DOCKETED	
Docket Number:	19-IEPR-03
Project Title:	Electricity and Natural Gas Demand Forecast
TN #:	230924
Document Title:	Hourly Load Model
Description:	Presentation by Nick Fugate of CEC
Filer:	Raquel Kravitz
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	12/2/2019 9:46:26 AM
Docketed Date:	12/2/2019

Hourly Load Model

California Energy Demand
2019-2030 Revised Forecast

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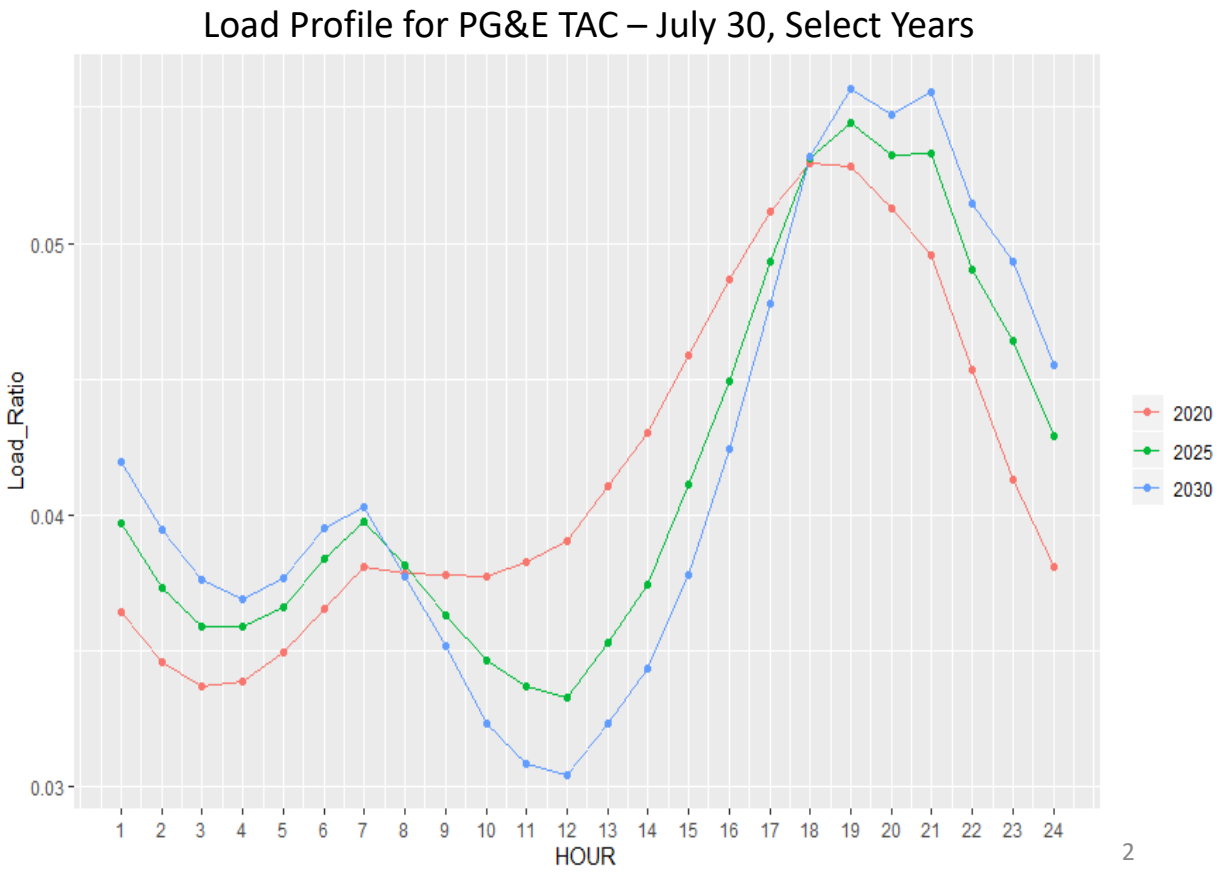
December 2, 2019
California Energy Commission

Purpose

The Hourly Load Model (HLM) appropriately reflects the contribution of BTM PV and other load modifiers to peak demand as the system peak hour moves later in the day



Use Cases

- Annual peak demand for IOU TACs and CAISO
- Monthly system peaks serve as a system-level benchmark for Resource Adequacy
- Input to system modeling

Method

1. Estimate the ratio of load in each hour to annual average hourly load
2. Apply estimated ratios to forecast of annual "consumption" load
3. Adjust consumption load using hourly profiles for climate change impacts, EV charging, PV generation, BTM storage, residential TOU impacts, and AAEE

Normalized Loads

1. Simulate 8760 load ratios varying historical hourly weather and calendar effects
2. Rank the load ratios in each simulation, highest to lowest
3. For each rank, select the median across all simulations
4. Assign these normalized load ratios to actual days and hours (calendar assignment)

Calendar Assignment

1. Use average TAC load ratio by day type and hour
2. Within each month, rank hourly load ratios and find the rank average across historical years
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
4. Assign simulated load ratios to calendar based on adjusted average load ratios for each calendar year

Key Inputs

CED 2019 Revised annual consumption forecast and 2019 weather normalized system peaks

Profiles:

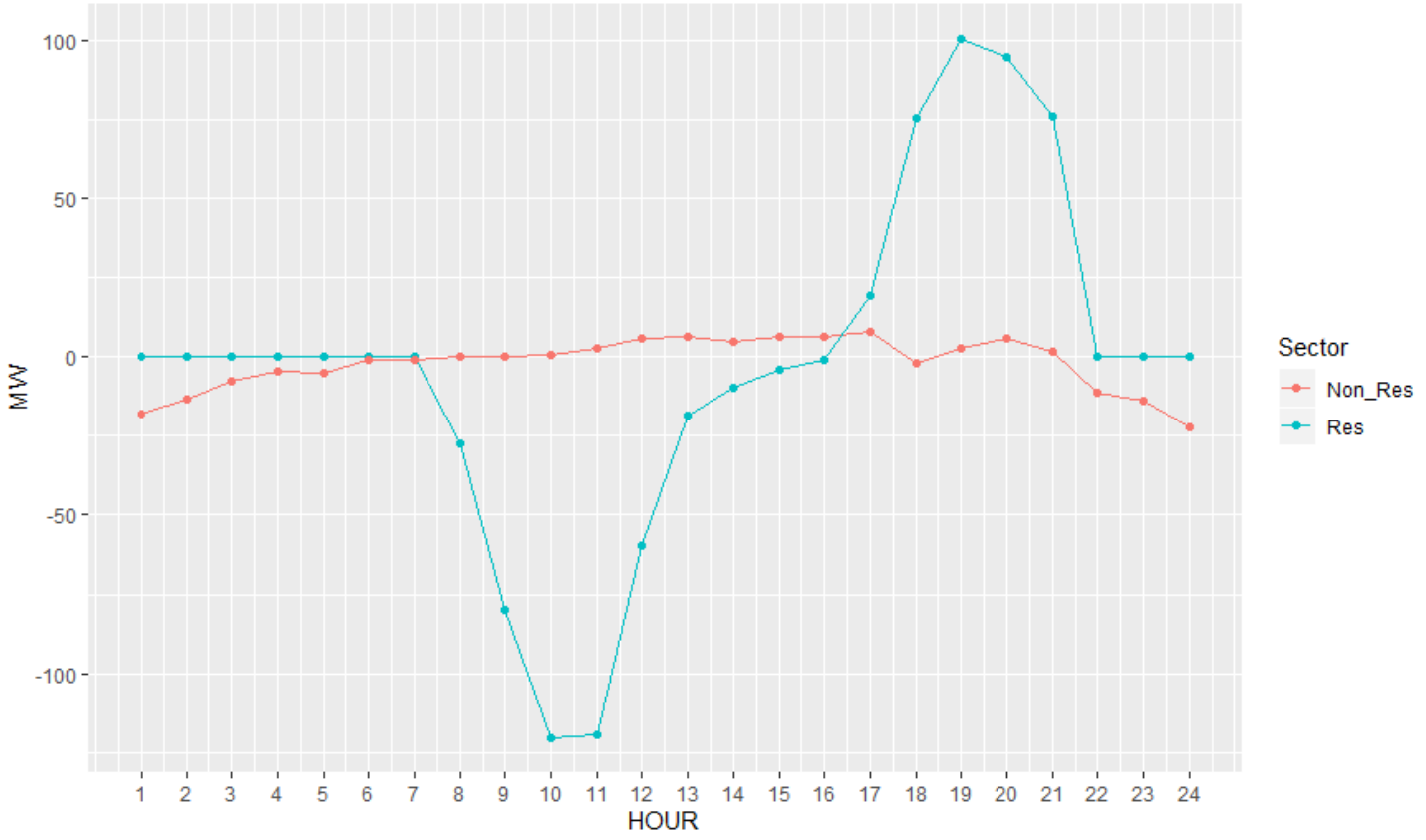
- PV generation – E3
- AAEE and vehicle charging profiles – ADM
  https://ww2.energy.ca.gov/2019publications/CEC-500-2019-046/CEC-500-2019-046.pdf
- Hourly temperature impacts – Scripps
- Residential TOU impact profiles – CEC
- BTM storage charge/discharge profiles – NREL* / Itron

Example Storage Profile

Sample summer 2030 weekday profile, PG&E TAC

Res profiles developed using NREL's System Advisor Model

Non-res profiles taken from Itron 2017 SGIP Impact Evaluation Report

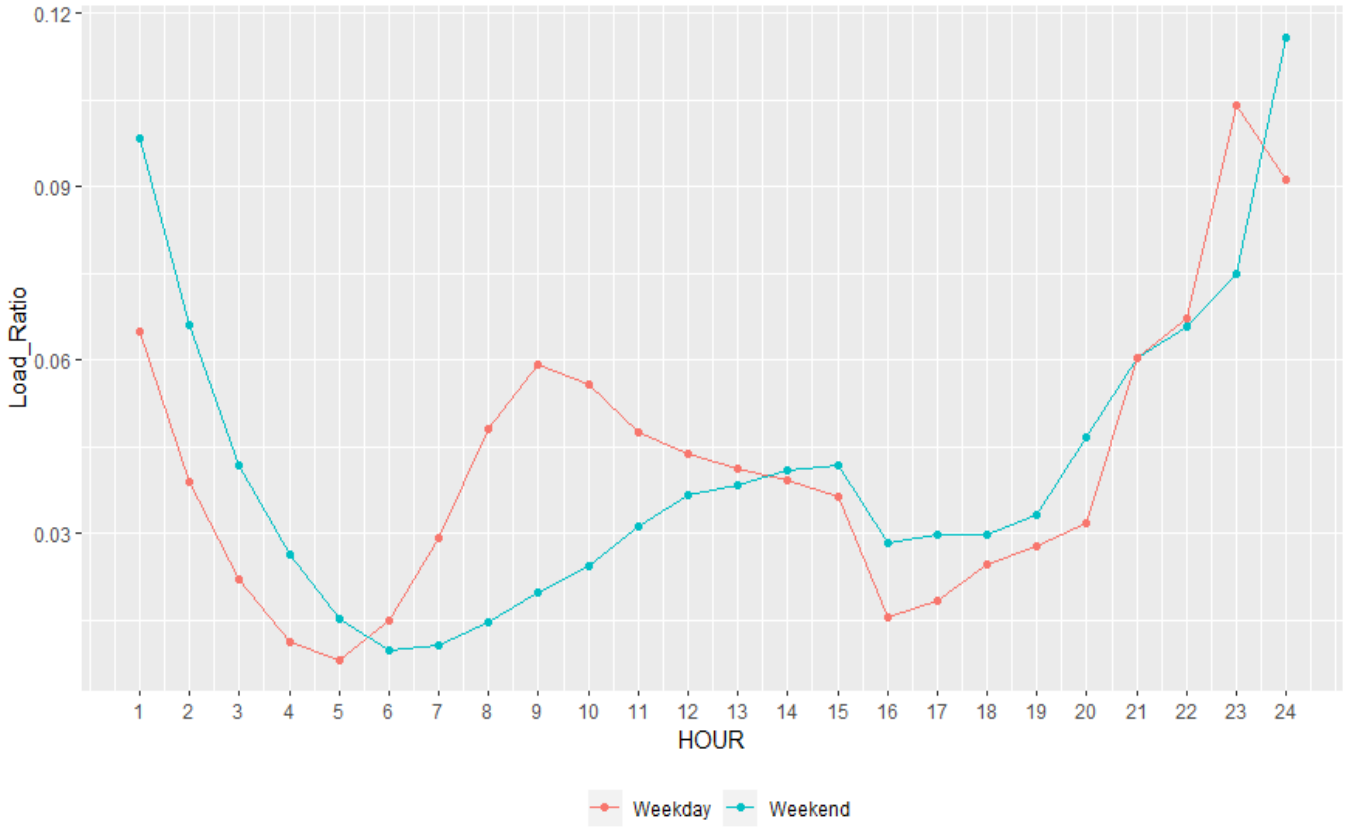


Example LDEV Charge Profile

Sample summer 2030 light-duty vehicle charging profile, SCE TAC

Profiles developed by ADM Associates through an EPIC-funded agreement

Leveraged ChargePoint data



Annual Weather Normalization

- TAC Annual Peak
  - Linear regression estimated using last 3 years of load data
  - Simulate through 30 years of summer days (June-Sept.)
  - Median of 30 annual peaks = 1-in-2 normalized peak
- Basic Equation for TACs:

Daily MW = Max + Max t-1 + Max t-2 + Min + DOW + monthly dummies + yearly dummies

Annual Model Fit

TAC	R-squared	MAPE	RMSE	Top 5 – MAPE *	Top 5 – RMSE *
PG&E	0.95	0.02	443	0.01	280
SCE	0.95	0.03	642	0.04	924
SDG&E	0.92	0.03	129	0.03	160

* Top 5 error is calculated based upon the predicted values from each TAC area model for the top 5 annual peak values for each of the years (2017-2019) used to estimate the model coefficients.

Annual Normalized Peaks

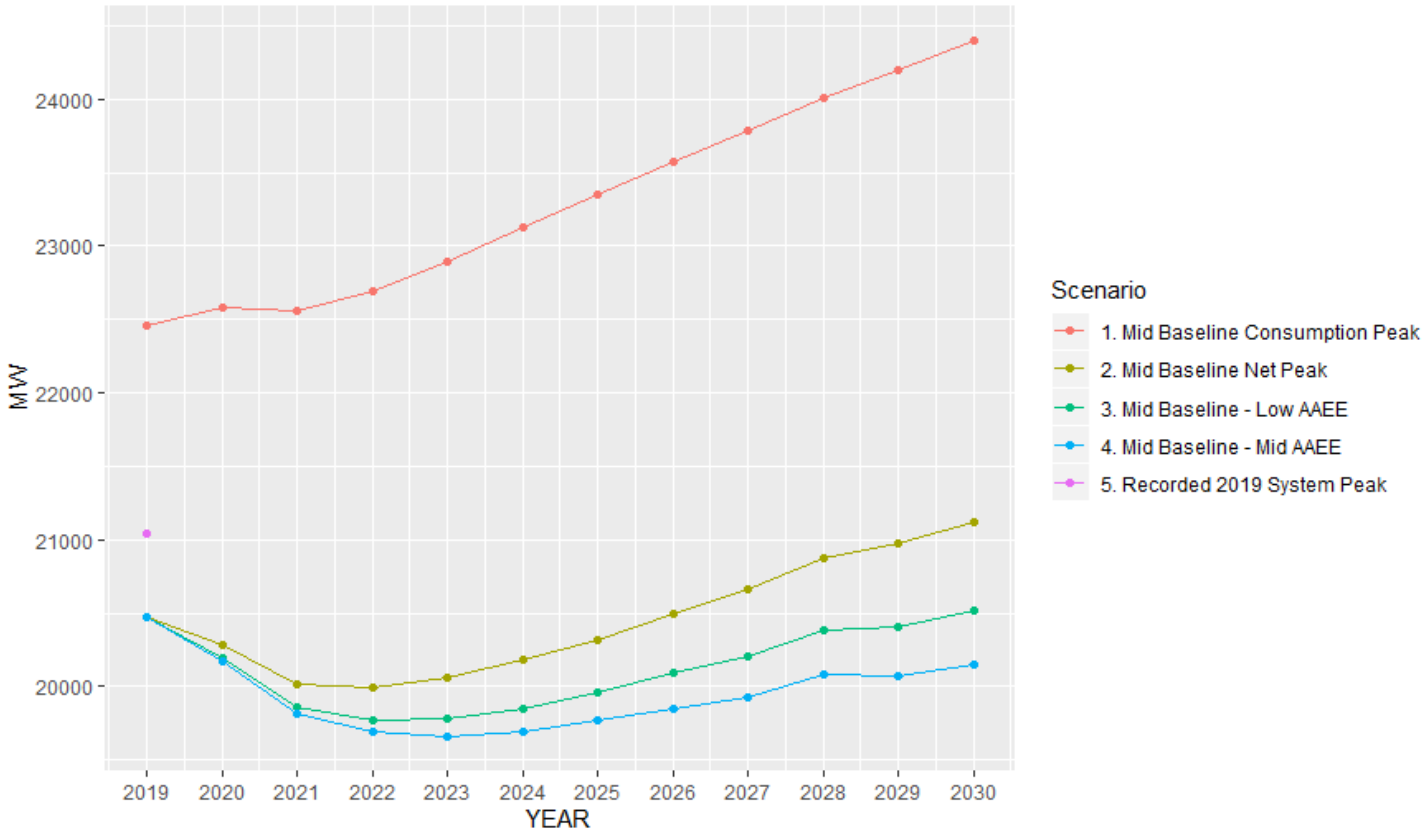
Weather Variant	Forecast	PG&E	SCE	SDG&E
1-in-2	CED 2019 Revised	20,468	22,708	4,126
	CEDU 2018	20,600	23,183	4,160
		-0.6% / -132 MW	-2% / -475 MW	-0.8% / -34 MW

PG&E Managed Peak Forecasts

2019 recorded peak:
21,037 MW

2019 Weather Normalized peak:
20,468 MW

Average annual growth (mid-mid):
-0.1%

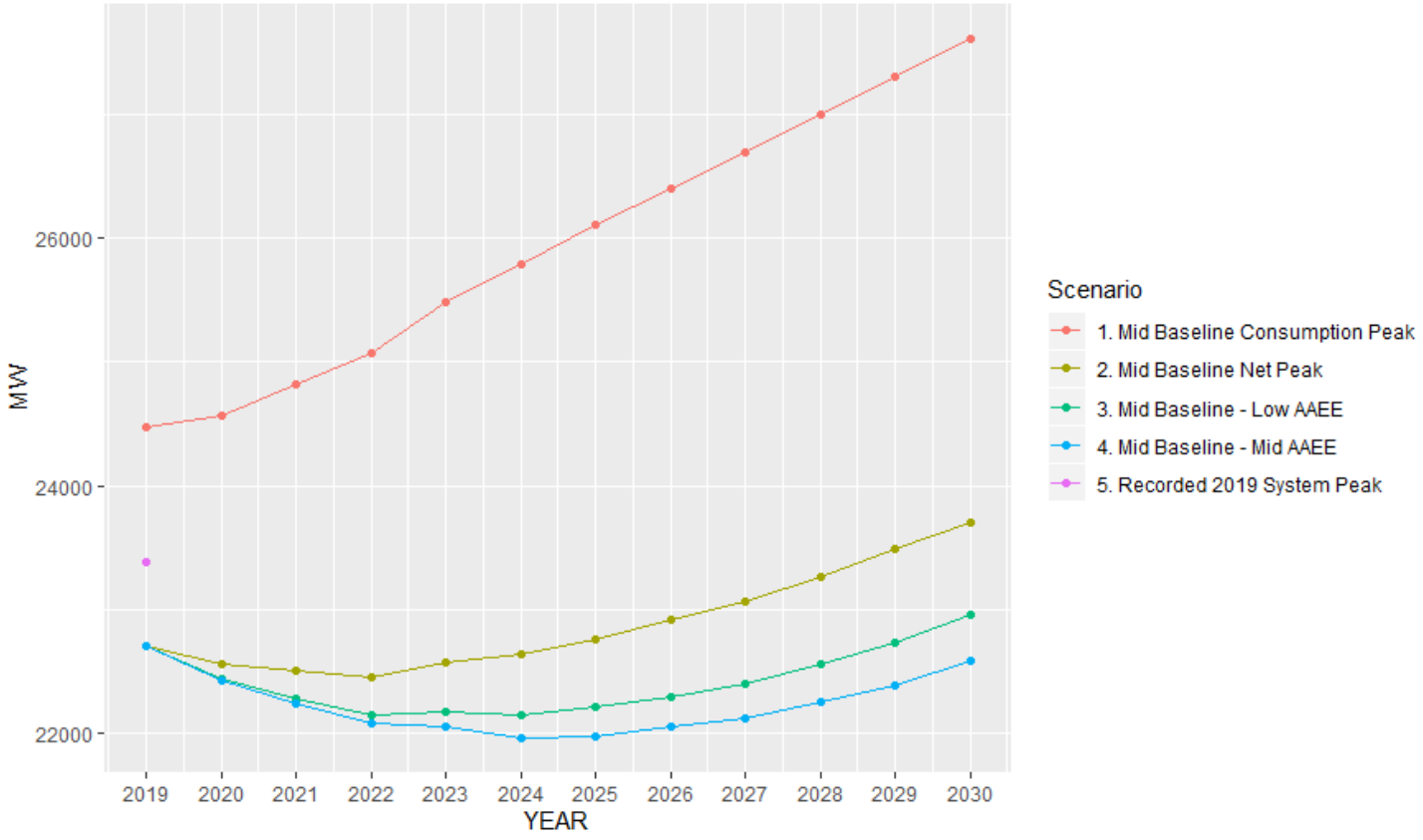


SCE Managed Peak Forecasts

2019 recorded peak:
23,383 MW

2019 Weather Normalized peak:
22,708 MW

Mid-mid scenario shows no growth over forecast

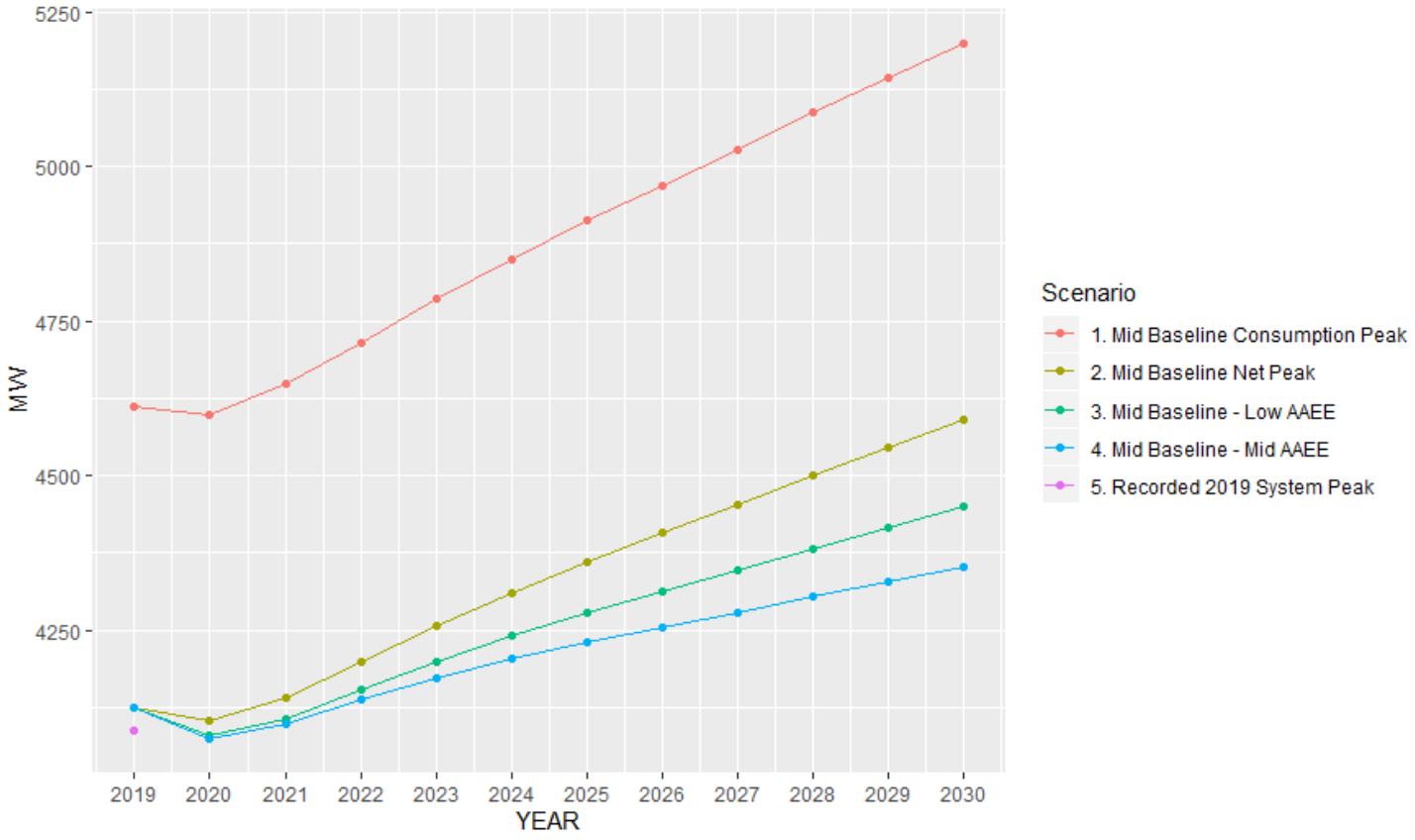


SDG&E Managed Peak Forecasts

2019 recorded peak:
4,088 MW

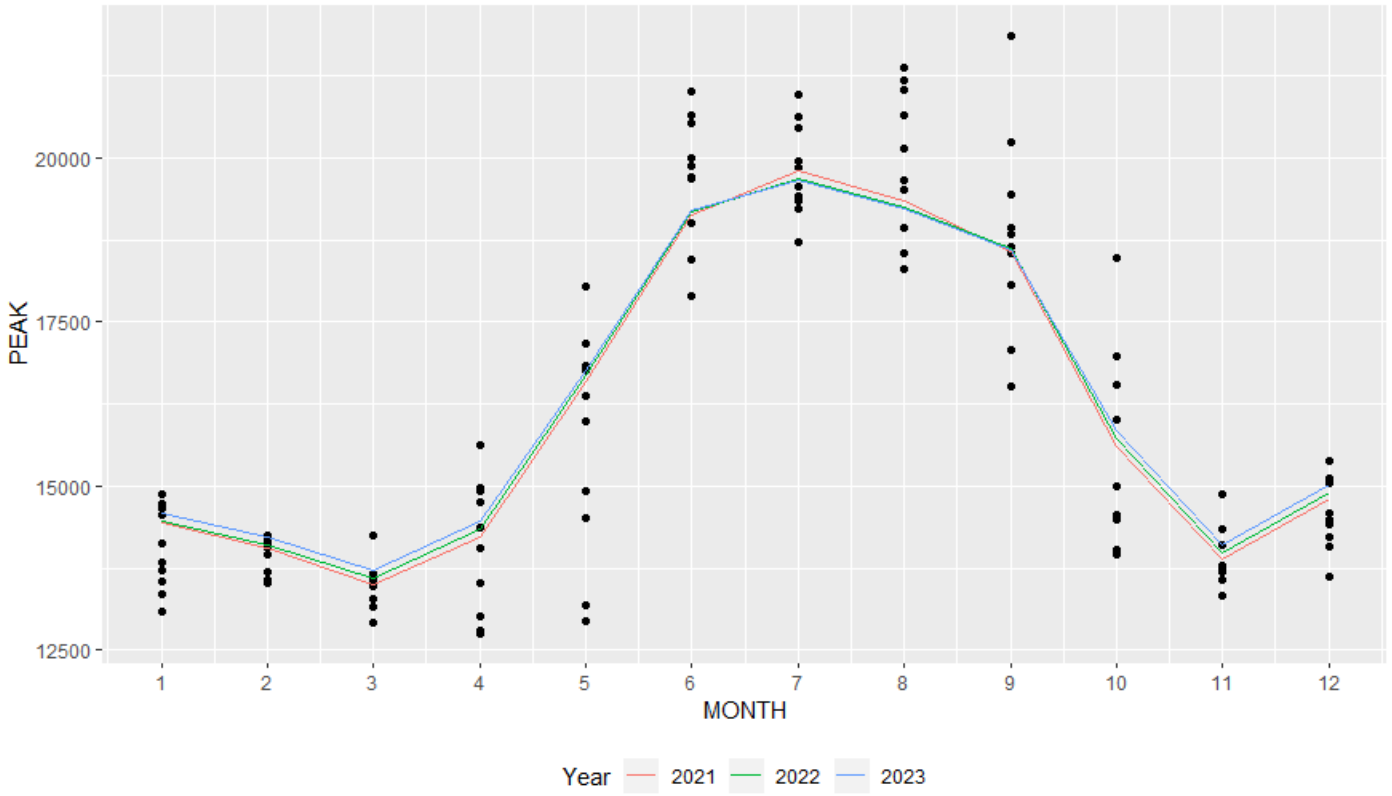
2019 Weather Normalized peak:
4,126 MW

Average annual growth (mid-mid):
0.48%



Monthly Peaks – PG&E TAC

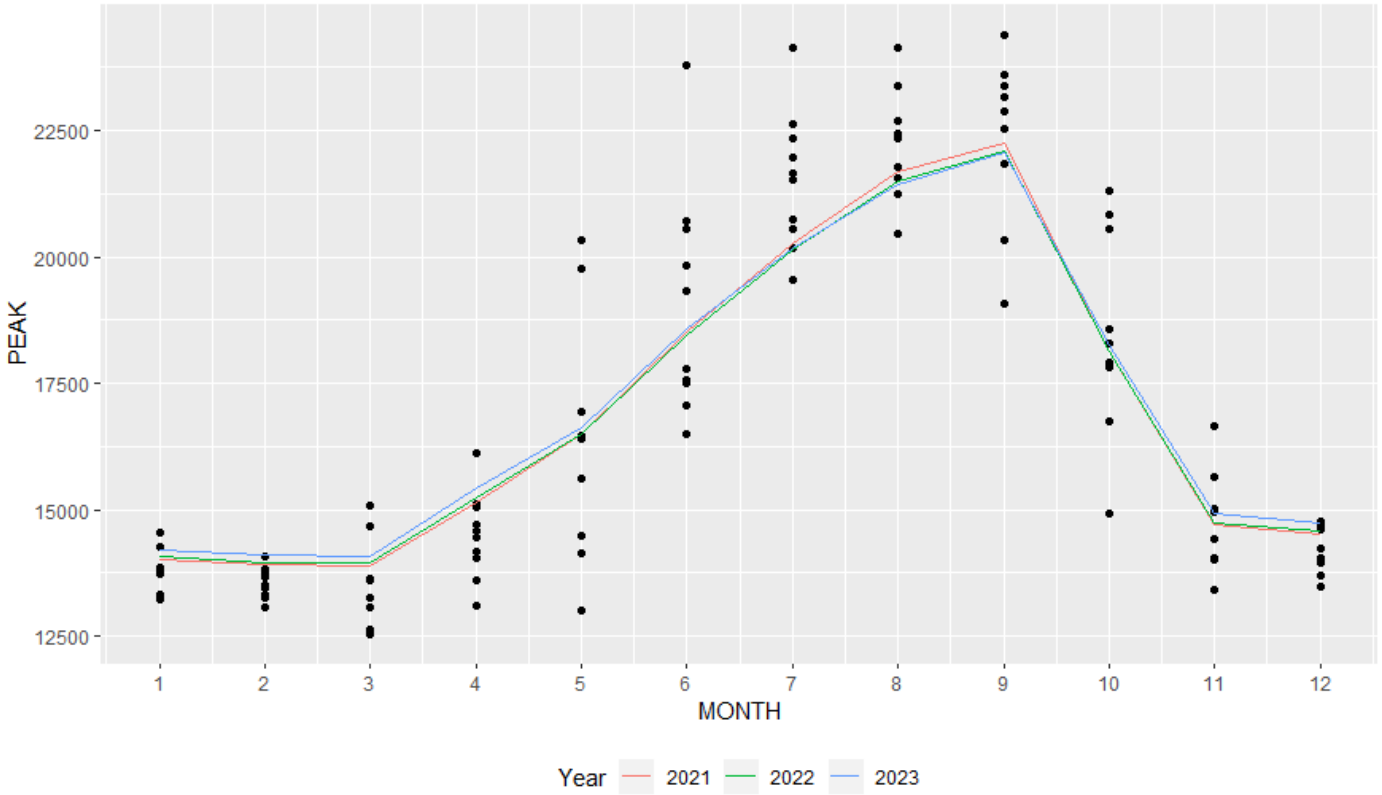
1-in-2 Non-coincident - Mid Baseline, Mid AAEE



MONTH	2021	2022	2023
1	14,449	14,466	14,580
2	14,057	14,100	14,216
3	13,506	13,590	13,707
4	14,227	14,333	14,477
5	16,591	16,684	16,767
6	19,118	19,179	19,189
7	19,816	19,692	19,661
8	19,348	19,252	19,217
9	18,580	18,620	18,602
10	15,592	15,711	15,830
11	13,881	13,990	14,100
12	14,812	14,907	15,020

Monthly Peaks – SCE TAC

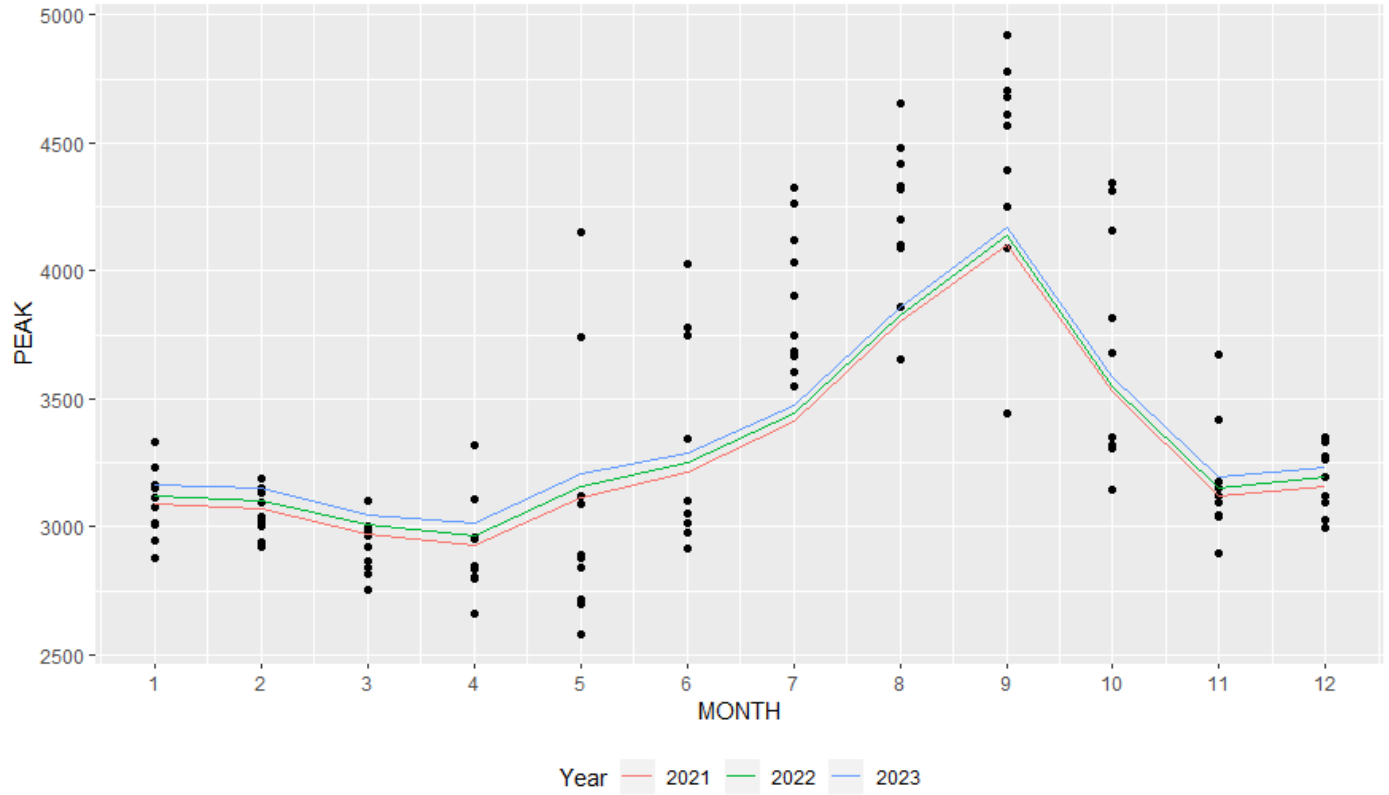
1-in-2 Non-coincident - Mid Baseline, Mid AAEE



MONTH	2021	2022	2023
1	14,031	14,069	14,204
2	13,916	13,967	14,110
3	13,902	13,947	14,093
4	15,162	15,232	15,418
5	16,510	16,506	16,631
6	18,522	18,457	18,562
7	20,258	20,127	20,173
8	21,679	21,484	21,437
9	22,247	22,079	22,052
10	18,143	18,120	18,249
11	14,706	14,754	14,913
12	14,528	14,583	14,741

Monthly Peaks – SDG&E TAC

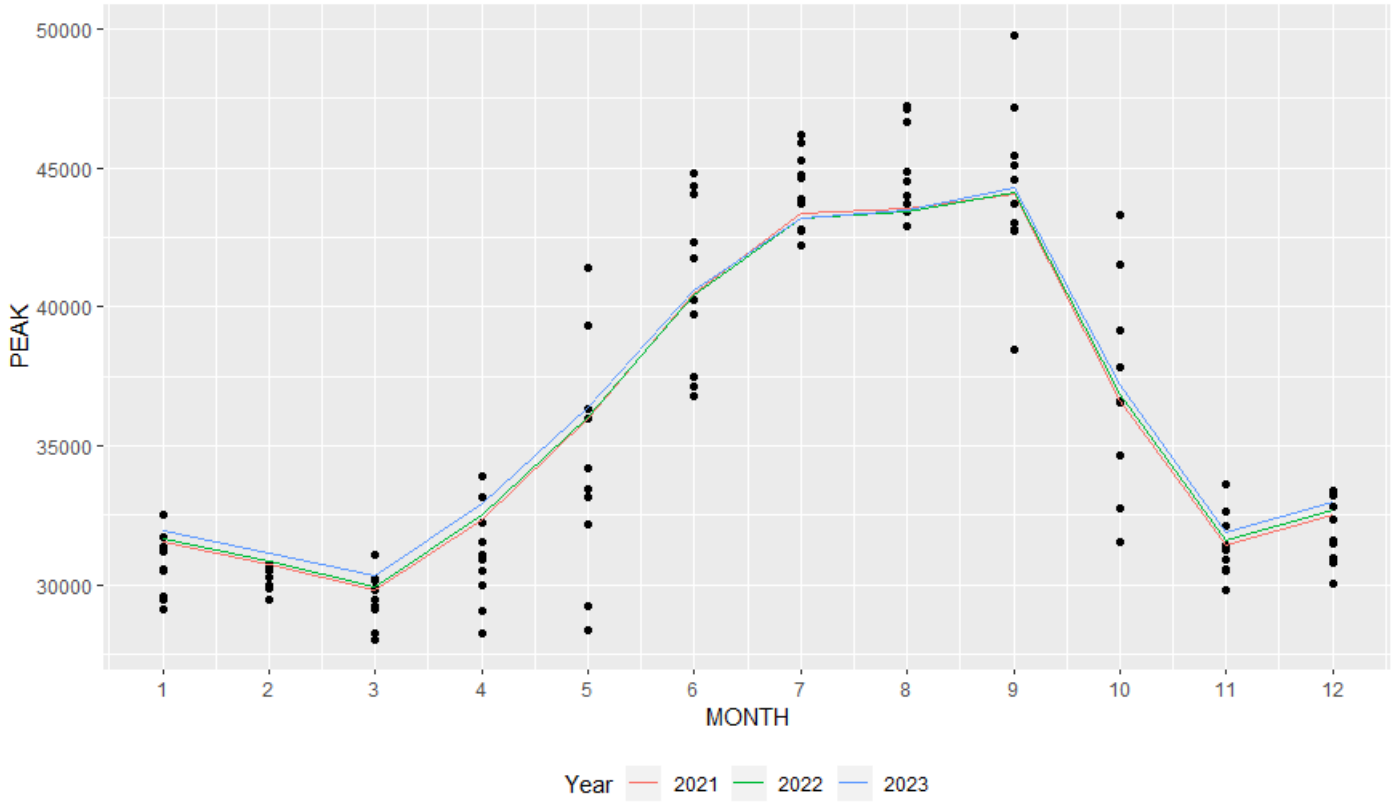
1-in-2 Non-coincident - Mid Baseline, Mid AAEE



MONTH	2021	2022	2023
1	3,087	3,122	3,164
2	3,071	3,105	3,149
3	2,971	3,009	3,049
4	2,929	2,967	3,013
5	3,113	3,157	3,207
6	3,217	3,249	3,288
7	3,415	3,443	3,476
8	3,804	3,827	3,858
9	4,099	4,139	4,173
10	3,530	3,552	3,586
11	3,122	3,155	3,194
12	3,158	3,192	3,235

Monthly Peaks – Combined TACS

1-in-2 CAISO-coincident - Mid Baseline, Mid AAEE



MONTH	2021	2022	2023
1	31,540	31,630	31,921
2	30,727	30,853	31,146
3	29,785	29,929	30,307
4	32,318	32,531	32,907
5	35,961	36,041	36,363
6	40,498	40,398	40,600
7	43,364	43,162	43,216
8	43,544	43,397	43,502
9	44,044	44,135	44,302
10	36,624	36,848	37,210
11	31,403	31,568	31,857
12	32,497	32,682	32,996

Finalizing CED 2019

- HLM results for the mid-mid and mid-low planning scenarios have been provided to key stakeholders
- Results for all baseline and managed scenarios will be docketed
- Staff are available during comment period for additional discussion with stakeholders
- Staff seek, in particular, stakeholder reaction to 2019 weather-normalized peak estimates

Appendix Slides

Appendix : PG&E Demand Modifiers

Contribution of demand modifiers at the hour of managed system peak demand, mid baseline – mid AAEE

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

Appendix: SCE Demand Modifiers

Contribution of demand modifiers at the hour of managed system peak demand, mid baseline – mid AAEE

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

Appendix: SDG&E Demand Modifiers

Contribution of demand modifiers at the hour of managed system peak demand, mid baseline – mid AAEE

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

Appendix: Baseline Net Peaks