

Hourly Load Model

CED 2019 Revised
Presentation to DAWG



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California Energy Commission



HLM Estimation

- Estimate ratio of hourly load to annual average load for each hour (24 regressions for each TAC) as a function of weather, day of the week, weekend/holiday, month, using hourly data by TAC for 2012-2018
 - $L_{i,d} / L_y = f(g(t), \text{dow}_d, \text{wkhold}_d, \text{month}_d, \text{constant}_i)$
 - $i=1,24$ $d=1,365-6$, $y=1,7$, $g(t)=\text{weather}$
(temperatures, dew point and cloud cover)



HLM Implementation

- Apply estimated ratios to annual forecast “consumption” load (load served by utilities plus PV energy minus EV load)
 - Annual load forecast accounts for economic/demographic growth and other changes
- Adjust consumption load using hourly profiles for climate change impacts, EV charging, PV generation, BTM storage, residential TOU impacts, and AAEE



HLM Weather-Normalized Loads

- Simulate 18 years using hourly weather and calendar effects assuming 7 different calendars ($18 \times 7 = 126$ simulations of 8760 hourly load ratios)
- Take highest hourly ratio for each simulation, rank, and select median—this becomes weather-normalized peak ratio
- Similarly for 2nd highest hourly load, etc., through 8760 hours
- Assign ratios to actual day and hour.



HLM Load Assignments

Step 1. Assign to calendar based on historical average TAC load ratio by day type (1st Tuesday in March, 2nd Thursday in June, Christmas, etc.) and hour.

Step 2. Calculate average peak load ratios for each month, average second highest load ratios, etc., all the way down to average of lowest hourly load ratios.



HLM Load Assignments

Step 3. Assign highest peak load ratios in a given month to the day type/hour with the highest average load ratios, 2nd highest to 2nd highest average load ratios, etc

Step 4. Assign simulated load ratios to calendar based on adjusted average load ratios for each calendar year



Updates for CED 2019 Revised

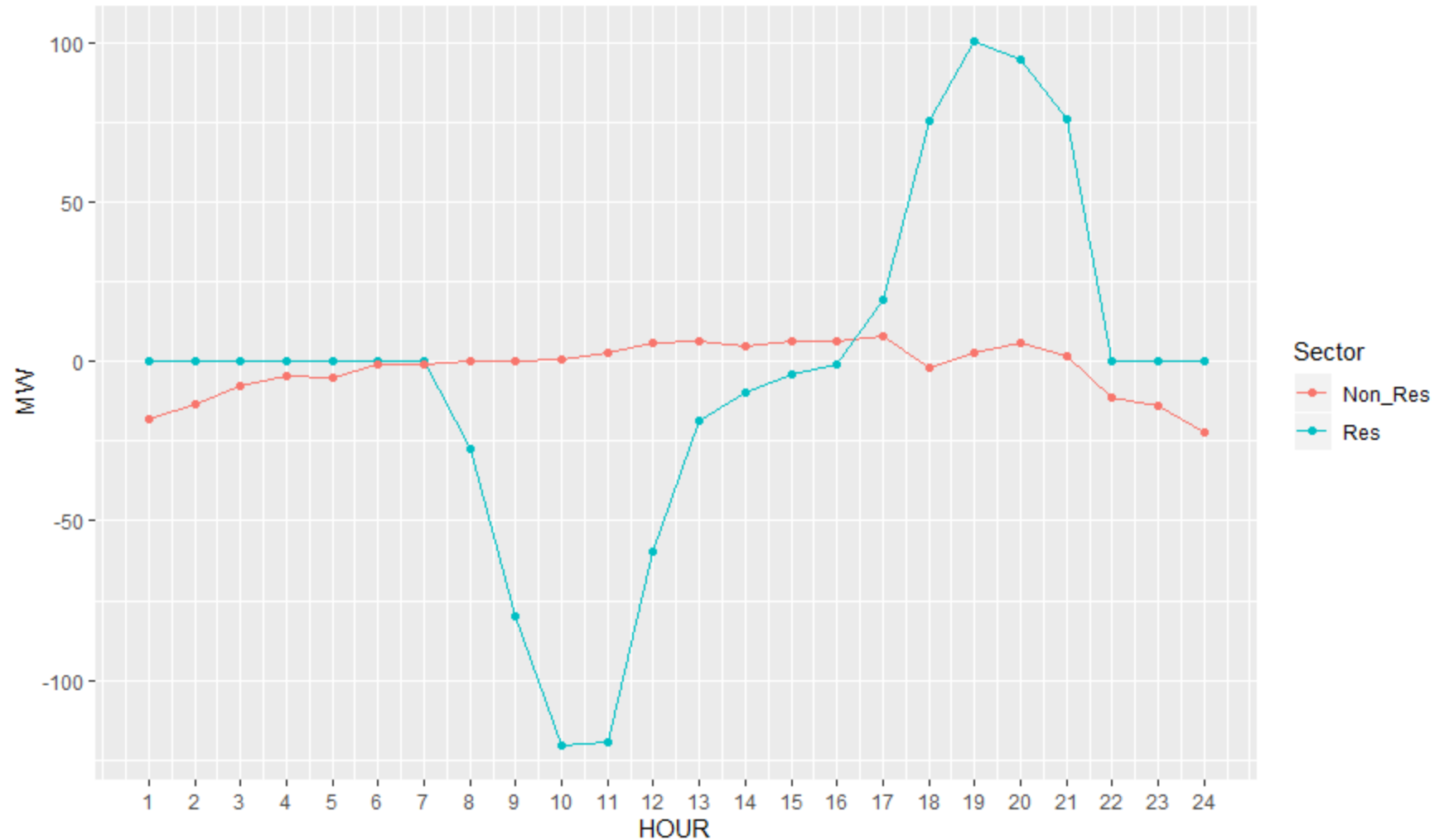
- CED 2019 Revised sales and self-gen forecasts
- Calibrate to 2019 weather-normalized annual peaks
- Residential TOU impact profiles
- New hourly climate change impacts
- BTM storage charge/discharge profiles
- Revised AAEE / LDEV / MDHD profiles



Example Storage Profile

PG&E

Sample day
August 29, 2030

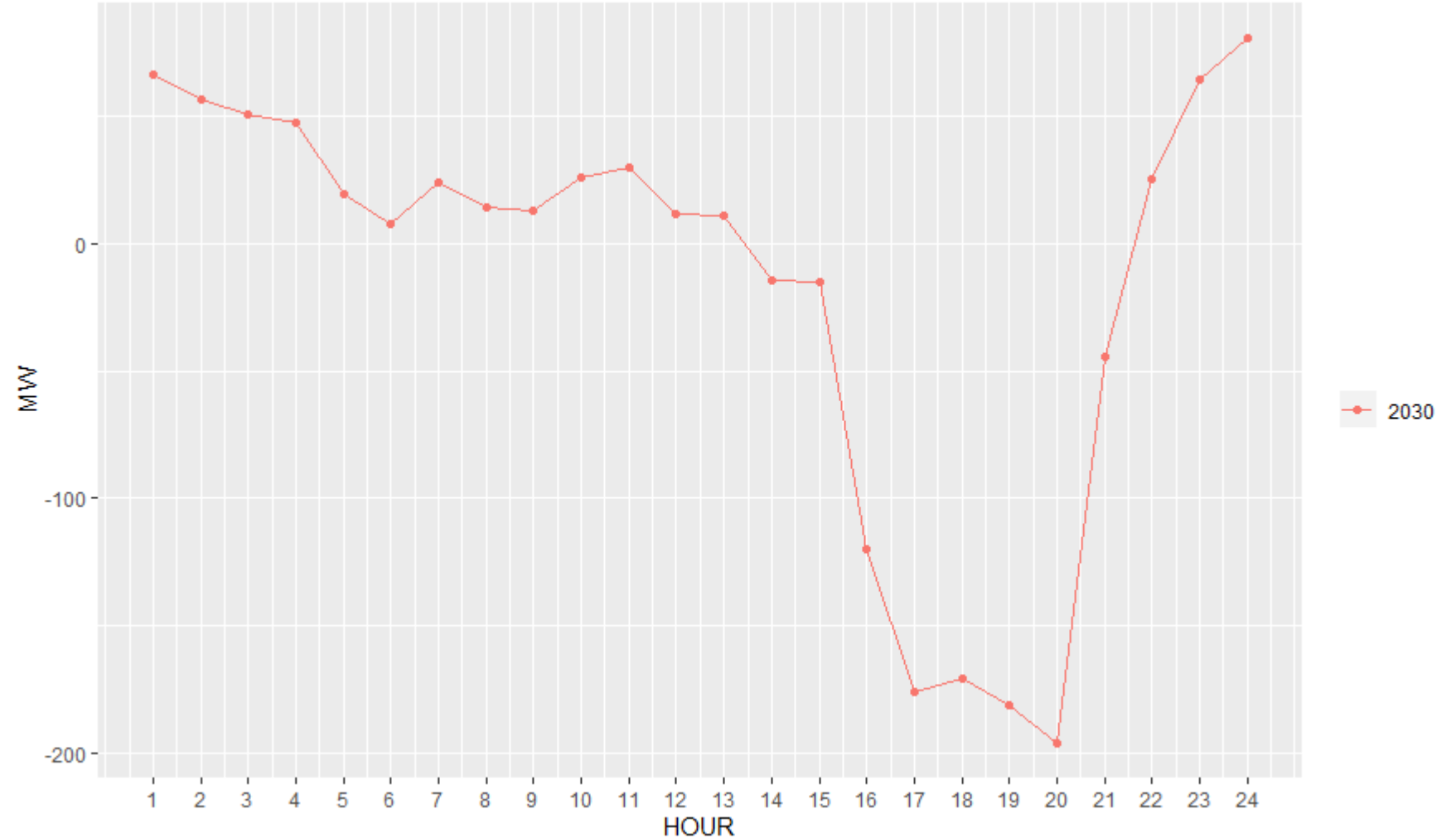




Example TOU Impact Profile

PG&E

Sample day
August 29, 2030



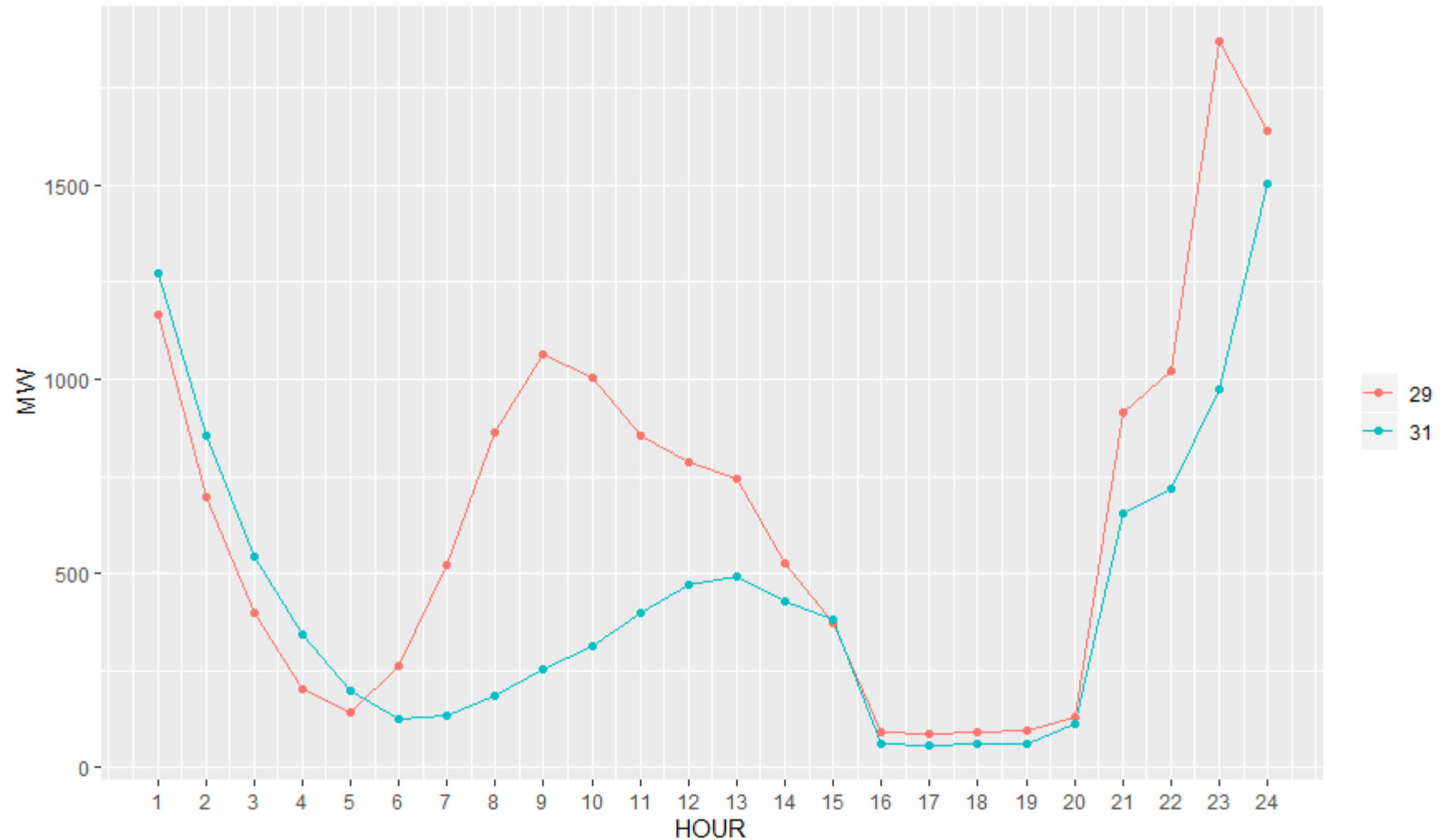


Example LDEV Charge Profile

PG&E

Sample days in
August, 2030

Wednesday – 29
Saturday – 31

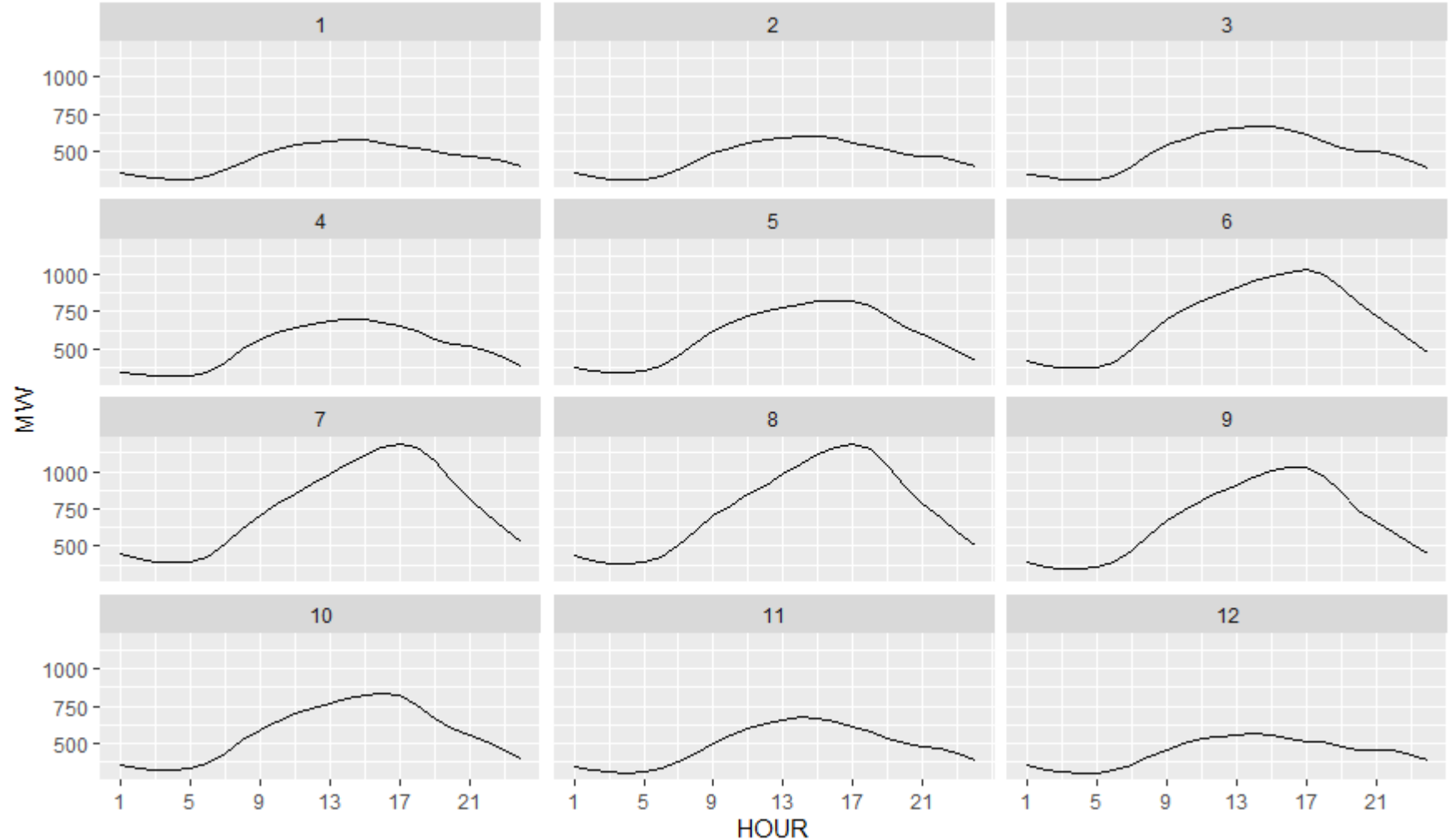




Example LDEV Charge Profile

SCE

Average weekday
savings profiles for
months in 2030



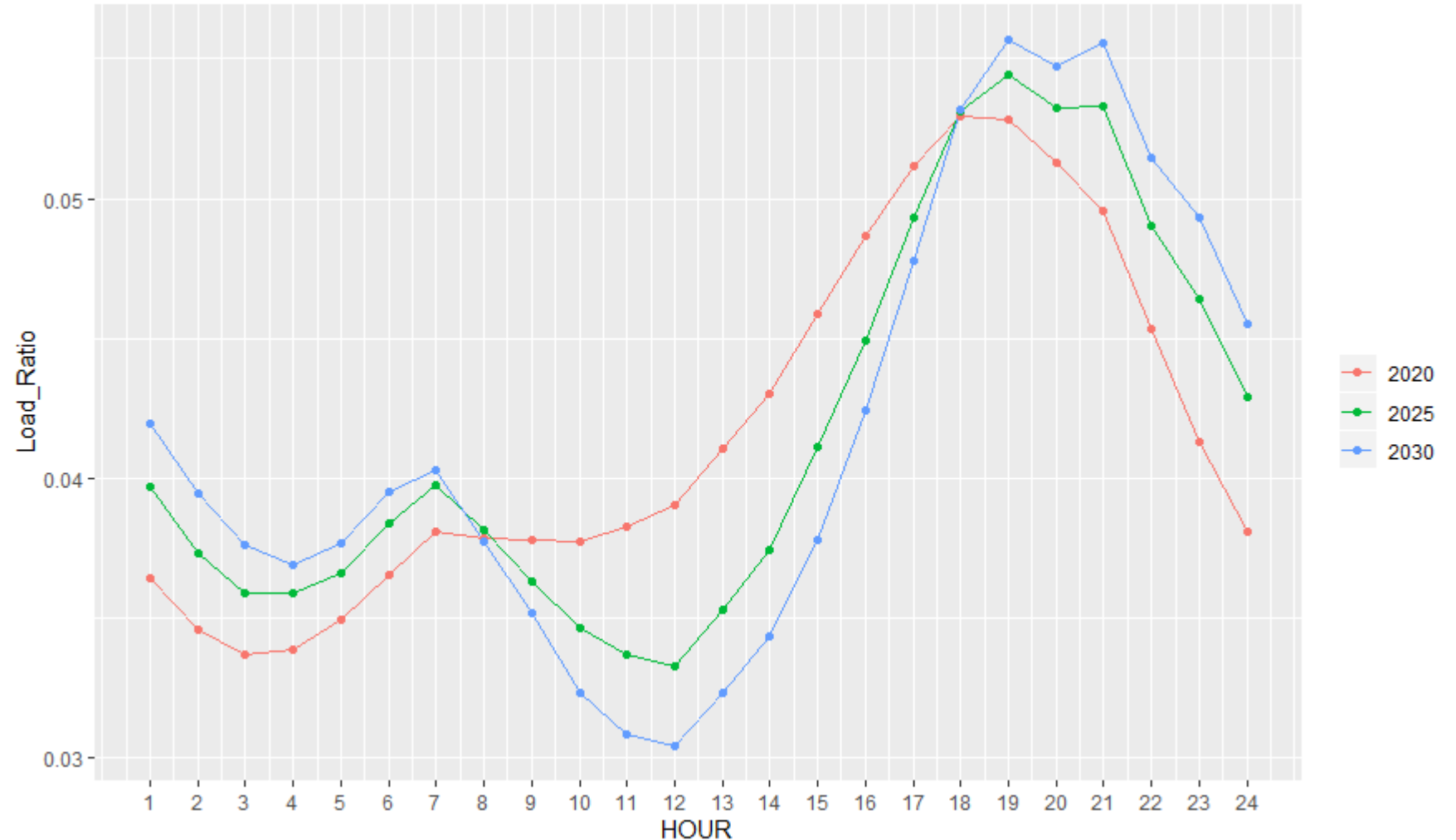


PG&E Daily Profile

Mid baseline,
Mid AAEE,
System load

July 30,
select years

Load as a
percent of
daily total



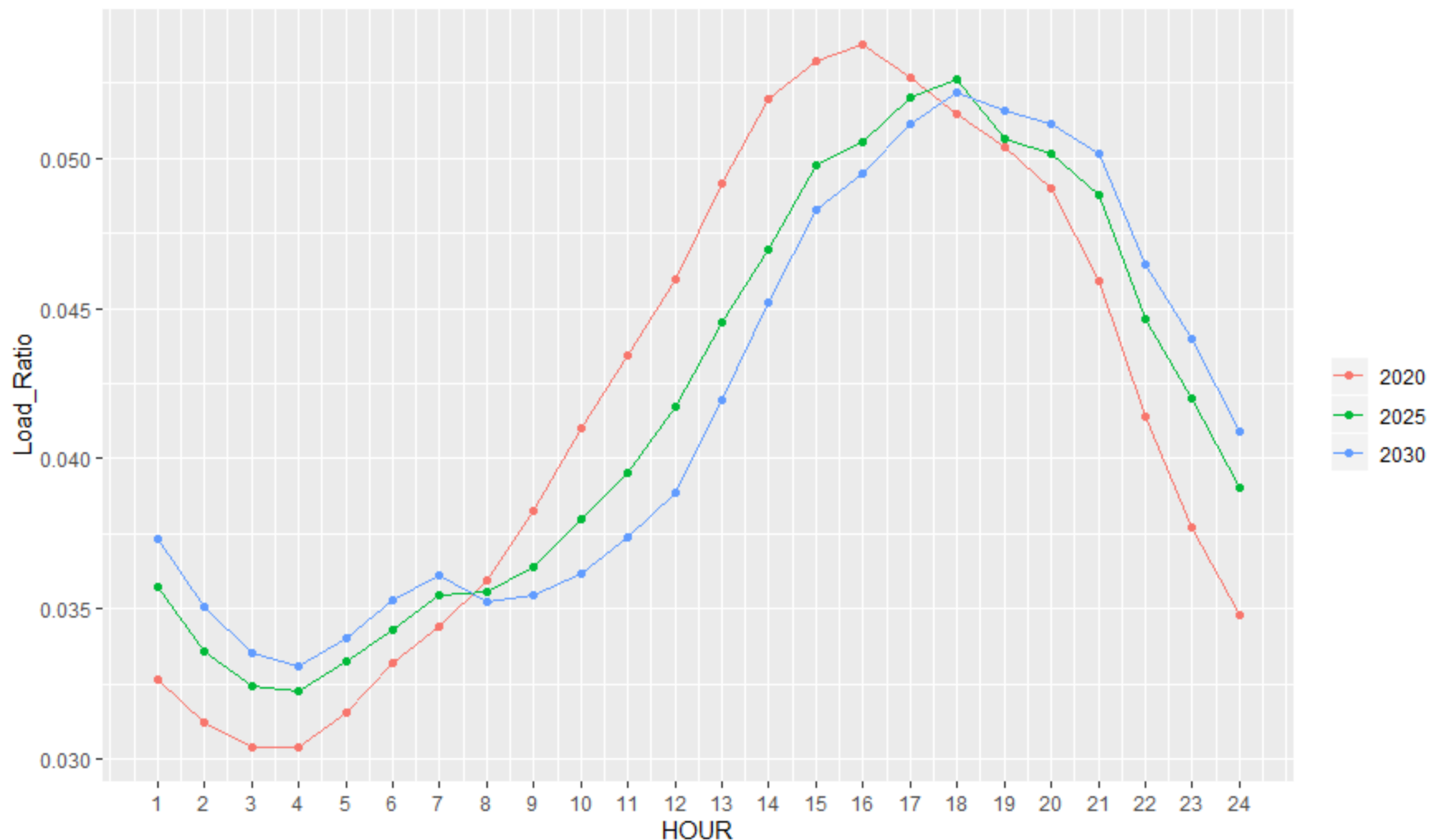


SCE Daily Profile

Mid baseline,
Mid AAEE,
System load

August 27,
select years

Load as a
percent of
daily total



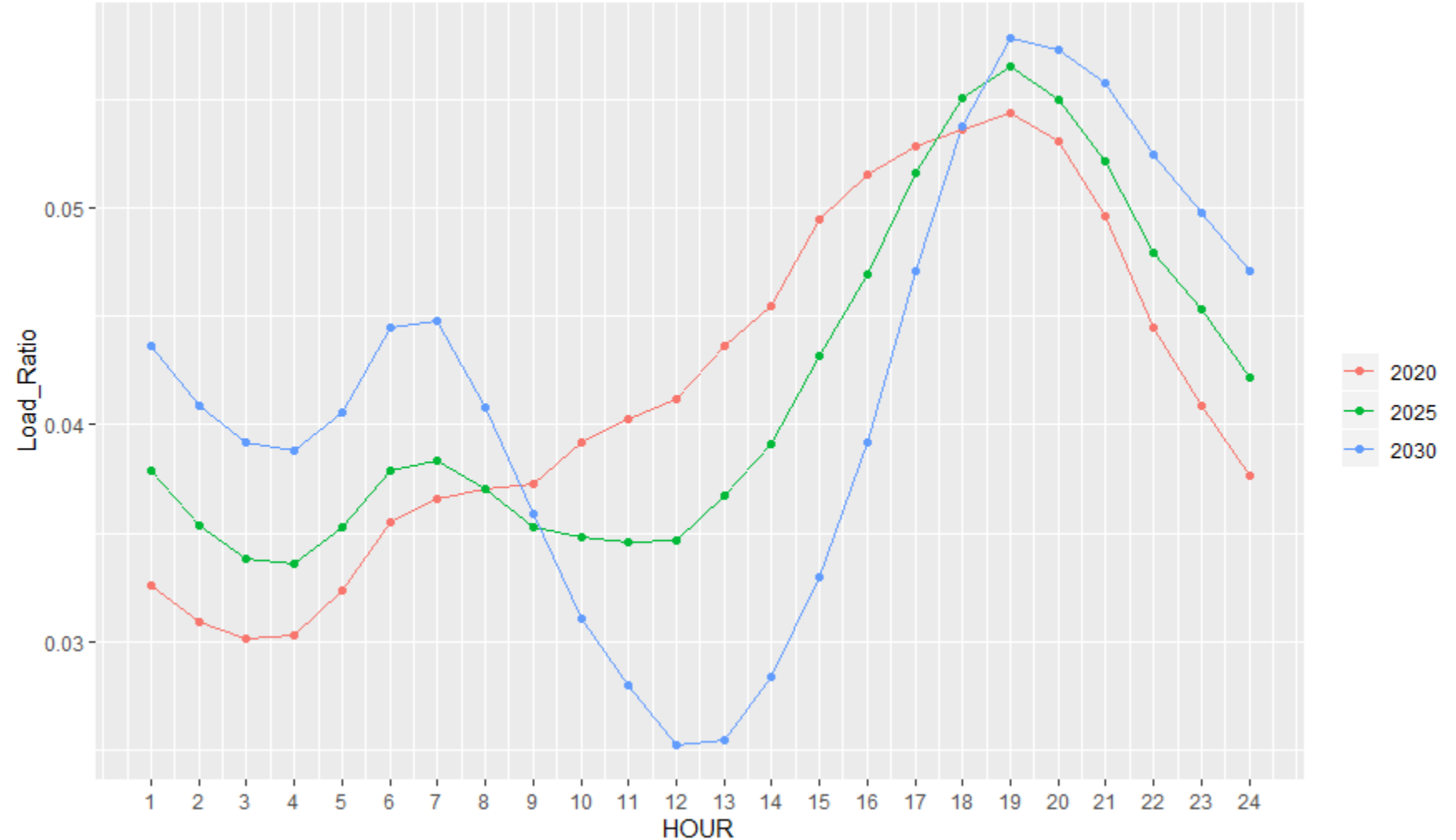


SDG&E Daily Profile

Mid baseline,
Mid AAEE,
System load

Sept 2, select
years

Load as a
percent of
daily total



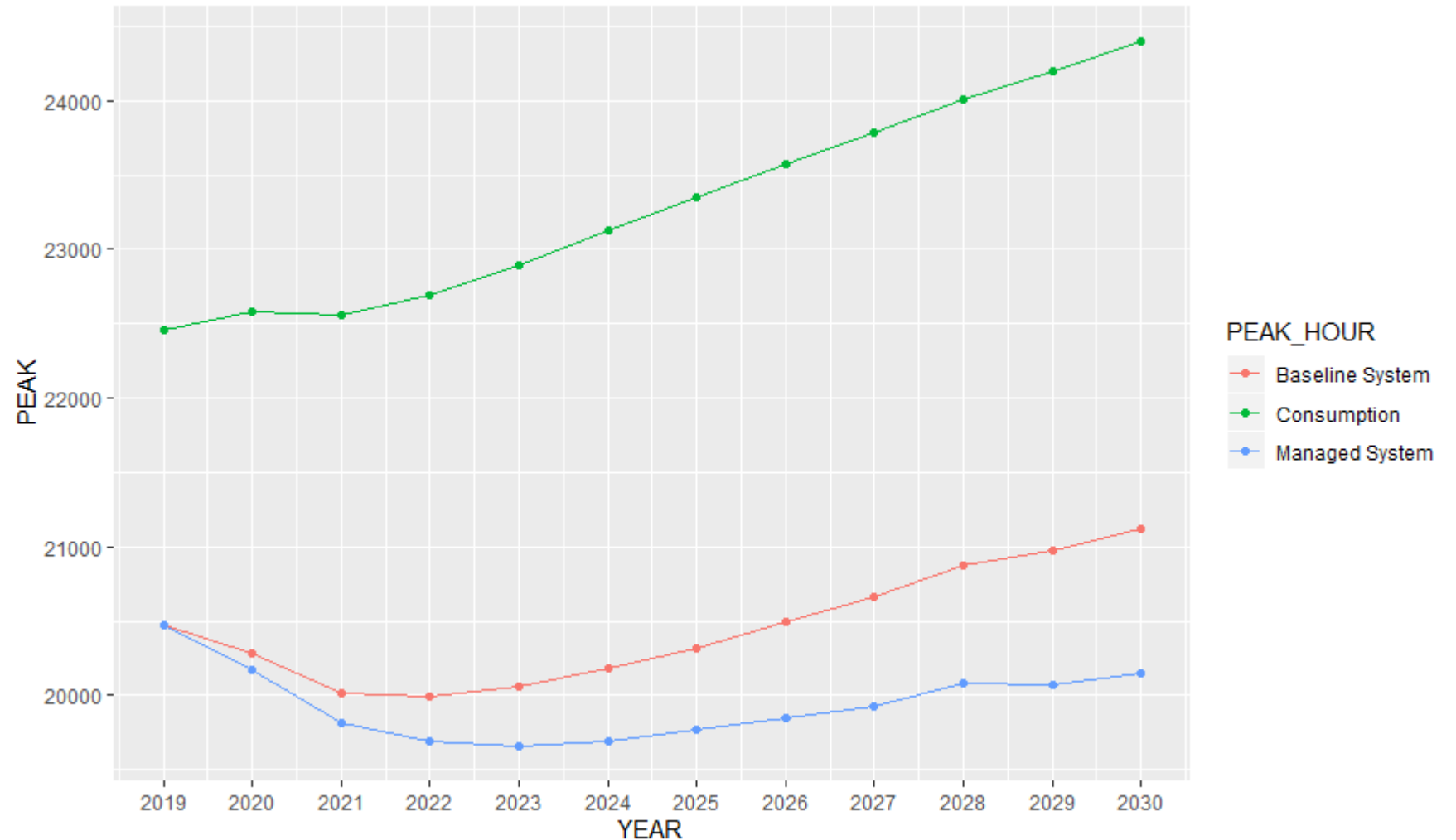


PG&E Peak Projections

Mid Baseline
Mid-Mid AAEE

2019 Weather
Normalized peak:
20,468 MW

Average annual
growth:
-0.1%





PG&E Demand Modifiers

YEAR	MONTH	DAY	HOUR	Climate Change	LDEV	MDHD	TOU	PV	Storage	AAEE
2019	7	25	17	11.8	25.3	0.4	0.0	1713.3	1.3	0.0
2020	7	23	17	23.8	56.2	0.9	0.0	2026.1	2.7	109.6
2021	7	22	18	34.2	26.5	0.7	-129.1	1059.1	13.2	196.8
2022	7	28	18	46.1	36.7	1.0	-178.0	1193.4	18.9	296.4
2023	7	5	19	56.0	48.6	1.3	-176.3	250.8	40.2	346.4
2024	7	2	19	67.7	57.7	1.9	-177.8	268.4	50.4	450.9
2025	7	1	19	79.6	65.8	2.8	-179.4	284.7	60.8	545.1
2026	7	7	19	91.7	72.1	4.2	-180.9	300.7	71.4	635.4
2027	7	6	19	104.0	77.8	6.2	-182.4	316.7	82.2	720.3
2028	7	5	19	116.7	83.7	9.5	-183.9	332.9	93.2	780.5
2029	7	3	19	129.3	89.5	14.3	-185.4	349.2	104.4	881.6
2030	7	2	19	142.1	95.9	20.0	-186.8	365.7	115.7	962.8

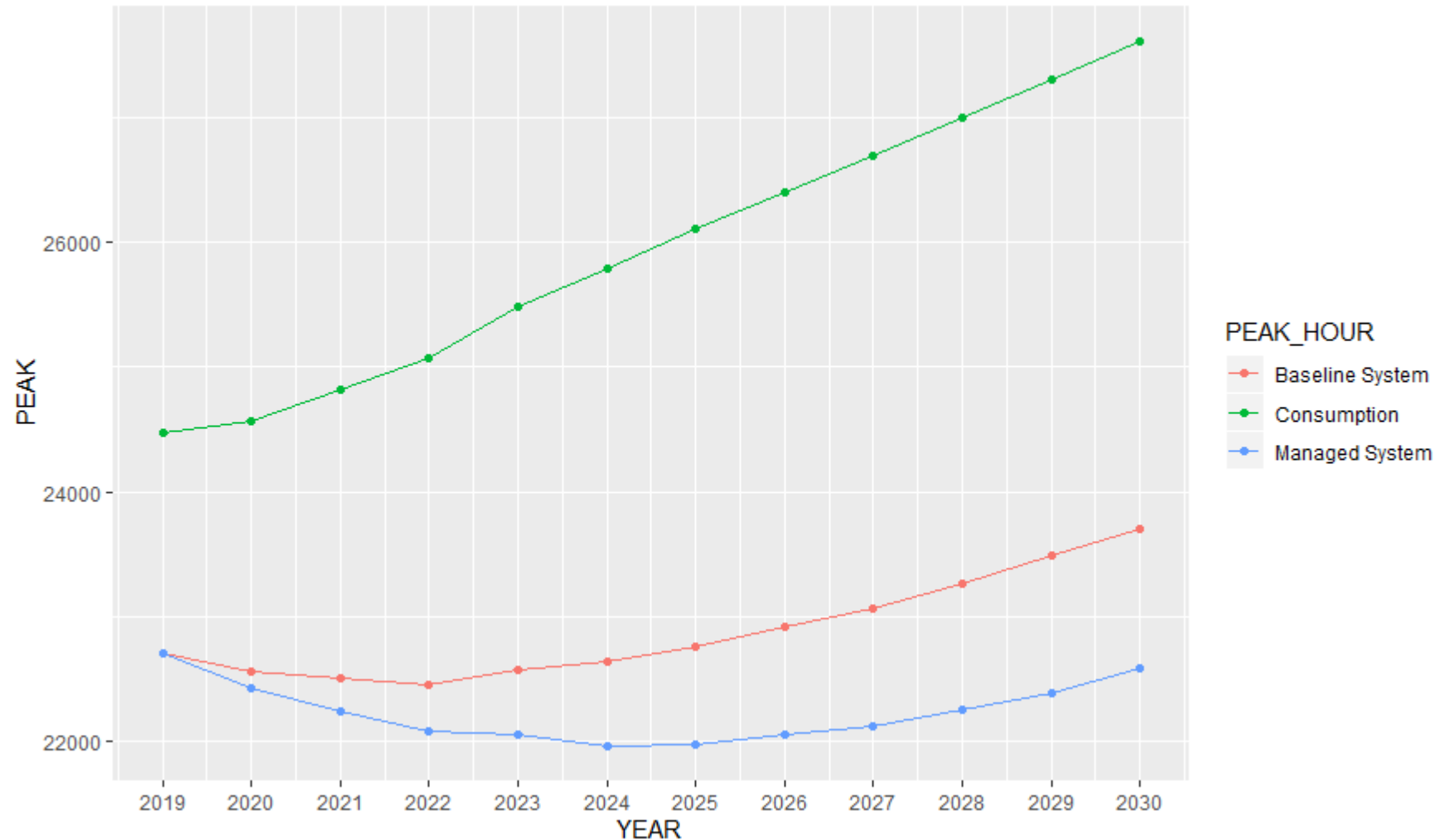


SCE Peak Projections

Mid Baseline
Mid-Mid AAEE

2019 Weather
Normalized peak:
22,708 MW

Average annual
growth (2019-2024):
-0.66%





SCE Demand Modifiers

YEAR	MONTH	DAY	HOUR	Climate Change	LDEV	MDHD	TOU	PV	Storage	AAEE
2019	9	3	16	20.2	17.2	0.3	0.0	1297.1	2.3	0.0
2020	9	1	16	40.9	38.8	0.7	0.0	1501.8	3.4	137.9
2021	9	7	16	61.8	43.3	0.8	-25.3	1746.5	4.9	255.2
2022	9	6	16	83.3	52.1	1.0	-68.4	1986.5	6.3	371.8
2023	9	5	16	105.4	66.1	1.4	-69.0	2209.3	7.8	523.8
2024	9	3	16	127.7	77.8	1.9	-69.6	2419.9	9.2	672.4
2025	9	2	17	148.1	105.1	2.8	-101.6	1373.7	32.6	791.6
2026	9	1	19	154.8	176.7	3.7	-86.3	0.1	63.1	731.3
2027	9	7	19	175.3	188.1	5.7	-87.1	0.1	73.4	829.5
2028	9	5	19	196.4	199.2	8.9	-87.8	0.2	84.1	925.8
2029	9	4	19	217.7	209.9	13.5	-88.5	0.2	94.9	1017.4
2030	9	3	19	239.5	221.4	19.2	-89.2	0.2	106.0	1108.1

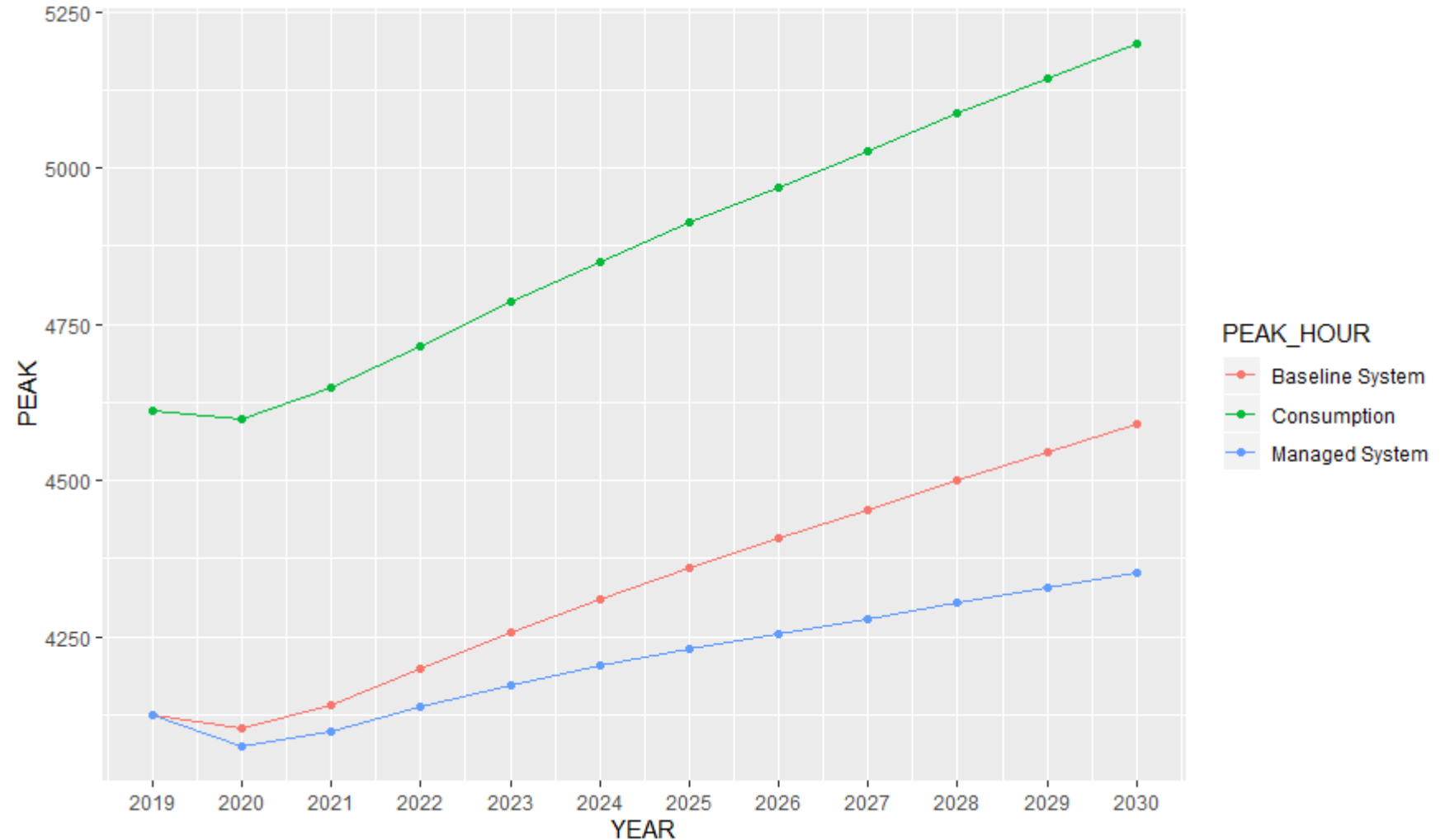


SDG&E Peak Projections

Mid Baseline
Mid-Mid AAEE

2019 Weather
Normalized peak:
4,125 MW

Average annual
growth:
0.48%





SDG&E Demand Modifiers

YEAR	MONTH	DAY	HOUR	Climate Change	LDEV	MDHD	TOU	PV	Storage	AAEE
2019	9	4	19	4.1	10.8	0.1	0.0	0.0	3.0	0.0
2020	9	2	19	8.2	21.3	0.3	-7.5	0.0	6.3	27.4
2021	9	1	19	12.4	30.3	0.5	-7.5	0.0	10.2	42.9
2022	9	7	19	16.7	41.8	0.7	-7.6	0.0	14.4	59.4
2023	9	6	19	21.1	53.5	1.0	-7.6	0.0	18.8	83.4
2024	9	4	19	25.5	63.4	1.4	-7.7	0.0	23.4	107.3
2025	9	3	19	30.0	72.2	2.0	-7.7	0.0	28.0	130.7
2026	9	2	19	34.6	78.8	3.0	-7.8	0.0	32.6	153.1
2027	9	1	19	39.2	84.6	4.5	-7.9	0.0	37.3	174.5
2028	9	6	19	44.0	90.4	6.9	-7.9	0.0	41.9	196.2
2029	9	5	19	48.7	96.1	10.3	-8.0	0.0	46.6	217.5
2030	9	4	19	53.5	102.2	14.4	-8.0	0.0	51.3	238.4



Base-year Monthly Peaks

	CEDU 2018				HLM 2019 (draft)				% change			
	PGE	SCE	SDGE	CAISO	PGE	SCE	SDGE	CAISO	PGE	SCE	SDGE	CAISO
Jan	14,476	13,936	3,136	31,597	14,343	13,998	3,178	31,482	-0.9%	0.4%	1.3%	-0.4%
Feb	14,131	13,774	3,109	30,746	13,929	13,868	3,184	30,613	-1.4%	0.7%	2.4%	-0.4%
Mar	13,567	13,747	3,010	29,855	13,349	13,830	3,086	29,672	-1.6%	0.6%	2.5%	-0.6%
Apr	14,219	15,141	2,953	32,233	14,053	15,214	3,024	32,120	-1.2%	0.5%	2.4%	-0.3%
May	16,477	16,681	3,143	36,171	16,657	16,683	3,240	36,364	1.1%	0.0%	3.1%	0.5%
Jun	19,344	18,935	3,282	41,185	19,456	18,852	3,267	41,170	0.6%	-0.4%	-0.4%	0.0%
Jul	20,379	21,016	3,499	44,890	20,468	20,649	3,466	44,692	0.4%	-1.7%	-0.9%	-0.4%
Aug	19,633	22,587	3,894	45,142	19,736	22,171	3,865	44,750	0.5%	-1.8%	-0.7%	-0.9%
Sep	18,694	23,105	4,197	45,406	18,819	22,708	4,126	44,979	0.7%	-1.7%	-1.7%	-0.9%
Oct	15,546	18,387	3,589	36,778	15,568	18,344	3,548	36,756	0.1%	-0.2%	-1.1%	-0.1%
Nov	14,043	14,553	3,183	31,561	13,828	14,712	3,190	31,421	-1.5%	1.1%	0.2%	-0.4%
Dec	14,860	14,383	3,214	32,542	14,797	14,538	3,268	32,576	-0.4%	1.1%	1.7%	0.1%

1-in-2 non-coincident system peaks (mid baseline, mid AAEE) in year 2019.
CEDU 2018 predicted vs. HLM 2019 calibrated.



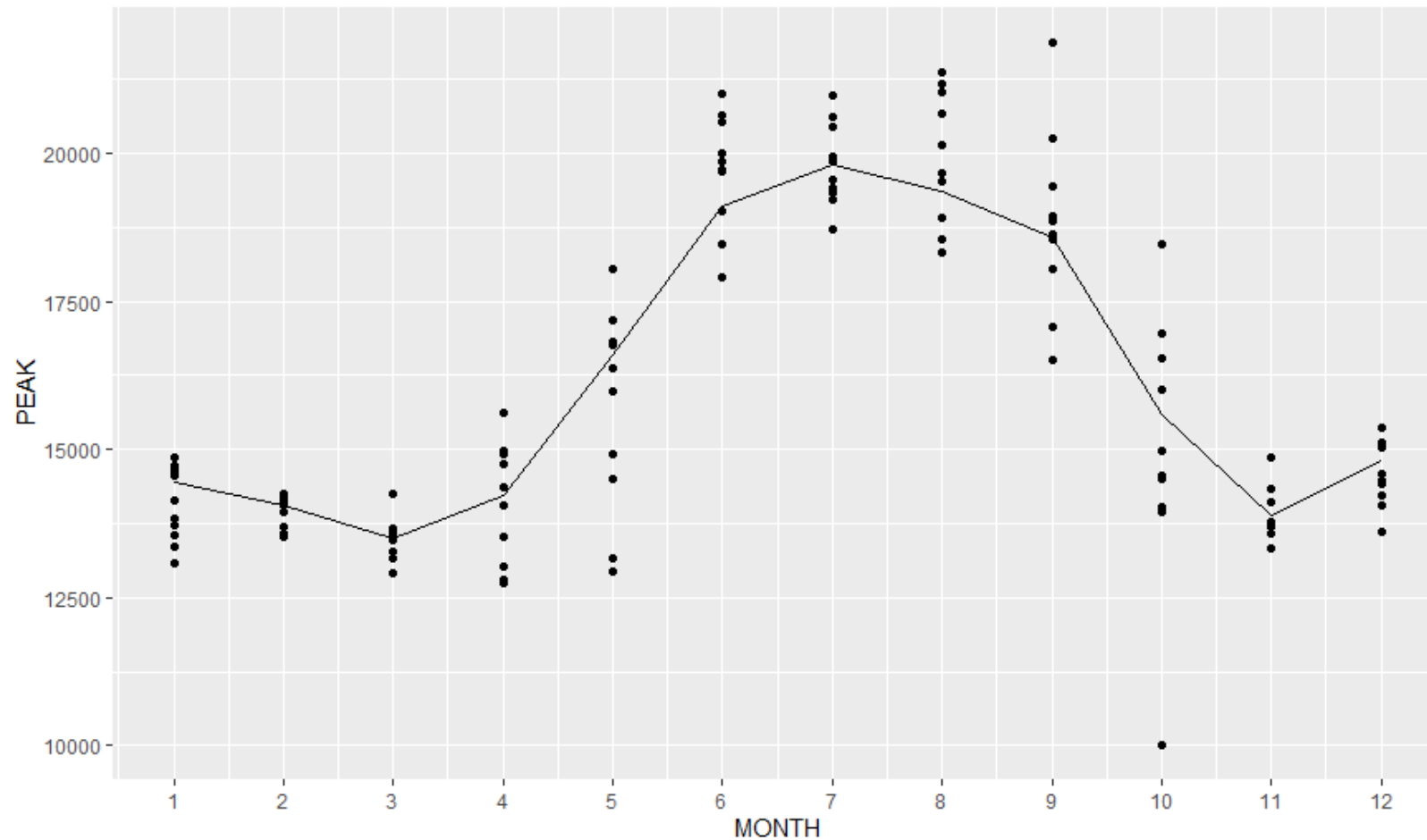
Monthly Peaks – 2021, 2022

	Year 2021				Year 2022			
	PGE	SCE	SDGE	CAISO	PGE	SCE	SDGE	CAISO
January	14,449	14,031	3,060	31,631	14,466	14,069	3,095	31,722
February	14,057	13,628	3,042	30,820	14,100	13,673	3,079	30,948
March	13,126	13,759	2,900	29,850	13,397	13,663	2,869	30,001
April	14,227	15,162	2,929	32,387	14,333	15,232	2,967	32,602
May	16,421	16,510	3,030	36,074	16,684	16,252	3,104	36,152
June	18,909	18,482	3,108	40,633	19,092	18,122	3,185	40,532
July	19,816	20,141	3,407	43,519	19,692	20,071	3,398	43,319
August	19,348	20,412	3,784	43,680	19,252	20,356	3,789	43,535
September	18,580	21,525	3,939	44,171	18,620	21,547	3,968	44,265
October	15,592	17,621	3,412	36,699	15,711	17,693	3,445	36,925
November	13,575	14,706	3,122	31,478	13,660	14,754	3,155	31,645
December	14,812	14,528	3,158	32,597	14,907	14,583	3,192	32,784

1-in-2 CAISO coincident peaks (mid baseline, mid AAEE)



PG&E – 2021 v Historical

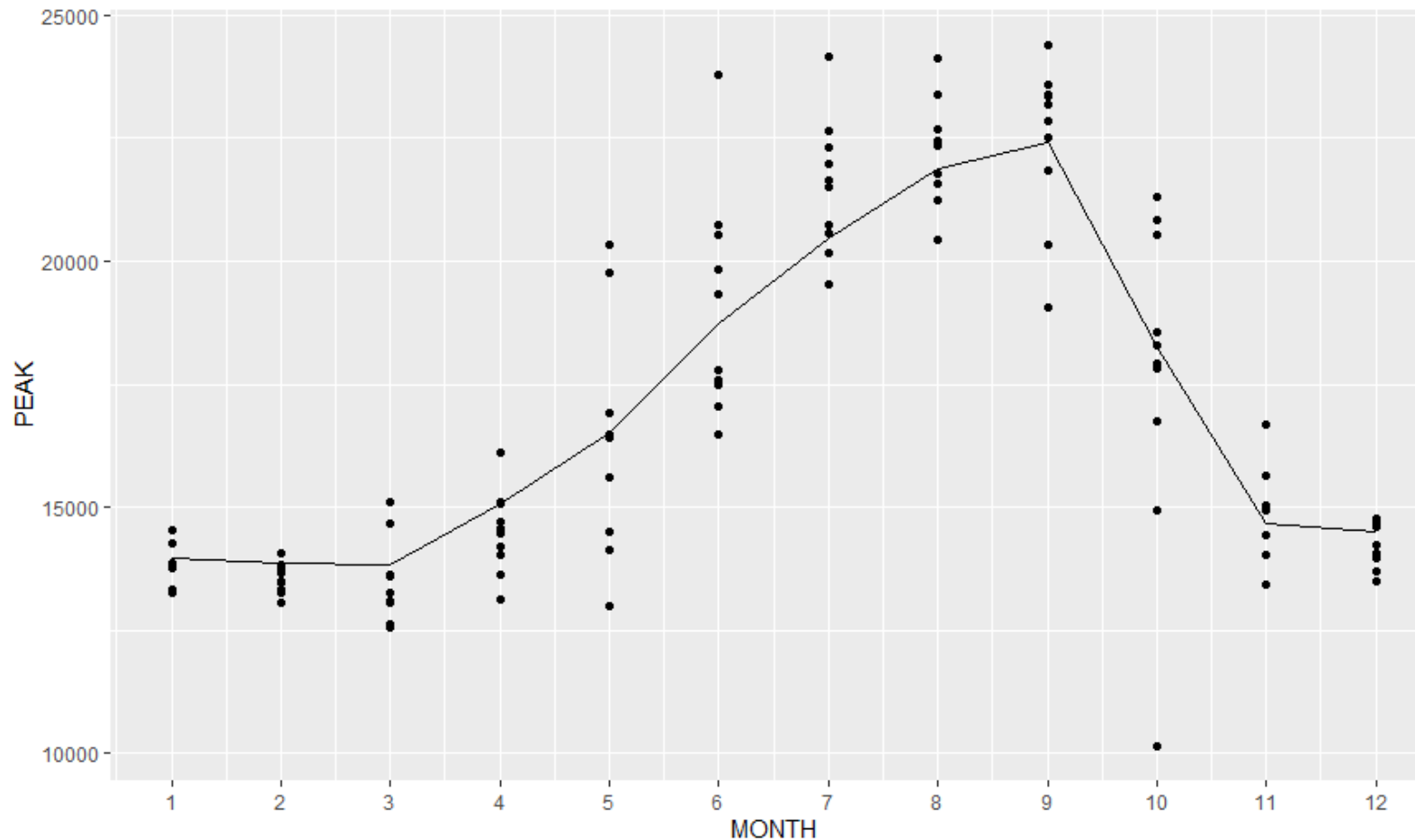


1-in-2 non-coincident (mid baseline, mid AAEE)

Predicted 2021 monthly peaks plotted against last ten historical years



SCE – 2021 v Historical

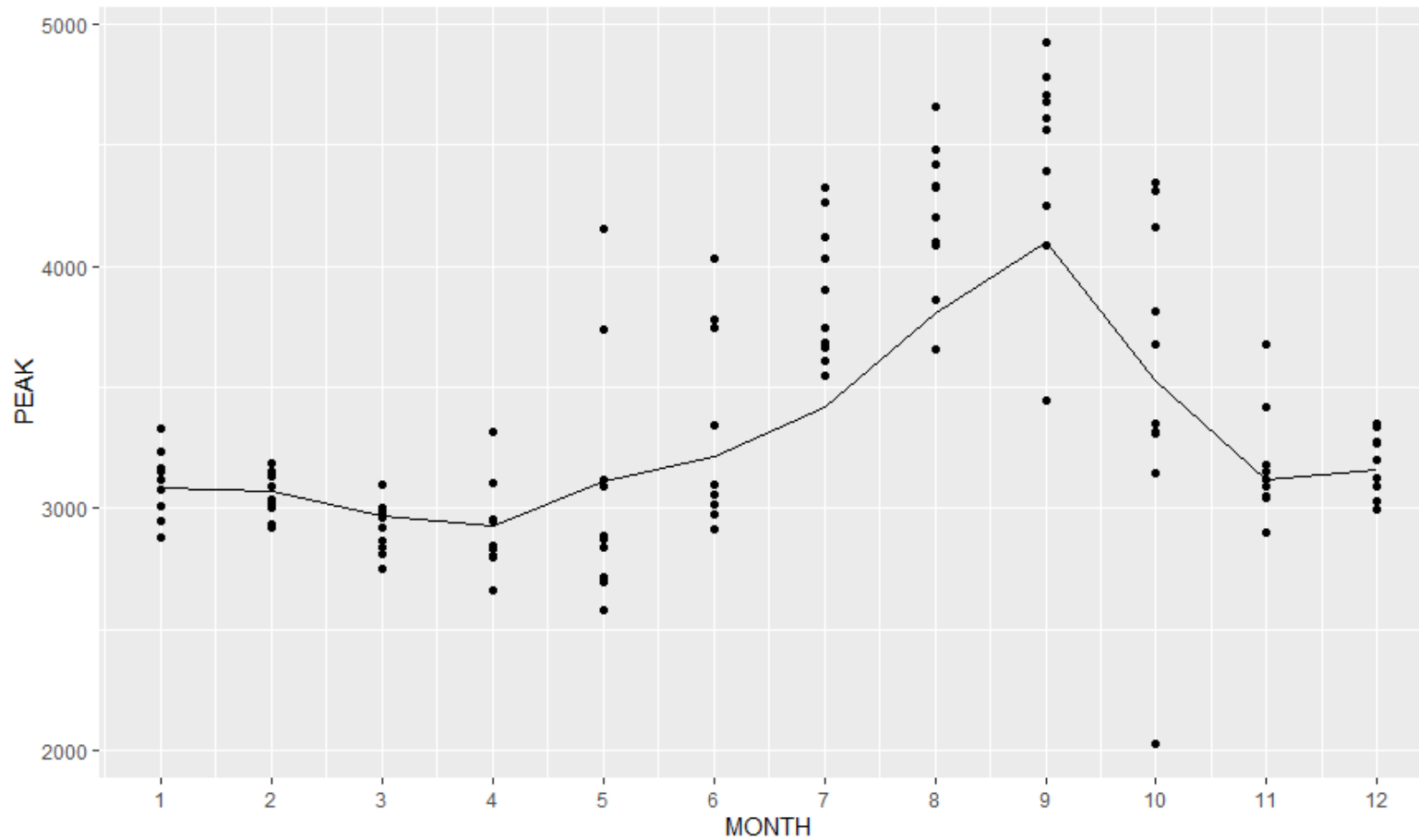


1-in-2 non-coincident (mid baseline, mid AAEE)

Predicted 2021 monthly peaks plotted against last ten historical years



SDG&E – 2021 v Historical



1-in-2 non-coincident (mid baseline, mid AAEE)

Predicted 2021 monthly peaks plotted against last ten historical years



Questions?