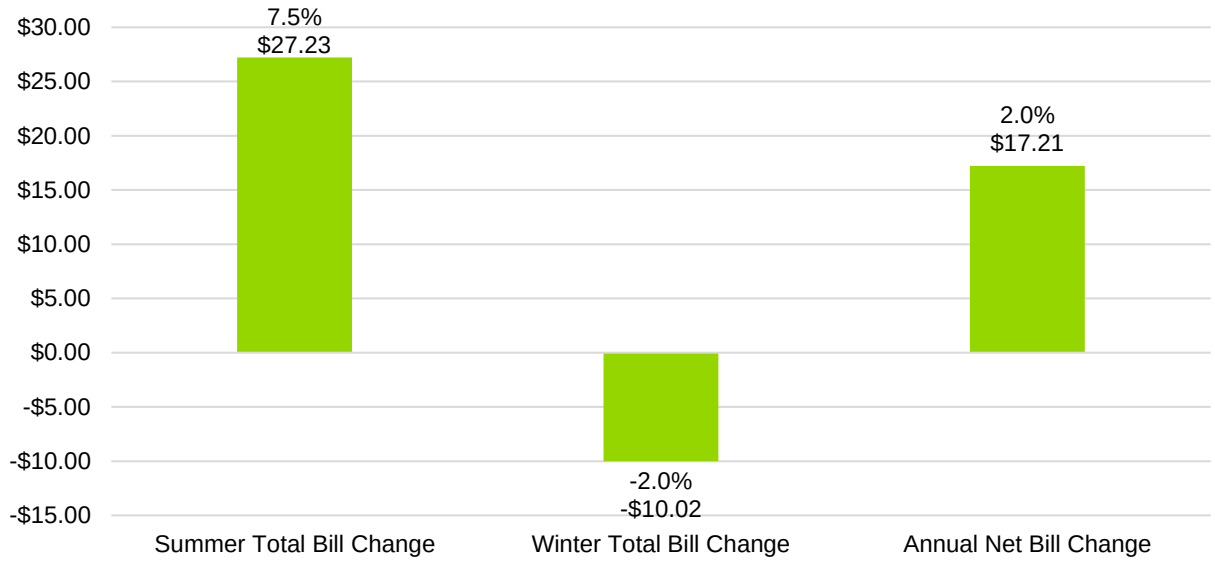


Figure B-8. Smart Thermostats - Winter – Monthly TOU Bill Impact

Figure B-9. Smart Thermostats – Total – Monthly TOU Bill Impact



B.4 Seniors (No EV)

Figure B-10. Seniors - Summer – Monthly TOU Bill Impact

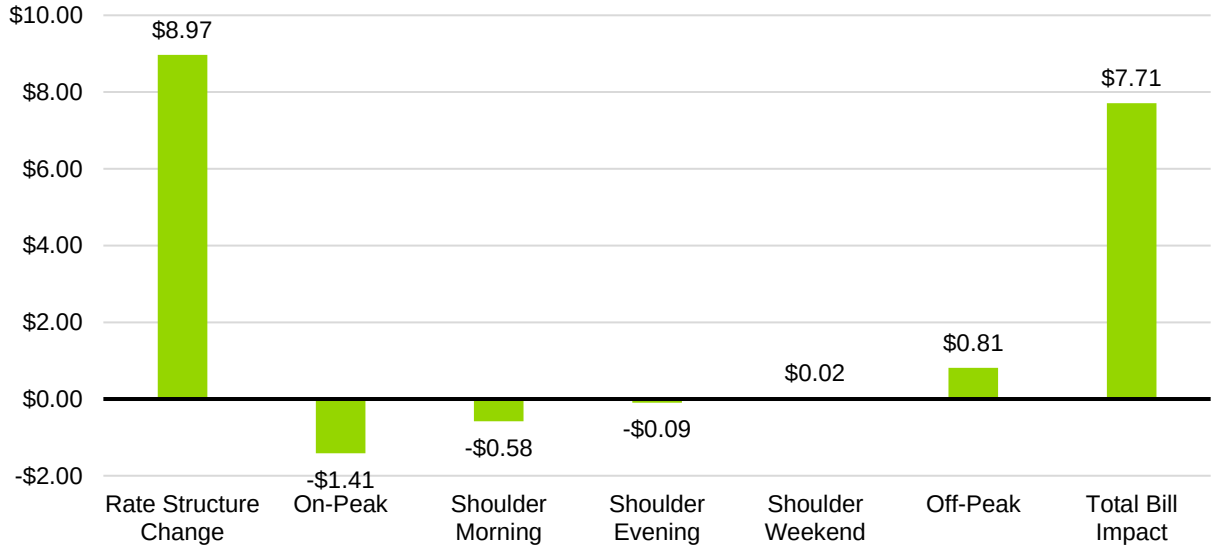
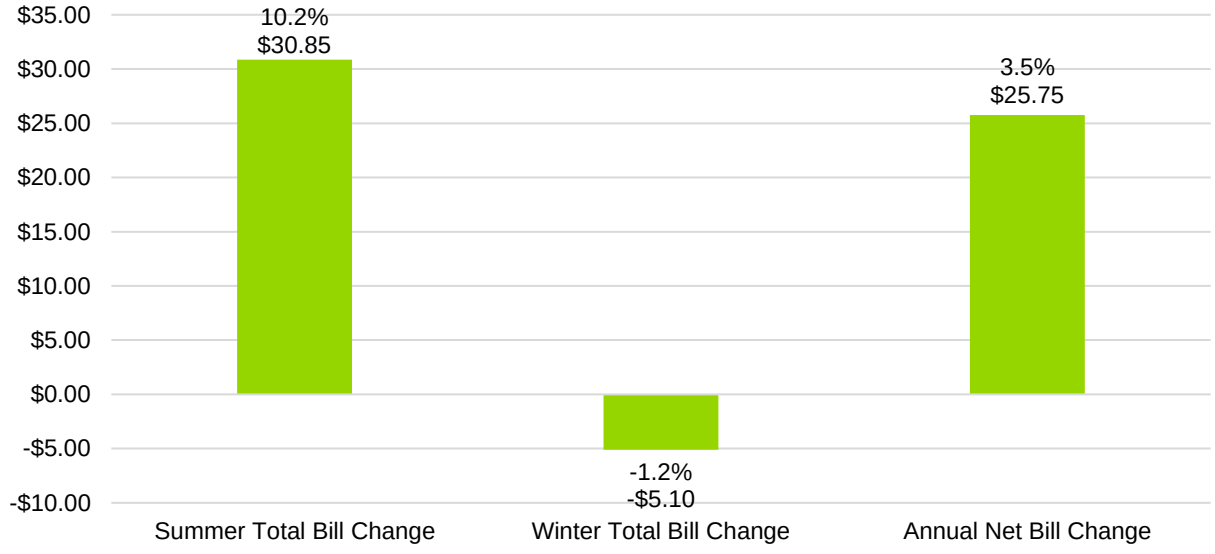


Figure B-11. Seniors - Winter – Monthly TOU Bill Impact

Figure B-12. Seniors – Total – Monthly TOU Bill Impact



B.5 Renters (No EV)

Figure B-13. Renters - Summer – Monthly TOU Bill Impact

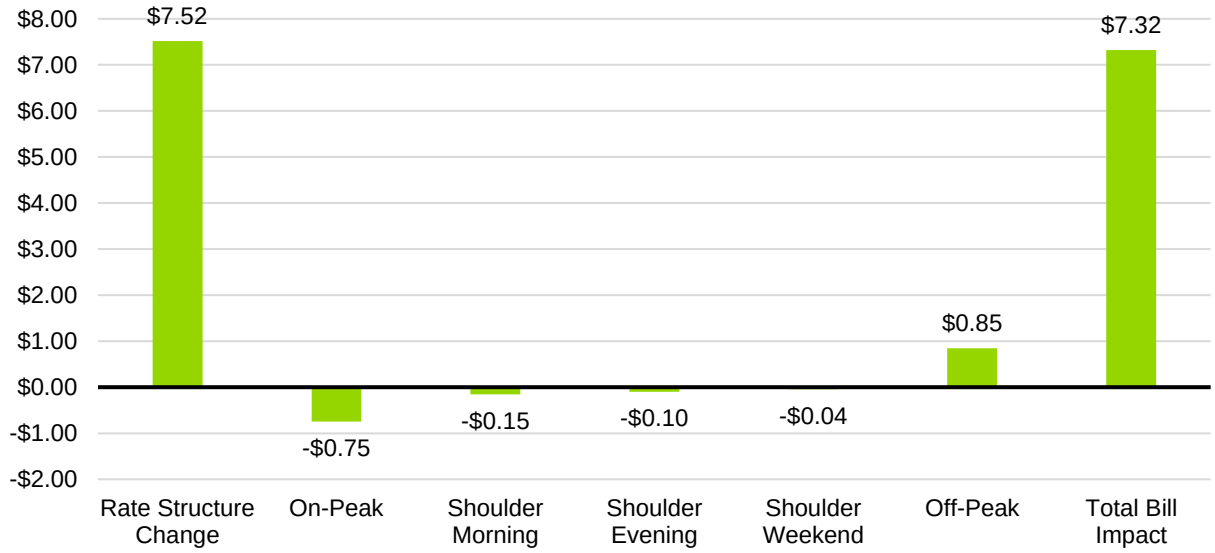


Figure B-14. Renters - Winter – Monthly TOU Bill Impact

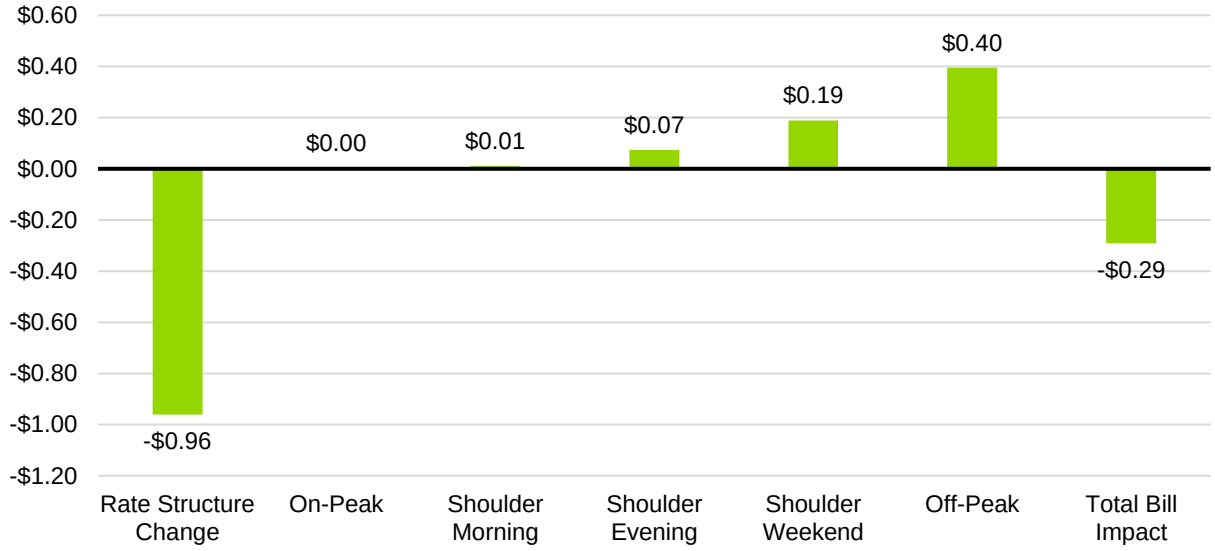
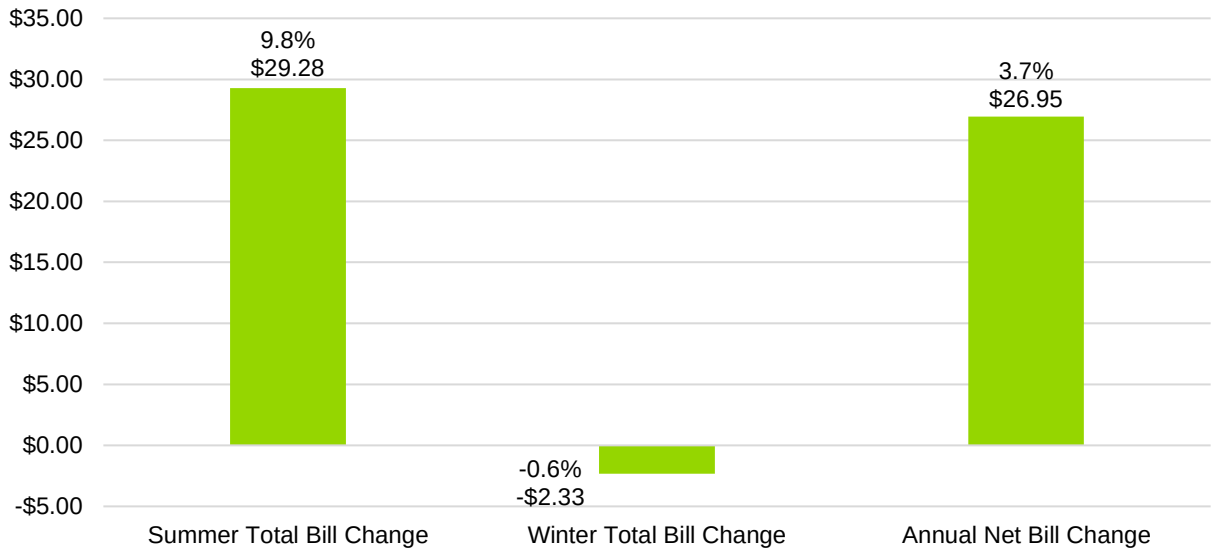


Figure B-15. Renters – Total – Monthly TOU Bill Impact



B.6 General Population

Figure B-16. General Population - Summer – Monthly TOU Bill Impact

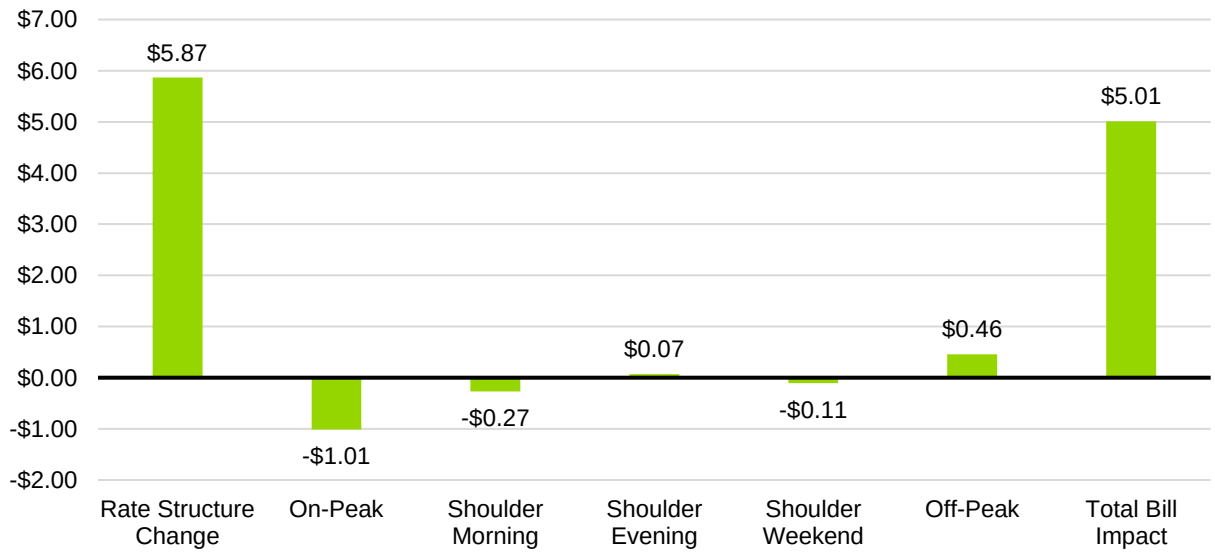


Figure B-17. General Population - Winter – Monthly TOU Bill Impact

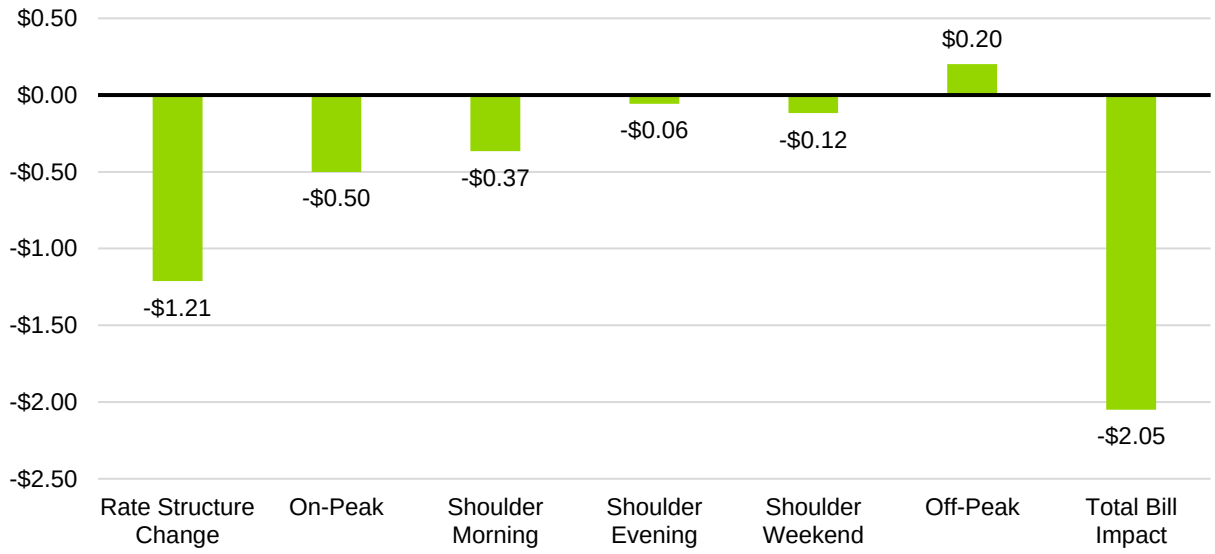
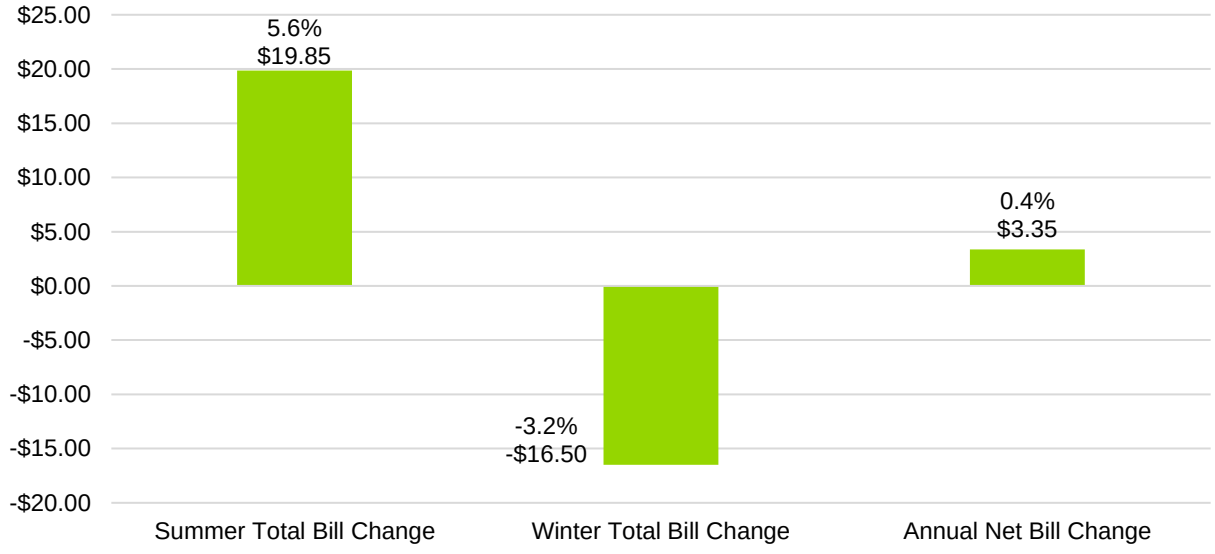


Figure B-18. General Population – Total – Monthly TOU Bill Impact

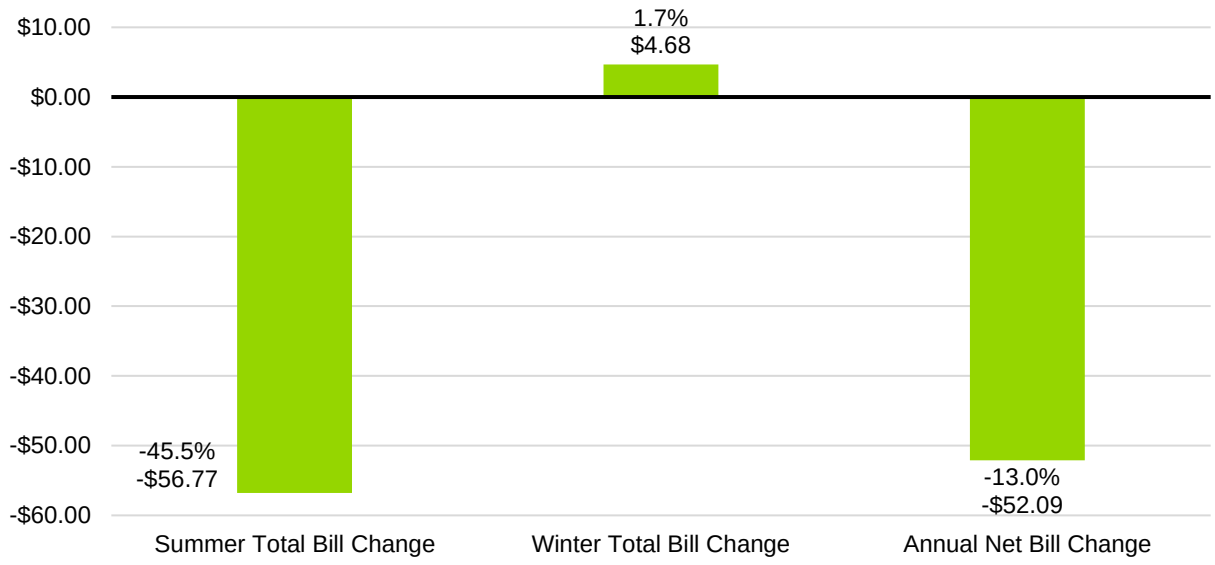


B.7 Solar

Figure B-19. Solar - Summer – Monthly TOU Bill Impact

Figure B-20. Solar - Winter – Monthly TOU Bill Impact

Figure B-21. Solar – Total – Monthly TOU Bill Impact



APPENDIX C. WAVE 3 SURVEY

Understanding your experiences on the TOU pricing plan is very important to us. This survey is part of a multi-year effort to gather customer feedback about your experiences over time. Even if you have responded to earlier surveys, we encourage you to complete this final 10-15 minute survey to help us improve our electricity pricing programs.

Special Thank You Sweepstakes. As a token of our appreciation, you will be entered into a special Thank You Sweepstakes Drawing upon completion of the survey. Sweepstakes prizes include one $250 Amazon gift card and two $50 Amazon gift cards. Sweepstakes eligibility is limited to participants in Xcel Energy's TOU or Peak Demand pricing plans who complete the survey before the deadline. The official sweepstakes rules can be viewed here.

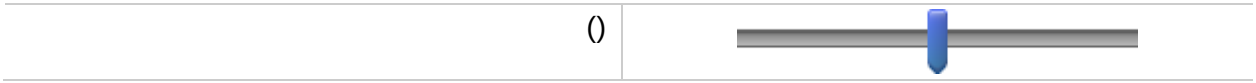
Your survey feedback will be used for the sole purposes of improving marketing and education efforts, improving future iterations of the pricing plans, and evaluating the effectiveness of these new pricing plans. Information you provide will not be distributed or shared with any person other than those explicitly necessary for the purposes stated above. To start the survey, click on the NEXT button.

End of Block: Wave 3 intro

Start of Block: Xcel Energy Recommendation

Q1 On a scale from 0 to 10, where 0 means "Not at all likely" and 10 means "Extremely likely", how likely are you to recommend Xcel Energy to a friend, relative or colleague for their residential electric service? (Drag the slider bar left or right to indicate your answer.)

0 1 2 3 4 5 6 7 8 9 10



Display This Question:

If Q1 [ ] < 7

Q2 Please explain why you rated your likeliness to recommend Xcel Energy as a ${Q1/TotalSum}.

_____

_____

_____

_____

End of Block: Xcel Energy Recommendation

Start of Block: Customer Understanding of the Pricing Plan

Display This Question:

If WAVE_2 = No

Q3 Which of the following statements best describes your typical response to your electricity bill since joining the TOU pricing plan?

- I typically spend at least several minutes looking at my monthly bill to gain an understanding of the costs, and other information that is provided. (1)
- I glance at the various costs and other information on the bill before paying. (2)
- I look at the total bill amount, and if it is within reason, I just pay it. (3)
- I don't look at it at all, I just pay for it or it gets paid automatically. (4)
- Don't Know (98)

Q4 How well do you understand the electricity bills you have been receiving since you enrolled in the TOU pricing plan?

- I typically don't look at my energy bill at all (1)
- I really don't understand the information in the bill at all (2)
- I have a basic understanding of the energy bill (3)
- I have a fairly complete understanding of the energy bill (4)
- I understand the bill completely (5)

Display This Question:

If CUSTOMERPLAN = TOU

Q5a Under the TOU pricing plan, the way you are charged for energy is different than your old plan. Based on your current knowledge of the plan, please indicate the accuracy of the following description of how the TOU pricing plan works: **Under the TOU pricing plan, the amount I pay per kWh is determined by the time of day I'm using electricity and whether it is a weekday, weekend or a holiday.**

- ○ Completely Accurate (1)
- ○ Partially Accurate (2)
- ○ Inaccurate (3)
- ○ Don't Know (98)

Display This Question:

If CUSTOMERPLAN = TOU

Q5b Under the TOU pricing plan, the way you are charged for energy is different than your old plan. Based on your current knowledge of the plan, please indicate the accuracy of the following description of how the TOU pricing plan works: **Under the TOU pricing plan, there are three different prices for electricity on any given weekday (unless it is a holiday).**

- ○ Accurate (1)
- ○ Inaccurate (2)
- ○ Don't Know (98)

Display This Question:

If CUSTOMERPLAN = TDR[29]

Q6 Under the Peak Demand pricing plan, the way you are charged for energy is different than your old plan. Based on your current knowledge of the Peak Demand plan, please indicate the accuracy of each of the following descriptions of how the Peak Demand pricing plan works:

	Accurate (1)	Inaccurate (2)	Don't Know (98)
Under the Peak Demand pricing plan, the amount I pay is determined in part by the time of day I'm using electricity. (31)	○	○	○
Under the Peak Demand pricing plan, the amount I pay is determined in part by the amount of electricity that I use during a single hour during the month. (32)	○	○	○

Q7 On a scale of 0 to 10, where 10 is "extremely likely" and 0 is "not at all likely", how likely are you to recommend the TOU pricing plan to friends or family? (Drag the slider bar left or right to indicate your answer.)

0 1 2 3 4 5 6 7 8 9 10

()

[29] TOU customers were not shown any questions related to the TDR rate plan. This question was skipped in the survey for TOU customers.

Q8 Which one of the following factors do you find most compelling as a reason for changing your normal routine on the TOU pricing plan? (select one)

- ○ I could save on my bill (1)
- ○ It would help the environment (2)
- ○ It would make the grid more stable for everyone (3)
- ○ My neighbors also made the change (4)
- ○ None of these reasons is sufficiently compelling enough for me to change my normal routine (5)
- ○ Don't Know (98)

X→

Q9a Has your participation in the TOU pricing plan helped you achieve more control over your electricity bill?

- ○ Yes, very helpful (1)
- ○ Yes, somewhat helpful (2)
- ○ Unsure (3)
- ○ No, Not helpful (4)
- ○ Other, please specify: (97) _____

X→

Q9b Has your participation in the TOU pricing plan helped you conserve energy?

- ○ Yes, very helpful (1)
- ○ Yes, somewhat helpful (2)
- ○ Unsure (3)
- ○ No, Not helpful (4)
- ○ Other, please specify: (97) _____

X→

Q9c Has your participation in the TOU pricing plan helped you save money on your electricity bill?

- ○ Yes, very helpful (1)
- ○ Yes, somewhat helpful (2)
- ○ Unsure (3)
- ○ No, Not helpful (4)
- ○ Other, please specify: (97) _____

End of Block: Customer Understanding of the Pricing Plan

Start of Block: Q10

Display This Question:

If CENTRAL_AC > 0

✱ X→ X→

Q10 During this past summer, what temperature did you typically set your thermostat to when running your air conditioner...

	Temperature Setting	We never/rarely ran the AC during these hours

	(1)	(2)
Weekday Peak hours(2pm-6 pm) (1)		☐
Weekday Shoulder hours (4)		☐
Weekends 9 am—9 pm (5)		☐
At Night 9 pm—9 am (6)		☐
When no one is home (7)		☐

End of Block: Q10

Start of Block: Changes in Behaviors and Technologies

Intro Now we would like to ask you a couple of questions about how you **were** using electricity **before** you signed up for the TOU pricing plan.

Display This Question:

If WAVE_2 = No

Q11 **Before** signing up for the TOU pricing plan, how frequently did you run the following appliances during the **summer months** (June – Sept) **between the hours of 2pm to 6pm**?

	Very frequently (1)	Frequently (2)	Sometimes (3)	Rarely (4)	Never (5)	Do not have this appliance or technology (99)
Air conditioning (Q10_1)	○	○	○	○	○	○
Electric oven (Q10_2)	○	○	○	○	○	○
Electric range (Q10_3)	○	○	○	○	○	○
Dishwasher (Q10_4)	○	○	○	○	○	○
Electric clothes dryer (Q10_5)	○	○	○	○	○	○
Electric vehicle charger (Q10_6)	○	○	○	○	○	○
Hot tub (Q10_7)	○	○	○	○	○	○

Display This Question:

If CENTRAL_AC > 0

And WAVE_2 = No

Or If

WINDOW_AC > 0

And WAVE_2 = No

Q12 **Before** signing up for the TOU pricing plan, how would you describe the typical air conditioning settings in your home during the summer months (June – Sept)? *Please select all that apply:*

As a household, we typically…

- ☐ Maintained a consistent temperature setting at or above 78 degrees throughout the day and night (1)
- ☐ Maintained a consistent temperature setting below 78 degrees throughout the day and night (2)
- ☐ Had at least one period during the day when the thermostat was set at a higher temperature (or we turn off the AC entirely) (3)
- ☐ Turned off the air conditioning at night and open the windows (4)
- ☐ Cranked up the AC sometime between 2pm and 6pm to cool off the house or apartment (5)
- ☐ Only turned on the AC when it was really hot outside (6)
- ☐ Other, please specify: (97) _____

End of Block: Changes in Behaviors and Technologies

Start of Block: Changes in Behaviors and Technologies Transition

Transition Now we would like to ask you a few questions about how you (and others in your household) have been using electricity **after** signing up for the TOU pricing plan.

Q13 **After** enrolling in the TOU pricing plan, how frequently have you run the following appliances during the hours of 2pm to 6pm during the summer months (June – Sept)?

	Very frequently (1)	Frequently (2)	Sometimes (3)	Rarely (4)	Never (5)	Do not have this appliance or technology (99)
Air conditioning (1)	○	○	○	○	○	○
Electric oven (2)	○	○	○	○	○	○
Electric range (3)	○	○	○	○	○	○
Dishwasher (4)	○	○	○	○	○	○
Electric clothes dryer (5)	○	○	○	○	○	○
Electric vehicle charger (6)	○	○	○	○	○	○
Hot tub (7)	○	○	○	○	○	○

Display This Question:

If CENTRAL_AC > 0

Or WINDOW_AC > 0

X→

Q14 **After** enrolling in the TOU pricing plan, how would you describe the typical air conditioning settings in your home during the summer months (June-Sept)? *Please select all that apply:*

As a household, we typically...

- ☐ Maintained a consistent temperature setting at or above 78 degrees throughout the day and night (1)
- ☐ Maintained a consistent temperature setting below 78 degrees throughout the day and night (2)
- ☐ Had at least one period during the day when the thermostat is set at a higher temperature (or we turn off the AC entirely) (3)
- ☐ Turned off the air conditioning at night and open the windows (4)
- ☐ Cranked up the AC sometime between 2pm and 6pm to cool off the house or apartment (5)
- ☐ Only turned on the AC when it is really hot outside (6)
- ☐ Other, please specify: (97) _____

Display This Question:

If CUSTOMERPLAN = TOU

Q15 Please indicate which of the following actions you or others in your household started doing (during the months June-Sept) **after** you signed up for the new pricing plan. *Please select all that apply:*

- ☐ Setting the thermostat at a higher temperature during peak periods, so the AC runs less often (1)
- ☐ Setting the thermostat at a higher temperature during shoulder periods, so the AC runs less often (2)
- ☐ Opening windows and turning off the AC at night to naturally cool my house or apartment (3)
- ☐ Precooling my house/apartment by running my AC more in the morning (4)
- ☐ Shifting the time of day when I use my washer/dryer (5)
- ☐ Shifting the time of day when I use my oven (6)
- ☐ Shifting the time of day when I use my dishwasher (7)
- ☐ Shifting the time of day when I watch TV or play video games (8)
- ☐ Turning off lights when not home or not needed (9)
- ⊗ We have not changed our behaviors (10)
- ☐ Other, please specify: (97) _____

Display This Question:

If CUSTOMERPLAN = TDR[30]

[30] TOU customers were not shown any questions related to the TDR rate plan. This question was skipped in the survey for TOU customers.

Q16 Please indicate which of the following actions you or others in your household started doing during the summer months (June-Sept) **after** you signed up for the new pricing plan. *Please select all that apply:*

- ☐ Setting the thermostat at a higher temperature during Peak periods, so the AC runs less often (1)
- ☐ Opening windows and turning off the AC at night to naturally cool my house or apartment (2)
- ☐ Precooling my house/apartment by running my AC in the morning and then setting my thermostat at a higher temperature in the afternoon (3)
- ☐ Staggering my use of major appliances during Peak periods (4)
- ☐ Staggering my use of major appliances during Off-Peak periods (5)
- ☐ Shifting the time of day when I use my washer/dryer (6)
- ☐ Shifting the time of day when I use my oven (7)
- ☐ Shifting the time of day when I use my dishwasher (8)
- ☐ Shifting the time of day when I watch TV or play video games (9)
- ☐ Turning off lights when not home or not needed (10)
- ☒ We have not changed our behaviors at all (11)
- ☐ Other, please specify: (97)

Display This Question:

If CUSTOMERPLAN = TDR[31]

[31] TOU customers were not shown any questions related to the TDR rate plan. This question was skipped in the survey for TOU customers.

Q17 Which of the following best describes your efforts to avoid using several appliances at the same time (in other words, ***stagger*** your appliance use)?

	Frequently (1)	Sometimes (2)	Rarely (3)	Never (4)
I/we stagger our use of appliances **during peak hours** (1)	○	○	○	○
I/we stagger our use of appliances **during off-peak hours** (4)	○	○	○	○

Q18 Please indicate which of the following technologies you currently own and/or have installed in your home. (Select all that apply.)

- ☐ A plug-in electric vehicle that you charge by plugging into an electrical outlet. (1)
- ☐ Solar PV panels used for generating electricity. (2)
- ☐ Energy storage or battery system (i.e., Powerwall, etc.) (3)
- ☐ A programmable thermostat (A thermostat with a digital display that allows you to program thermostat settings according to the household schedule.) (4)
- ☐ A smart thermostat (A Wi-Fi-enabled thermostat also known as a communicating thermostat that you can control from your smart phone or computer.) (5)
- ☐ A thermostat that cannot be programmed and that is not Wi-Fi-enabled. (6)
- ☐ Don't know (98)

End of Block: Changes in Behaviors and Technologies Transition

Start of Block: Thermostat Block

Q19a Did you have a programmable or smart thermostat in your home before enrolling in the TOU pricing plan or did you buy it after enrolling?

- Had it **before** enrolling (1)
- Installed it **after** enrolling (4)
- Don't Know (98)

Display This Question:

If Q19a = Had it before enrolling

Q19b **Before enrolling** in the TOU pricing plan, had you programmed your thermostat to automatically increase or reduce the temperature according to a particular schedule?

- Yes (1)
- No (2)
- Unsure (98)

Display This Question:

If Q19b = No

Q20 Did you start using a programmed schedule on your thermostat after enrolling in the TOU pricing plan?

- Yes (1)
- No (2)
- Unsure (98)

Display This Question:

If Q19a = Installed it after enrolling

Q21 Did you start using a programmed schedule on your thermostat once your new thermostat was installed?

- Yes (1)
- No (2)
- Unsure (98)

Display This Question:

If Q19a = Had it before enrolling

Q22 Have you ***changed*** the program settings on your thermostat since enrolling in the TOU pricing plan?

- Yes (1)
- No (2)
- Unsure (98)

Display This Question:

If Q20 = Yes

Or Q21 = Yes

Or Q22 = Yes

Q23 Were the changes that you made to the thermostat program helpful for reducing your use of air conditioning during peak periods?

- ○ Yes (1)
- ○ No (2)
- ○ Unsure (3)

Display This Question:

If Q19b = Yes

Or Q20 = Yes

Or Q21 = Yes

Or Q22 = Yes

X→

Q24 How easy or difficult is it to reprogram your thermostat?

- ○ Very easy (1)
- ○ Somewhat easy (2)
- ○ Somewhat difficult (3)
- ○ Very difficult (4)
- ○ Unsure (98)

Display This Question:

If Q20 = No

Or Q20 = Unsure

Or Q21 = No

Or Q21 = Unsure

Or Q22 = No

Or Q22 = Unsure

X→

Q25 If Xcel Energy offered to optimize or reprogram your thermostat schedule remotely (using wireless communications technologies) to best fit the pricing plan, how likely would you be to participate?

- ○ Very likely (1)
- ○ Likely (2)
- ○ Unlikely (3)
- ○ Very unlikely (4)
- ○ Unsure (98)

Display This Question:

If Q25 = Unlikely

Or Q25 = Very unlikely

Q25a Please tell us why you would choose not to participate.

_____

End of Block: Thermostat Block

Start of Block: Electric Vehicles

Q26 What make(s) and model(s) of plug-in electric vehicle do you (or others in your household) currently drive? (select all that apply)

- ☐ Toyota Prius Prime (1)
- ☐ Tesla Model S (2)
- ☐ Tesla Model X (3)
- ☐ Nissan Leaf (4)
- ☐ Chevy Bolt (5)
- ☐ Chevy Volt (6)
- ☐ Other (specify) (98) _____
- ☒ No one in my household drives a plug-in electric vehicle (0)

Skip To: End of Block If What make(s) and model(s) of plug-in electric vehicle do you (or others in your household) curren... = No one in my household drives a plug-in electric vehicle

X→

Q26a Is the car that **you** typically drive a:

- ○ Plug-in electric vehicle (1)
- ○ A hybrid vehicle that does not plugin (2)
- ○ A conventional gasoline or diesel-powered vehicle (3)
- ○ Other (97)

Skip To: End of Block If Q26a = A hybrid vehicle that does not plugin
Skip To: End of Block If Q26a = A conventional gasoline or diesel-powered vehicle
Skip To: End of Block If Q26a = Other

Q27 During an average week, approximately how many times per week do you charge your electric vehicle in each of the following locations? Please enter a numeric response.

- ○ At home (1) _____
- ○ At work (2) _____
- ○ At a public charging station (3) _____
- ○ Elsewhere (specify) (4) _____
- ○ Don't Know (5) _____

Display This Question:

If If Q27 At home Is Greater Than 0

Q28 When charging your car at home, how often do you typically use the scheduler function in your vehicle or on the charger to set the start and end time for the charging session?

- ○ Always (1)
- ○ Frequently (2)
- ○ Sometimes (3)
- ○ Rarely (4)
- ○ Never (5)
- ○ Not sure (98)

Display This Question:

If Q26a = Plug-in electric vehicle

Q29 How would you describe your typical charging patterns? I typically charge my electric vehicle…

- ○ Nightly (1)
- ○ On a schedule (2)
- ○ As needed (3)
- ○ Other (97)

End of Block: Electric Vehicles

Start of Block: Solar

Q30

	Yes (1)	No (2)	Unsure (3)
Did your solar installer encourage you to enroll in the TOU pricing plan? (1)	○	○	○
Did you consider the orientation of the solar panels when deciding to enroll in the TOU pricing plan? (2)	○	○	○
Did you choose to switch to rollover banked credits due to your enrollment in the TOU pricing plan? (3)	○	○	○

End of Block: Solar

Start of Block: Battery Questions

*

Q31 What were the two most important factors that motivated you to get battery storage for your home? (Select two.)

- [ ] To have reliable back-up power (1)
- [ ] To use in combination with solar panels and enable our ability to store and use the electricity that we produce even when the sun isn't shining (4)
- [ ] To minimize or eliminate our use of expensive electricity during peak pricing periods (5)
- [ ] To maximize our ability to sell electricity back to the grid during peak periods (with or without solar) (6)
- [ ] Other (specify) (7) _____
- [ ] Don't Know (8)

End of Block: Battery Questions

Start of Block: Bill Expectations

Q32 Since enrolling in the TOU pricing plan, have your household's electricity bills been higher than expected, lower than expected, or about the same as you expected?

- ○ Higher than I expected (1)
- ○ About the same as I expected (2)
- ○ Lower than I expected (3)
- ○ Did not have any expectation (4)
- ○ Don't know (98)

End of Block: Bill Expectations

Start of Block: Marketing, Messaging and Materials

Q33 Please indicate whether you recall receiving information about the TOU pricing plan by means of any of the following methods.

- [ ] Information enclosed with your Xcel Energy bill (1)
- [ ] An email from Xcel Energy (2)
- [ ] Information sent by mail (3)
- [ ] Other (97) _____

Q34 Since joining the TOU pricing plan, would you say that the frequency of communications about the pricing plan from Xcel Energy has been…

- ○ Much too frequent (1)
- ○ A little too frequent (2)
- ○ A little too infrequent (3)
- ○ Much too infrequent (4)
- ○ The frequency of communications was just right (5)
- ○ Don't Know (98)

Display This Question:

If WAVE_2 = No

Q35 On a scale of 0 to 10 where 10 is "very helpful" and 0 is "very unhelpful", please use the slider bars below to indicate how helpful the following **information resources** have been in your **understanding** of ***the new TOU pricing plan***. (Drag the slider bar left or right to indicate your answer.)

Not Applicable

0 1 2 3 4 5 6 7 8 9 10

An email from Xcel Energy ()	
Reminder stickers sent in the mail ()	
Personalized charts and graphs on My Account ()	
Xcel Energy Call Center ()	
Information about the rates on Xcel Energy's website ()	

Q36 Since joining the TOU pricing plan, how often have you referenced each of the following resources

	never (1)	once (2)	a few times (3)	monthly (4)	several times per month or more (5)
An email from Xcel Energy (Q36_1)	○	○	○	○	○
Reminder stickers sent in the mail (Q36_2)	○	○	○	○	○
Personalized charts and graphs on My Account (Q36_3)	○	○	○	○	○
Information about the rates on Xcel Energy's website (Q36_4)	○	○	○	○	○

Q37 Which of the following communication channels have you used to contact Xcel Energy for help with the TOU pricing plan? (Select all that apply.)

- ☐ Xcel Energy Call Center (1)
- ☐ Email to Xcel Energy (2)
- ☐ Xcel Energy Website email (3)
- ☐ Xcel Energy Website survey (4)
- ☐ Direct call to Xcel Energy program team (5)
- ☐ ⊗I have not used any of these communication channels (0)

Display This Question:

If Q37 != I have not used any of these communication channels

X→

Q38 Which of the following communications channels was most effective in answering your questions? (select one)

Q37 = Xcel Energy Call Center

- ○ Xcel Energy Call Center (1)

Q37 = Email to Xcel Energy

- ○ Direct email to Xcel Energy (2)

Q37 = Xcel Energy Website email

- ○ Email by means of Xcel Energy Website (3)

Q37 = Xcel Energy Website survey

- ○ Survey by means of Xcel Energy Website (4)

Q37 = Direct call to Xcel Energy program team

- ○ Direct call to Xcel Energy program team (5)
- ○ My Account website (6)

Q39 Is there any additional information that Xcel Energy could provide to help you understand the TOU pricing plan or your bill?

- ○ Yes, please specify: (1) _____
- ○ No (2)

Q40 Do you have any recommendations concerning ways that Xcel Energy could improve customer experience on the TOU pricing plan?

- ○ Yes, please specify: (1) _____
- ○ No (2)

End of Block: Marketing, Messaging and Materials

Start of Block: General Feedback

Q41 Are there any additional thoughts, suggestions or questions that you would like to share?

_____

_____

_____

_____

_____

End of Block: General Feedback

APPENDIX D. CUSTOMER INTAKE SURVEY

Colorado Time-of-Use and Peak Demand Pricing Plans
Application Form

INTRODUCTION

Thank you for agreeing to participate in Xcel Energy's new pricing plans! Your participation will be critical to helping Xcel Energy make decisions about how best to price electricity in a way that fair and equitable for all customers.

Once we've processed your application and determined that you're eligible for participation, you'll receive a confirmation email.

Note that your responses will not be sold for any reason and are strictly confidential to Xcel Energy and its partners. Please see our privacy notice for further information.

-The Xcel Energy Team

SCREENERS / NPS

Q1. **[SINGLE CHOICE QUESTION]**
By participating in our new rates, you agree to receive communication from Xcel Energy with important updates and notifications (such as the status of your application), suggestions on reducing your energy bill, and tips on managing your energy usage. In addition to these important communications, we'll also be sending you surveys periodically to see how things are going. While completing our surveys won't be required, your feedback will be important to us as we work through the testing and design phases of these new rates.

Got it. [FOR AFS ONLY] Email address: _____
No, I'd rather receive communication via paper mail about my participation. (This may limit the communications you receive since many notices are email only)

Q2. **[SINGLE CHOICE QUESTION]**
Are you the primary decision maker about your home's energy use?

Yes
No

Q3. **[SINGLE CHOICE QUESTION]**
On a scale from 0 to 10, where 0 means Not at all likely and 10 means Extremely likely, how likely are you to recommend Xcel Energy to a friend, relative or colleague for their residential electric service?

0 - Not at all likely

1
2
3
4
5
6
7
8
9
10 - Extremely likely

HOUSEHOLD CHARACTERISTICS

Q4. **[SINGLE CHOICE QUESTION]**
Which of the following best describes your home?
Single family home - fully detached
Mobile home
Duplex, triplex, four-plex
Townhome
Condominium or loft
Apartment

Q5. **[SINGLE CHOICE QUESTION]**
What is the approximate total square footage of your home?
0-500 square feet
501-1000 square feet
1001-1500 square feet
1501-2000 square feet
2001-2500 square feet
2501-3000 square feet
3001-3500 square feet
3501-4000 square feet
4001 or more square feet
Don’t know

Q6. **[SINGLE CHOICE QUESTION]**
What is the approximate age of your home?
- 5 years or less
- 6-15 years
- 16 to 25 years
- 26 to 35 years
- More than 35 years old
- Don't know

Q7. **[SINGLE CHOICE QUESTION]**
Do you own or rent your home?
- Own
- Rent

Q8. **[ASK IF Q7=RENT, SINGLE CHOICE QUESTION]**
How do you pay your electricity bills?
- I pay my own electricity bill directly to Xcel Energy
- I pay my landlord or building owner/manager for electricity that I specifically use, and they pay Xcel Energy on my behalf
- I pay my landlord or building owner/manager for a portion of the building's electricity use or a set amount as part of my monthly rent
- Don't know

Q9. **[SINGLE CHOICE QUESTION]**
How long have you lived at your current residence?
- Less than a year
- 1 year up to 5 years
- 5 years up to 10 years
- 10 years up to 15 years
- 15 years up to 20 years
- 20 years up to 25 years
- 25 years up to 35 years
- 35 years or more

Q10. **[NUMERIC ENTRY]**
How many people of each age group (including yourself) live in your home?
- 10 and under_____
- 11 to 18 _____
- 19 to 30 _____
- 31 to 61_____
- 62 and older _____

Q11. **[SINGLE CHOICE QUESTION]**

Do you regularly work from home or operate a business from your home?

Yes
No

Q12. **[NUMERIC ENTRY]**
How many people are typically at home on weekdays between 2pm and 6pm?

_____

APPLIANCES & TECHNOLOGY

Q13. **[NUMERIC ENTRY]**
Please indicate which of the following appliances / equipment are present in your home and the quantity of each.

____Central air conditioning
____Evaporative or swamp cooler
____Window unit air conditioner
____Electric water heater
____Electric stove / range
____Laundry dryer (natural gas)
____Laundry dryer (electric)
____Dishwasher
____Refrigerator
____Freezer (separate from refrigerator)
____Heat pump (ground or air source)
____Solar thermal (solar hot water heating)
____Swimming pool with filtration system and/or pool pump
____Hot tub with filtration system and/or pump
____Whole home lighting control system
____Computer

Q14. **[SINGLE CHOICE QUESTION]**
What type of fuel is used for the space heating that is primarily used in your home?
- Electricity
- Natural gas
- Don't know

Q15. **[MULTI-CHOICE QUESTION]**
Which of the following do you have in or on your home? Select all that apply.
- Rooftop solar
- Plug-in electric vehicles (i.e., those that can be plugged-in and recharged from an outlet)
- Programmable thermostat (i.e., a thermostat that can be set to adjust your HVAC system according to a specific schedule)
- Smart thermostat (i.e., a programmable thermostat that is Wi-Fi enabled)
- Energy storage or battery system (i.e., Powerwall, etc.)
- Smart / Programmable dishwasher (ability to delay start)
- Smart / Programmable washing machine (ability to delay start)
- I don't have any of these technologies

Q16. **[ASK IF Q15=Electric Vehicles, NUMERIC ENTRY]**
How many plug-in electric vehicles does your household have?

_____

Q17. **[ASK IF Q15=Electric Vehicles, SINGLE-CHOICE QUESTION]**
What type of EV charger do you have?
- Level One (Plugs into common 120 V outlet)
- Level Two (Hard wired or plugs into 240 V circuit)

Q18. **[ASK IF Q15=Smart thermostats, SINGLE-CHOICE QUESTION]**
What kind of smart thermostat do you have?
- Nest
- Ecobee
- Honeywell
- Emerson
- Carrier
- Radio
- Lux
- Venstar
- Other

Q19. **[SINGLE-CHOICE QUESTION]**
Is there are need for ongoing medical equipment that requires electricity use at your home?

Yes
No

ENERGY EFFICIENCY BEHAVIORS

Q20. **[MULTI-CHOICE QUESTION]**
Please indicate if you typically do any of the following things to save energy. Select all that apply.

Turn off lights to reduce electric use
Wash clothes in cold water
Unplug electronic equipment/appliances when not in use
Adjust thermostats to save energy when no one is at home
Lower the thermostat setting during the heating season to save on energy or cost
Increase the thermostat setting during the cooling season to save on energy or cost
Turn off power strips when not in use
Take shorter showers
None of the above

Q21. **[SINGLE CHOICE QUESTION]**
If you were to make a change to your normal routine on this new pricing plan, such as shifting the time of day you use the dishwasher or washing machine, which would be the most compelling reason for you?

I could save on my bill
It would help the environment
It would make the grid more stable for everyone
My neighbors also made the change
I wouldn't change for any reason

DEMOGRAPHICS

Q22. **[SINGLE CHOICE QUESTION]**
I identify my gender as:

Female
Male
Prefer not to answer

Q23. **[SINGLE CHOICE QUESTION]**
What age group do you fall in?

- Under 25
- 25-34
- 35-44
- 45-54
- 55-61
- 62-74
- 75 or higher
- Prefer not to answer

Q24. **[SINGLE CHOICE QUESTION]**
What is the highest level of education you have completed?

- Less than high school graduate
- High school graduate
- Some college/Trade school
- College graduate
- Some graduate school
- Graduate degree
- Prefer not to answer

Q25. **[SINGLE CHOICE QUESTION]**
What was your total household income in 2016 before taxes and including Social Security and other payments, if applicable?

Up to $30,000
$30,000 to under $50,000
$50,000 to under $75,000
$75,000 to under $100,000
$100,000 to under $150,000
$150,000 to under $200,000
More than $200,000
Prefer not to answer]

Q26. **[SINGLE CHOICE QUESTION]**
You don't need to be home when we install your new meter. But do you have any issues that our installation technician needs to be aware of when accessing your meter, like a gate code or to watch for a dog?

Yes **[IN AFS, AGENTS SHOULD ENTER THIS INFORMATION DIRECTLY INTO THE SPECIAL METER ACCESS FIELD IN CRS, NOT THIS FORM]**
No

Q27. **[MY ACCOUNT VERSION ONLY IF Q26=YES, OPEN END QUESTION]**
Please provide your special meter access instructions.

_____

You've reached the end of the form. Thanks again for your interest in participating in this important study. We'll send you a confirmation email once your application has been approved within the next 48 hours.

Please note, that as part of this test, it will be necessary to select a random group of customers to be a part of a control group so we can measure how effective the rates are at encouraging shifts in energy usage. If you are selected for the control group, you will remain on your current rate. While you no longer will be put on a different rate or need to change any of your energy consumption patterns, you will be just as crucial to the success of this test.