SDG&E PY 24 ELECTRIC VEHICLE RATE EVALUATION

Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS

DRMEC PRESENTATION MAY 13, 2025

PRESENTATION OVERVIEW

- Overview and introduction
- Participation, rates, and system conditions
- Ex-post load reductions
- Ex-ante load reductions
- Key findings and recommendations

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KEY RESEARCH QUESTIONS

1. What were the ex-post load reductions due to electric vehicle (EV) time of use (TOU) rates?
2. How do load reductions differ by system conditions and weather?
3. How do load reductions differ for different types of customers?
4. What is the ex-ante load reduction capability for 1-in-2 and 1-in-10 weather conditions?
5. How do ex-ante reductions compare with ex-post results and prior ex-ante forecasts?

PREVIEW OF RESULTS

1. What were the load reductions due to electric vehicle (EV) time of use (TOU) rates?
   0.19 kW per home, on average, over the 4-9 PM peak period on Aug. monthly worst day (10% of the household load, for 11 MW of peak demand reductions across 59k accounts)

2. How do load reductions differ by system conditions and weather?
   Similar across systems, slightly weather sensitive

3. How do load reductions differ for different types of customers?
   Quite consistent, but NEM customers deliver larger reductions

4. What is the ex-ante load reduction capability for 1-in-2 and 1-in-10 weather conditions?
   0.23 and 0.25 kW per home, respectively, on 1-in-2 and 1-in-10 Aug. monthly worst day for CAISO system

5. How do ex-ante reductions compare with ex-post results and prior ex-ante forecasts?
   Similar with 1-in-10 slightly higher due to weather sensitivity

ELECTRIC VEHICLES IN SDG&E TERRITORY

ZEV POPULATION

Total Light-Duty Vehicles end of 2023

132,113

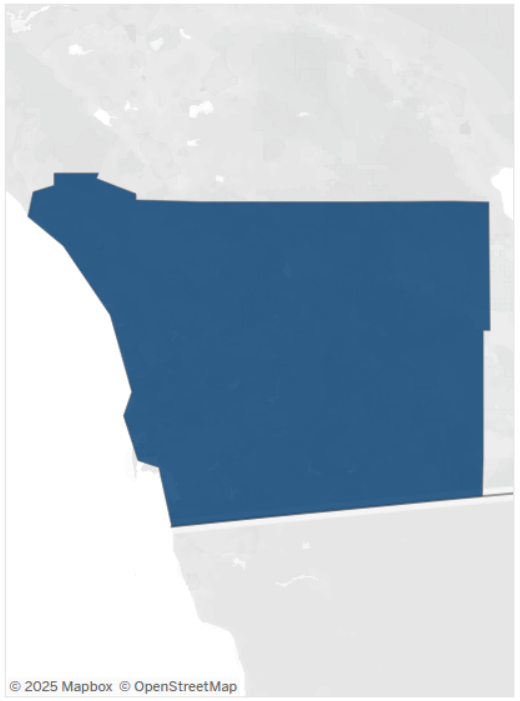
Battery Electric (BEV)	Plug-in Hybrid (PHEV)	Fuel Cell (FCEV)
3.90%	1.26%	0.02%
99,528	32,043	542

NON-ZEV POPULATION

Total Light-Duty Vehicles end of 2023

2,419,003

Gasoline	Gasoline Hybrid	Diesel	Other
87.35%	5.62%	1.82%	0.03%
2,228,524	143,331	46,480	668



Fuel Type	Range	Number of Vehicles
BEV	≥ 200 miles	92,383
	< 200 miles	7,145
PHEV		32,043
FCEV		542

MAKE	MODEL	Number of Vehicles
Tesla	Model 3	29,851
	Model Y	24,723
	Model S	6,905
	Model X	4,284
	Roadster	25
Toyota	Prius Prime	4,352
	Rav4 Prime	2,125
	Prius PHEV	1,236
	Mirai	447
	bZ4X	405
	RAV4 EV	111
Chevrolet	Volt	3,462
	Bolt EV	2,878
	Bolt EUV	2,002
	Spark EV	197
	Blazer EV	2
Ford	Mustang Mach-E	3,234
	Fusion Energi	1,741
	C-Max Energi	1,075
	F-150 Lightning	684
	Escape PHEV	297
	Focus	158

SELECT FILTERS

Year: 2023

Map Filter: County

County: San Diego

Fuel Type: (All)

Make: (All)

EVs made up 26% of new vehicle sales in San Diego County in 2023 and 2024.

- Over 60,000 homes on EV rates in SDG&E territory
- SDG&E has developed four EV rates:
  - EVTOU – legacy rate with end use metering
  - EVTOU2 – stronger price signals than default TOU, peak, off peak, and super off-peak periods
  - EVTOU5 – lowest volumetric rates during super off-peak period, with a higher fixed charge (nonvolumetric).
  - TOU-ELEC – newest rate for qualifying technology with a higher fixed charge and smaller price difference between off peak and super off-peak periods.

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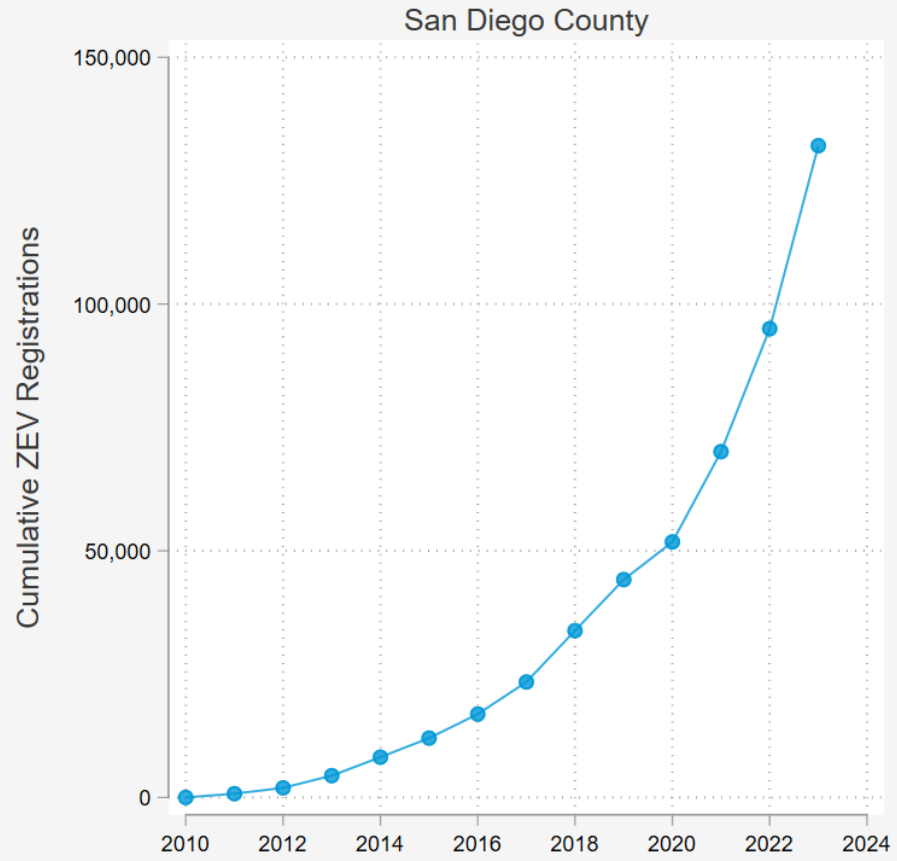
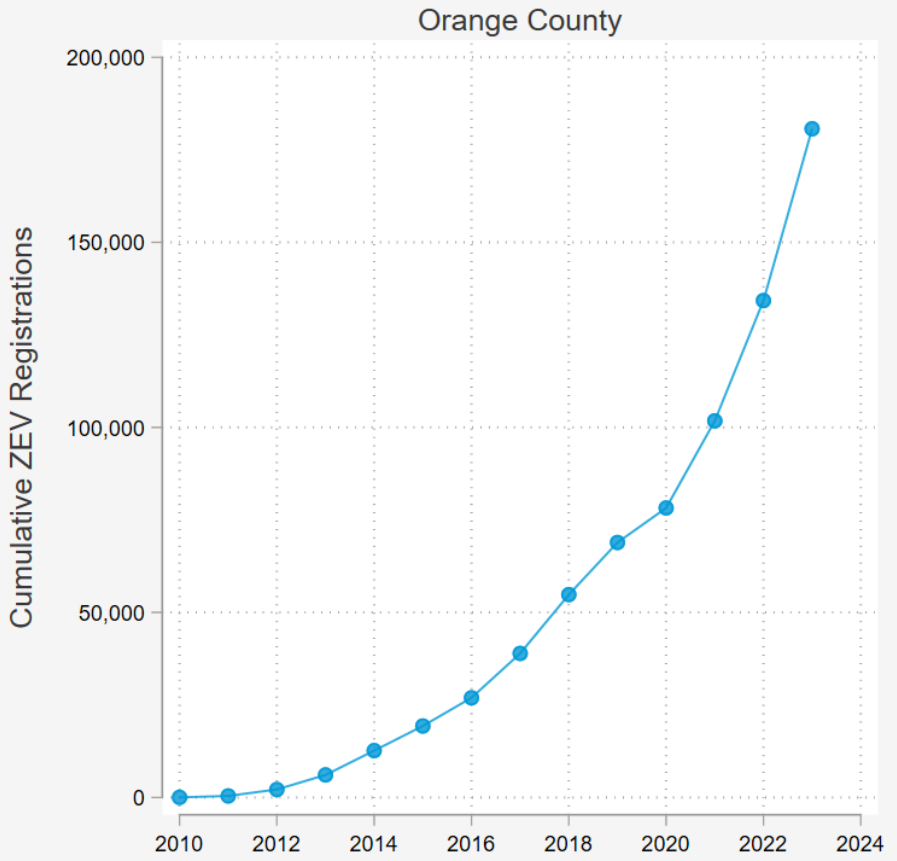
EV PENETRATION IN SDG&E SERVICE TERRITORY IS GROWING





Source: California Energy Commission (2024). Light-duty vehicle population in California. Data last updated December 31, 2023. Retrieved April 21, 2025 from https://www.energy.ca.gov

ESTIMATING EV RATE IMPACTS: CHALLENGES

- The fundamental challenge: we don't observe what EV rate customers' consumption would have been if they had stayed on their previous rate
  - Some customers enroll because their charging behavior was favorable
  - We cannot simply compare avg. participant to avg. non-participant because of these selection effects

- There are several potential effects that can be confounded with EV rate impacts:
  - Arrival of new electric vehicle often coincides with rate change
  - Solar or battery installation that coincides with the EV rate enrollment

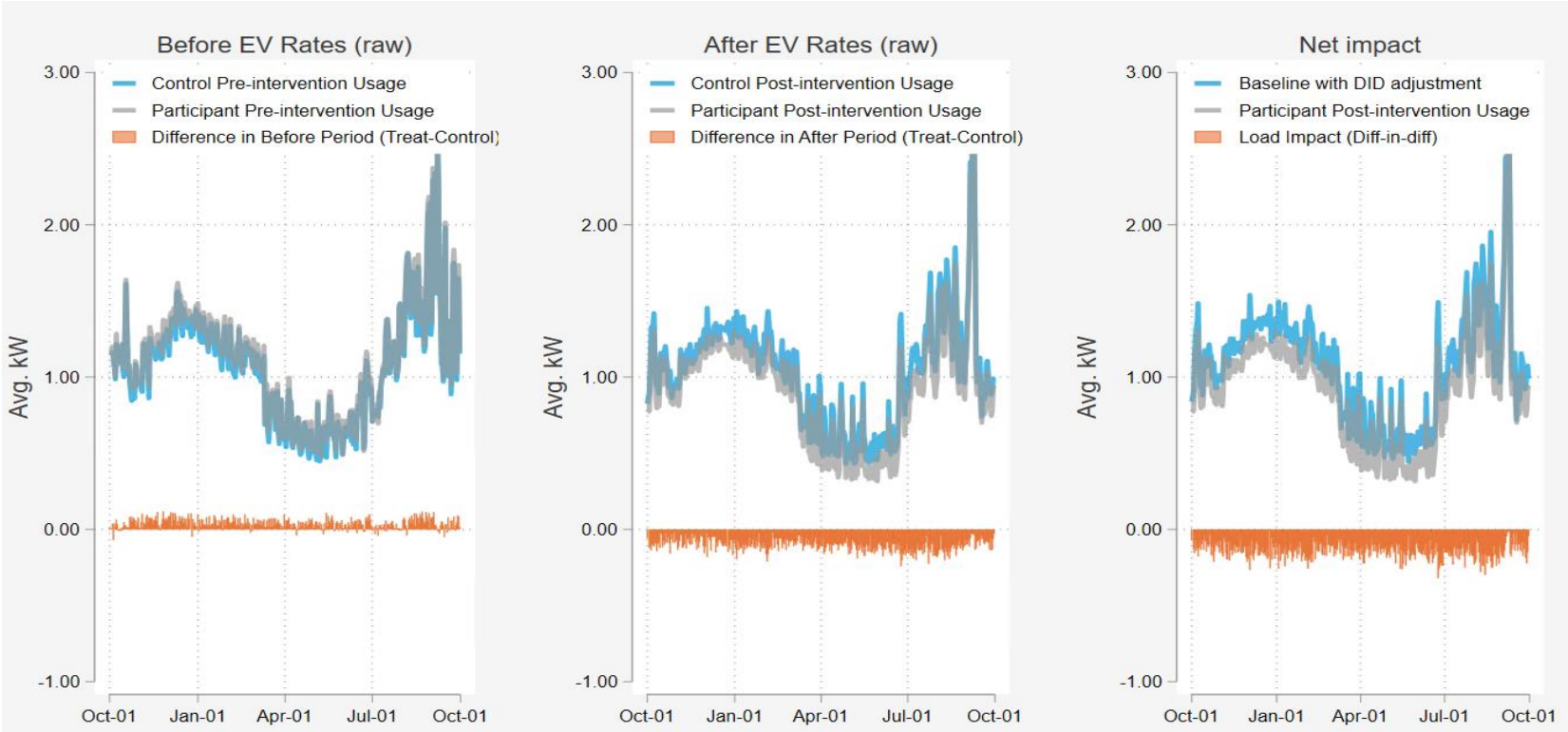
- Estimating precise calendar month effects requires a large sample of panel data

ESTIMATING EV RATE IMPACTS: METHODOLOGY AND MOTIVATION

Methodology	Motivation
Identify sites with EVs who were not on EV rates using a pool of ~250k sites (oversampling areas with high EV penetration)	Avoids confounding EV load with rate effect
Use a matched control group focused on identifying sites with EVs but not on EV rates	Controls for observable characteristics related to treatment status e.g. EV ownership, pre-treatment load, etc.
Use a full year of pre- and post-EV rate data	Enables estimation of monthly effects
Identify and screen out sites with changes in EV status, solar, or battery status during the analysis period	Avoids confounding changes in load with rate effect
Impacts estimated using difference-in-differences with matched controls	Allows for differences between participants and matched non-participants that are constant over time

ESTIMATING EV RATE IMPACTS: ROBUSTNESS CHECKS

- If EV rates leads to peak reductions, we should observe:
  - Similar load patterns when neither participants nor controls are on the rate
  - A decrease in peak demand for customers who enroll on EV rates
  - An increase in super off-peak demand for customers who enroll on EV rates
  - No similar change for the control group
  - The timing of the change should coincide with the enrollment on the EV rate



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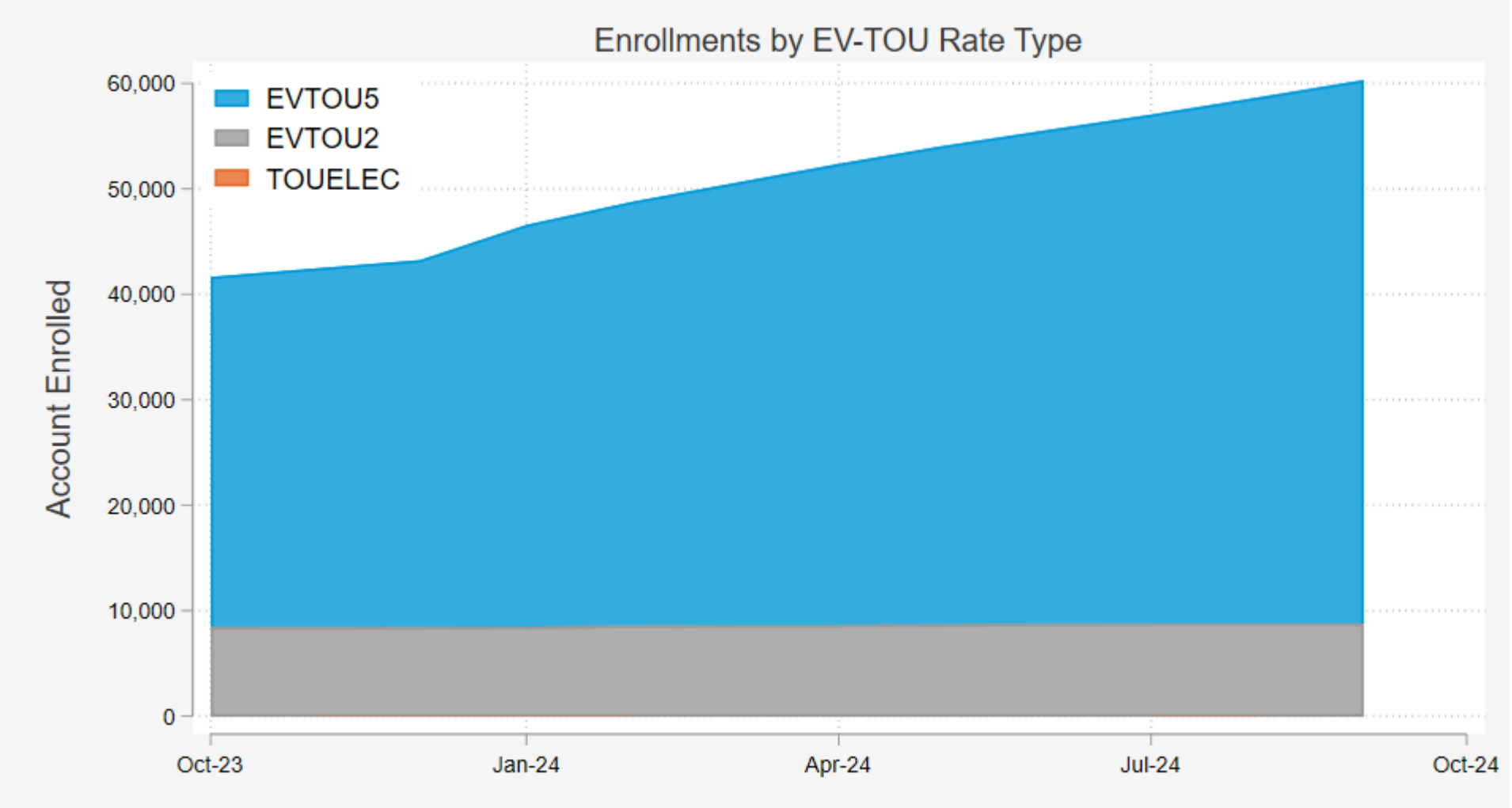
PARTICIPATION, RATES, AND SYSTEM CONDITIONS

SDG&E HAS ENROLLED OVER 60K EVS ON EV TOU RATES



- Most growth is in EVTOU5
- TOUELEC has very few customers and is not visible

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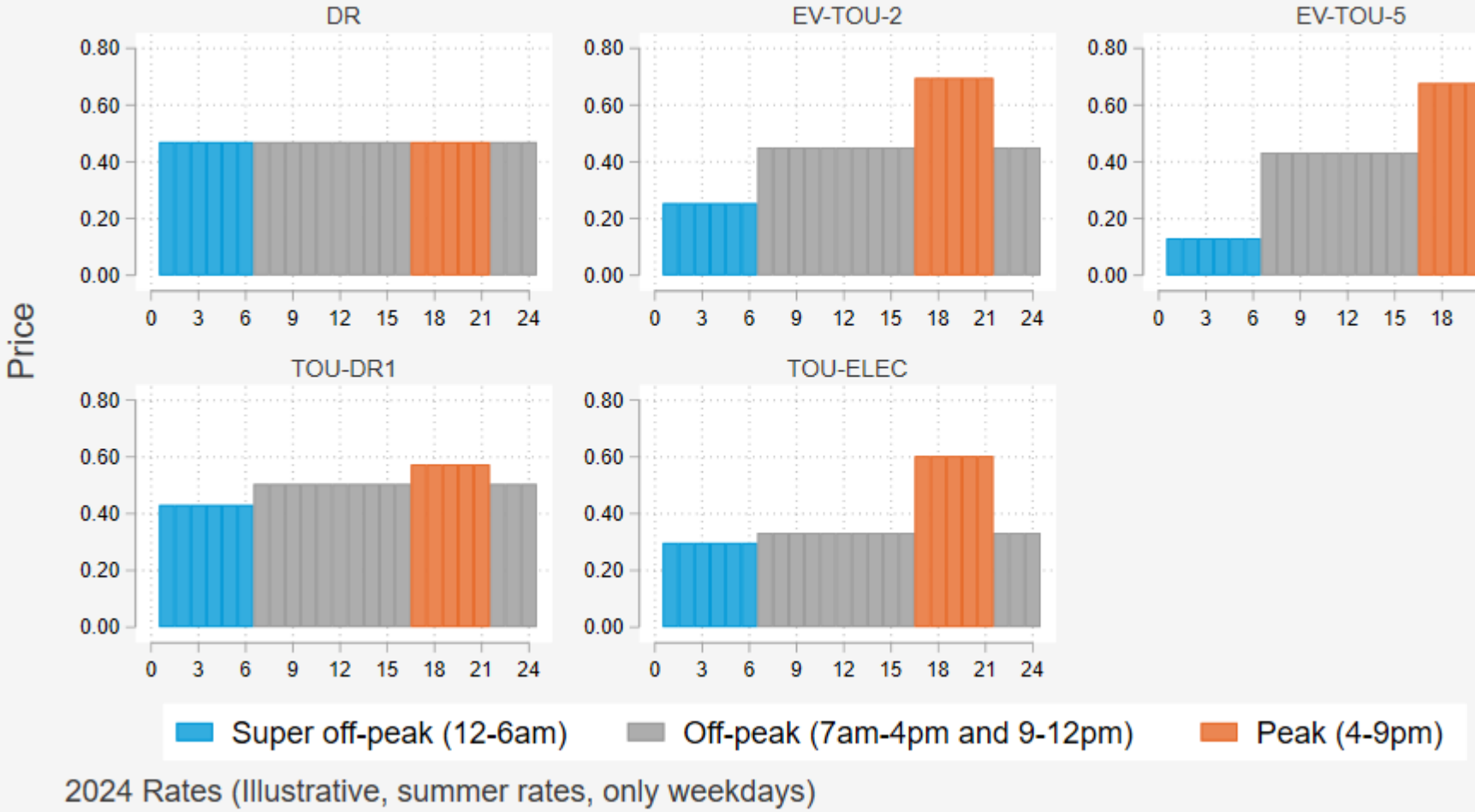
SUMMER RATE COMPARISON



- EV rates have lower charges from 12-6 AM and higher charges from 4-9 PM
- EV-TOU-5 has a very low super off-peak charge, and a higher fixed charge

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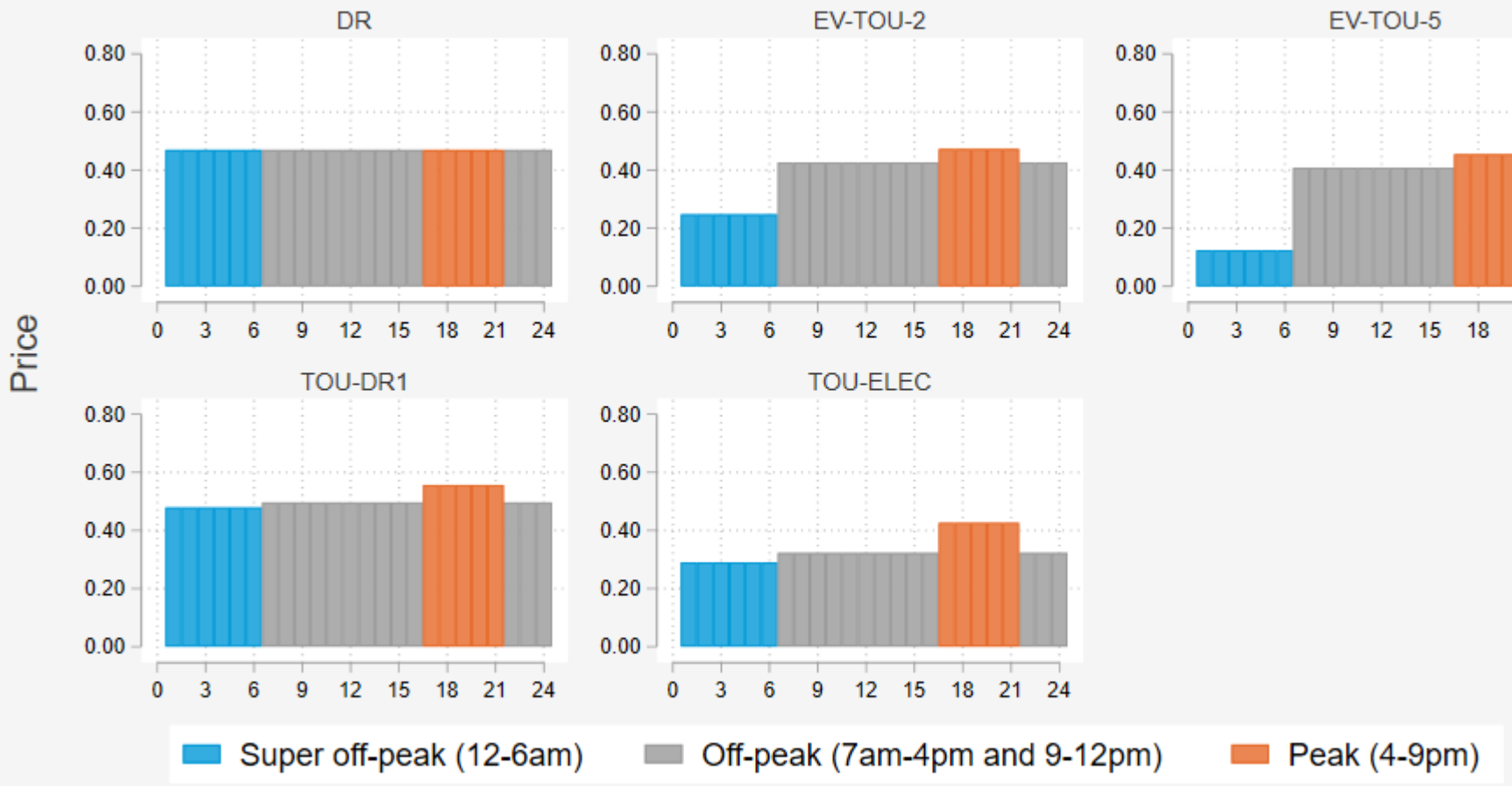
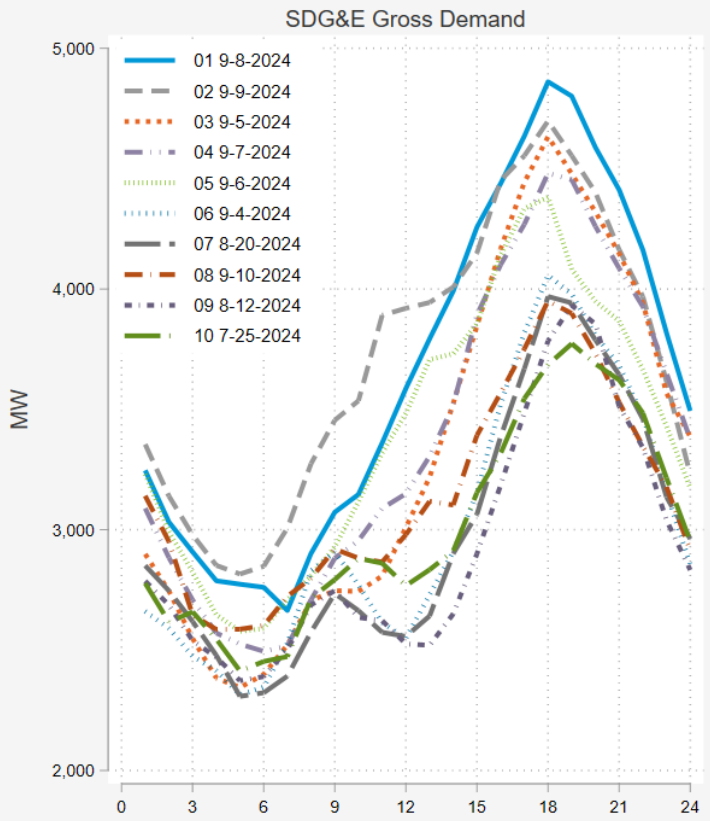
WINTER RATE COMPARISON

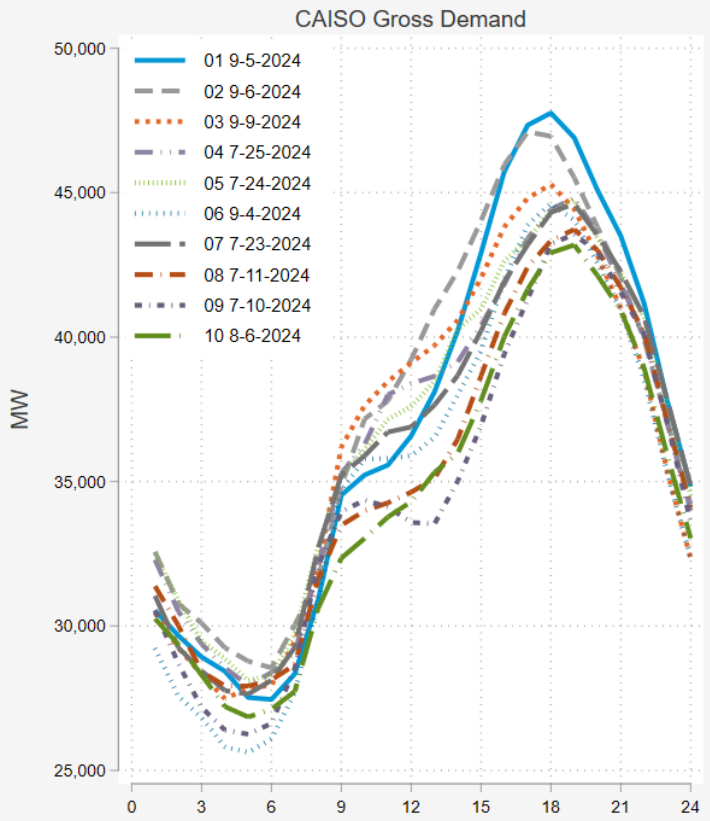


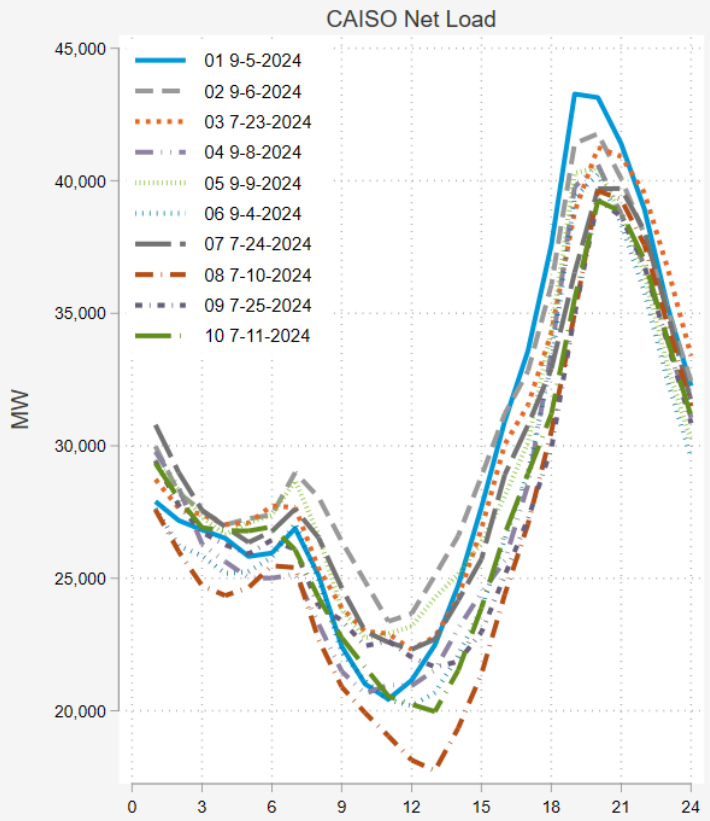
Winter EV rates have a smaller peak to super off-peak ratio

TOU-ELEC, with a higher fixed charge, is lower than TOU-DR1 in every period

OVERALL SYSTEM LOADS HIGHER IN 2024

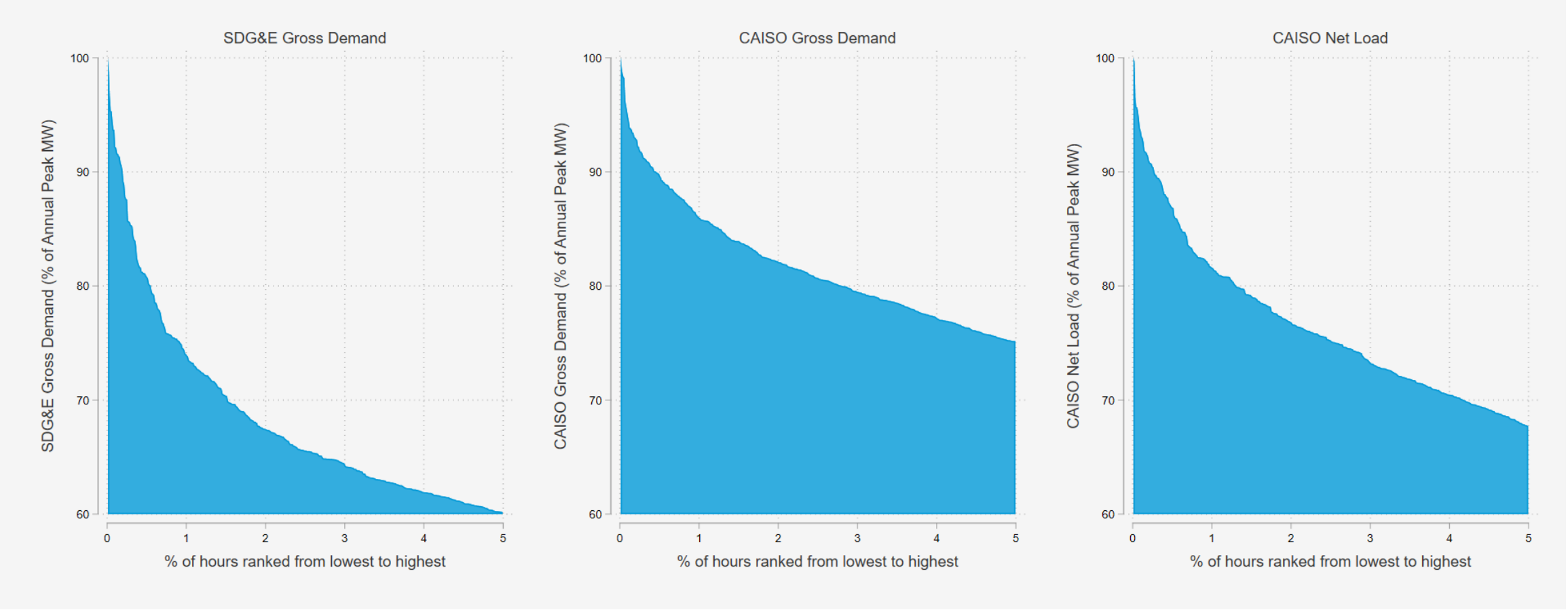






- SDG&E system reached an all-time peak of 5,032 MW on Sunday September 8 at 6:45 PM
- 7-25, 9-4, 9-5, 9-6, and 9-9 are shared peak days across systems

PEAK LOADS REMAIN HIGHLY CONCENTRATED ACROSS BOTH SDG&E AND CAISO



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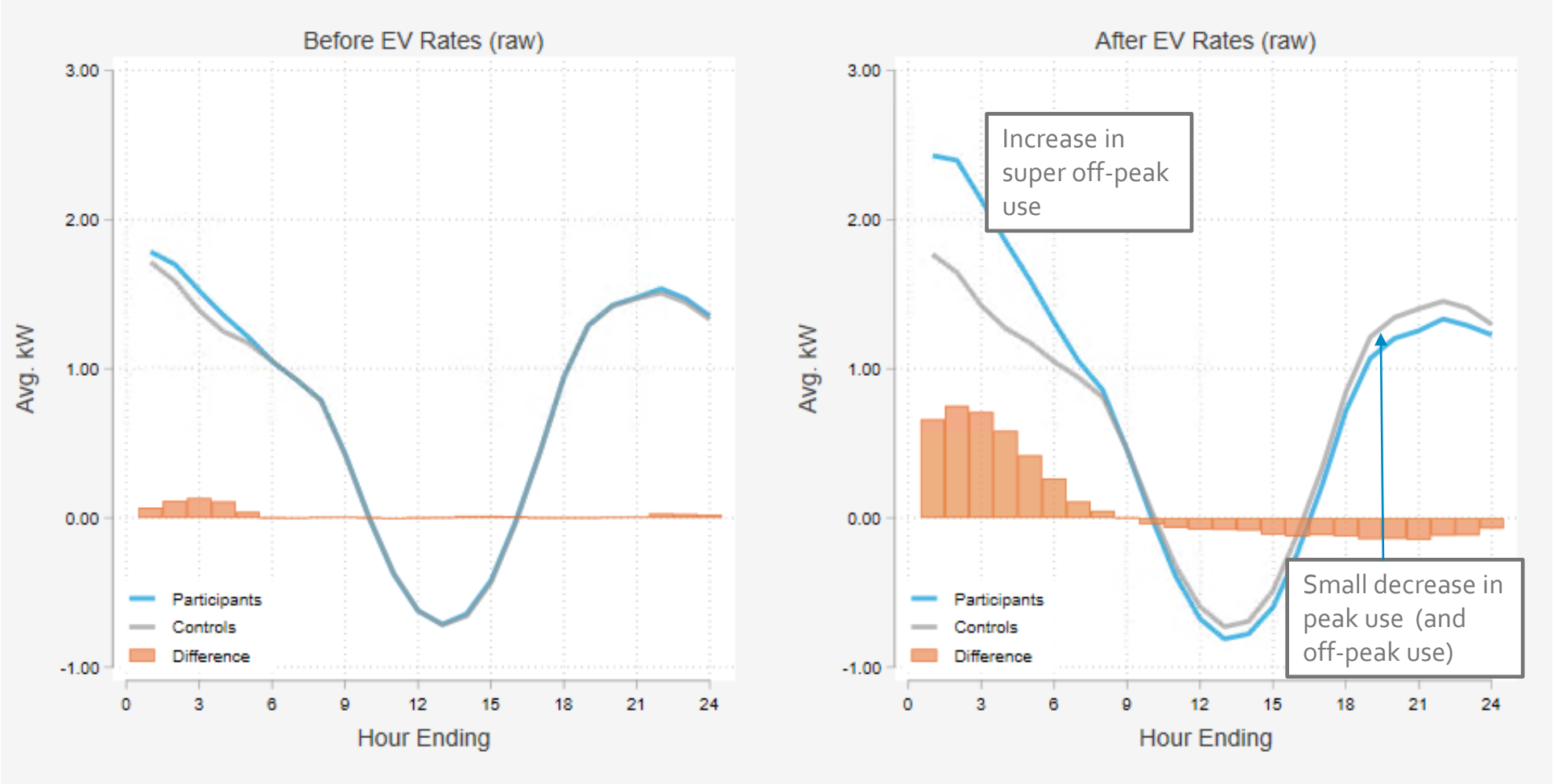
EX-POST LOAD IMPACTS

WE CAN SEE A CHANGE IN ENERGY WITHOUT ANY MODELING BY COMPARING HOURLY LOAD SHAPES THE YEAR BEFORE AND AFTER EV RATES



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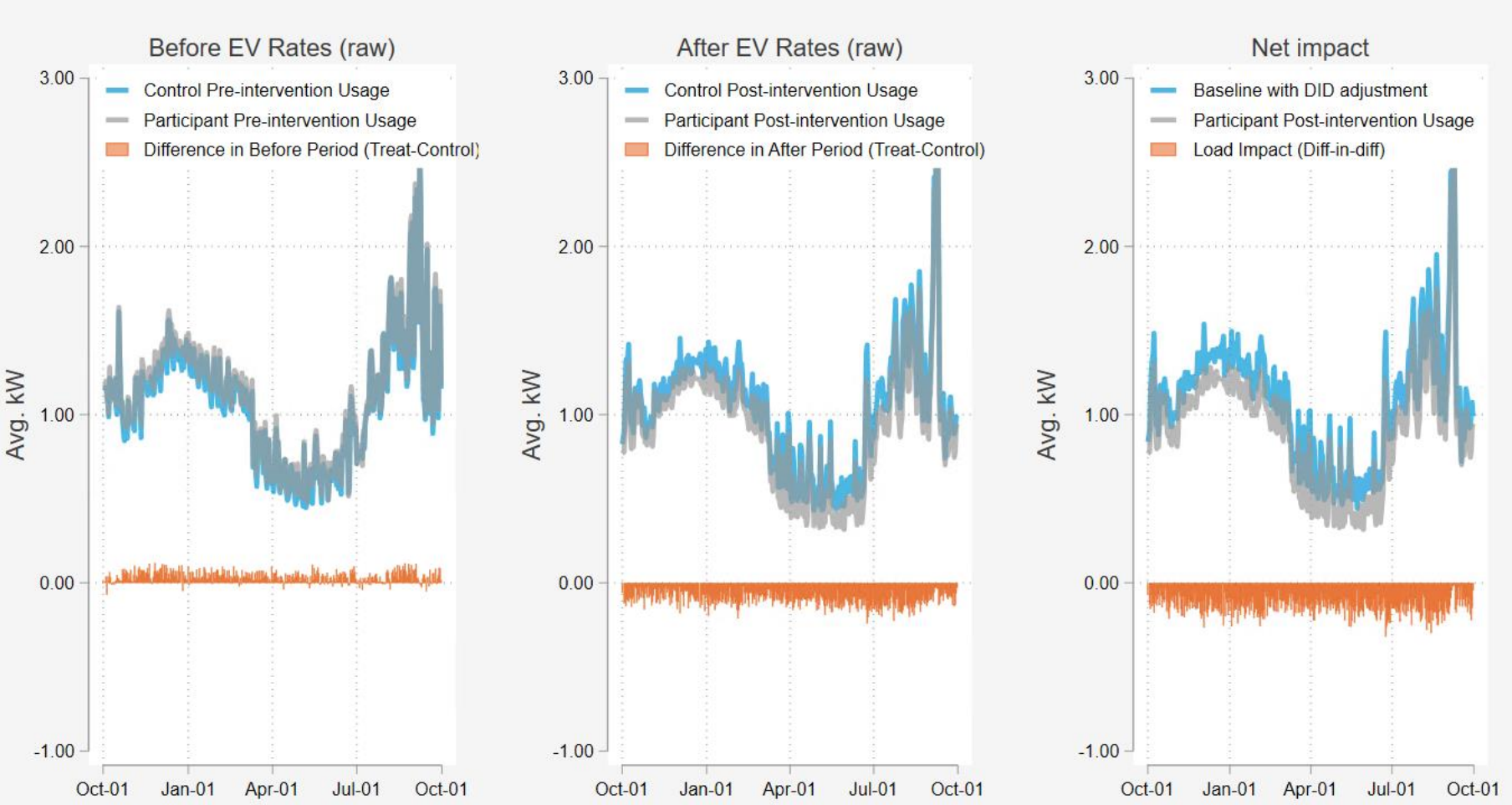
THE RAW DATA SHOWS A DECREASE IN PEAK USE WHEN THE RATE IS INTRODUCED (NO MODELING)



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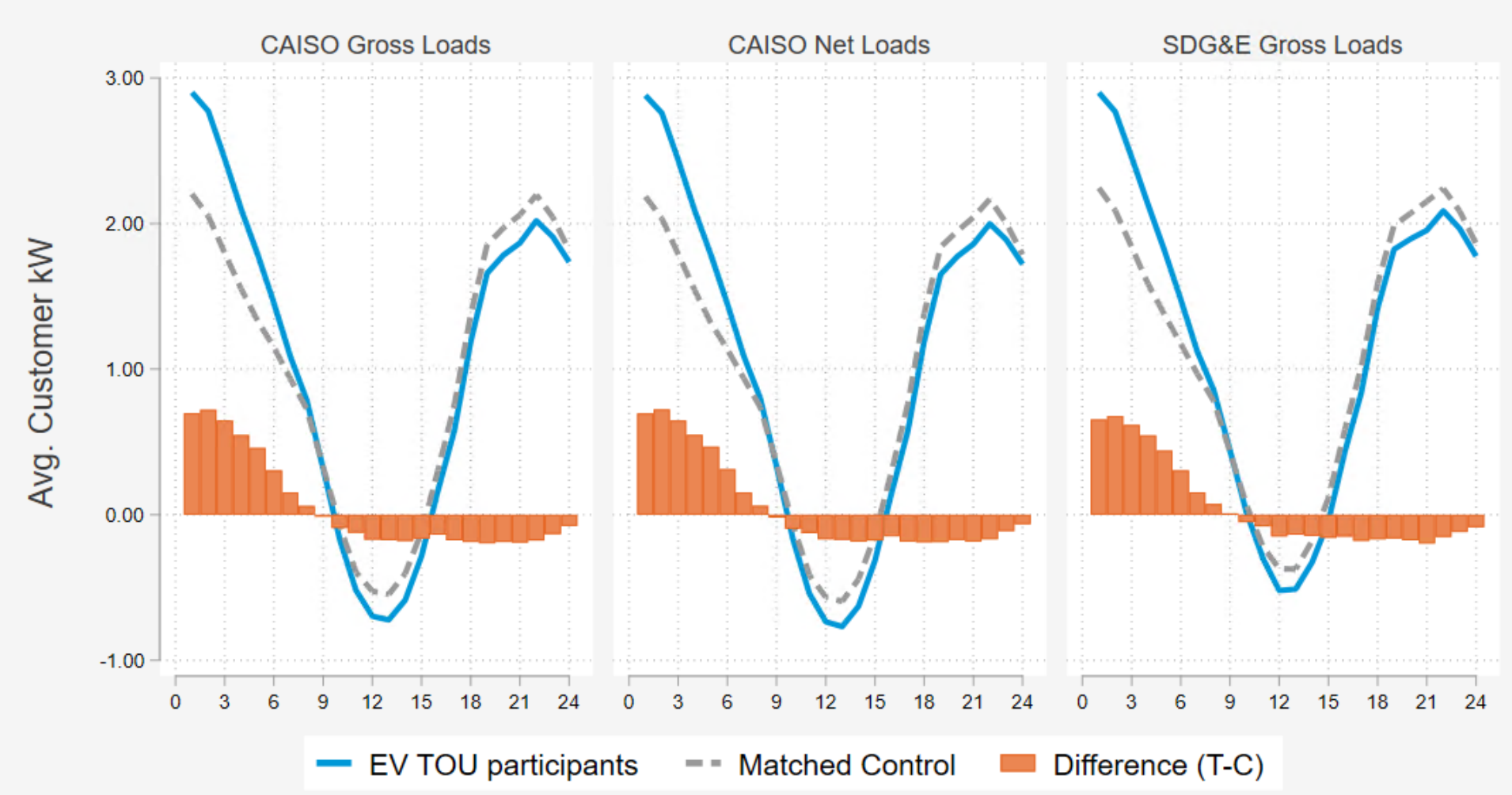
THE LOAD REDUCTIONS ON THE TOP TEN HIGHEST SYSTEM LOAD DAYS WERE CONSISTENT



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PEAK PERIOD LOAD REDUCTIONS ON HIGHEST SYSTEM LOAD DAYS

- 10%-14% Peak reduction on top days

						Avg. Customer (kW)				
System	Month	Sample[1]	New Accounts	Total Accounts	Daily avg. temp[2]	Reference Load	Load Reduction	% Change	New Load Reduction (MW)	Total Load Reduction (MW)
CAISO Gross Loads	Top 05 load day(s)	2,221	10,538	60,327	75.0	1.7	0.20	-12.1%	2.2	12.4
	Top 10 load day(s)	2,221	10,538	60,327	74.3	1.6	0.19	-11.7%	2.0	11.4
	Top 20 load day(s)	2,221	10,538	60,327	73.1	1.5	0.20	-13.6%	2.1	11.9
CAISO Net Loads	Top 05 load day(s)	2,221	10,538	60,327	73.5	1.6	0.19	-12.0%	2.0	11.5
	Top 10 load day(s)	2,221	10,538	60,327	73.8	1.6	0.18	-11.6%	1.9	11.1
	Top 20 load day(s)	2,221	10,538	60,327	73.2	1.5	0.19	-13.0%	2.0	11.6
SDG&E Gross Loads	Top 05 load day(s)	2,221	10,538	60,327	76.8	1.9	0.20	-10.7%	2.1	12.2
	Top 10 load day(s)	2,221	10,538	60,327	75.8	1.8	0.18	-10.1%	1.9	10.7
	Top 20 load day(s)	2,221	10,538	60,327	74.5	1.6	0.19	-11.6%	2.0	11.3

[1] Estimating sample is lower than populations because it excludes sites that whose transition to EV TOU coincided with the arrival of the electric vehicle or with solar or battery installation.

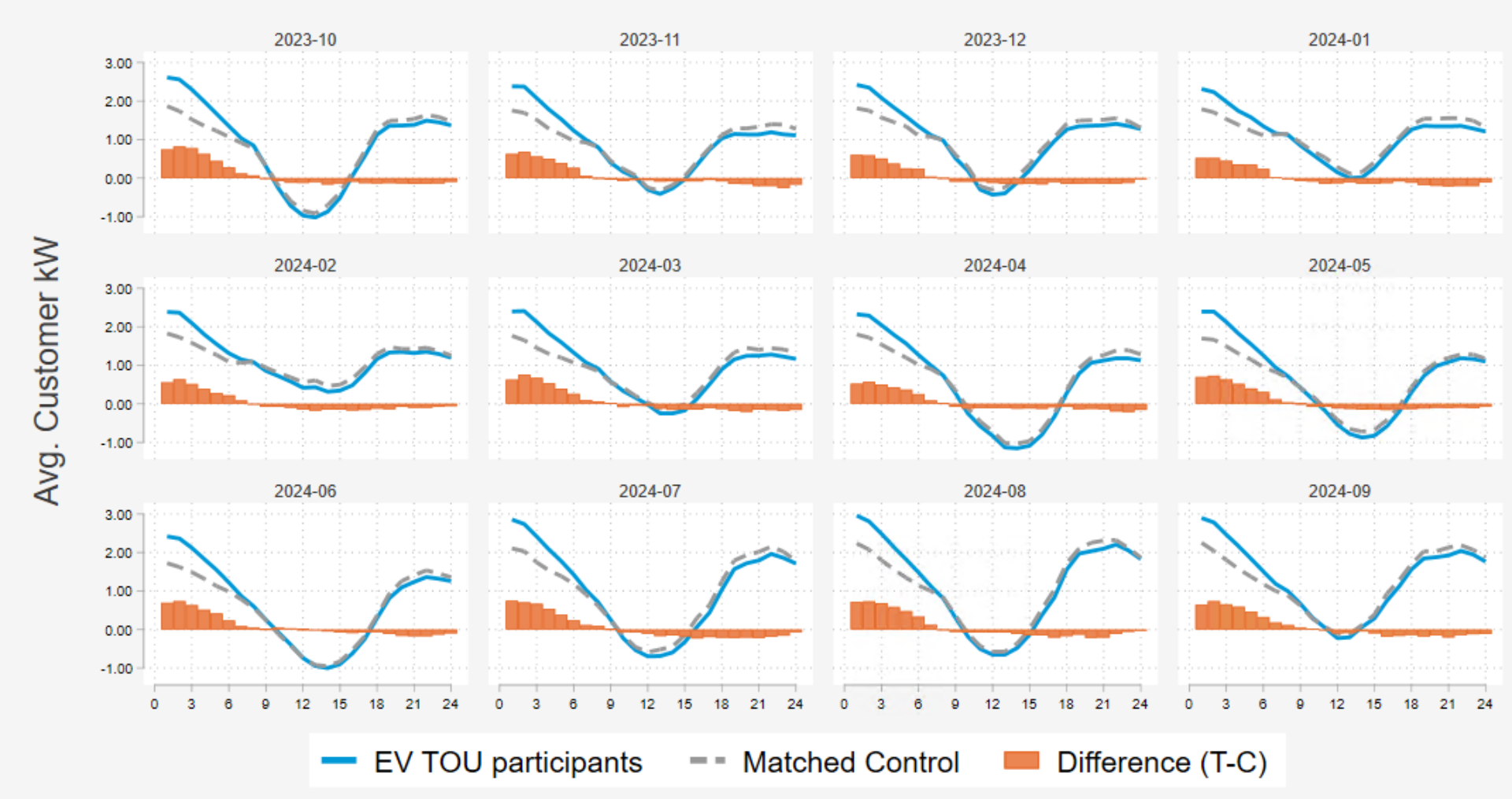
[2] Participant weighted average temperature. SDG&E maps all customers to eight distinct weather stations.

Rate Period	Month	New Accts	Daily avg. temp[1]	Avg. Customers (kW)		Aggregate Incremental (MW)		
				Reference Load	Load Reduction	Reference Load	Load Reduction	% Change
Peak (4-9 PM)	2023-Oct	41,658	71.4	1.30	0.14	54.20	5.76	-10.6%
	2023-Nov	42,476	62.0	1.17	0.13	49.56	5.47	-11.0%
	2023-Dec	43,251	57.6	1.40	0.14	60.60	6.01	-9.9%
	2024-Jan	46,589	53.8	1.42	0.16	66.07	7.44	-11.3%
	2024-Feb	48,793	52.9	1.32	0.12	64.22	5.95	-9.3%
	2024-Mar	50,516	53.1	1.17	0.16	59.27	8.06	-13.6%
	2024-Apr	52,380	59.7	0.70	0.12	36.77	6.04	-16.4%
	2024-May	54,055	60.6	0.70	0.12	37.83	6.53	-17.3%
	2024-Jun	55,593	66.7	0.76	0.12	42.25	6.63	-15.7%
	2024-Jul	57,046	74.6	1.53	0.21	87.07	12.17	-14.0%
	2024-Aug	58,665	76.2	1.89	0.19	110.73	11.02	-10.0%
	2024-Sep	60,327	76.7	1.84	0.17	110.78	10.18	-9.2%

PEAK PERIOD LOAD REDUCTIONS ON MONTHLY WORST DAYS

- Reductions are largest in hot summer months
- Relative (%) reductions are largest in the spring

THE MONTHLY WORST DAY IMPACTS ARE HIGHEST IN THE SUMMER MONTHS



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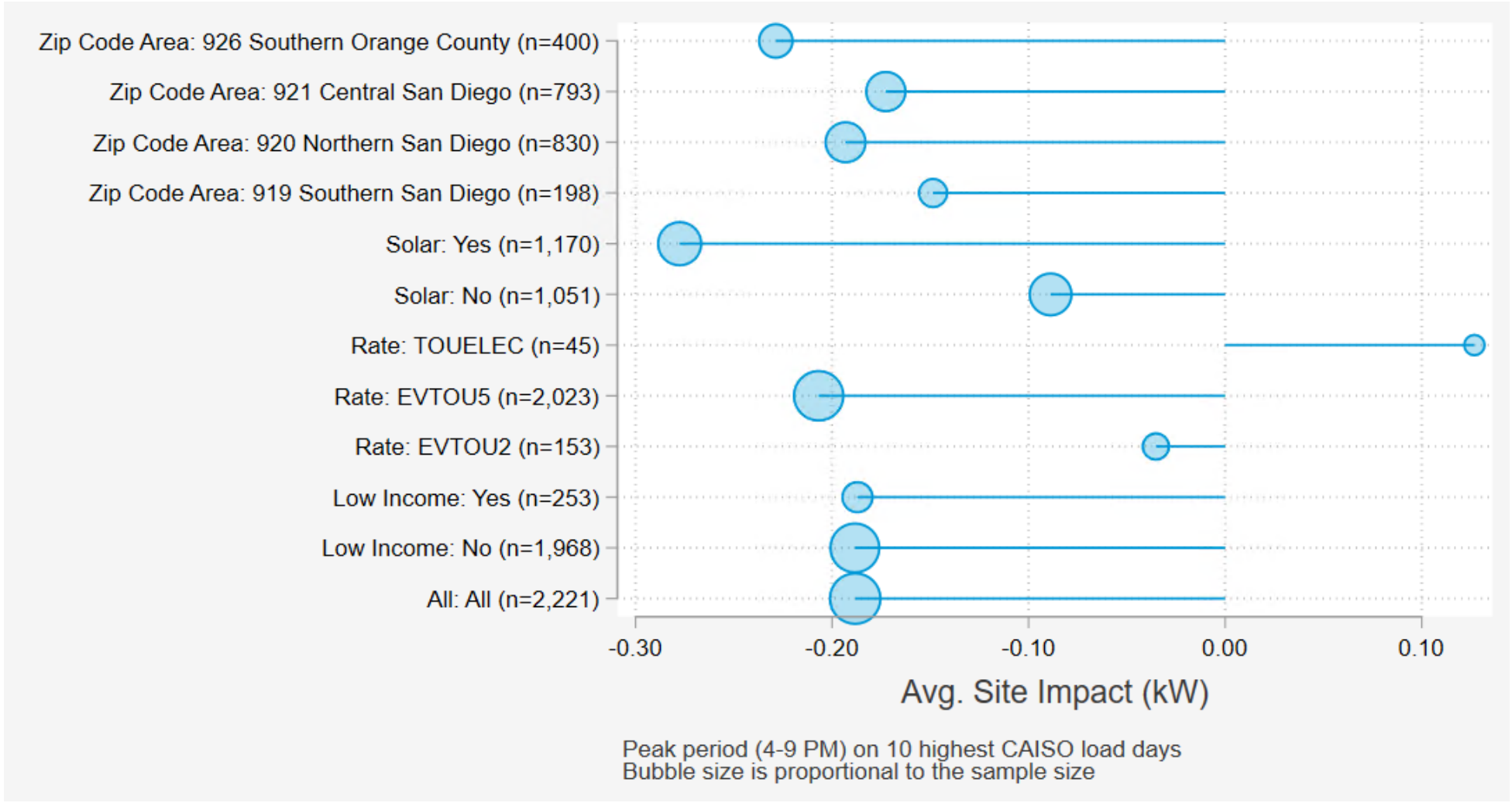
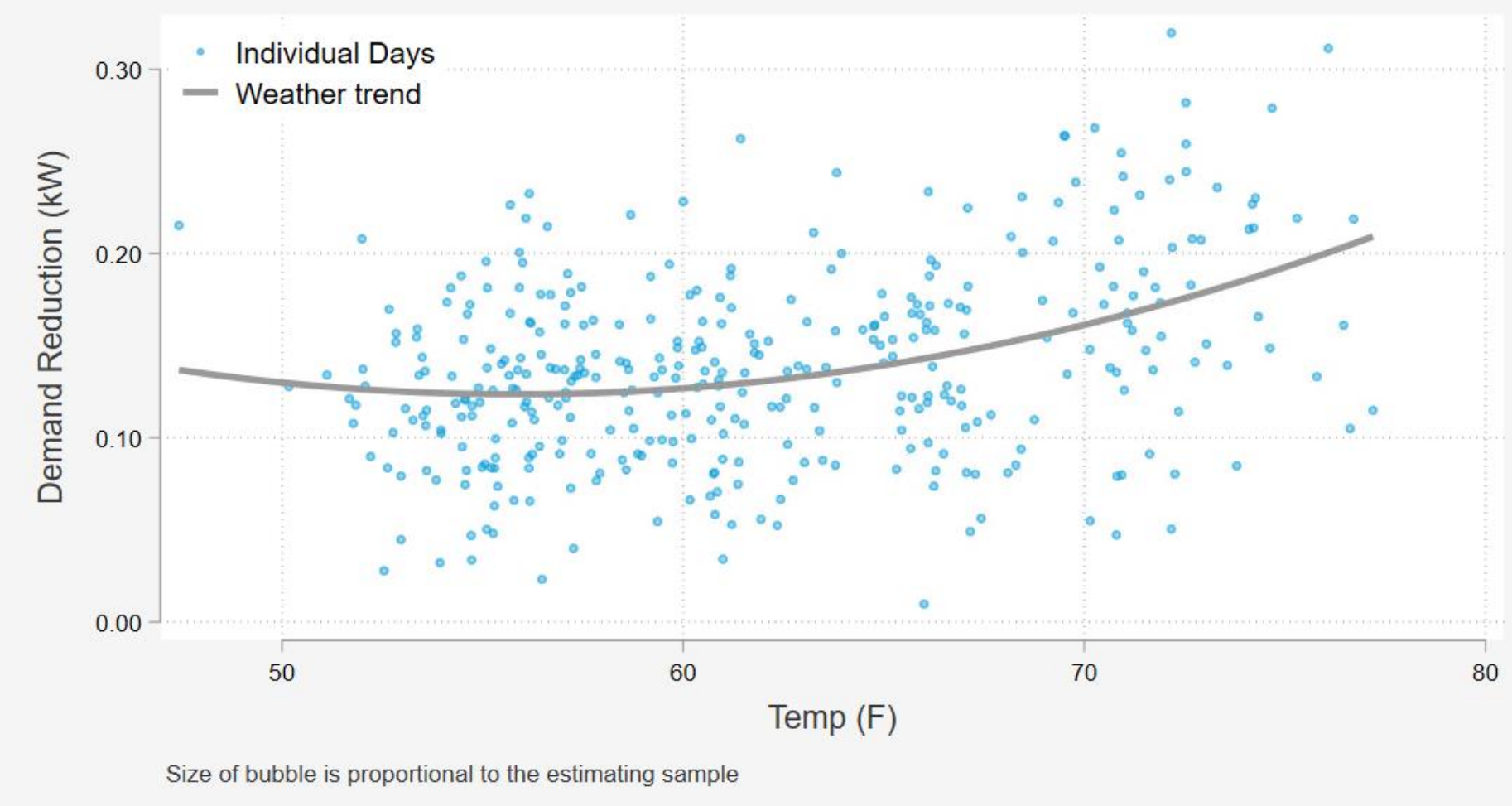
HOW DO LOAD IMPACTS VARY FOR KEY SEGMENTS?



ARE EV RATE LOAD REDUCTIONS WEATHER SENSITIVE?



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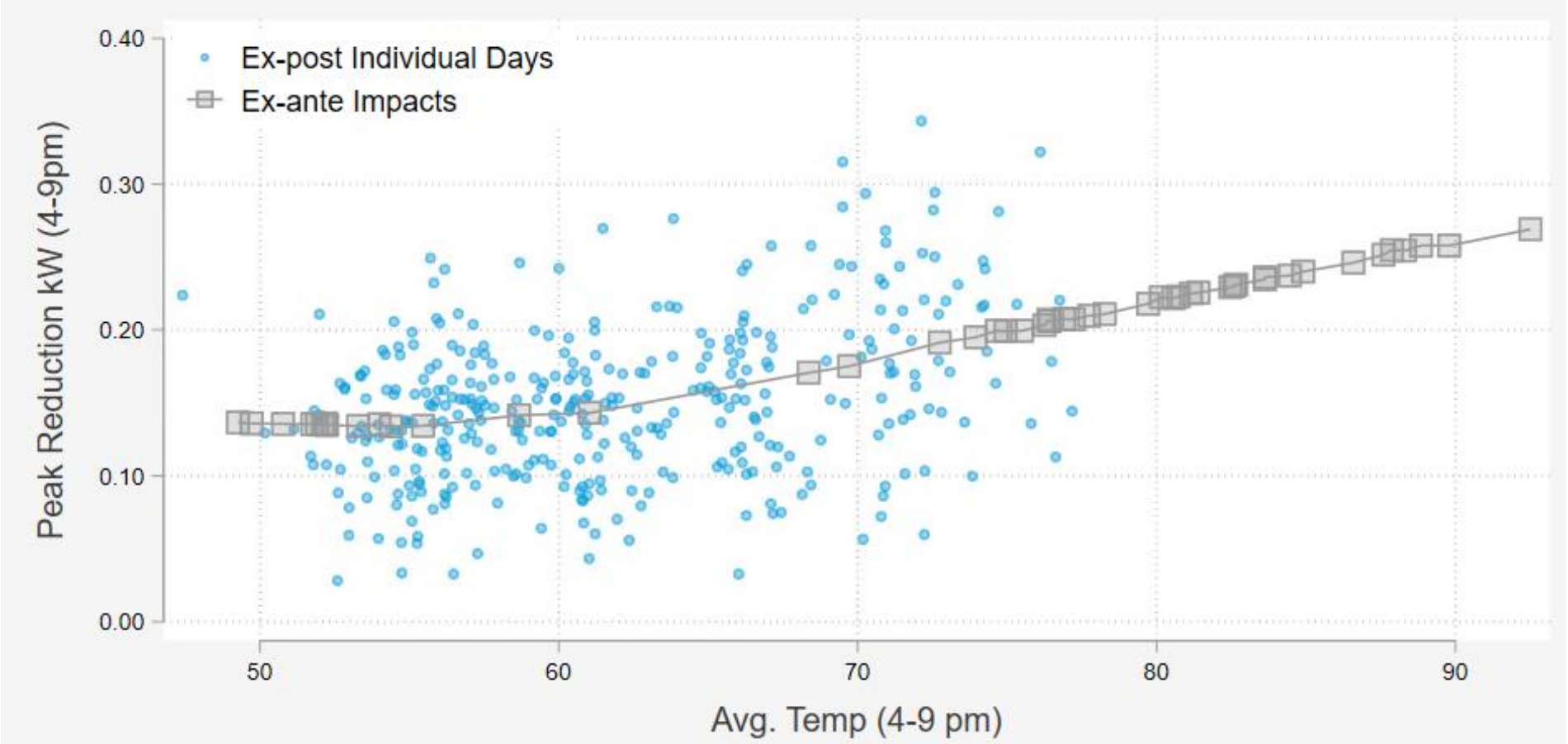
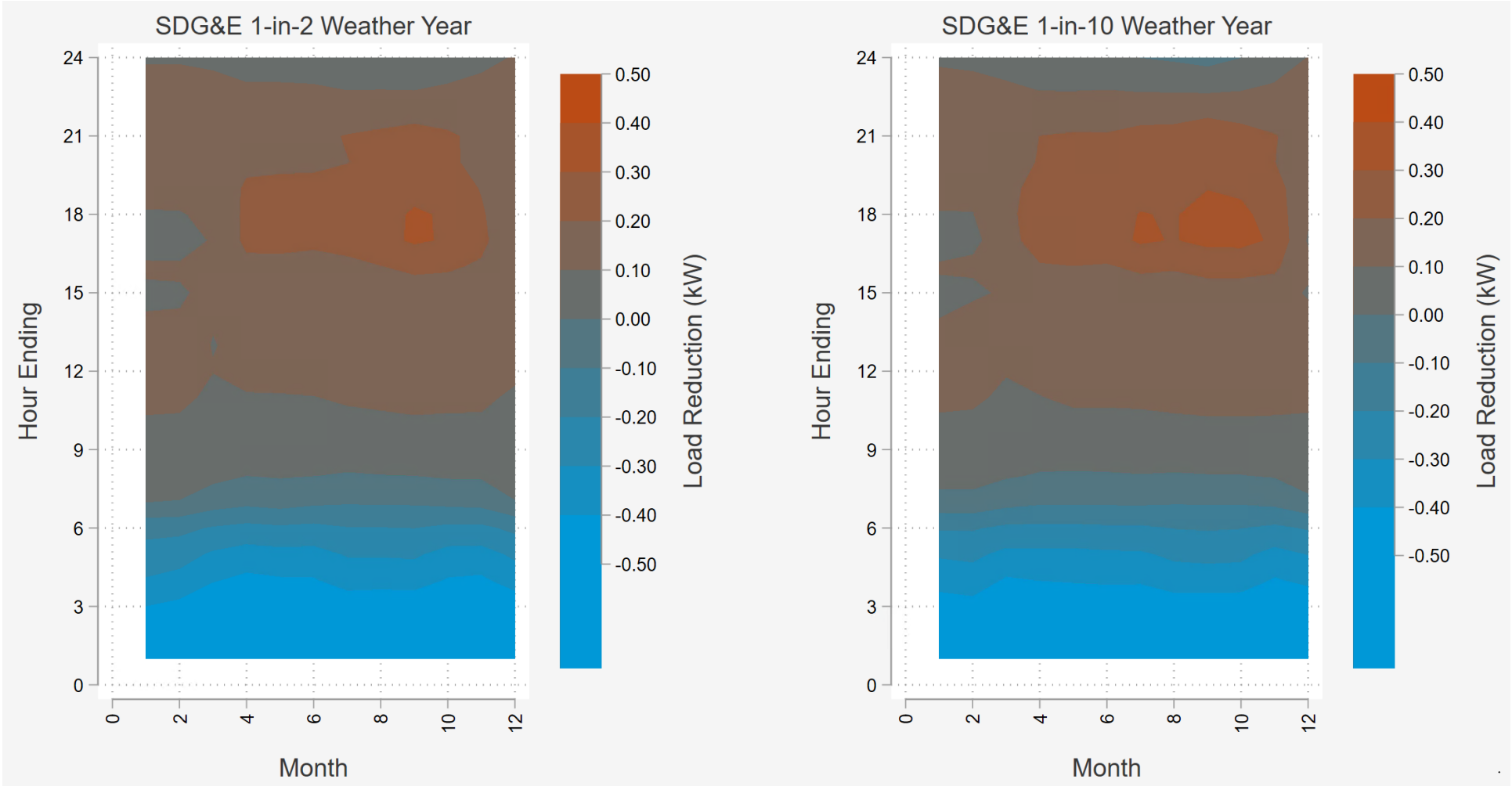
EX-ANTE LOAD IMPACTS

EX-ANTE REDUCTIONS ARE BASED ON EX-POST WEATHER SENSITIVITY



Size of bubble is proportional to the estimating sample. Per customer impacts reflect the mix of the estimating sample.
Ex-ante impact include monthly peak days for CAISO, SDG&E and for 1-in-2 and 1-in-10 weather years

MONTHLY WORST DAY EX-ANTE LOAD REDUCTIONS PER PREMISE HEAT MAP



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PER HOME EX ANTE LOAD REDUCTIONS

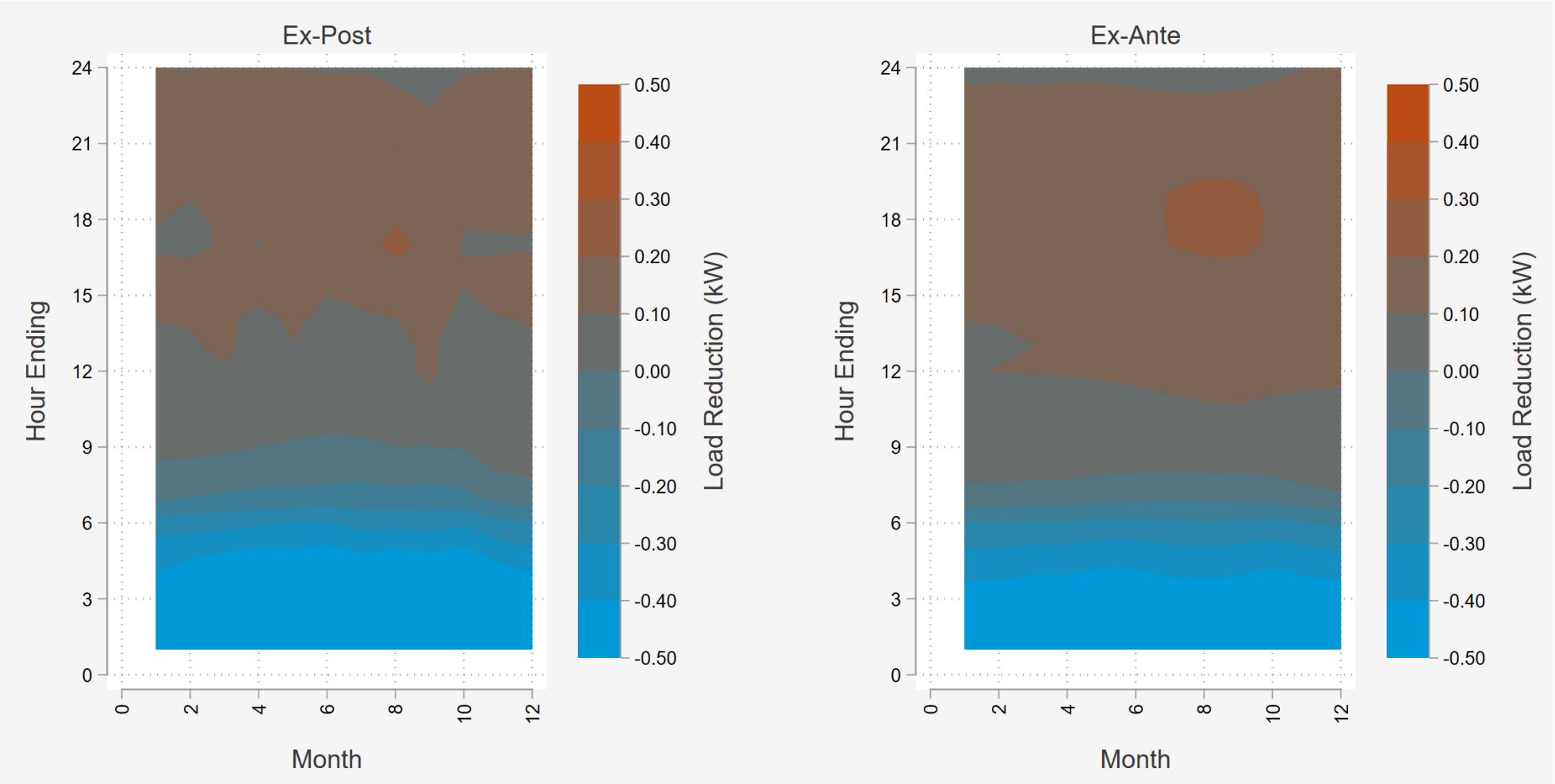
		SDG&E		CAISO	
Day Type	Month	1-in-2	1-in-10	1-in-2	1-in-10
AVERAGE WEEKDAY	05 May	0.14	0.16	0.14	0.16
	06 Jun	0.17	0.18	0.17	0.18
	07 Jul	0.19	0.21	0.20	0.21
	08 Aug	0.21	0.22	0.21	0.21
	09 Sep	0.21	0.22	0.21	0.21
	10 Oct	0.18	0.20	0.18	0.20
MONTHLY SYSTEM PEAK DAY	05 May	0.21	0.25	0.16	0.23
	06 Jun	0.20	0.24	0.20	0.21
	07 Jul	0.22	0.27	0.21	0.23
	08 Aug	0.24	0.26	0.23	0.25
	09 Sep	0.27	0.30	0.24	0.28
	10 Oct	0.25	0.28	0.25	0.28
TYPICAL EVENT DAY	08 Aug	0.24	0.27	0.22	0.25

AS EV ADOPTION GROWS, THE DAILY PEAK LOAD REDUCTION IS EXPECTED TO GROW TO OVER 100 MW

Forecast Year	Enrollment Forecast	SDG&E Weather		CAISO Weather	
		1-in-2	1-in-10	1-in-2	1-in-10
2024	62,240	15.2	16.5	14.5	15.8
2025	81,370	20.2	21.9	19.3	21.0
2026	100,895	25.2	27.2	24.1	26.1
2027	122,289	30.6	33.1	29.3	31.8
2028	145,748	36.6	39.5	35.0	37.9
2029	172,734	43.5	46.9	41.6	45.0
2030	203,648	51.3	55.3	49.1	53.2
2031	237,754	60.0	64.7	57.4	62.1
2032	274,531	69.3	74.7	66.3	71.8
2033	312,142	78.9	85.0	75.5	81.7
2034	352,755	89.2	96.1	85.3	92.4
2035	387,237	98.0	105.6	93.7	101.4

August Monthly Worst Day Results

EX-POST TO EX-ANTE COMPARISON (AVG. WEEKDAY)



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COMPARISON TO PRIOR YEAR EVALUATION – MONTHLY WORST DAY

	PY23 Evaluation				PY24 Evaluation			
	EVTOU5		EVTOU2		EVTOU5		EVTOU2	
	1-in-2	1-in-10	1-in-2	1-in-10	1-in-2	1-in-10	1-in-2	1-in-10
May	0.22	0.23	0.27	0.33	0.21	0.25	0.17	0.26
June	0.22	0.23	0.27	0.32	0.21	0.24	0.16	0.23
July	0.22	0.23	0.28	0.36	0.22	0.27	0.18	0.30
August	0.23	0.23	0.32	0.35	0.25	0.26	0.24	0.28
September	0.23	0.23	0.36	0.40	0.27	0.29	0.29	0.35
October	0.23	0.23	0.33	0.36	0.26	0.28	0.25	0.30

*Per Customer impacts for 2023

- Most differences are due to slightly more weather sensitive results in PY24 evaluation

KEY FINDINGS AND RECOMMENDATIONS

KEY FINDINGS

1. As of April 2024, there were 173,172 EVs registered in SDG&E territory, and 52,380 households on EV rates. Most new enrollment is occurring on the EV-TOU-5 rate

2. Customers who enroll on EV TOU rates decrease demand when prices are higher usage when the prices are lowest. Moreover, the change in load patterns coincides with the enrollment on TOU rates for electric vehicles

3. On top 5 highest CAISO gross, CAISO net, and SDG&E system load days over the study period, customers reduced demand by 0.2 kW per home, on average, over the 4-9 PM peak period. This amounted to reduction in demand between 11%-12% of the household load, and over 11 MW of peak demand reductions

4. On Aug. monthly worst day for the CAISO system, ex ante load reductions are 0.23 and 0.25 kW per home, respectively, for 1-in-2 and 1-in-10 weather

5. Peak demand reductions are generally larger when weather is hotter

EVALUATION RECOMMENDATIONS

1. Study the persistence of impacts and cohort effects.
2. Assess whether SDG&E can incorporate California Department of Motor Vehicle (DMV) registration data to identify non-participant sites with EVs.
3. Consider modifying the building blocks used for ex-ante impacts.

QUESTIONS?

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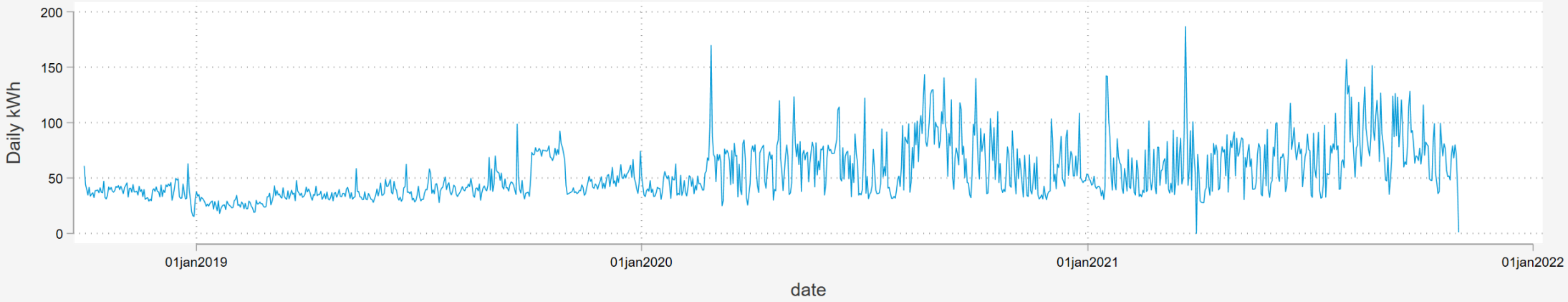
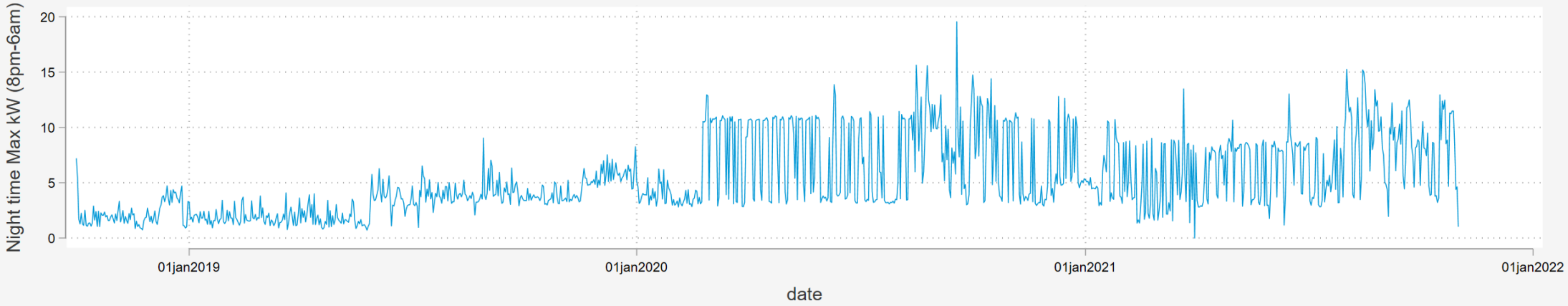
IDENTIFYING SITES WITH EVS BUT NOT ON EV RATES

WHEN AN EV IS INTRODUCED, IT CHANGES USAGE AND MAX DEMAND PATTERNS





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IDENTIFYING SITES WITH EVS (WHO WERE NOT ON EV RATES)

Input Data

1. SDG&E Data:
   - ~25,000 customers on EV rates
   - ~240,000 customer not on EV rates, oversampling zips with high EV rates
   - AMI data for all site
   - Customer characteristics (e.g., solar status, CARE, locations, etc.)

2. California DMV
Most recent data on vehicle penetration by fuel type and zip code

3. US Census Bureau
Zip code level demographics

4. CALMAC weather data (include solar irradiance)

Analysis

1. Narrow AMI data to 2021 and temperate days
(Avg. Temp <70 & Max Temp <90 F)

2. Calculate AMI summary metrics for all hour and night hours only (e.g. max night time kWh, volatility, etc.)

3. Combine summary AMI data with other customer/area characteristics

4. Exploratory data analysis to identify strongest predictors

5. Run tournament to identify the best predictive model

6. Apply model to full population and identify sites with high likelihood of EVs

Outputs

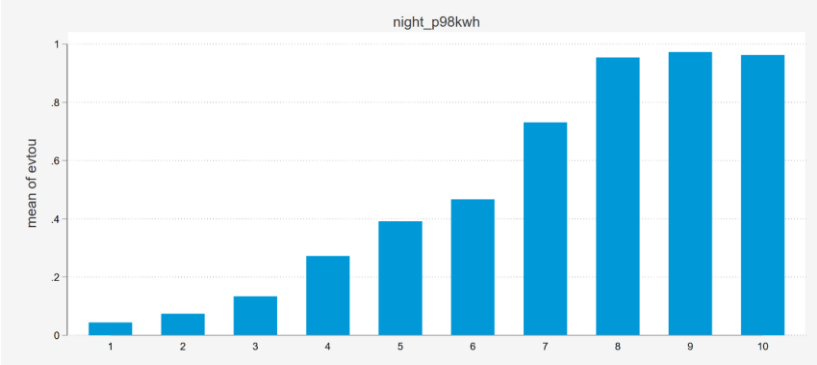
1. EV likelihood for all ~265,000 sites

2. Detection of when EV was adopted (if adopted over time frame)

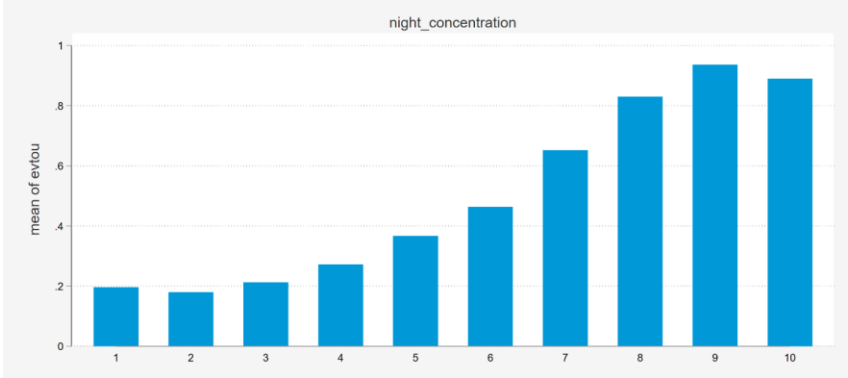
KEY PREDICTORS OF EVS

We consider over 40 variables. Here are some of the best predictors:

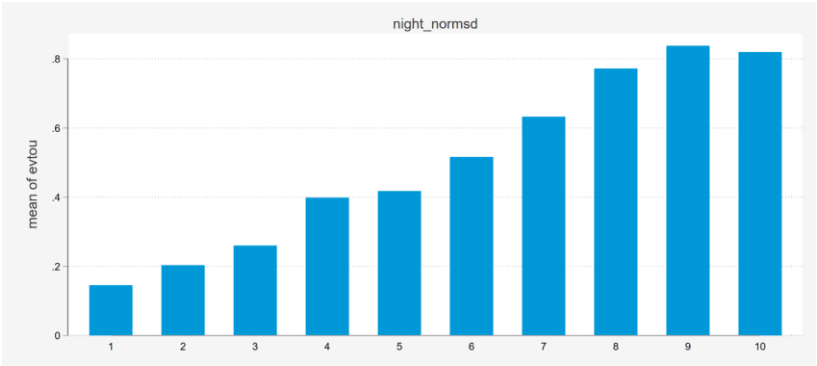
Night time Demand p98 (8pm6am)



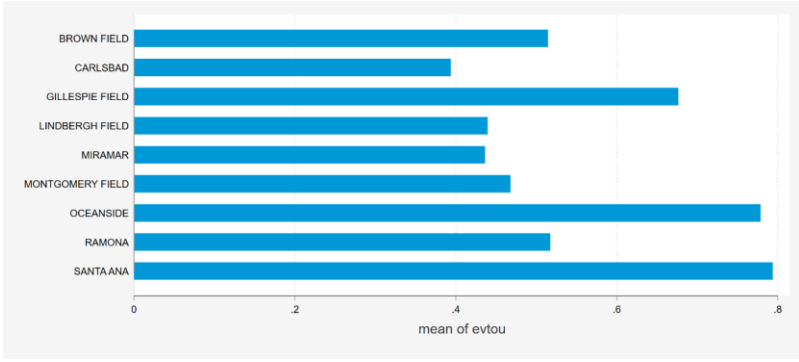
Little drop off in night time load duration (p98/max)



Volatility in nighttime load (Norm SD)



Location
(based on weather station mapping)

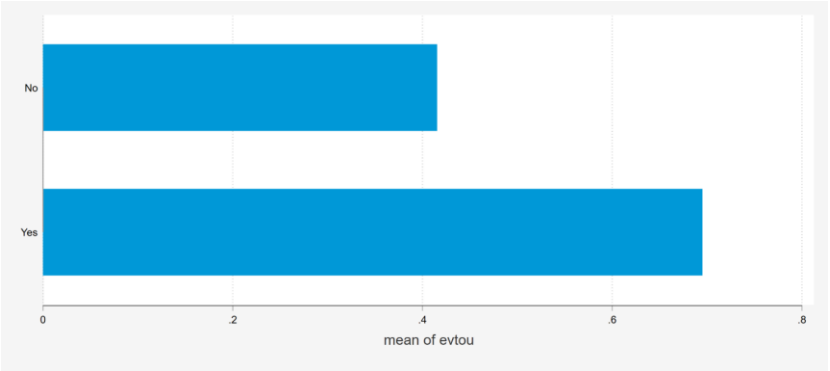


Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS

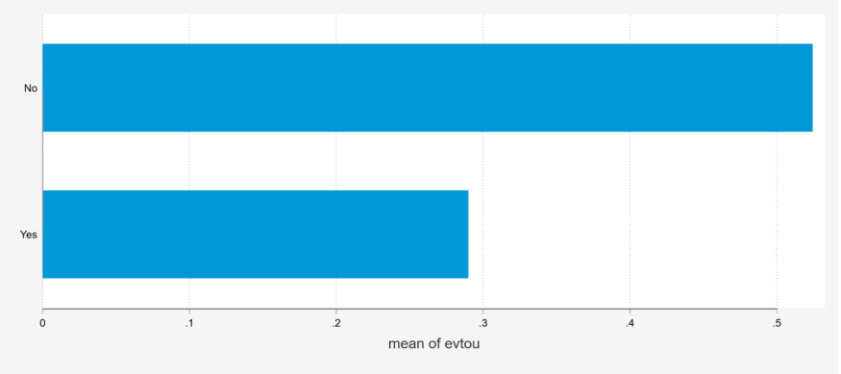
KEY PREDICTORS OF EVS

We consider over 40 variables. Here are some of the best predictors:

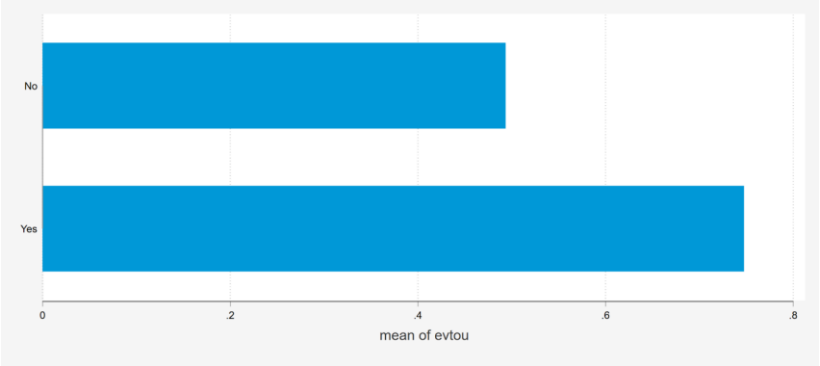
Solar



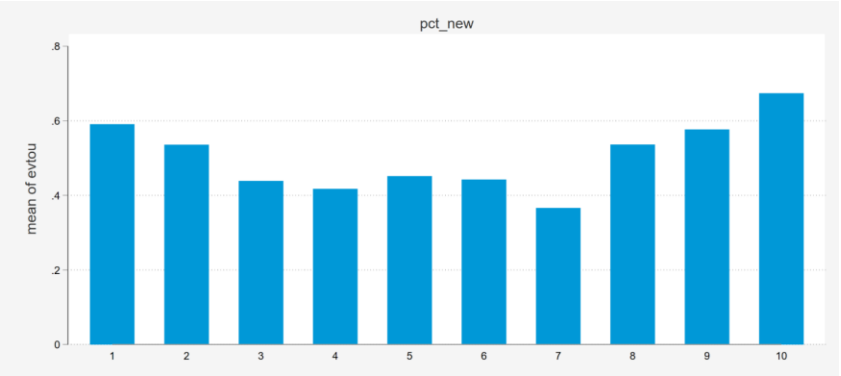
Low Income (CARE)



Battery Storage



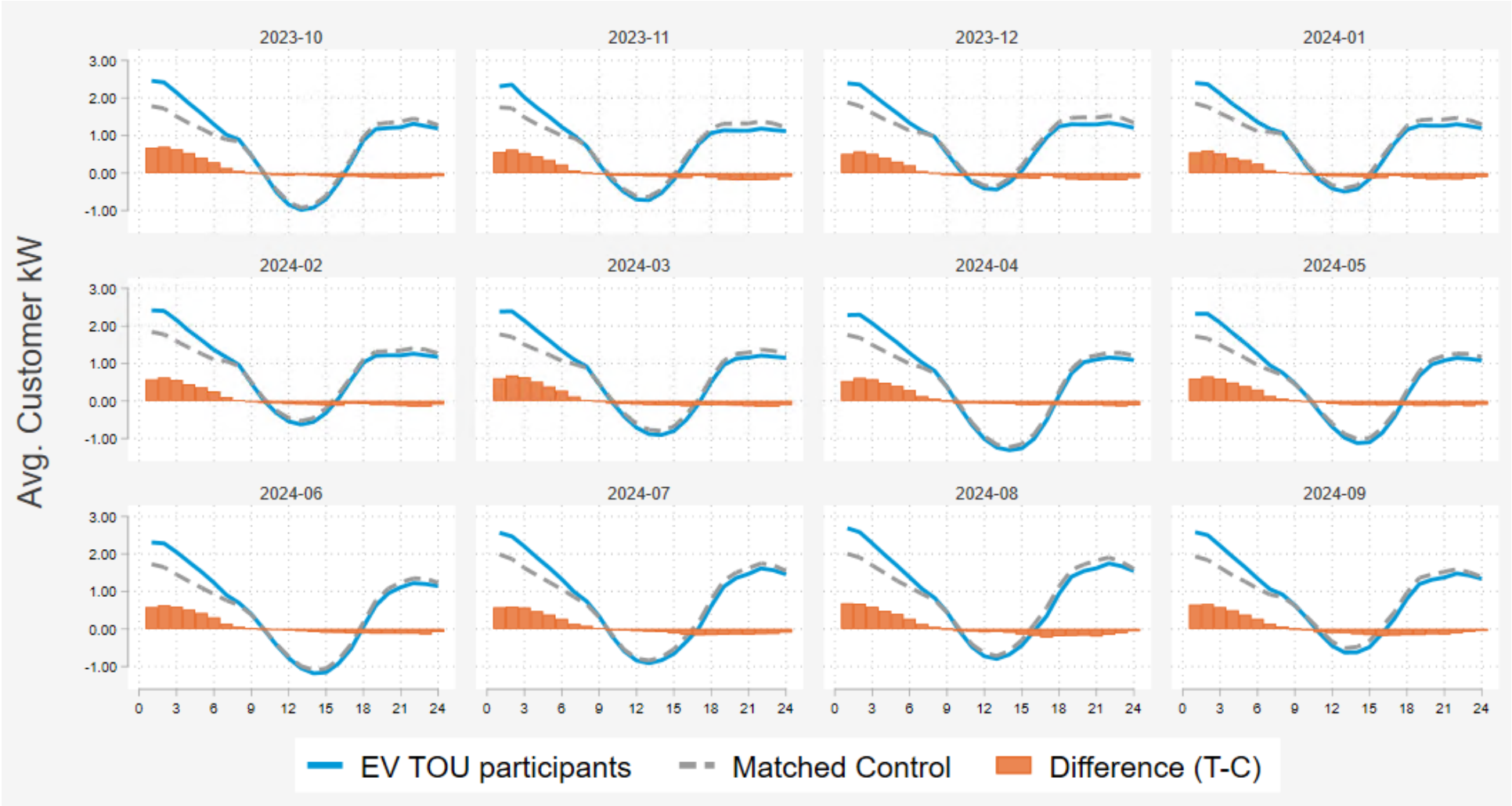
% of Newer Vehicles (3 years or newer)



Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS

MONTHLY AVG. DAY EX-POST RESULTS

MONTHLY AVERAGE DAY REDUCTIONS SHOW THE SAME PATTERN BUT ARE MORE STABLE



Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS

MONTHLY AVERAGE DAY EX POST PEAK PERIOD REDUCTIONS

				Avg. Customers (kW)		Aggregate Incremental (MW)		
Rate Period	Month	New Accts	Daily avg. temp[1]	Reference Load	Load Impact	Reference Load	Load Impact	% Change
Peak (4-9 PM)	2023-Oct	11,322	66.6	1.07	0.12	12.15	1.41	-11.6%
	2023-Nov	11,244	60.0	1.20	0.15	13.53	1.73	-12.8%
	2023-Dec	11,180	56.1	1.37	0.15	15.29	1.69	-11.1%
	2024-Jan	11,122	54.7	1.28	0.13	14.25	1.50	-10.5%
	2024-Feb	11,066	55.0	1.15	0.10	12.70	1.10	-8.7%
	2024-Mar	10,994	55.6	0.86	0.12	9.48	1.32	-14.0%
	2024-Apr	10,959	58.3	0.62	0.11	6.75	1.19	-17.6%
	2024-May	10,883	60.3	0.62	0.12	6.71	1.32	-19.6%
	2024-Jun	10,819	64.1	0.57	0.12	6.16	1.33	-21.6%
	2024-Jul	10,711	70.6	1.08	0.16	11.57	1.71	-14.8%
	2024-Aug	10,630	71.8	1.37	0.20	14.54	2.08	-14.3%
	2024-Sep	10,538	68.7	1.16	0.16	12.19	1.68	-13.8%