



California Energy Commission

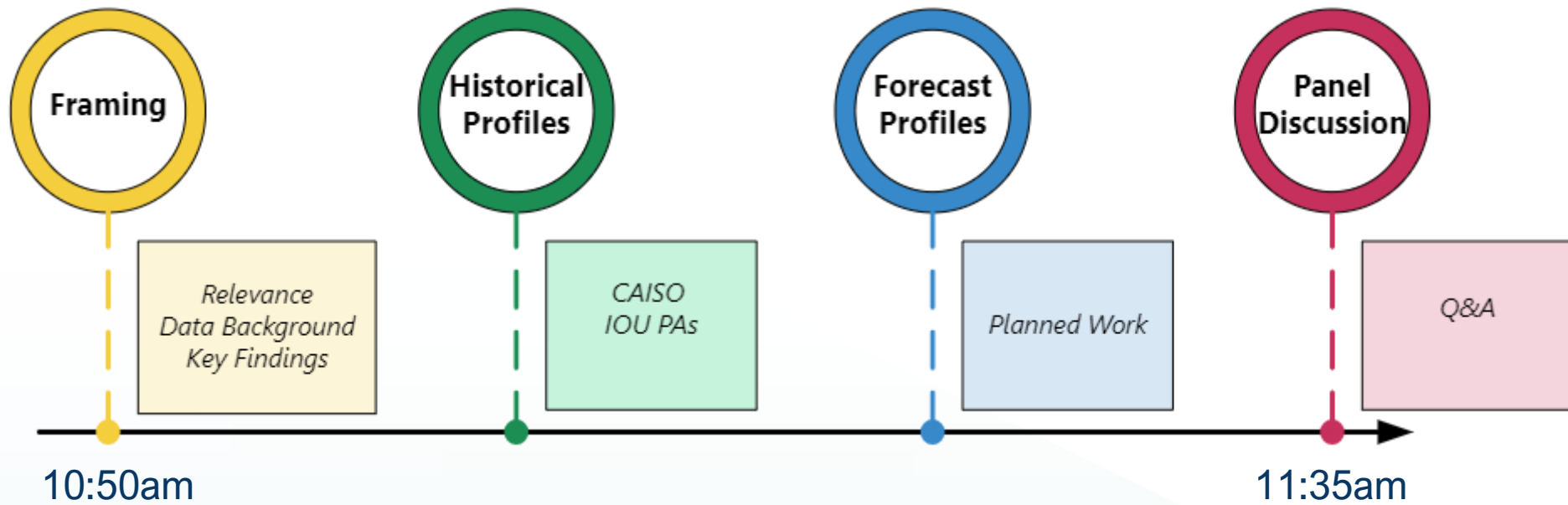
Title: Behind-The-Meter Hourly PV Updates

Presenter: Alex Lonsdale, Distributed Generation Forecast Supervisor

Date: August 21, 2024



Agenda





List of Acronyms and Initialisms

BTM – Behind-the-meter

CA - California

CHP – Combined Heat and Power

DAWG – Demand Analysis Working Group

DG – Distributed Generation

dGen – Distributed Generation Market Demand Model

DER – Distributed Energy Resource

IEPR – Integrated Energy Policy Report

MW – Megawatt

NCNC – Northern California Non-California ISO

NBT – Net Billing Tariff

NEM – Net Energy Metering

PA – Planning Area

POU – Publicly Owned Utility

PV – Photovoltaics

SGIP – Self Generation Incentive Program



Present Updates: 2024 IEPR

- Staff plan to limit hourly updates to BTM PV

Technology	Planned Updates
PV	Historical and forecast normalized profiles
	Historical and forecast capacity factors

Source: CEC Staff



Relevance

- **BTM PV capacity factors:**
 - Estimate historical BTM PV electric generation
- **Historical BTM PV generation use cases:**
 - Hourly Load Model (HLM)
 - Sector models forecast consumption
 - Utility billing data is sales, and need to add BTM generation to the sales data to estimate consumption



Key Findings: Historical BTM PV Generation

- CED 2024 PV capacity factors are lower than CED 2023
- Implications:
 - **Reduction in BTM PV generation estimates for CED 2024**
 - In September 2022, the average BTM PV capacity factor during hour of peak demand (17) is about 2% points or 260 MW lower than previously estimated
 - HLM and sector models require re-estimation to further assess impacts



Background: PV Profile Data

- **Level setting:** Following slides highlight changes to CEC's historical BTM PV capacity factors
 - **Capacity Factor:** Measures ratio of actual power output to rated capacity
 - Factors are utilized to estimate total historical BTM PV generation
- **Data Procurement:** In 2023, CEC procured a large sample of behind-the-meter (BTM) PV generation data
 - **Spatiotemporal elements:**
 - Date
 - Hour
 - Minutes
 - Customer sector
 - CEC forecast zone
 - **Measurements:**
 - 15-minute average power measured at the AC side of the inverter
 - Total installed inverter AC active power



Historical BTM PV Profiles



CAISO Historical BTM PV Capacity Factors

- Annual capacity factors calculated from new vendor data are 3-4% points lower than CED 2023
- Monthly average capacity factors were calculated from calendar years 2018-2022
 - Monthly average factors from vendor data are 2-5% points lower than CED 2023

		Year				
pa	source	2018	2019	2020	2021	2022
CAISO	CED 2023	21.2%	20.3%	20.8%	21.0%	21.6%
CAISO	Vendor Data	18.1%	17.4%	17.8%	17.9%	18.5%

		Month											
pa	source	1	2	3	4	5	6	7	8	9	10	11	12
CAISO	CED 2023	12.8%	18.5%	21.1%	25.8%	27.4%	28.8%	27.8%	25.2%	21.5%	18.1%	14.2%	10.6%
CAISO	Vendor Data	10.9%	15.7%	18.0%	22.0%	23.4%	24.6%	23.7%	21.5%	18.3%	15.5%	12.2%	9.1%

Source: CEC Staff



IOU PA Historical BTM PV Factors

- IOU PA annual capacity factors are consistently lower than last year
- Average reduction in capacity factors:
 - PG&E – 3.3%
 - SCE – 3.0%
 - SDG&E – 2.8%

Sector: All		Year		
Planning Area	Source	2020	2021	2022
PGE	CED 2023	20.3%	20.9%	21.5%
PGE	Vendor Data	17.2%	17.6%	18.2%
SCE	CED 2023	21.1%	21.3%	22.0%
SCE	Vendor Data	18.1%	18.4%	19.0%
SDGE	CED 2023	22.0%	20.9%	21.0%
SDGE	Vendor Data	19.1%	18.2%	18.3%

Source: CEC Staff



IOU Monthly BTM PV Capacity Factors: PG&E

- Average reduction in seasonal capacity factors:
 - Winter – 2.1%
 - Spring – 4.0%
 - Summer – 4.3%
 - Fall – 2.7%

Sector: All			Month											
Planning Area	Year	Source	1	2	3	4	5	6	7	8	9	10	11	12
PGE	2020	CED 2023	11.4%	19.6%	18.9%	24.4%	27.9%	29.8%	28.9%	24.0%	18.6%	15.8%	13.7%	11.4%
PGE	2020	Vendor Data	9.6%	16.5%	15.9%	20.6%	23.6%	25.2%	24.4%	20.2%	15.7%	13.3%	11.6%	9.6%
PGE	2021	CED 2023	11.1%	17.5%	22.4%	27.9%	30.7%	30.2%	27.8%	24.3%	21.8%	16.4%	12.6%	8.0%
PGE	2021	Vendor Data	9.3%	14.7%	18.9%	23.5%	25.8%	25.4%	23.4%	20.4%	18.3%	13.8%	10.6%	6.7%
PGE	2022	CED 2023	12.9%	18.8%	21.7%	27.1%	30.6%	30.0%	28.7%	26.4%	21.7%	18.1%	14.0%	8.4%
PGE	2022	Vendor Data	10.8%	15.8%	18.4%	23.0%	25.9%	25.3%	24.3%	22.3%	18.4%	15.2%	11.9%	7.1%

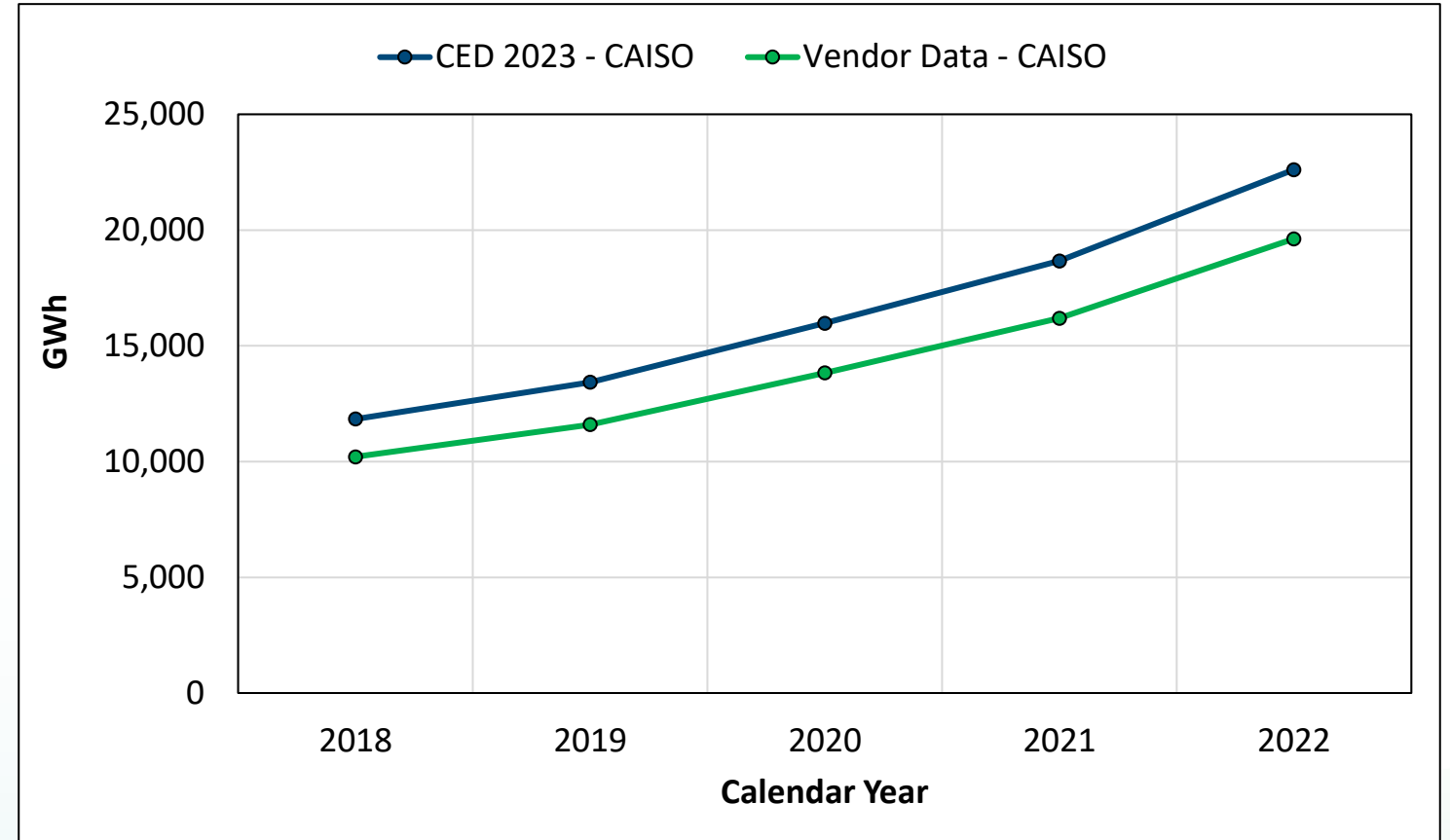
Source: CEC Staff



Annual BTM PV Generation: CAISO

- Vendor capacity factors results in 12-13% reduction in historical BTM PV generation
- Translates to about 3,000 GWh less generation in 2022

Calendar Year	CED 2023	Vendor Data
2018	11,841	10,206
2019	13,426	11,600
2020	15,974	13,828
2021	18,667	16,191
2022	22,607	19,622



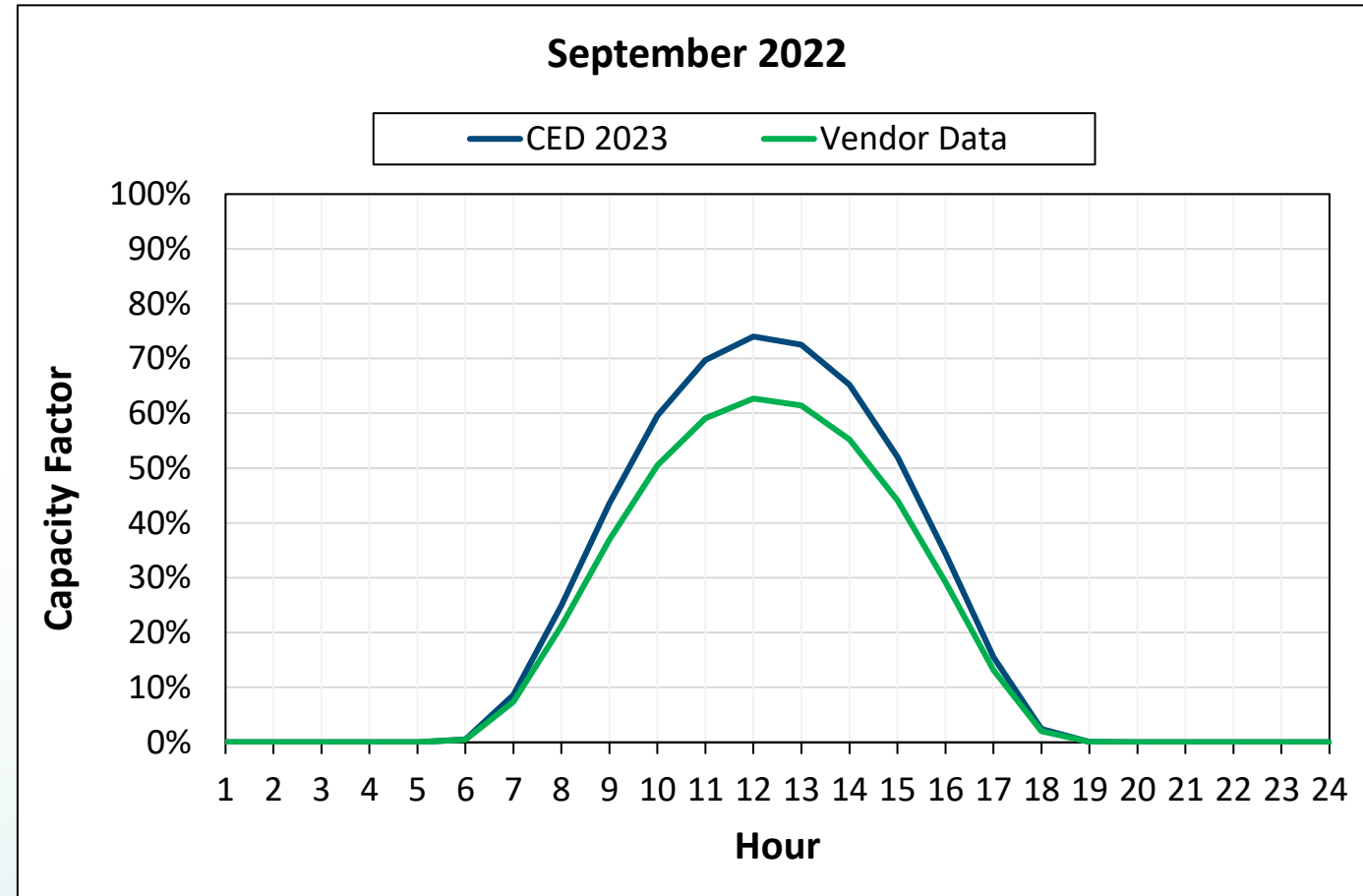
Source: CEC Staff



CAISO Historical Average Hourly BTM PV Capacity Factors

- Vendor data reduces
 - Daily max capacity factor by ~11% points
 - Net peak hour (17) capacity factor by ~2% points

Hour	Source	
	CED 2023	Vendor Data
1	0%	0%
2	0%	0%
3	0%	0%
4	0%	0%
5	0%	0%
6	1%	0%
7	9%	7%
8	25%	21%
9	44%	37%
10	60%	51%
11	70%	59%
12	74%	63%
13	73%	61%
14	65%	55%
15	52%	44%
16	34%	29%
17	16%	13%
18	2%	2%
19	0%	0%
20	0%	0%
21	0%	0%
22	0%	0%
23	0%	0%
24	0%	0%



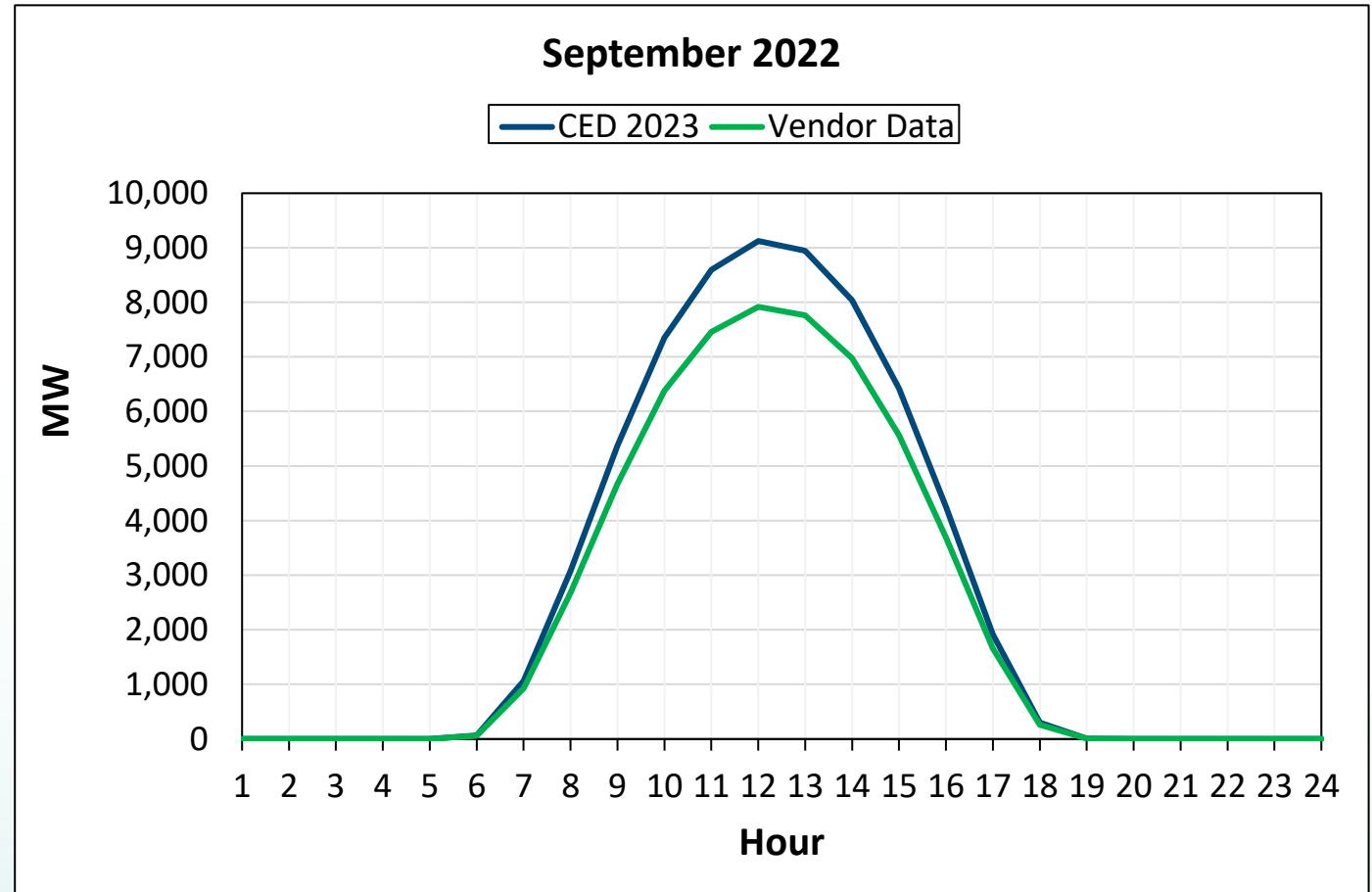
Source: CEC Staff



CAISO Historical Average Hourly BTM PV Generation

- Over 13 GW of BTM PV capacity in 2022
- Hour of peak demand (17) is ~260 MW lower than CED 2023
- Daily maximum generation is ~1,200 MW lower than CED 2023

Hour	Source	
	CED 2023	Vendor Data
1	0	0
2	0	0
3	0	0
4	0	0
5	2	1
6	63	55
7	1,063	926
8	3,080	2,680
9	5,369	4,665
10	7,348	6,379
11	8,593	7,458
12	9,123	7,916
13	8,945	7,759
14	8,040	6,973
15	6,417	5,565
16	4,251	3,687
17	1,915	1,660
18	298	257
19	9	7
20	3	2
21	0	0
22	0	0
23	0	0
24	0	0

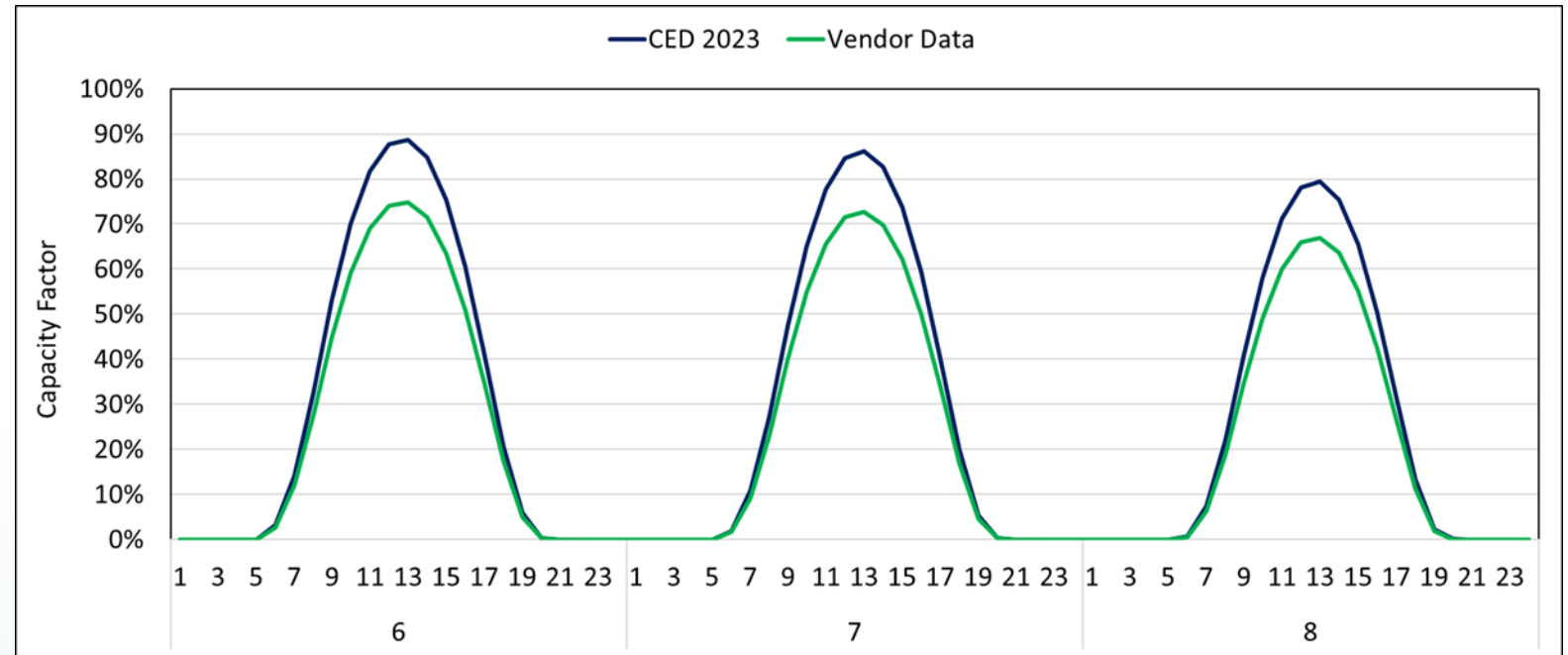


Source: CEC Staff



PG&E Historical Average BTM PV Profiles: Summer Months, 2020-2022

- Averages include 2020-2022 calendar year data
- Vendor data reduces:
 - Daily max capacity factor by 10-12% points
 - Net peak hour (17) capacity factor by 4-5% points



Source: CEC Staff



Forecast BTM PV Profiles



Planned Updates

- Forecast BTM PV profiles methodology remains unchanged
 - Incorporates new PV data
 - Lower generation estimates across PAs
 - Expect less change to hourly shapes
- Staff will present forecast profiles at a fall DAWG meeting



Panel Discussion



Appendix





IOU PA Monthly BTM PV Capacity Factors: SDG&E

- Average seasonal percentage point reduction in monthly capacity factors
 - Winter – 2.0%
 - Spring – 3.2%
 - Summer – 3.4%
 - Fall – 2.4%

Sector: All			Month											
Planning Area	Year	Source	1	2	3	4	5	6	7	8	9	10	11	12
SDGE	2020	CED 2023	16.3%	20.4%	19.9%	22.6%	28.9%	26.5%	29.4%	26.9%	22.1%	19.0%	17.3%	14.0%
SDGE	2020	Vendor Data	14.2%	17.7%	17.4%	19.7%	25.2%	23.1%	25.6%	23.4%	19.2%	16.5%	15.1%	12.2%
SDGE	2021	CED 2023	14.6%	19.1%	22.8%	25.0%	25.5%	26.7%	26.2%	23.8%	22.0%	18.3%	15.8%	10.6%
SDGE	2021	Vendor Data	12.7%	16.7%	19.8%	21.8%	22.2%	23.2%	22.8%	20.7%	19.1%	16.0%	13.7%	9.2%
SDGE	2022	CED 2023	14.1%	19.4%	23.5%	26.4%	26.0%	28.1%	25.7%	24.3%	20.8%	16.7%	15.6%	11.9%
SDGE	2022	Vendor Data	12.3%	16.9%	20.5%	23.0%	22.6%	24.4%	22.4%	21.1%	18.1%	14.6%	13.6%	10.4%

Source: CEC Staff



IOU PA Monthly BTM PV Capacity Factors: SCE

- Average seasonal percentage point reduction in monthly capacity factors
 - Winter – 2.2%
 - Spring – 3.6%
 - Summer – 3.8%
 - Fall – 2.6%

Sector: All			Month											
Planning Area	Year	Source	1	2	3	4	5	6	7	8	9	10	11	12
SCE	2020	CED 2023	15.1%	20.1%	19.6%	23.2%	28.9%	27.3%	28.4%	24.7%	19.9%	16.7%	16.0%	13.2%
SCE	2020	Vendor Data	12.9%	17.2%	16.8%	19.9%	24.8%	23.4%	24.4%	21.2%	17.1%	14.3%	13.7%	11.3%
SCE	2021	CED 2023	14.4%	19.5%	23.4%	26.0%	27.4%	27.9%	26.5%	24.8%	21.9%	18.5%	15.4%	10.6%
SCE	2021	Vendor Data	12.3%	16.8%	20.0%	22.3%	23.5%	24.0%	22.8%	21.4%	18.8%	15.9%	13.2%	9.1%
SCE	2022	CED 2023	14.3%	20.1%	23.8%	27.6%	28.6%	29.5%	27.8%	24.9%	21.9%	18.4%	16.3%	11.4%
SCE	2022	Vendor Data	12.3%	17.3%	20.5%	23.8%	24.8%	25.2%	23.9%	21.6%	18.9%	15.9%	14.0%	9.9%

Source: CEC Staff



IOU PA Annual BTM PV Capacity Factors By Sector

Sector: Residential		Year		
Planning Area	Source	2020	2021	2022
PGE	CED 2023	20.6%	20.1%	20.7%
PGE	Vendor Data	17.3%	16.8%	17.4%
SCE	CED 2023	21.2%	21.0%	21.6%
SCE	Vendor Data	18.3%	18.2%	18.7%
SDGE	CED 2023	22.0%	20.7%	20.8%
SDGE	Vendor Data	19.2%	18.0%	18.1%

Sector: Nonresidential		Year		
Planning Area	Source	2020	2021	2022
PGE	CED 2023	20.0%	22.1%	22.8%
PGE	Vendor Data	17.0%	18.6%	19.4%
SCE	CED 2023	20.9%	22.0%	23.1%
SCE	Vendor Data	17.7%	18.7%	19.8%
SDGE	CED 2023	21.7%	21.5%	22.0%
SDGE	Vendor Data	18.9%	18.7%	19.2%

Source: CEC Staff



IOU PA Residential BTM PV Monthly Capacity Factors

Sector: Residential			Month											
Planning Area	Year	Source	1	2	3	4	5	6	7	8	9	10	11	12
PGE	2020	CED 2023	11.4%	19.8%	19.1%	24.6%	28.1%	30.2%	29.3%	24.3%	18.9%	16.1%	13.9%	11.5%
PGE	2020	Vendor Data	9.6%	16.6%	16.0%	20.7%	23.6%	25.4%	24.6%	20.4%	15.9%	13.5%	11.7%	9.7%
PGE	2021	CED 2023	10.7%	16.7%	21.5%	26.8%	29.5%	29.0%	26.7%	23.3%	21.1%	15.7%	11.9%	7.7%
PGE	2021	Vendor Data	9.0%	14.0%	18.1%	22.5%	24.8%	24.4%	22.4%	19.6%	17.7%	13.2%	10.0%	6.4%
PGE	2022	CED 2023	12.2%	17.8%	21.1%	26.1%	29.3%	28.7%	27.8%	25.5%	21.0%	17.3%	13.4%	8.1%
PGE	2022	Vendor Data	10.3%	14.9%	17.7%	21.9%	24.6%	24.1%	23.4%	21.4%	17.6%	14.5%	11.3%	6.8%

Sector: Residential			Month											
Planning Area	Year	Source	1	2	3	4	5	6	7	8	9	10	11	12
SCE	2020	CED 2023	15.3%	20.1%	19.6%	23.2%	29.0%	27.2%	28.4%	24.7%	20.0%	16.9%	16.1%	13.3%
SCE	2020	Vendor Data	13.3%	17.3%	16.9%	20.0%	25.0%	23.5%	24.5%	21.4%	17.3%	14.6%	13.9%	11.5%
SCE	2021	CED 2023	14.3%	19.2%	22.9%	25.4%	26.8%	27.4%	26.1%	24.5%	21.6%	18.3%	15.3%	10.6%
SCE	2021	Vendor Data	12.3%	16.6%	19.8%	22.0%	23.2%	23.7%	22.5%	21.2%	18.7%	15.8%	13.2%	9.2%
SCE	2022	CED 2023	14.0%	19.6%	23.4%	27.1%	28.1%	28.5%	27.2%	24.6%	21.4%	18.0%	16.0%	11.4%
SCE	2022	Vendor Data	12.1%	16.9%	20.2%	23.4%	24.3%	24.7%	23.5%	21.2%	18.5%	15.6%	13.9%	9.9%

Sector: Residential			Month											
Planning Area	Year	Source	1	2	3	4	5	6	7	8	9	10	11	12
SDGE	2020	CED 2023	16.4%	20.4%	20.0%	22.7%	29.1%	26.7%	29.5%	27.0%	22.2%	19.0%	17.4%	14.1%
SDGE	2020	Vendor Data	14.3%	17.8%	17.4%	19.8%	25.3%	23.2%	25.7%	23.5%	19.3%	16.6%	15.1%	12.2%
SDGE	2021	CED 2023	14.5%	19.0%	22.4%	24.7%	25.3%	26.5%	26.0%	23.6%	21.8%	18.1%	15.7%	10.5%
SDGE	2021	Vendor Data	12.6%	16.5%	19.5%	21.5%	22.0%	23.0%	22.6%	20.5%	19.0%	15.8%	13.6%	9.2%
SDGE	2022	CED 2023	14.0%	19.2%	23.1%	25.9%	25.5%	27.7%	25.3%	23.9%	20.5%	16.6%	15.5%	11.8%
SDGE	2022	Vendor Data	12.2%	16.7%	20.1%	22.6%	22.2%	24.1%	22.0%	20.8%	17.9%	14.5%	13.5%	10.3%

Source: CEC Staff



IOU PA Nonresidential BTM PV Monthly Capacity Factors

Sector: Nonresidential			Month											
Planning Area	Year	Source	1	2	3	4	5	6	7	8	9	10	11	12
PGE	2020	CED 2023	11.3%	19.3%	18.5%	24.0%	27.6%	29.3%	28.4%	23.5%	18.1%	15.3%	13.5%	11.2%
PGE	2020	Vendor Data	9.6%	16.4%	15.8%	20.4%	23.6%	24.9%	24.1%	20.0%	15.4%	13.0%	11.6%	9.6%
PGE	2021	CED 2023	11.6%	18.5%	23.7%	29.4%	32.2%	31.8%	29.4%	25.6%	22.7%	17.5%	13.6%	8.6%
PGE	2021	Vendor Data	9.8%	15.6%	19.9%	24.9%	27.2%	26.8%	24.8%	21.6%	19.1%	14.8%	11.4%	7.2%
PGE	2022	CED 2023	13.8%	20.2%	22.7%	28.7%	32.5%	32.0%	30.1%	27.7%	23.0%	19.3%	15.0%	8.8%
PGE	2022	Vendor Data	11.6%	17.0%	19.3%	24.6%	27.8%	27.2%	25.7%	23.6%	19.5%	16.3%	12.8%	7.5%

Sector: Nonresidential			Month											
Planning Area	Year	Source	1	2	3	4	5	6	7	8	9	10	11	12
SCE	2020	CED 2023	14.6%	20.1%	19.5%	23.2%	28.9%	27.5%	28.5%	24.6%	19.6%	16.4%	15.7%	12.9%
SCE	2020	Vendor Data	12.2%	16.9%	16.4%	19.6%	24.4%	23.3%	24.1%	20.8%	16.6%	13.8%	13.2%	10.8%
SCE	2021	CED 2023	14.5%	20.1%	24.4%	27.3%	28.6%	29.1%	27.5%	25.5%	22.6%	18.9%	15.5%	10.6%
SCE	2021	Vendor Data	12.2%	17.1%	20.6%	23.1%	24.2%	24.9%	23.5%	21.9%	19.1%	16.2%	13.2%	8.9%
SCE	2022	CED 2023	14.9%	21.5%	24.6%	28.9%	29.8%	31.8%	29.4%	25.9%	23.2%	19.3%	16.9%	11.3%
SCE	2022	Vendor Data	12.6%	18.1%	21.1%	24.8%	26.1%	26.5%	25.0%	22.5%	19.8%	16.6%	14.5%	9.7%

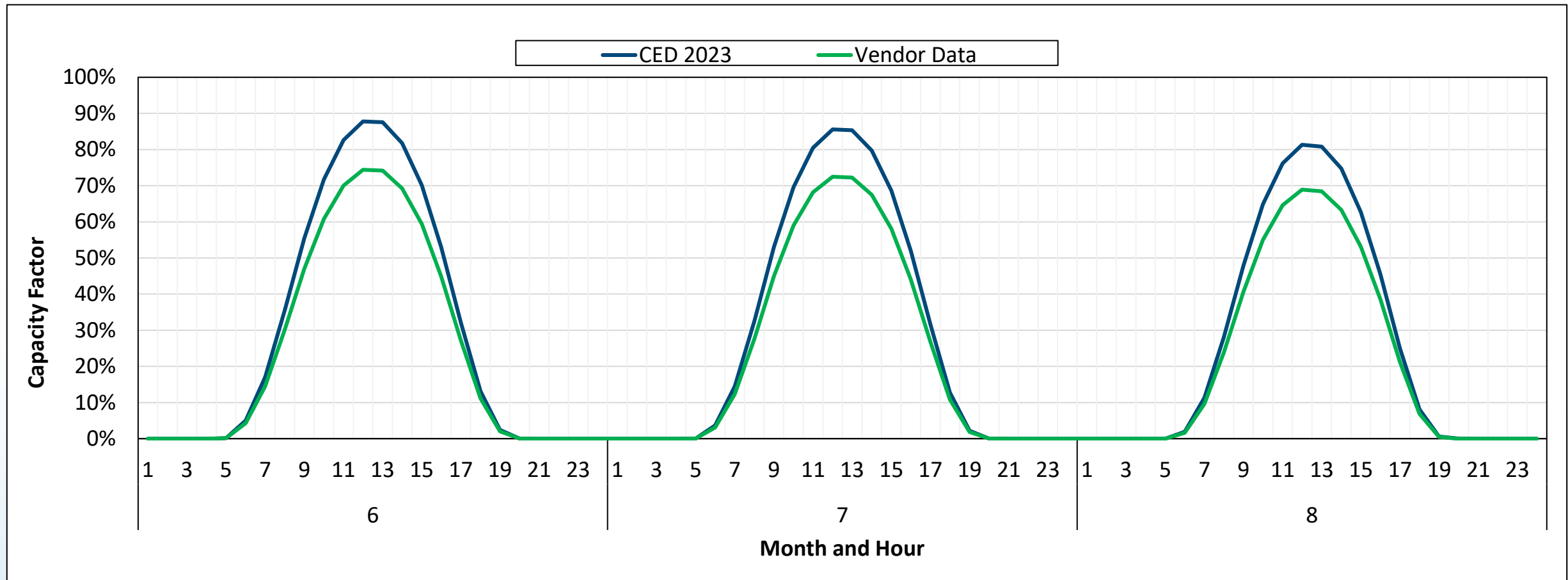
Sector: Nonresidential			Month											
Planning Area	Year	Source	1	2	3	4	5	6	7	8	9	10	11	12
SDGE	2020	CED 2023	16.1%	20.1%	19.7%	22.4%	28.5%	26.1%	29.0%	26.6%	21.9%	18.7%	17.1%	13.9%
SDGE	2020	Vendor Data	14.0%	17.6%	17.2%	19.5%	24.8%	22.8%	25.3%	23.2%	19.1%	16.3%	15.0%	12.1%
SDGE	2021	CED 2023	14.9%	19.7%	23.8%	26.0%	26.3%	27.5%	26.9%	24.4%	22.4%	19.0%	16.1%	10.9%
SDGE	2021	Vendor Data	13.0%	17.2%	20.7%	22.7%	22.9%	24.0%	23.5%	21.3%	19.5%	16.5%	14.0%	9.5%
SDGE	2022	CED 2023	14.4%	20.1%	24.9%	28.1%	27.5%	29.4%	27.0%	25.4%	21.8%	17.1%	16.0%	12.2%
SDGE	2022	Vendor Data	12.6%	17.5%	21.7%	24.5%	24.0%	25.6%	23.5%	22.1%	19.0%	14.9%	14.0%	10.7%

Source: CEC Staff



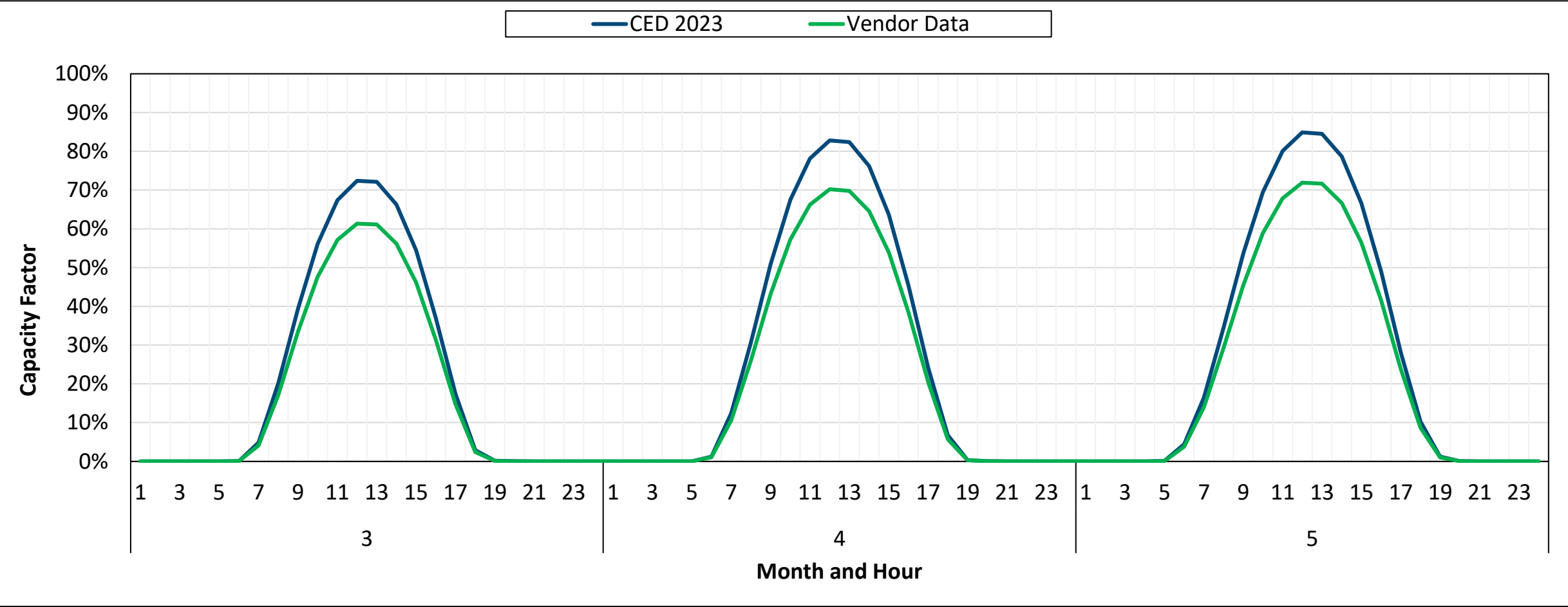
CAISO Historical Average BTM PV Profiles: Summer Months, 2018-2022

- Average summer months
 - Capacity factors during hour of peak demand (17) are about 5% points lower
 - Daily maximum capacity factors from vendor data are approximately 13% points lower



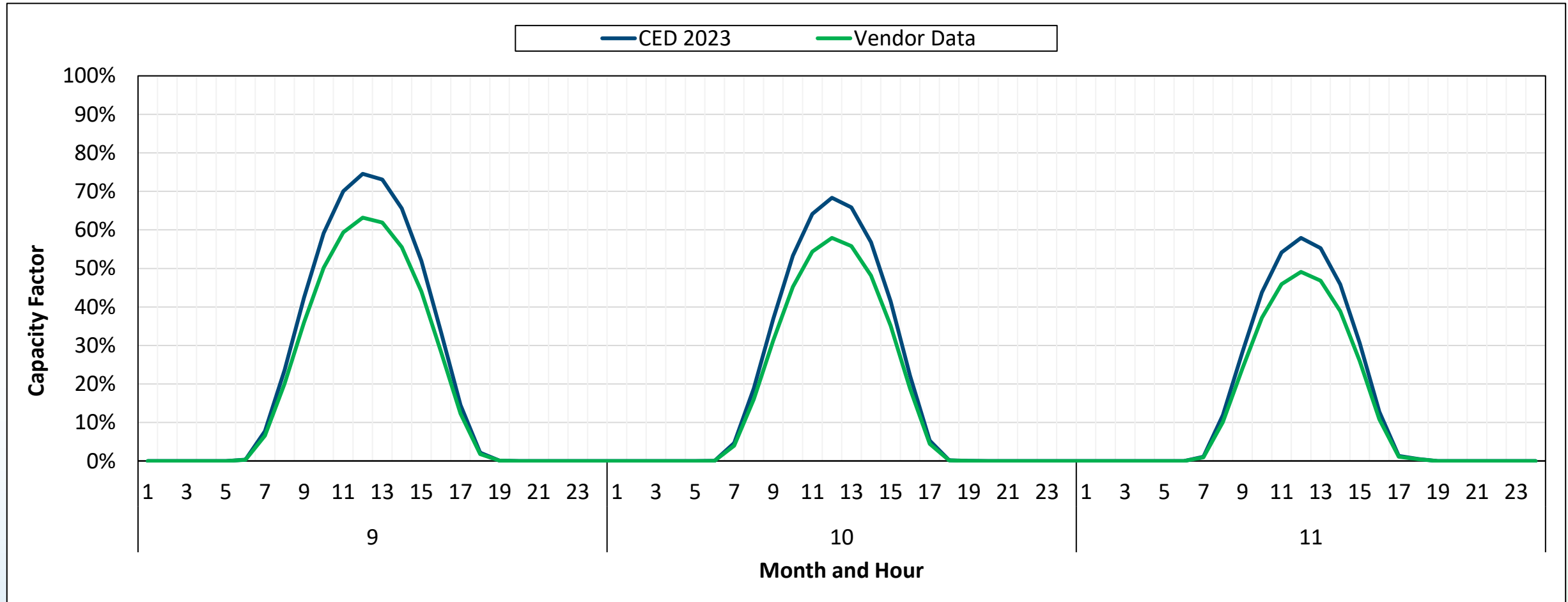


CAISO Historical Average BTM PV Profiles: Spring Months, 2018-2022



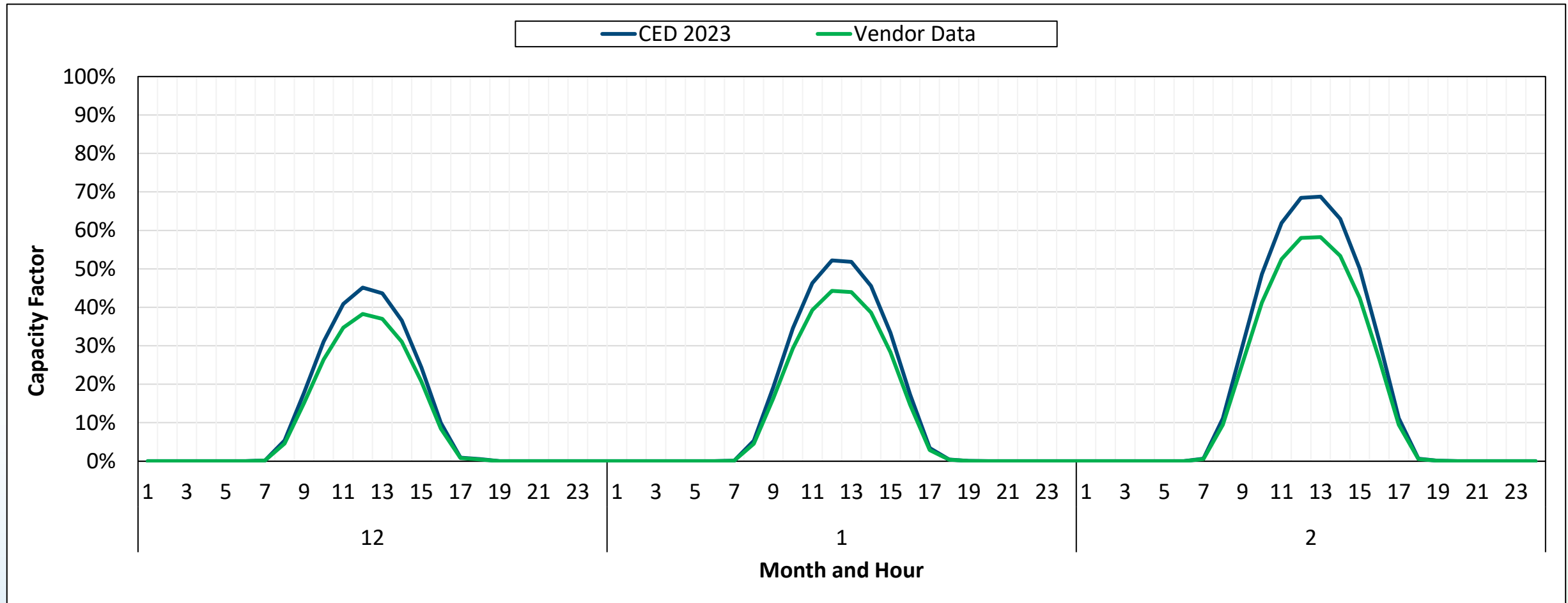


CAISO Historical Average BTM PV Profiles: Fall Months, 2018-2022





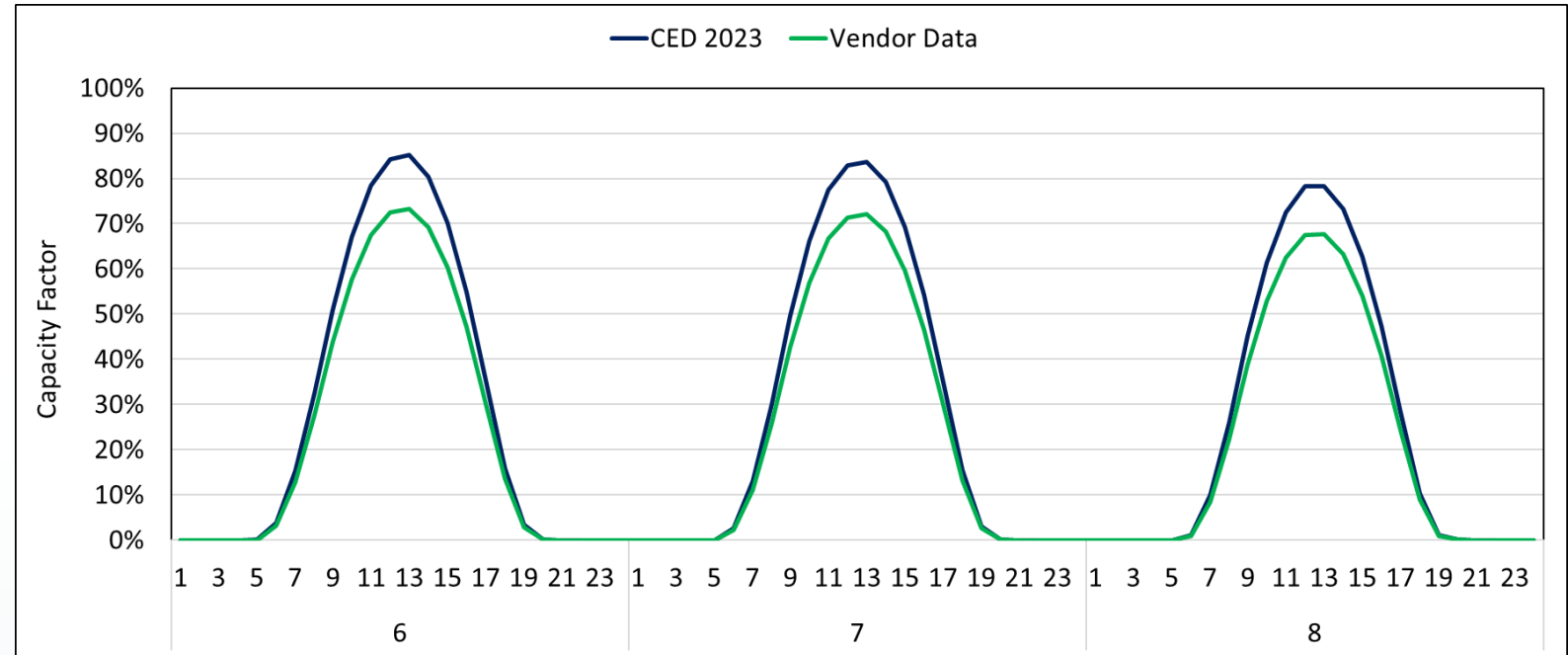
CAISO Historical Average BTM PV Profiles: Winter Months, 2018-2022





SCE Historical Average BTM PV Profiles: Summer Months, 2020-2022

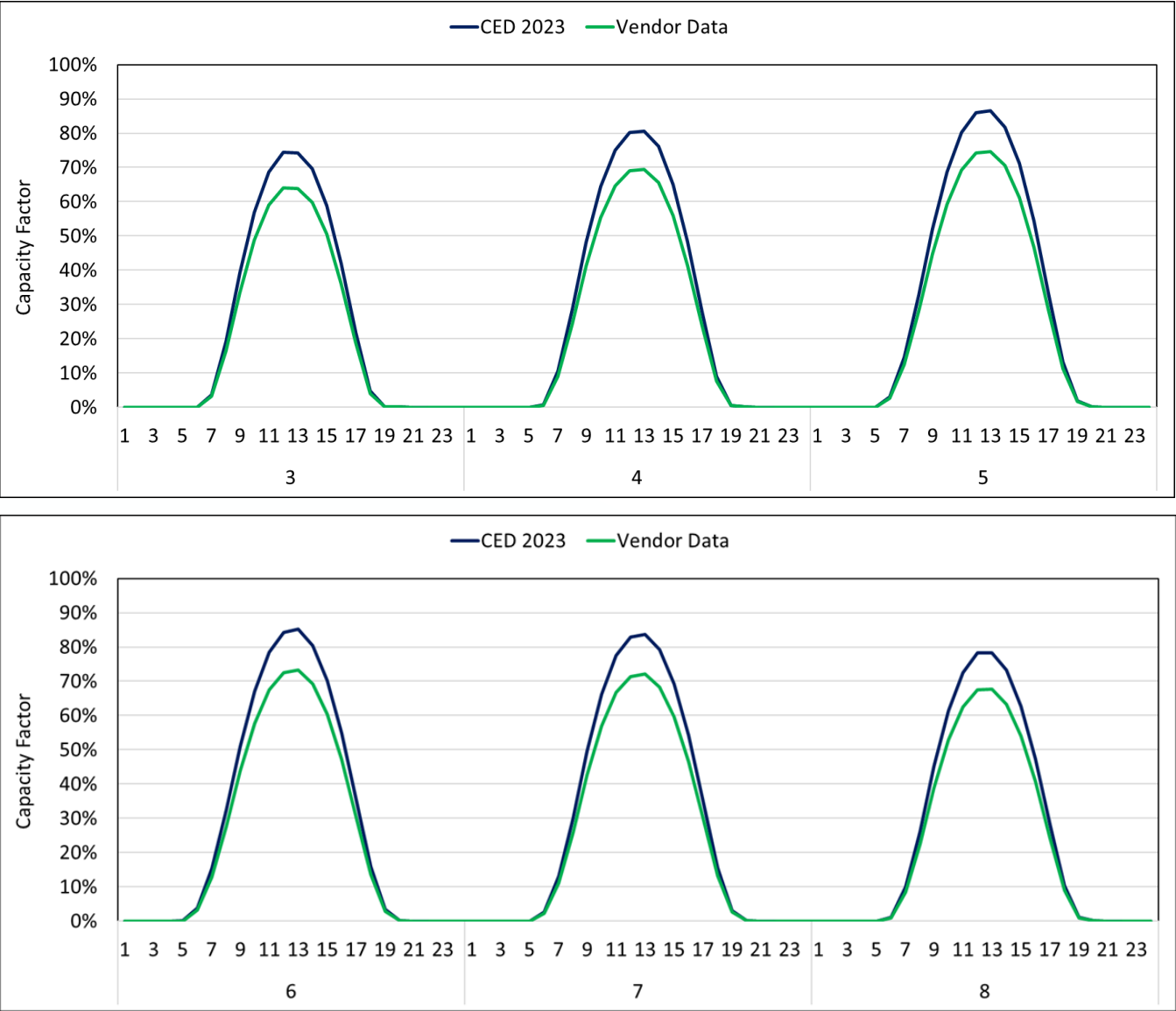
- Averages include 2020-2022 calendar year inverter data
- Vendor data reduces:
 - Daily max capacity factor by ~9-10% points
 - Net peak hour (17) capacity factor by ~5% points



Source: CEC Staff



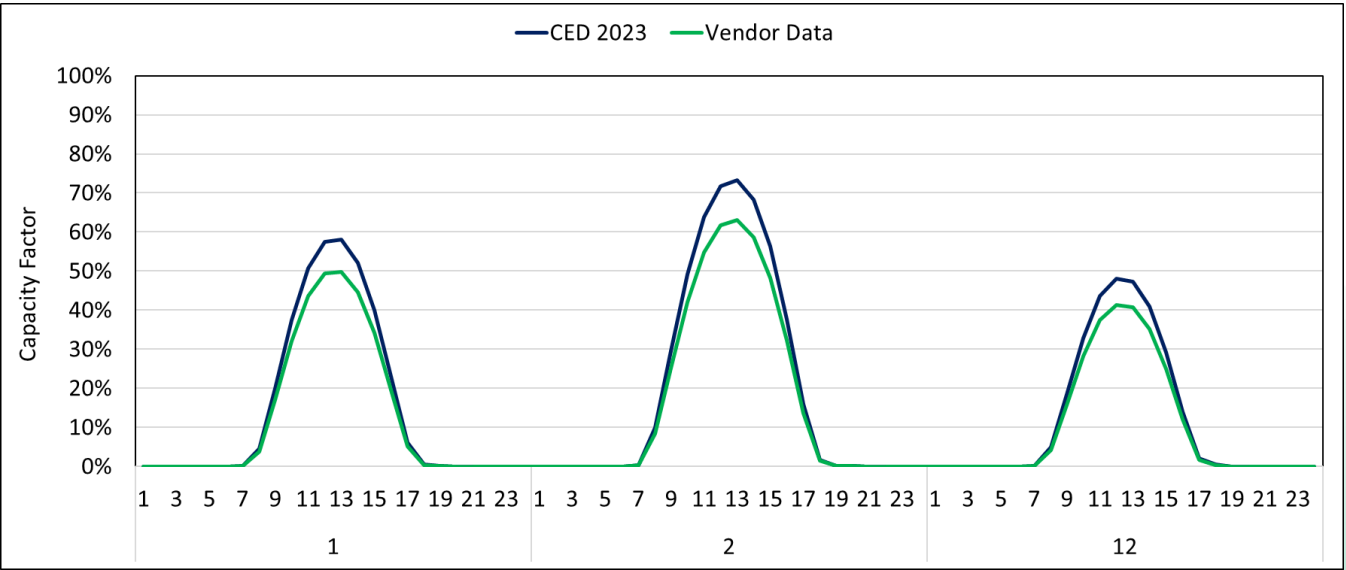
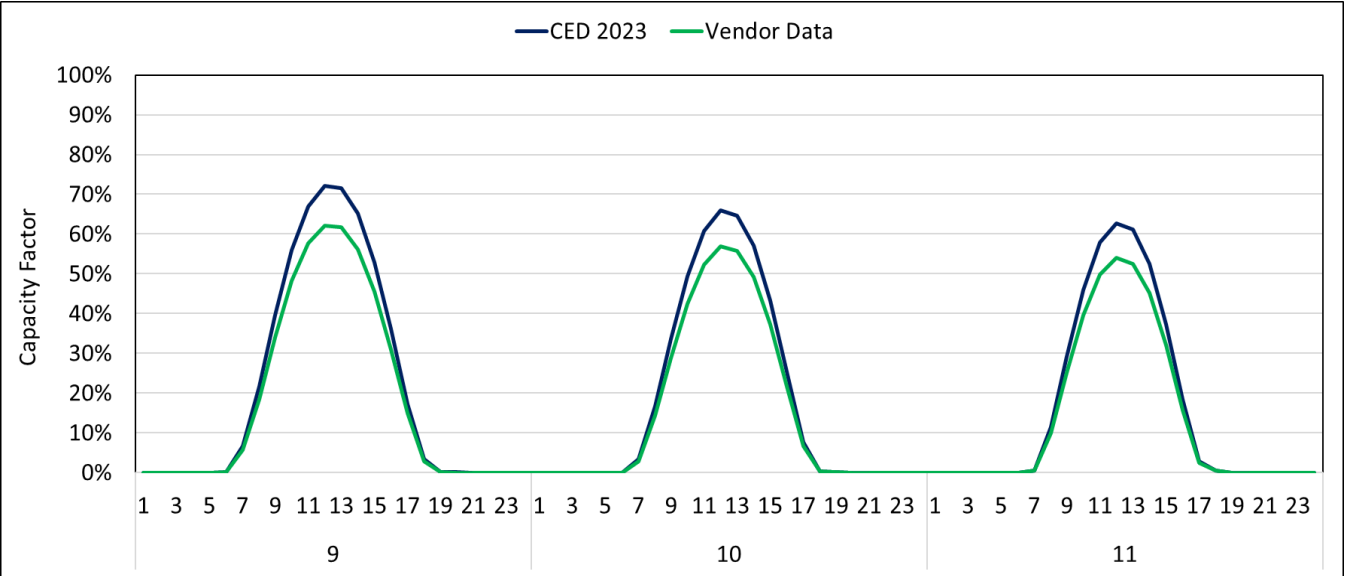
SCE Historical Average BTM PV Profiles: Spring & Summer, 2020-2022



Source: CEC Staff



SCE Historical Average BTM PV Profiles: Fall & Winter, 2020-2022

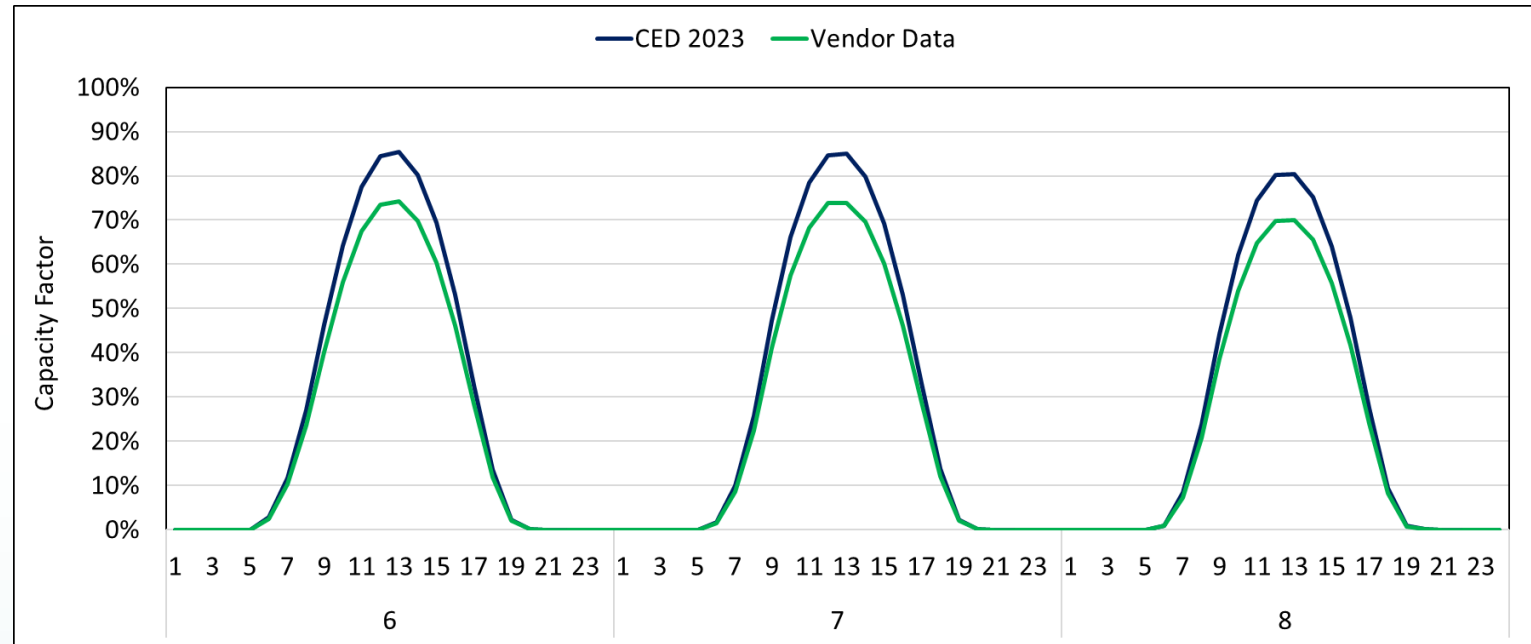


Source: CEC Staff



SDG&E Historical Average BTM PV Profiles: Summer Months, 2020-2022

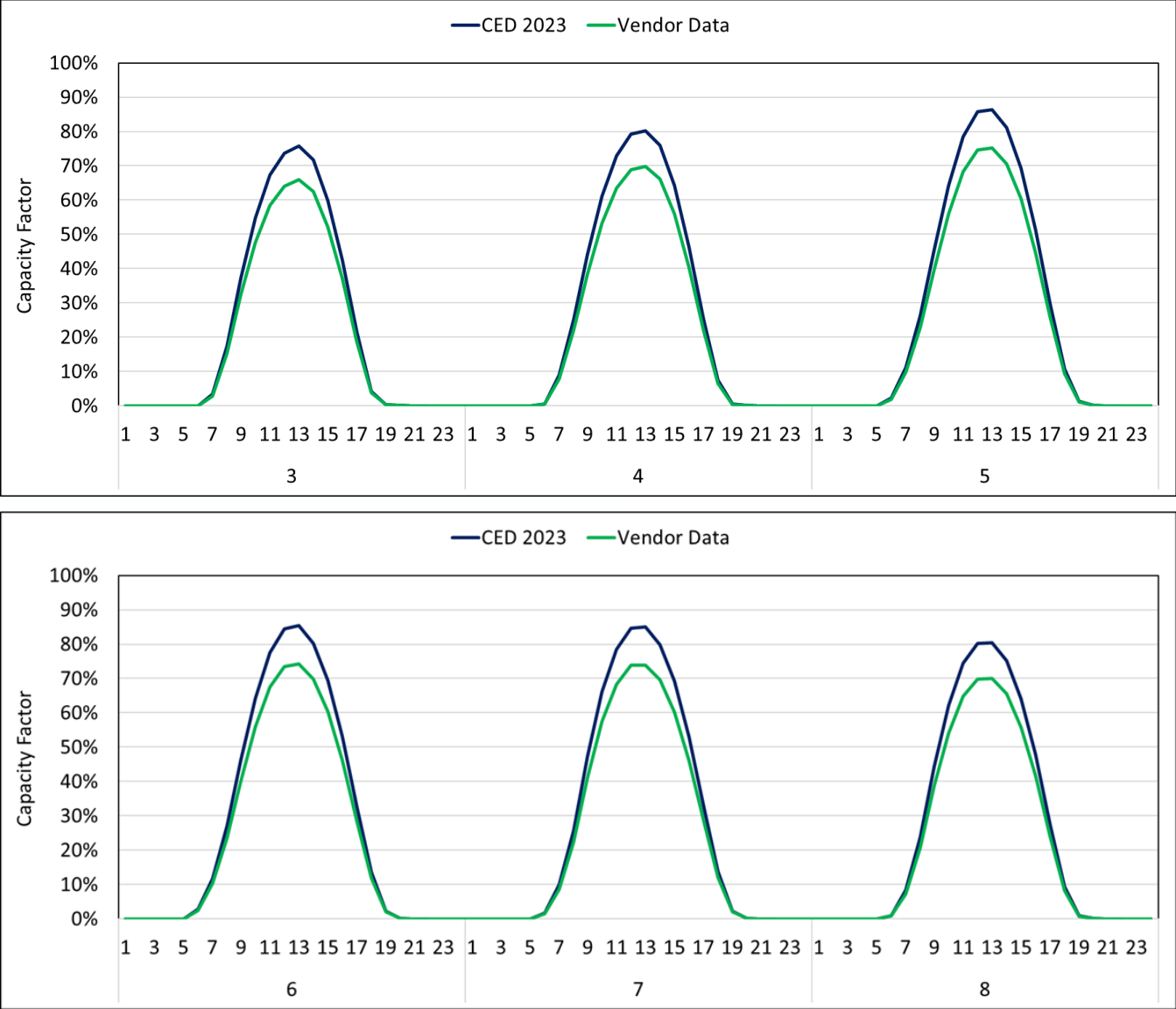
- Averages include 2020-2022 calendar year inverter data
- Vendor data reduces:
 - Daily max capacity factor by ~9-10% points
 - Net peak hour (17) capacity factor by ~4% points



Source: CEC Staff



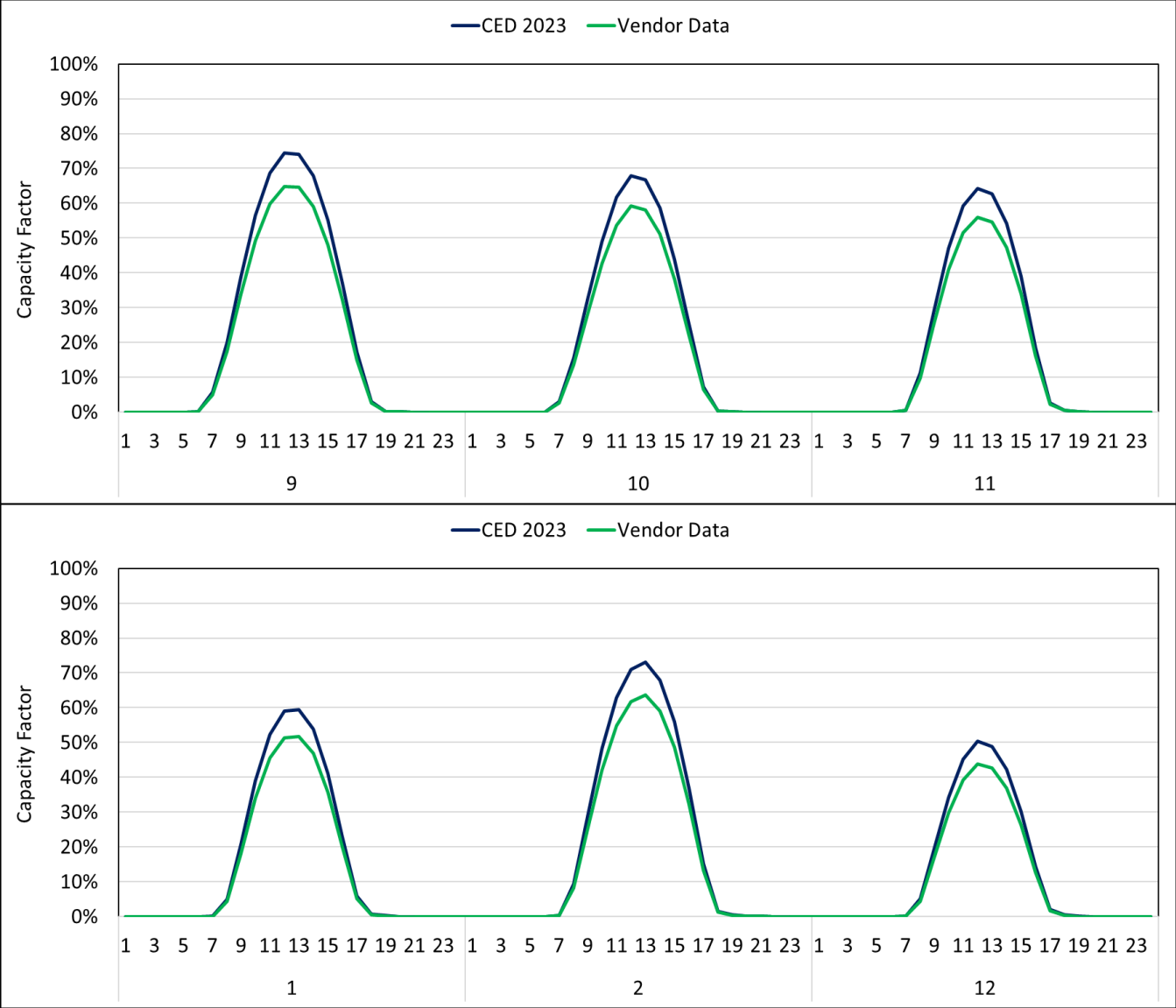
SDG&E Historical Average BTM PV Profiles: Spring & Summer, 2020-2022



Source: CEC Staff



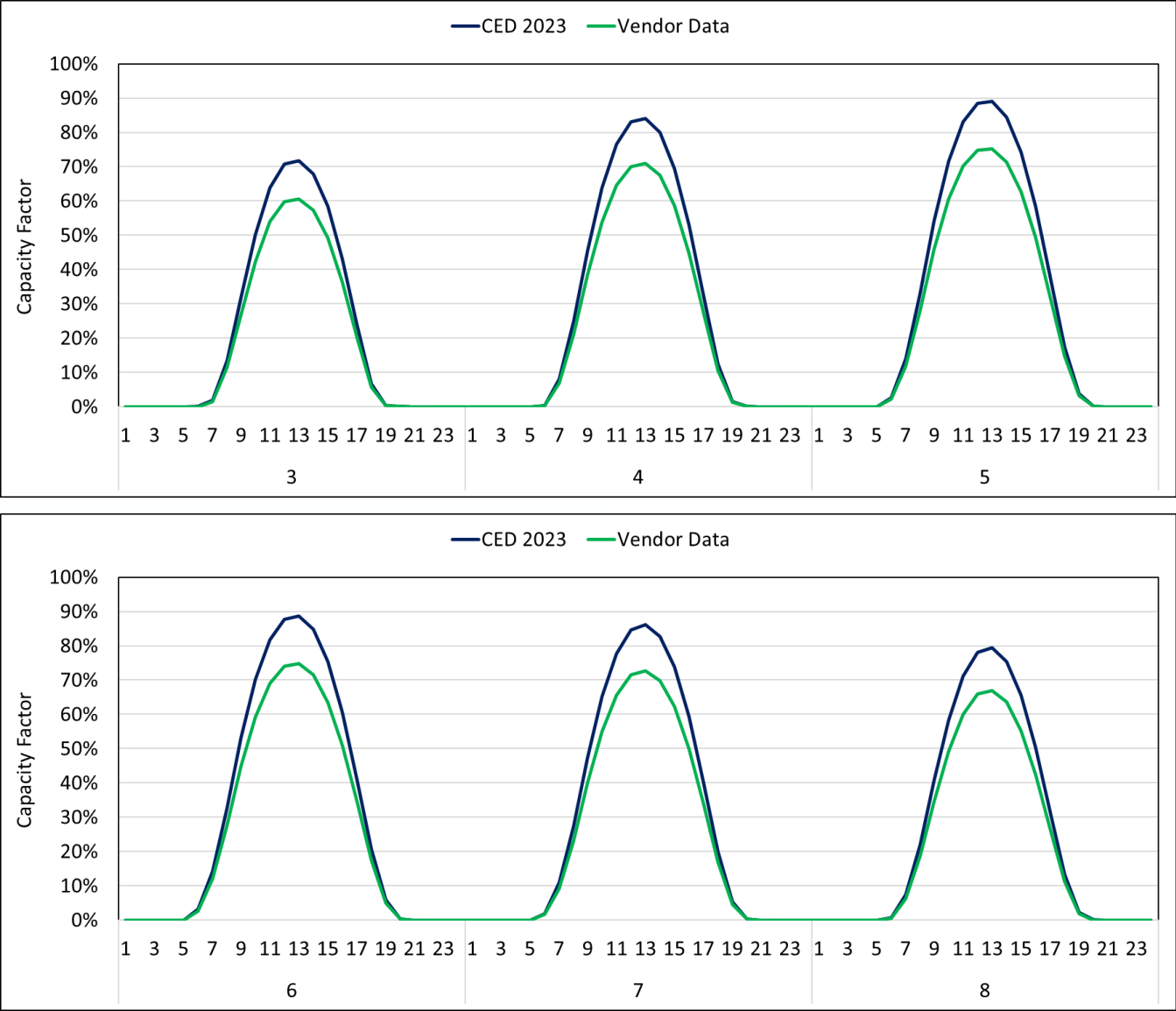
SDG&E Historical Average BTM PV Profiles: Fall & Winter, 2020-2022



Source: CEC Staff



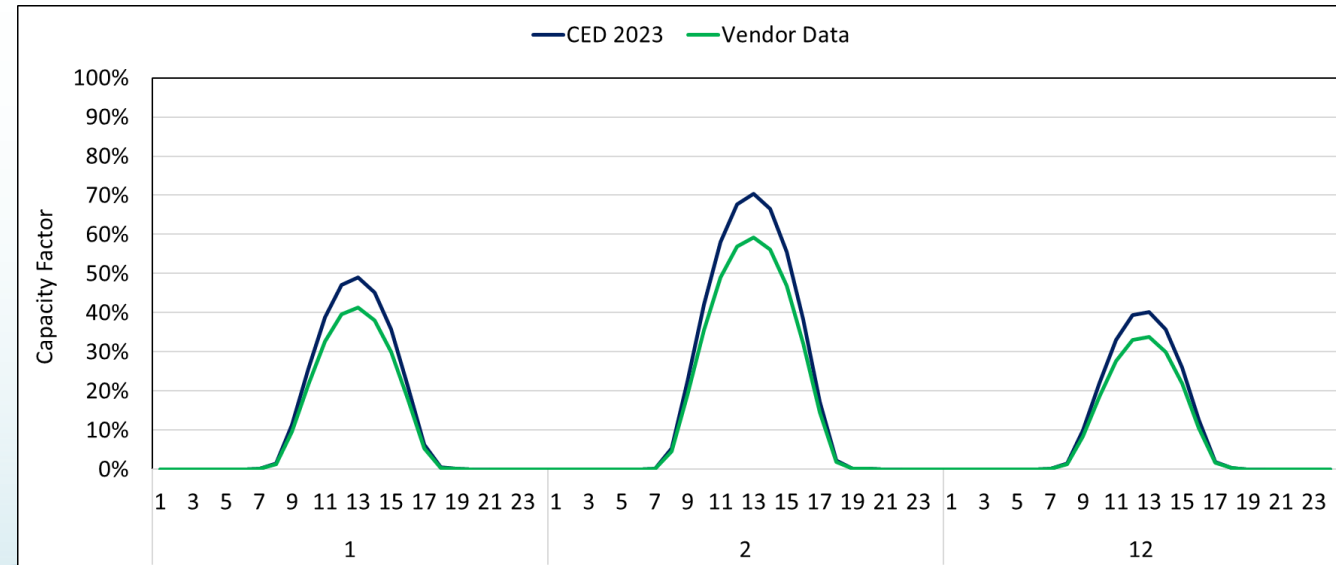
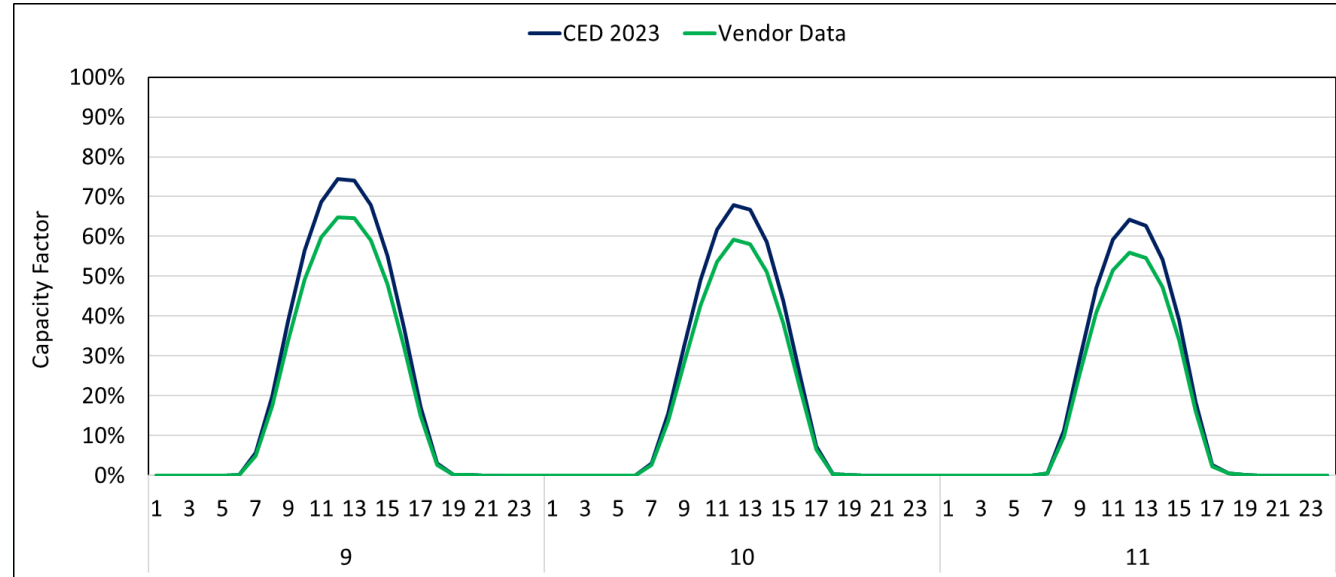
PG&E Historical Average BTM PV Profiles: Spring & Summer, 2020-2022



Source: CEC Staff



PG&E Historical Average BTM PV Profiles: Fall & Winter, 2020-2022



Source: CEC Staff