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Description:	5A. 5B. & 5C. Alex Lonsdale, Mark Palmere, CEC
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California Energy Commission

Behind-The-Meter Storage Profile Updates

Presenters: Alex Lonsdale, DG Forecast Supervisor & Mark Palmere, DG Forecast Lead

Date: 11/15/2023

Presentation Overview (Update)

- Forecast Framework
- Annual Forecast
  - Key Inputs update
  - Results
- Non-residential Hourly Storage Forecast
  - Methodology
  - Results
- Residential Hourly Storage Forecast
  - Methodology
  - Results

Forecast Framework

CED Distributed Generation Forecast Changes

- For CED 2023, CEC's DG forecast team has implemented new:
  - Methods for determining historical behind-the-meter DG capacity
    - Slightly lower estimate of PV capacity
    - Higher estimate for storage capacity
  - Market adoption and standalone storage models
  - Storage charge and discharge profiles
- Net Billing Tariff (NBT)
  - The Net Billing Tariff (NBT) was adopted by CPUC in late 2022 as a replacement for Net Energy Metering (NEM 2.0)
  - Went into effect April 2023
- Federal Investment Tax Credit (ITC) extension
  - Most recent extension is part of Inflation Reduction Act (IRA)
  - Now extended through 2034
  - Provides tax credit of up to 30% of installation cost

CED DG Adoption Models

- Four models are used to forecast growth in BTM DG capacity resulting from retrofits and new construction.
- Previous CED forecast tools did not distinguish between standalone and paired storage adoption for retrofits.

Installation Type	BTM DG Adoption Model	Standalone Solar PV	Standalone Energy Storage	Paired Solar PV + Energy Storage
Retrofit	dGen	✓	x	✓
	Standalone Storage	x	✓	x
New Construction	Title 24 - Residential	✓	x	x
	Title 24 - Commercial	✓	x	✓

Source: CEC Staff

CED Distributed Generation Forecast: Programs Scope

- **Economics Based Forecast**:
  - Program requirements and economics related to DG adoption are factored into the forecast.
- **Compliance Based Forecast:**
  - Forecast adheres to Title 24 and does not account for program requirements, or the economics associated with DG adoption.

Renewable DG Program	Economics Based Forecast	Compliance Based Forecast
Net Billing Tariff	✓	✓
Virtual Net Energy Metering	x	✓
Net Energy Metering Aggregation	x	✓
Community Solar	x	x
Renewable Energy Self-Generation Bill Credit Transfer	x	x

Source: CEC Staff

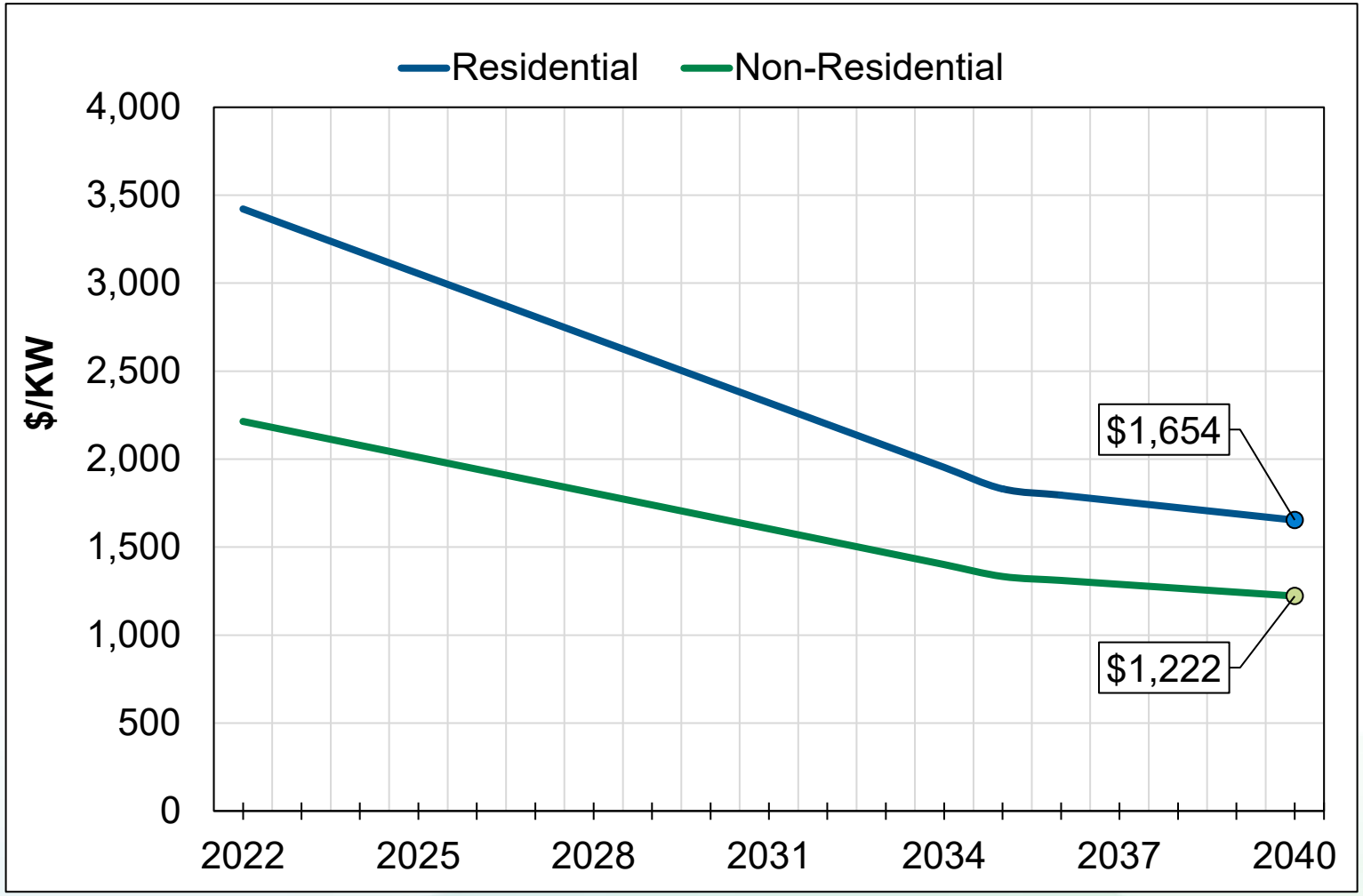
Excluded Programs

- **Virtual Net Energy Metering (VNEM) :**
  - Solar PV + storage **retrofits** to existing buildings aren't forecasted due to owner-tenant barriers for adoption.
- **Net Energy Metering Aggregation (NEMA) :**
  - Adoption is not considered by our model framework due to the complexities associated with modelling DG intended to reduce electricity costs from multiple meters.
  - CPUC released a proposed decision on August 2, 2023, to revise VNEM and NEMA programs and is pending board approval.
- **Community Solar:**
  - Forecasted adoption of community solar is a challenge to include in current forecast models.
  - Current renewable energy subscription programs are under review by CPUC and may be replaced in the ongoing consolidated Community Solar Proceeding
  - CEC staff will consider ways to include renewable energy subscription programs in future CED forecasts based on the outcomes of the consolidated Community Solar Proceeding.
- **Renewable Energy Self-Generation Bill Credit Transfer (RES-BCT):**
  - CEC forecast tools aren't configured to forecast adoption of DG where bill credits are shared across multiple billing accounts.
  - Program has a statewide capacity limit of 250MW and closes thereafter.

Annual Forecast Inputs Updates

Solar PV Installation Costs

- To estimate the cost of solar, staff used CPUC's adoption of $3.30/Watt as the current cost of installing a residential solar system in California in 2023
- Staff then used NREL's Annual Technology Baseline (ATB) data to model rate of change in costs throughout forecast period.
- The ATB was also used to calculate the discount rate of commercial installation costs.
  - $2.15/Watt in 2023

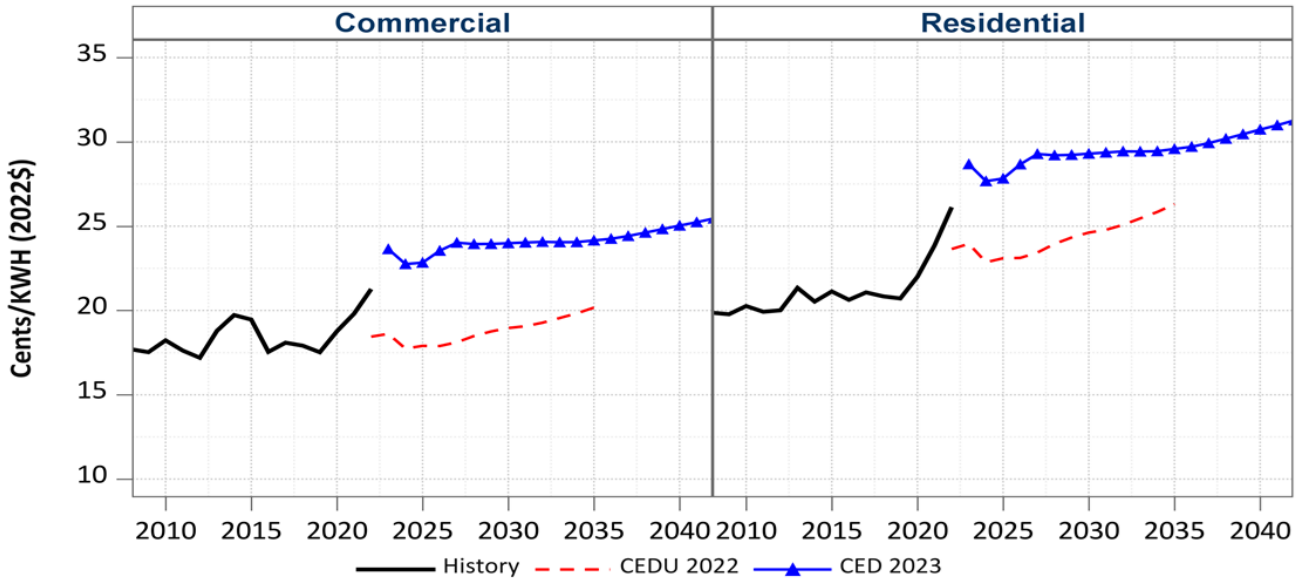


Source: CEC Staff

Electricity Rates

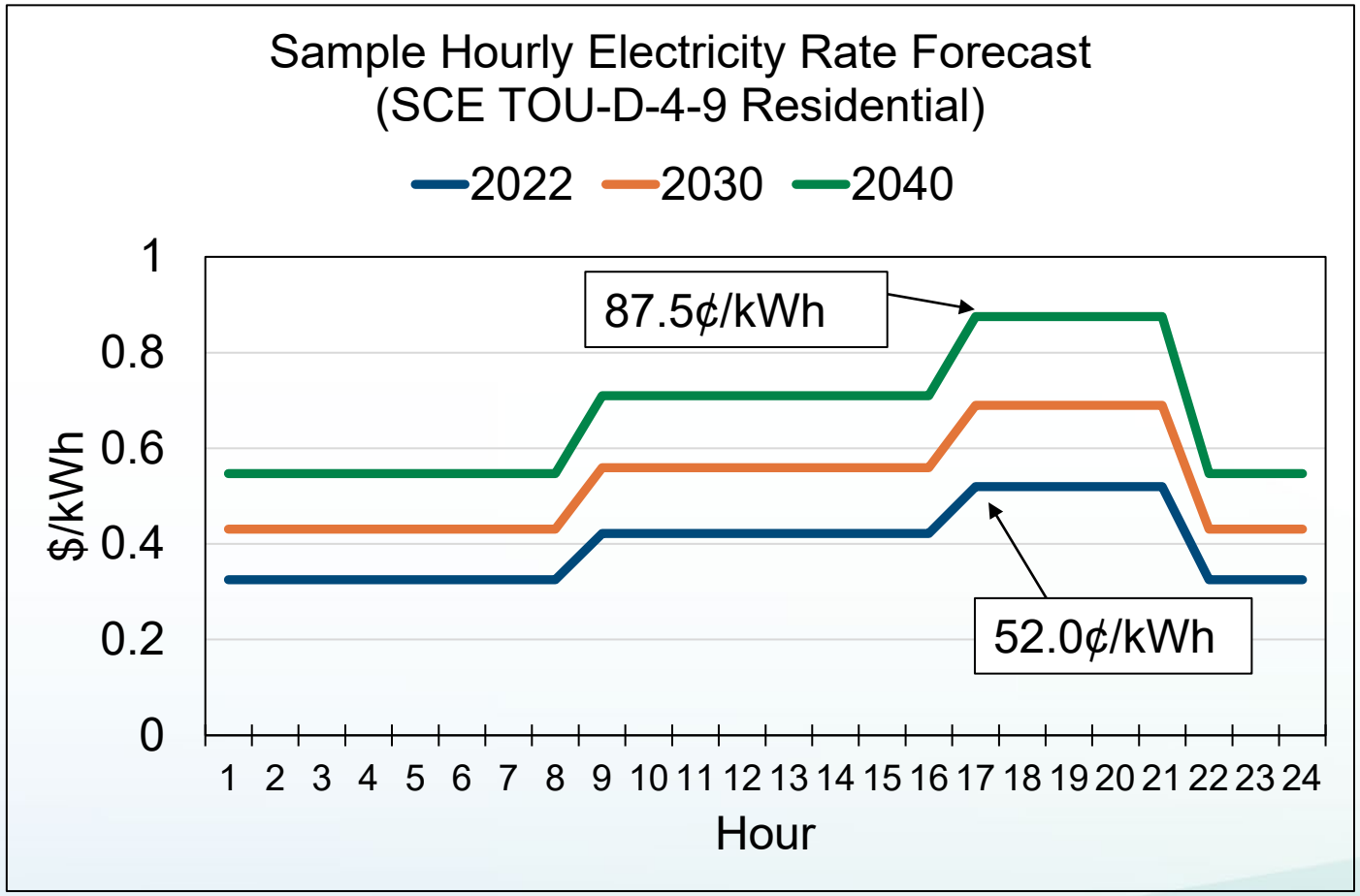
- Electricity rates in our market adoption tool in the forecast base year (2022) are reflective of 2022 electricity import rates.
- TOU rates escalate in accordance with the CED 2023 electricity rate forecast.
  - When considering DG adoption, payback periods and net present values are calculated from NBT compliant tariffs.

SCE Planning Area Rates

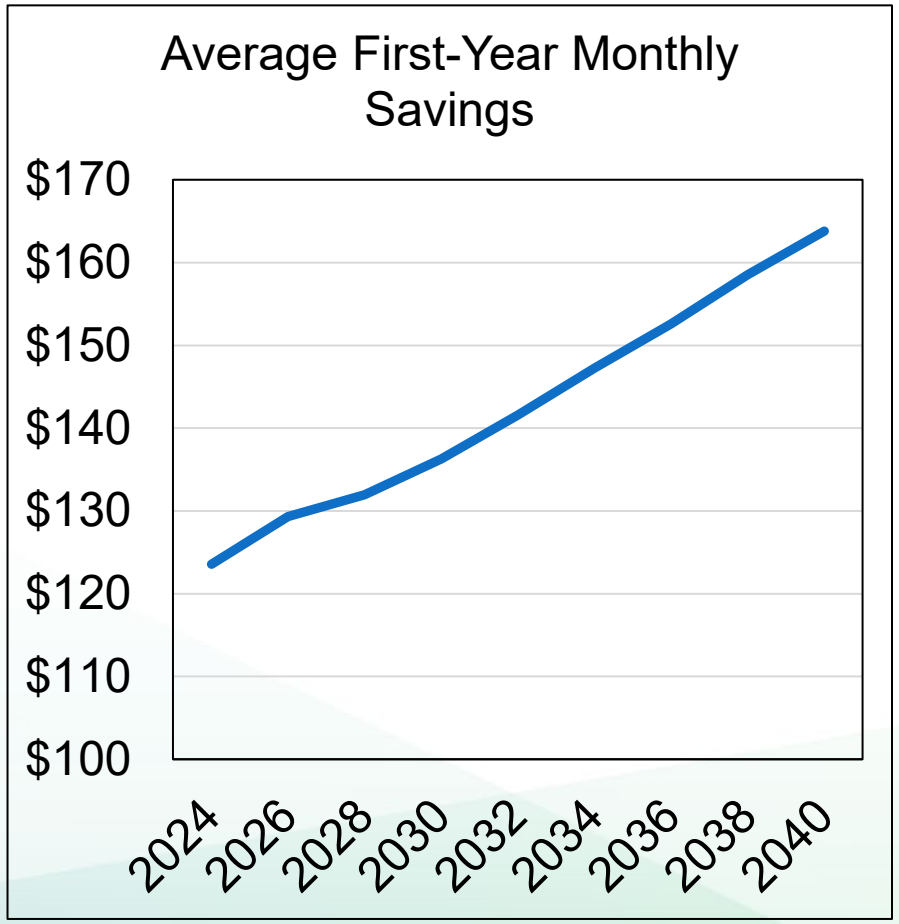


Source: CEC Staff

Electricity Rates Align With Monthly Savings



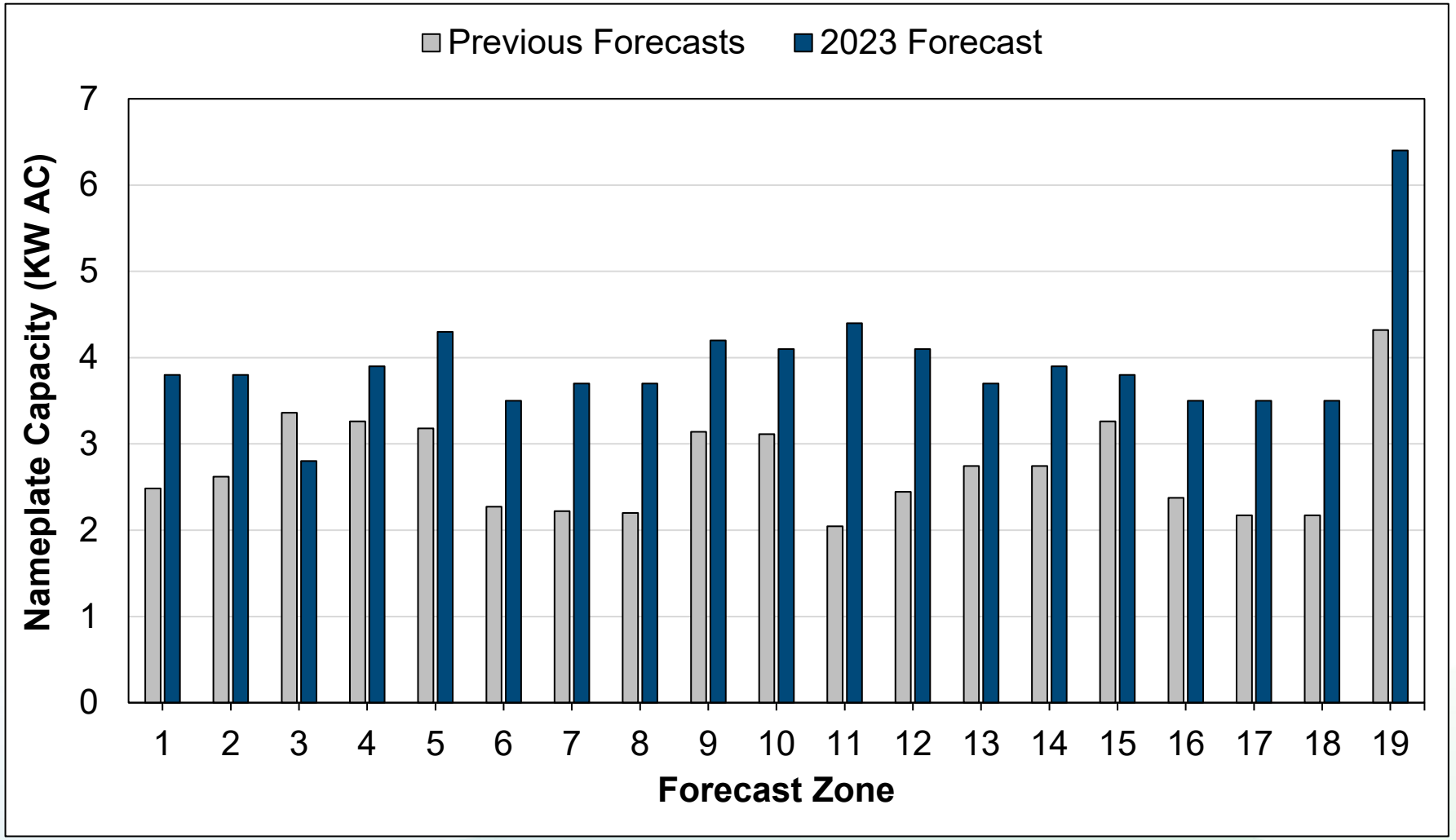
Source: CEC Staff



Source: CEC Staff

Title 24 Residential Solar PV Installations

- Forecast staff acquired Title 24 permit data from CEC's Standards Compliance Branch to inform Solar PV installation size estimates for new homes.
- Average sizes are greater than previously estimated, leading to increased compliance-based solar PV capacity in the forecast.

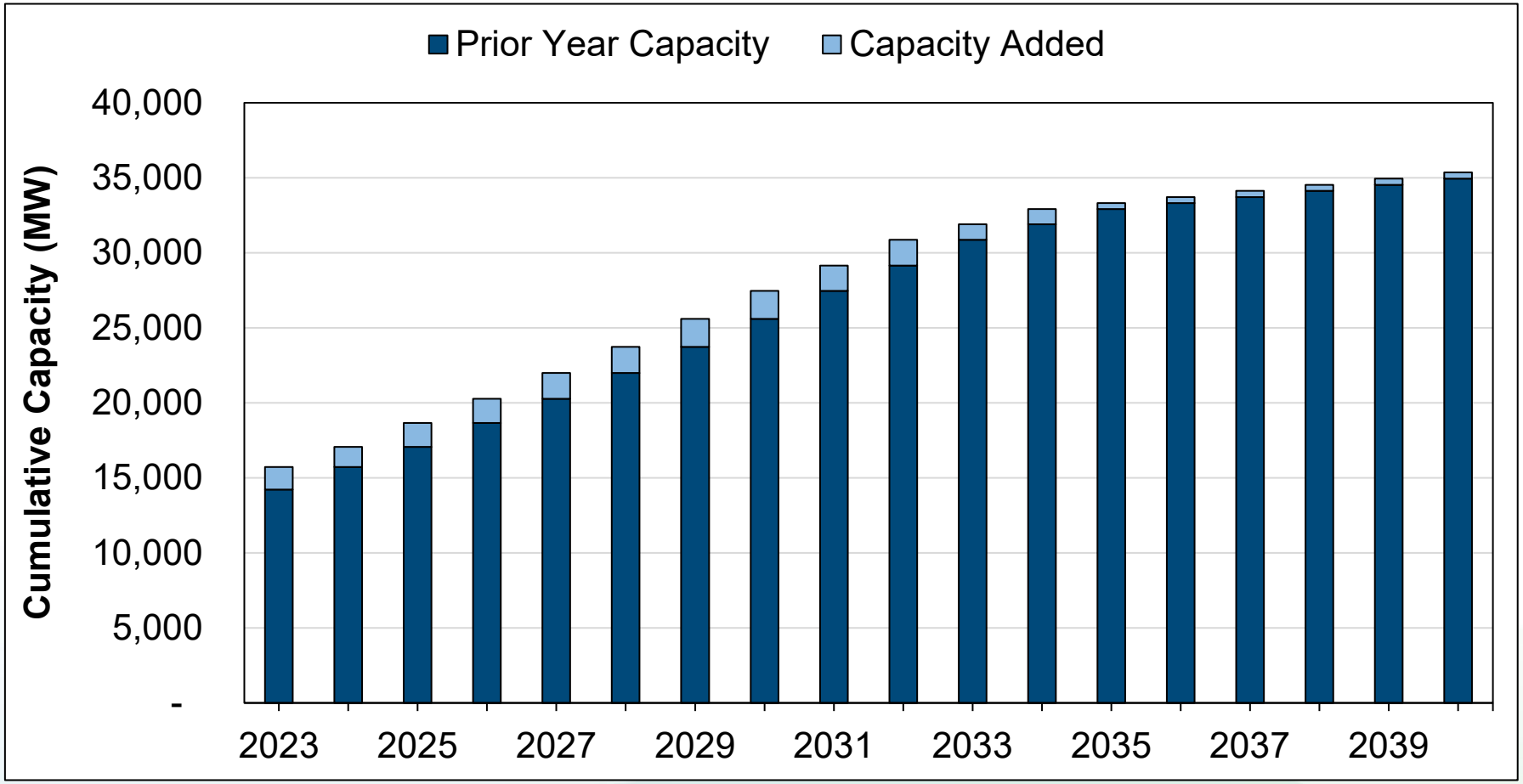


Source: CEC Staff

Annual Capacity Forecast Results

Solar PV Forecast Results

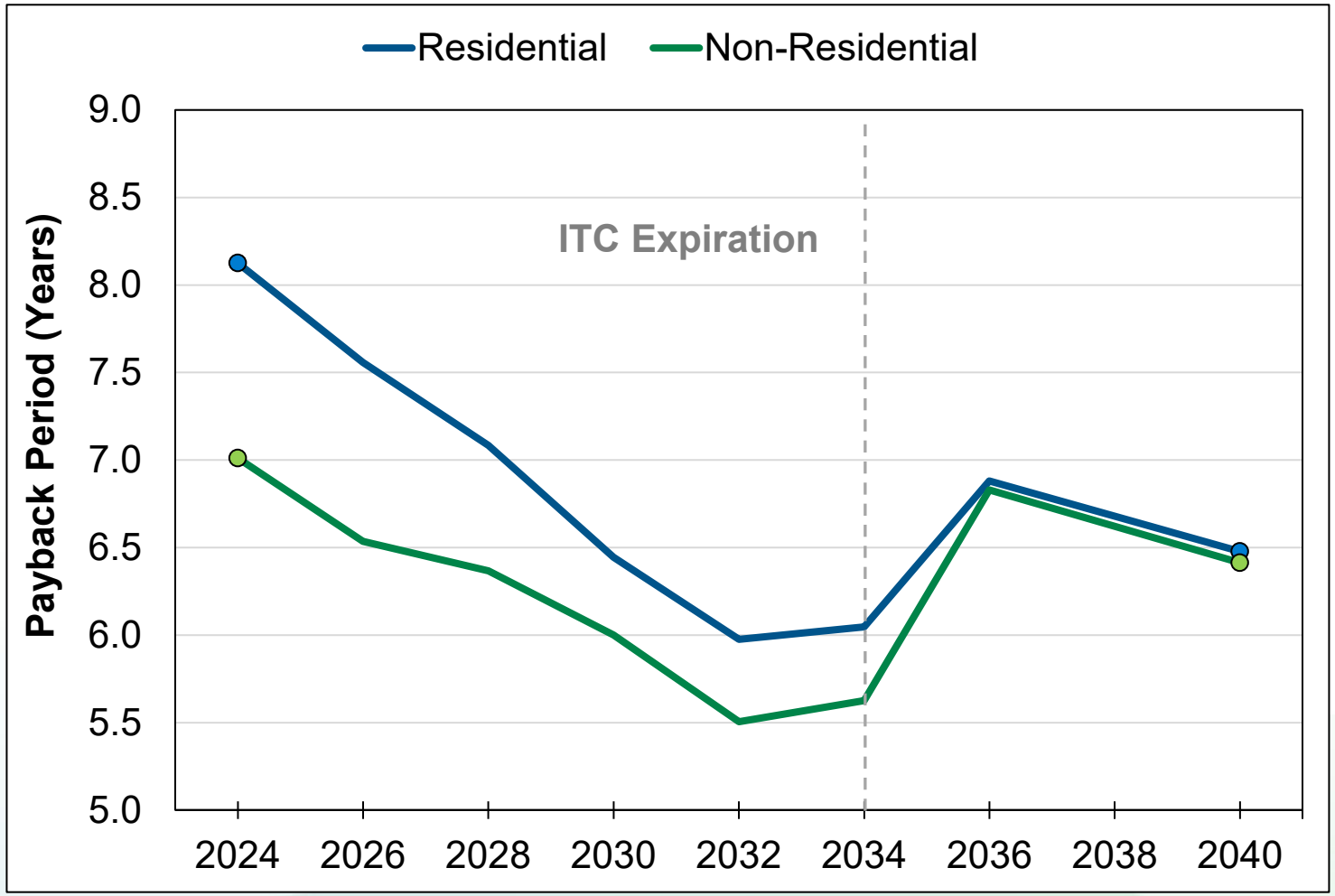
- Forecast shows steady adoption rate until mid 2030s
- Capacity additions level off after 2034 due to elimination of Investment Tax Credit (ITC) incentive.



Source: CEC Staff

Forecasted Solar PV Payback Periods

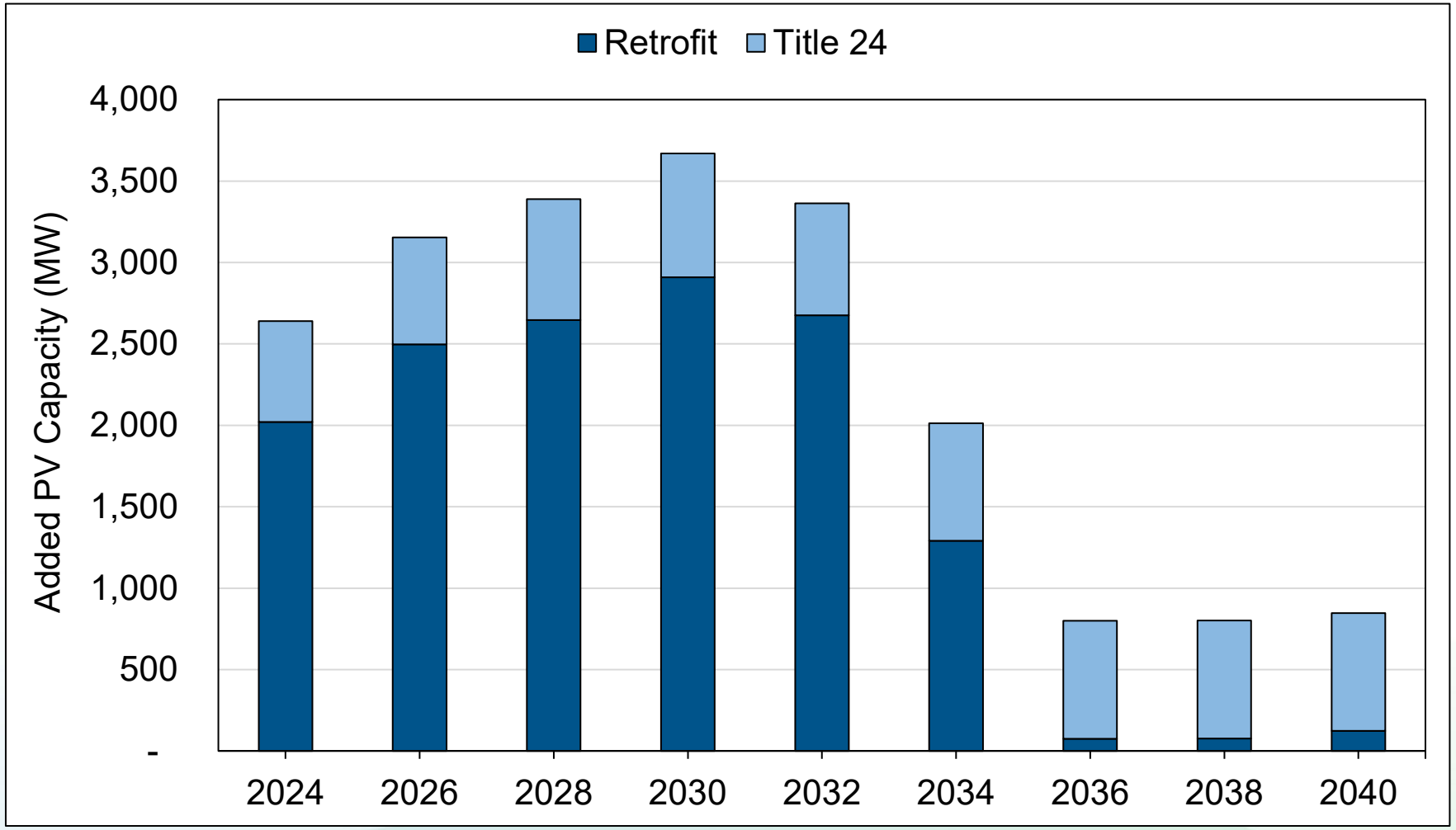
- Updates to solar PV costs and electricity rate forecast affected payback period calculation.
- Payback period is 1-2 years quicker on average for solar plus storage installations.
- Payback period expected to decrease until phase out of ITC in mid-2030s.



Source: CEC Staff

PV Forecast by Installation Type

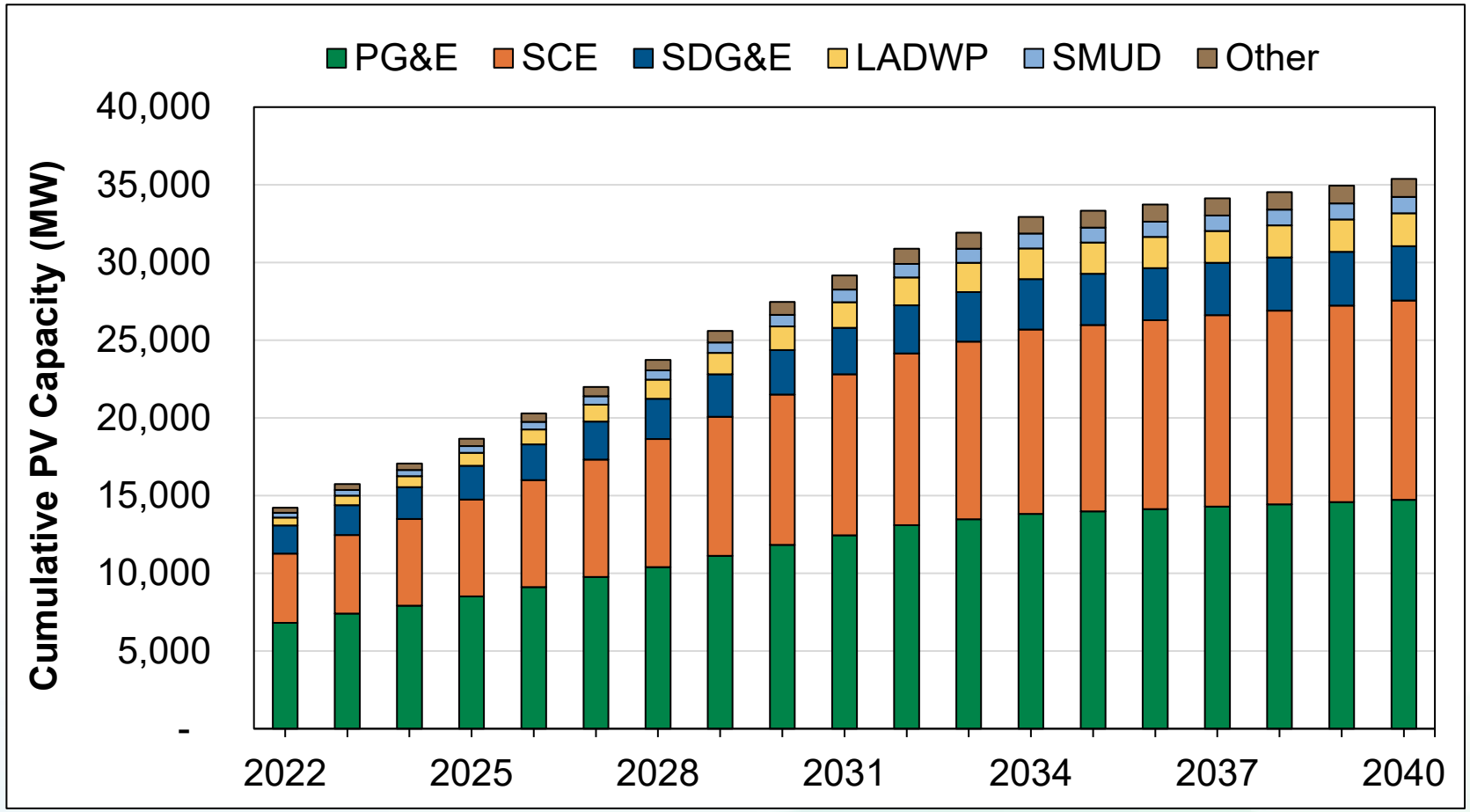
- A majority of installed solar is forecast to be from retrofits of existing buildings
- Because Title 24 new home installations are based on compliance, they do not level off with expiration of credit.
- Throughout the forecast period, close to 70 percent of added capacity is from retrofits.



Source: CEC Staff

Solar PV Capacity Forecast by Planning Area

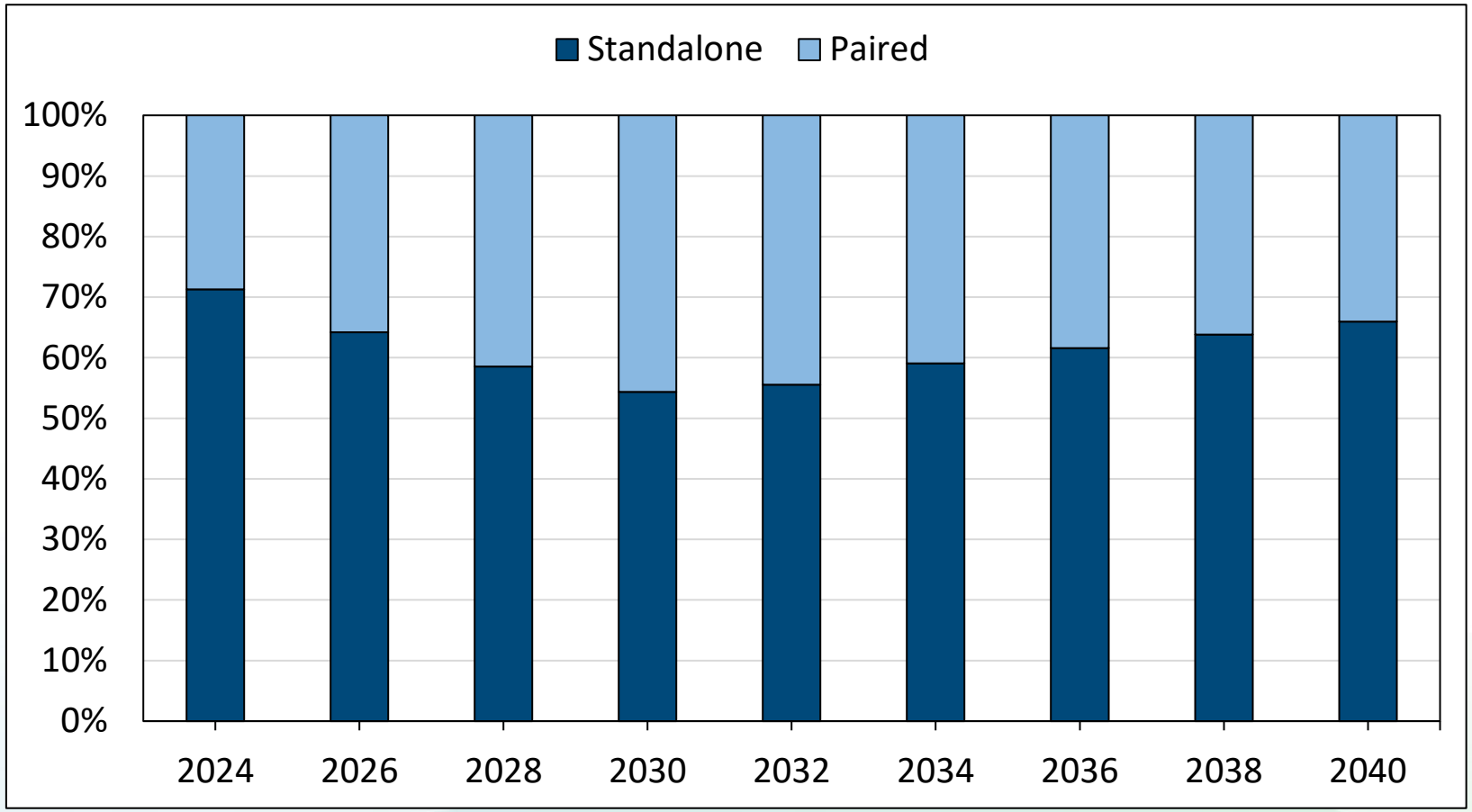
- Majority of PV capacity is in IOU territory (PG&E, SCE, and SDG&E)
  - 92% in 2022
  - 88% (forecast) in 2040
- Total capacity (GW) in 2040 forecast to be:
  - PG&E: 14.7
  - SCE: 12.8
  - SDG&E: 3.5
  - LADWP: 2.1
  - SMUD: 1.0
  - Others: 1.2



Source: CEC Staff

Statewide Solar PV Capacity Additions by Configuration

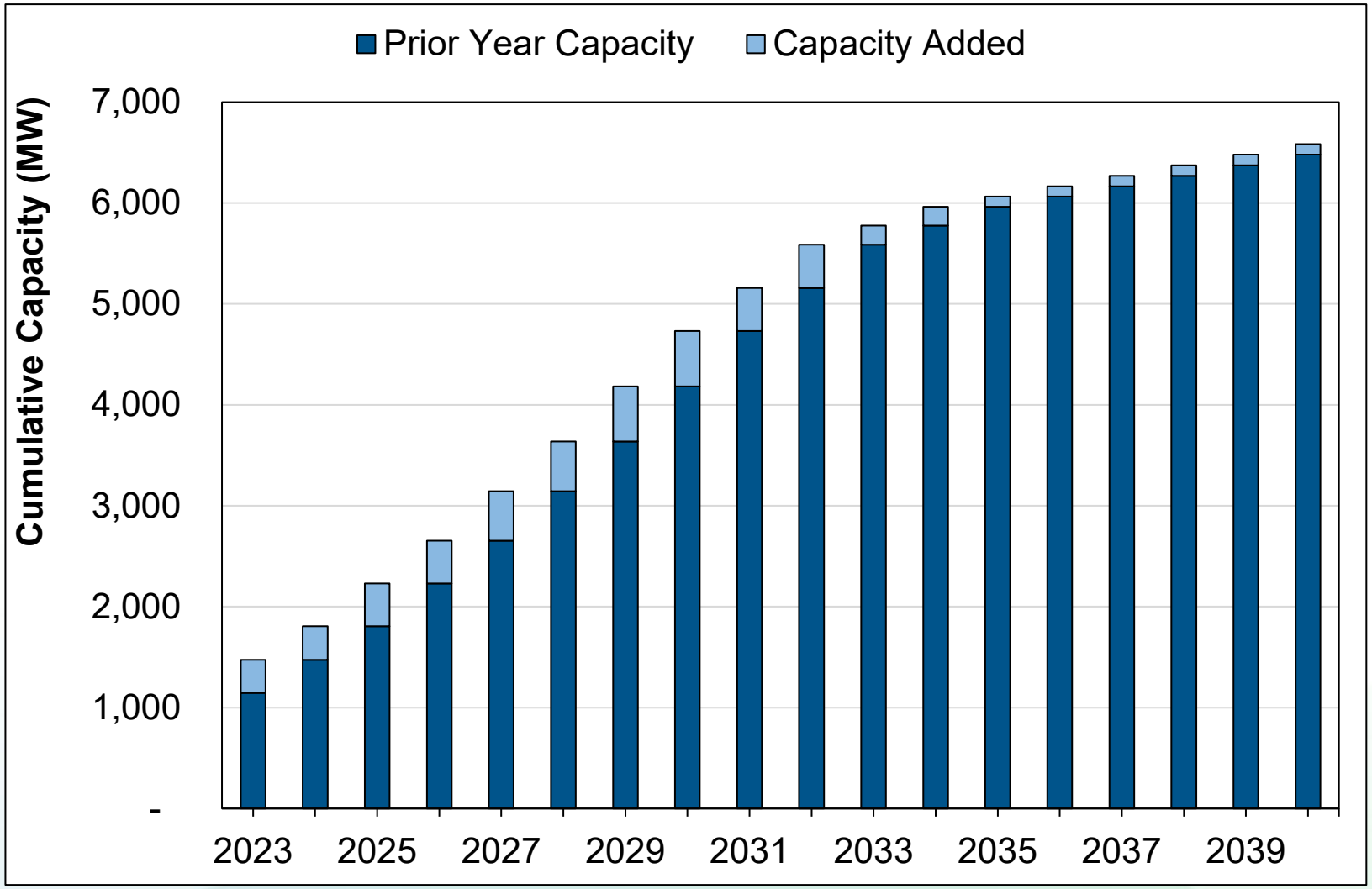
- Reductions in installation costs of energy storage coupled with rising electricity rates results in an increased share of paired DG adoption through 2032.
- The share of standalone solar PV increases in later years due to the ITC expiration, which affects storage more than solar.



Source: CEC Staff

Energy Storage Capacity Forecast: Statewide Results

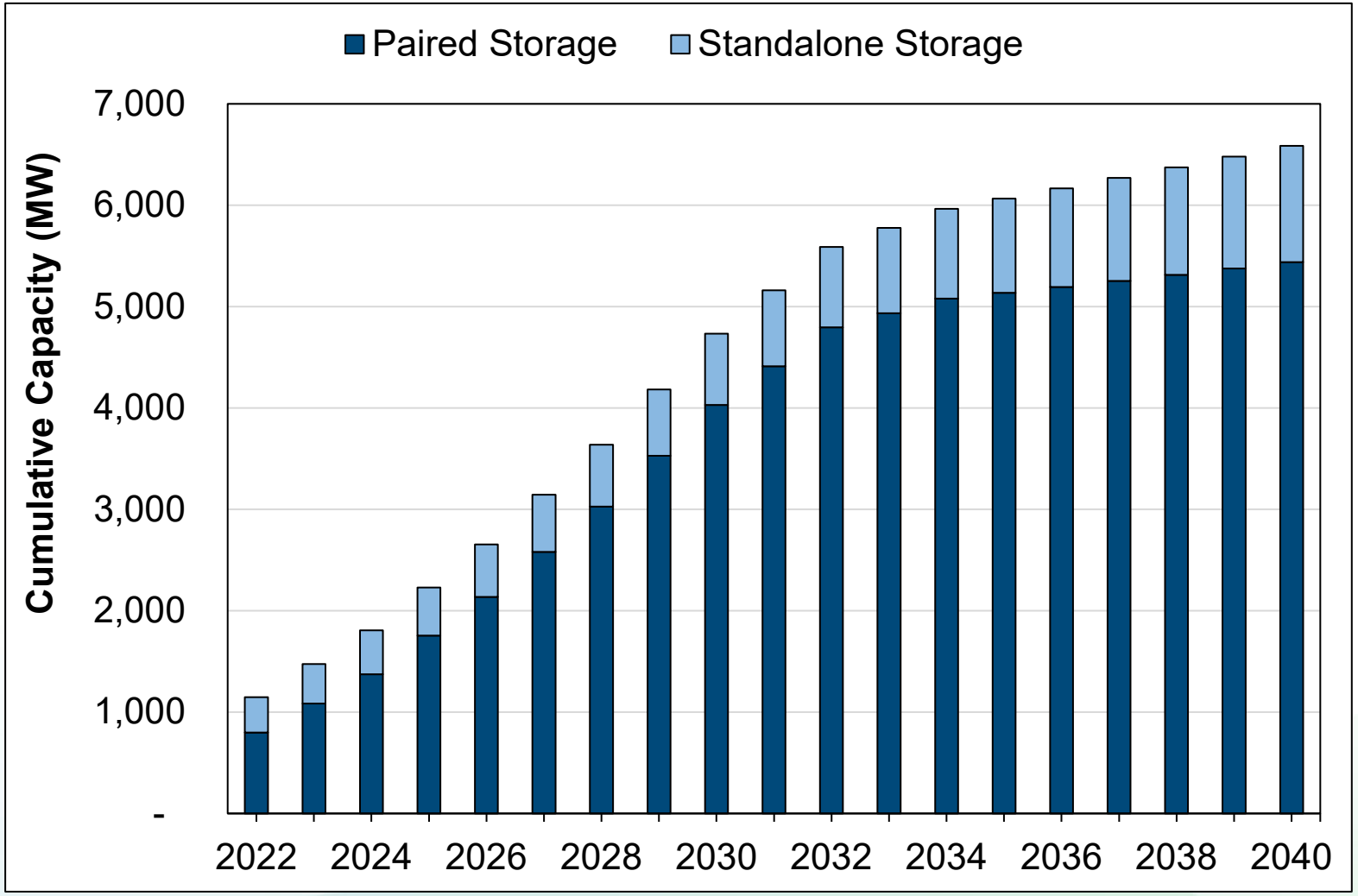
- Forecasted storage adoption is affected by elimination of ITC incentive in 2034.
- Adoption increases at a greater rate than PV as changes to excess solar compensation (in addition to factors mentioned in previous slide) incentivize storage adoption.
- Average growth rate throughout forecast:
  - 32% for storage
  - 14% for solar



Source: CEC Staff

Energy Storage Capacity Forecast by Configuration

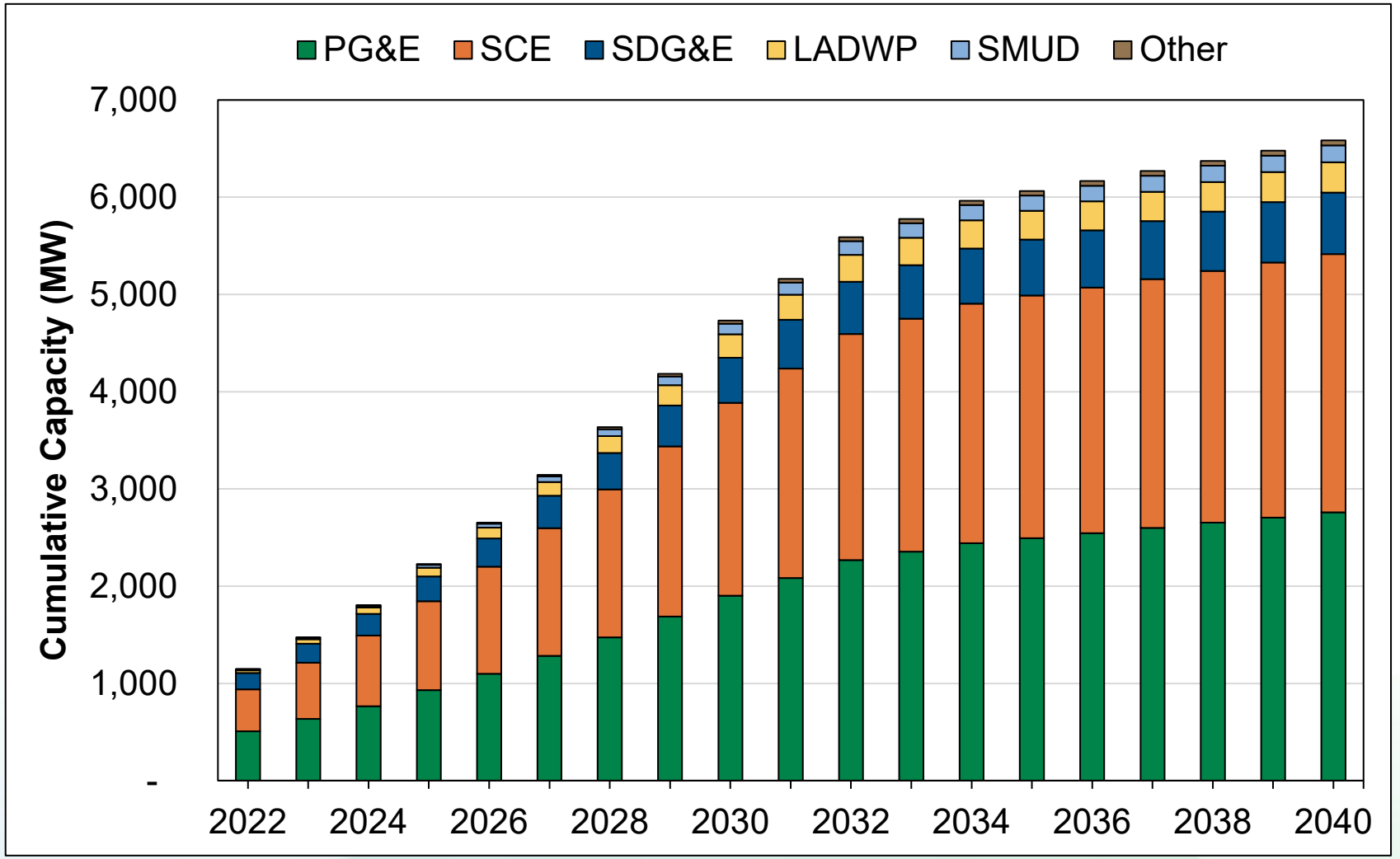
- 83% of storage capacity is paired with PV systems in 2040.
- Standalone storage is now eligible for the ITC, resulting in increased adoption rates until 2034.
  - Growth is more modest post-2034 due to expiration of credit.



Source: CEC Staff

Energy Storage Capacity Forecast by Planning Area

- The distribution of energy storage capacity by planning area is similar to the PV forecast.
- As of 2022, it's estimated 95% of installed storage capacity is in IOU territory.
- The share of cumulative capacity in IOU territory is forecast to be about 90% by 2040.

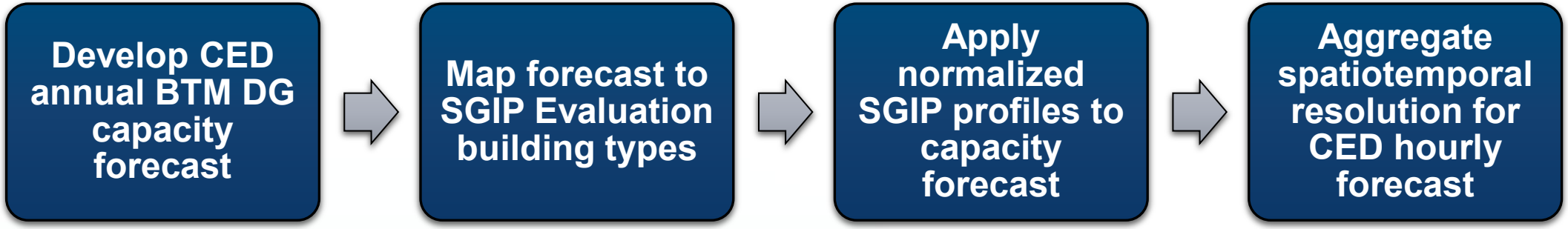


Source: CEC Staff

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.

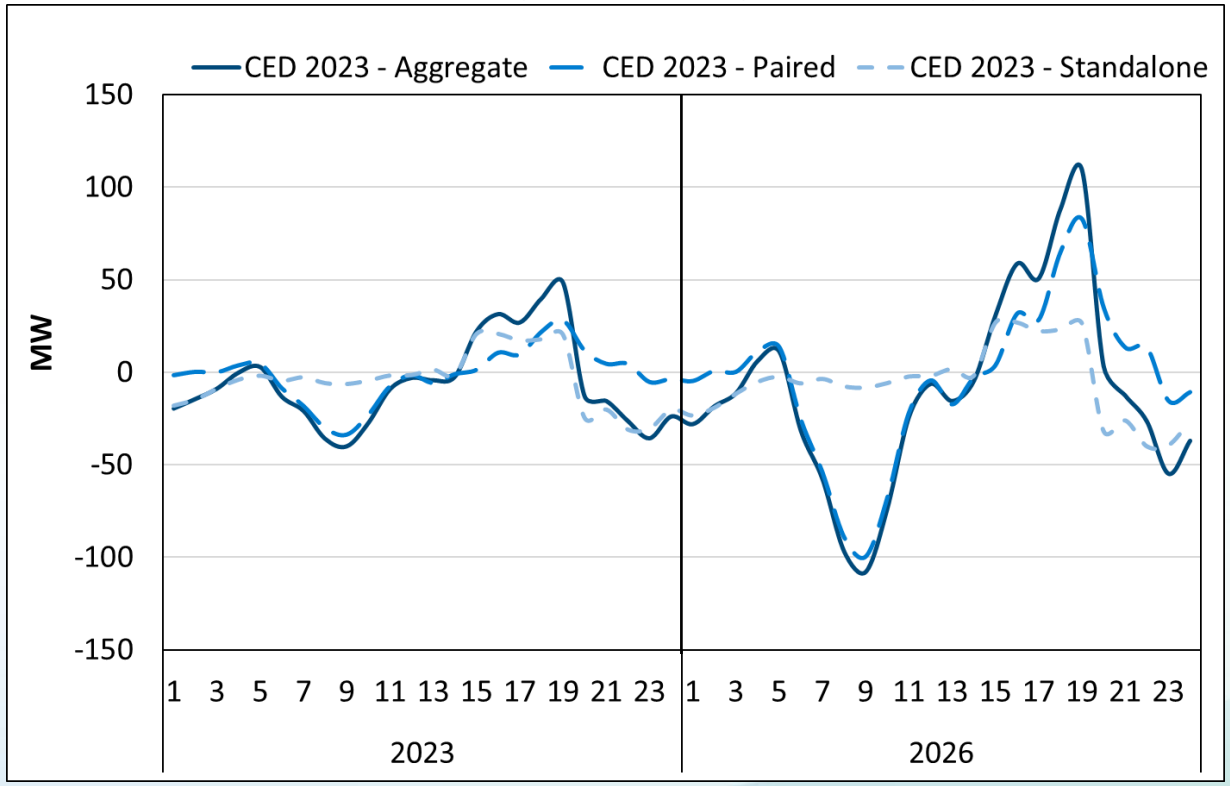
Storage Configuration	Number of Non-res BTM Storage Systems, Calendar Year 2022	SGIP Evaluation Data Project Sample Size
Paired With Solar PV	900	247
Standalone	1,198	479

Source: CEC Staff

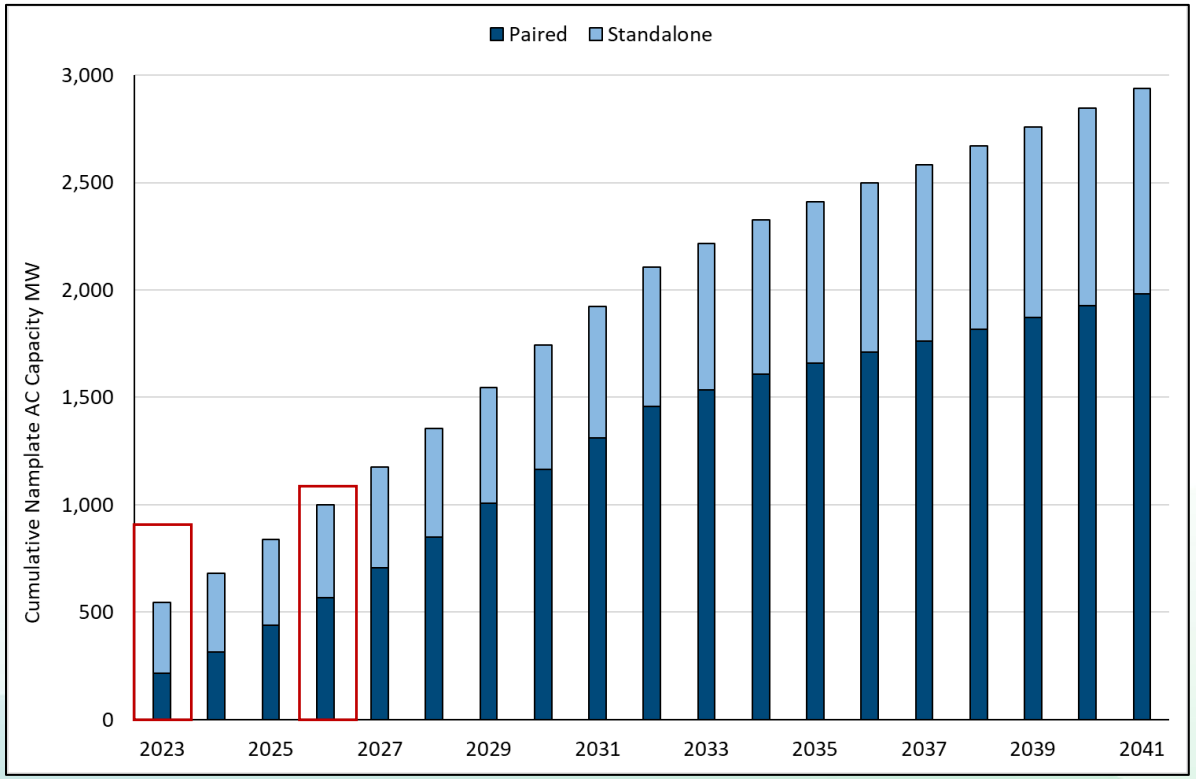
Methodology Refinement

- 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

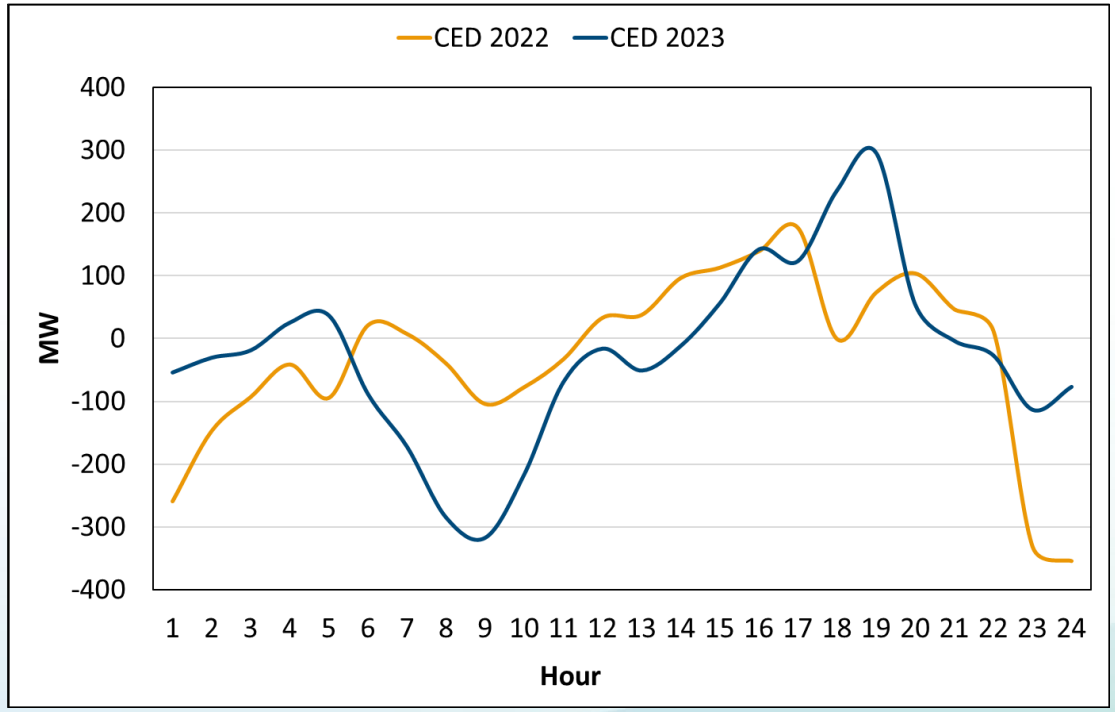


Source: CEC Staff

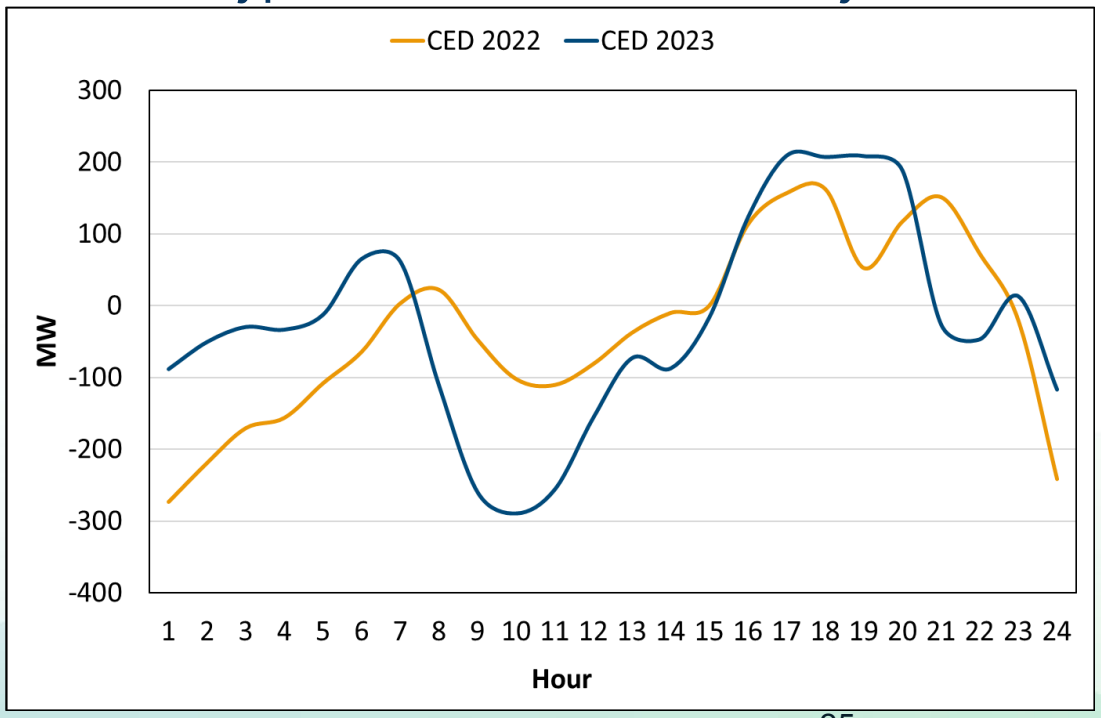
BTM Profile Comparison: CAISO, Forecast Profiles, 2035

- 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



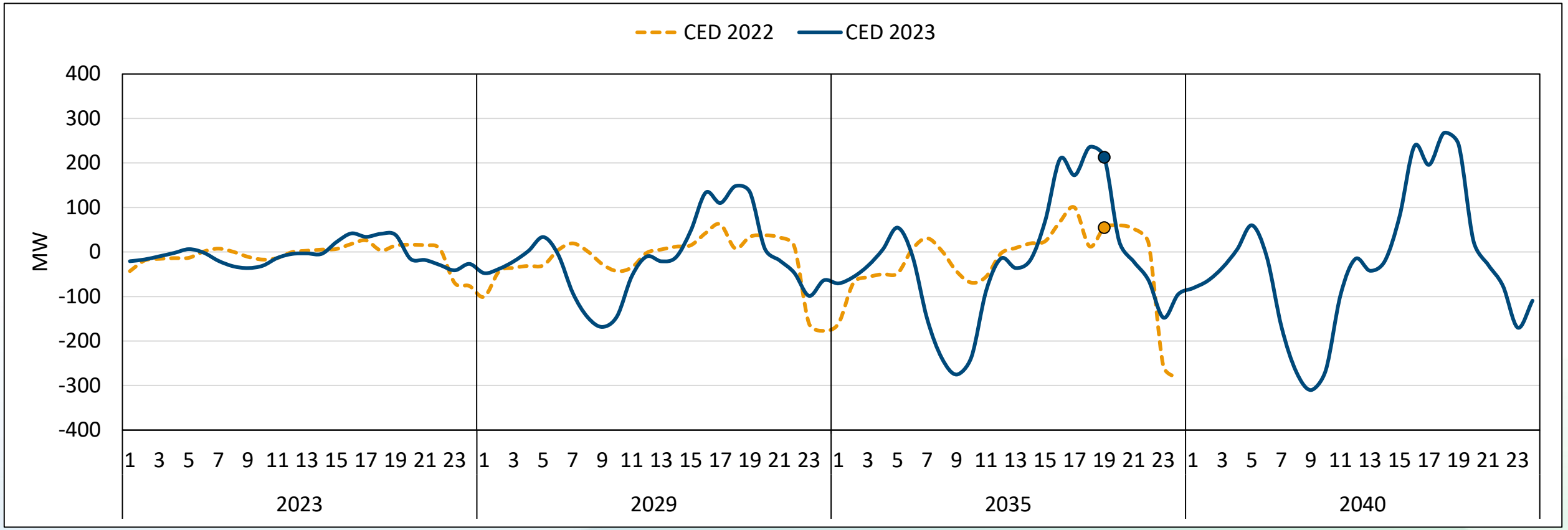
Typical December Weekday



Source: CEC Staff

BTM Profile Comparison: CAISO, September 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): 158MW



Source: CEC Staff

Residential Behind-The-Meter Storage Profiles

Residential Hourly Forecast Methodology

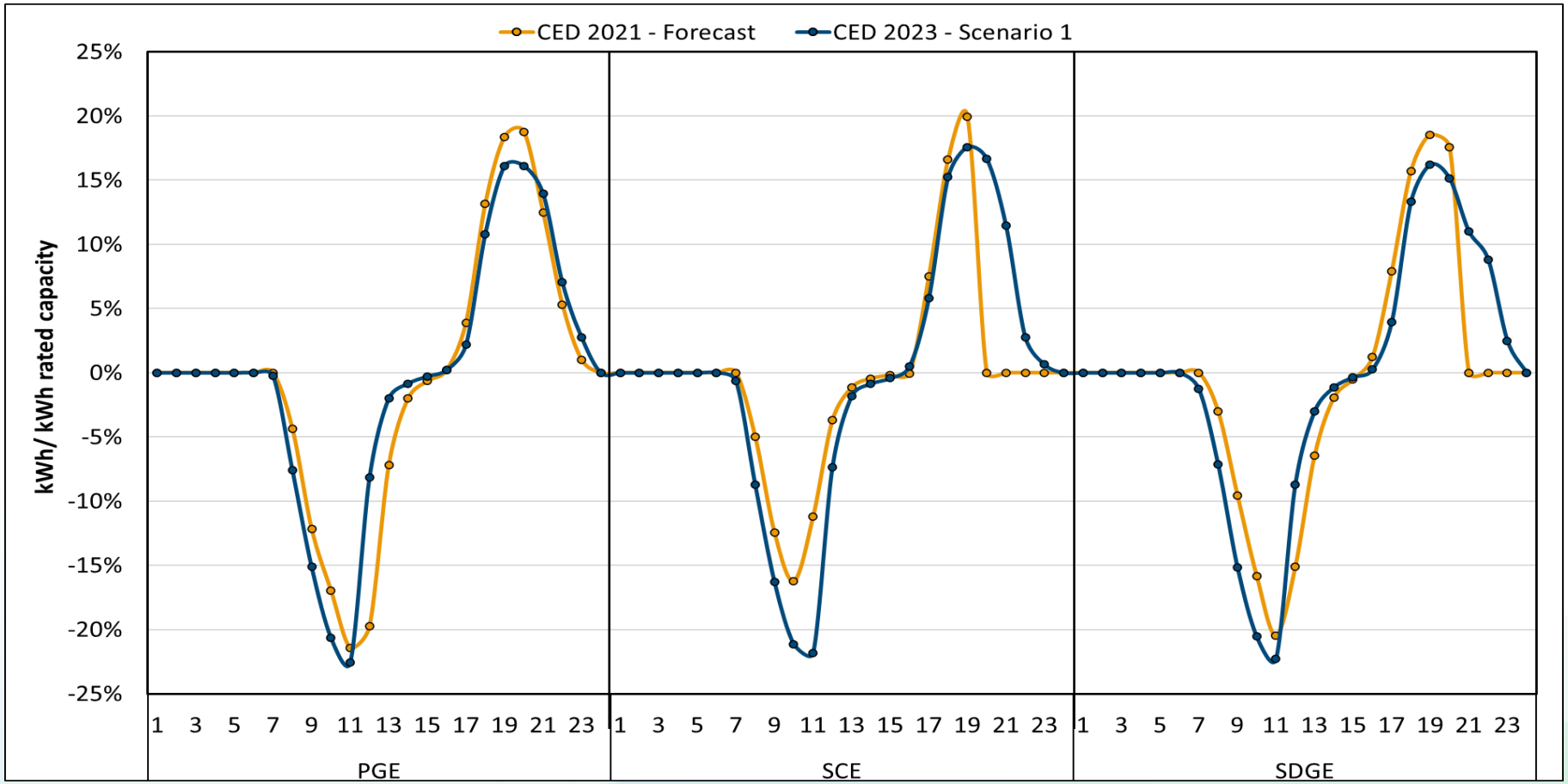
- Staff use NREL's System Advisor Model (SAM) to develop BTM residential storage profiles.
  - SAM simulations are configured for a prototypical single-family home with BTM solar PV and storage.
- Several SAM parameters are modified to produce hourly profiles for the CED forecast.
  - Solar PV and storage 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.

CED Residential Profile Assumptions

- Past CED forecasts consider Time-Of-Use (TOU) arbitrage during the on-peak period.
  - When scaled to planning area projections, this resulted in large hour-to-hour changes in load (shown on following slide).
- While it's assumed most energy storage discharge occurs during the on-peak period, SGIP impact evaluations suggest some discharge occurs outside these hours.
  - Furthermore, with the electrification of appliances and vehicles, it's probable storage discharge will extend beyond traditional on-peak hours.
- In result, staff developed and presented several profile scenarios to stakeholders at the October DAWG meeting.
  - The following slide compares the preferred CED 2023 scenario to profiles used in CED 2021 and 2022.

BTM Profile Comparison: July

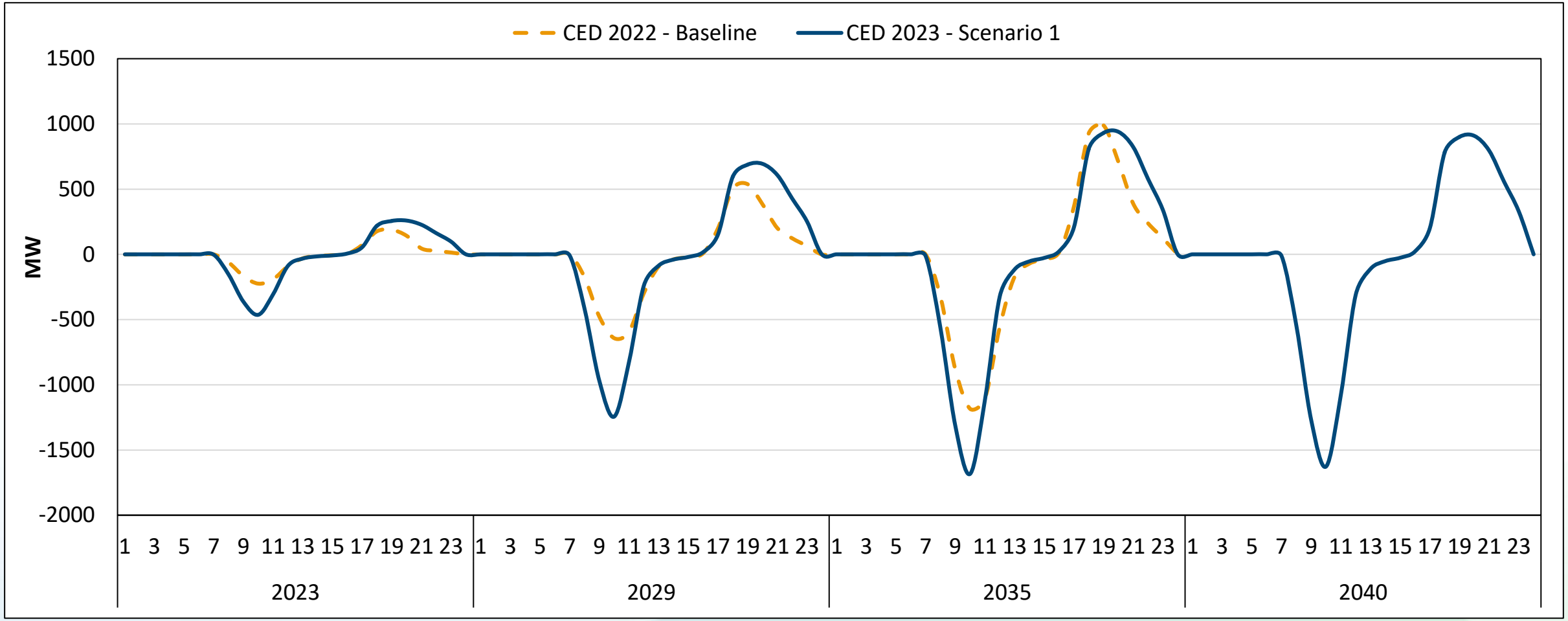
- The following chart highlights how dispatch strategy decisions impact the assumed planning area-scale hourly profiles on a typical day in July.



Source: CEC Staff

BTM Res Storage Profiles: CAISO, September Peak Impacts

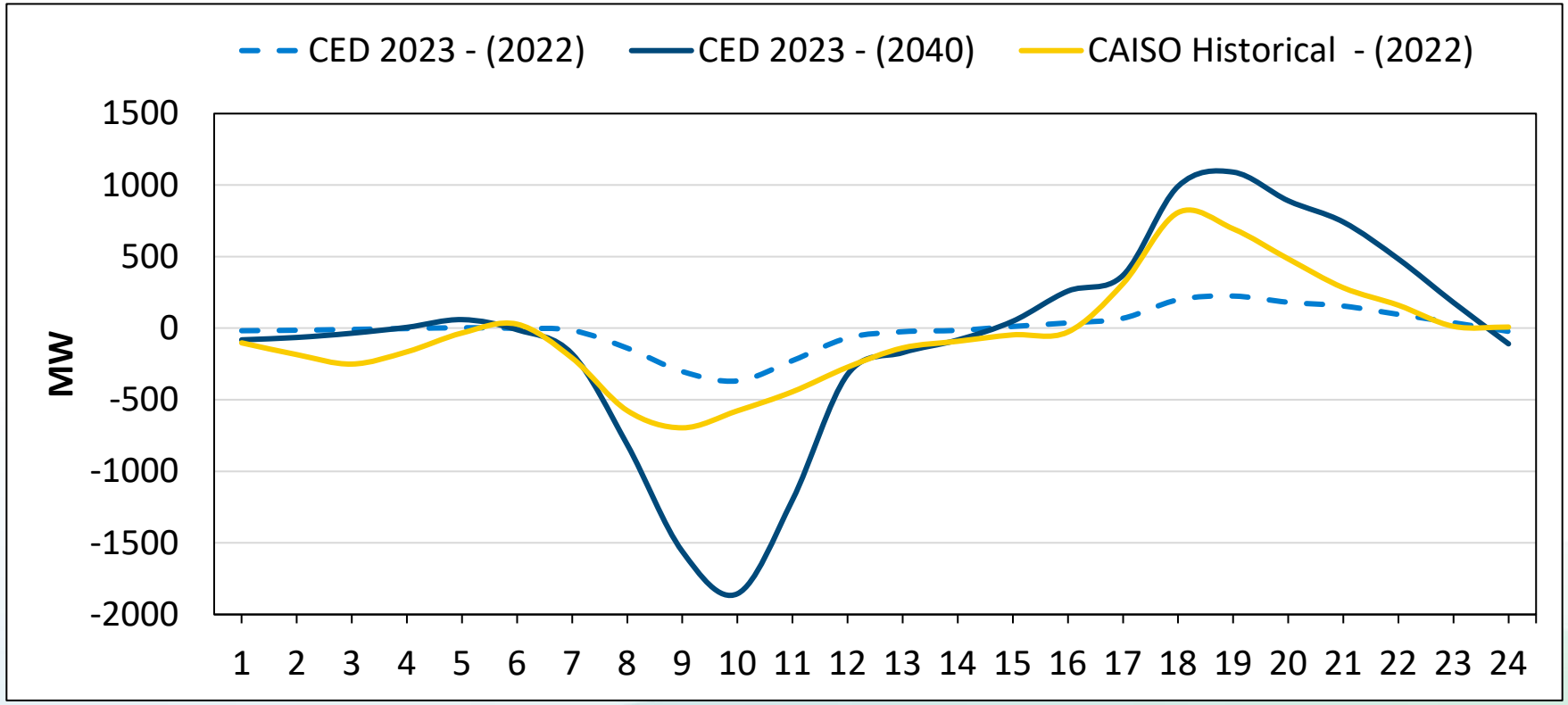
- Decreased discharge during hour 19 in 2035 (CED 2023 – CED 2022): -57 MW



Source: CEC Staff

CAISO Storage Profiles: Average Weekday in September

- The following chart compares average **CED 2023 BTM storage profiles** to a **historical average CAISO Limited Energy Storage (LESR) profile** in 2022**.**
  *CED profiles include residential and non-residential sectors.
- Forecasted BTM energy storage net discharge in calendar year 2040 surpasses historical average 2022 LESR impacts during on-peak hours.



Source: CEC Staff

Special Thanks To:

- CPUC and their team
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- Verdant
  - Brian McAuley
  - William Marin
- CEC DG Forecast Team
  - Mark Palmere - Lead Forecaster
  - Bobby Wilson - Forecaster
  - Sudhakar Konala - Forecast Advisor

Thank You!