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Ameren Missouri Program Year 2021 Annual EM&V Report

Volume 4: Demand Response Portfolio Appendices

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Appendix A. Residential Demand Response Program Appendix

Detailed Event Season Demand Impact Methodology

Runtime Data Cleaning – Event Impacts and Resource Capability Impacts

Table 1 summarizes drops, by device manufacturer and event day, made to the analytic data set as part of the data preparation and cleaning process.

Table 1. Residential DR Program: Event Day Modeling Data Cleaning Steps

Drop Reason	Number of Devices Remaining		
	Ecobee	Emerson	Nest
Event 1			
Initial number of devices	8,506	7,783	19,773
Drop invalid cooling minutes (-999 values or > 60 minutes)	7,048	6,838	18,976
Drop duplicates	7,048	6,837	18,976
Drop devices assigned to control	5,987	5,713	18,976
Drop devices assigned as learning	5,987	5,713	16,496
Total	5,987	5,713	16,496
Event 2			
Initial number of devices	8,509	7,829	19,873
Drop invalid cooling minutes (-999 values or > 60 minutes)	7,049	6,870	19,080
Drop duplicates	7,049	6,870	19,080
Drop devices assigned to control	6,000	5,763	19,080
Drop devices assigned as learning	6,000	5,763	16,606
Total	6,000	5,763	16,606
Event 3			
Initial number of devices	8,509	7,885	19,978
Drop invalid cooling minutes (-999 values or > 60 minutes)	7,207	6,844	19,119
Drop duplicates	7,207	6,843	19,119
Drop devices assigned to control	7,200	6,700	19,119
Drop devices assigned as learning	7,200	6,700	16,394
Total	7,200	6,700	16,394
Event 4			
Initial number of devices	8,829	8,156	20,590
Drop invalid cooling minutes (-999 values or > 60 minutes)	7,284	6,728	19,336
Drop duplicates	7,284	6,728	19,336
Drop devices assigned to control	6,118	5,580	19,336
Drop devices assigned as learning	6,118	5,580	16,800
Total	6,118	5,580	16,800

Drop Reason	Number of Devices Remaining		
	Ecobee	Emerson	Nest
Event 5			
Initial number of devices	9,361	8,999	22,145
Drop invalid cooling minutes (-999 values or > 60 minutes)	7,827	6,831	20,498
Drop duplicates	7,827	6,831	20,498
Drop devices assigned to control	6,675	5,748	20,498
Drop devices assigned as learning	6,675	5,748	17,891
Total	6,675	5,748	17,891

Runtime Data Cleaning – Emerson Non-Event Energy Optimization Impacts

Table 2 summarizes drops made to the analytic data set as part of the data preparation and cleaning process for the purposes of non-event energy savings estimation from Emerson devices. Data cleaning was performed on data only inclusive of the days during which optimization was running during the PY2021 event season.

Table 2. Residential DR Program: Non-Event Day Emerson Energy Optimization Modeling Data Cleaning Steps

Drop Reason	Number of Devices Remaining
Initial number of devices	9,342
Drop event days	9,342
Drop invalid cooling minutes (-999 values or > 60 minutes)	8,131
Drop duplicates	8,131
Drop devices not matching with treatment and control assignment file	7,767
Drop devices not assigned in treatment or control group	7,719
Drop devices without both treatment and control days	7,354
Total	7,354

Event Season Demand Model Specification and Outputs

Equation shows the model specification used to develop event day demand impacts.

Equation 1. Residential DR Program: Event Day Impact and Resource Capability Model Specification

$$kW_{it} = \alpha_0 + \alpha_i + \beta_{Event} \cdot Event + \sum_{H=1}^{23} \beta_{Hour_H} \cdot Hour_H + \sum_{H=1}^{23} \beta_{Event Hour_H} \cdot Event \cdot Hour_H + \varepsilon_{it}$$

Where:

α_0 = Overall intercept

α_i = Device-specific intercept

Event = Indicator variable for event day

Hour = Set of 23 indicator variables of hours of the day (or reference hour for Resource Capability modeling)

Event by Hour = The interaction of event day vs hour of the day

ϵ_{it} = Error term

Tables below provide impact values for each event and event day hour by device manufacturer.

Table 3. Residential DR Program: Average Hour Ex Post DR kW Impacts by Event, Event Hour (Nest)

Event	Hour Beginning	Baseline Load (kW)	Event Day Load (kW)	Load Impact (kW)	% Load Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
1	0	1.00	0.99	0.01	1.20%	0.00	0.01	0.01
	1	0.87	0.81	0.06	7.23%	0.03	0.01	0.11
	2	0.74	0.66	0.08	10.29%	0.03	0.03	0.13
	3	0.64	0.58	0.07	10.41%	0.03	0.02	0.12
	4	0.60	0.49	0.10	17.33%	0.03	0.05	0.15
	5	0.53	0.43	0.10	18.82%	0.03	0.05	0.15
	6	0.49	0.40	0.09	17.97%	0.03	0.04	0.14
	7	0.53	0.51	0.02	3.54%	0.03	-0.03	0.07
	8	0.60	0.61	-0.01	-0.96%	0.03	-0.06	0.04
	9	0.70	0.77	-0.07	-9.94%	0.03	-0.12	-0.02
	10	0.86	0.97	-0.10	-11.90%	0.03	-0.15	-0.05
	11	1.09	1.16	-0.07	-6.43%	0.03	-0.12	-0.02
	12	1.30	1.36	-0.06	-4.56%	0.03	-0.11	-0.01
	13	1.45	2.40	-0.95	-65.46%	0.03	-1.00	-0.90
	14	1.60	2.30	-0.70	-43.48%	0.03	-0.75	-0.65
	15	1.73	0.48	1.25	72.47%	0.03	1.20	1.30
	16	1.82	0.94	0.87	48.05%	0.03	0.82	0.92
	17	1.88	1.35	0.54	28.42%	0.03	0.49	0.58
	18	1.86	2.27	-0.41	-21.93%	0.03	-0.46	-0.36
	19	1.74	2.04	-0.30	-16.94%	0.03	-0.34	-0.25
	20	1.76	1.89	-0.14	-7.79%	0.03	-0.19	-0.09
	21	1.69	1.80	-0.10	-6.09%	0.03	-0.15	-0.05
	22	1.55	1.66	-0.10	-6.74%	0.03	-0.15	-0.06
23	1.44	1.44	0.00	-0.07%	0.03	-0.05	0.05	
2	0	0.90	0.78	0.12	12.82%	0.00	0.12	0.12
	1	0.78	0.59	0.19	24.20%	0.04	0.13	0.25
	2	0.68	0.47	0.21	30.78%	0.04	0.15	0.27
	3	0.61	0.38	0.23	37.46%	0.04	0.17	0.29
	4	0.53	0.32	0.21	40.24%	0.04	0.16	0.27

Event	Hour Beginning	Baseline Load (kW)	Event Day Load (kW)	Load Impact (kW)	% Load Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)	
	5	0.48	0.28	0.20	42.02%	0.04	0.14	0.26	
	6	0.45	0.27	0.18	39.72%	0.04	0.12	0.24	
	7	0.47	0.34	0.13	27.41%	0.04	0.07	0.19	
	8	0.52	0.41	0.11	20.95%	0.04	0.05	0.17	
	9	0.60	0.52	0.07	12.40%	0.04	0.02	0.13	
	10	0.77	0.68	0.09	11.47%	0.04	0.03	0.15	
	11	0.97	0.89	0.07	7.68%	0.04	0.02	0.13	
	12	1.18	2.20	-1.02	-86.24%	0.04	-1.08	-0.96	
	13	1.32	2.08	-0.76	-57.49%	0.04	-0.82	-0.70	
	14	1.48	0.27	1.21	81.57%	0.04	1.15	1.27	
	15	1.65	0.61	1.05	63.38%	0.04	0.99	1.11	
	16	1.76	1.07	0.69	39.47%	0.04	0.64	0.75	
	17	1.84	2.32	-0.48	-25.78%	0.04	-0.53	-0.42	
	18	1.80	1.63	0.18	9.72%	0.03	0.12	0.23	
	19	1.70	1.98	-0.28	-16.31%	0.03	-0.33	-0.22	
	20	1.65	1.85	-0.20	-12.38%	0.03	-0.26	-0.15	
	21	1.62	1.74	-0.12	-7.33%	0.03	-0.18	-0.06	
	22	1.48	1.53	-0.05	-3.48%	0.03	-0.11	0.01	
	23	1.35	1.25	0.09	7.02%	0.03	0.04	0.15	
	3	0	0.99	1.40	-0.41	-41.70%	0.00	-0.41	-0.41
		1	0.86	1.24	-0.38	-44.87%	0.04	-0.45	-0.32
		2	0.75	1.12	-0.37	-48.75%	0.04	-0.43	-0.31
		3	0.63	1.02	-0.38	-60.82%	0.04	-0.45	-0.32
4		0.62	0.92	-0.30	-47.89%	0.04	-0.36	-0.24	
5		0.55	0.82	-0.28	-50.36%	0.04	-0.34	-0.21	
6		0.51	0.74	-0.23	-45.31%	0.04	-0.29	-0.17	
7		0.53	0.77	-0.24	-45.45%	0.04	-0.30	-0.18	
8		0.63	0.83	-0.20	-31.04%	0.04	-0.26	-0.13	
9		0.71	1.00	-0.29	-40.80%	0.04	-0.35	-0.23	
10		0.90	1.19	-0.29	-32.68%	0.04	-0.35	-0.23	
11		1.13	1.39	-0.27	-23.91%	0.04	-0.33	-0.21	
12		1.34	1.56	-0.22	-16.30%	0.04	-0.28	-0.16	
13		1.50	1.72	-0.23	-15.15%	0.04	-0.29	-0.17	
14		1.64	2.53	-0.89	-54.66%	0.04	-0.96	-0.83	
15		1.79	2.47	-0.68	-38.09%	0.04	-0.74	-0.62	
16		1.88	0.78	1.10	58.54%	0.04	1.04	1.16	
17		1.97	2.25	-0.28	-14.16%	0.04	-0.34	-0.22	
18		1.95	2.19	-0.24	-12.28%	0.04	-0.30	-0.18	
19		1.81	2.07	-0.26	-14.51%	0.04	-0.32	-0.20	

Event	Hour Beginning	Baseline Load (kW)	Event Day Load (kW)	Load Impact (kW)	% Load Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
	20	1.82	2.04	-0.21	-11.78%	0.04	-0.27	-0.15
	21	1.77	2.01	-0.24	-13.78%	0.04	-0.30	-0.18
	22	1.61	1.92	-0.31	-19.30%	0.04	-0.37	-0.25
	23	1.50	1.76	-0.27	-18.02%	0.04	-0.33	-0.21
4	0	0.80	0.65	0.15	19.10%	0.00	0.15	0.15
	1	0.67	0.49	0.17	26.05%	0.02	0.14	0.21
	2	0.58	0.40	0.18	31.48%	0.02	0.15	0.22
	3	0.52	0.32	0.20	37.69%	0.02	0.16	0.23
	4	0.46	0.27	0.19	41.56%	0.02	0.16	0.23
	5	0.41	0.24	0.17	41.18%	0.02	0.14	0.20
	6	0.39	0.22	0.17	43.15%	0.02	0.13	0.20
	7	0.41	0.27	0.14	35.10%	0.02	0.11	0.18
	8	0.46	0.32	0.14	29.74%	0.02	0.10	0.17
	9	0.55	0.39	0.16	29.08%	0.02	0.13	0.19
	10	0.70	0.52	0.17	24.83%	0.02	0.14	0.21
	11	0.87	0.71	0.16	17.99%	0.02	0.12	0.19
	12	1.04	0.94	0.10	9.83%	0.02	0.07	0.14
	13	1.19	1.15	0.04	3.08%	0.02	0.00	0.07
	14	1.35	2.26	-0.91	-67.34%	0.02	-0.94	-0.87
	15	1.49	2.17	-0.68	-45.54%	0.02	-0.71	-0.64
	16	1.58	0.38	1.20	76.15%	0.02	1.17	1.24
	17	1.65	0.76	0.88	53.67%	0.02	0.85	0.92
	18	1.61	1.92	-0.31	-19.36%	0.02	-0.35	-0.28
	19	1.50	1.88	-0.39	-25.85%	0.02	-0.42	-0.35
	20	1.46	1.77	-0.31	-21.56%	0.02	-0.35	-0.28
	21	1.44	1.72	-0.28	-19.74%	0.02	-0.32	-0.25
	22	1.31	1.57	-0.26	-19.84%	0.02	-0.29	-0.23
	23	1.19	1.34	-0.15	-12.50%	0.02	-0.18	-0.12
5	0	0.99	1.41	-0.42	-41.96%	0.00	-0.42	-0.42
	1	0.85	1.23	-0.38	-44.05%	0.03	-0.43	-0.32
	2	0.74	1.08	-0.34	-45.58%	0.03	-0.39	-0.28
	3	0.62	0.97	-0.34	-55.10%	0.03	-0.40	-0.29
	4	0.60	0.86	-0.26	-43.80%	0.03	-0.32	-0.21
	5	0.53	0.77	-0.24	-44.91%	0.03	-0.29	-0.19
	6	0.51	0.70	-0.19	-36.78%	0.03	-0.24	-0.13
	7	0.54	0.69	-0.15	-27.51%	0.03	-0.20	-0.09
	8	0.62	0.68	-0.06	-9.53%	0.03	-0.11	0.00
	9	0.71	0.80	-0.09	-12.53%	0.03	-0.14	-0.03
	10	0.89	0.99	-0.10	-11.28%	0.03	-0.15	-0.05

Event	Hour Beginning	Baseline Load (kW)	Event Day Load (kW)	Load Impact (kW)	% Load Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
	11	1.10	1.22	-0.12	-10.60%	0.03	-0.17	-0.06
	12	1.34	1.47	-0.13	-9.81%	0.03	-0.19	-0.08
	13	1.53	2.44	-0.90	-58.66%	0.03	-0.95	-0.85
	14	1.66	2.38	-0.72	-43.18%	0.03	-0.77	-0.66
	15	1.82	0.62	1.20	65.85%	0.03	1.14	1.25
	16	1.91	1.19	0.72	37.77%	0.03	0.67	0.78
	17	2.00	2.45	-0.45	-22.38%	0.03	-0.50	-0.39
	18	1.97	2.35	-0.38	-19.01%	0.03	-0.43	-0.32
	19	1.83	2.22	-0.38	-20.77%	0.03	-0.43	-0.33
	20	1.85	2.18	-0.32	-17.50%	0.03	-0.38	-0.27
	21	1.79	2.12	-0.33	-18.40%	0.03	-0.38	-0.28
	22	1.65	1.96	-0.31	-18.92%	0.03	-0.37	-0.26
	23	1.51	1.76	-0.25	-16.30%	0.03	-0.30	-0.19

Table 4. Residential DR Program: Average Hour Ex Post DR kW Impacts by Event, Event Hour (ecobee)

Event	Hour Beginning	Baseline Load (kW)	Event Day Load (kW)	Load Impact (kW)	% Load Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
1	0	0.85	0.89	-0.04	-5.05%	0.00	-0.04	-0.04
	1	0.71	0.75	-0.04	-6.18%	0.01	-0.06	-0.03
	2	0.60	0.64	-0.04	-7.52%	0.01	-0.06	-0.03
	3	0.53	0.54	-0.02	-3.49%	0.01	-0.03	0.00
	4	0.49	0.49	0.00	-0.71%	0.01	-0.02	0.01
	5	0.45	0.45	0.00	-0.40%	0.01	-0.02	0.01
	6	0.43	0.42	0.00	0.60%	0.01	-0.01	0.02
	7	0.43	0.46	-0.02	-5.44%	0.01	-0.04	-0.01
	8	0.49	0.58	-0.09	-18.57%	0.01	-0.11	-0.07
	9	0.61	0.74	-0.14	-22.78%	0.01	-0.15	-0.12
	10	0.79	0.91	-0.13	-16.18%	0.01	-0.14	-0.11
	11	0.98	1.11	-0.12	-12.69%	0.01	-0.14	-0.11
	12	1.18	1.29	-0.11	-9.37%	0.01	-0.13	-0.09
	13	1.36	1.44	-0.08	-5.90%	0.01	-0.10	-0.06
	14	1.52	2.01	-0.49	-32.28%	0.01	-0.51	-0.47
	15	1.67	0.60	1.06	63.76%	0.01	1.05	1.08
	16	1.78	0.92	0.87	48.64%	0.01	0.85	0.88
	17	1.85	1.30	0.55	29.80%	0.01	0.53	0.57
	18	1.82	2.30	-0.47	-25.97%	0.01	-0.49	-0.46
	19	1.74	2.04	-0.31	-17.55%	0.01	-0.32	-0.29
	20	1.67	1.84	-0.16	-9.81%	0.01	-0.18	-0.15
21	1.61	1.70	-0.09	-5.36%	0.01	-0.10	-0.07	

Event	Hour Beginning	Baseline Load (kW)	Event Day Load (kW)	Load Impact (kW)	% Load Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
	22	1.51	1.54	-0.03	-1.85%	0.01	-0.04	-0.01
	23	1.36	1.35	0.01	0.68%	0.01	-0.01	0.03
2	0	0.79	0.74	0.05	5.86%	0.00	0.05	0.05
	1	0.63	0.58	0.05	8.24%	0.01	0.03	0.07
	2	0.52	0.46	0.06	11.27%	0.01	0.04	0.08
	3	0.43	0.41	0.02	5.62%	0.01	0.01	0.04
	4	0.38	0.36	0.02	4.49%	0.01	0.00	0.04
	5	0.33	0.32	0.01	2.53%	0.01	-0.01	0.03
	6	0.32	0.31	0.00	1.29%	0.01	-0.01	0.02
	7	0.32	0.34	-0.02	-7.21%	0.01	-0.04	0.00
	8	0.36	0.41	-0.05	-14.32%	0.01	-0.07	-0.03
	9	0.47	0.52	-0.05	-10.07%	0.01	-0.07	-0.03
	10	0.62	0.66	-0.03	-5.19%	0.01	-0.05	-0.01
	11	0.82	0.83	-0.01	-1.52%	0.01	-0.03	0.01
	12	1.01	1.03	-0.02	-1.51%	0.01	-0.03	0.00
	13	1.21	1.72	-0.51	-42.06%	0.01	-0.53	-0.49
	14	1.38	0.74	0.64	46.45%	0.01	0.62	0.66
	15	1.55	1.14	0.41	26.22%	0.01	0.39	0.42
	16	1.69	1.46	0.23	13.63%	0.01	0.21	0.25
	17	1.77	2.13	-0.36	-20.31%	0.01	-0.38	-0.34
	18	1.77	1.94	-0.16	-9.19%	0.01	-0.18	-0.14
	19	1.71	1.82	-0.11	-6.50%	0.01	-0.13	-0.09
	20	1.64	1.63	0.00	0.24%	0.01	-0.02	0.02
	21	1.59	1.48	0.11	6.95%	0.01	0.09	0.13
	22	1.48	1.33	0.15	10.10%	0.01	0.13	0.17
23	1.30	1.10	0.19	14.95%	0.01	0.17	0.21	
3	0	0.82	1.32	-0.49	-60.07%	0.00	-0.49	-0.49
	1	0.69	1.16	-0.47	-68.01%	0.01	-0.49	-0.45
	2	0.58	1.05	-0.47	-80.77%	0.01	-0.49	-0.45
	3	0.52	0.95	-0.43	-82.58%	0.01	-0.45	-0.41
	4	0.48	0.86	-0.38	-78.60%	0.01	-0.40	-0.36
	5	0.45	0.77	-0.32	-69.84%	0.01	-0.34	-0.30
	6	0.44	0.70	-0.26	-59.78%	0.01	-0.28	-0.24
	7	0.46	0.68	-0.23	-49.03%	0.01	-0.24	-0.21
	8	0.51	0.79	-0.28	-55.09%	0.01	-0.30	-0.26
	9	0.62	0.93	-0.31	-49.47%	0.01	-0.33	-0.29
	10	0.81	1.13	-0.32	-40.32%	0.01	-0.34	-0.31
	11	1.00	1.32	-0.32	-31.73%	0.01	-0.34	-0.30
	12	1.21	1.47	-0.26	-21.96%	0.01	-0.28	-0.25

Event	Hour Beginning	Baseline Load (kW)	Event Day Load (kW)	Load Impact (kW)	% Load Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
	13	1.40	1.62	-0.22	-15.38%	0.01	-0.23	-0.20
	14	1.57	1.76	-0.19	-12.15%	0.01	-0.21	-0.17
	15	1.72	2.19	-0.47	-27.08%	0.01	-0.48	-0.45
	16	1.85	0.76	1.09	58.97%	0.01	1.07	1.11
	17	1.93	2.32	-0.39	-20.33%	0.01	-0.41	-0.37
	18	1.91	2.25	-0.35	-18.22%	0.01	-0.37	-0.33
	19	1.85	1.50	0.35	18.86%	0.01	0.33	0.37
	20	1.79	1.51	0.28	15.44%	0.01	0.26	0.30
	21	1.72	1.49	0.23	13.26%	0.01	0.21	0.25
	22	1.61	1.42	0.19	11.70%	0.01	0.17	0.21
	23	1.46	1.33	0.13	8.89%	0.01	0.11	0.15
4	0	0.75	0.61	0.14	18.61%	0.00	0.14	0.14
	1	0.60	0.50	0.10	16.84%	0.01	0.09	0.12
	2	0.50	0.42	0.08	15.90%	0.01	0.06	0.09
	3	0.43	0.36	0.07	15.29%	0.01	0.05	0.08
	4	0.38	0.33	0.05	12.91%	0.01	0.03	0.06
	5	0.33	0.30	0.03	8.56%	0.01	0.01	0.04
	6	0.32	0.28	0.04	12.47%	0.01	0.02	0.06
	7	0.33	0.28	0.05	14.84%	0.01	0.03	0.06
	8	0.39	0.33	0.07	16.87%	0.01	0.05	0.08
	9	0.51	0.40	0.11	21.22%	0.01	0.09	0.12
	10	0.66	0.53	0.13	19.83%	0.01	0.12	0.15
	11	0.81	0.68	0.14	16.91%	0.01	0.12	0.15
	12	0.98	0.86	0.12	11.88%	0.01	0.10	0.13
	13	1.14	1.04	0.10	8.48%	0.01	0.08	0.11
	14	1.27	1.18	0.08	6.56%	0.01	0.07	0.10
	15	1.41	1.88	-0.47	-33.64%	0.01	-0.49	-0.46
	16	1.50	0.41	1.10	72.88%	0.01	1.08	1.11
	17	1.58	0.70	0.89	56.06%	0.01	0.87	0.90
	18	1.58	2.19	-0.61	-38.80%	0.01	-0.63	-0.60
	19	1.53	1.97	-0.44	-28.65%	0.01	-0.45	-0.42
	20	1.44	1.71	-0.28	-19.26%	0.01	-0.29	-0.26
	21	1.36	1.58	-0.21	-15.51%	0.01	-0.23	-0.20
	22	1.27	1.41	-0.14	-11.39%	0.01	-0.16	-0.13
	23	1.08	1.23	-0.15	-13.44%	0.01	-0.16	-0.13
5	0	0.81	1.25	-0.44	-54.39%	0.00	-0.44	-0.44
	1	0.68	1.09	-0.42	-61.95%	0.01	-0.44	-0.40
	2	0.57	0.97	-0.40	-70.72%	0.01	-0.42	-0.38
	3	0.51	0.86	-0.35	-68.92%	0.01	-0.37	-0.33

Event	Hour Beginning	Baseline Load (kW)	Event Day Load (kW)	Load Impact (kW)	% Load Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
	4	0.48	0.77	-0.30	-61.62%	0.01	-0.31	-0.28
	5	0.45	0.72	-0.27	-58.48%	0.01	-0.28	-0.25
	6	0.44	0.66	-0.22	-50.85%	0.01	-0.24	-0.20
	7	0.46	0.63	-0.17	-36.00%	0.01	-0.18	-0.15
	8	0.52	0.70	-0.18	-35.17%	0.01	-0.20	-0.16
	9	0.63	0.81	-0.18	-29.02%	0.01	-0.20	-0.16
	10	0.81	1.02	-0.21	-26.09%	0.01	-0.23	-0.19
	11	1.00	1.20	-0.19	-19.45%	0.01	-0.21	-0.18
	12	1.21	1.39	-0.18	-15.01%	0.01	-0.20	-0.16
	13	1.41	1.59	-0.18	-12.89%	0.01	-0.20	-0.16
	14	1.57	2.16	-0.58	-37.05%	0.01	-0.60	-0.56
	15	1.72	0.68	1.04	60.38%	0.01	1.02	1.06
	16	1.84	1.19	0.65	35.47%	0.01	0.64	0.67
	17	1.92	2.49	-0.57	-29.69%	0.01	-0.59	-0.55
	18	1.90	2.36	-0.46	-24.11%	0.01	-0.48	-0.44
	19	1.85	2.18	-0.33	-17.91%	0.01	-0.35	-0.31
	20	1.79	2.05	-0.26	-14.57%	0.01	-0.28	-0.24
	21	1.71	1.94	-0.23	-13.20%	0.01	-0.25	-0.21
	22	1.60	1.81	-0.21	-13.40%	0.01	-0.23	-0.19
	23	1.44	1.63	-0.19	-13.27%	0.01	-0.21	-0.17

Table 5. Residential DR Program: Average Hour Ex Post DR kW Impacts by Event, Event Hour (Emerson)

Event	Hour Beginning	Baseline Load (kW)	Event Day Load (kW)	Load Impact (kW)	% Load Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
1	0	0.99	0.95	0.04	3.75%	0.00	0.04	0.04
	1	0.83	0.80	0.03	3.51%	0.01	0.02	0.04
	2	0.70	0.68	0.02	2.86%	0.01	0.01	0.03
	3	0.59	0.58	0.01	1.09%	0.01	-0.01	0.02
	4	0.48	0.51	-0.03	-6.11%	0.01	-0.04	-0.02
	5	0.44	0.45	-0.01	-1.19%	0.01	-0.02	0.01
	6	0.44	0.49	-0.05	-11.50%	0.01	-0.06	-0.04
	7	0.43	0.56	-0.13	-29.86%	0.01	-0.14	-0.12
	8	0.50	0.67	-0.17	-34.01%	0.01	-0.18	-0.16
	9	0.70	0.88	-0.18	-26.20%	0.01	-0.20	-0.17
	10	0.92	1.11	-0.19	-20.58%	0.01	-0.20	-0.18
	11	1.18	1.45	-0.27	-23.01%	0.01	-0.29	-0.26
	12	1.41	1.66	-0.25	-17.54%	0.01	-0.26	-0.23
	13	1.62	1.82	-0.20	-12.24%	0.01	-0.21	-0.18
	14	1.76	1.91	-0.15	-8.52%	0.01	-0.16	-0.14

Event	Hour Beginning	Baseline Load (kW)	Event Day Load (kW)	Load Impact (kW)	% Load Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
	15	1.91	0.60	1.31	68.37%	0.01	1.29	1.32
	16	2.01	1.01	1.00	49.69%	0.01	0.98	1.01
	17	2.09	1.40	0.70	33.35%	0.01	0.68	0.71
	18	2.06	2.12	-0.06	-2.84%	0.01	-0.07	-0.04
	19	1.91	2.18	-0.27	-13.95%	0.01	-0.28	-0.25
	20	1.77	1.98	-0.21	-11.95%	0.01	-0.23	-0.20
	21	1.66	1.80	-0.14	-8.38%	0.01	-0.15	-0.13
	22	1.52	1.58	-0.06	-3.85%	0.01	-0.07	-0.04
	23	1.33	1.38	-0.05	-3.99%	0.01	-0.07	-0.04
2	0	0.82	0.76	0.06	6.95%	0.00	0.06	0.06
	1	0.65	0.54	0.11	17.54%	0.01	0.10	0.13
	2	0.54	0.40	0.14	26.15%	0.01	0.13	0.16
	3	0.44	0.34	0.10	23.61%	0.01	0.09	0.12
	4	0.38	0.29	0.09	23.80%	0.01	0.08	0.11
	5	0.35	0.28	0.07	20.88%	0.01	0.06	0.09
	6	0.37	0.33	0.04	11.00%	0.01	0.03	0.06
	7	0.38	0.40	-0.03	-7.76%	0.01	-0.05	-0.01
	8	0.42	0.48	-0.06	-14.40%	0.01	-0.08	-0.04
	9	0.56	0.66	-0.11	-19.14%	0.01	-0.12	-0.09
	10	0.76	0.80	-0.04	-4.72%	0.01	-0.05	-0.02
	11	1.00	1.09	-0.09	-8.73%	0.01	-0.10	-0.07
	12	1.23	1.30	-0.06	-5.12%	0.01	-0.08	-0.05
	13	1.46	1.47	-0.01	-0.82%	0.01	-0.03	0.00
	14	1.67	0.31	1.36	81.55%	0.01	1.34	1.38
	15	1.85	0.72	1.12	60.82%	0.01	1.11	1.14
	16	1.99	1.13	0.86	43.09%	0.01	0.84	0.87
	17	2.11	2.12	-0.01	-0.41%	0.01	-0.02	0.01
	18	2.05	2.23	-0.17	-8.50%	0.01	-0.19	-0.16
	19	1.92	2.05	-0.12	-6.47%	0.01	-0.14	-0.11
	20	1.78	1.86	-0.08	-4.43%	0.01	-0.09	-0.06
	21	1.70	1.68	0.02	0.91%	0.01	0.00	0.03
	22	1.52	1.46	0.06	4.01%	0.01	0.05	0.08
	23	1.35	1.22	0.13	9.34%	0.01	0.11	0.14
3	0	0.99	1.26	-0.27	-27.42%	0.00	-0.27	-0.27
	1	0.82	0.98	-0.16	-19.93%	0.01	-0.18	-0.15
	2	0.67	0.91	-0.24	-34.93%	0.01	-0.25	-0.22
	3	0.56	0.85	-0.29	-52.67%	0.01	-0.31	-0.28
	4	0.44	0.77	-0.34	-77.49%	0.01	-0.35	-0.32
	5	0.40	0.75	-0.35	-87.15%	0.01	-0.37	-0.33

Event	Hour Beginning	Baseline Load (kW)	Event Day Load (kW)	Load Impact (kW)	% Load Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
	6	0.39	0.88	-0.50	-128.01%	0.01	-0.51	-0.48
	7	0.38	0.82	-0.43	-112.86%	0.01	-0.45	-0.42
	8	0.45	0.86	-0.41	-91.66%	0.01	-0.43	-0.40
	9	0.66	1.04	-0.38	-57.15%	0.01	-0.39	-0.36
	10	0.87	1.23	-0.35	-40.48%	0.01	-0.37	-0.34
	11	1.15	1.42	-0.27	-23.60%	0.01	-0.29	-0.25
	12	1.39	1.50	-0.11	-7.56%	0.01	-0.12	-0.09
	13	1.63	1.69	-0.06	-3.85%	0.01	-0.08	-0.05
	14	1.77	1.83	-0.06	-3.26%	0.01	-0.07	-0.04
	15	1.93	1.82	0.11	5.92%	0.01	0.10	0.13
	16	2.04	0.53	1.51	74.08%	0.01	1.50	1.53
	17	2.15	2.10	0.04	1.93%	0.01	0.02	0.06
	18	2.13	2.44	-0.31	-14.71%	0.01	-0.33	-0.30
	19	1.97	2.31	-0.34	-17.20%	0.01	-0.36	-0.32
	20	1.83	2.16	-0.33	-18.24%	0.01	-0.35	-0.32
21	1.70	2.03	-0.33	-19.58%	0.01	-0.35	-0.32	
22	1.55	1.88	-0.33	-21.02%	0.01	-0.34	-0.31	
23	1.35	1.73	-0.39	-28.75%	0.01	-0.40	-0.37	
4	0	0.83	0.74	0.09	10.50%	0.00	0.09	0.09
	1	0.65	0.49	0.16	24.47%	0.01	0.15	0.17
	2	0.52	0.41	0.11	20.68%	0.01	0.10	0.12
	3	0.42	0.35	0.07	17.21%	0.01	0.06	0.08
	4	0.33	0.31	0.03	8.20%	0.01	0.02	0.04
	5	0.30	0.29	0.02	5.28%	0.01	0.01	0.03
	6	0.30	0.33	-0.02	-7.31%	0.01	-0.03	-0.01
	7	0.32	0.38	-0.06	-18.84%	0.01	-0.07	-0.05
	8	0.37	0.53	-0.16	-43.01%	0.01	-0.17	-0.15
	9	0.51	0.77	-0.25	-49.52%	0.01	-0.26	-0.24
	10	0.68	1.02	-0.34	-50.58%	0.01	-0.35	-0.33
	11	0.89	1.29	-0.40	-44.39%	0.01	-0.41	-0.38
	12	1.09	1.65	-0.56	-51.70%	0.01	-0.57	-0.55
	13	1.30	1.82	-0.53	-40.60%	0.01	-0.54	-0.52
	14	1.42	1.94	-0.51	-36.03%	0.01	-0.52	-0.50
15	1.60	1.88	-0.27	-16.94%	0.01	-0.28	-0.26	
16	1.73	0.23	1.50	86.83%	0.01	1.49	1.51	
17	1.83	0.64	1.18	64.71%	0.01	1.17	1.19	
18	1.77	1.92	-0.15	-8.70%	0.01	-0.16	-0.14	
19	1.63	1.94	-0.31	-19.23%	0.01	-0.32	-0.30	
20	1.49	1.71	-0.22	-14.76%	0.01	-0.23	-0.21	

Event	Hour Beginning	Baseline Load (kW)	Event Day Load (kW)	Load Impact (kW)	% Load Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
	21	1.37	1.58	-0.21	-15.16%	0.01	-0.22	-0.20
	22	1.24	1.39	-0.16	-12.56%	0.01	-0.17	-0.15
	23	1.05	1.20	-0.16	-14.83%	0.01	-0.17	-0.14
5	0	0.99	1.56	-0.58	-58.74%	0.00	-0.58	-0.58
	1	0.81	1.55	-0.74	-90.67%	0.01	-0.75	-0.72
	2	0.67	1.24	-0.57	-85.17%	0.01	-0.59	-0.55
	3	0.55	1.05	-0.50	-91.90%	0.01	-0.52	-0.49
	4	0.42	0.89	-0.47	-110.29%	0.01	-0.48	-0.45
	5	0.39	0.79	-0.40	-103.81%	0.01	-0.42	-0.39
	6	0.38	0.78	-0.41	-108.80%	0.01	-0.42	-0.39
	7	0.37	0.82	-0.45	-119.75%	0.01	-0.46	-0.43
	8	0.44	1.01	-0.58	-131.51%	0.01	-0.59	-0.56
	9	0.64	1.25	-0.61	-94.44%	0.01	-0.63	-0.59
	10	0.85	1.60	-0.75	-87.41%	0.01	-0.76	-0.73
	11	1.13	1.97	-0.84	-73.72%	0.01	-0.85	-0.82
	12	1.37	2.18	-0.81	-59.17%	0.01	-0.83	-0.80
	13	1.60	2.31	-0.71	-44.21%	0.01	-0.73	-0.69
	14	1.75	2.26	-0.51	-29.42%	0.01	-0.53	-0.50
	15	1.92	0.38	1.53	80.07%	0.01	1.52	1.55
	16	2.03	0.84	1.19	58.57%	0.01	1.17	1.20
	17	2.14	2.19	-0.05	-2.26%	0.01	-0.06	-0.03
	18	2.12	2.38	-0.26	-12.23%	0.01	-0.28	-0.24
	19	1.96	2.18	-0.22	-10.96%	0.01	-0.23	-0.20
	20	1.82	2.03	-0.21	-11.77%	0.01	-0.23	-0.20
	21	1.69	1.91	-0.22	-13.02%	0.01	-0.24	-0.20
	22	1.54	1.75	-0.21	-13.82%	0.01	-0.23	-0.20
23	1.33	1.59	-0.26	-19.59%	0.01	-0.28	-0.24	

Table 6 summarizes impacts by devices manufacturer and hour for each event

Table 6. Residential DR Program: Summary of Hourly Per Device Impacts by Event and Manufacturer

Manufacturer	Event	Hour 1			Hour 2			Hour 3		
		Baseline Load	Load Impact	Event Hour Temp	Baseline Load	Load Impact	Event Hour Temp	Baseline Load	Load Impact	Event Hour Temp
Nest	1	1.73	1.25	96	1.82	0.87	95	1.88	0.54	93
	2	1.48	1.21	94	1.65	1.05	95	1.76	0.69	94
	3	1.88	1.10	100						
	4	1.58	1.20	91	1.65	0.88	90			
	5	1.82	1.20	99	1.91	0.72	98			

Manufacturer	Event	Hour 1			Hour 2			Hour 3		
		Baseline Load	Load Impact	Event Hour Temp	Baseline Load	Load Impact	Event Hour Temp	Baseline Load	Load Impact	Event Hour Temp
ecobee	1	1.67	1.06	96	1.78	0.87	95	1.85	0.55	93
	2	1.38	0.64	94	1.55	0.41	95	1.69	0.23	94
	3	1.85	1.09	100						
	4	1.50	1.10	91	1.58	0.89	90			
	5	1.72	1.04	99	1.84	0.65	98			
Emerson	1	1.91	1.31	96	2.01	1.00	95	2.09	0.70	93
	2	1.67	1.36	94	1.85	1.12	95	1.99	0.86	94
	3	2.04	1.51	100						
	4	1.73	1.50	91	1.83	1.18	90			
	5	1.92	1.53	99	2.03	1.19	98			

Resource Capability Model Specification and Outputs

Equation 2 shows the model specification used to develop resource capability.

Equation 2. Residential DR Program: Event Day Impact and Resource Capability Model Specification

$$kW_{it} = \alpha_0 + \alpha_i + \beta_{Event} \cdot Event + \sum_{H=1}^{23} \beta_{Hour_H} \cdot Hour_H + \sum_{H=1}^{23} \beta_{Event \cdot Hour_H} \cdot Event \cdot Hour_H + \beta_{CDH} \cdot CDH_t + \varepsilon_{it}$$

Where:

α_0 = Overall intercept

α_i = Device-specific intercept

Event = Indicator variable for event day

Hour = Set of 23 indicator variables of hours of the day (or reference hour for Resource Capability modeling)

Event by Hour = The interaction of event day vs hour of the day

CDH = Base 75 cooling degree hours

ε_{it} = Error term

Table 7 provides resource capability impact values for each event and event day hour by device manufacturer.

Table 7. Residential DR Program: Average Hour Resource Capability kW Impacts by Hour

Event Hour	Baseline Load (kW)	Event Day Load (kW)	Load Impact (kW)	% Load Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
Nest							
1	1.50	0.14	1.37	91%	0.010	1.35	1.38
2	1.63	0.63	0.99	61%	0.011	0.98	1.01
3	1.77	1.12	0.65	37%	0.018	0.62	0.68
ecobee							
1	1.45	0.31	1.14	79%	0.006	1.13	1.15
2	1.56	0.76	0.81	51%	0.007	0.79	0.82
3	1.67	1.24	0.43	26%	0.010	0.41	0.45
Emerson							
1	1.68	0.09	1.59	95%	0.005	1.58	1.60
2	1.79	0.54	1.24	70%	0.006	1.23	1.25
3	1.94	1.14	0.80	41%	0.008	0.79	0.82

Event Season Impacts and Resource Capability – Model Fit

Figure 1 through Figure 12 show the model fit when predicting both baseline and event-day load compared to the actual load curves for both event days and proxy days. This comparison is done for both the event-specific models as well as the pooled-event resource capability models across all device manufacturers. Overall, these figures show that both the event-specific models as well as the pooled resource capability model are able to properly capture the load curve information for both baseline (proxy) and event days.

Figure 1. Residential DR Program: Nest Event Model Fit

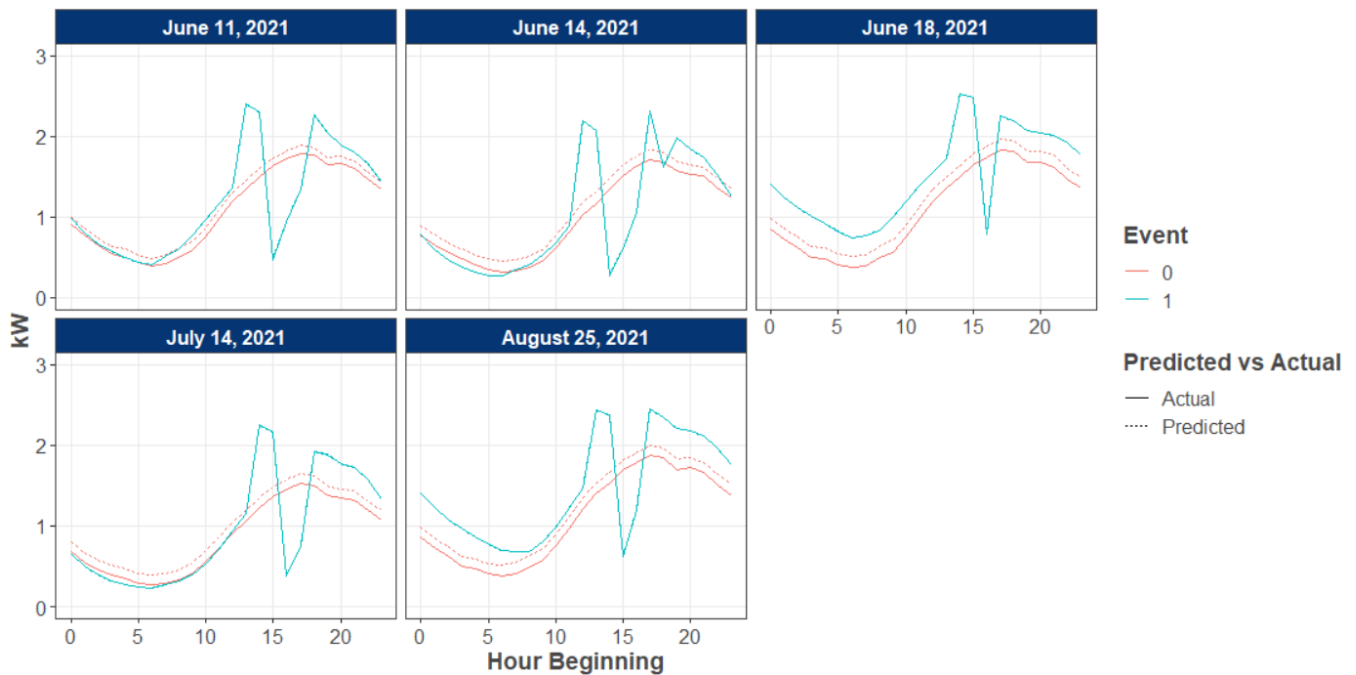


Figure 2. Residential DR Program: ecobee Event Model Fit

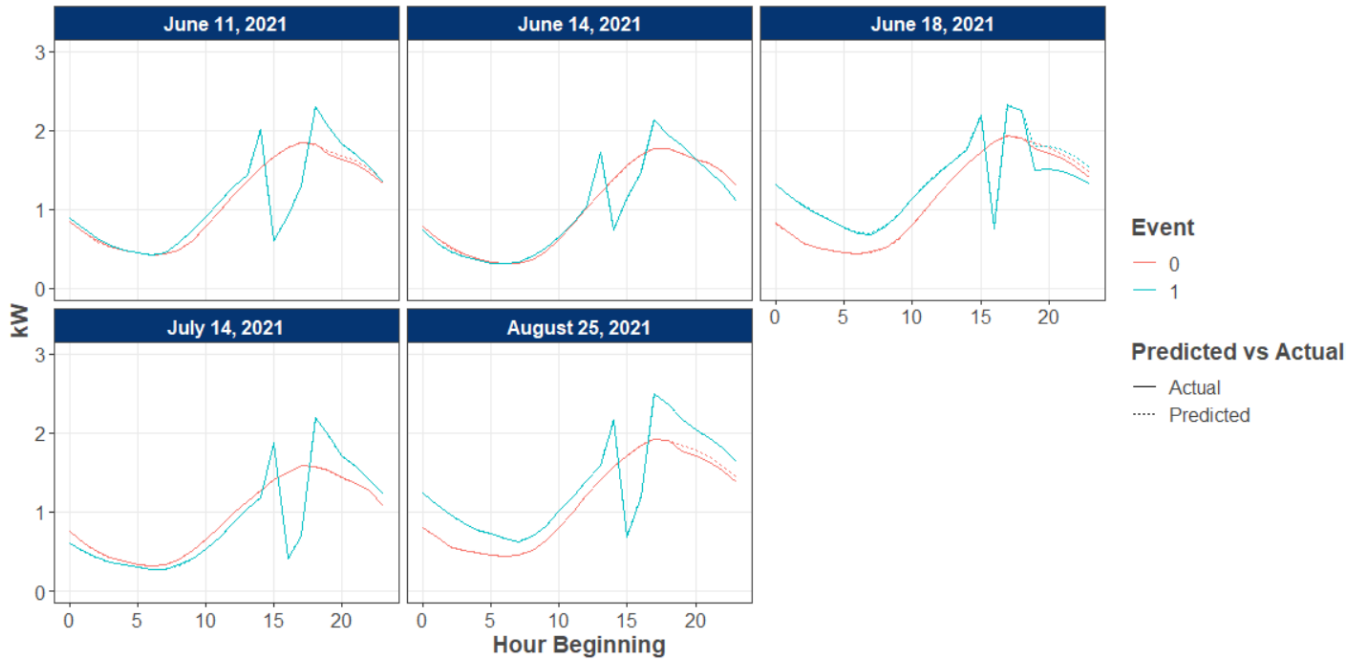


Figure 3. Residential DR Program: Emerson Event Model Fit

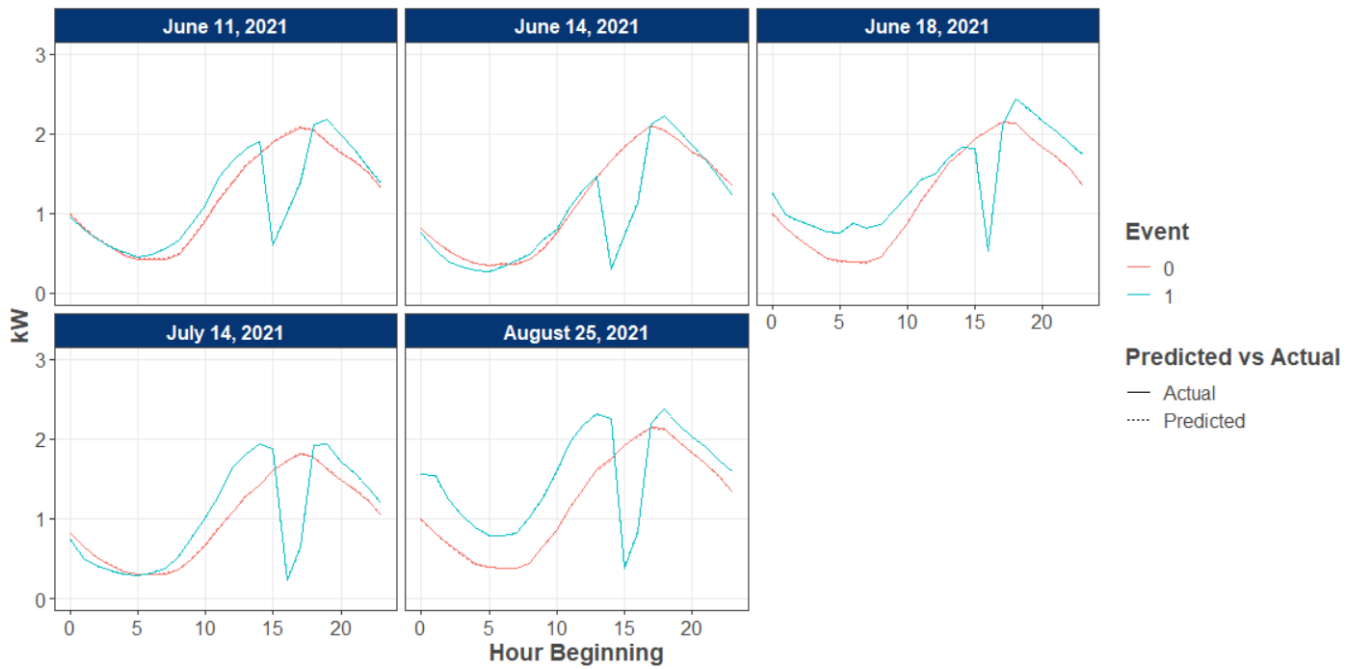


Figure 4. Residential DR Program: Nest Resource Capability Model Fit – Hour 1

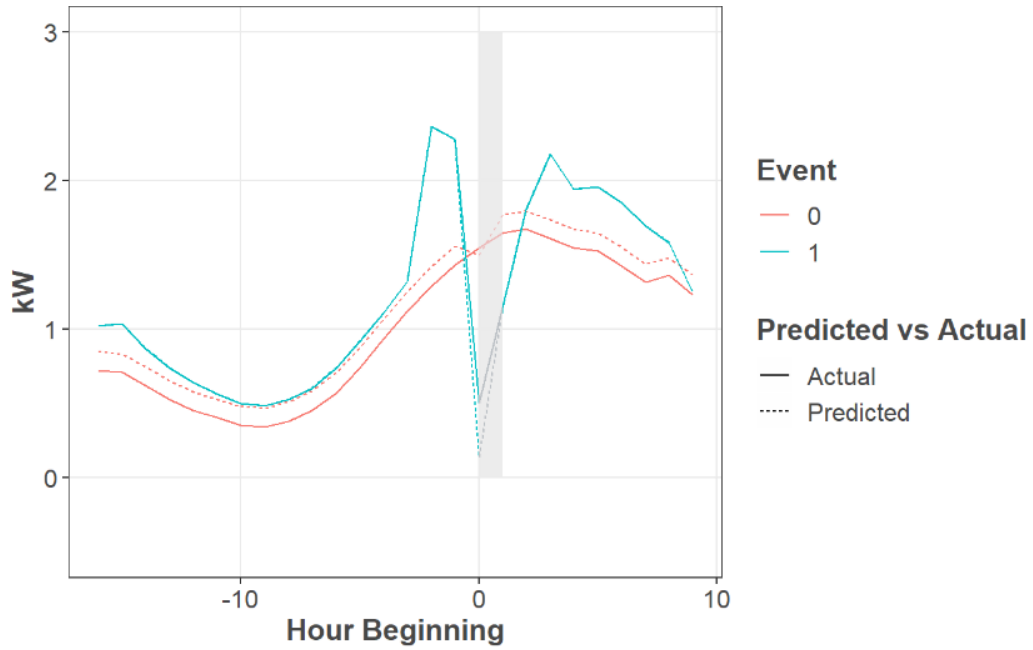


Figure 5. Residential DR Program: Nest Resource Capability Model Fit – Hour 2

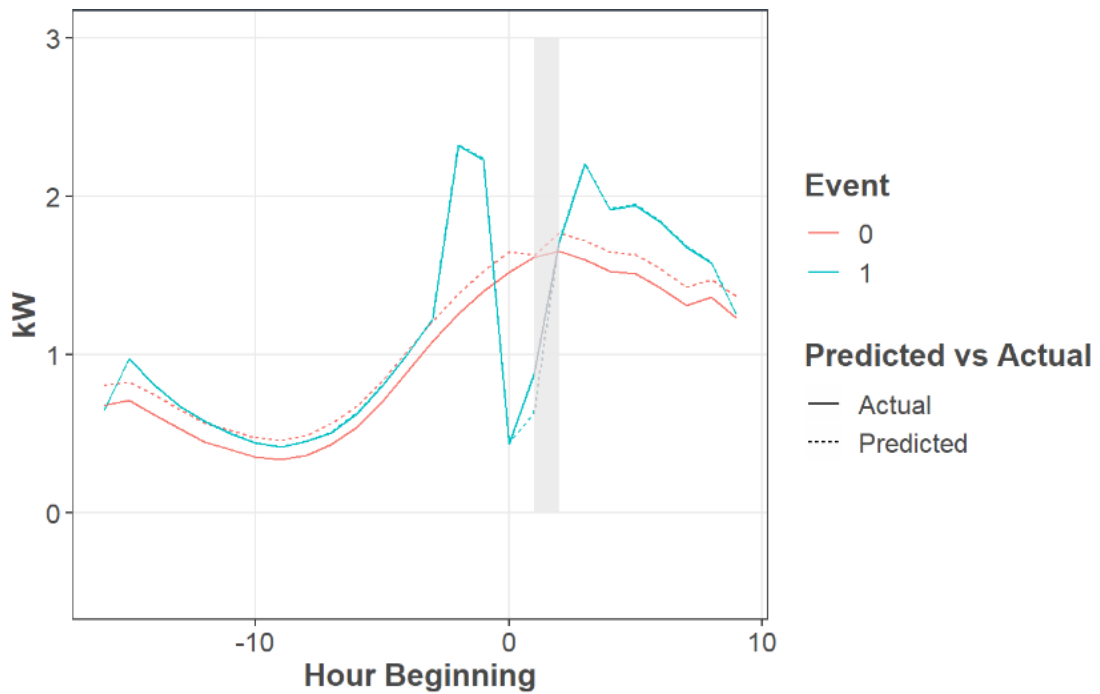


Figure 6. Residential DR Program: Nest Resource Capability Model Fit – Hour 3

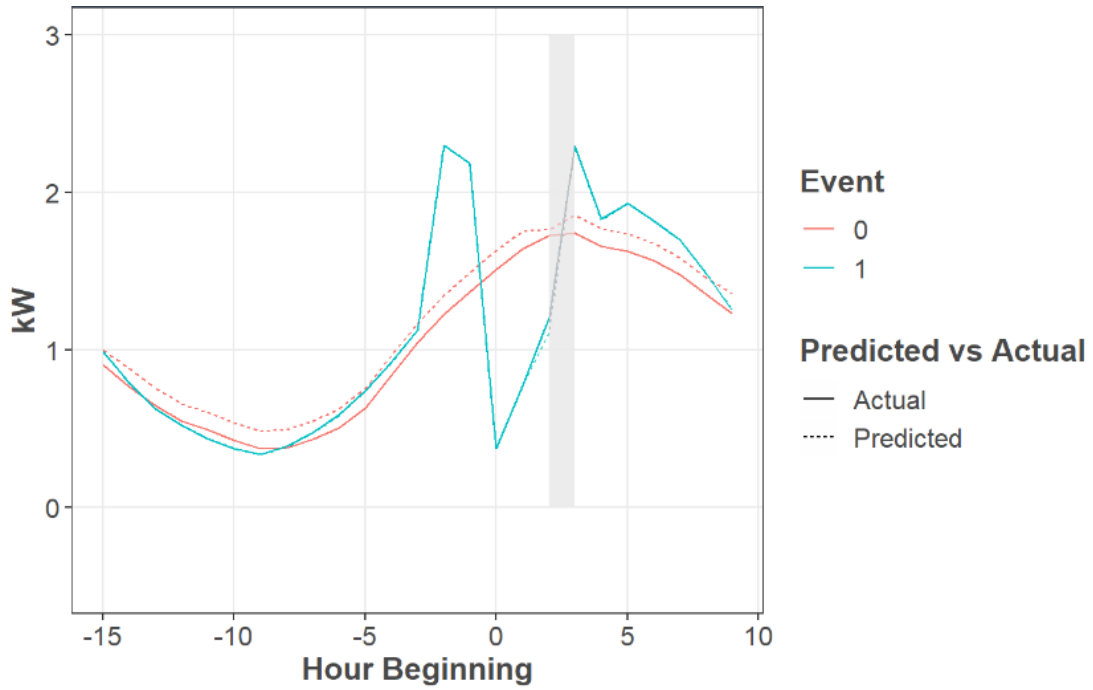


Figure 7. Residential DR Program: ecobee Resource Capability Model Fit – Hour 1

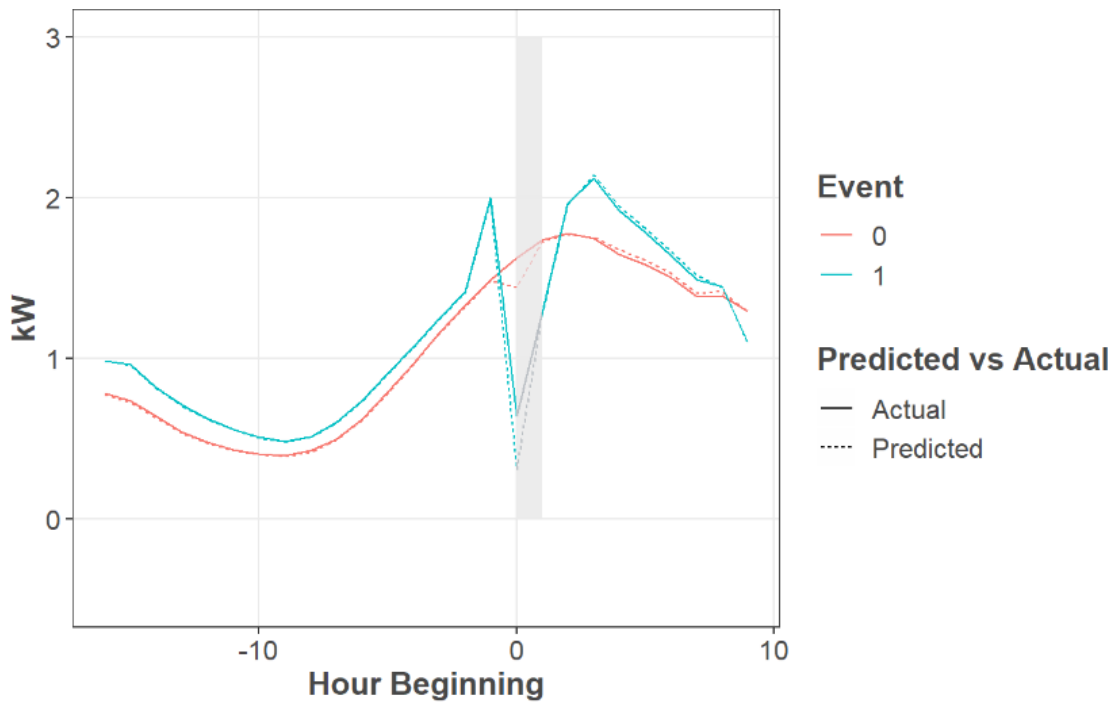


Figure 8. Residential DR Program: ecobee Resource Capability Model Fit – Hour 2

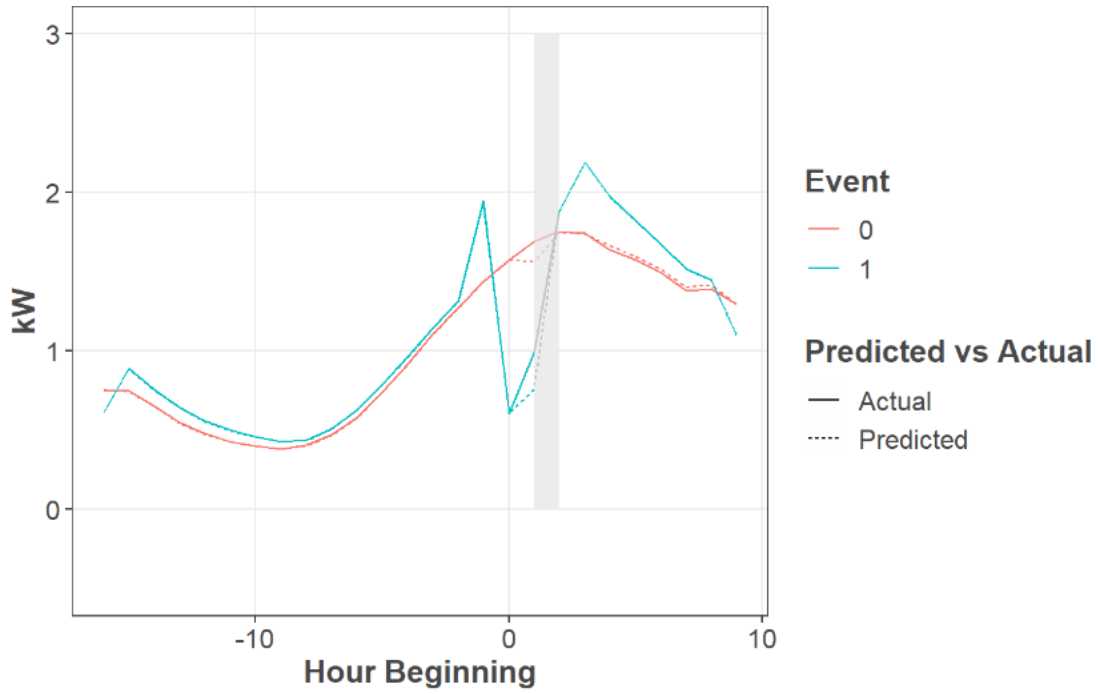


Figure 9. Residential DR Program: ecobee Resource Capability Model Fit – Hour 3

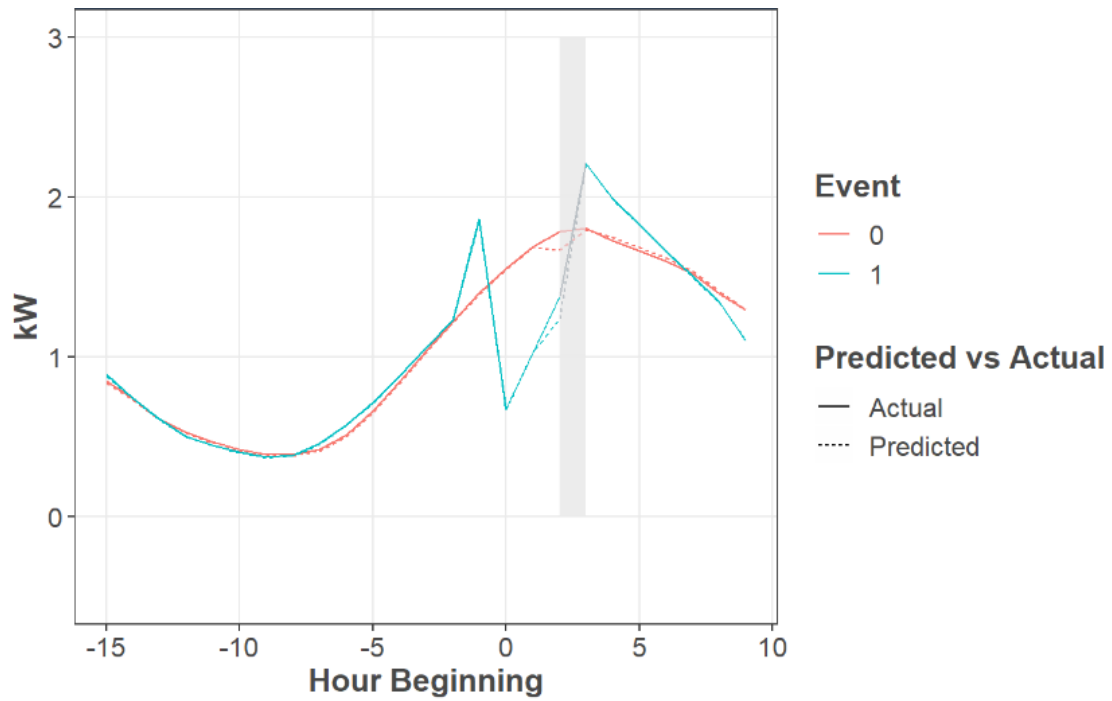


Figure 10. Residential DR Program: Emerson Resource Capability Model Fit – Hour 1

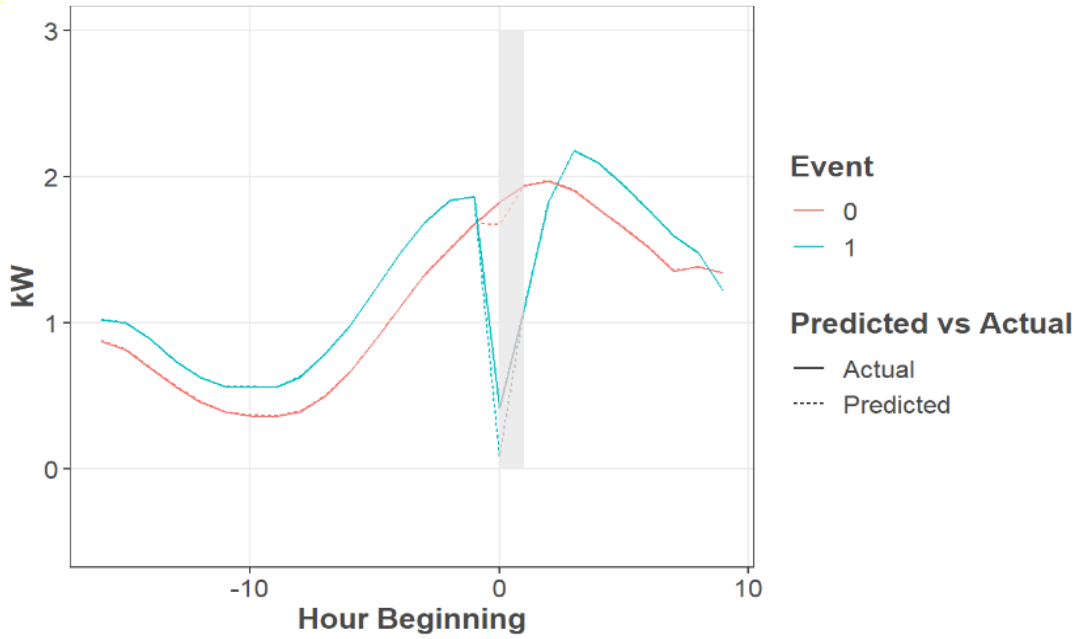


Figure 11. Residential DR Program: Emerson Resource Capability Model Fit – Hour 2

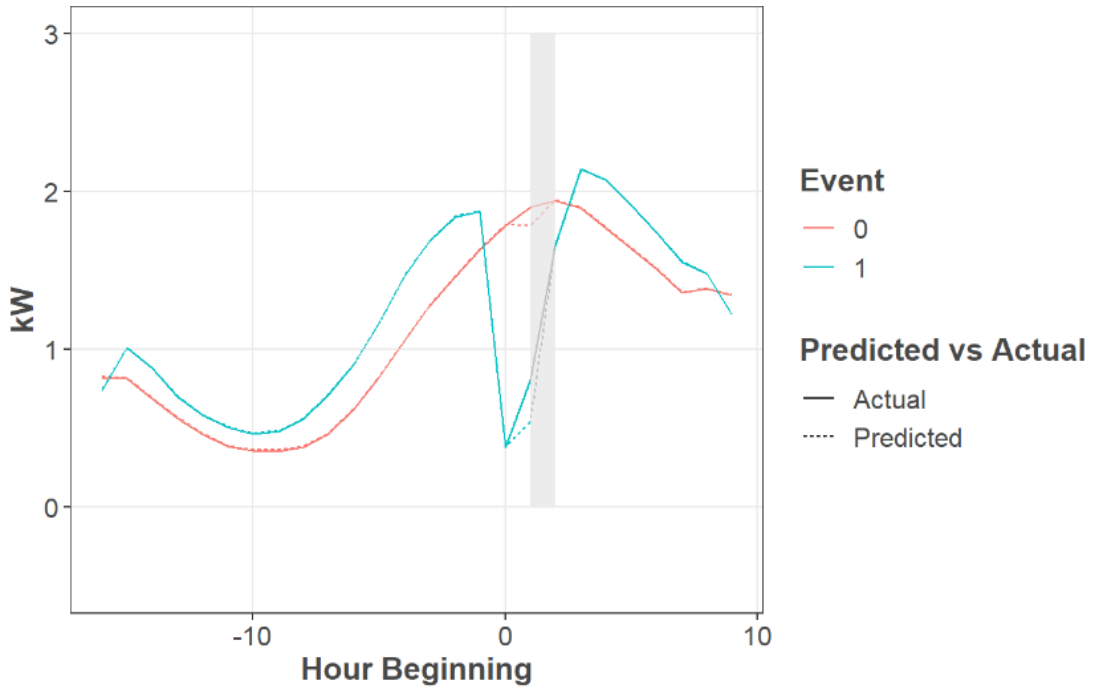
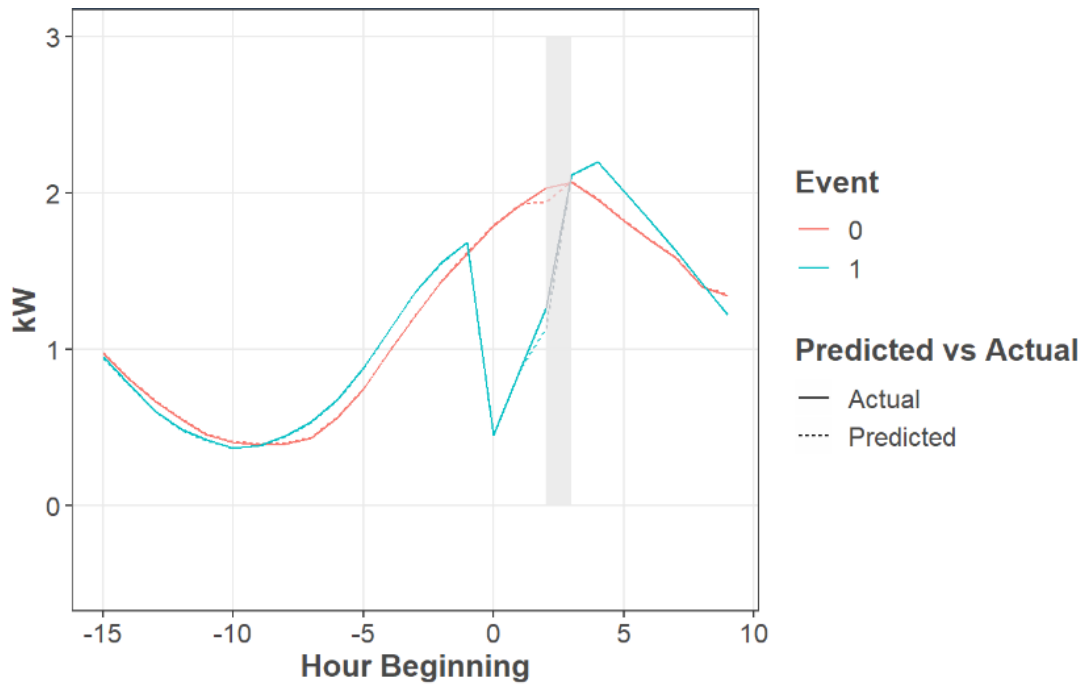


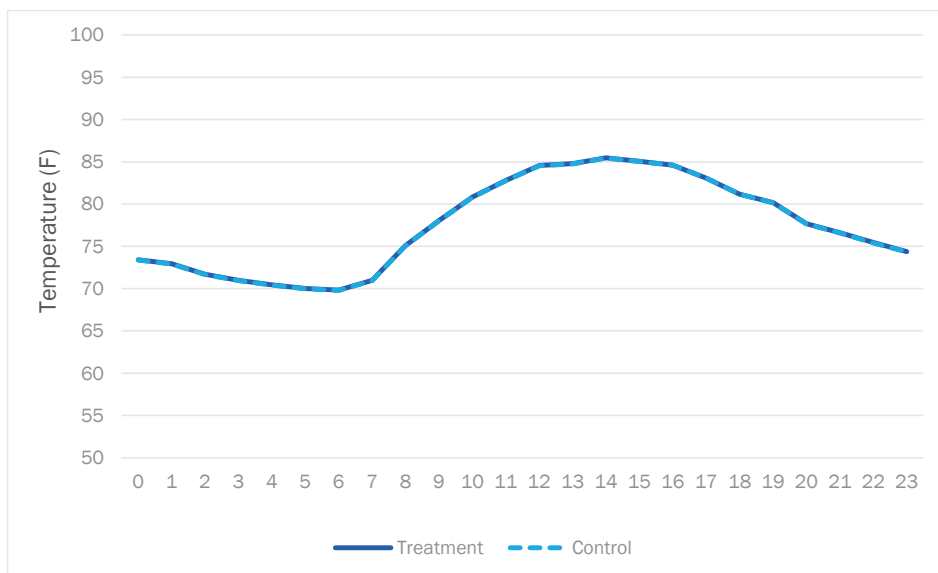
Figure 12. Residential DR Program: Emerson Resource Capability Model Fit – Hour 3



Non-Event Emerson Optimization Model Equivalency Analysis Results

Figure 13 compares average hourly temperature on treatment and control days to demonstrate equivalency in experimental assignment of the Emerson devices into treatment and control for energy optimization purposes.

Figure 13. Residential DR Program: Non-Event Day Emerson Optimization Equivalency Analysis



Non-Event Emerson Optimization Model Specification and Outputs

Equation 2 shows the model specification used to develop non-event optimization impacts for Emerson devices.

Equation 2. Residential DR Program: Non-Event Day Emerson Optimization Model Specification

$$kW_{it} = \alpha_0 + \alpha_i + \sum_{H=1}^{23} \beta_{Hour_H} \cdot Hour_H + \sum_{H=1}^{23} \beta_{Opt Hour_H} \cdot Opt \cdot Hour_H + \beta_{CDH} \cdot CDH_t + \beta_{Opt CDH} \cdot Opt \cdot CDH_t + \varepsilon_{it}$$

where:

α_0 = Overall intercept

α_i = Device-specific intercept for device i

Opt = Indicator variable for homes in optimization mode

$Hour$ = Set of 23 indicator variables of hours of the day

$Opt \cdot Hour$ = The interaction of homes in optimization mode vs hour of the day

CDH_t = Base 75 cooling degree hours for time period t

ε_{it} = Error term

The kW for each hour was summed to determine the kWh saving per day per device, and then multiplied by the number of device days when the devices were optimized to obtain the total kWh savings for the PY2021 event season.

Table 8 provides impact values for an average treatment day from the modeling efforts.

Table 8. Residential DR Program: Modeled Non-Event Emerson Energy Savings

Hour Beginning	Baseline Load (kWh)	Treatment Load (kWh)	Impact (kWh)	% Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
0	0.801	0.894	-0.093	-11.7%	0.0081	-0.11	-0.08
1	0.649	0.700	-0.051	-7.8%	0.0081	-0.06	-0.04
2	0.525	0.549	-0.024	-4.6%	0.0081	-0.04	-0.01
3	0.443	0.435	0.008	1.8%	0.0083	-0.01	0.02
4	0.384	0.297	0.086	22.5%	0.0089	0.07	0.10
5	0.352	0.266	0.085	24.2%	0.0090	0.07	0.10
6	0.366	0.252	0.114	31.1%	0.0114	0.09	0.13
7	0.323	0.245	0.078	24.2%	0.0106	0.06	0.10

Hour Beginning	Baseline Load (kWh)	Treatment Load (kWh)	Impact (kWh)	% Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
8	0.333	0.264	0.069	20.9%	0.0109	0.05	0.09
9	0.429	0.388	0.041	9.5%	0.0114	0.02	0.06
10	0.571	0.497	0.074	12.9%	0.0123	0.05	0.09
11	0.738	0.683	0.055	7.4%	0.0129	0.03	0.08
12	0.907	0.828	0.079	8.7%	0.0135	0.06	0.10
13	1.061	1.007	0.053	5.0%	0.0134	0.03	0.08
14	1.188	1.068	0.120	10.1%	0.0137	0.10	0.14
15	1.294	1.217	0.077	6.0%	0.0135	0.05	0.10
16	1.375	1.293	0.082	5.9%	0.0133	0.06	0.10
17	1.469	1.372	0.097	6.6%	0.0136	0.07	0.12
18	1.355	1.311	0.045	3.3%	0.0123	0.02	0.06
19	1.214	1.185	0.029	2.4%	0.0113	0.01	0.05
20	1.115	1.044	0.072	6.4%	0.0106	0.05	0.09
Mean Hourly kWh	0.819	0.759	0.060	7.4%	0.0023	0.06	0.06
Daily kWh	19.660	18.214	1.4	7.4%	0.0023	1.44	1.45

Table 9 provides actual impacts for an average treatment day as observed in the cleaned telemetry data.

Table 9. Residential DR Program: Actual Non-Event Emerson Energy Savings

Hour Beginning	Baseline Load (kWh)	Treatment Load (kWh)	Impact (kWh)	% Impact
0	0.836	0.914	-0.078	-9%
1	0.681	0.718	-0.037	-5%
2	0.551	0.565	-0.014	-3%
3	0.467	0.446	0.021	4%
4	0.404	0.304	0.100	25%
5	0.369	0.274	0.094	26%
6	0.378	0.264	0.115	30%
7	0.337	0.255	0.082	24%
8	0.352	0.274	0.078	22%
9	0.452	0.399	0.053	12%
10	0.600	0.509	0.090	15%
11	0.770	0.694	0.077	10%
12	0.941	0.839	0.102	11%
13	1.097	1.022	0.075	7%
14	1.225	1.088	0.137	11%
15	1.325	1.235	0.090	7%
16	1.402	1.314	0.089	6%
17	1.492	1.404	0.088	6%

Hour Beginning	Baseline Load (kWh)	Treatment Load (kWh)	Impact (kWh)	% Impact
18	1.381	1.342	0.039	3%
19	1.246	1.220	0.025	2%
20	1.148	1.081	0.067	6%
Mean Hourly kWh	1.085	0.970	0.115	11%
Daily kWh	0.991	0.879	0.112	11%

Connected Load Assumption Development

We leveraged onsite data collected as part of the Residential Baseline study completed as part of a broader 2020 DSM Market Potential study¹ as a data source to support the development of the connected load assumptions. We used the information on the respondents’ central air conditioning system SEER rating and size.² We reviewed the data and made adjustments to it for more accurate calculations. In cases where the central air conditioning system size was missing, we imputed it using home type weighted sample average for missing observations. In cases where SEER values were missing, we imputed them using other variables available in the data, including home vintage. We made additional adjustments to the SEER for aging and wear based on the central air conditioning system’s vintage and tune-ups performed recently.

We calculated connected load for each device associated with the central air conditioning systems using the air conditioning system information and the information on the number of devices attached to each system in a home. To ensure that per-device connected load assumptions were representative of the population of the Residential DR program participants, we checked the differences in connected load results by key observable demographics that were available to us through the participant survey and the baseline study. We applied weights by home type and income to better align the connected load with the distribution of the participant population. Table 10 details the distribution of the Residential Baseline study respondents and Residential DR participants across demographic characteristics and summarizes the resulting weights.

Table 10. Residential DR Program: Participant Survey Weighting Scheme

Stratum	% of Residential Baseline Study Participants	% of Residential DR Participants	Weight
Low-income multifamily	22.5%	0.7%	.0317965
Low-income single-family	28.3%	3.7%	.1290564
Non-low-income multifamily	14.2%	6.9%	.4881698
Non-low-income single-family	35.0%	88.7%	2.534636

Table 11 presents the final weighted per device connected load. We applied the average connected load estimate to all participating device runtime results to convert the runtime reductions into demand reductions.

Table 11. Residential DR Program: Per Device Connected Load Results

Metric	Result
Sample size	119

¹ GDS Associates. Ameren Missouri 2020 DSM Market Potential Study. Final Report. March 2020. <https://efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=936289645>

² Notably, EER data was not available from the baseline study.

Metric	Result
Connected load	3.07

Table 12 provides a comparison of the connected load estimates without missing data imputations as well as without the weights applied and offers insight into the changes caused by those adjustments. As can be seen in the table, the connected load estimates are comparable across the scenarios and the difference in estimates is driven by the application of weights primarily.

Table 12. Residential DR Program: Per Device Connected Load Results

Scenario	Connected Load Estimate
Weighted and with missing data imputations	3.07
Unweighted and without missing data imputations	2.99
Unweighted and with missing data imputations	2.99

Participant Survey Data

Opinion Dynamics leveraged participant survey data collected by Uplight at the close of the event season to support focused process analysis. Uplight completed a web survey with program participants active in the program during the PY2021 event season. Uplight administered the survey between December 13, 2021 and January 9, 2022 and received 1,705 responses. Opinion Dynamics cleaned the data to remove partial respondents as well as respondents who did not recall participating in the program, leaving a total of 1,341 completed survey respondents. We compared the distribution of the survey sample and the available participant population by device manufacturer and applied survey weights to better align our survey sample with the participant population by device manufacturer. Table 13 presents survey weights applied to the survey sample.

Table 13. Residential DR Program – Participant Survey Weights

Device Manufacturer	Survey Sample %	Participant Population %	Survey Weight
Nest	44%	56%	1.27
ecobee	38%	22%	1.21
Emerson	18%	21%	0.56

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