SOUTHERN CALIFORNIA EDISON
SMART ENERGY PROGRAM: 2019 LOAD IMPACT EVALUATION

MAY 4, 2020

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DATA DRIVEN RESEARCH AND INSIGHTS

PROGRAM OVERVIEW

- Residential demand response (DR) program that utilizes Wi-Fi connected smart thermostats to reduce AC load
  - Can be called anytime during the year between 11am and 9pm for up to 4 hours per day
- Participants are provided a monthly bill credit in exchange for allowing their smart thermostat provider to temporarily adjust their temperature setpoint
  - Thermostat providers adjust cooling setpoints upward by as much as four degrees (F) to limit AC usage and reduce electric demand
- Participants are required to receive bundled service from SCE
  - In spring 2019 a significant number of accounts were released from SEP due to migration to Community Choice Aggregators (CCAs)
- Integrated into the CAISO wholesale energy market in April 2019 and offered as a dispatchable resource based on energy prices

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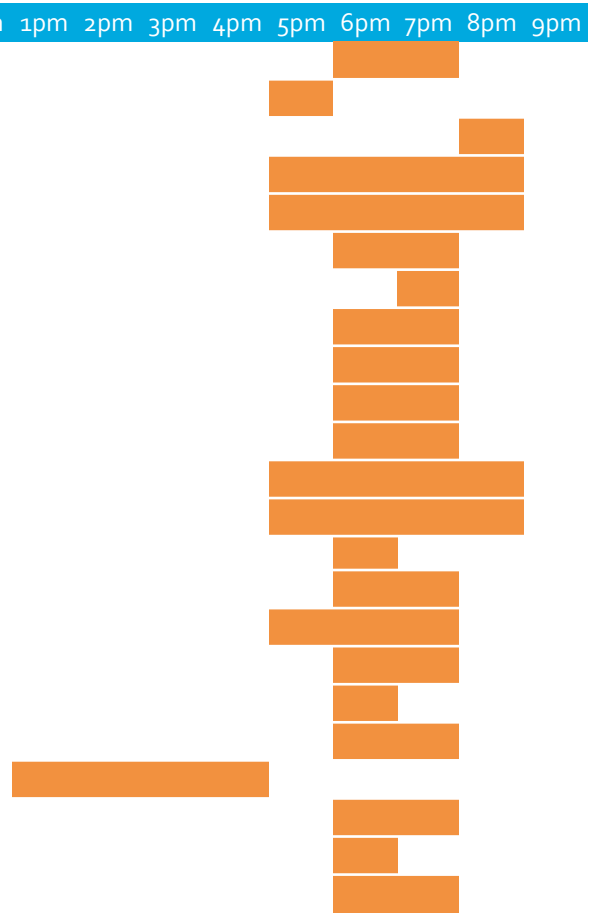
2019 EVENTS AND SEGMENTATION

Event Date	Dispatch Region	Participants
7/24/2019	Territory Wide	51,009
8/13/2019	Territory Wide	51,946
8/13/2019	Territory Wide	51,946
8/14/2019	Territory Wide	51,932
8/15/2019	Territory Wide	52,024
8/21/2019	SCEW	22,447
8/21/2019	SCEC, SCEN, SCHD, SCLD, SCNW	29,729
8/26/2019	SCEC, SCEW, SCHD, SCLD, SCNW	47,018
8/27/2019	Territory Wide	52,259
8/28/2019	Territory Wide	52,240
9/3/2019	Territory Wide	52,441
9/4/2019	Territory Wide	52,432
9/5/2019	Territory Wide	52,562
9/12/2019	SCNW	975
9/13/2019	Territory Wide	52,664
9/24/2019	SCEC, SCHD, SCLD, SCEW	46,910
9/24/2019	SCEN, SCNW	6,086
9/25/2019	SCEN, SCEW, SCNW	28,970
9/25/2019	SCEC, SCHD, SCLD	23,996
10/16/2019	Territory Wide	52,927
10/21/2019	SCEN	5,236
10/21/2019	SCNW	990
10/22/2019	SCEN	5,248



Segmentation Variable	Segment Description	Participants (N)	Participants (%)
Tariff Type	Dynamic	10,514	19.8%
	Flat	42,534	80.2%
Size	Greater than 1.82 kW during RA window	26,524	50.0%
	Less than 1.82 kW during RA window	26,524	50.0%
Net Energy Metering Status	Not NEM	43,892	82.7%
	NEM	9,156	17.3%
Income Qualified	Non-Care/FERA	46,412	87.5%
	CARE/FERA	6,636	12.5%
LCA	Big Creek/Ventura	6,329	11.9%
	LA Basin	45,472	85.7%
	Outside LA Basin	1,247	2.4%
Region	Remainder of System	23,287	43.9%
	South Orange County	10,602	20.0%
	South of Lugo	19,159	36.1%
Sub-LAP	SCEC	22,615	42.6%
	SCEN	5,265	9.9%
	SCEW	22,855	43.1%
	SCHD	1,279	2.4%
	SCLD	46	0.1%
	SCNW	988	1.9%
All Customers		**53,048**	**100.0%**

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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 CDD bin 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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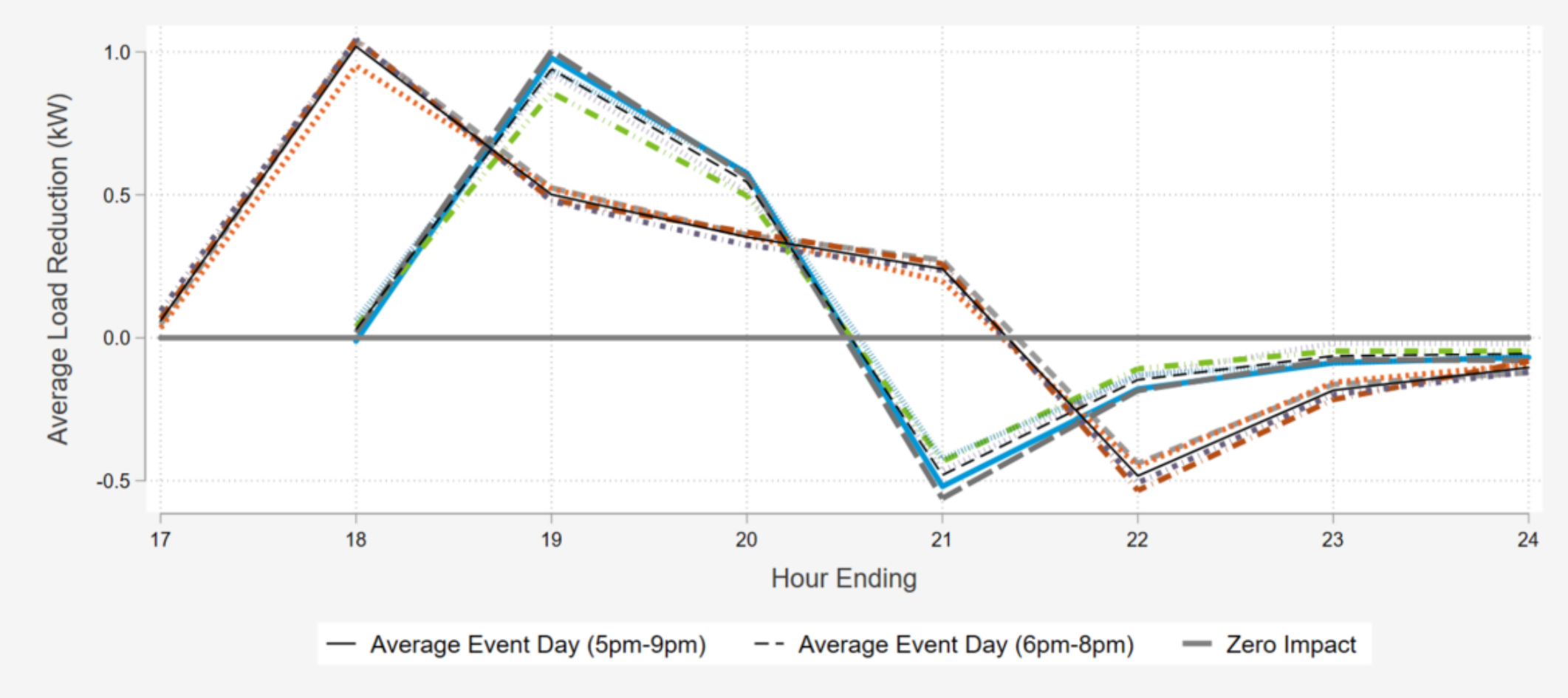
EX POST RESULTS – TERRITORY WIDE EVENTS

- On 8/21, 9/24, and 9/25, all participants experienced a DR event, but the sub-LAPs were dispatched at different times
- On 8/26, 9/12, 10/21, and 10/22, only a subset of sub-LAPs were called

Event Date	Start Time	End Time	Participants	Average Event Temp	Daily Max Temp	Per Home kW Reduction				Average Hourly Impact (kW Reduction)	Average Aggregate Hourly Impact (MW Reduction)
						Hour 1	Hour 2	Hour 3	Hour 4		
7/24/2019	6:00 PM	8:00 PM	51,009	84.8	96.5	0.98	0.57			**0.78**	39.6
8/13/2019	5:00 PM	6:00 PM	51,946	81.9	90.0	1.03	0.63			**0.83**	43.0
	8:00 PM	9:00 PM									
8/14/2019	5:00 PM	9:00 PM	51,932	85.1	92.7	1.04	0.52	0.36	0.27	**0.55**	28.5
8/15/2019	5:00 PM	9:00 PM	52,024	83.3	91.9	0.95	0.52	0.36	0.20	**0.51**	26.4
8/27/2019	6:00 PM	8:00 PM	52,259	81.4	89.9	0.92	0.51			**0.72**	37.4
8/28/2019	6:00 PM	8:00 PM	52,240	80.4	86.3	0.86	0.50			**0.68**	35.4
9/3/2019	6:00 PM	8:00 PM	52,441	86.2	93.9	1.00	0.56			**0.78**	41.1
9/4/2019	5:00 PM	9:00 PM	52,432	86.1	96.9	1.04	0.48	0.37	0.26	**0.54**	28.2
9/5/2019	5:00 PM	9:00 PM	52,562	85.2	93.0	1.04	0.48	0.32	0.24	**0.52**	27.4
9/13/2019	6:00 PM	8:00 PM	52,664	85.9	94.1	0.94	0.58			**0.76**	39.9
10/16/2019	1:00 PM	5:00 PM	52,927	84.7	86.8	0.06	0.08	0.08	0.07	**0.07**	3.9
Average Event Day (6pm-8pm)	6:00 PM	8:00 PM	52,129	83.8	92.0	0.94	0.54			**0.74**	38.7
Average Event Day (5pm-9pm)	5:00 PM	9:00 PM	52,239	84.9	93.4	1.02	0.50	0.35	0.24	**0.53**	27.6

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



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COMPARISON TO PRIOR YEARS

Measure	2017	2018	2019 (5-9PM)	2019 (6-8PM)
Avg. Reference Load (kW)	2.31	1.50	2.50	2.48
Avg. Load Impact (kW)	0.64	0.42	0.53	0.74
% Load Impact	27.8%	27.9%	21.1%	30.0%
Avg. Event Temperature	89.8	75.7	84.9	83.8
Event Hours	2-6PM	2-6PM	5-9PM	6-8PM
Participants	34,120	51,089	52,239	52,129

- Only 1 really hot event day in 2018
- Reference loads are larger in 2019 due to later event window
- Steeper decay in event hours 2, 3, and 4 in 2019, possibly due to opt-outs

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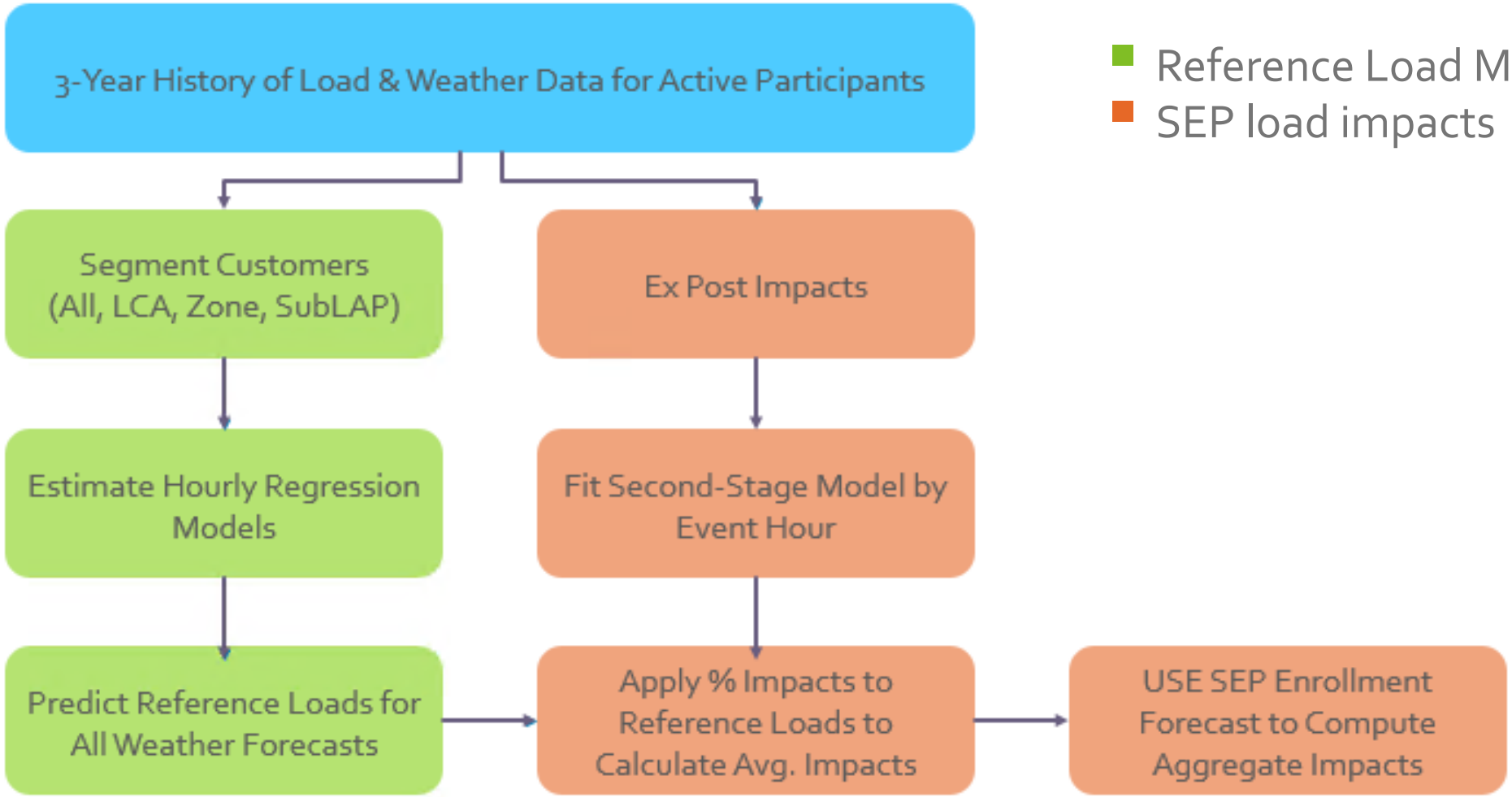
SEP EX ANTE METHODOLOGY



- Reference Load Modeling
- SEP load impacts

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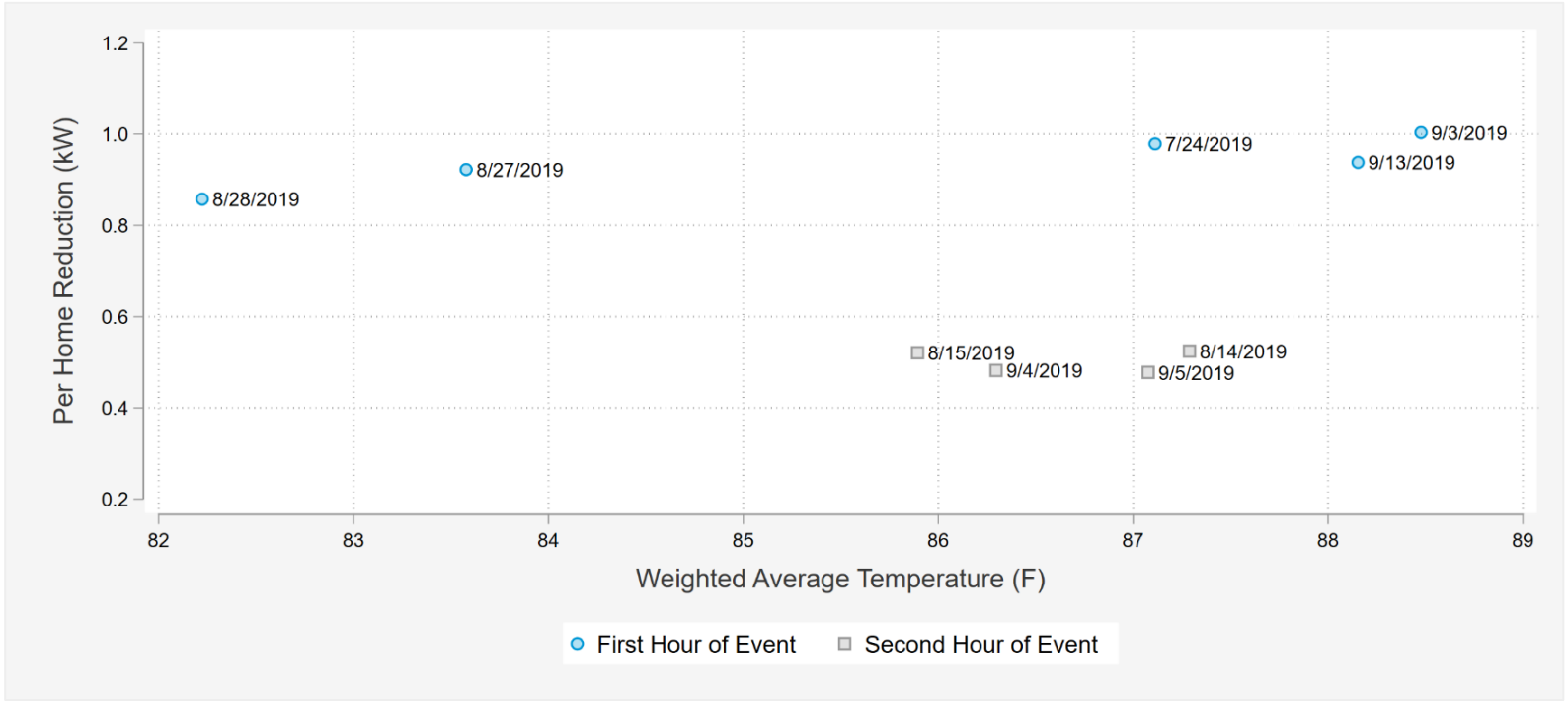
SECOND STAGE MODELING OF IMPACTS



- Hour of dispatch is far more important than time of day or weather
- The figure to the left compares ex post impacts during hour ending 19:00
- Impacts when hour 19 is the first hour of dispatch are almost double the impacts when hour 19 is the second event hour

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A LIMITED AMOUNT OF TRANSLATION IS NEEDED FROM EX POST TO EX ANTE

- SCE 1-in-2 weather for an August system peak day is slightly warmer than the PY2019 territory wide events, on average
- If we assume a 4pm-9pm event for ex ante, hour ending 17 becomes "Hour 1" and we construct an "Hour 5" using the percent impacts from hour 4

Date	Average Daily Temp (F)	CDD60	Max Daily Temp (F)	Hour 1 Impact (kW)	Hour 2 Impact (kW)	Hour 3 Impact (kW)	Hour 4 Impact (kW)	Four Hour Average
7/24/2019	83.6	23.6	96.5	-0.98	-0.57			
8/13/2019	76.6	16.6	90.0	-1.03				
8/14/2019	78.3	18.3	92.7	-1.04	-0.52	-0.36	-0.27	-0.55
8/15/2019	77.6	17.6	91.9	-0.95	-0.52	-0.36	-0.20	-0.51
8/27/2019	79.2	19.2	89.9	-0.92	-0.51			
8/28/2019	77.0	17.0	86.3	-0.86	-0.50			
9/3/2019	83.1	23.1	93.9	-1.00	-0.56			
9/4/2019	83.9	23.9	96.9	-1.04	-0.48	-0.37	-0.26	-0.54
9/5/2019	83.2	23.2	93.0	-1.04	-0.48	-0.32	-0.24	-0.52
9/13/2019	80.2	20.2	94.1	-0.94	-0.58			
Ex Post Average (no 10/16)	**80.3**	**20.3**	**92.5**	**-0.98**	**-0.53**	**-0.35**	**-0.24**	**-0.52**
SCE 1-in-2 August Peak Day	**82.9**	**22.9**	**93.7**	**-1.04**	**-0.61**	**-0.42**	**-0.30**	**-0.59**

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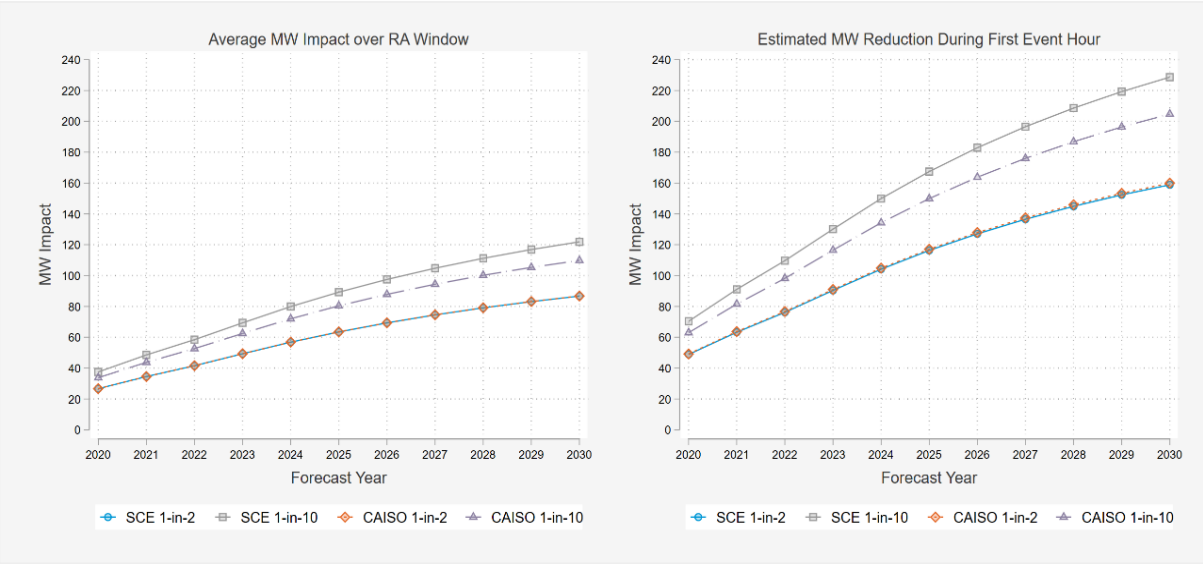
EX ANTE IMPACTS

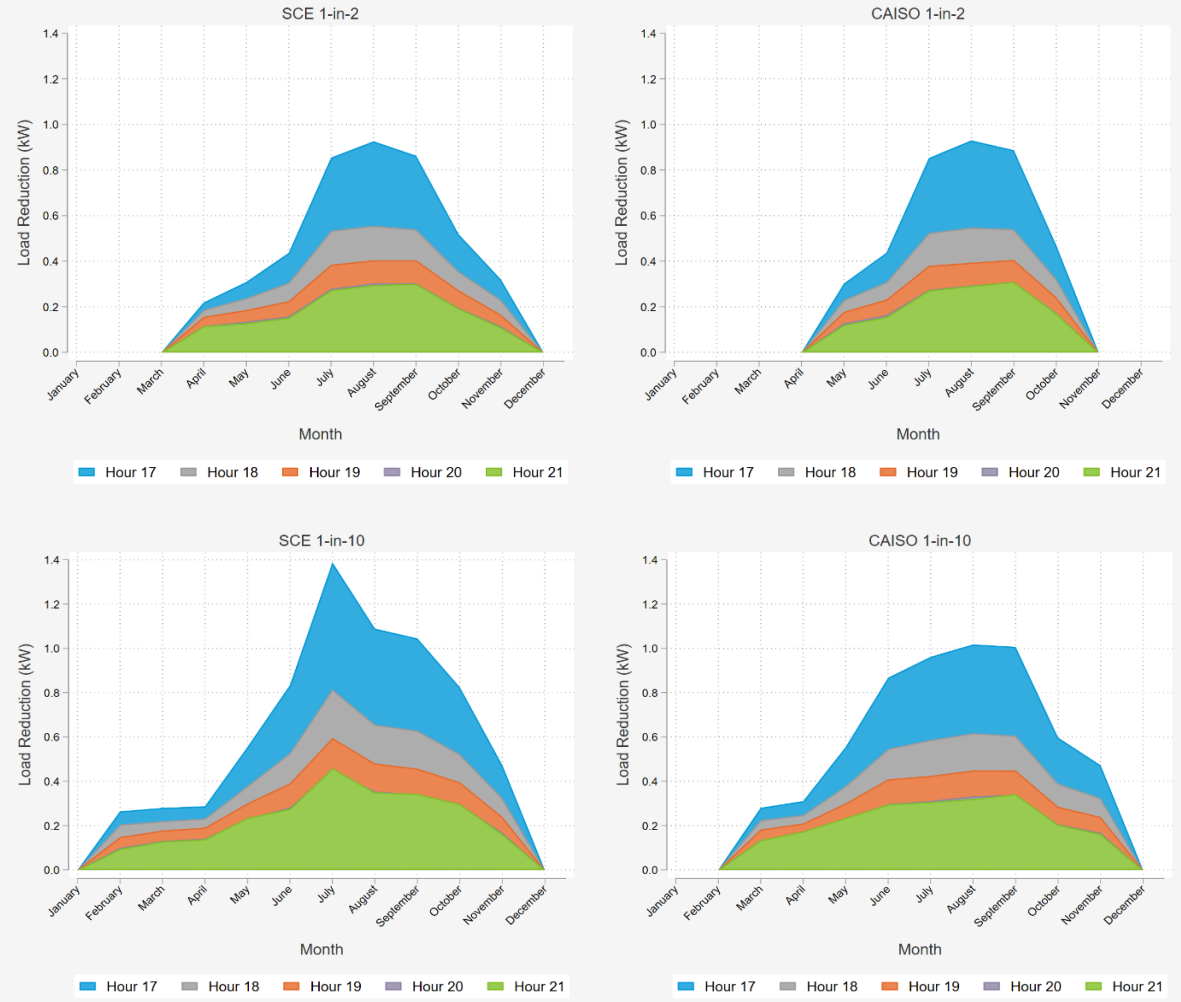
Aggregate Impacts – Typical Event Day



By 2030 SEP is expected to be a ~ 200 MW resource during the first hour of dispatch. ~ 100 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



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COMPARISON TO PRIOR YEAR: AUGUST SYSTEM PEAK SCE 1-IN-2

Hour Ending	2018 (kW)	2019 (kW)	2018 (%)	2019 (%)	2018 (Temp)	2019 (Temp)
17	1.11	0.93	48.1%	39.8%	93.8	93.1
18	0.79	0.56	31.1%	21.4%	92.6	91.6
19	0.58	0.40	21.6%	14.2%	90.5	90.1
20	0.42	0.30	16.3%	10.3%	87.9	88.5
21	0.41	0.30	16.3%	10.3%	83.7	85.1
RA Window Average	**0.66**	**0.50**	**26.7%**	**19.2%**	**89.7**	**89.7**

- Despite similar weather, 2019 impacts are much lower on an absolute and percent basis
- Numerous 2019 events on hot days during the new RA window. 2017 and 2018 events were 2pm-6pm, but impacts had to be mapped to the new RA window definition.
- AC load is a smaller share of premise load in the evening than in the afternoon
- Steeper decay across event hours in 2019. More opt-outs during evening events because of occupancy?

Conclusions

- The most important predictor of SEP load impact is position of *hour* within an event
- The PY2019 analysis showed a more rapid decline in impacts across event hours than the PY2018 analysis.
  - May be weather related as outdoor temperatures are declining during the evening hours when PY2019 events were dispatched.
  - May be related to more frequent customer opt-outs due to increased occupancy during evening hours (new event window).

Recommendations

- If a more consistent load impact across dispatch hours is desired, there are several tactics used by other program administrators to mitigate the decay of impacts across the event.
  - Pre-cooling
  - Cascading offsets
  - Stagger entry/exit across devices
- SCE is deploying default TOU pricing for residential customers beginning in October 2020
  - Keep this in mind for changes in reference loads and average load impacts in PY 2020

QUESTIONS?

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