SOUTHERN CALIFORNIA EDISON
SMART ENERGY PROGRAM:
2022 LOAD IMPACT EVALUATION

MAY 2, 2023

Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS

SEP PROGRAM DESCRIPTION

Overview

- SEP operates through temporary thermostat adjustments which reduce AC usage and lowers electric demand.

- Events can be called year-round, though customers only receive bill credits for June through September participation.

- New SEP participants receive a one-time $75 bill credit for enrolling and a daily bill credit of $0.3275 per day June to September.

- SEP includes multiple vendors and smart thermostat manufacturers (OEMs)

  ➤ For analysis purposes, we only focus on thermostat vendors

Participant Make-Up

Segmentation Variable	Segment Description	Participants
All	All Customers	57,505
LCA	Big Creek/Ventura	7,297
	LA Basin	48,479
	Outside	1,729
Low Income	CARE	11,366
	Non-CARE	46,139
NEM	NEM Customer	16,341
	Non-NEM Customer	41,164
Size	Above Median kW	28,753
	Below Median kW	28,752
Sublap	SCEC	24,311
	SCEN	6,911
	SCEW	24,162
	SCHD	1,652
	SCLD	52
	SCNW	417
Tariff	Dynamic	35,334
	Flat	22,171
Vendor	EnergyHub, Inc.	12,323
	Resideo Technologies Inc.	45,182
Zone	Remainder of System	25,152
	South Orange County	11,189
	South of Lugo	21,164
Thermostats	1 Thermostat	49,906
	2 Thermostats	7,012
	3+ Thermostats	587

2022 SEP EVENTS VARIED IN TIMING AND DURATION; THE MOST COMMON EVENT WINDOW WAS 6PM-8PM.
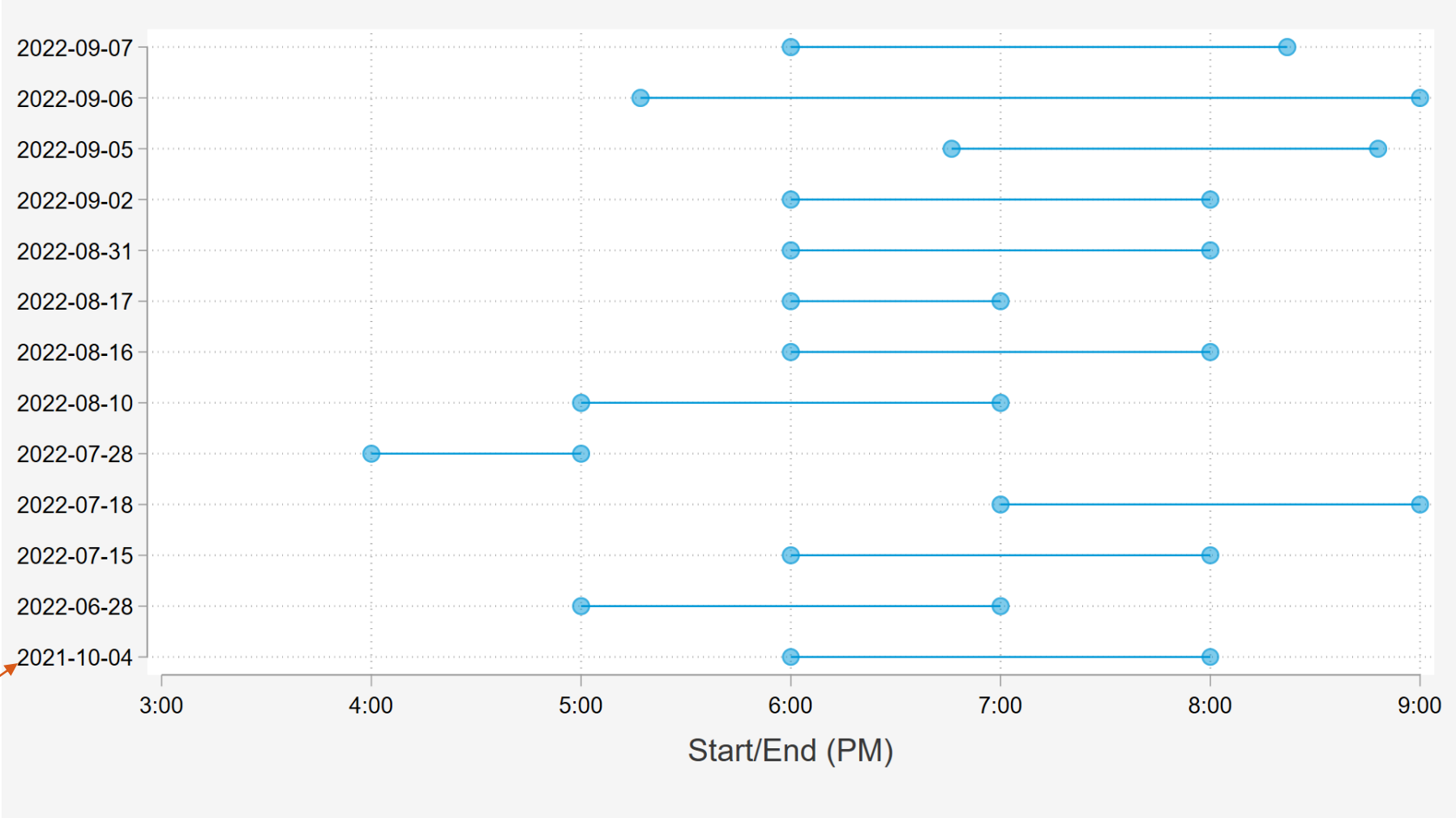
SEP EX POST METHODOLOGY

Proxy Day Selection

- Three proxy days were selected for each event day based on SCE system load

Matched Controls

- A single control customer was chosen for each participant based on individual load during all proxy days
- Hard matched within NEM status, climate zone, and size quartile groups
- Propensity score matching model with replacement

Regression Analysis

- Difference-in-differences panel regression
- Hourly event impacts estimated by subcategory and across all customers
- Separate regression for each event day hour using event day and it's 3 proxy days

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TREATMENT AND MATCHED CONTROL GROUP

- Control matches were assigned characteristics (including sub-LAPs and vendor) from their treated counterpart

- Matches are done with replacement

- In 2022, 2% of participants were unable to be matched

  ➤ This may be due to missing data or usage values that do not match any controls in our sample

Average Hourly kW on Proxy Days
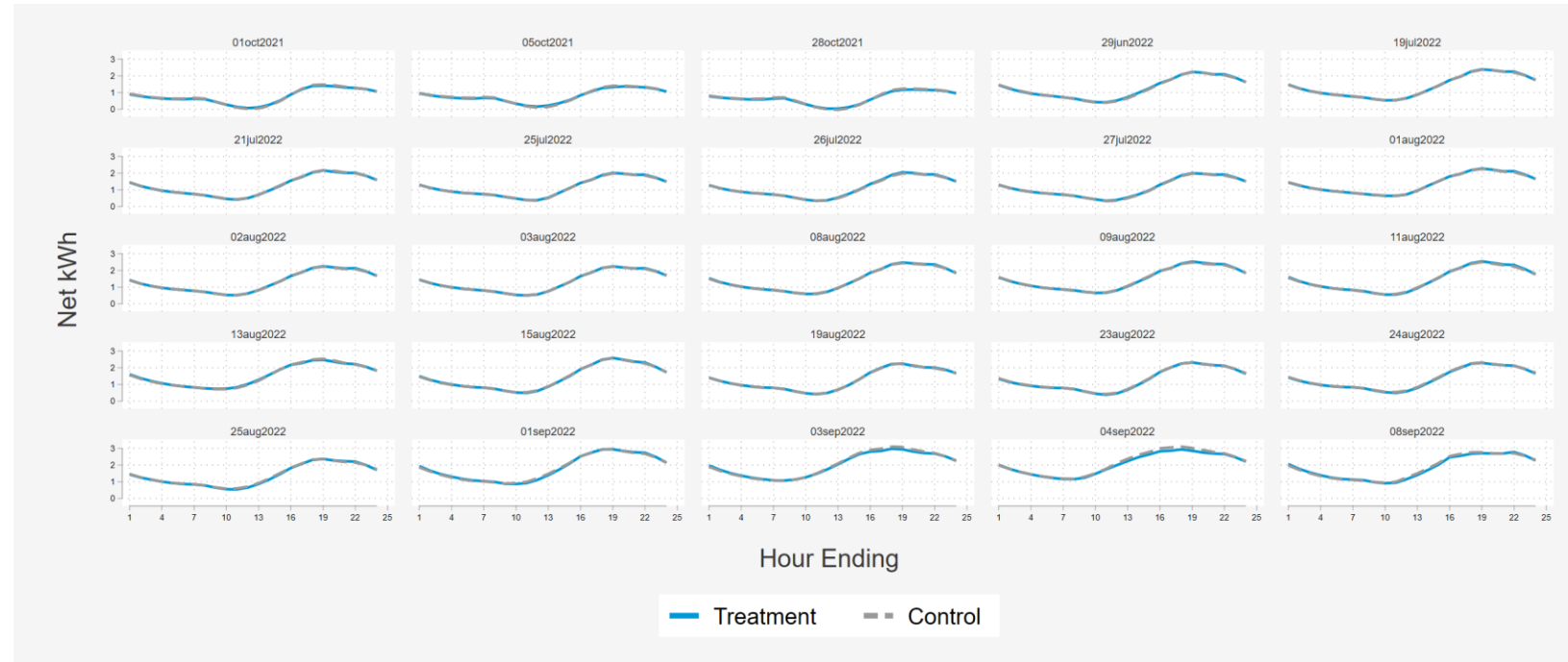
HANDLING OF ELRP AND FLEX ALERTS

ELRP	Flex Alerts

ELRP

- In PY2022, default Emergency Load Reduction Program (ELRP) enrollment meant that all high usage and low-income customers not currently enrolled in a demand response program were defaulted onto ELRP

- After discussions with the SCE DR team and testing matching without ELRP customers, we chose to allow ELRP customers into our control group for data sufficiency and matching quality

- This means that in PY 2022, SEP impacts can be viewed as incremental impacts on top of ELRP impacts for those customer segments.

Flex Alerts

- Flex Alerts were sent out in California from September 1st-9th calling for reduced energy usage during peaks times.

- Since this alert was sent to both SEP customers and control customers, we expect that it would have affected both groups similarly.

- This means that any impacts the Flex Alerts had should be netted out of the SEP impacts with our Difference-in-Differences approach.

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SYSTEM PEAK DAY – 9/6/2022

- **Four hour dispatch**
  - ➢ First hour was a partial hour
  - ➢ Average per-customer impact of 0.80 kW in the first full hour

- **Maximum daily temperature of 97.2°F**
  - ➢ Event hours were slightly cooler

Table 1: Menu options

Type of Result	Per Customer
Category	All
Segment	All Customers
Date	9/6/2022 (5:17pm-9pm)

Table 2: Event day information

Total sites	57,502
Daily Max Temp	97.2
Average Impact - kW	0.63
Average Impact - %	21.2%
Full Hours Only - Average Impact - kW	0.53
Full Hours Only - Average Impact - %	18.2%
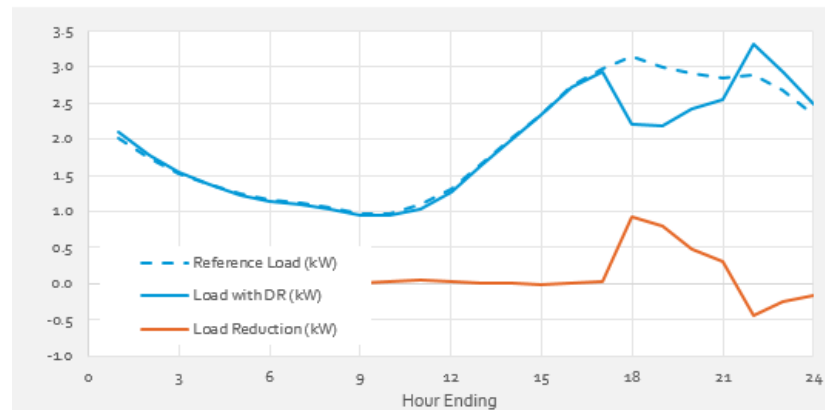
Hour Ending	Reference Load (kW)	Load with DR (kW)	Load Reduction (kW)	% Load Reduction	Avg Temp (°F, Site-Weighted)
1	2.01	2.09	-0.08	-4%	82.99
2	1.74	1.78	-0.04	-3%	81.51
3	1.53	1.55	-0.02	-1%	80.19
4	1.36	1.37	0.00	0%	79.17
5	1.24	1.23	0.01	1%	78.11
6	1.16	1.14	0.02	1%	77.40
7	1.11	1.09	0.02	1%	76.48
8	1.06	1.04	0.01	1%	75.85
9	0.98	0.96	0.02	2%	75.70
10	0.98	0.94	0.03	3%	77.15
11	1.09	1.04	0.06	5%	80.58
12	1.31	1.27	0.04	3%	84.84
13	1.64	1.64	0.01	1%	89.62
14	2.00	2.00	0.00	0%	93.71
15	2.33	2.34	-0.01	0%	95.87
16	2.72	2.72	0.01	0%	96.82
17	2.96	2.92	0.04	1%	97.22
18	3.15	2.21	0.94	30%	97.05
19	2.98	2.18	0.80	27%	96.03
20	2.91	2.42	0.48	17%	94.43
21	2.85	2.55	0.30	11%	90.59
22	2.88	3.31	-0.43	-15%	87.38
23	2.68	2.93	-0.24	-9%	84.84
24	2.32	2.47	-0.15	-6%	83.52
Daily	Reference Load (kWh)	Load with DR (kWh)	Energy Savings (kWh)	% Change	Daily Avg Temp (°F)
	46.98	45.18	1.80	4%	85.7

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EX POST RESULTS

- All events, but one (September 5th) were called territory wide

- Events marked with an asterisk (*) include partial event hours which are not shown here

- Program participation grew over the summer

- Pre-cooling was successfully implemented in all non-emergency 2022 events

Event Date	Dispatch Region	Participants	Average Event Temp	Daily Max Temp	Average Full Hour Impact (kW Reduction)	Average Aggregate Full Hour Impact (MW Reduction)	Pre-Cooling
10/4/2021 (6pm-8pm)	Territory Wide	49,881	80.4	86.2	0.23	11.6	No
6/28/2022 (5pm-7pm)	Territory Wide	55,668	89.5	91.5	0.83	46.4	Yes
7/15/2022 (6pm-8pm)	Territory Wide	55,480	85.9	88.5	0.73	40.4	Yes
7/18/2022 (7pm-9pm)	Territory Wide	55,346	84.5	89.7	0.65	36.2	Yes
7/28/2022 (4pm-5pm)	Territory Wide	55,659	85.4	85.4	0.81	45.1	Yes
8/10/2022 (5pm-7pm)	Territory Wide	56,237	90.8	91.1	0.94	53.1	Yes
8/16/2022 (6pm-8pm)	Territory Wide	56,350	89.7	92.2	0.82	46.3	Yes
8/17/2022 (6pm-7pm)	Territory Wide	56,501	90.2	91.0	1.05	59.3	Yes
8/31/2022 (6pm-8pm)	Territory Wide	57,375	98.4	99.5	0.95	54.5	Yes
9/2/2022 (6pm-8pm)	Territory Wide	57,420	93.9	95.4	0.95	54.8	Yes
*9/5/2022 (6:46pm-8:48pm)	SCEC, SCEN, SCEW, SCHD, SCNW	57,241	96.4	98.9	0.92	52.9	No
**9/6/2022 (5:17pm-9pm)	Territory Wide	57,502	93.7	97.2	0.53	30.5	No
*9/7/2022 (6pm-8:22pm)	Territory Wide	57,471	95.4	96.6	0.86	49.7	No
Average Event Day (6pm-8pm)	Territory Wide	56,668	92.0	93.8	0.86	49.0	Yes

*Hourly impacts correspond to full event hours. Partial hours are excluded.

** System Peak Day

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AVERAGE EVENT DAY (6 PM – 8PM)

Table 1: Menu options

Type of Result	Per Customer
Category	All
Segment	All Customers
Date	Average Event Day (6pm-8pm)

Table 2: Event day information

Total sites	56,668
Daily Max Temp	93.8
Average Impact - kW	0.86
Average Impact - %	32.4%
Full Hours Only - Average Impact - kW	0.86
Full Hours Only - Average Impact - %	32.4%
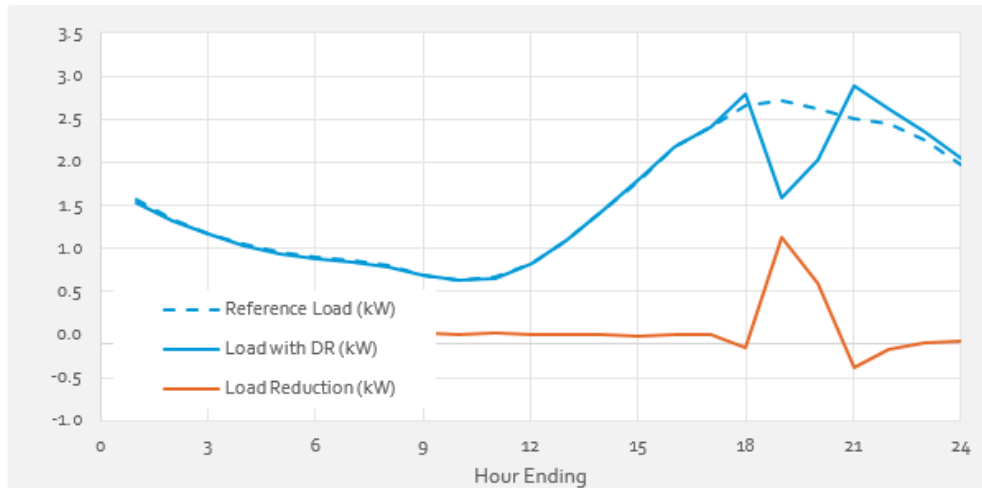
Hour Ending	Reference Load (kW)	Load with DR (kW)	Load Reduction	% Load Reduction	Avg Temp (°F, Site-Weighted)
1	1.56	1.53	0.03	2%	76.67
2	1.34	1.32	0.02	1%	75.63
3	1.17	1.16	0.01	1%	74.66
4	1.05	1.04	0.01	1%	73.93
5	0.95	0.95	0.01	1%	73.20
6	0.90	0.88	0.02	2%	72.52
7	0.86	0.85	0.01	2%	71.90
8	0.80	0.78	0.01	2%	71.50
9	0.70	0.68	0.01	2%	71.84
10	0.64	0.63	0.01	2%	74.22
11	0.67	0.66	0.02	2%	78.04
12	0.82	0.81	0.01	1%	82.12
13	1.09	1.09	0.00	0%	85.44
14	1.43	1.43	0.00	0%	88.72
15	1.78	1.80	-0.02	-1%	91.30
16	2.18	2.18	0.00	0%	92.76
17	2.41	2.41	0.00	0%	93.60
18	2.65	2.80	-0.15	-6%	93.81
19	2.72	1.59	1.13	42%	92.89
20	2.62	2.03	0.60	23%	91.19
21	2.51	2.89	-0.38	-15%	88.03
22	2.46	2.62	-0.17	-7%	84.37
23	2.25	2.35	-0.10	-4%	81.74
24	1.97	2.04	-0.07	-4%	79.97

Daily	Reference Load (kWh)	Load with DR (kWh)	Energy Savings (kWh)	% Change	Daily Avg Temp (°F)
	37.53	36.52	1.01	3%	81.7

Average includes four event days in 2022
- 7/15/2022
- 8/16/2022
- 8/31/2022
- 9/2/2022

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Partial hours dilute program performance, especially at the end of events due to snapback

We used weekend days for proxy-days for this event. Labor day is on a weekday, but, since it is a holiday, loads more closely reflect weekend loads.

Table 1: Menu options

Type of Result	Per Customer
Category	All
Segment	All Customers
Date	9/5/2022 (6:46pm-8:48pm)

Table 2: Event day information

Total sites	57,241
Daily Max Temp	98.9
Average Impact - kW	0.51
Average Impact - %	15.8%
Full Hours Only - Average Impact - kW	0.92
Full Hours Only - Average Impact - %	28.7%
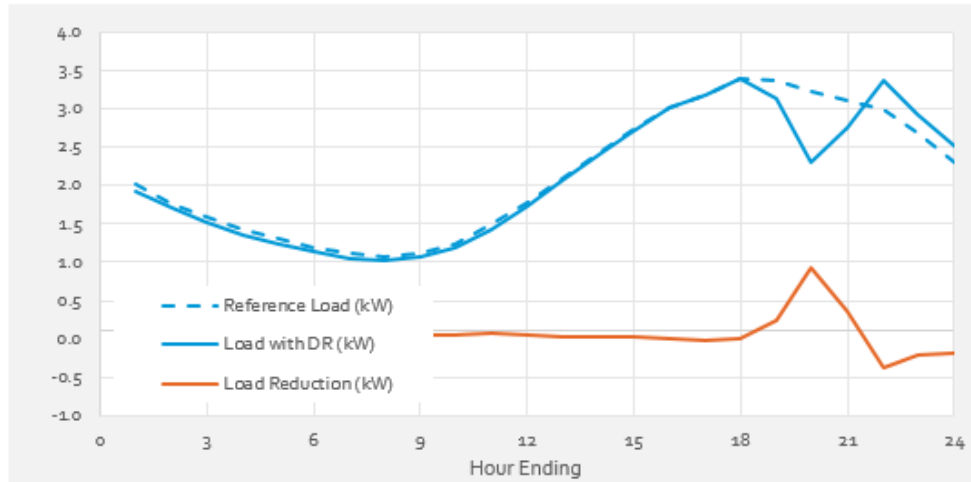
Hour Ending	Reference Load (kW)	Load with DR (kW)	Load Reduction (kW)	% Load Reduction	Avg Temp (°F, Site-Weighted)
1	2.01	1.93	0.07	4%	82.05
2	1.76	1.70	0.06	3%	81.75
3	1.58	1.51	0.07	4%	80.92
4	1.42	1.36	0.06	4%	79.50
5	1.29	1.23	0.06	5%	78.83
6	1.19	1.14	0.05	4%	78.43
7	1.11	1.05	0.06	5%	77.45
8	1.08	1.01	0.07	6%	76.51
9	1.11	1.06	0.05	5%	76.20
10	1.24	1.19	0.05	4%	78.12
11	1.50	1.42	0.08	5%	81.66
12	1.78	1.73	0.05	3%	86.20
13	2.10	2.06	0.03	2%	90.57
14	2.42	2.39	0.03	1%	93.27
15	2.72	2.69	0.03	1%	95.12
16	3.01	3.00	0.01	0%	96.89
17	3.17	3.18	-0.01	0%	98.70
18	3.39	3.38	0.01	0%	98.86
19	3.37	3.12	0.25	7%	98.18
20	3.22	2.29	0.92	29%	96.41
21	3.10	2.74	0.36	12%	93.90
22	2.97	3.36	-0.38	-13%	90.37
23	2.68	2.90	-0.22	-8%	87.15
24	2.31	2.50	-0.19	-8%	85.06
Daily	Reference Load (kWh)	Load with DR (kWh)	Energy Savings (kWh)	% Change	Daily Avg Temp (°F)
	51.54	49.97	1.57	3%	86.8

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EVENT IMPACTS ARE LARGEST DURING THE FIRST HOUR OF DISPATCH AND FADE IN SUBSEQUENT HOURS

Pre-Cooling effects
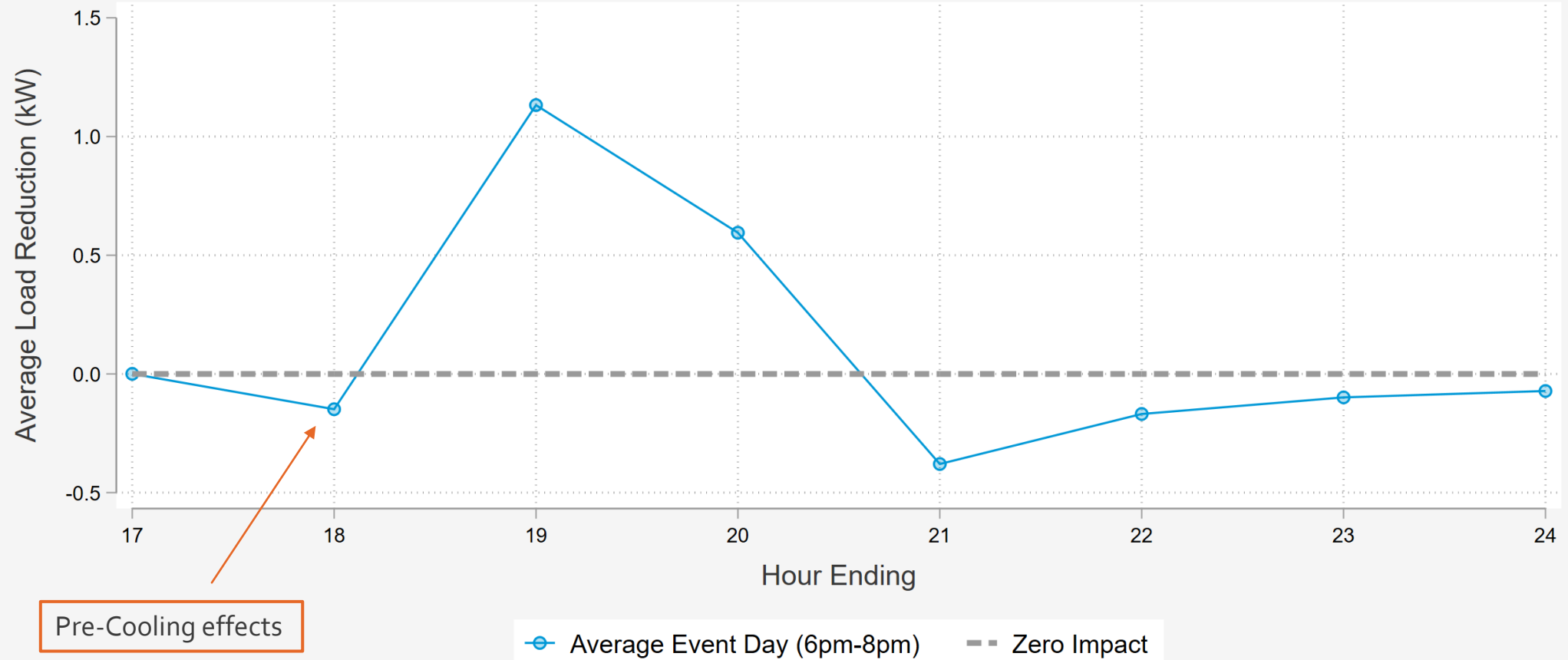
EX POST COMPARISON TO PRIOR YEARS – AVERAGE EVENT DAYS

Measure	2019 (6-8PM)	2021 (6-8 PM)	2022 (6-8 PM)
Avg. Reference Load (kW)	2.48	2.49	2.67
Avg. Load Impact (kW)	0.74	0.73	0.86
% Load Impact	29.84%	29.32%	32.40%
Avg. Event Temperature	83.8	88.0	92.0
Heat Buildup (Avg. F, 12 AM to 5 PM)	80.6	78.5	79.3
Enrollment	52,139	48,498	56,668

- 2019, 2021, and 2022 all had the same average event window

- 2021 and 2019 impacts and reference loads were very similar

- 2019 had higher average impacts than 2021 despite lower event temperatures due to heat buildup

- 2022 impacts and reference loads exceed the two comparison years.

- Enrollment increases in 2022 mean that aggregate impacts we also up in 2022

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AVERAGE EVENT DAY IMPACTS SEGMENTED BY TARIFF GROUP

- TOU default in 2022 means that ~62% of SEP customers were on Dynamic rates

- Customers on dynamic rates reduced a similar percentage of their loads, but flat rate customers tended to shed more overall

- Flat rate customers tend to live in hotter areas and are less likely to have solar, whereas dynamic rate customers live in cooler areas and are more likely to have solar

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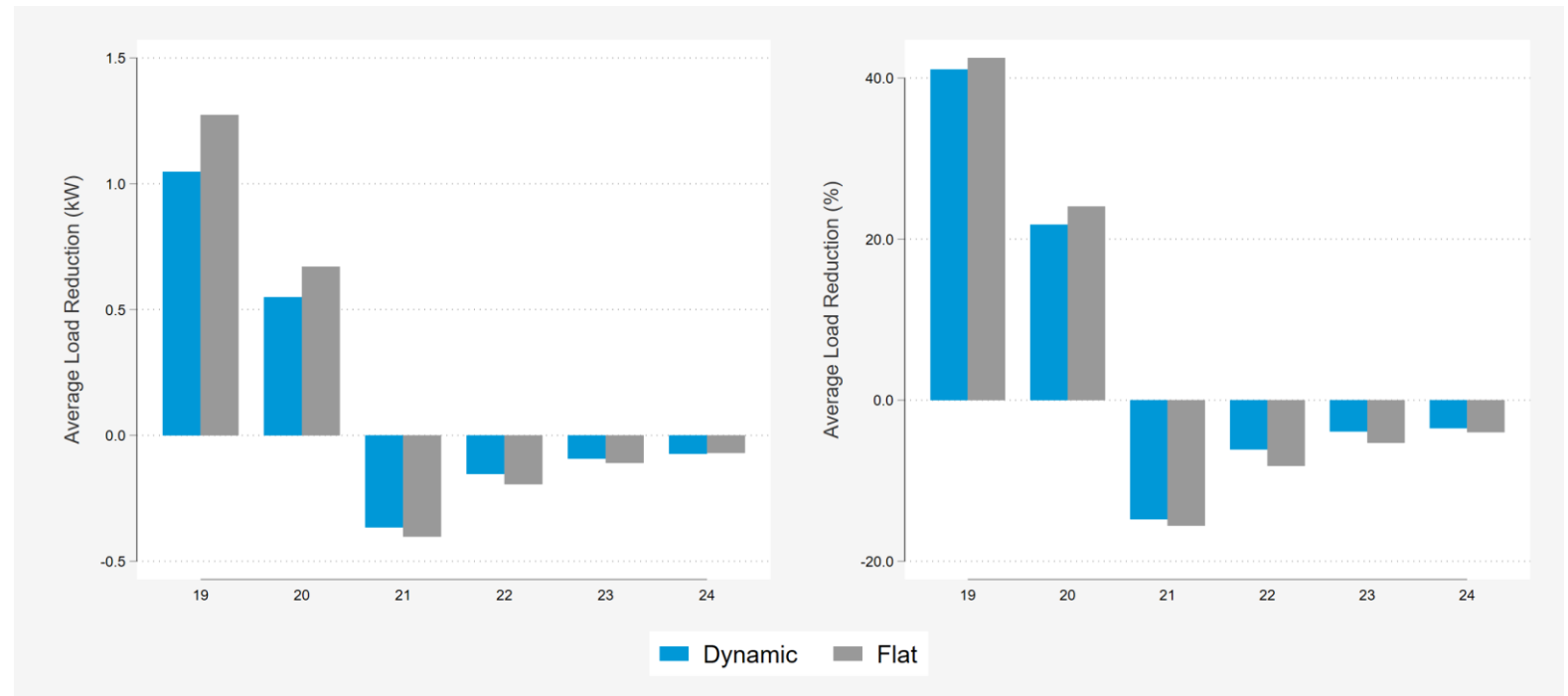
2022 EX-POST VS 2021 EX-ANTE, HOW DID WE DO?

6/28/2022 (5-7 PM)			Per-Customer Impact (kW)			
Results	Daily Max Temp (F)	Customers	Hour 1	Hour 2	Hour 3	Hour 4
SCE 1-in-2 June Peak Day (2021 Ex-Ante predictions for 2022)	86.0	60,885	0.86	0.47	0.28	0.21
SCE 1-in-10 June Peak Day	97.0	60,885	1.11	0.69	0.43	0.29
Ex-Post	91.5	55,668	1.07	0.60		

8/31/2022 (6-8 PM)			Per-Customer Impact (kW)			
Results	Daily Max Temp (F)	Customers	Hour 1	Hour 2	Hour 3	Hour 4
SCE 1-in-10 Typical Event Day (2021 Ex-Ante predictions for 2022)	97.0	63,114	1.11	0.69	0.44	0.31
Ex-Post	99.5	57,375	1.26	0.64		

9/2/2022 (6-8 PM)			Per-Customer Impact (kW)			
Results	Daily Max Temp (F)	Customers	Hour 1	Hour 2	Hour 3	Hour 4
SCE 1-in-10 September Peak Day (2021 Ex-Ante predictions for 2022)	99.7	64,595	1.17	0.73	0.45	0.31
Ex-Post	95.4	57,420	1.24	0.67		

- These comparisons use the first four hours of the 2021 ex ante predictions
  - Ex Ante predictions assume a 4pm to 9pm dispatch
  - 2022 comparison events began 1-2 hours later
- June 28th weather was in between SCE 1-in-2 and SCE 1-in-10 weather, but performed closer to an SCE 1-in-10 day
- June 31st was warmer than the SCE 1-in-10 typical event day, and hour 1 showed higher impacts, but impacts in hour 2 declined quicker than projected
- September 2nd showed a similar pattern of higher impacts in hour 1 and lower in hour 2
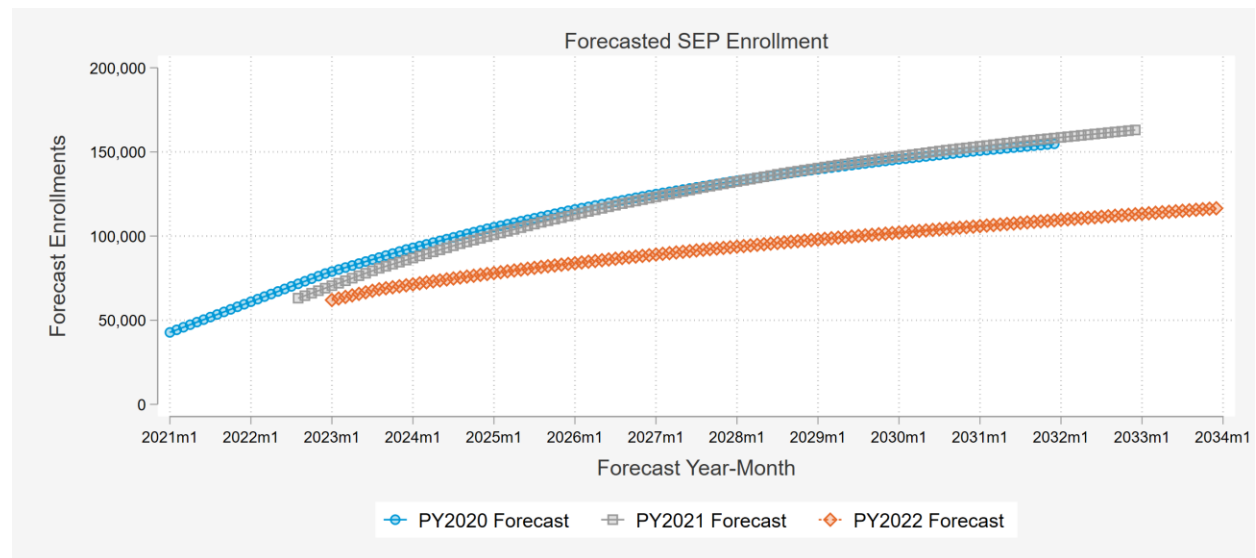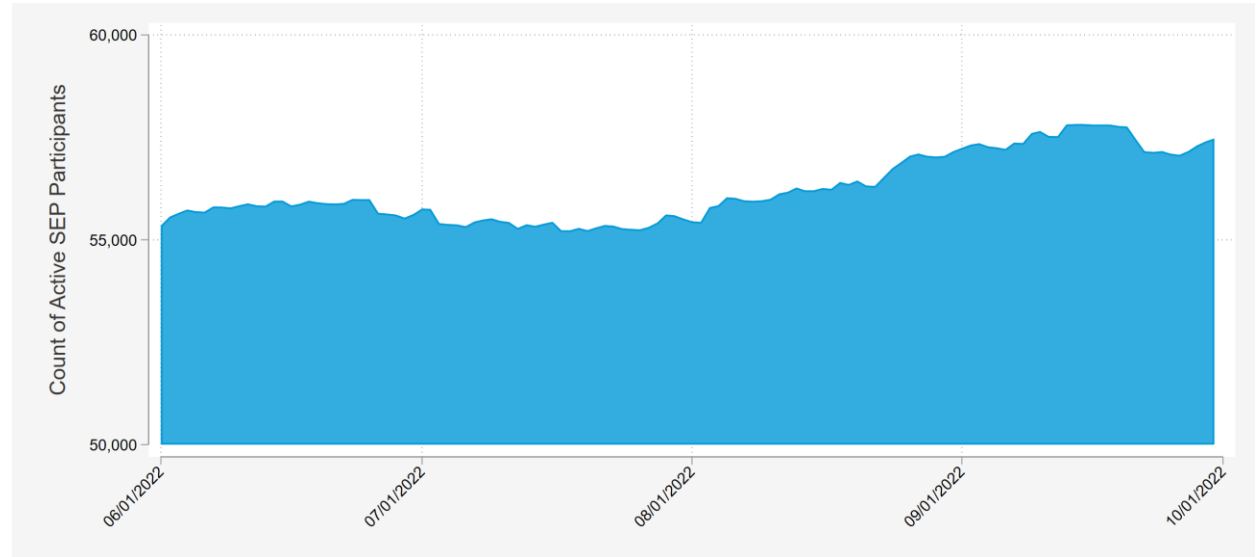
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SEP EX ANTE METHODOLOGY

- Estimate hourly average customer reference loads

  ➢ Estimate loads for all weather forecasts

- Use the past three years of events in a second stage model to estimate impacts in varying conditions

- In 2022, we did not include any COVID affected months.

  ➢ March 2020-Dec 2020 were not included in reference load modeling

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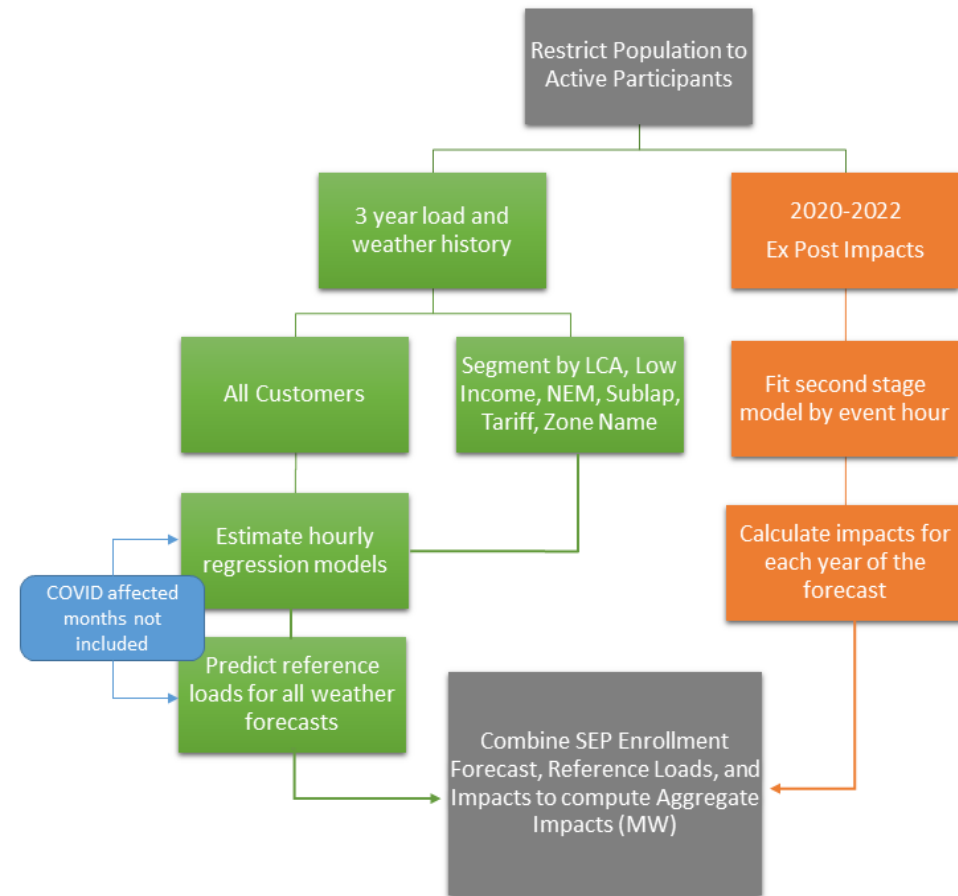
ENROLLMENT FORECAST

- Enrollment in 2022 was lower than projected in previous years, but rose over the course of the summer due to increased marketing of the program

- Future enrollment, which plays a major part in program potential, is expected to grow to over 110,000 participants by 2033.

RELATIONSHIP BETWEEN LOAD IMPACTS, TEMPERATURE, AND EVENT HOUR

SEP Event Hours

Only full hours are included. Circles = 2020 | Squares = 2021 | Triangles = 2022
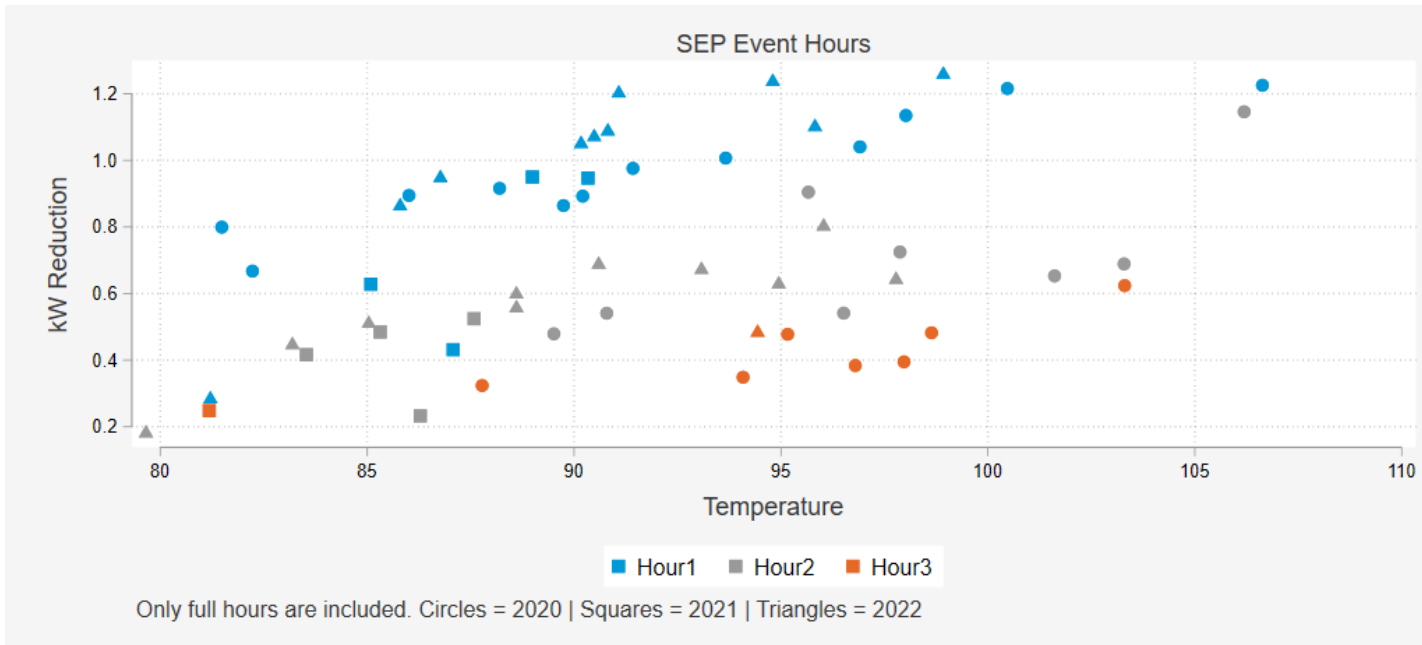
- Models are run separately for each event hour and snapback hour

- 2020, 2021, and 2022 impacts are used

- Models are run separately for each customer category

- Second stage model regresses kW impact on temperature (°F)

  ➢ Event hour is the most important factor in impact

  ➢ Temperature increases magnitude of impact

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APPROACH TO SECOND STAGE MODELING OF KW IMPACTS IN 2022

- Seven different regression models (one per hour) run for each subcategory
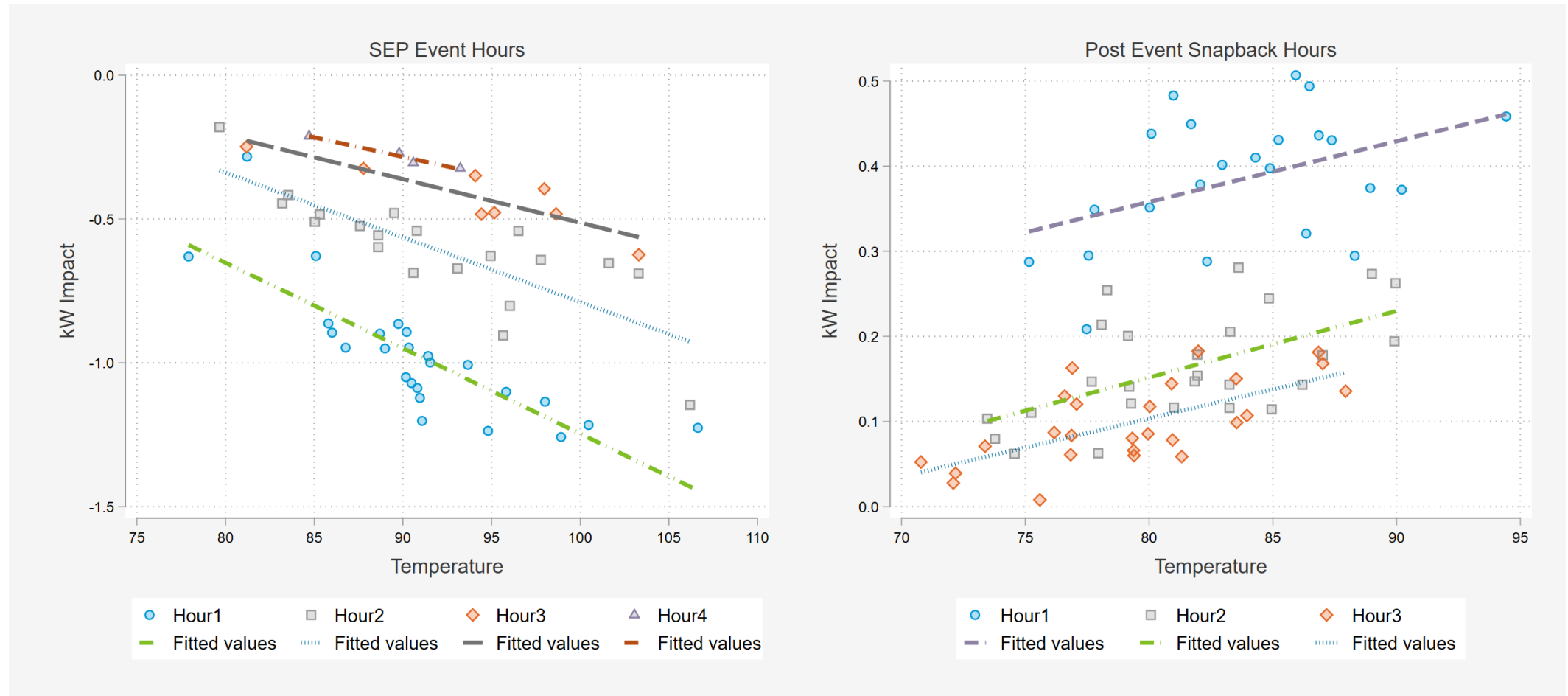
# 2023 AVERAGE CUSTOMER SCE 1-IN-2 CONDITIONS (AUGUST PEAK DAY)

Table 1: Menu options

Type of result	Per Customer
Category	All
Segment	All Customers
Weather Data	SCE
Weather Year	1-in-2
Day Type	August Monthly Peak Day
Forecast Year	2023
Portfolio Level	Portfolio

Table 2: Event day information

Event start	4:00 PM
Event end	9:00 PM
Total sites	68,428
Event window temperature (F)	90.1
Event window load reduction (kW)	0.51
% Load reduction (Event window)	19.3%
Redaction Information	Public

Hour Ending	Reference Load (kW)	Load with DR (kW)	Load Reduction (kW)	% Load Reduction	Avg Temp (°F, Site-Weighted)
1	1.64	1.64	0.00	0.0%	78.84
2	1.40	1.40	0.00	0.0%	77.64
3	1.24	1.24	0.00	0.0%	76.75
4	1.11	1.11	0.00	0.0%	75.71
5	1.01	1.01	0.00	0.0%	74.93
6	0.95	0.95	0.00	0.0%	74.42
7	0.90	0.90	0.00	0.0%	73.78
8	0.86	0.86	0.00	0.0%	73.74
9	0.78	0.78	0.00	0.0%	75.81
10	0.71	0.71	0.00	0.0%	79.96
11	0.68	0.68	0.00	0.0%	84.17
12	0.85	0.85	0.00	0.0%	87.79
13	1.15	1.15	0.00	0.0%	90.22
14	1.52	1.52	0.00	0.0%	92.35
15	1.87	1.87	0.00	0.0%	93.90
16	2.26	2.26	0.00	0.0%	94.01
17	2.48	1.42	1.05	42.6%	93.54
18	2.72	2.11	0.61	22.4%	92.05
19	2.77	2.40	0.37	13.4%	90.57
20	2.63	2.36	0.27	10.2%	88.94
21	2.51	2.29	0.22	8.9%	85.54
22	2.45	2.83	-0.37	-15.2%	82.23
23	2.22	2.37	-0.15	-6.9%	80.13
24	1.88	1.98	-0.09	-5.0%	78.57

Daily	Reference Load (kWh)	Load with DR (kWh)	Energy Savings (kWh)	% Change	Daily Avg Temp (°F)
	38.59	36.68	1.91	4.9%	83.15

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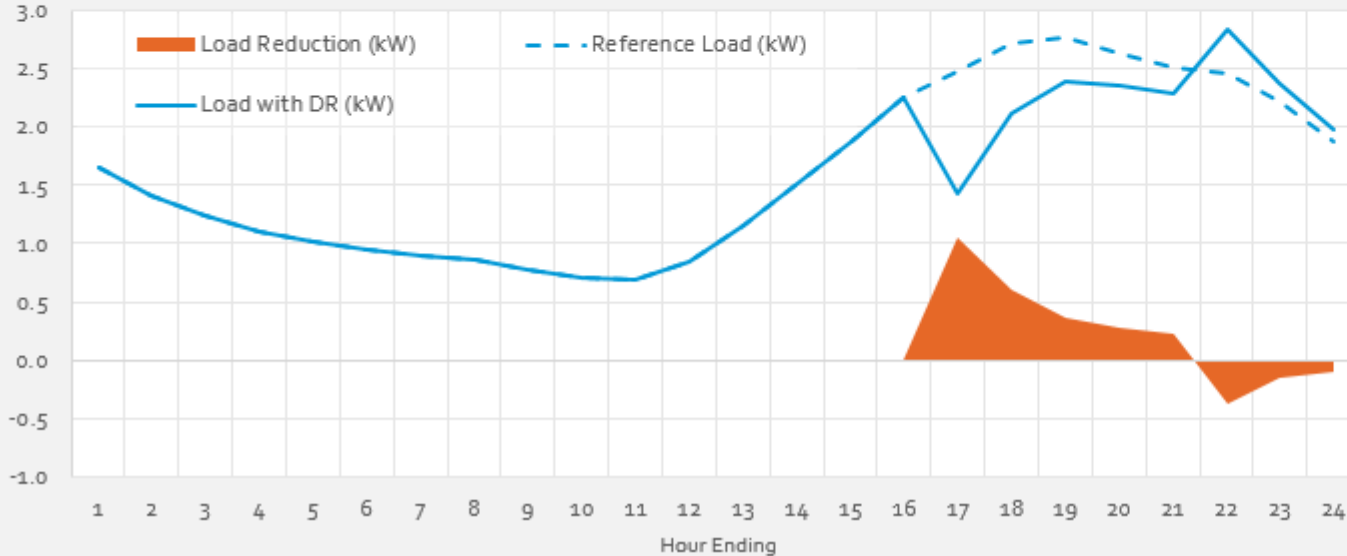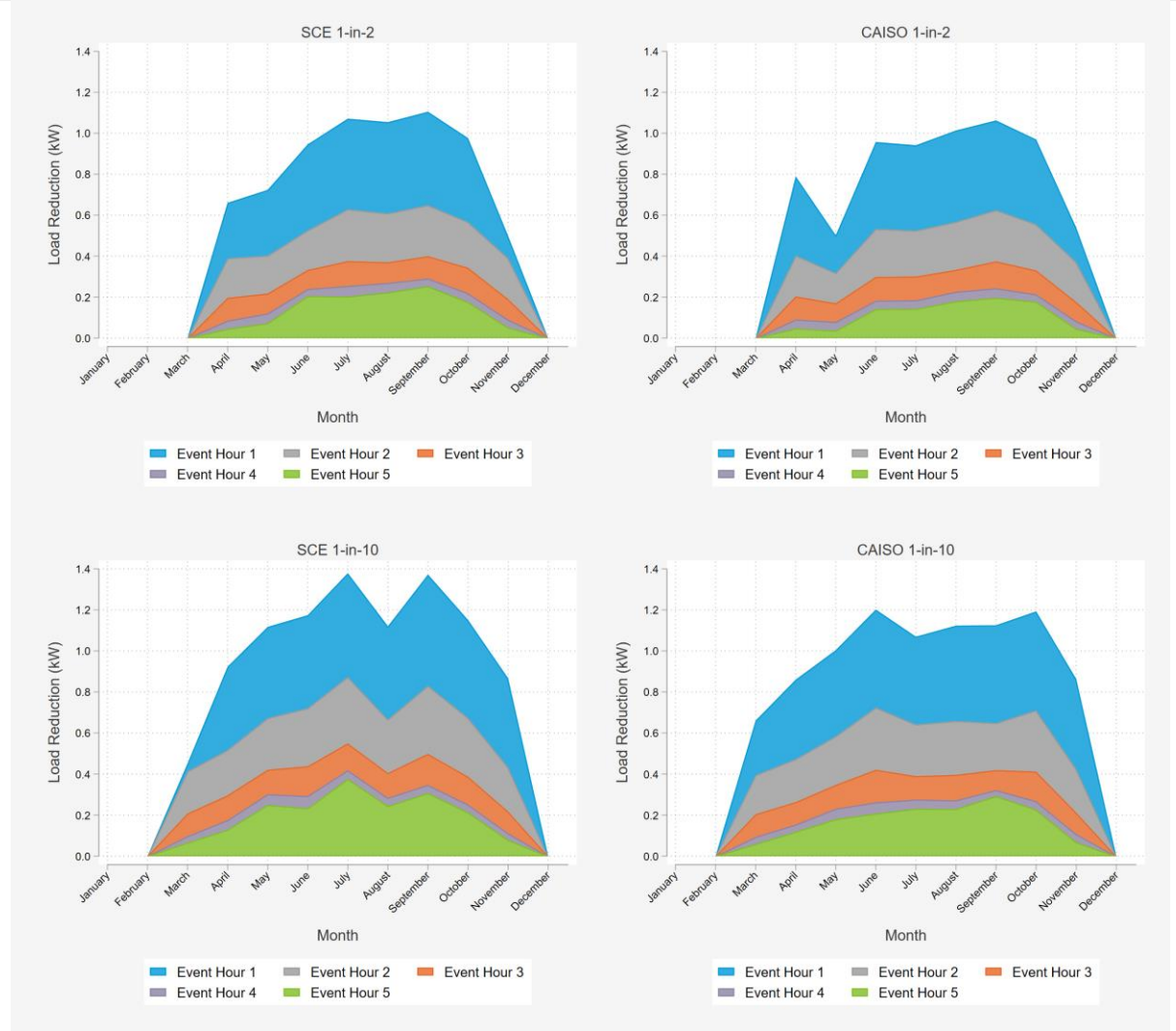
EX ANTE IMPACTS

Aggregate Impacts – Typical Event Day
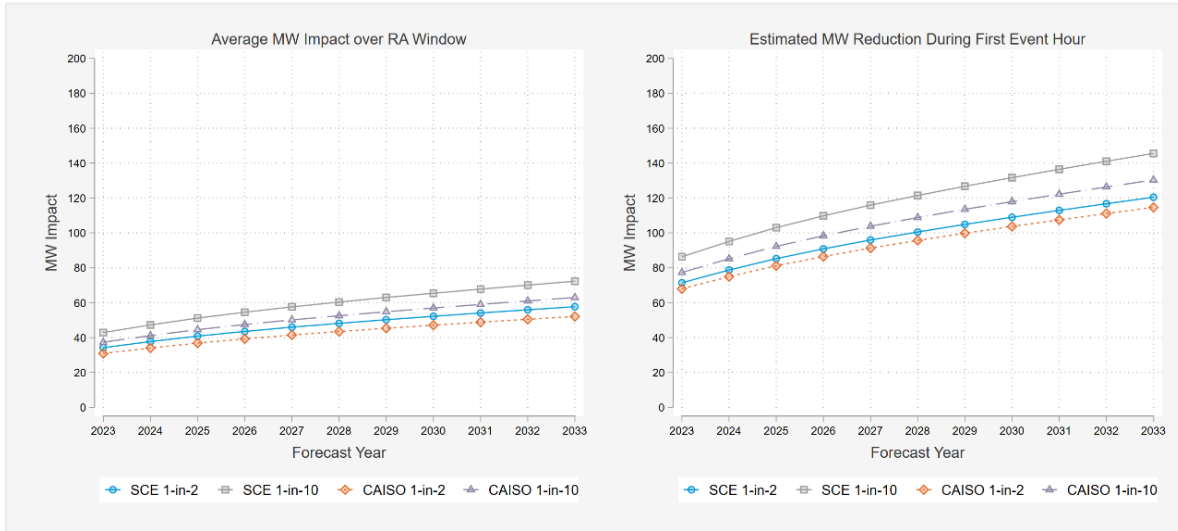
By 2033 SEP is expected to be a ~ 120 MW resource during the first hour of dispatch. ~ 50 MW average over RA window

Event impacts peak in warmer months but decline with each event hour in all months

Per Customer Impacts by Month

TAKEAWAYS

- The most important predictor of SEP load impact is not time of day or weather, but the position of an hour within an event.

  ➢ Impacts are largest during the first event hour and decline sharply in each subsequent hour.

  ➢ Shorter events show larger average load impacts than longer events.

- In PY2022, default Emergency Load Reduction Program (ELRP) enrollment meant that all high usage and low-income customers not currently enrolled in a demand response program were defaulted onto ELRP. This meant there were no high usage or low-income SCE customers not enrolled in some form of demand response from which to select a matched control group. We chose to make default ELRP customers eligible for matching after discussions with the SCE SEP team as ELRP enrollment represented the appropriate counterfactual for any participating customers in those groups.

  ➢ Their PY2022 SEP impacts could be considered incremental on top of the impacts that would have come from the ELRP program had they not been enrolled in SEP.

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TAKEAWAYS

- Between PY2021 and PY2022 there was strong enrollment growth. Since enrollment is a major factor in projected aggregate event impacts, strong enrollment numbers are vital for program health.

  ➢ The addition of CCA enrollment for PY2023 should mean another strong year of offseason enrollment.

- The rollout of default TOU in SCE territory happened prior to PY2022. This altered SEP participant reference loads and potentially lowered the average load impact of SEP dispatch.

  ➢ This change means that ex-ante impacts, especially in later event hours, were lower than previous years.

  ➢ Ecobee thermostats have TOU optimization settings that allow for changes in energy usage without much input from the participant

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QUESTIONS?

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