TIMING THE SHIFT: EXPLORING CUSTOMER RESPONSES TO TOU PRICING

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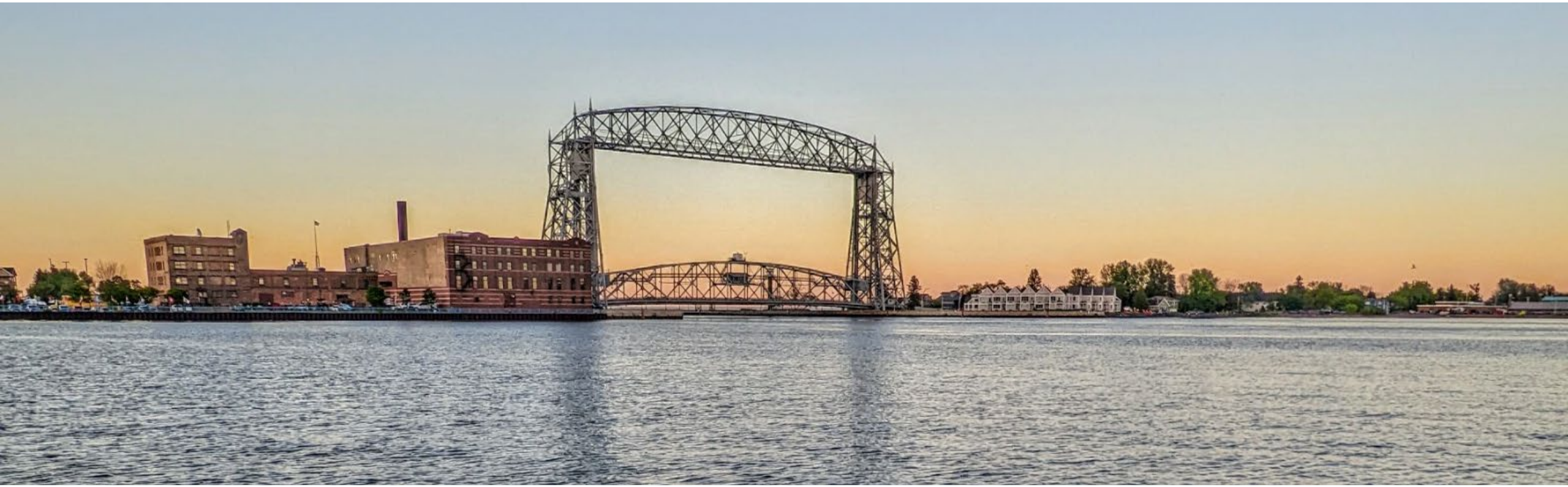

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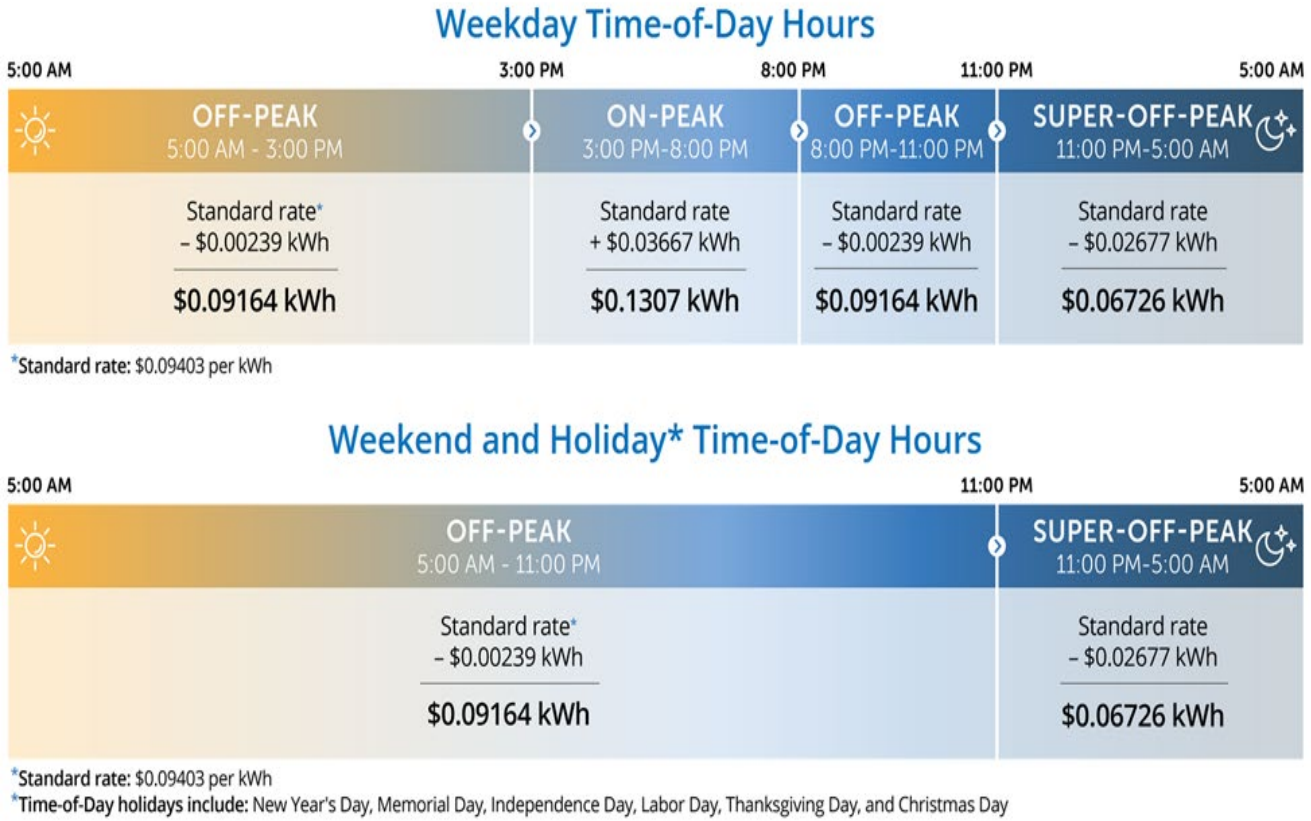
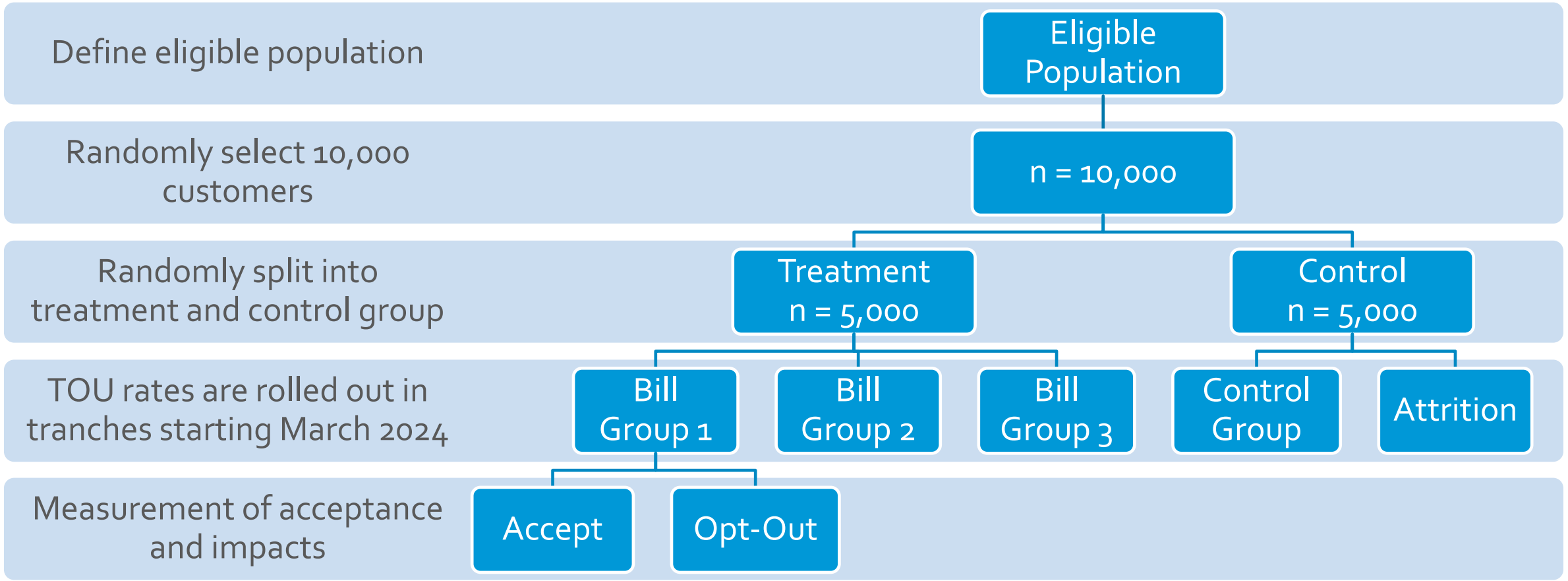
INTRODUCTION

- This study examines the summer impacts of residential customers when defaulting them from a flat rate to a TOU rate
  - *TOU pricing is a useful tool for managing peak demand, but its limits matter*
  - *Small shifts at the customer level can add up to meaningful megawatts on the grid*
- Revenue neutrality and equitable outcomes across income groups is of key concern
- The rollout was staggered, with customers transitioning at different times. The experimental method used accounts for this staggered timing.



EXPERIMENTAL METHOD: RANDOMIZED ENCOURAGEMENT DESIGN (RED)



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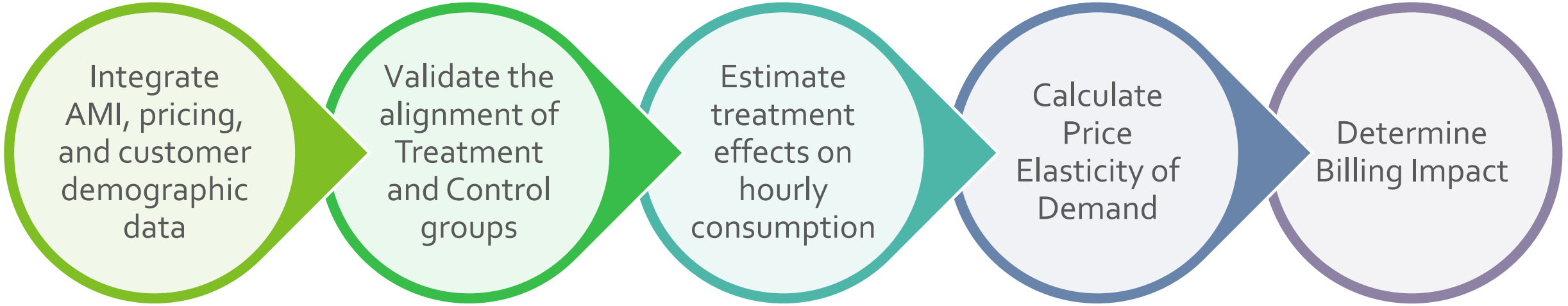
KEY ANALYSIS STEPS



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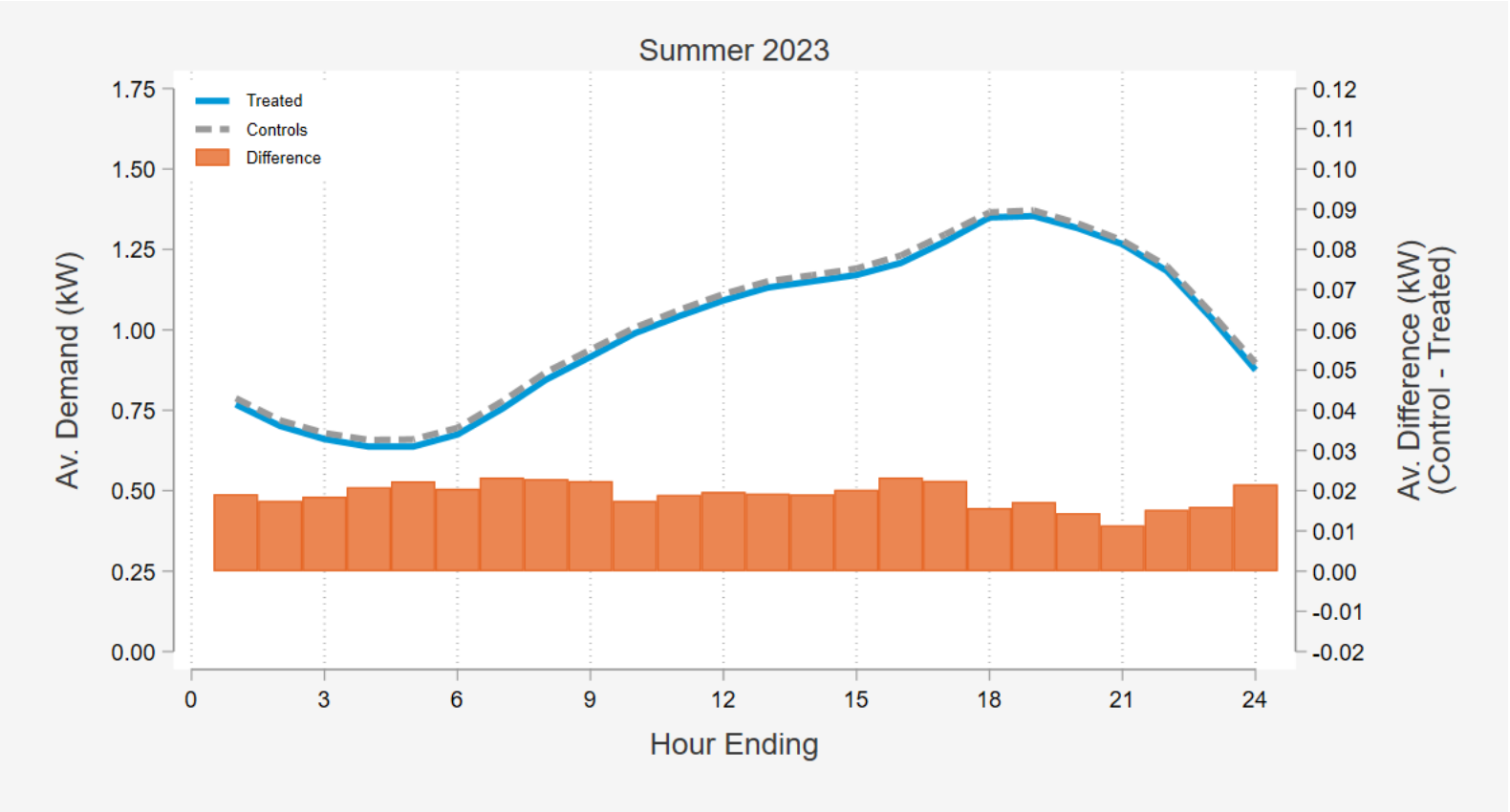
IN THE PRE-INTERVENTION PERIOD, THE CONTROL GROUP ALIGNED CLOSELY WITH THE TREATMENT GROUP

- Overall, there was notable alignment between the groups
- The distribution of key characteristics (consumption, low-income, service start date) was comparable
- The treatment group had a slight tendency to consume less than the control group in the pre-intervention period.



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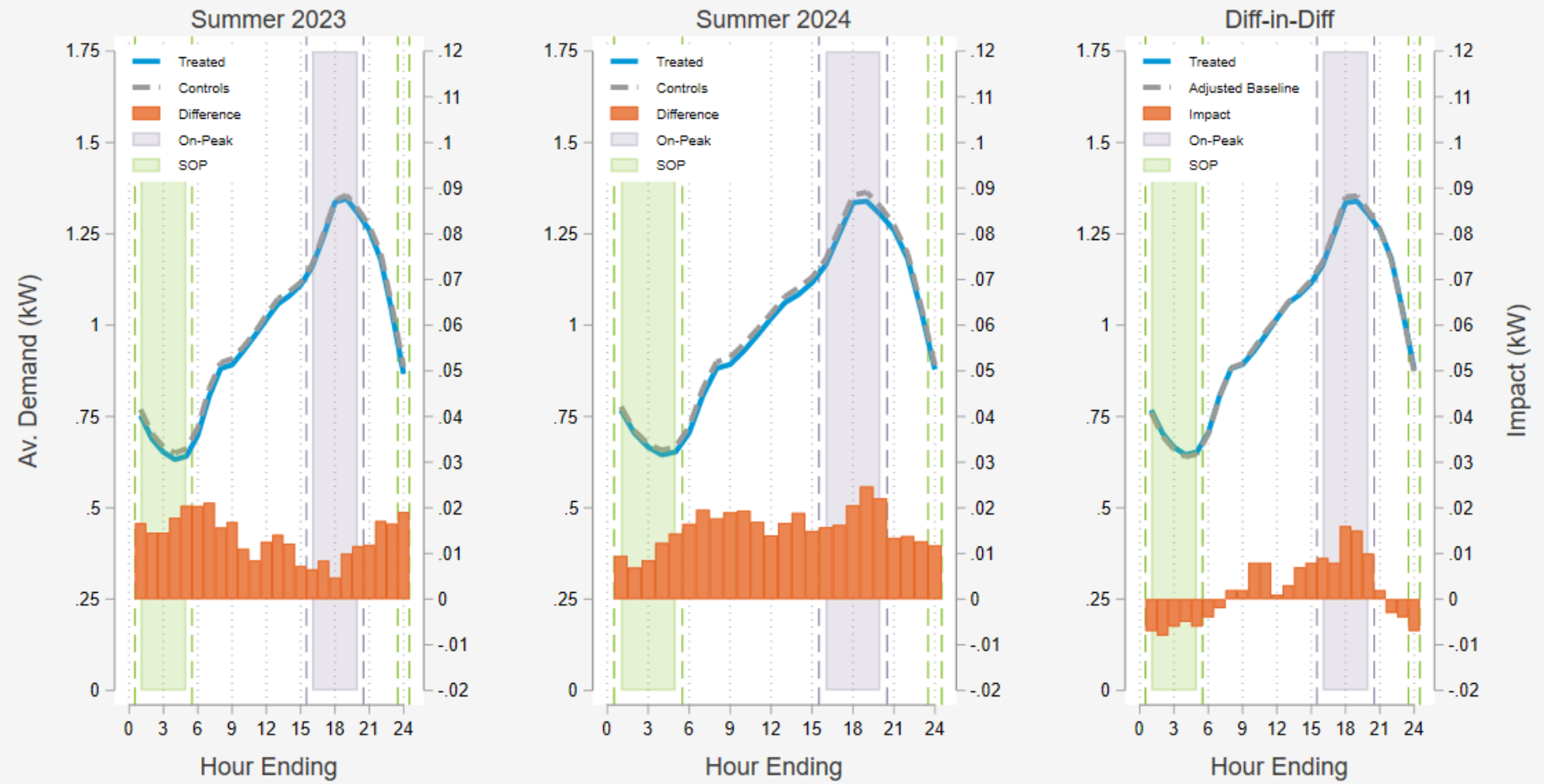
TO IDENTIFY IMPACTS, A MODIFIED DIFFERENCE-IN-DIFFERENCES APPROACH WAS APPLIED



$$Impact\ (Savings) = \left(Participant\ \overline{kWh}_{post} - Participant\ \overline{kWh}_{pre}\right) - \left(Control\ \overline{kWh}_{post} - Control\ \overline{kWh}_{pre}\right)$$

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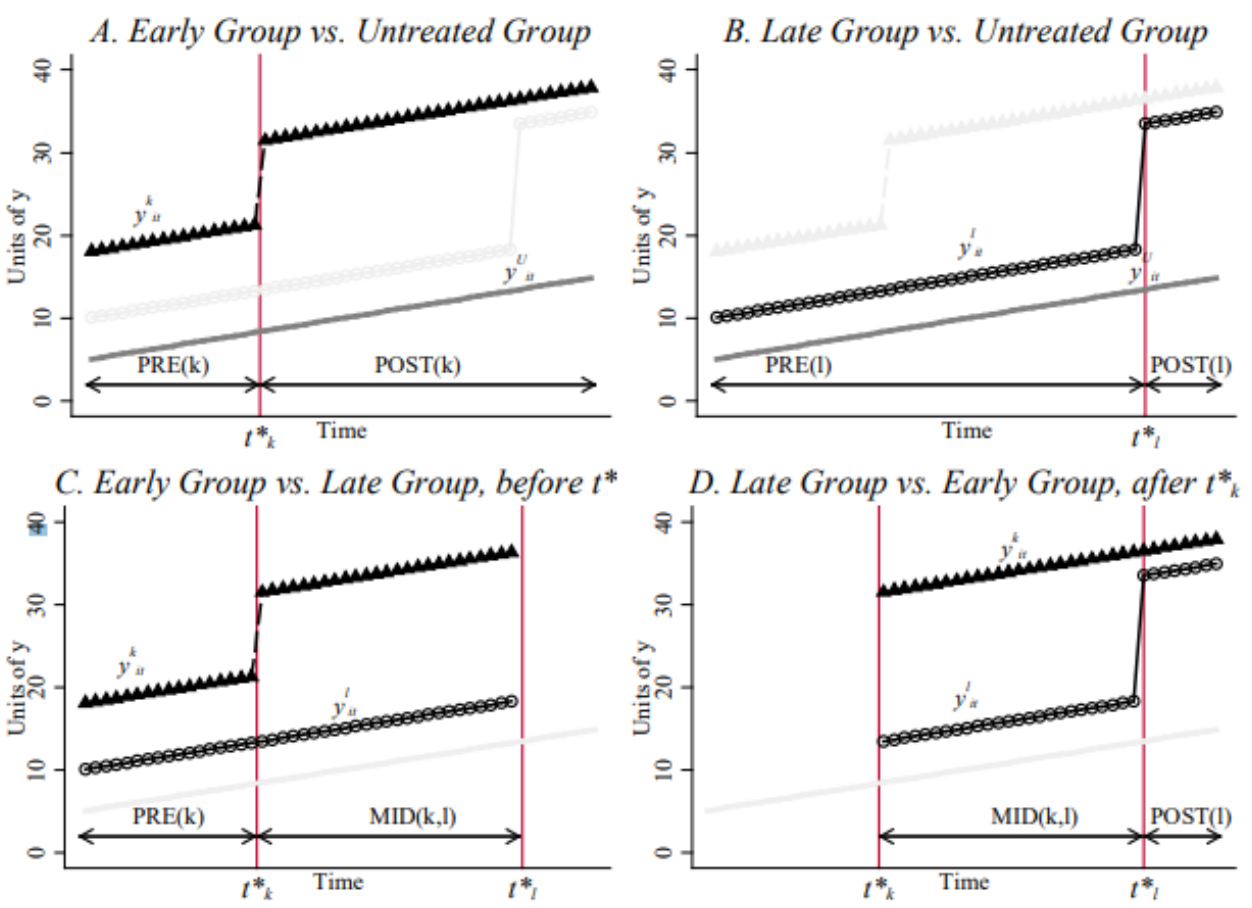
WHILE DID IS A GOOD STARTING POINT, IT DOES NOT HANDLE DIFFERENTIAL TREATMENT TIMING VERY WELL

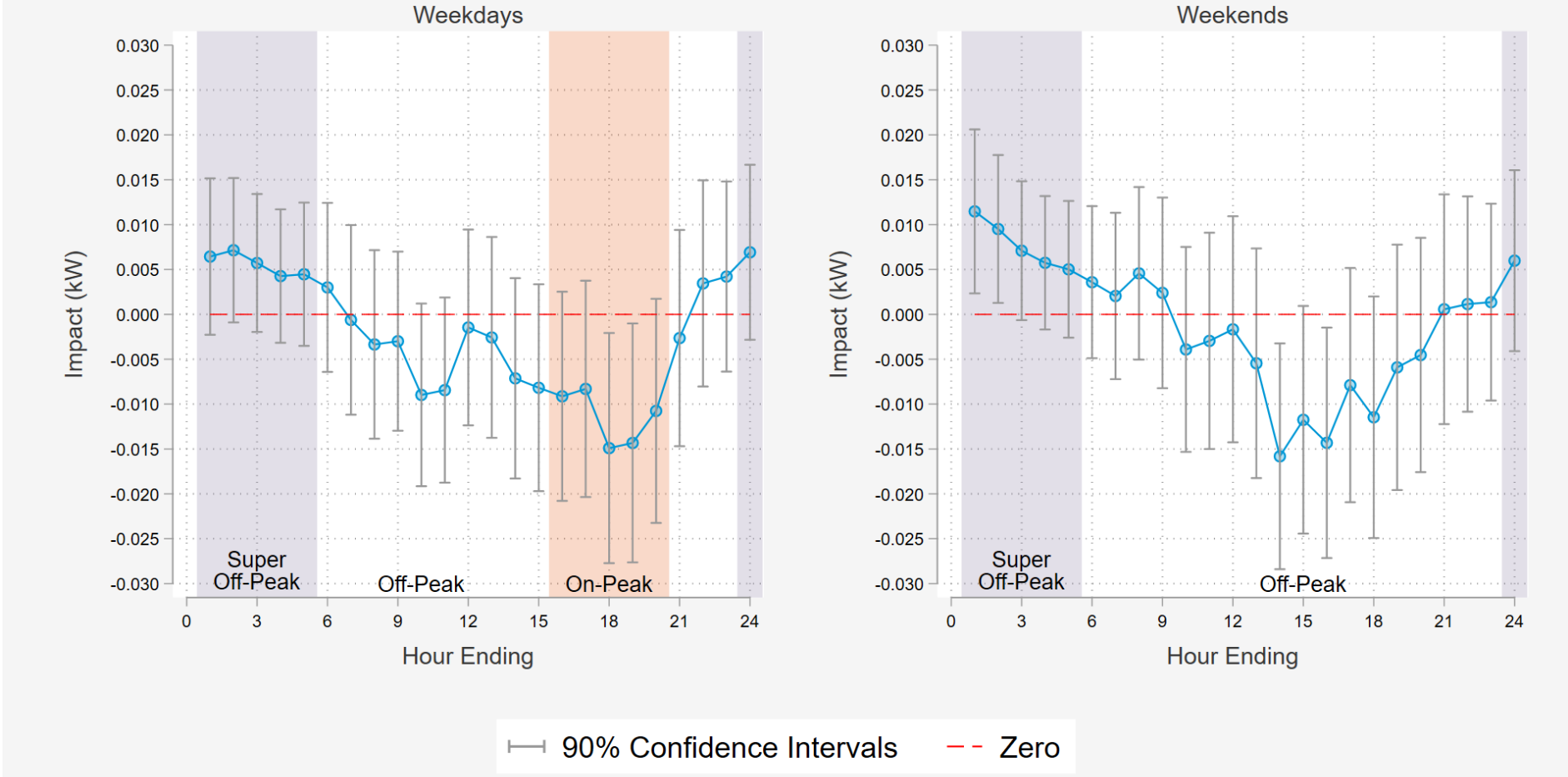
- The classic difference-in-differences method assumes all treated units receive treatment at the same time.
- This can cause "early treated" customers to be compared against "later treated" customers, creating a "forbidden comparison" (Pane D)
- Solution:
  - Impute counterfactuals using the individual's pre-treatment trajectory and the daily fixed effects observed in the control group
  - Small adjustment that avoids the forbidden comparisons from staggered treatment timing.



Source: Andrew Goodman-Bacon, Difference-in-differences with variation in treatment timing, Journal of Econometrics, Volume 225, Issue 2, 2021, Pages 254-277, ISSN 0304-4076, https://doi.org/10.1016/j.jeconom.2021.03.014.

IMPACT RESULTS: AVERAGE INCREASES IN USAGE DURING THE SUPER OFF-PEAK PERIOD AND DECREASES IN THE ON-PEAK PERIOD

Impacts were generally quite small, but some statistically significant shifts were detected



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THE ON-PEAK ELASTICITY OF DEMAND WAS SMALL BUT NOT UNEXPECTED

- Overall, the elasticity estimate suggests that a 100% increase in price would result in approximately a 2.6% reduction in demand

Income Status	Sites	Average Hourly Baseline kWh	Average Hourly Observed kWh	Estimated Impact (B-A)	% Change in Demand (C/A)	Base Price per kWh	Observed Price per kWh	Price Differential (F-E)	% Change in Price (G/E)	Price Elasticity of Demand (D/H)
		A	B	C	D	E	F	G	H	I
Not Income Qualified	4,118	1.34	1.33	-0.011	-0.84%	$0.127	$ 0.169	$0.042	33.3%	-0.025
Income Qualified	1,073	1.13	1.11	-0.012	-1.04%	$0.105	$0.147	$0.042	40.0%	-0.026
All	5,191	1.30	1.29	-0.012	-0.89%	$0.123	$0.165	$0.042	34.4%	-0.026

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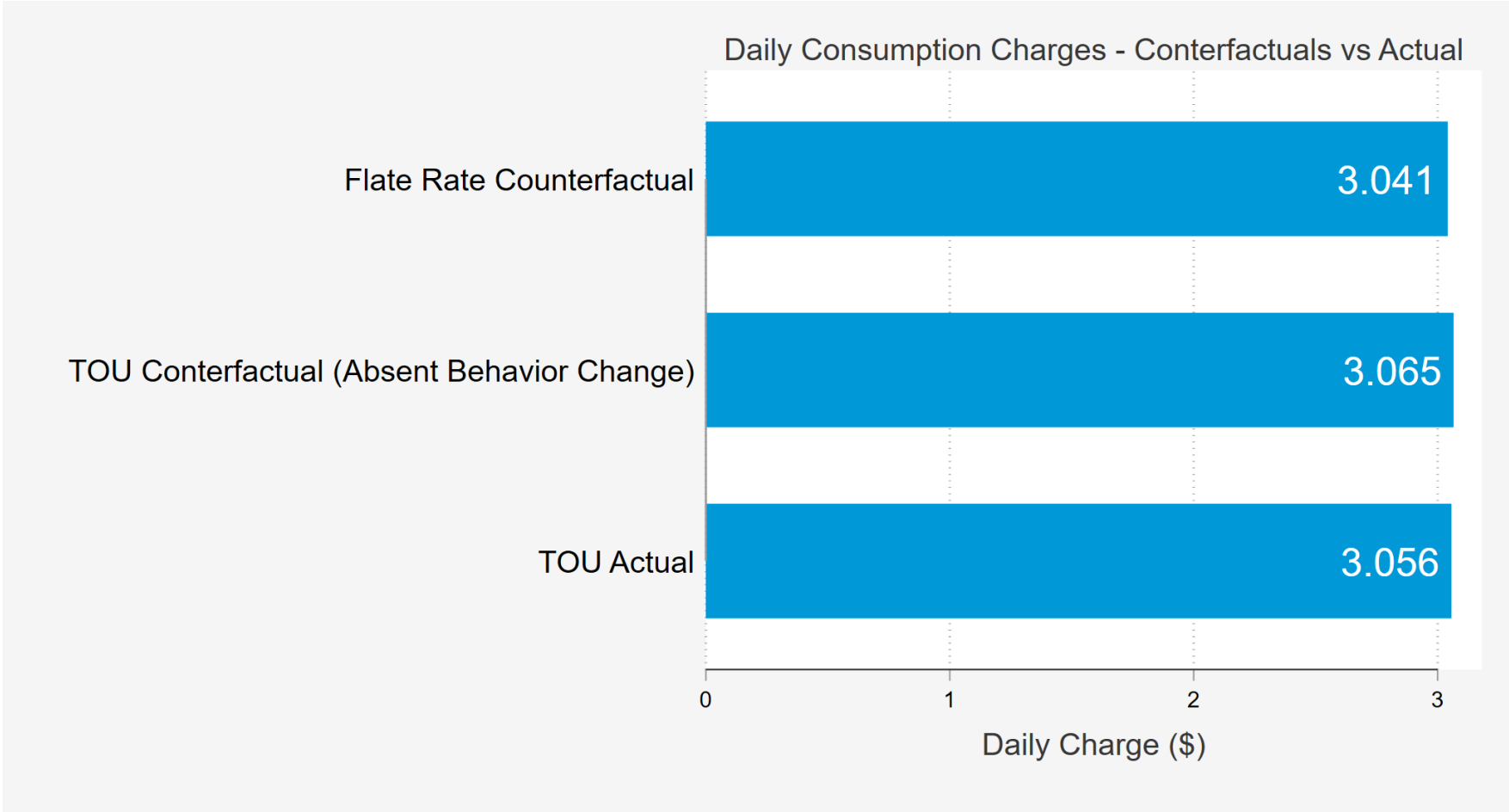
THE SUPER OFF-PEAK ELASTICITY WAS MUCH HIGHER FOR INCOME-QUALIFIED CUSTOMERS

- Income qualified customers tended to increase their super off-peak consumption by a larger factor than other customers

Income Status	Sites	Average Hourly Baseline kWh	Average Hourly Observed kWh	Estimated Impact (B-A)	% Change in Demand (C/A)	Base Price per kWh	Observed Price per kWh	Price Differential (F-E)	% Change in Price (G/E)	Price Elasticity of Demand (D/H)
		A	B	C	D	E	F	G	H	I
Not Income Qualified	4,118	0.90	0.90	0.002	0.26%	$0.127	$0.103	-$0.024	-18.6%	-0.014
Income Qualified	1,073	0.75	0.76	0.014	1.81%	$0.105	$0.081	-$0.024	-22.7%	-0.080
All	5,191	0.87	0.87	0.005	0.52%	$0.123	$0.099	-$0.024	-19.4%	-0.027

WE CONSTRUCTED COUNTERFACTUAL BILLS UNDER FLAT AND TOU TARIFFS TO ASSESS BILL IMPACTS

- TOU customers' projected summer bills were slightly higher than under the flat rates
  - ➢ *A $0.015 total increase in daily charges*
- Modest load shifting reduced TOU bills relative to the no-behavior change counterfactual, narrowing the gap
  - ➢ *A $0.009 decrease in charges relative to the TOU counterfactual*



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KEY TAKEAWAYS

1. Overall, impacts were small, but the changes observed were directionally consistent with expectations for the TOU rate periods.
2. Statistically significant reductions were observed for select on-peak hours.
3. Low-income treatment customers tended to consume more during the super off-peak periods relative to other customers
4. On average, customers' projected summer bills under TOU rates would have been slightly higher than under the flat rate. However, modest load shifting reduced the overall TOU charges, partially offsetting these increases.
5. The low opt-out rate highlights concerns about awareness of the rate, making messaging an important component of future analysis

QUESTIONS?

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