California Energy Commission

Behind-The-Meter Storage Profile Updates

Presenter: Alex Lonsdale, DG Forecast Supervisor

Date: 10/26/2023

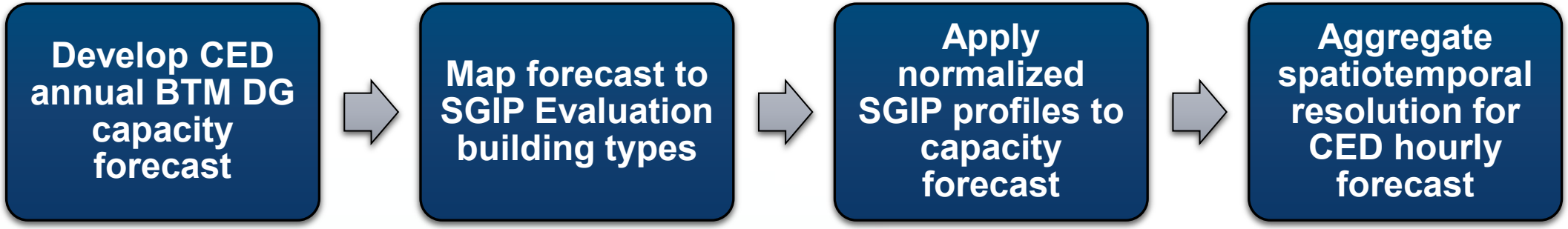
Presentation Overview

- Non-residential hourly storage forecast
  - Methodology
  - Inputs and Assumptions
  - Results
- Residential hourly storage forecast
  - Methodology
  - Inputs and Assumptions
  - Results

Non-Residential Behind-The-Meter Storage Profiles

Non-Residential Hourly Forecast Methodology

- Overarching methodology remains unchanged from previous California Energy Demand (CED) forecasts.
- For CED 2023, Behind-The-Meter (BTM) non-residential profiles are from CPUC's upcoming Self-Generation Incentive Program (SGIP) Energy Storage Impact Evaluation.



- Average hourly storage profiles from the upcoming SGIP evaluation represent a considerable portion of installed non-residential BTM storage in California.

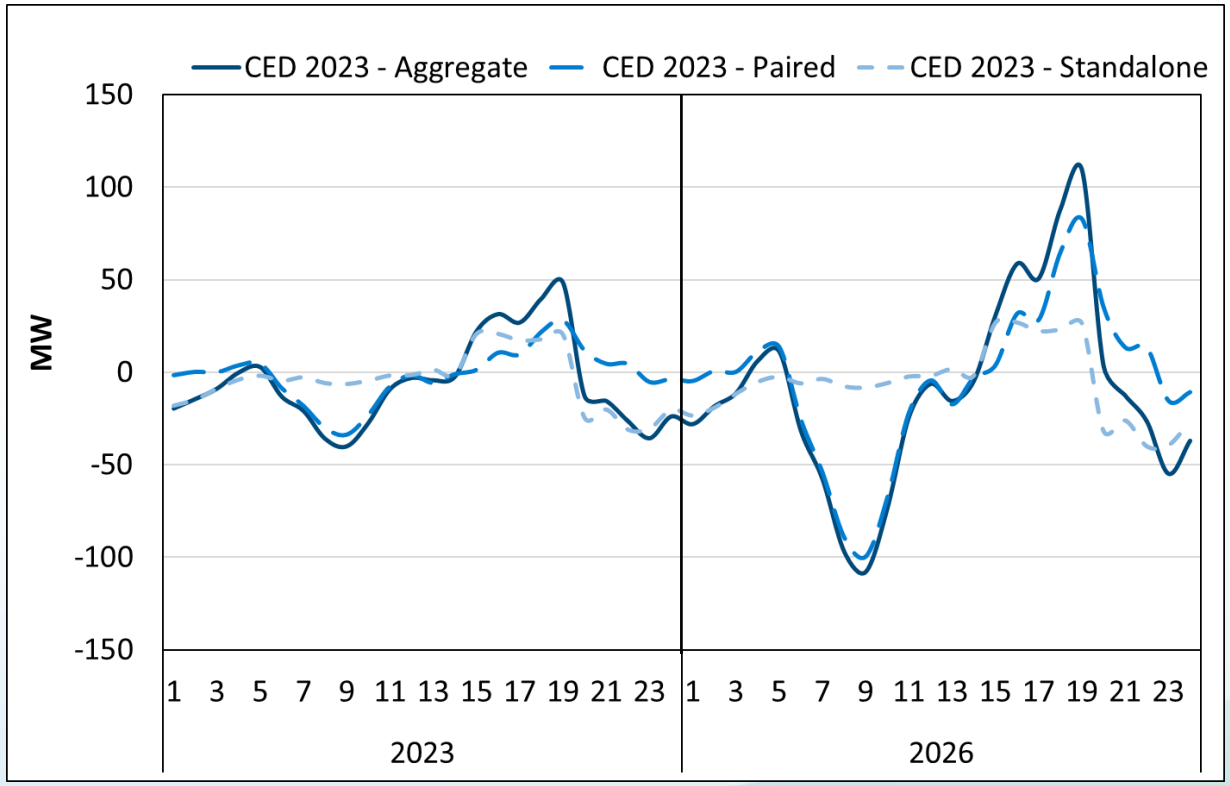
Storage Configuration	Number of Non-res BTM Storage Systems, Calendar Year 2022	SGIP Evaluation Data Project Sample Size
Paired With Solar PV	900	247
Standalone	1,198	479

Source: CEC Staff

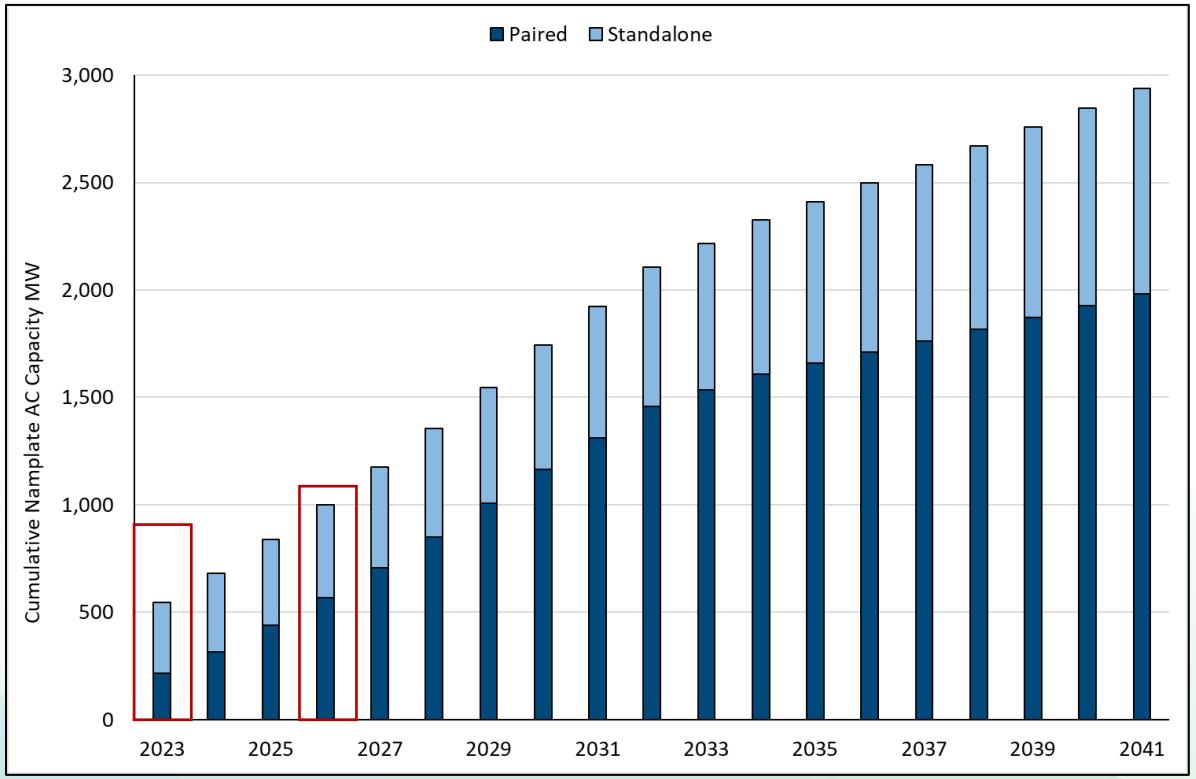
Methodology Refinement

- CEC's new DG capacity forecast tools distinguish between standalone and paired BTM storage adoption and capture this distinction more precisely.
- Note for hourly charts: (+) MW indicates energy storage discharge. (-) MW values indicate charge.

CAISO, Typical July Weekday



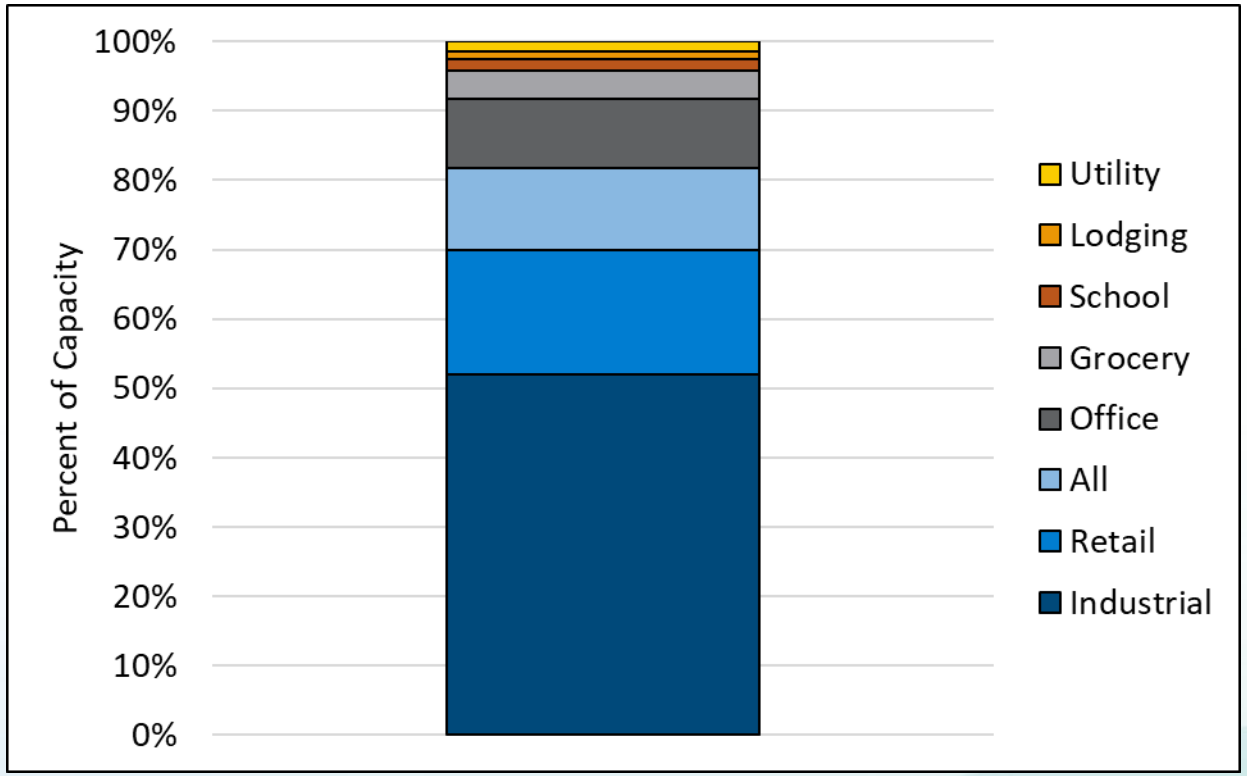
CAISO Non-Residential BTM Storage



Source: CEC Staff

Key Assumptions

- The 2023 CED non-residential storage capacity forecast is disaggregated to align with data available from the upcoming SGIP Energy Storage Impact Evaluation.
- Forecasted capacity is disaggregated based on historical BTM storage capacity estimates for calendar year 2022.



Source: CEC Staff

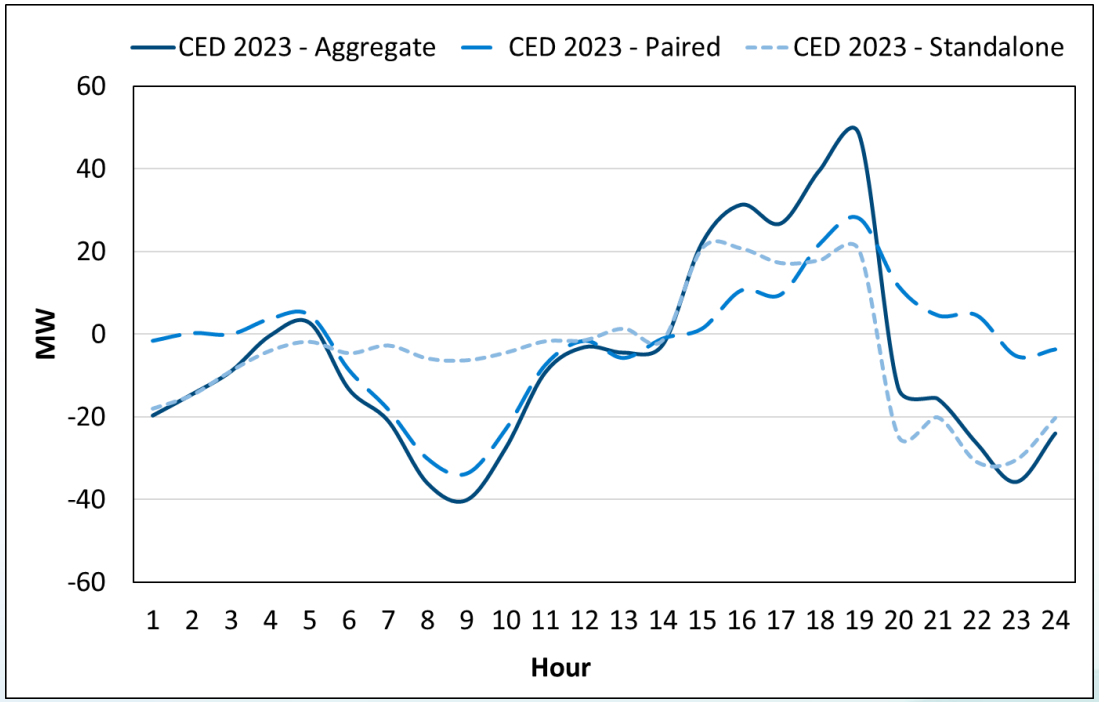
CEC Forecast Sector	CEC NAICS Category	SGIP Building Type
Ag & Water Pumping	Aggregate	Industrial
Commercial	Retail Store	Retail
Commercial	Misc.	Industrial
Commercial	Office	Office
Commercial	School	School
Commercial	Food/Liquor	Grocery
Commercial	Health Care	Office
Commercial	Warehouse	Industrial
Commercial	College	All
Commercial	Hotel	Lodging
Commercial	Restaurant	Retail
Commercial	Refr. Warehouse	Industrial
Commercial	Aggregate	All
Industrial	Aggregate	Industrial
Mining	Aggregate	Industrial
TCU	Aggregate	Industrial
TCU	22132, 562	Utility

Source: CEC Staff

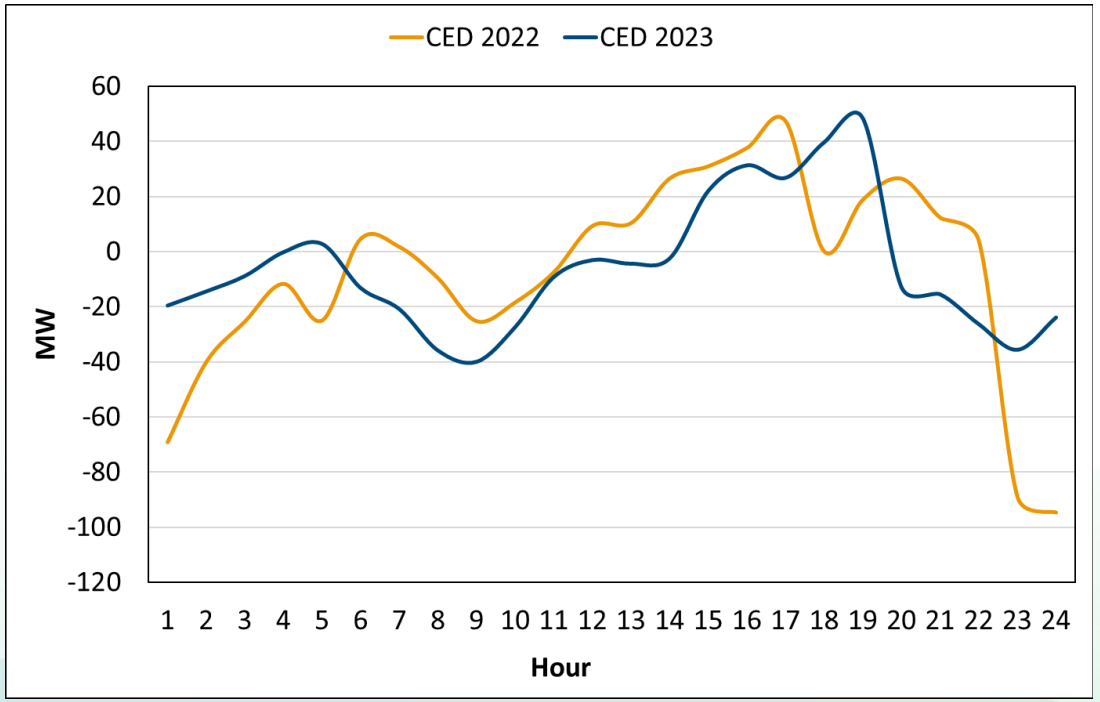
BTM Profiles: CAISO, Average July Weekday 2023

- The average percent of total energy discharged from Hour Ending (HE) 17 to 19 increased 38% from CED 2022 to CED 2023.

CED 2023 Load by Configuration



CED Comparison

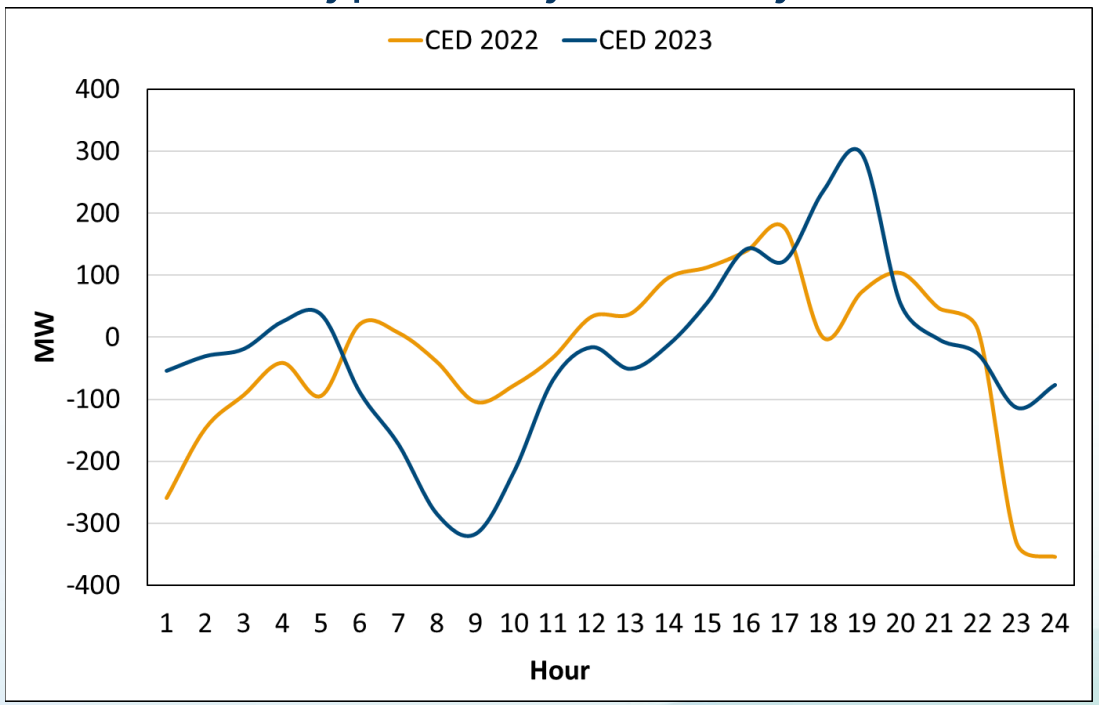


Source: CEC Staff

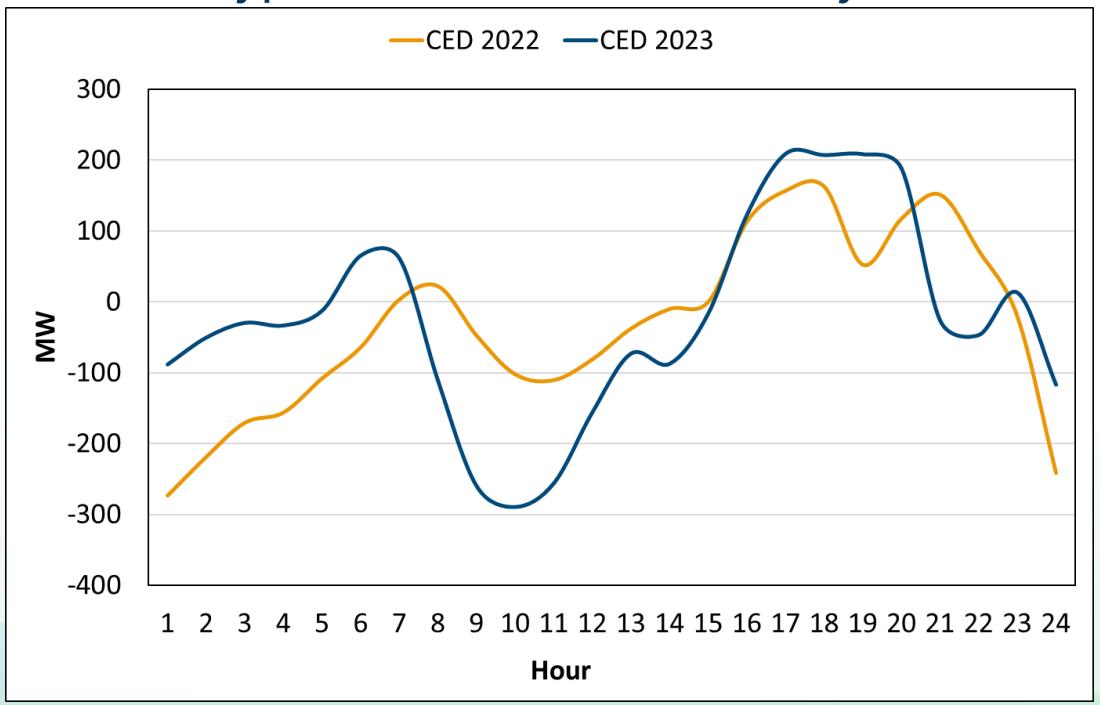
BTM Profile Comparison: CAISO, Forecast Profiles, 2035

- Growth in paired storage system adoption by 2035 results in an increased share of energy storage systems charging when solar PV generation is available.
  - Reduction in total energy charged overnight (HE 21 to HE 6) from CED 2022 to CED 2023:
    - July weekday: 57%
    - December weekday: 51%

Typical July Weekday



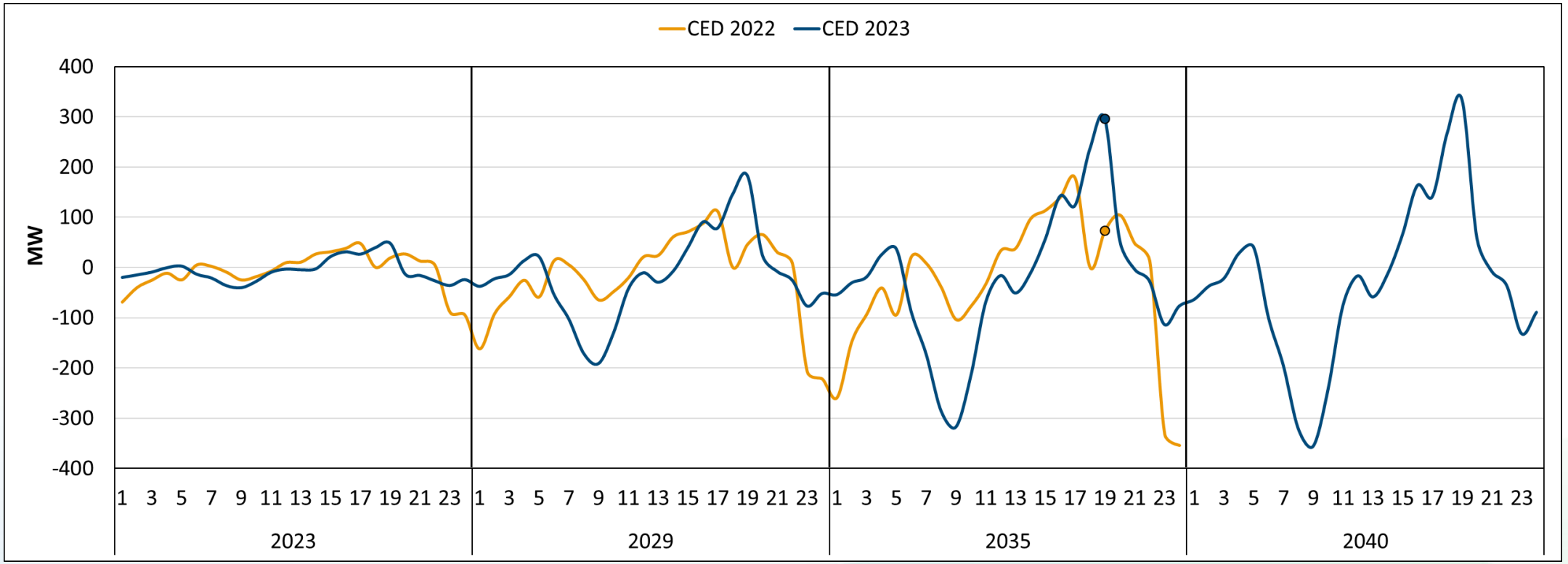
Typical December Weekday



Source: CEC Staff

BTM Profile Comparison: CAISO, July Peak Impacts

- Revised capacity projections accompanied with refreshed profiles results in greater system-wide peak reductions.
- Increased storage discharge during hour 19 in 2035 (CED 2023 – CED 2022): 222 MW



Source: CEC Staff

Residential Behind-The-Meter Storage Profiles

Residential Hourly Forecast Methodology

- Like non-residential storage, the general method for developing hourly residential BTM storage profiles remain unchanged.
- Staff develop BTM residential storage profiles using NREL's System Advisor Model (SAM).
  - SAM simulations are configured for a prototypical single-family home with BTM solar PV and storage.
  - **Model documentation:** https://sam.nrel.gov/
- Staff aren't using residential BTM storage profiles based on SGIP Energy Storage Impact Evaluations.
  - Average hourly profiles from the 2020 SGIP Energy Storage Impact Evaluation (Released in 2022) provides insight into BTM storage behavior but is of a less substantial sample size compared to the non-residential sector.

Methodology (Cont.)

- Several SAM parameters are modified to generate hourly profiles for the CED forecast.
  - Solar PV and storage system size were selected based on CEC analysis of utility interconnection data.
  - Single-family home annual electricity consumption is estimated from CEC's revamped residential sector end-use model.
  - TOU rates were selected in accordance with the Net Billing Tariff.
  - Hourly dispatch strategies are configured based on the assumption that systems dispatch stored energy in the evening.

Inputs and Assumptions

- The following design characteristics apply to all IOU planning areas.

Input Variable	Value
Solar PV Capacity (KW AC)	6
Energy Storage Power Rating (KW AC)	5
Energy Storage Capacity (kWh)	13.5
Minimum Battery State of Charge	25%
Maximum Hourly Discharge Rate in kWh per kWh rated capacity (Summer, Winter)	25%, 15%

Source: CEC Staff

- Minimum SOC included to simulate reserved energy for unplanned outages.
- As of 2022, CEC estimated 54% of residential storage systems in California have a KW AC capacity rating within +/- 1KW of the modeled system.

Inputs and Assumptions (Cont.)

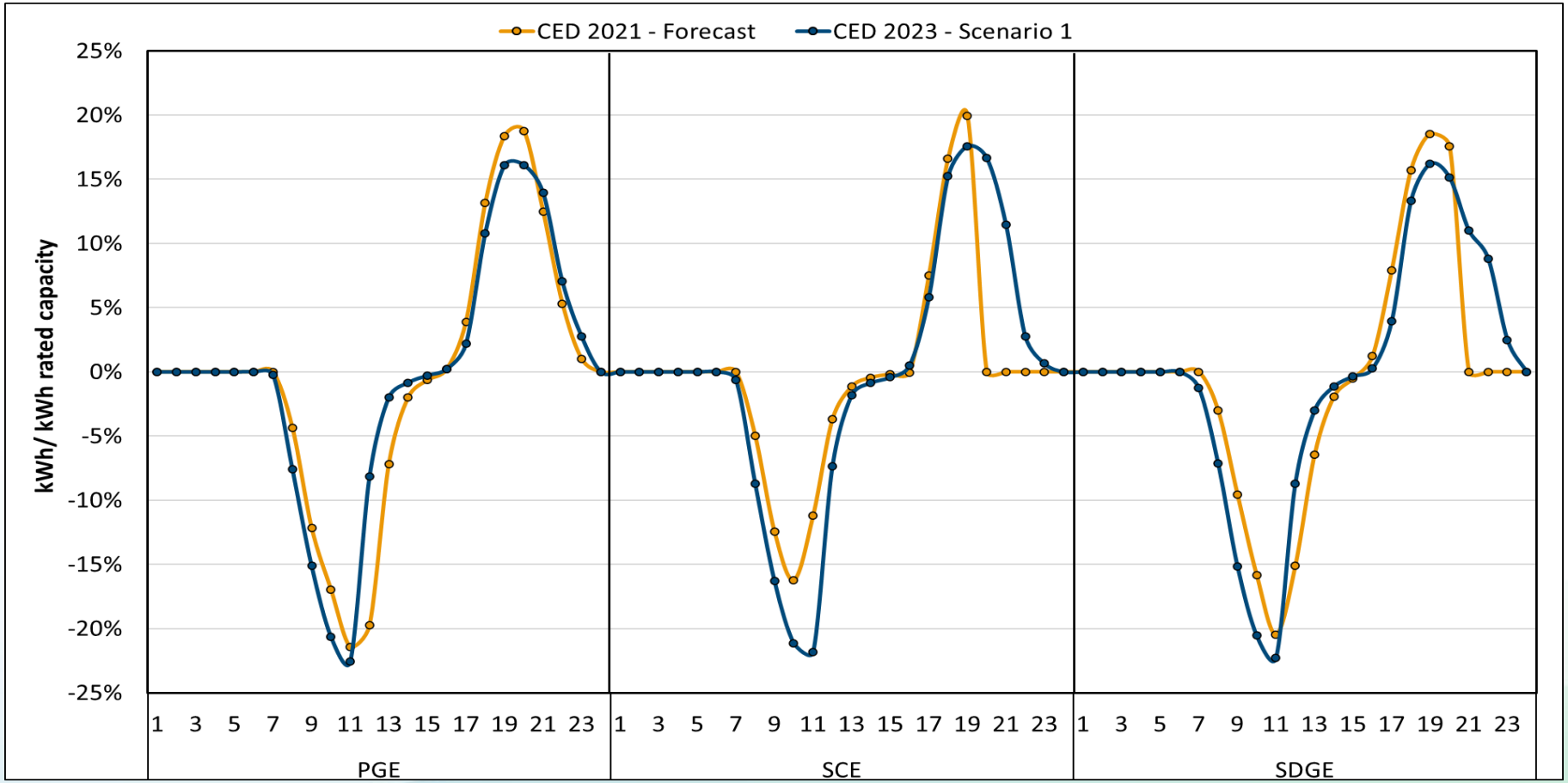
- Past CED forecasts consider Time-Of-Use (TOU) arbitrage during the on-peak period.
  - When scaled to planning area projections, this results in large hour-to-hour changes in load (shown on following slides).
- While it's assumed most dispatch occurs during the on-peak period, SGIP impact evaluations suggest some dispatch occurs outside these hours.
  - When scaling SAM simulations to system-wide projections, the inclusion of dispatch past the on-peak period results in less hour-to-hour changes in load.
- Given these considerations, CEC staff have developed several dispatch scenarios and are seeking stakeholder feedback.

Scenario	SAM Dispatch Strategy	Discharge Period
1	Manual Dispatch	4:00pm – 12:00am
2	Manual Dispatch	4:00pm – 12:00am *Discharge allowance reduced to 5% at 9pm
3	Manual Dispatch	TOU On-Peak Period

Source: CEC Staff

BTM Profile Comparison: July

- The following chart highlights how dispatch strategy decisions impact the assumed planning area-scale hourly profiles on a typical day in July.
  - Recall CED 2023 Scenario 1 assumes manual dispatch from 4:00pm 12:00am.



Source: CEC Staff

2020 SGIP Energy Storage Impact Evaluation: Residential Profiles

- 2020 SGIP Impact Evaluation average percent discharge and charge (kWh per kWh Rebated Capacity) profiles depict energy discharge during and after the on-peak period (4:00 – 9:00pm), with a bulk of dispatch during the onset of the peak period.

SCE, Project Sample Size: 252

Hour	Jan 1	Feb 2	Mar 3	Apr 4	May 5	Jun 6	Jul 7	Aug 8	Sep 9	Oct 10	Nov 11	Dec 12
0	1%	1%	1%	1%	1%	1%	1%	0%	0%	0%	1%	0%
1	1%	1%	1%	1%	1%	1%	1%	0%	0%	0%	0%	0%
2	0%	1%	1%	1%	1%	1%	1%	0%	0%	0%	0%	0%
3	0%	1%	1%	1%	1%	1%	1%	0%	0%	0%	0%	0%
4	0%	1%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%
5	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
6	0%	1%	0%	-2%	-3%	-3%	-2%	-2%	-1%	0%	0%	0%
7	-1%	-2%	-4%	-8%	-10%	-8%	-8%	-6%	-5%	-4%	-2%	-1%
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22	1%	2%	1%	1%	1%	1%	1%	1%	0%	1%	1%	1%
23	1%	1%	1%	1%	1%	1%	1%	0%	0%	1%	1%	0%

SDG&E, Project Sample Size: 45

Hour	Jan 1	Feb 2	Mar 3	Apr 4	May 5	Jun 6	Jul 7	Aug 8	Sep 9	Oct 10	Nov 11	Dec 12
0	1%	2%	1%	1%	2%	2%	1%	1%	1%	1%	1%	0%
1	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%
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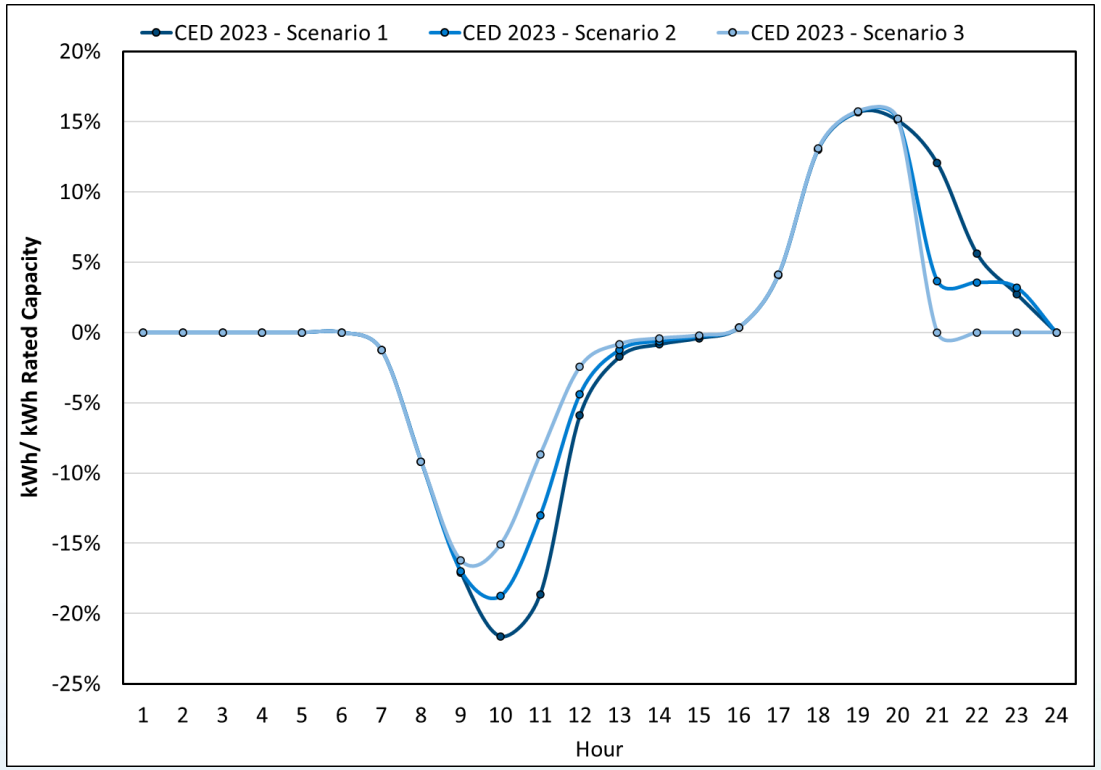
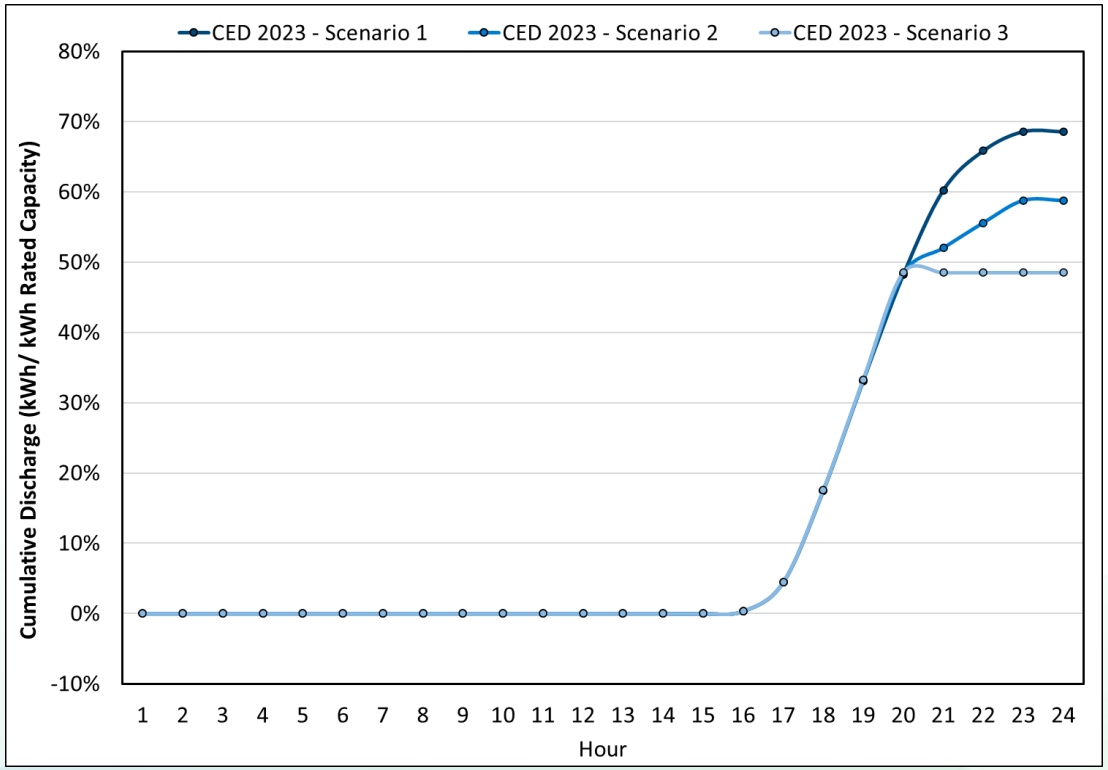
20	4%	5%	4%	5%	6%	5%	4%	3%	3%	3%	4%	4%
21	3%	5%	3%	3%	4%	3%	3%	2%	2%	2%	3%	2%
22	2%	3%	2%	2%	3%	2%	2%	1%	1%	1%	2%	1%
23	1%	2%	2%	2%	2%	2%	1%	1%	1%	1%	1%	1%

Source: CPUC 2020 SGIP Energy Storage Impact Evaluation.
Prepared by: Verdant Associates

SCE Scenarios Comparison: Average Summer Day

- Modifications to the SAM manual dispatch strategy affects the shape of the profile and cumulative energy dispatched.



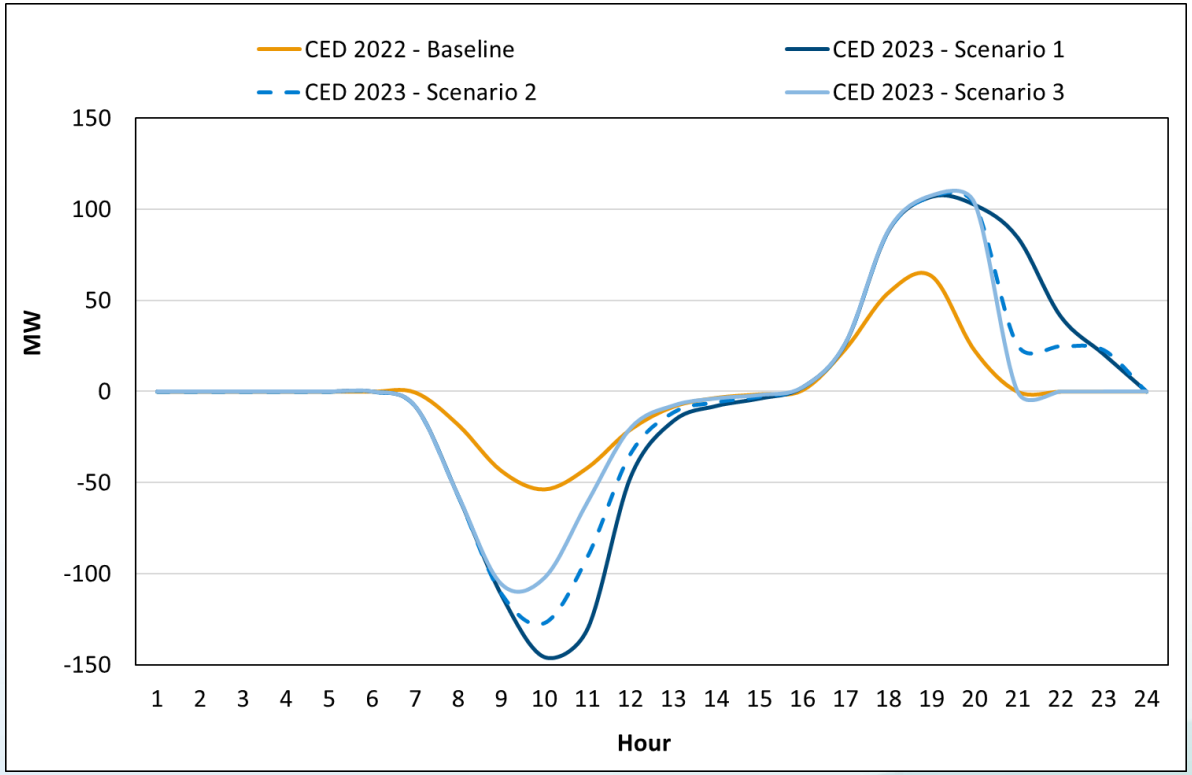


Source: CEC Staff

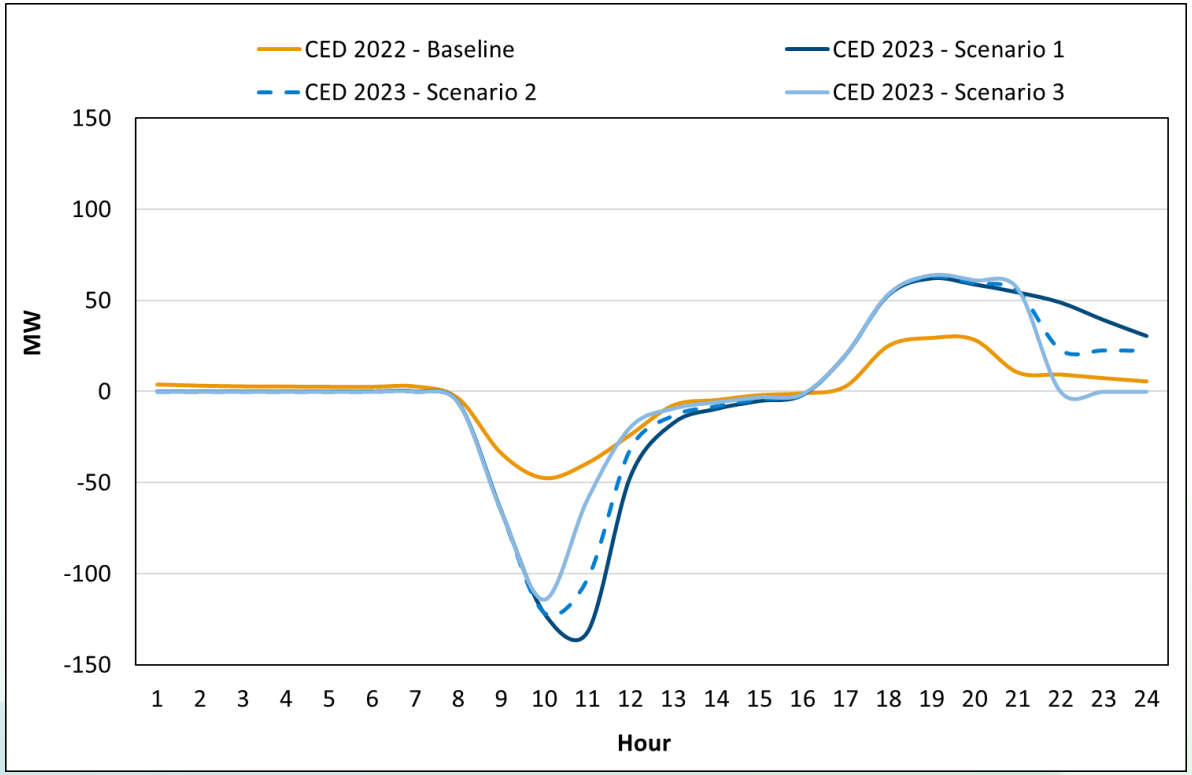
SCE Scenarios Comparison: Calendar Year 2023

- Charts are illustrative of current scenario trade-offs and are similar for PG&E and SDG&E (See Appendix B).

Average Summer Day



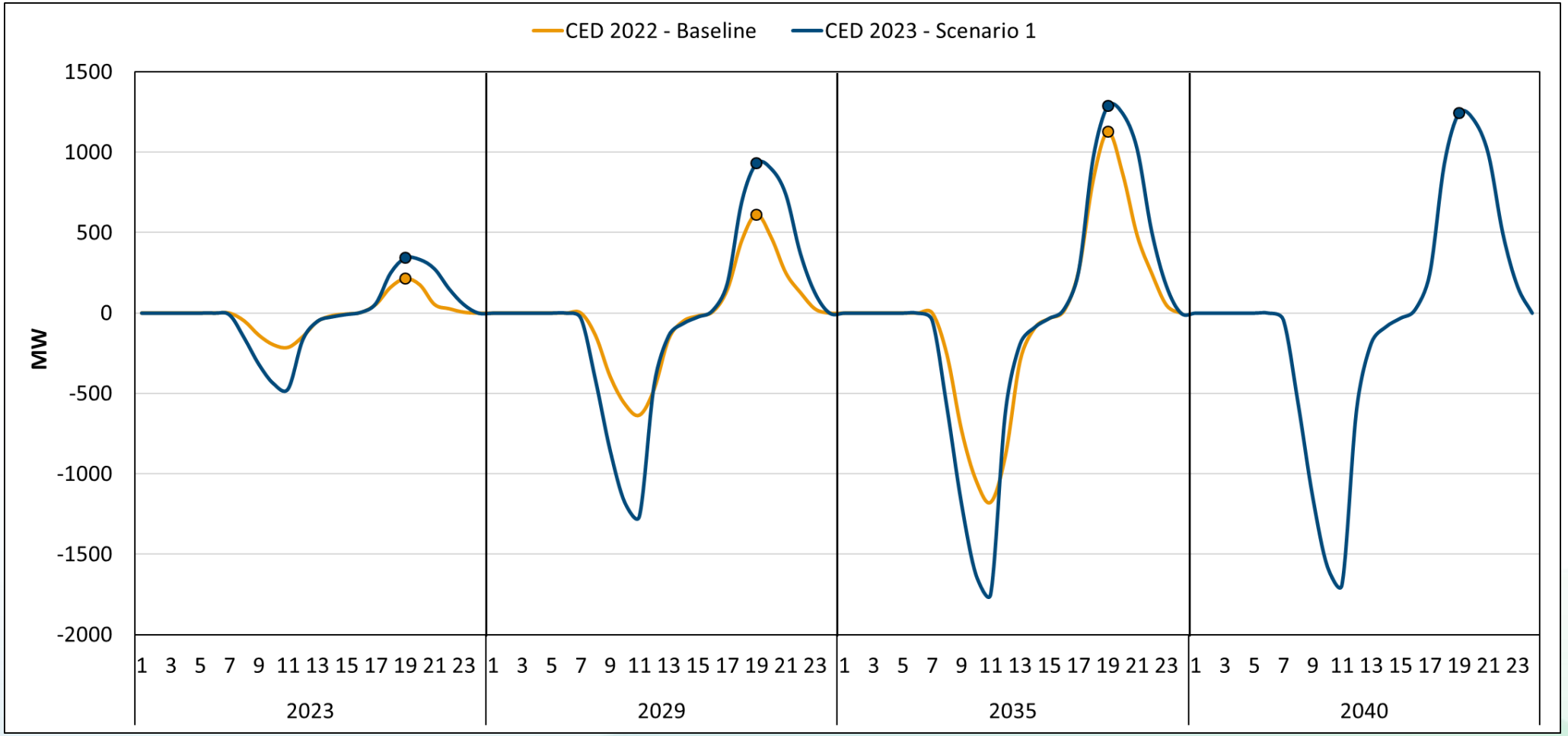
Average Winter Day



Source: CEC Staff

BTM Res Storage Profiles: CAISO, July Peak Impacts

- Increased discharge during hour 19 in 2035 (CED 2023 – CED 2022): 160 MW



Source: CEC Staff

Question for Stakeholders

- Which scenario do stakeholders feel is most suitable for system-wide application?
- Are there refinements stakeholders recommend CEC consider for the most applicable profile?

Special Thanks To:

- CPUC and their team
  - Justin Galle
  - Gabe Petlin
  - Fang Yu Hu
- Verdant
  - Brian McAuley
  - William Marin
- CEC DG Forecast Team
  - Mark Palmere - Lead Forecaster
  - Bobby Wilson - Forecaster
  - Sudhakar Konala - Forecast Advisor

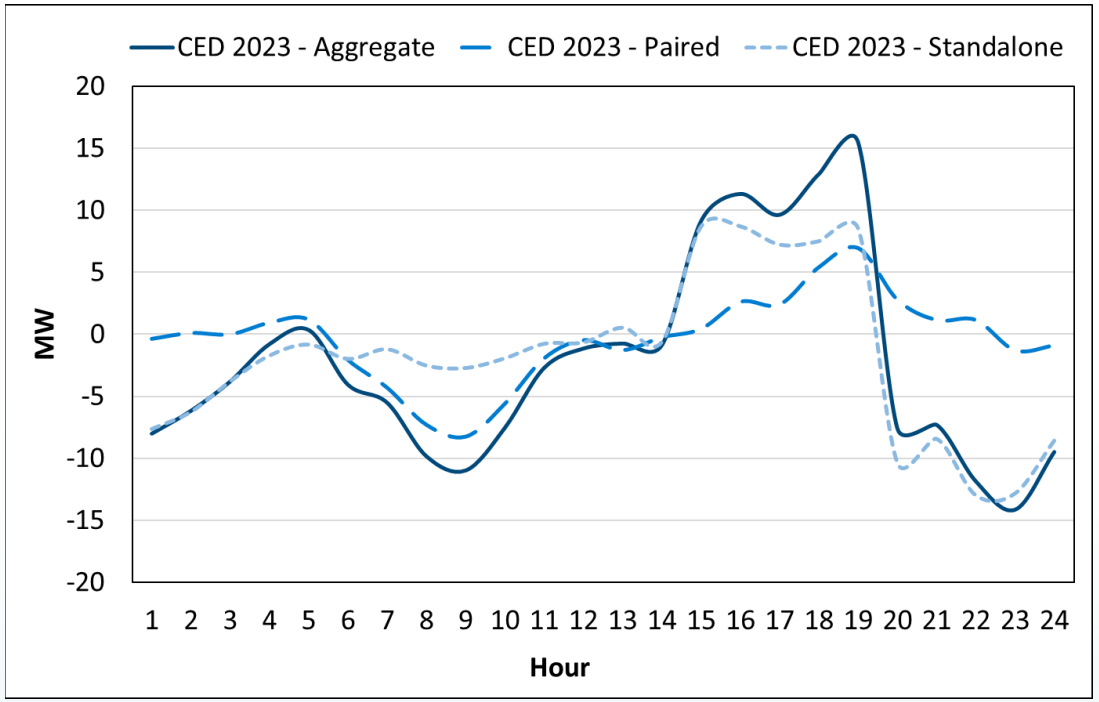
And of course…

Thank You!

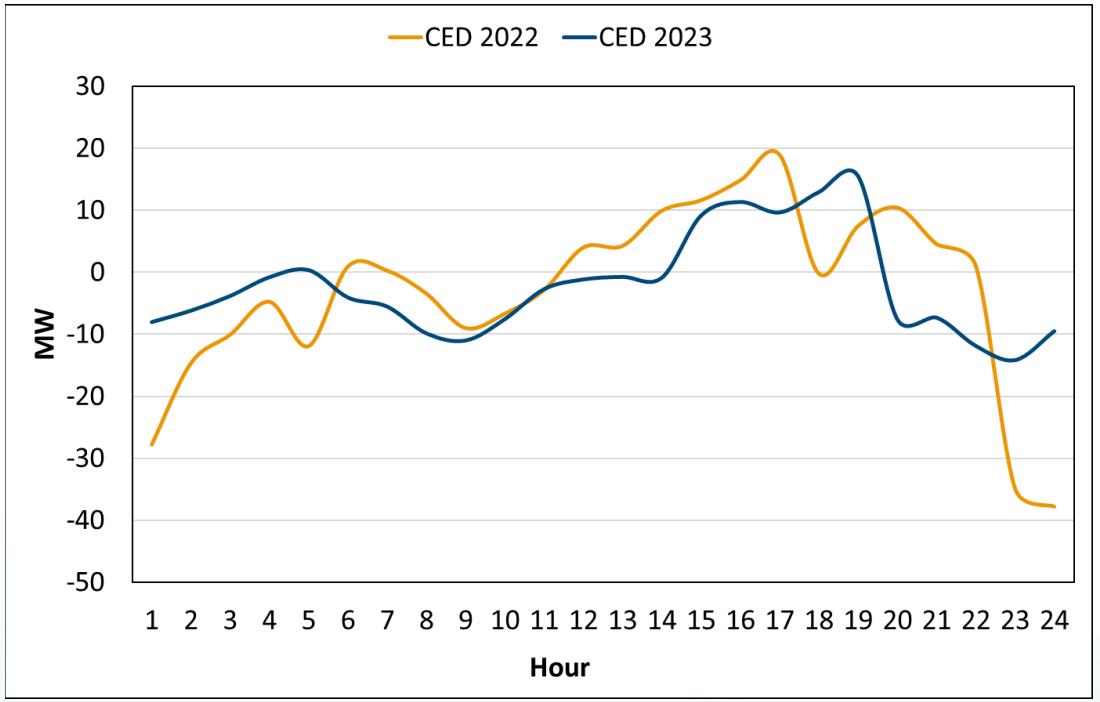
Appendix A:
Non-Residential BTM Storage Profiles

BTM Profile Comparison: PG&E, Average July Weekday 2023

CED 2023 Load by Configuration



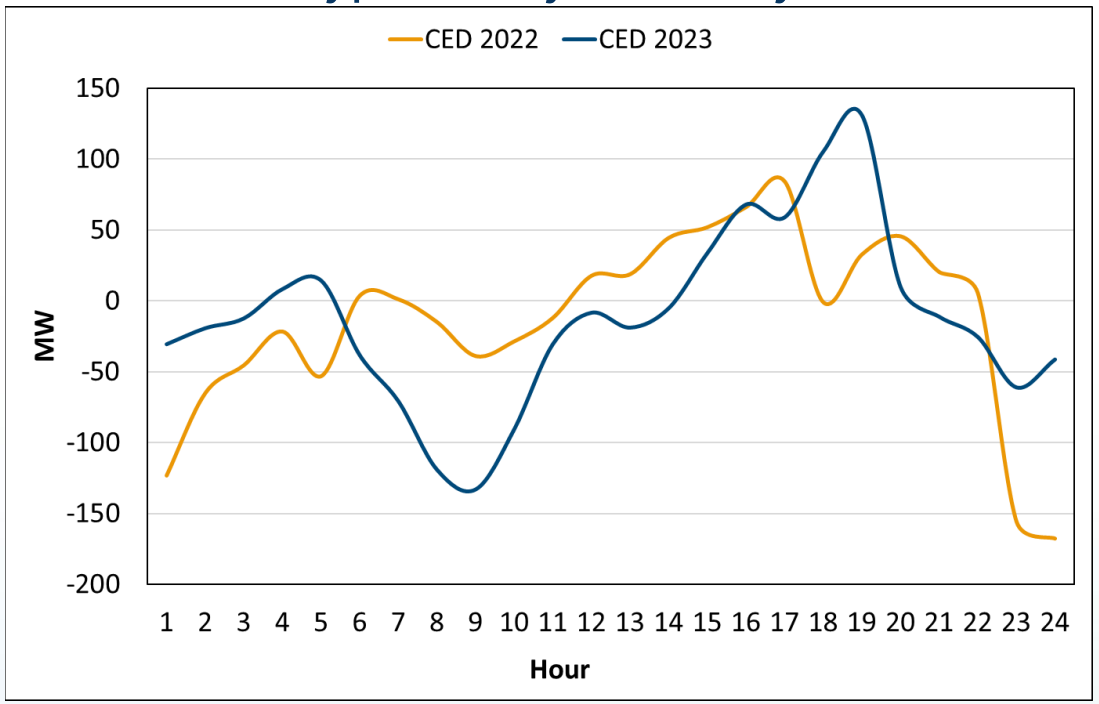
CED Comparison



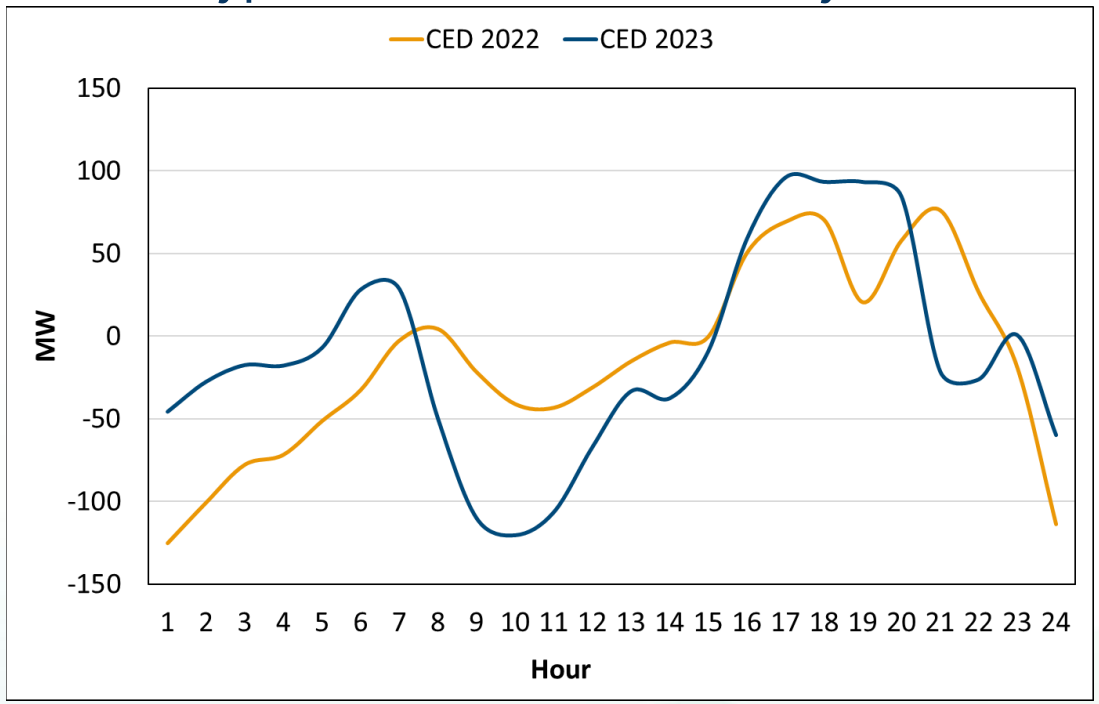
Source: CEC Staff

BTM Profile Comparison: PG&E, Aggregate Profiles, 2035

Typical July Weekday



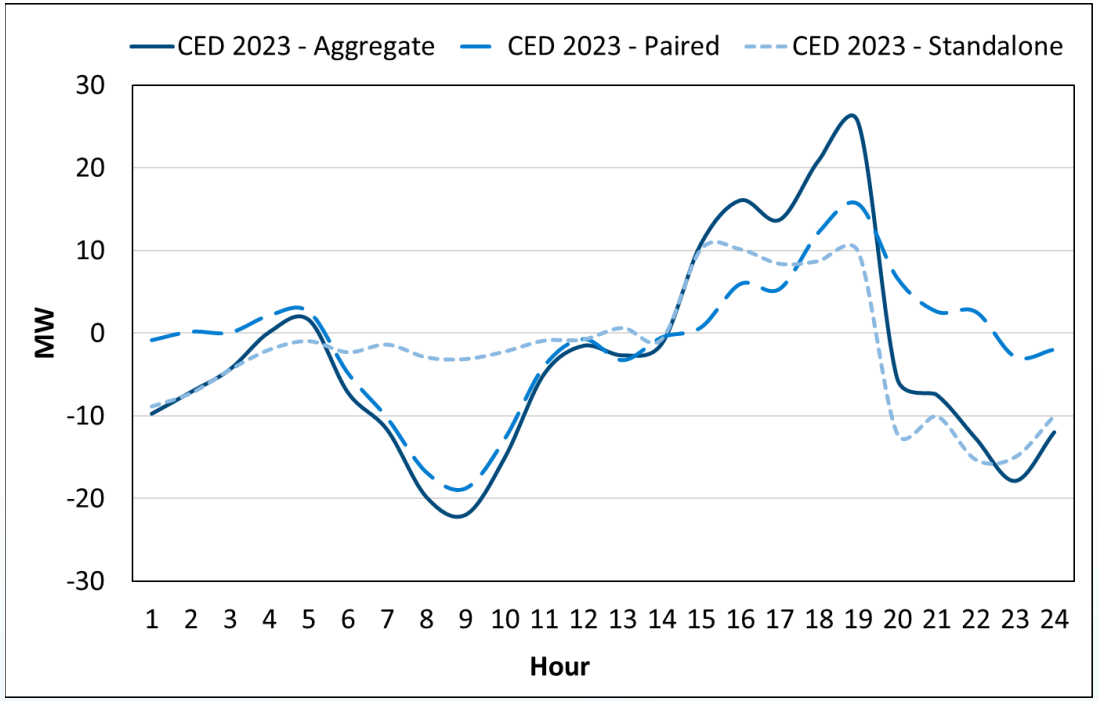
Typical December Weekday



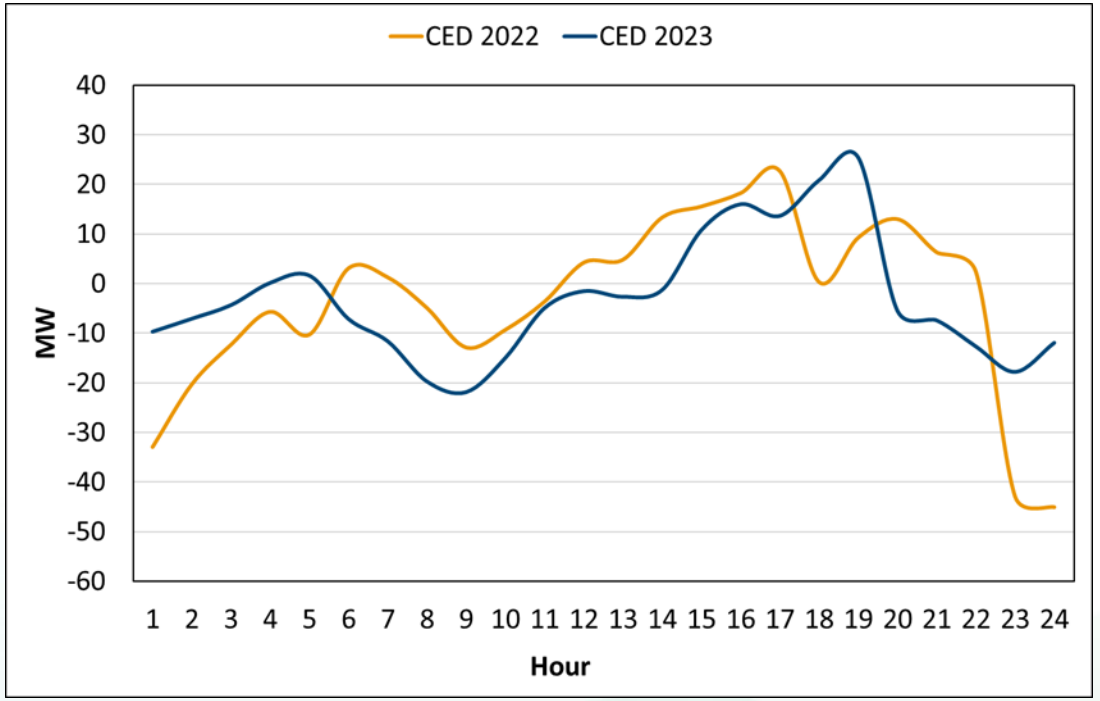
Source: CEC Staff

BTM Profile Comparison: SCE, Average July Weekday 2023

CED 2023 Load by Configuration



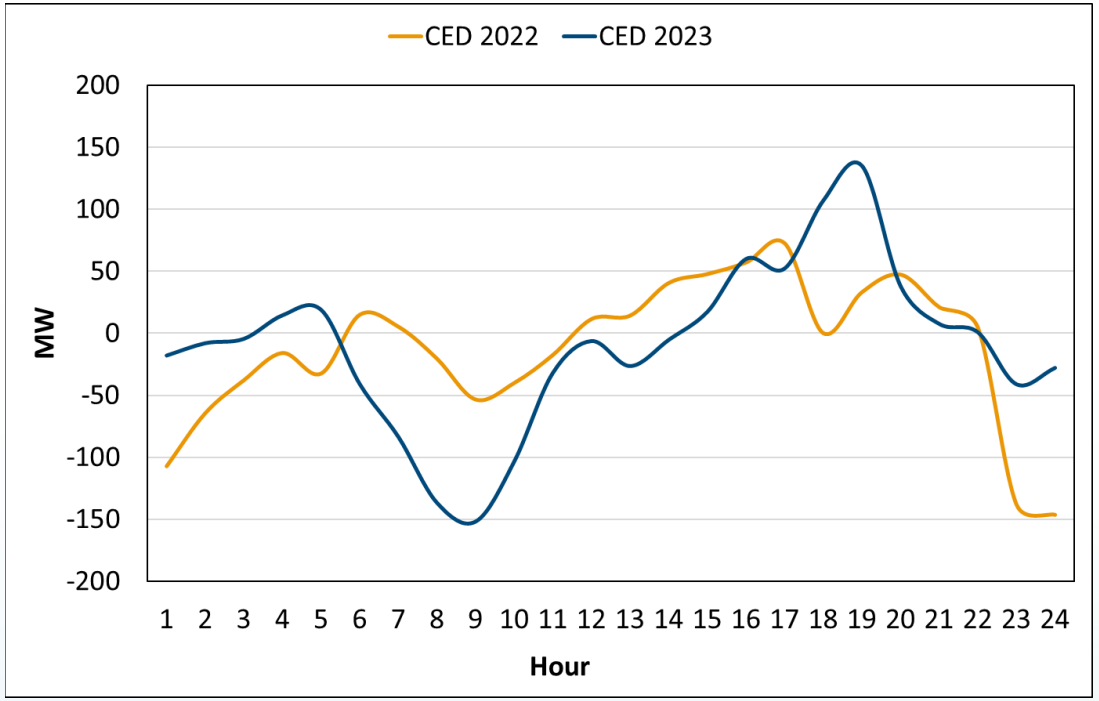
CED Comparison



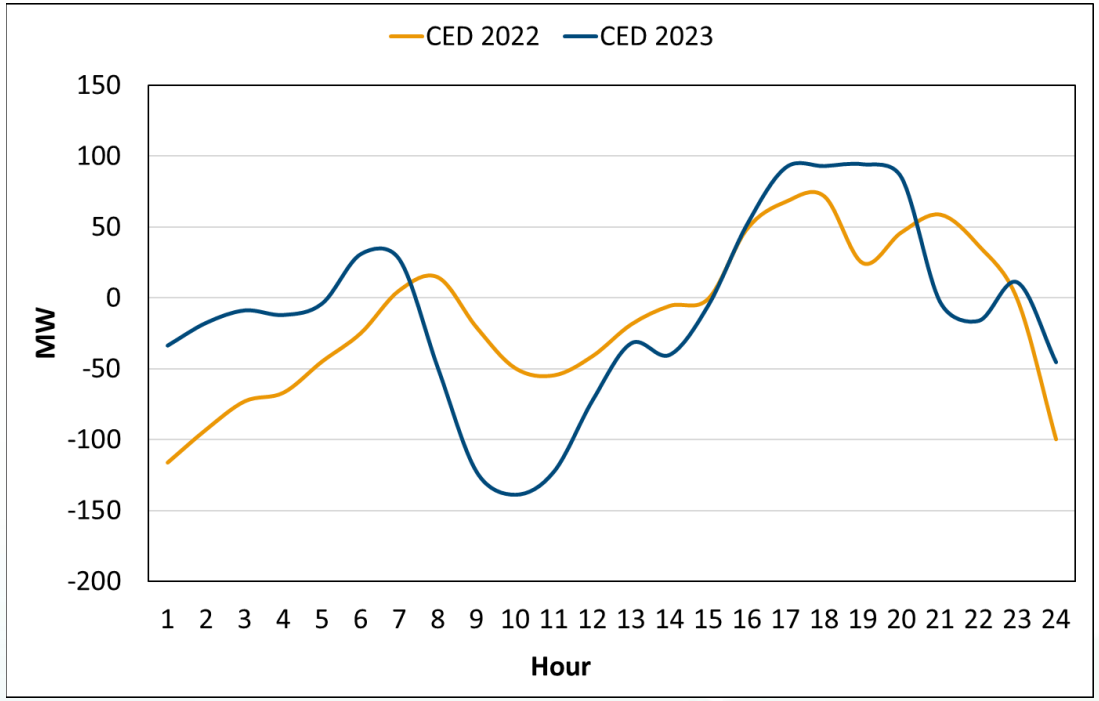
Source: CEC Staff

BTM Profile Comparison: SCE, Aggregate Profiles, 2035

Typical July Weekday



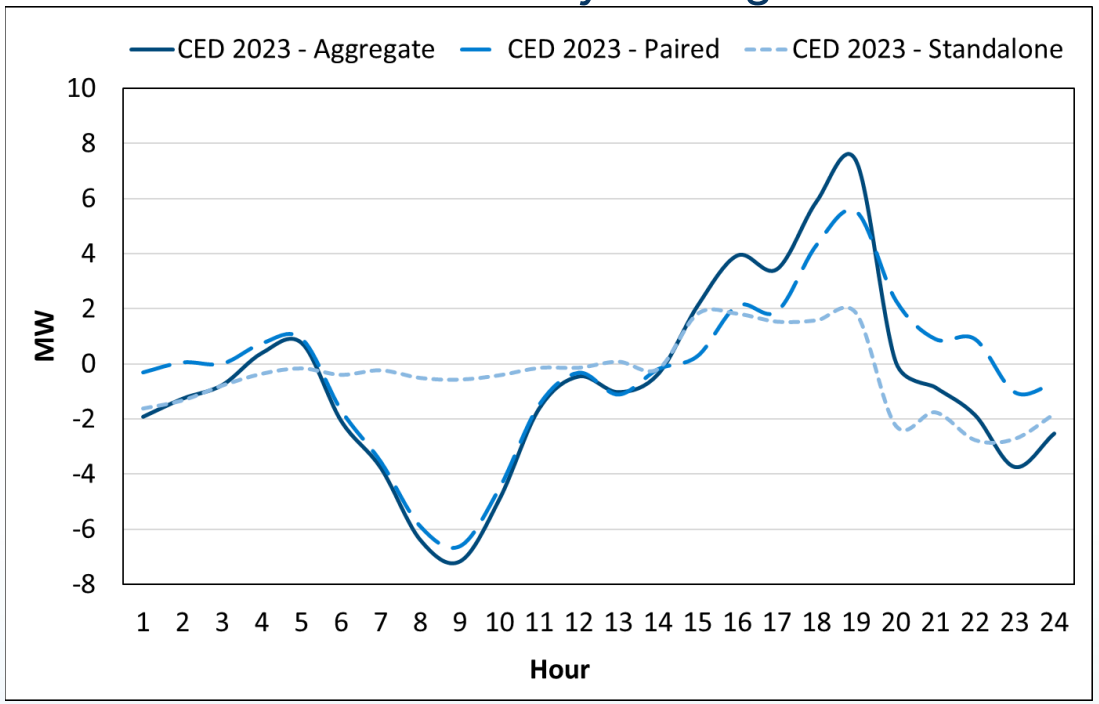
Typical December Weekday



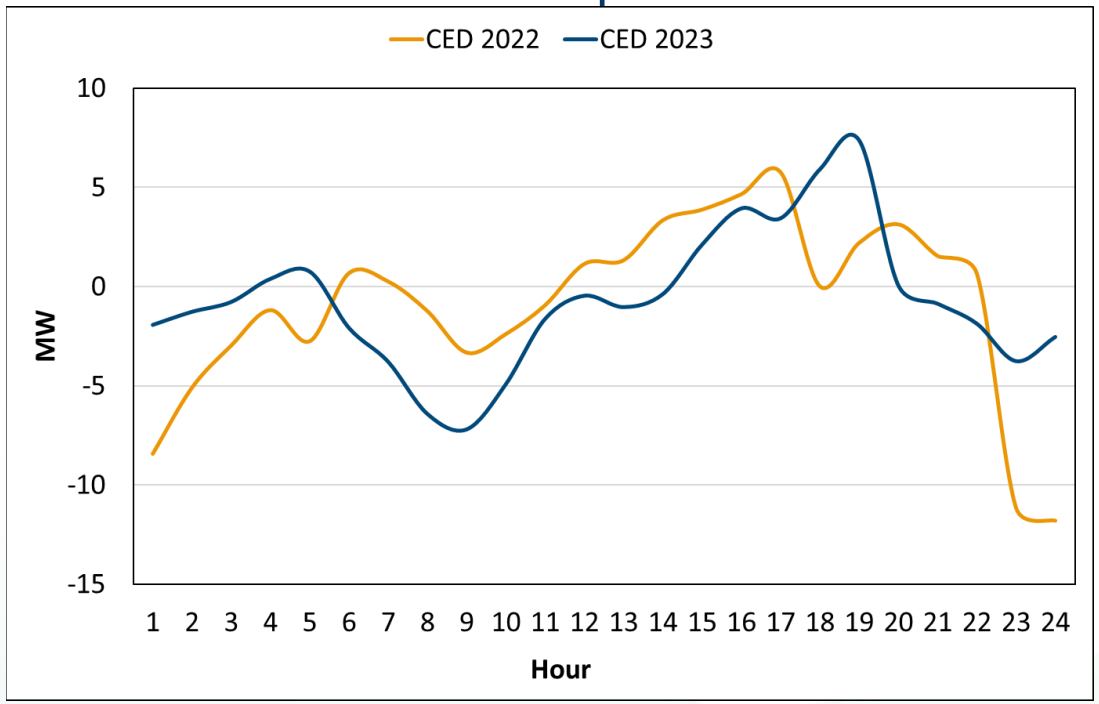
Source: CEC Staff

BTM Profile Comparison: SDG&E, Average July Weekday 2023

CED 2023 Load by Configuration



CED Comparison



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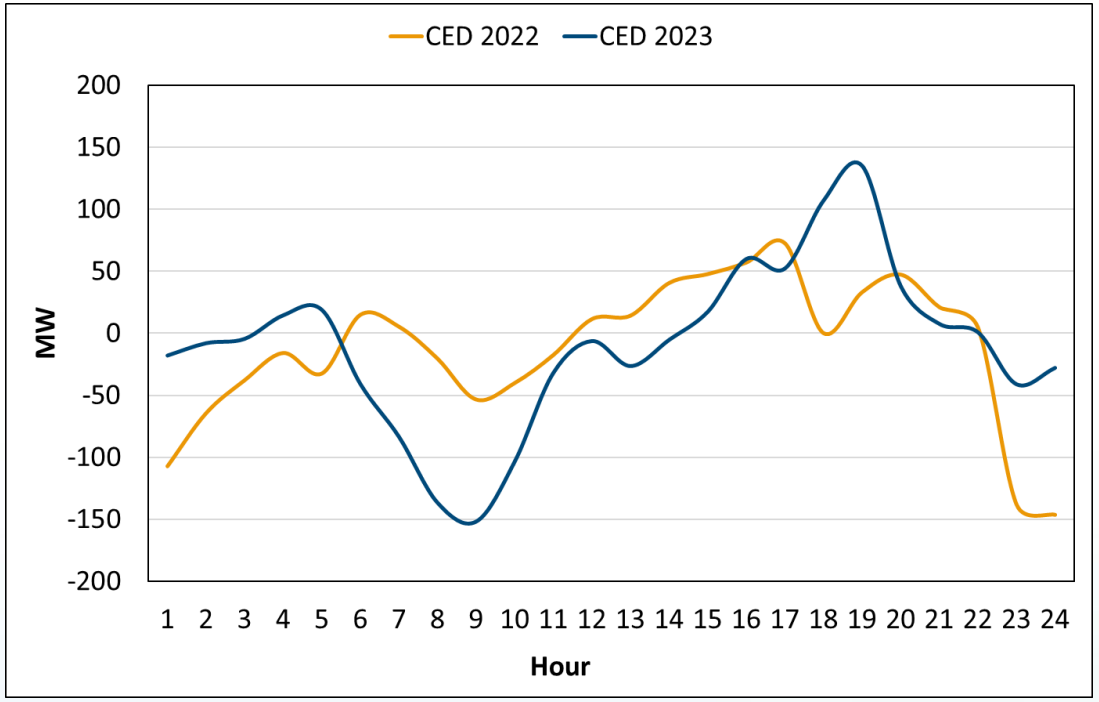
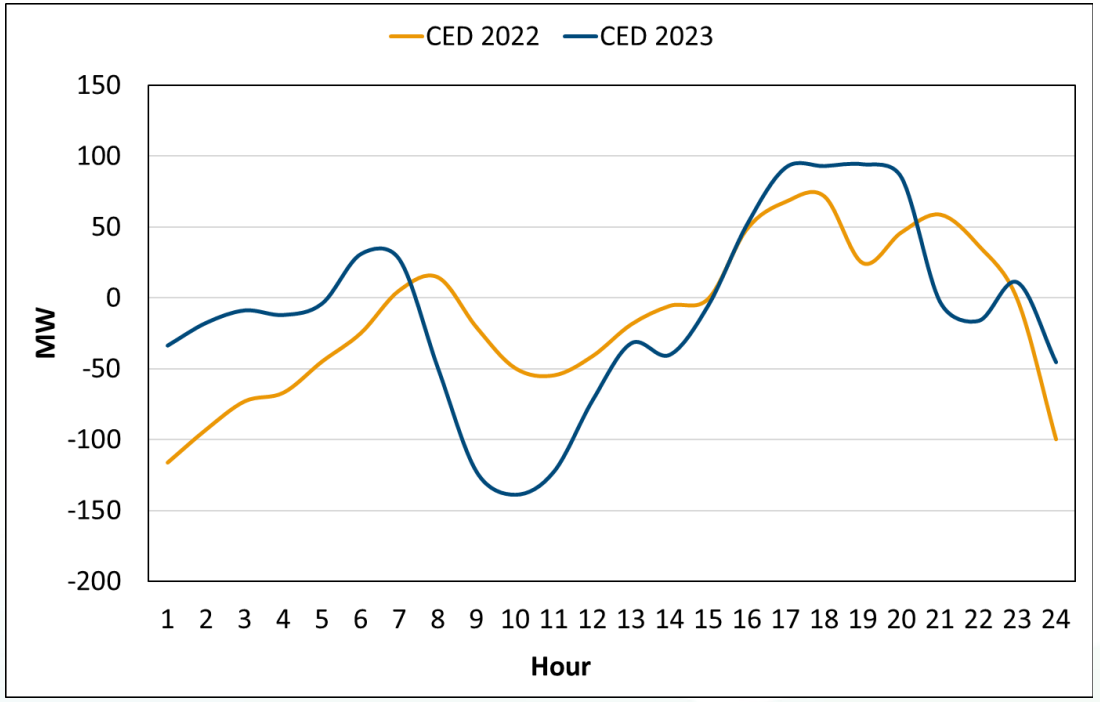
BTM Profile Comparison: SDG&E, Aggregate Profiles, 2035

Typical July Weekday



Typical December Weekday

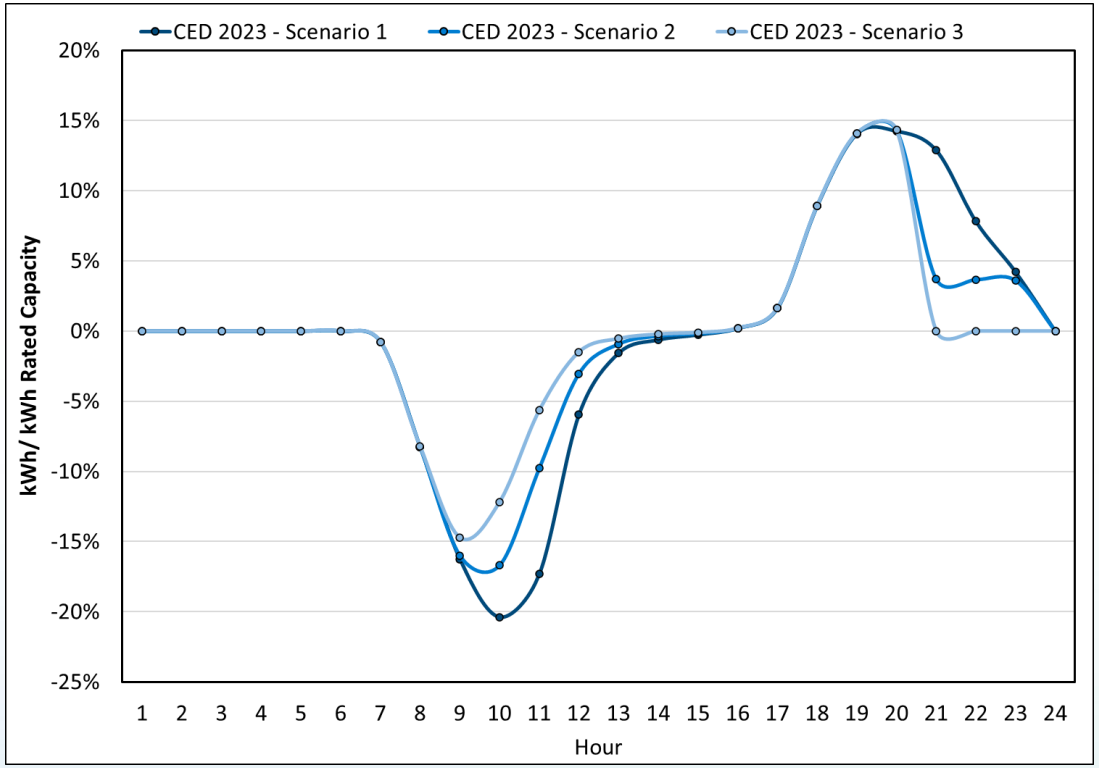


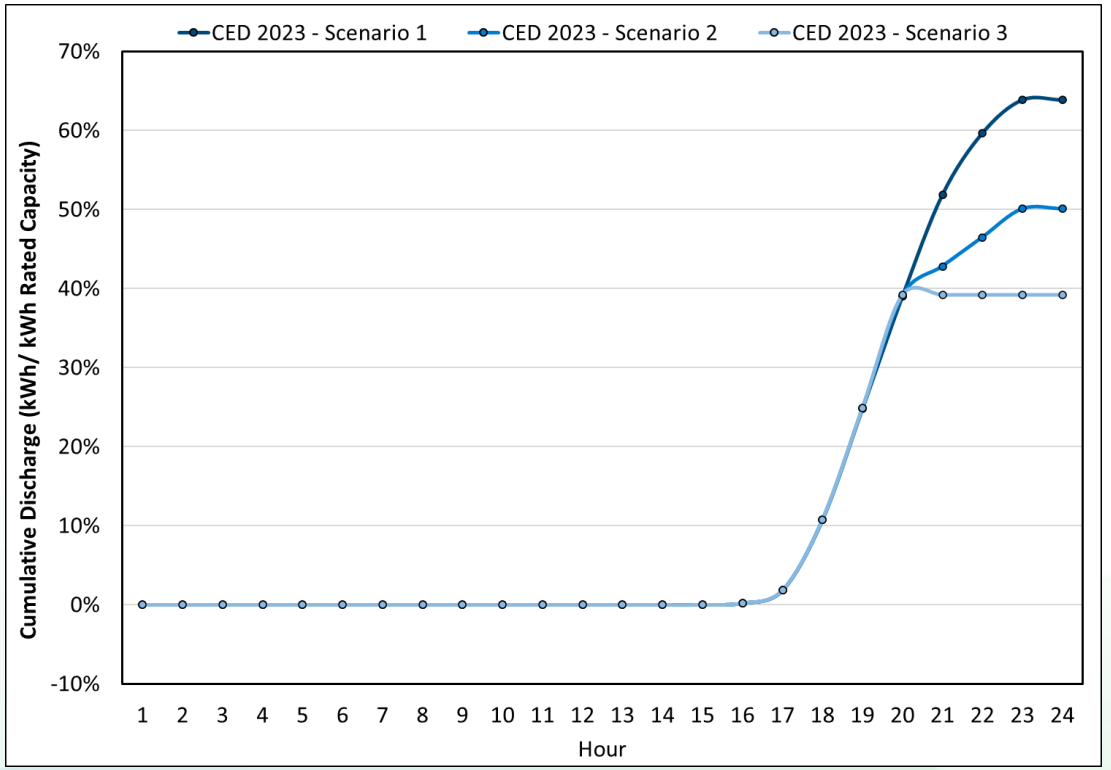
Source: CEC Staff

Appendix B:
Residential BTM Storage Profiles

PG&E Scenarios Comparison: Average Summer Day

- Modifications to the SAM manual dispatch strategy affects the shape of the profile and cumulative energy dispatched.

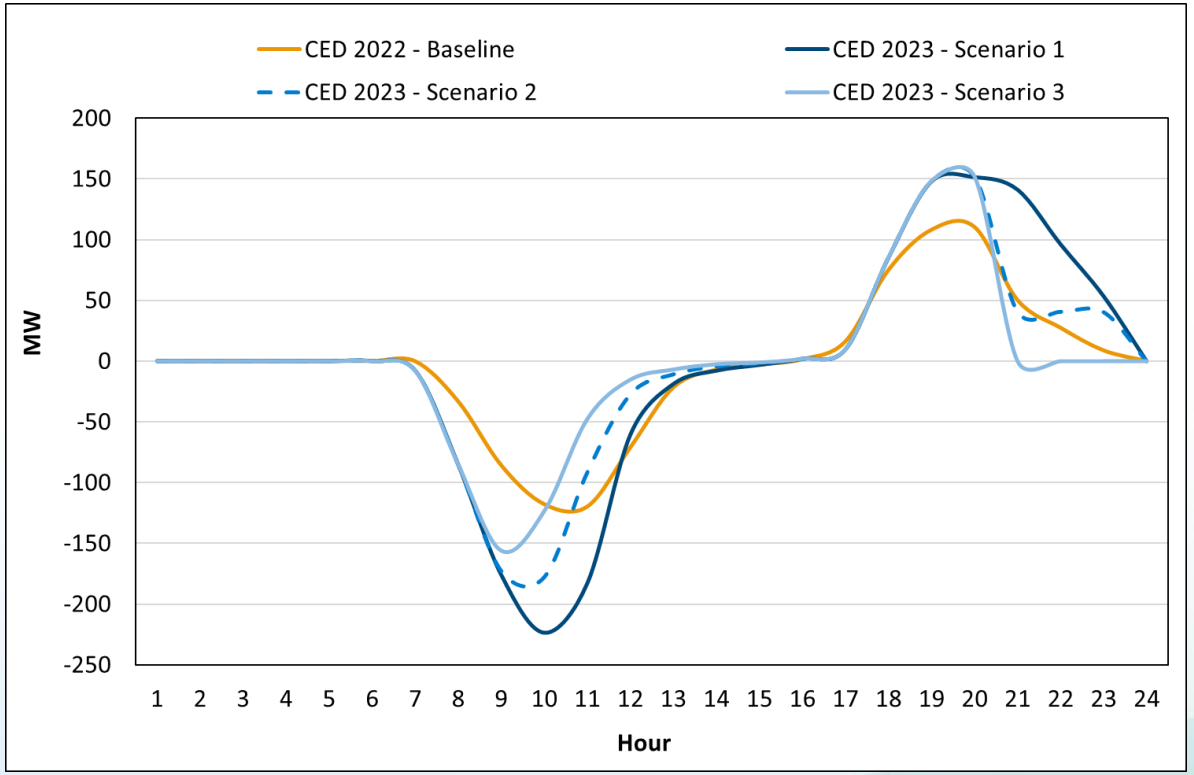




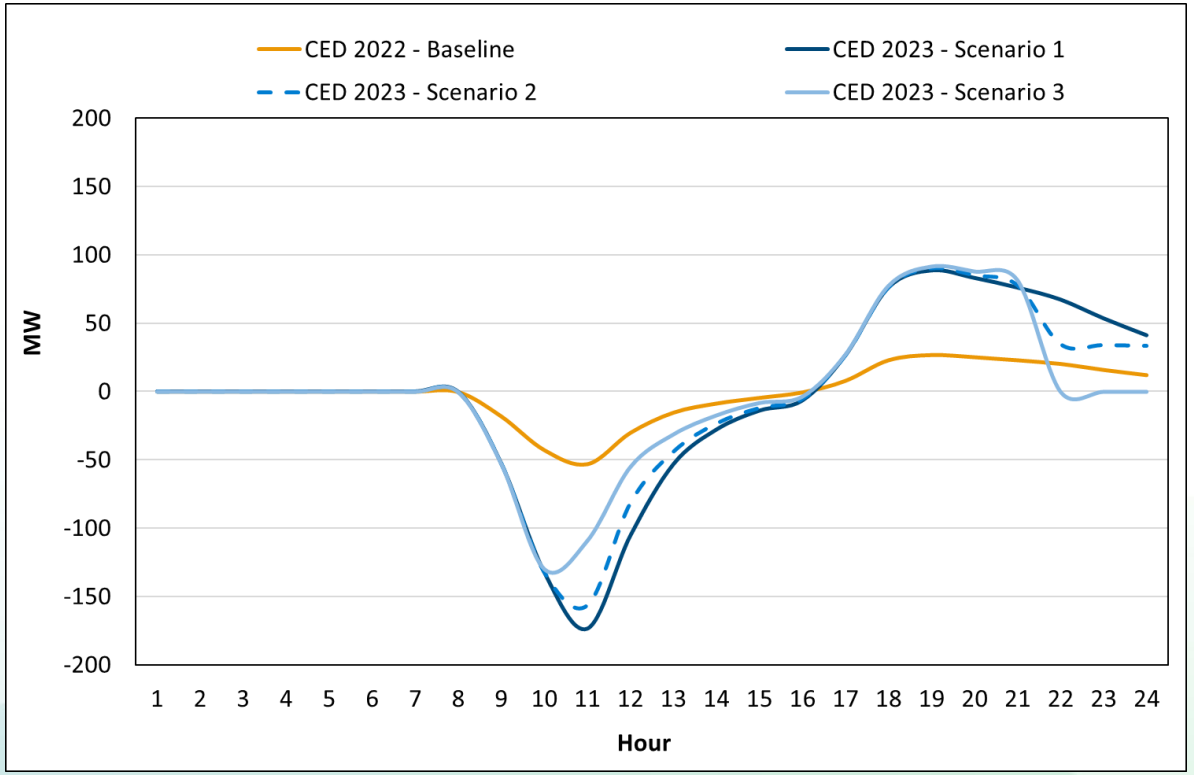
Source: CEC Staff

PG&E Scenarios Comparison: Calendar Year 2023

Average Summer Day

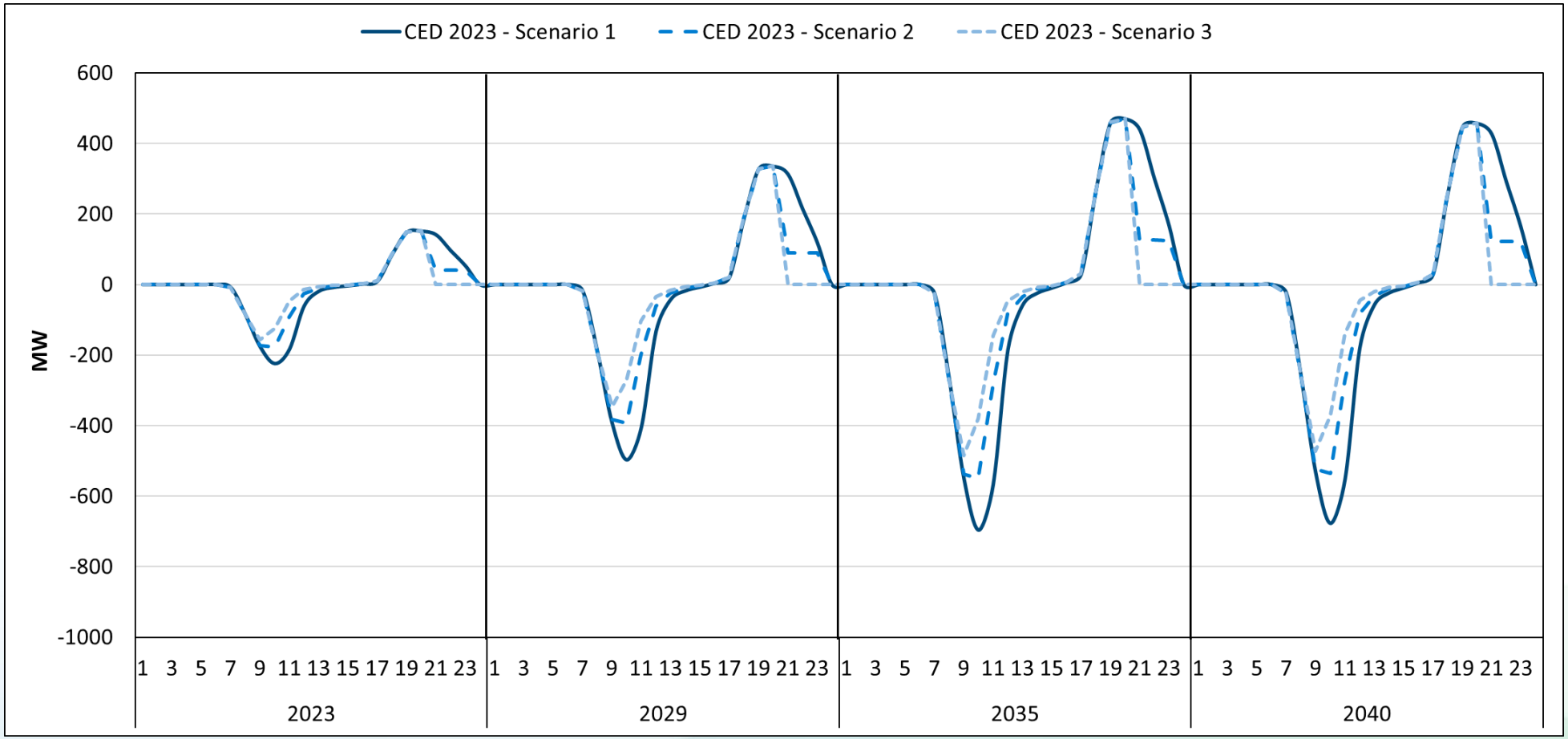


Average Winter Day



Source: CEC Staff

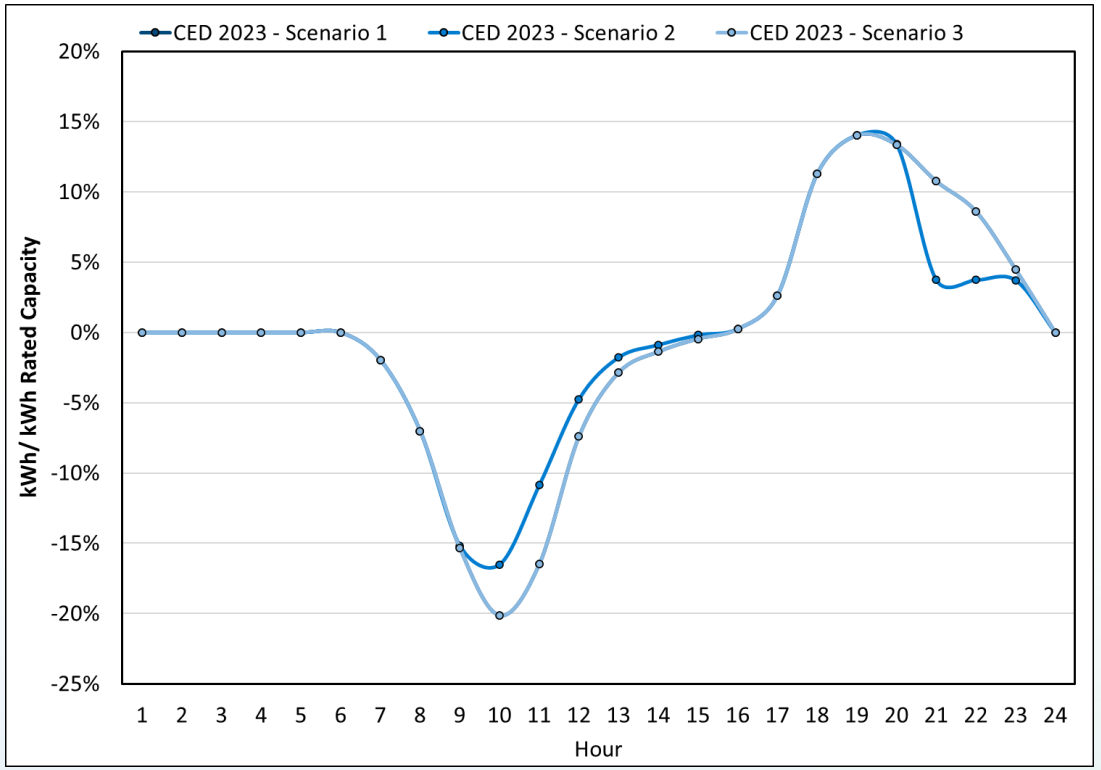
Residential Scenarios Comparison: PG&E, Average Summer Day

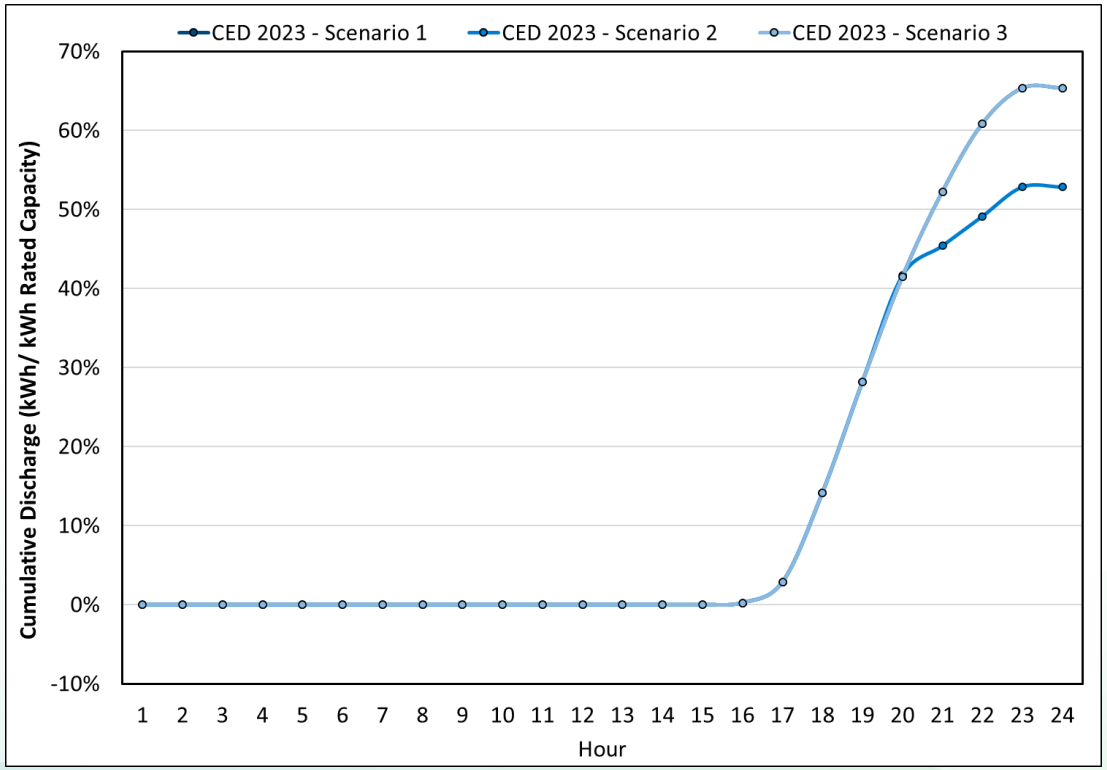


Source: CEC Staff

SDG&E Scenarios Comparison: Average Summer Day

- Modifications to the SAM manual dispatch strategy affects the shape of the profile and cumulative energy dispatched.

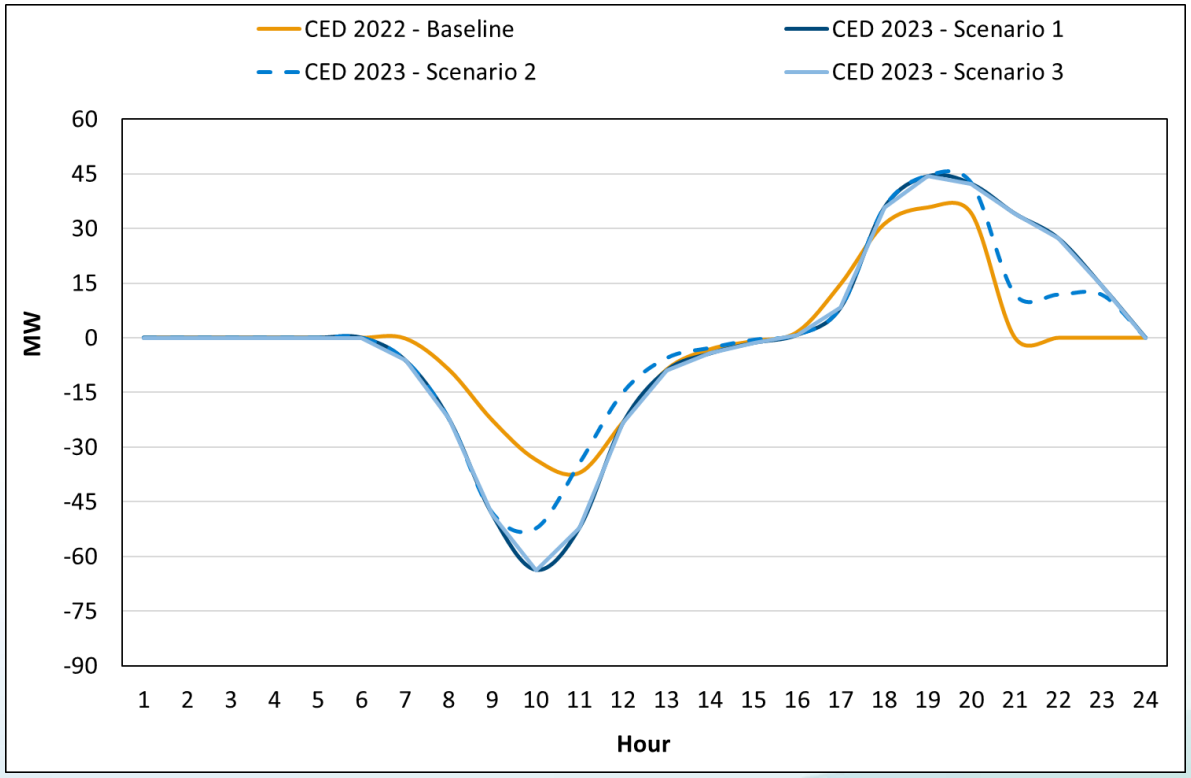




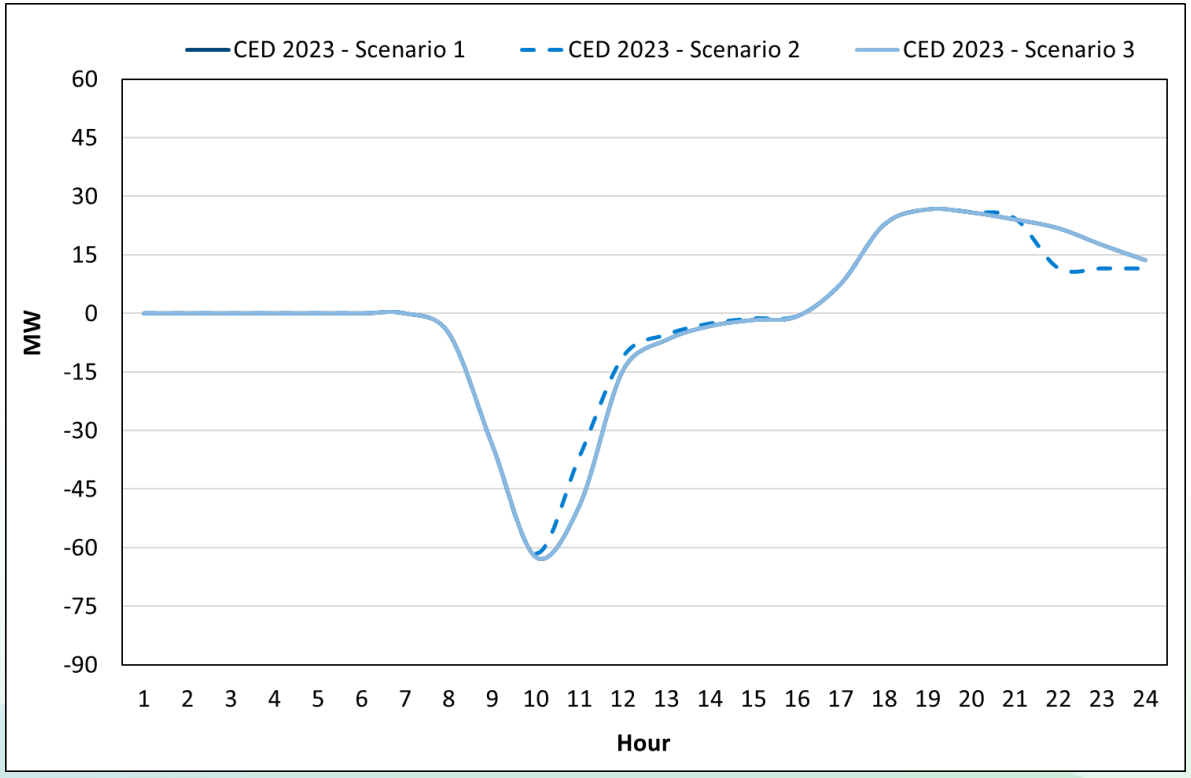
Source: CEC Staff

SDG&E Scenarios Comparison: Calendar Year 2023

Average Summer Day

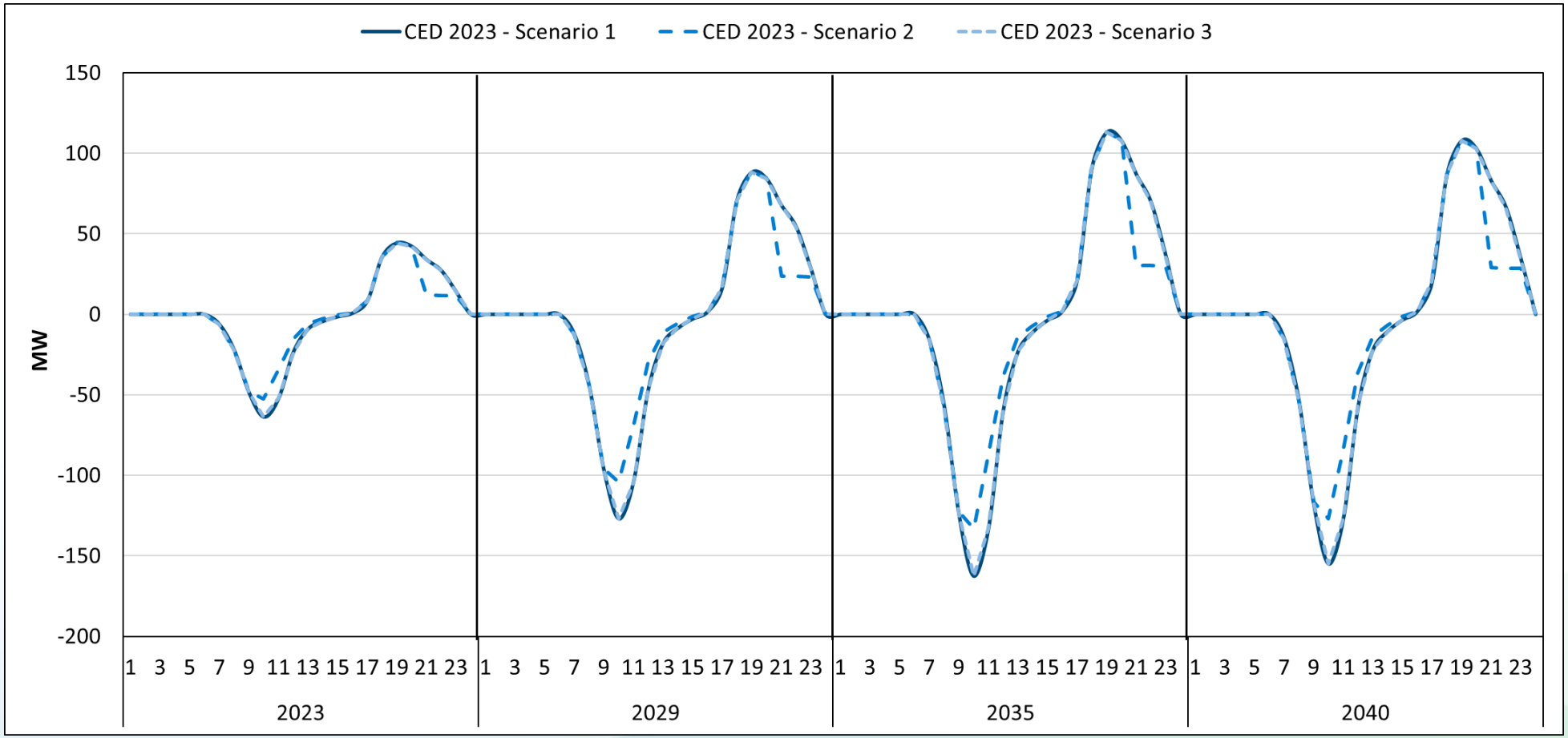


Average Winter Day



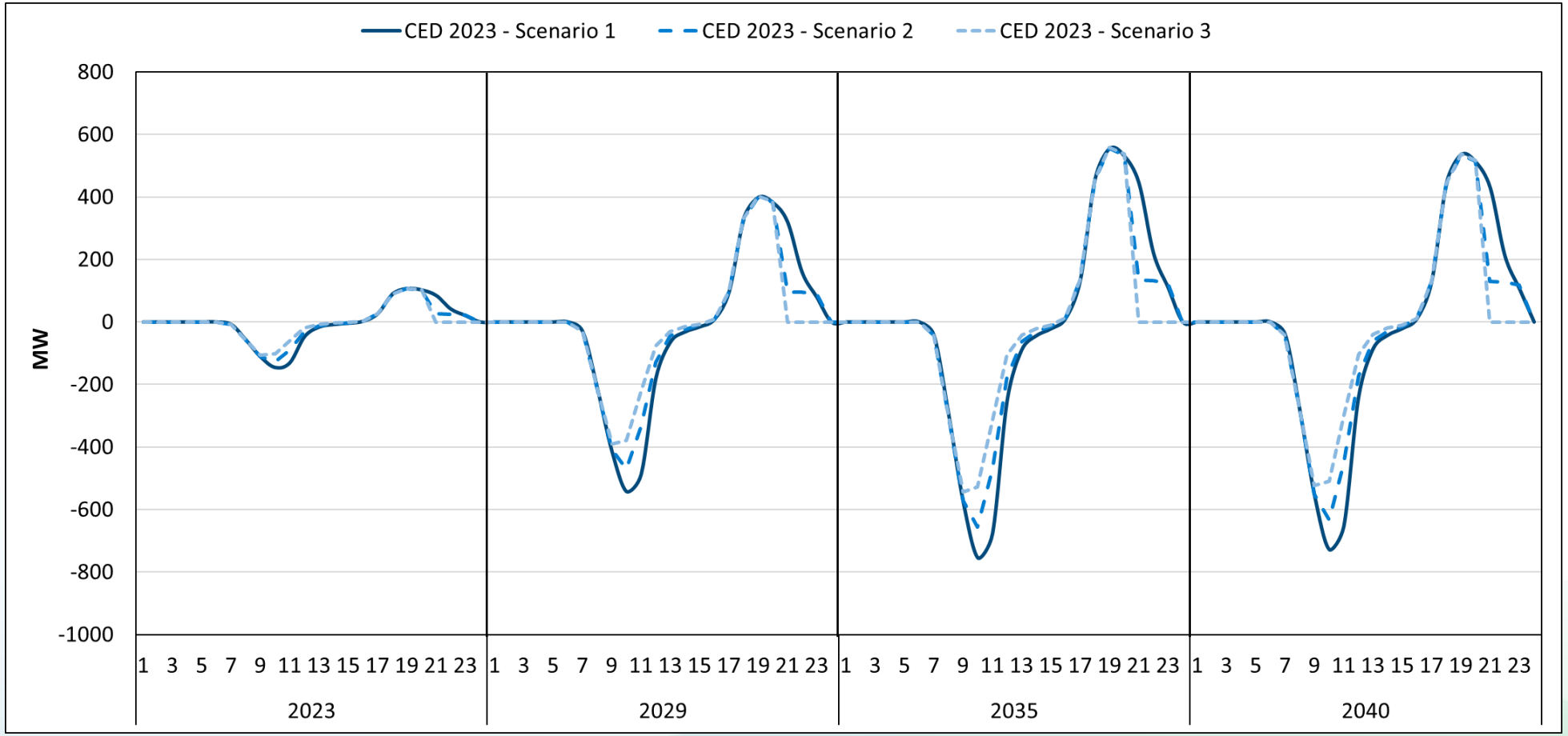
Source: CEC Staff

Residential Scenarios Comparison: SDG&E, Average Summer Day



Source: CEC Staff

Residential Scenarios Comparison: SCE, Average Summer Day



Source: CEC Staff