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California Energy Commission

Final Workshop: Energy Accounting for the 2025 Energy Code

November 10, 2022

Energy Accounting for the 2025 Energy Code

Good morning. We will begin shortly.

Welcome and Workshop Logistics

Erik Jensen, California Energy Commission

Workshop Participation

- The workshop is being recorded and transcribed
- There will be two public comment periods
- Comments limited to three minutes per person or organization
- Start with name and affiliation
- The last date to submit written comments is November 24, 2022

Workshop Agenda

1) Opening remarks by Commissioner Andrew McAllister
2) Energy accounting summary
3) Explanation of new terminology
4) Systemwide life cycle cost and source energy hourly factors
5) Public comments
6) Break
7) Weather data
8) Construction projections, prototypes, and period of analysis
9) Public comments

Opening Remarks

Commissioner Andrew McAllister, California Energy Commission

Energy Accounting Summary

Erik Jensen, California Energy Commission

Energy Accounting Purpose and Background

- The Energy Commission creates Building Energy Efficiency Standards, which are required to be cost effective
- Received input on approach and best available data to support the 2025 Energy Code
- Approve hourly factors and other data used to demonstrate cost-effectiveness for the 2025 Energy Code

2025 Energy Code Timeline

- November 2022: CEC workshop to finalize systemwide life cycle cost and source energy hourly factors
- January – March 2023: Utility-sponsored stakeholder meetings
- July 2023: CASE Reports to CEC
- May – August 2023: CEC pre-rulemaking workshops
- October 2023 – January 2024: File and open rulemaking
- January – June 2024: CEC rulemaking
- June 2024: 2025 Energy Code adopted
- January 1, 2026: 2025 Energy Code goes into effect

Energy Code Terminology

Will Vicent, California Energy Commission

Making Comments

- Comments limited to three minutes per person or organization
- Start with name and affiliation
- On computer: Use the “raise hand” feature so we can announce your name and call on you. You will need to unmute yourself.
- On phone: Press *9 to “raise your hand” and *6 to unmute and mute

Systemwide Life Cycle Cost and Source Energy Hourly Factors

Jared Landsman, Snuller Price, Michael Sontag
Energy and Environmental Economics, Inc.

E3 Presentation Team

Snuller Price

Overall E3 Lead

Jared Landsman

Lead Presenter & Project Manager 2025 Cycle

Michael Sontag

Project Manager 2022 Cycle

Agenda

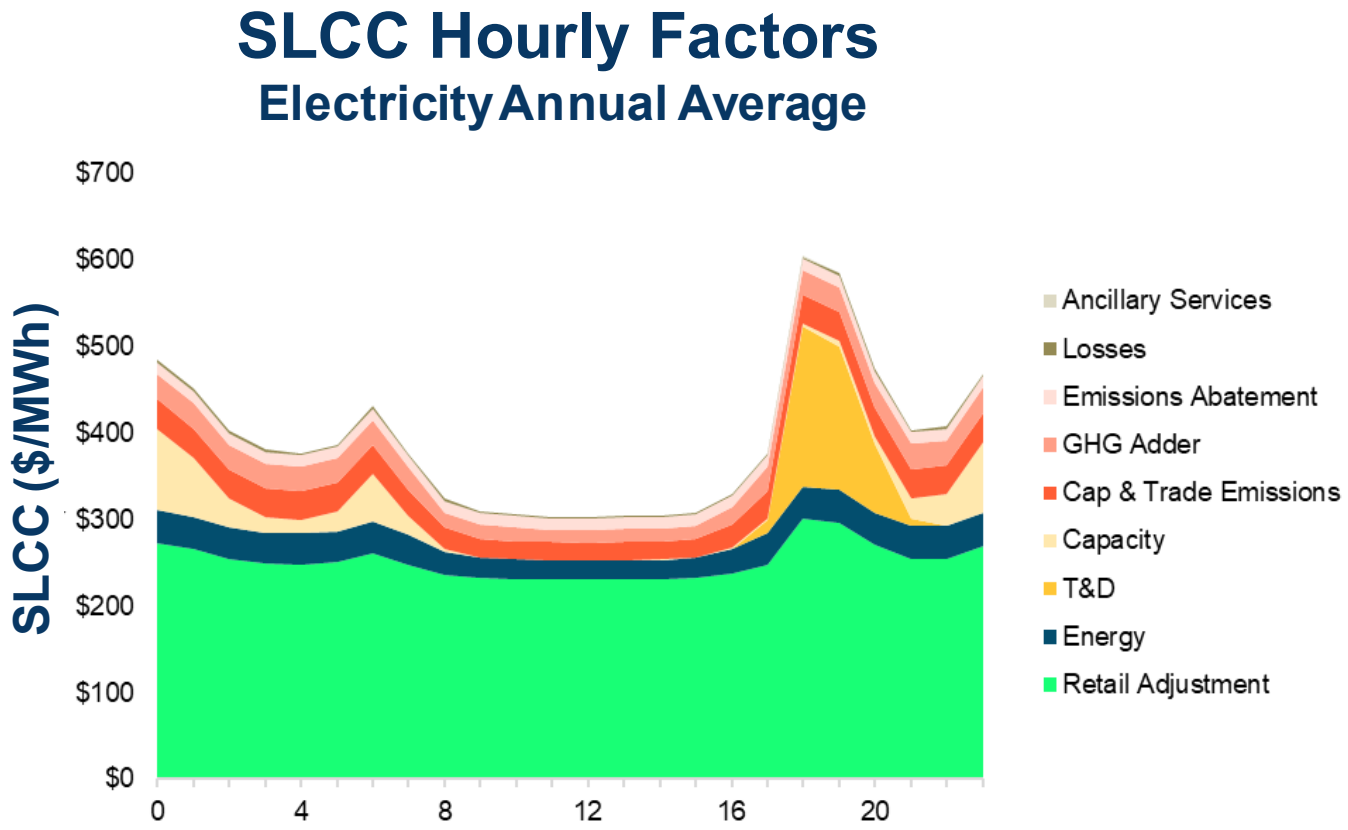
- Background
- Final Scenario & Methodology
- Systemwide Life Cycle Cost Hourly Factors Results
- Source Energy Hourly Factors Results
- Cost-Effectiveness Results

Background

Systemwide Life Cycle Cost

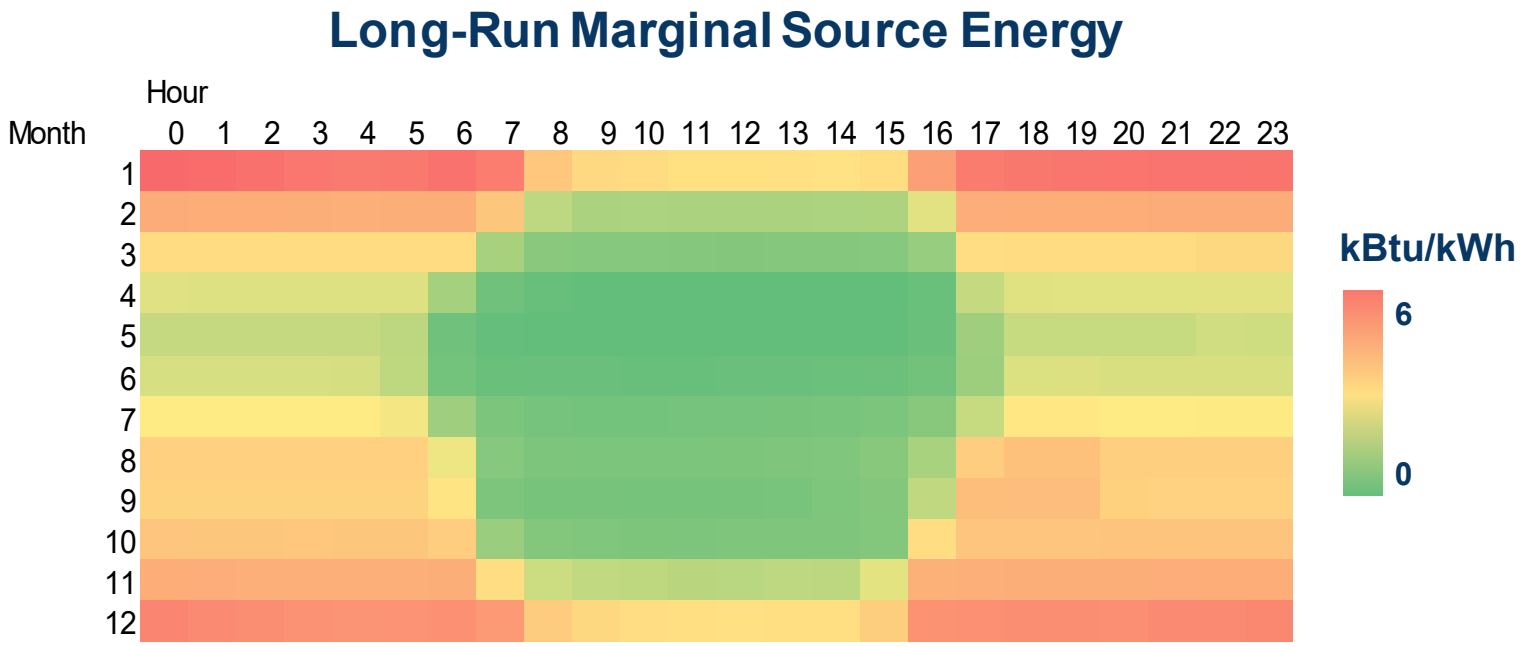
Systemwide Life Cycle Cost (SLCC) hourly factors are used to convert predicted site energy use to **long-term dollar costs to California's energy system.**

Since the *time* energy is used, is as important as the *amount* of energy used, these factors are generated on an **hourly basis** for a representative year and created for each of California's diverse climate zones.



Source Energy

Source Energy hourly factors are used to convert predicted site energy use to source energy. Source energy accounts for **energy losses incurred in the production, transmission, and delivery of energy to the building.** Source Energy correlates strongly with **greenhouse gas emissions.**



Uses of Hourly Factors

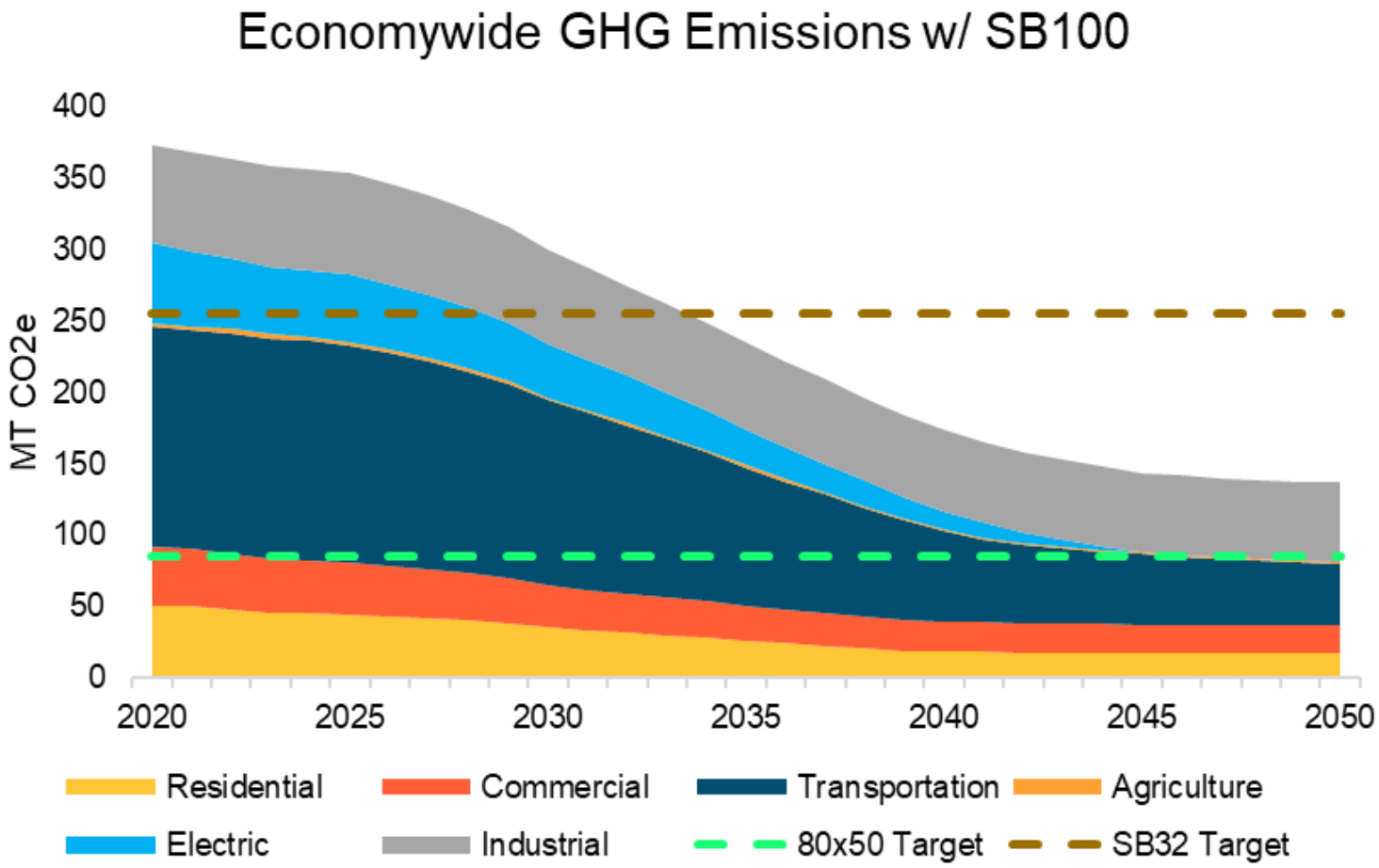
1. **New Measure Proposals** – Used to evaluate cost-effectiveness and source energy of measures proposed for inclusion in CA Building Energy Efficiency Standards (Energy Code & CALGreen)
2. **Project Compliance** – Used to establish 'energy budgets' that must be exceeded to comply via the Energy Code performance modeling approach; compliance must be demonstrated using CEC-approved compliance software

Final Scenario & Methodology

Scenario Selection

- CEC High Electrification Policy Compliance selected for 2025 hourly factors

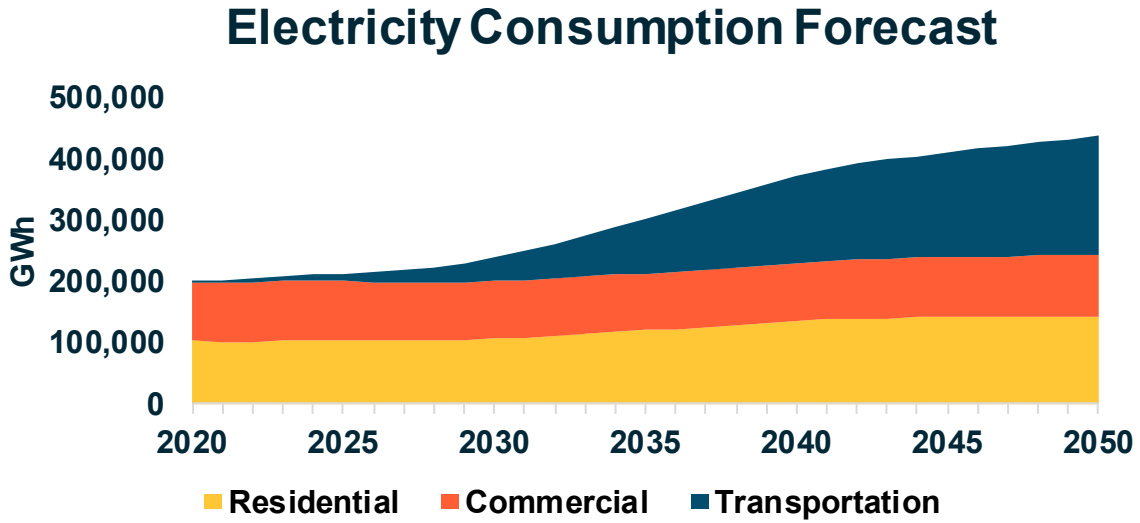
- Includes:
  - Electricity targets from SB 100 & CPUC Rulemaking 20-05-003
  - Renewable natural gas targets from SB 1440

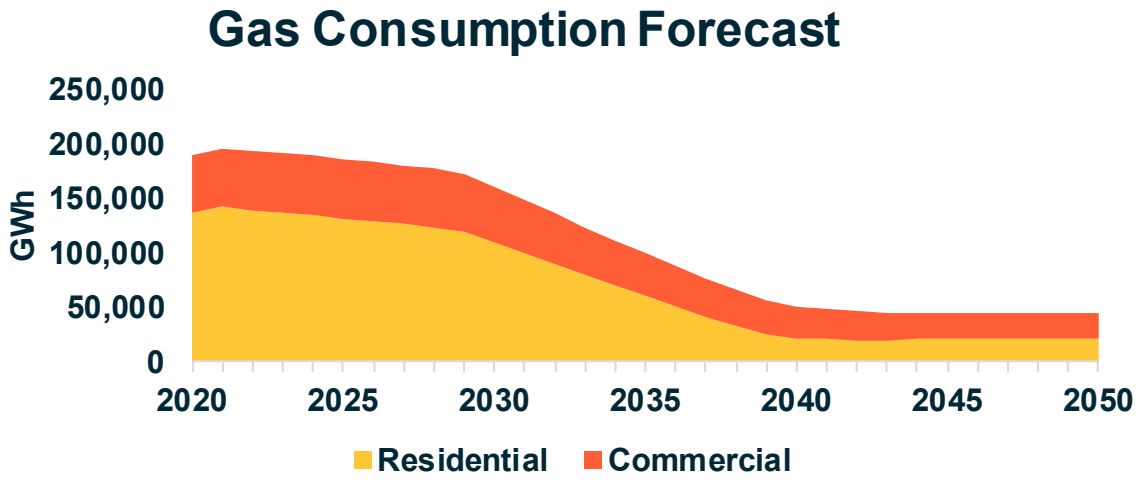


Annual Load Forecast

Annual load forecast developed using **weather regression of historical electric load** plus new hourly **transportation and building electrification** load from selected demand scenario

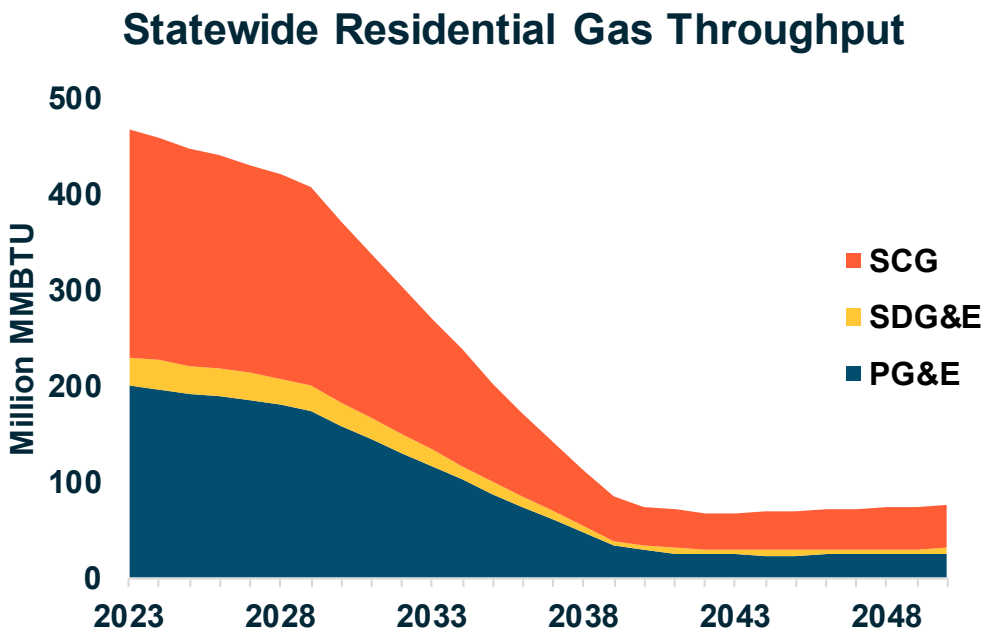
- Significant transportation electrification and moderate building electrification from 2020-2050
- Steep decline in residential building gas consumption from 2030-2040

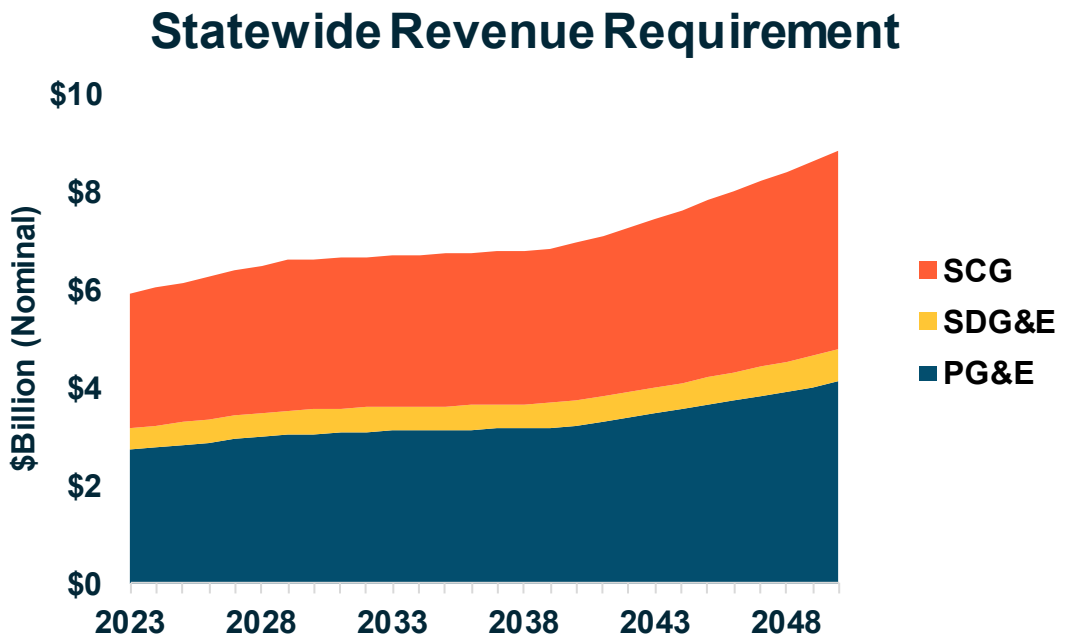




Systemwide Gas Forecast

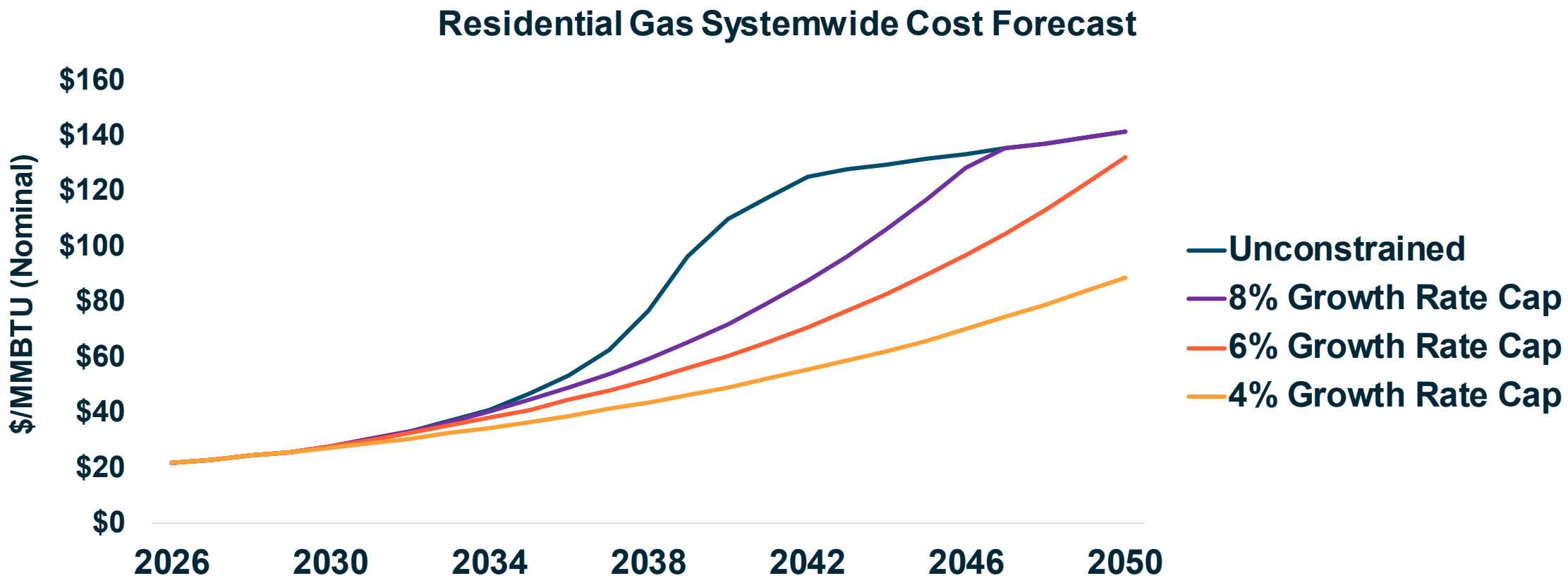
- Gas throughput forecast from selected demand scenario
- Gas revenue requirements from latest utility general rate cases & 2021 IEPR
- 8% annual growth cap applied to forecasted systemwide residential gas costs





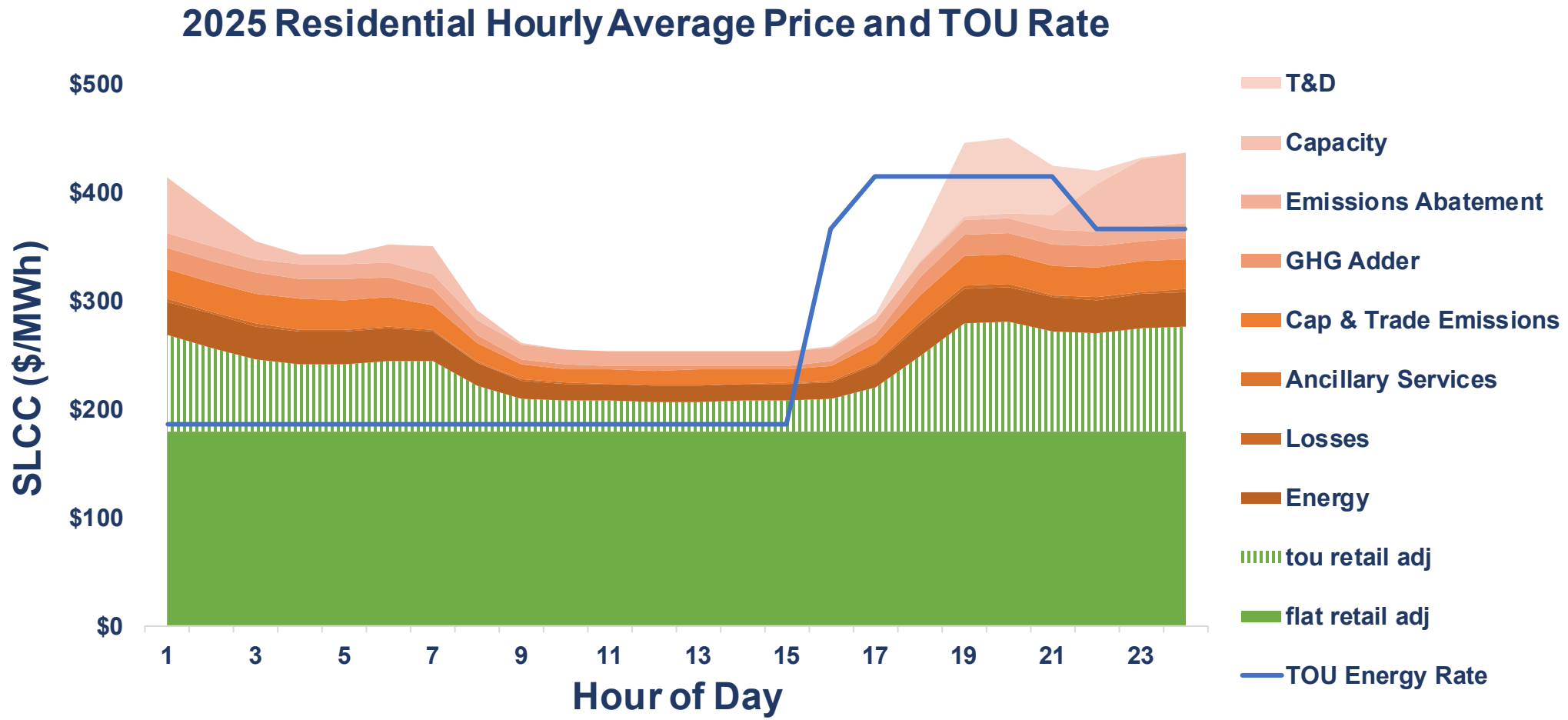
Systemwide Gas Forecast

8% annual growth cap applied to forecasted systemwide residential gas costs



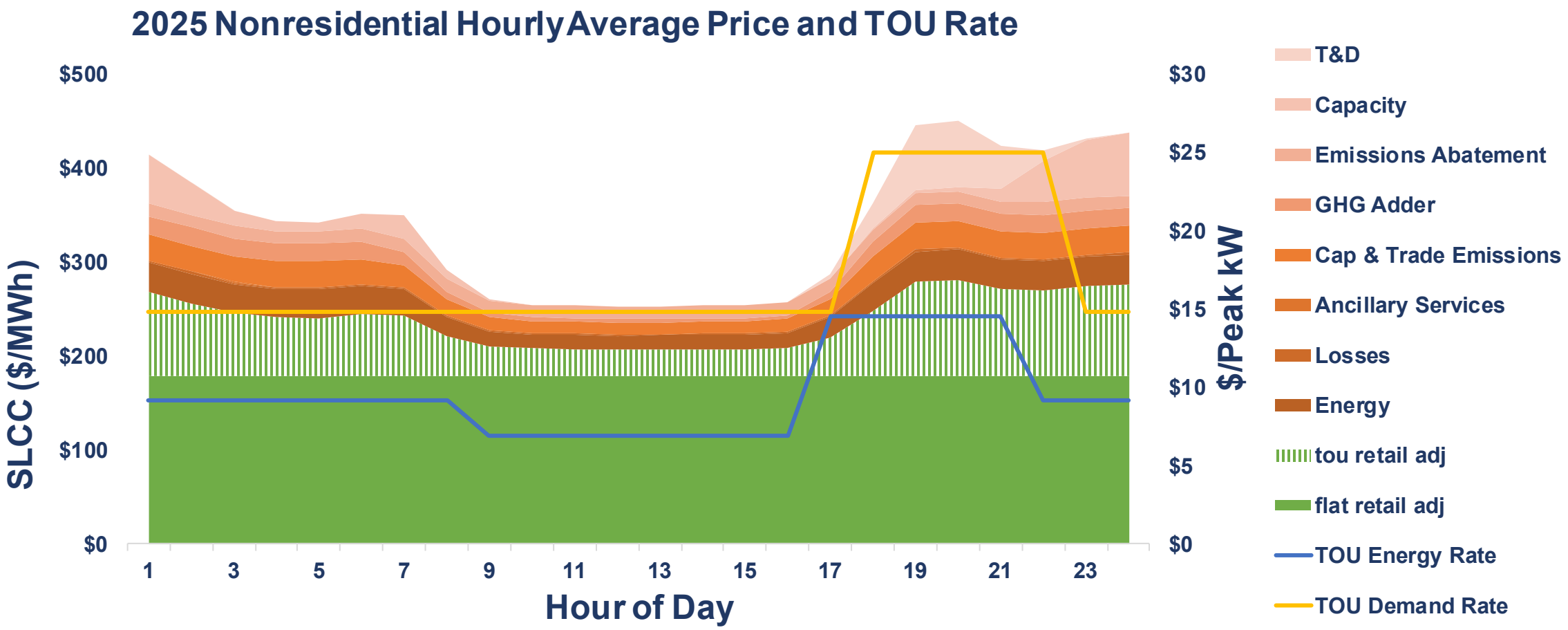
Residential Electric Cost Adder

2025 code cycle will use 15% systemwide cost adders for residential factors



Nonresidential Electric Cost Adder

2025 code cycle will use 25% systemwide cost adders for nonresidential factors



Period of Analysis

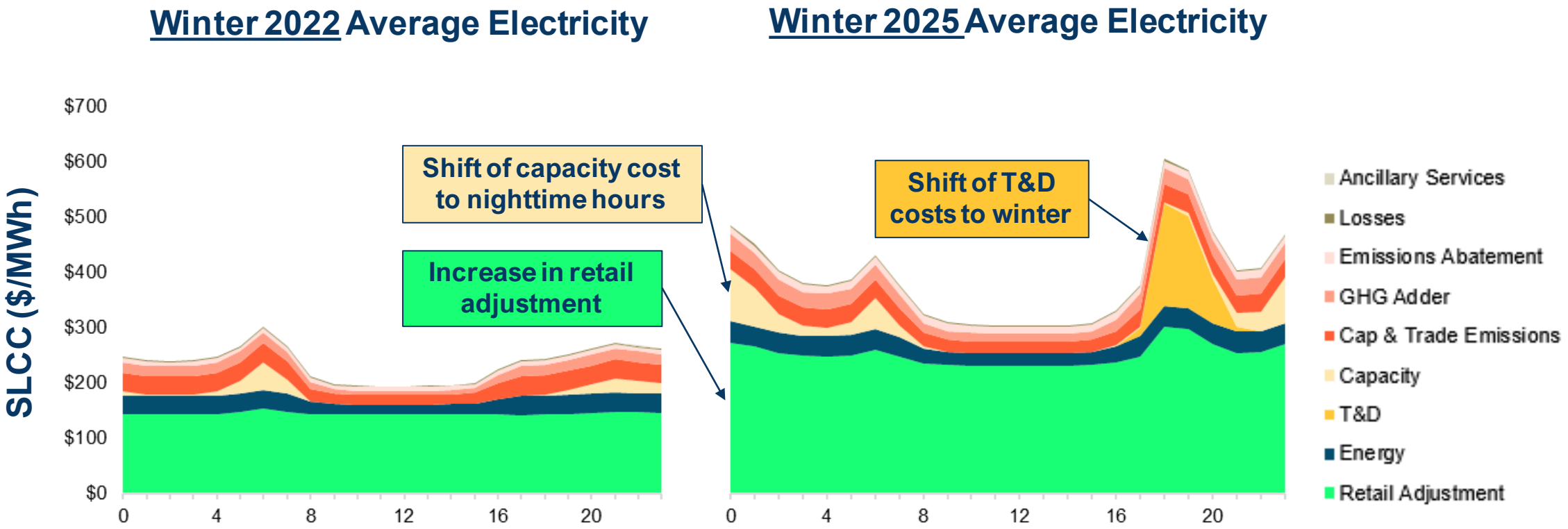
All measures for 2025 cycle will use a **30-year period of analysis**

- Alignment with **long-term energy and weather outlook**
- Less vulnerable to impact of **short-term trends**
- All measures are evaluated over **same period of analysis**
- Established consistency for **compliance of mixed-used buildings**

Systemwide Life Cycle Cost Hourly Results

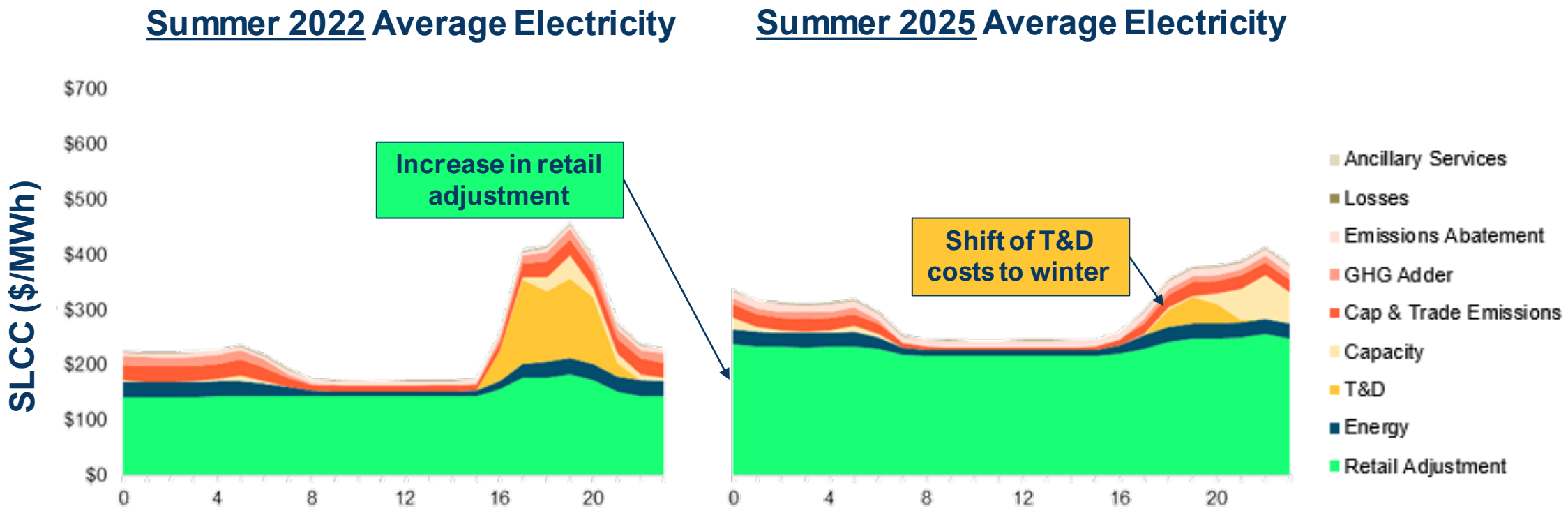
Winter Electricity

Winter electric factors higher than 2022 cycle, mainly due to increases in retail adjustment and winter capacity cost (**36-75% increase** in winter electric factors)



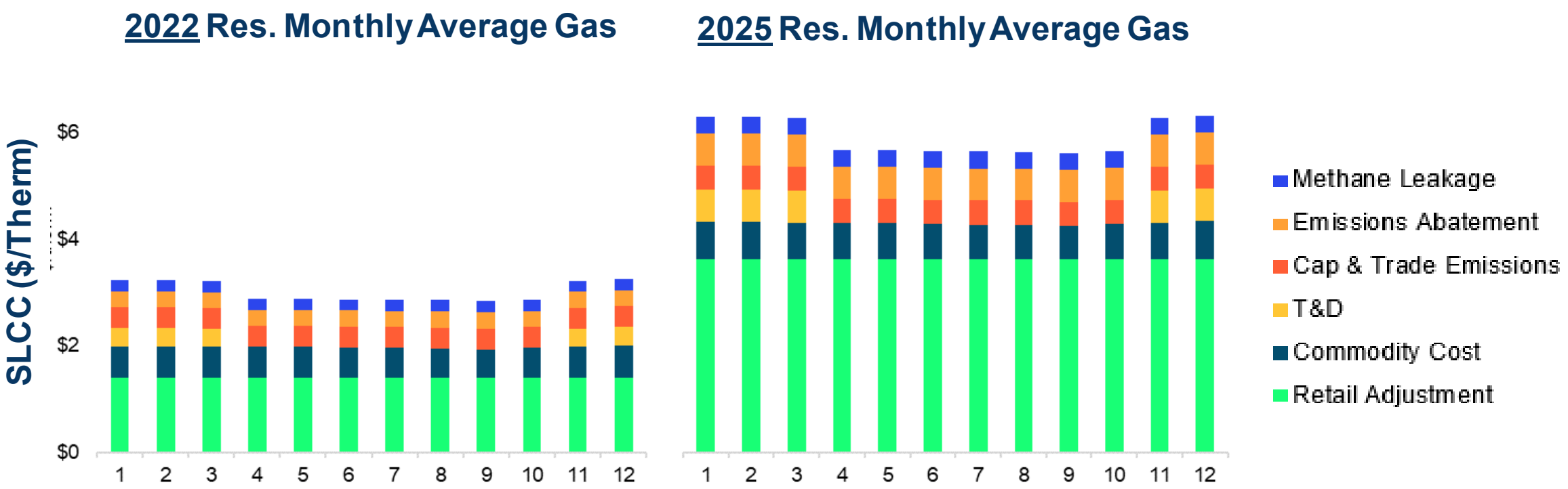
Summer Electricity

Summer electric factors higher than 2022 cycle, mainly due to increases in retail adjustment (**13-44% increase** in summer electric factors)



Residential Gas

Residential gas factors significantly higher than 2022 cycle, mainly due to increases in retail adjustment from high electrification (**80% increase** in residential gas factors)

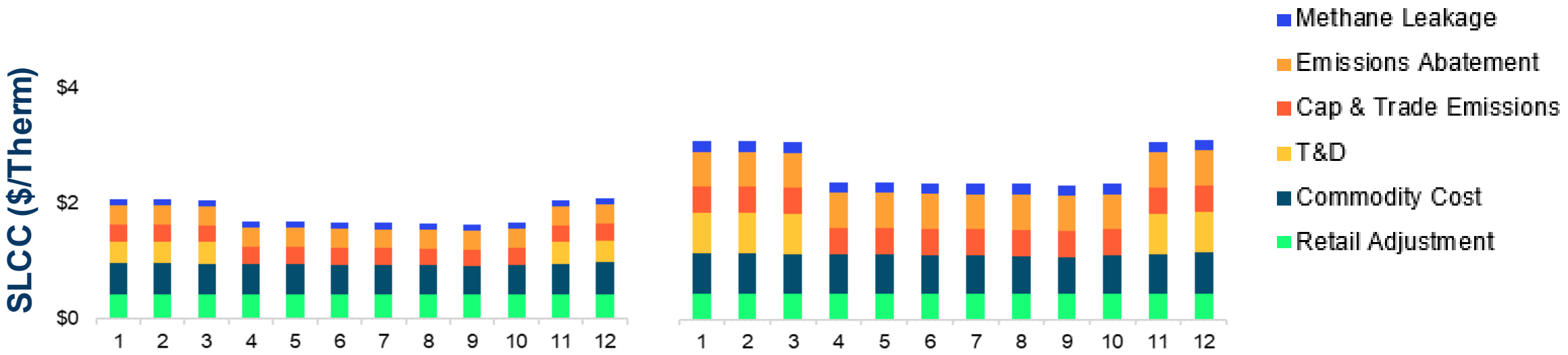


Nonresidential Gas

Nonresidential gas factors slightly higher than 2022 cycle, mainly due to change in period of analysis (**40-50% increase** in nonresidential gas factors)

2022 Nonres. Monthly Average Gas

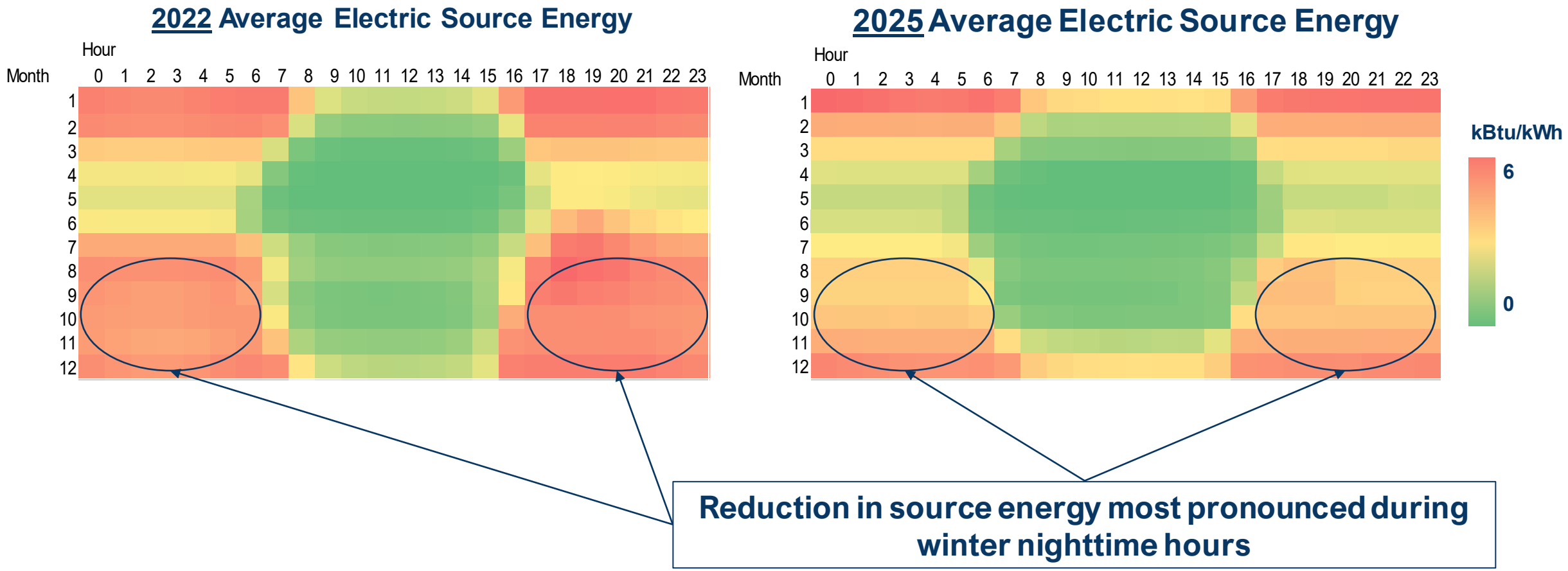
2025 Nonres. Monthly Average Gas



Source Energy Hourly Results

Electric Source Energy

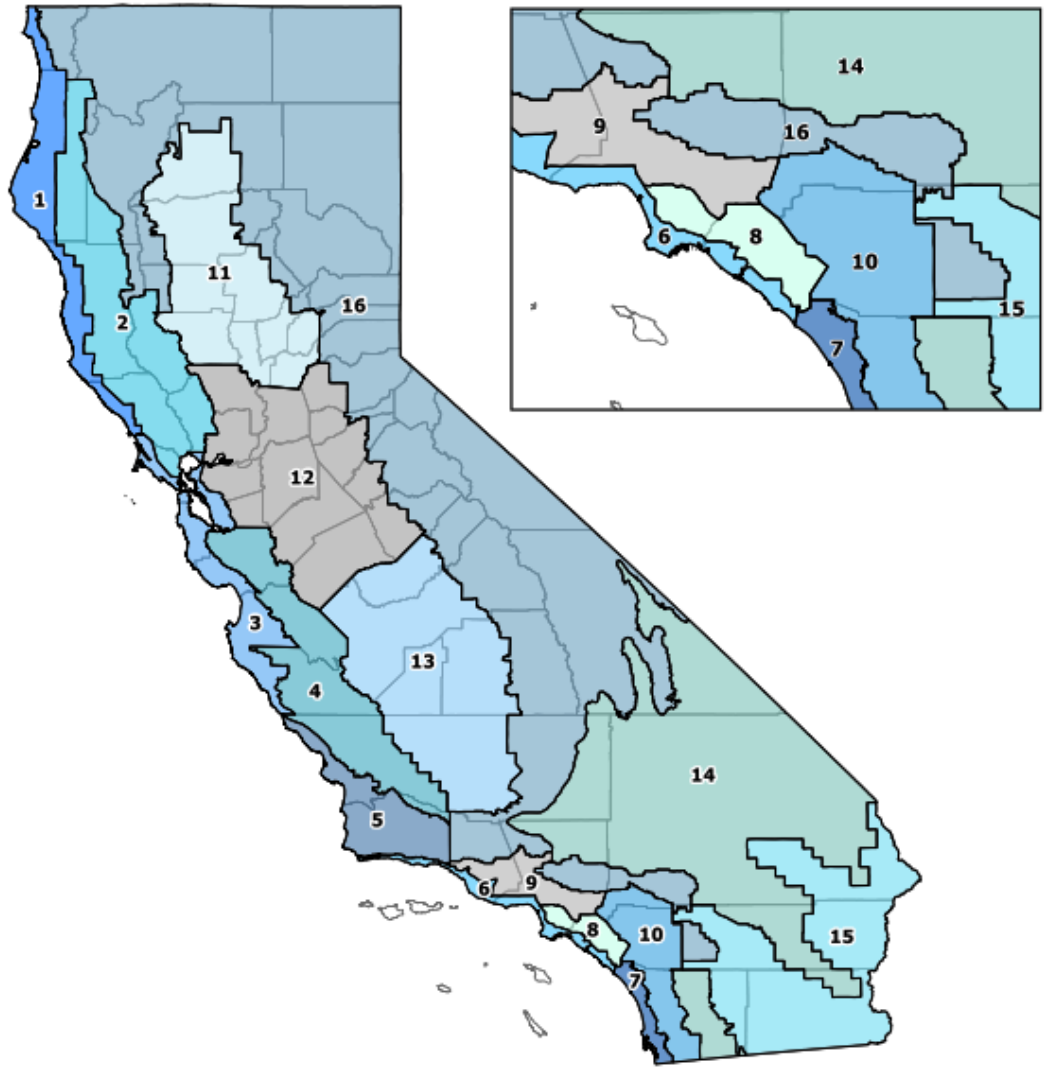
Electric source energy slightly lower than 2022 cycle, mainly due to **SB 100** and **offshore wind**



Systemwide Life Cycle Cost Results

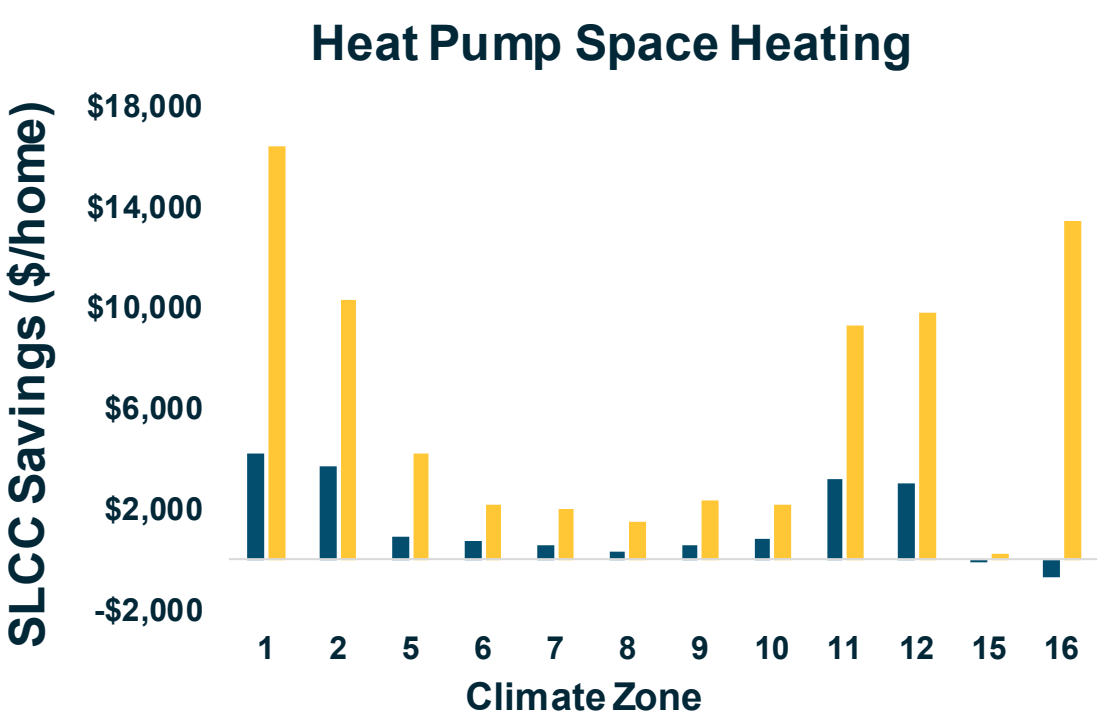
CA Building Climate Zones

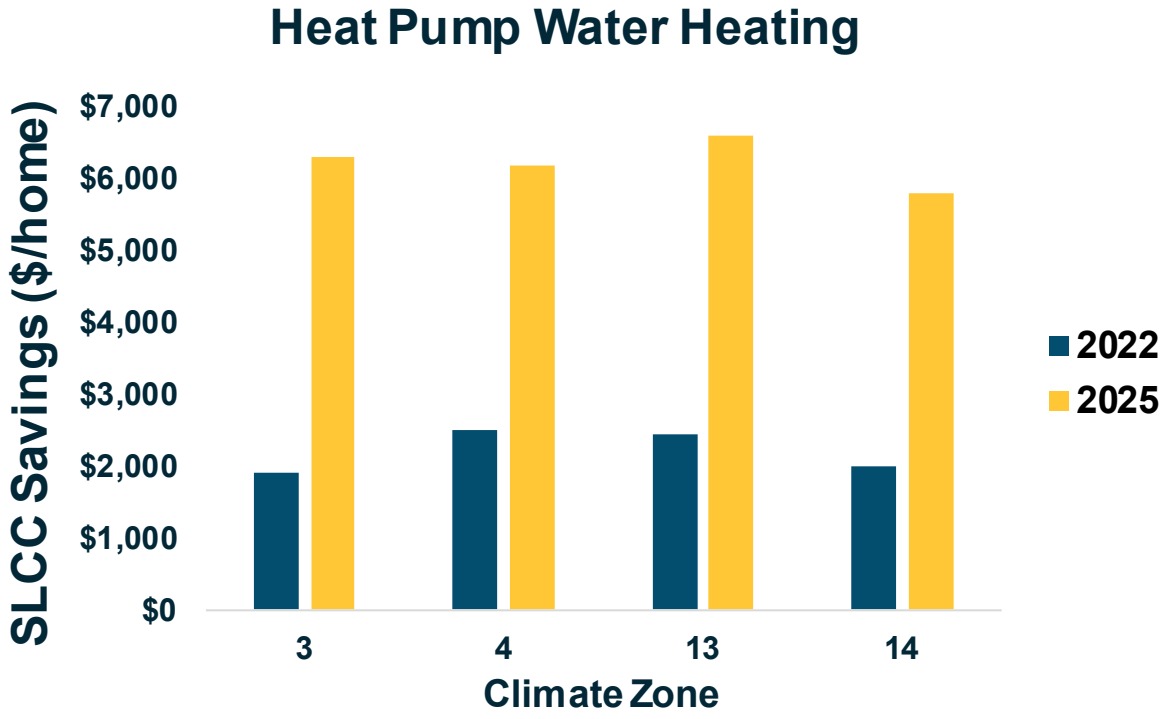
Climate Zone	Description
1	North Coastal
2	Northern Coastal Valley
3	San Francisco Bay Area and Coastal
4	Central Coastal Valley
5	Central Coastal
6	Los Angeles Coastal
7	San Diego Coastal
8	Orange County Coastal and Inland
9	North Los Angeles Inland
10	Southern California Inland
11	North Central Valley
12	Sacramento Central Valley
13	Southern Central Valley
14	High Desert
15	Low Desert
16	Mountains



Single-Family Heat Pumps

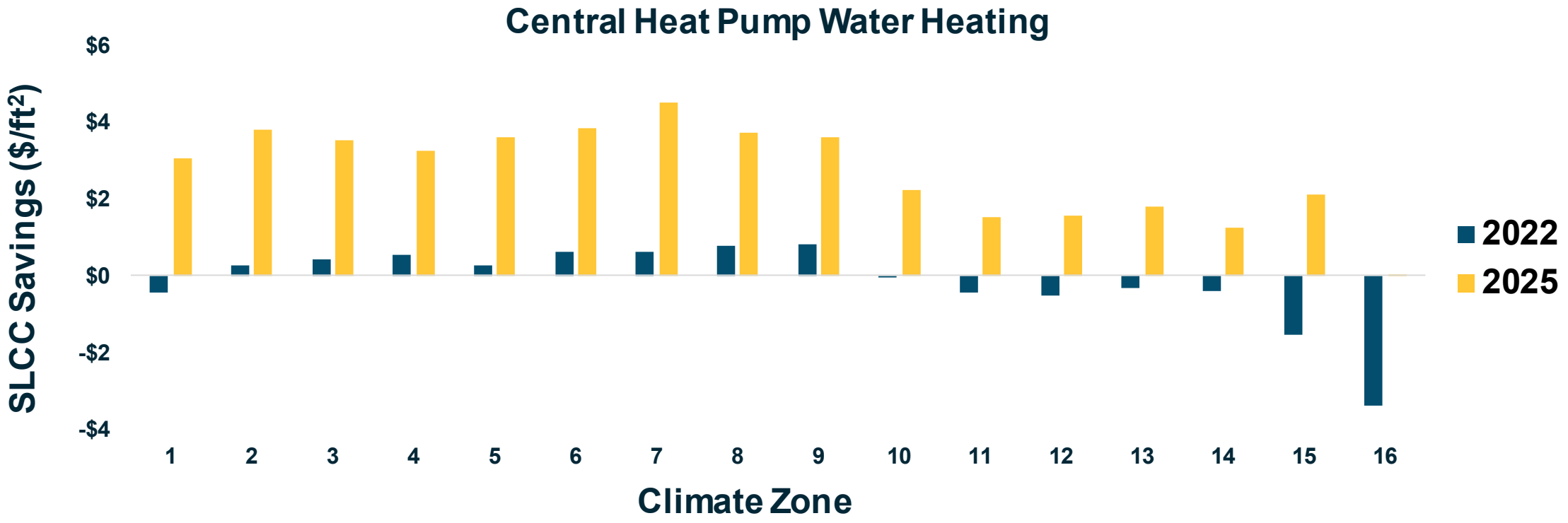
- Switching from natural gas space heating baseline to electric heat pump generates SLCC savings in all climate zones, ranging from **$200-$16,400** per home (left graph)
- Switching from natural gas water heating baseline to electric heat pump generates SLCC savings in all climate zones, ranging from **$5,800-$6,600** per home (right graph)





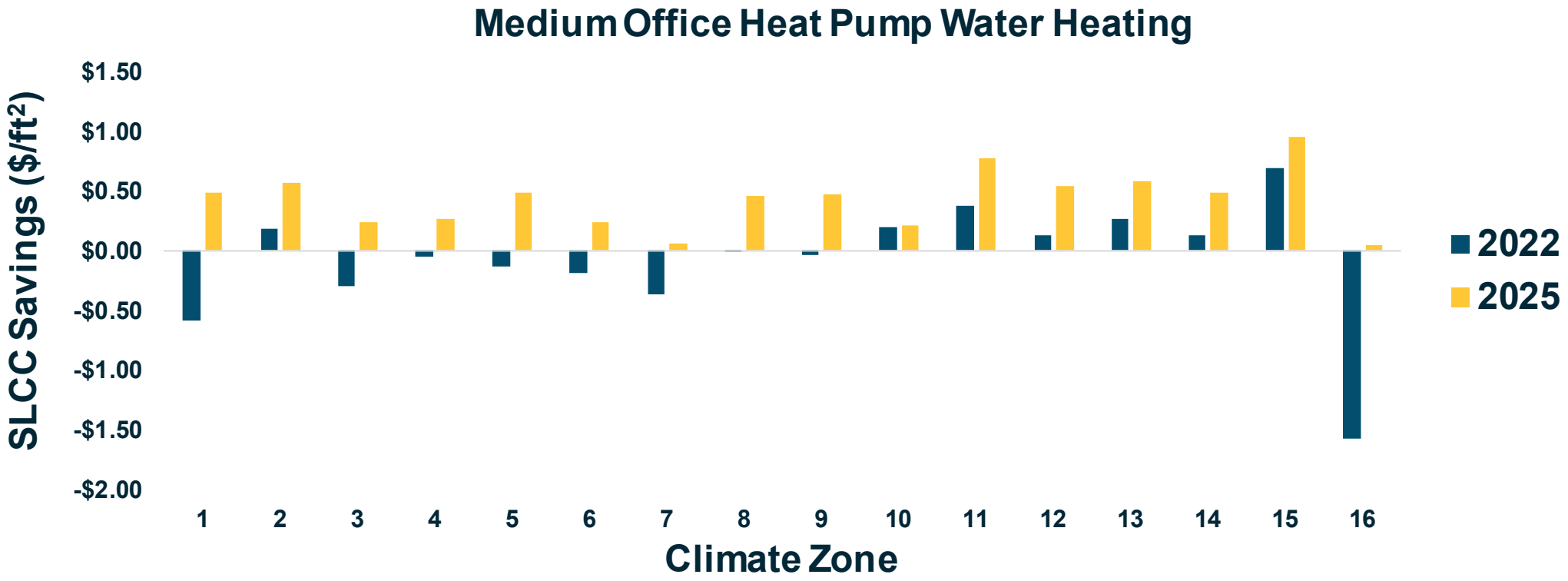
Multifamily Central Heat Pump Water Heaters

Switching from a natural gas central water heating baseline to a central electric heat pump water heater generates SLCC savings in all 16 climate zones, ranging from **$0.01/ft² - $4.50/ft²**



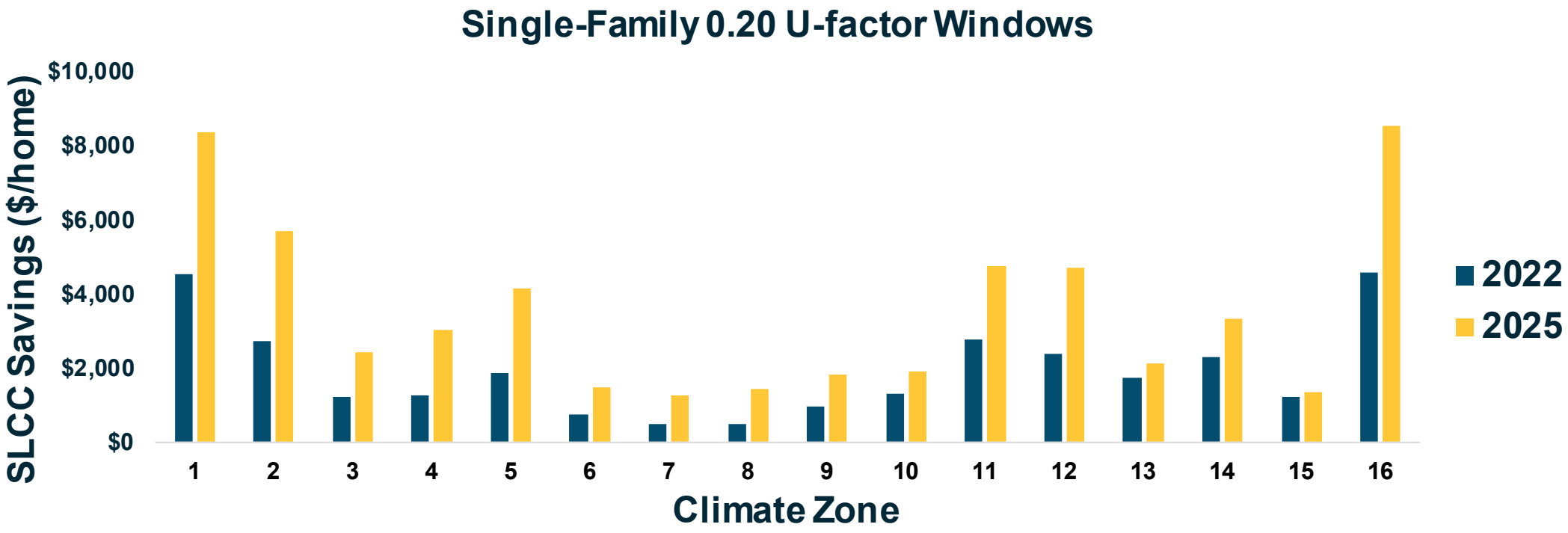
Medium Office Heat Pump Water Heating

Switching a natural gas water heating baseline to electric air-to-water heat pump generates SLCC savings in all 16 climate zones, ranging from **$0.05/ft^2 - $0.95/ft^2**



Single-Family 0.20 U-Factor Windows

Lowering the window baseline U-factor from 0.30 to 0.20 generates SLCC savings in all climate zones, ranging from **$1,300-$8,500** per building



Public Comments on Systemwide Life Cycle Cost, Source Energy, and Sensitivity Analysis

Jared Landsman, Energy and Environmental Economics, Inc.

Energy Accounting for the 2025 Energy Code

We will resume at …

Weather Data

Danny Tam, California Energy Commission

2025 Weather Files

- Development completed for new Typical Meteorological Year (TMY) weather files
  - 2000-2020 dataset
  - Life Cycle Costing hourly factors and Source Energy hourly factors completed using the new 2025 weather files
  - Hourly factors have been incorporated into CBECC beta software

Climate Change Projected Weather

- Data available on **Cal-Adapt** support exploration of climate change impacts in California
  - Contain the latest scientific data to support local decision making
- Existing global climate models (GCM) cannot be used directly as weather files
  - Building simulation requires hourly data
  - Most data in current GCMs has daily resolution

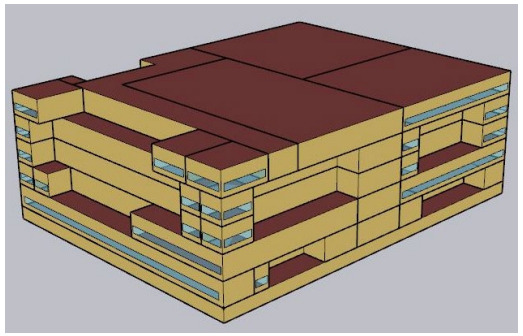
2028 Weather Files

- Ongoing work to explore feasibility of incorporating future/projected weather data
  - Identify one or more methodologies for weather files adjustment
  - Analyze impact of climate change-adjusted weather files in the Energy Code
- Results will allow CEC to make informed decision on the **2028 Energy Code**

Construction Forecast, Prototype Models, and Period of Analysis

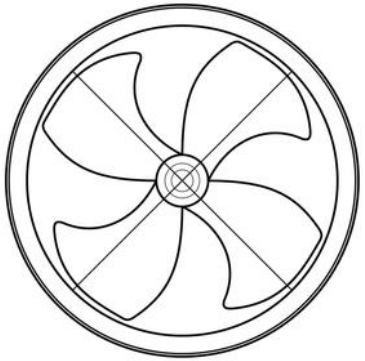
Eric Shadd, NORESCO
Rahul Athalye, NORESCO
Mohammad Dabbagh, NORESCO

Prototypes and construction forecast work together



Prototype Model

+



Measure

=

Unit Savings in each Climate Zone

Unit Savings in each Climate Zone

×

Forecasted Annual Floor Area by Prototype and Climate Zone

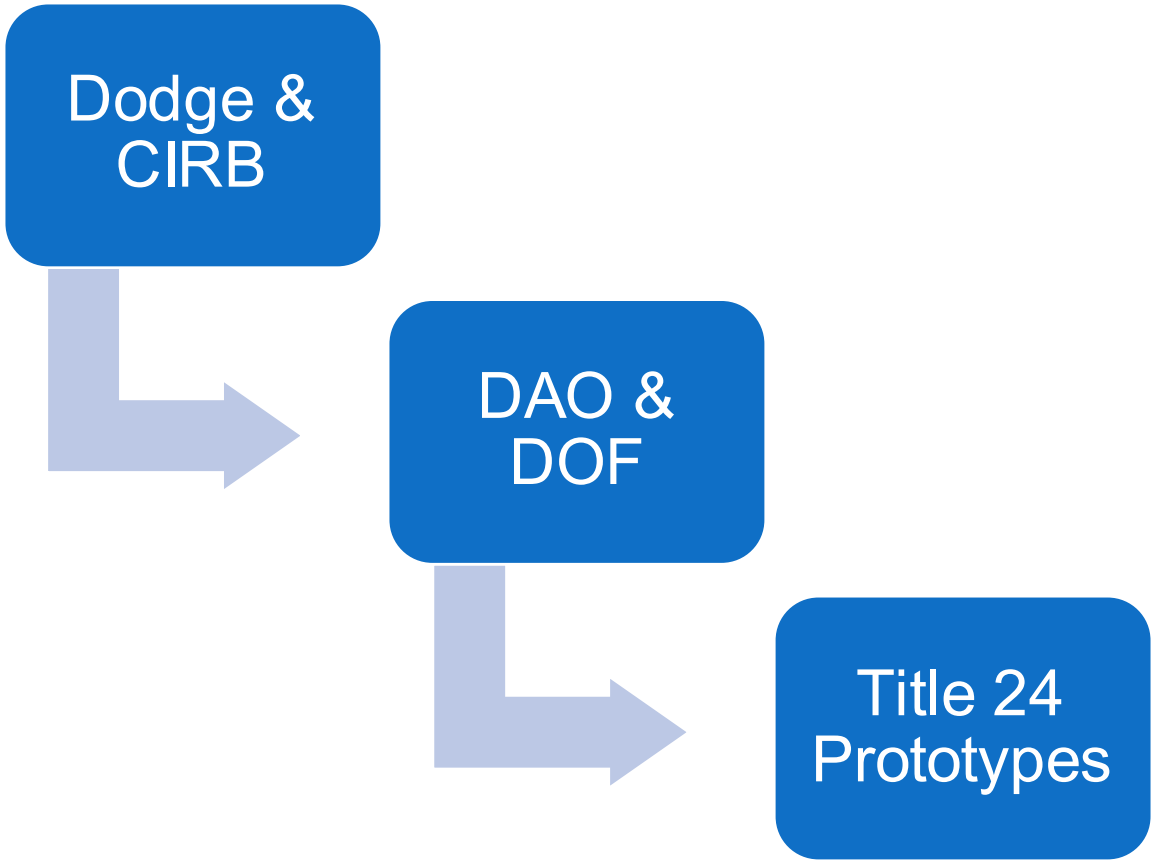
=

Annual Statewide savings

2025 Construction Forecast

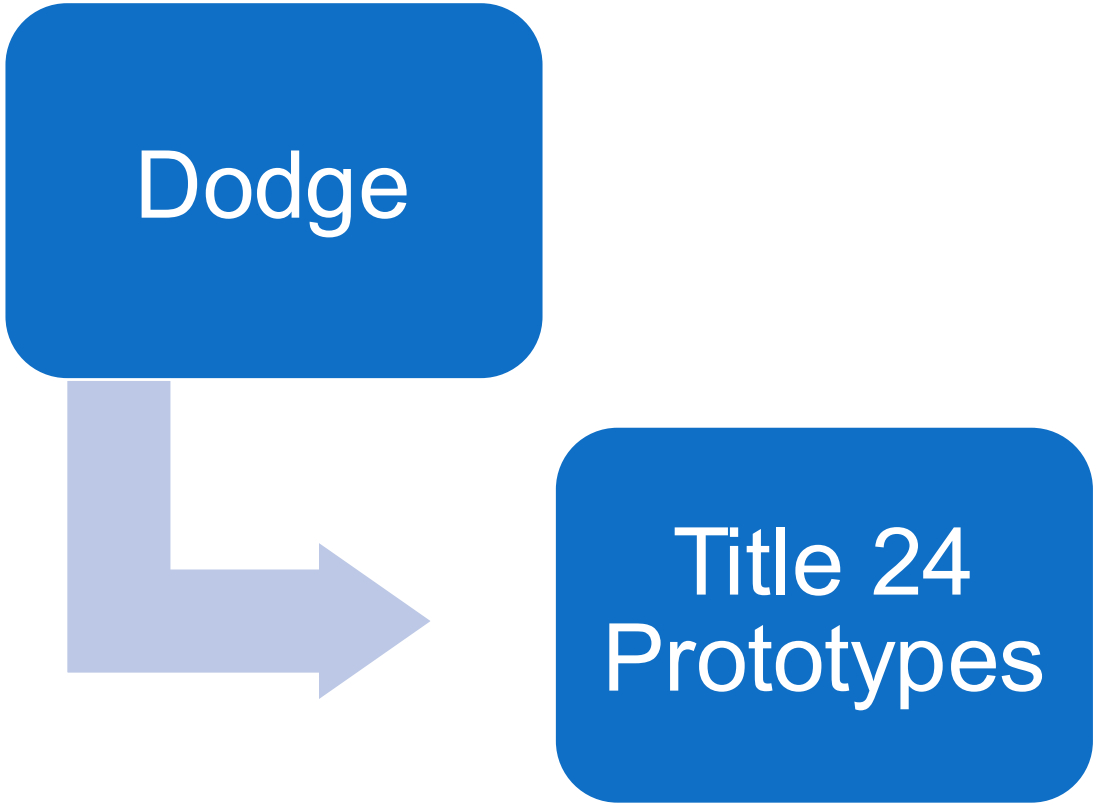
Previous Building Forecast

- CEC Demand Analysis Office (DAO) and CA Department of Finance (DOF) provide the construction forecast
- Based on an econometric model that uses jobs and other economic parameters
- DAO forecasts nonresidential based on Dodge data
- Department of Finance (DOF) forecasts residential based on CIRB data
- Both based on construction permit data



New Approach to Mapping

- New approach uses same underlying data as that used by the CEC DAO
- New approach maps individual project starts to **desired** building categories
- Develop direct mapping from project starts data to prototype models
- Focused on nonresidential and high-rise multifamily



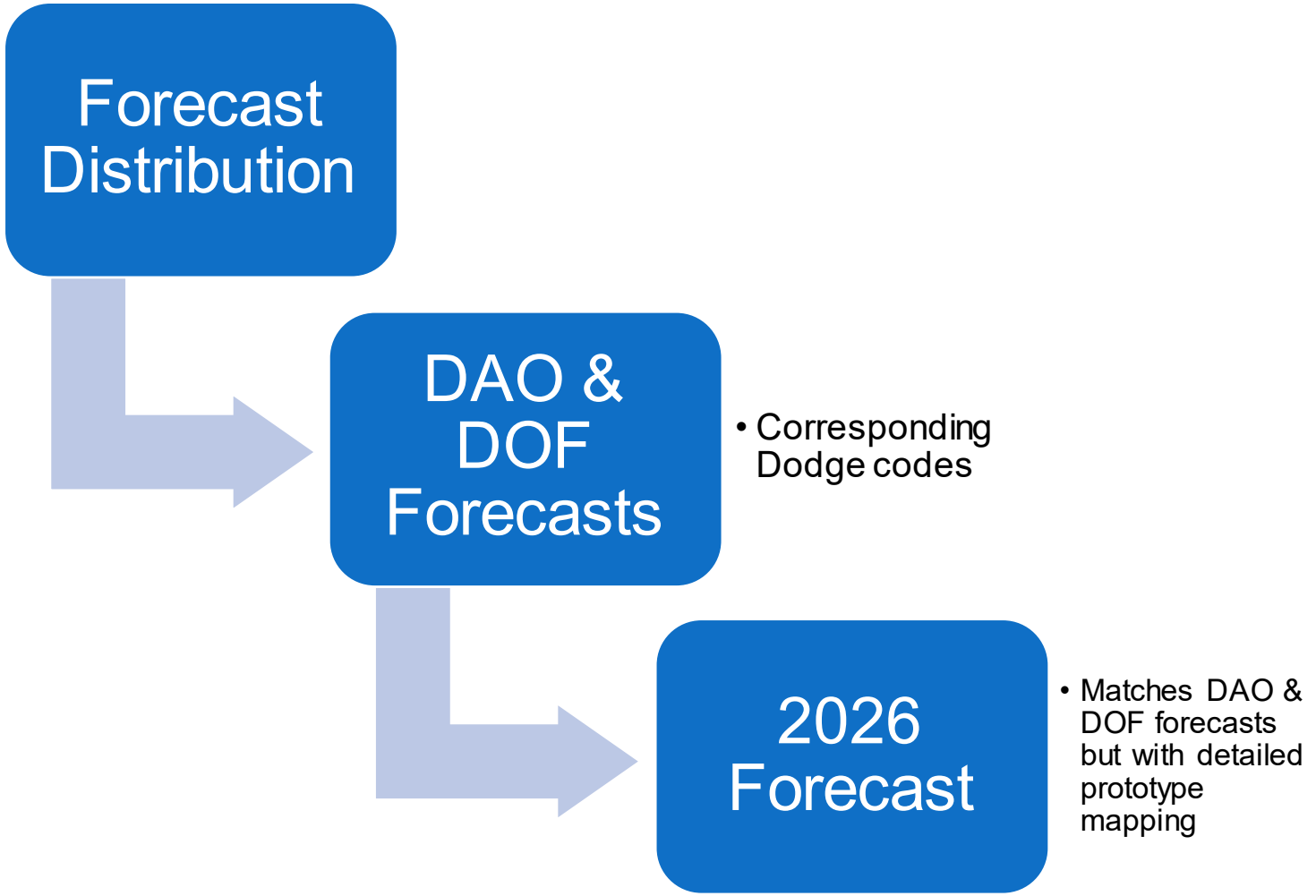
New Prototype Mapping

Building Category	Dodge STC Name
High-rise Apartment	Apartments 5+ Units, 4+ Stories
Assembly	Airline Terminals; Arenas/Coliseums; Auditoriums; Bus, Truck and Railroad Terminals; Clubs and Lodges; Exhibition Halls; Funeral/Internment Facilities; Houses of Worship, Other Religious Bldgs; Libraries; Museums; Theaters, Miscellaneous Amusement/Recreational, Gyms/Field Houses/Indoor Pools, Bowling Alleys; Arenas/Coliseums (Non-School/Univ); Auditoriums (Non-School/College); Railroad Terminals; Religious Bldgs
Hospital	Hospitals
Hotel	Hotels/Motels 4+ Stories, Hotels/Motels 1-3 Stories
Laboratory	Laboratories/Testing/R&D
Office	Offices, 1-3 stories; Offices, 4+ stories; Banks/Financial, 1-3 stories; Banks/Financial, 4+ stories; Capitols/Court Houses/City Halls; Police/Fire Stations; Post Offices; Offices and Banks/Financial Bldgs (incl all owner)
Parking Garage	Parking Garages
Restaurant	Food/Beverage Service
Retail	Stores, Shopping Centers
School	Primary Schools; Colleges/Universities Except Community; Community Colleges; Junior High Schools; Senior High Schools; Special Schools; Vocational Schools; Schools-Educational/ Science Bldgs; Sunday Schools
Warehouse	Warehouses (Non-Refrigerated)
Controlled-environment Horticulture	Animal/Fish/Plant Facilities after 1996
Refrigerated Warehouse	Refrigerated Warehouses
Vehicle Service	Aircraft Service; Auto Service; Bus and Truck Service; Railroad/Boat/Other Vehicle Service; Truck Service
Manufacturing	All 88 STCs beginning with “Mfg”
Miscellaneous	Miscellaneous Non-Residential Buildings, Communications Buildings, Animal/Fish/Plant Facilities before 1997
Unassigned	Armories/Military Buildings

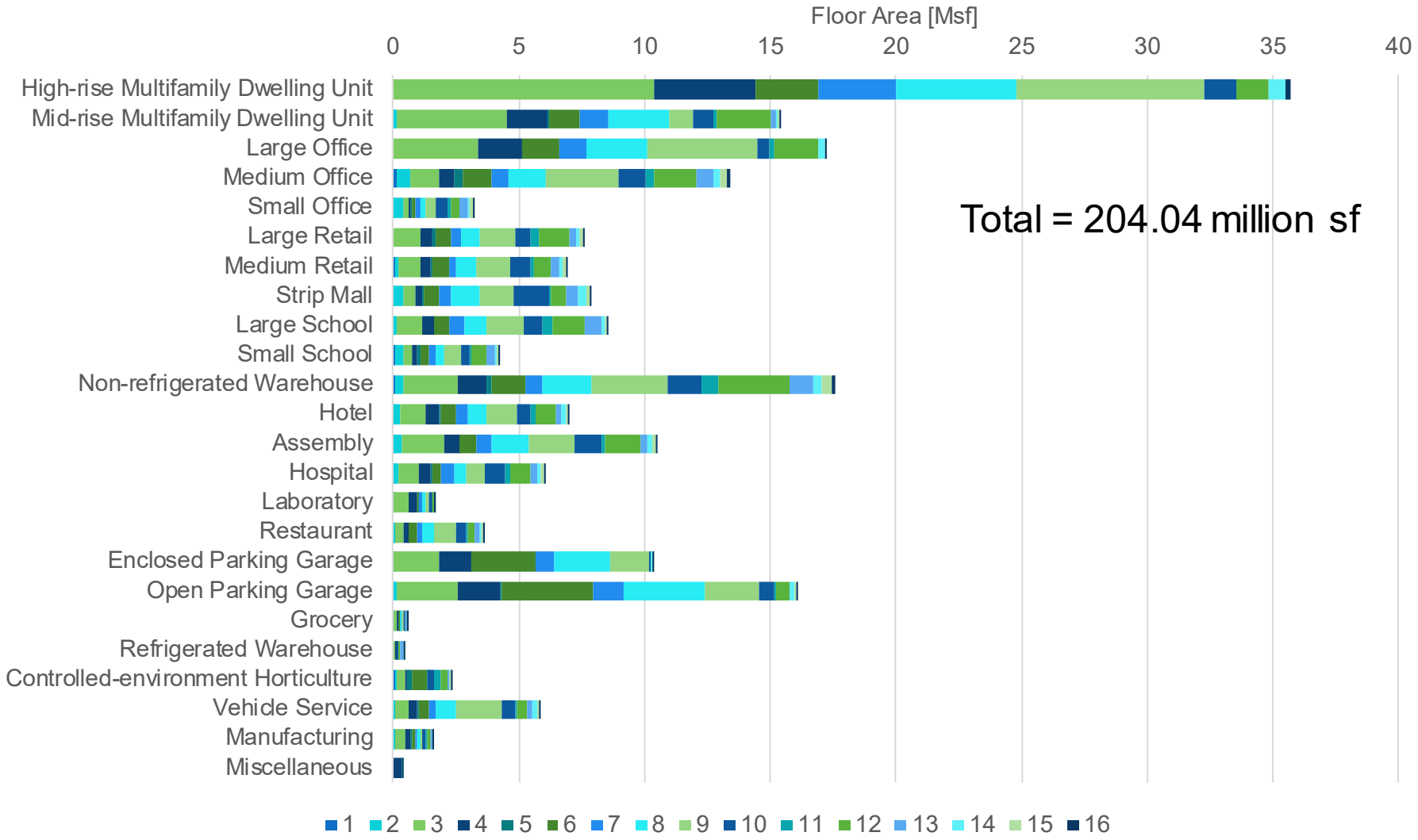
Developing the 2026 Forecast

- 2025 analysis: 2026 forecast
- Multiple approaches available for developing the 2026 forecast:
  - Average of past few years
  - Regression model
  - DAO forecast

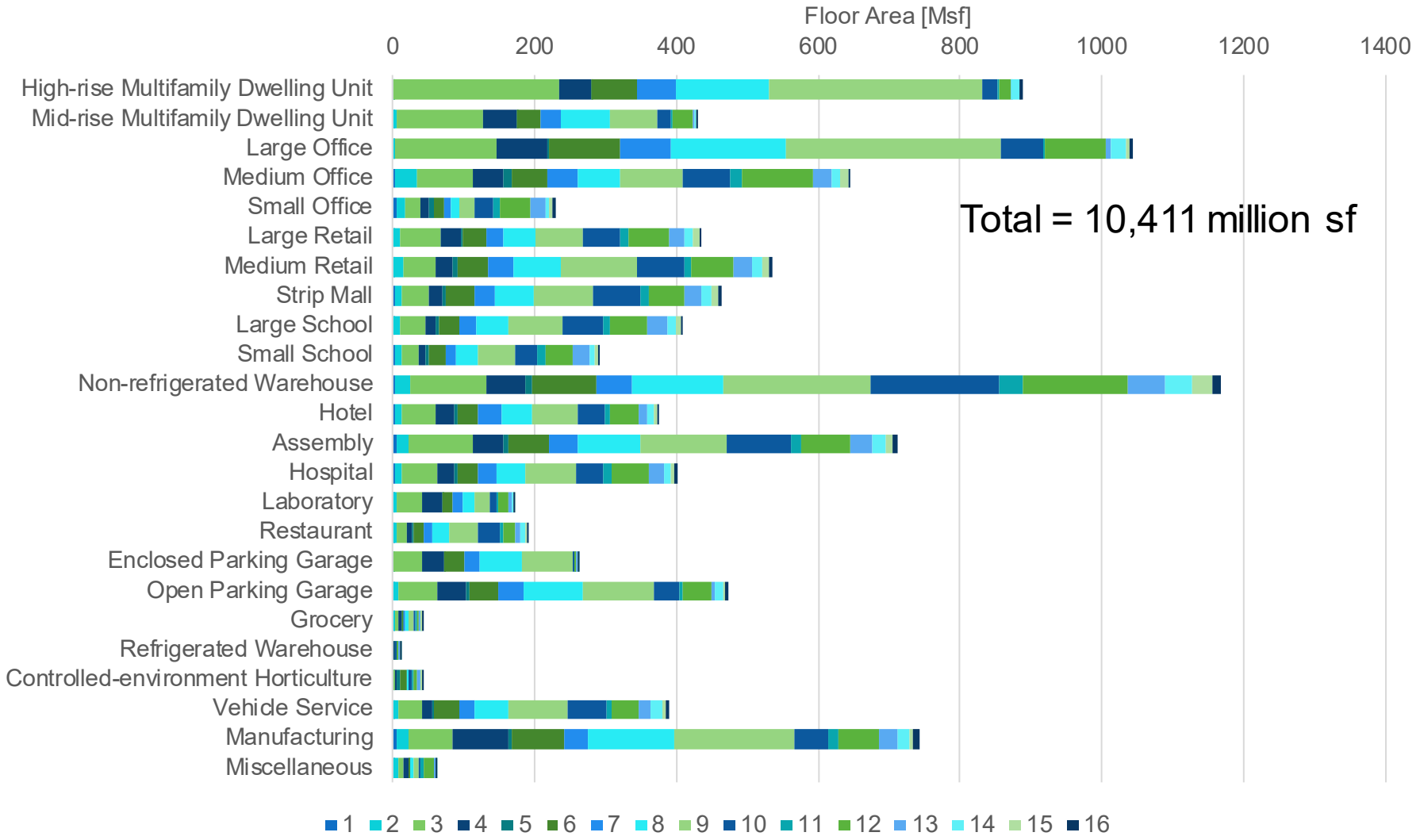
- A hybrid approach was developed that combines DAO & DOF's forecast with "current" forecast distribution



2026 New Construction Forecast



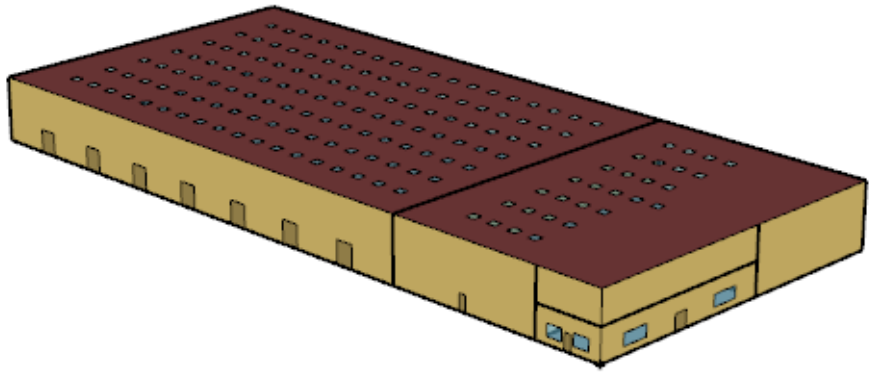
2026 Existing Buildings Forecast



Prototype Models

Building Prototype Models

- Intended to represent building stock, hence called “prototypes”
- Prototype models enable modeling of proposed measures and to estimate impacts on energy, TDV, HSE, and other metrics
- Enable capturing of interactive effects between measures
- Used to estimate the statewide impacts of a measure
- Focus of improvements is nonresidential and high-rise multifamily.

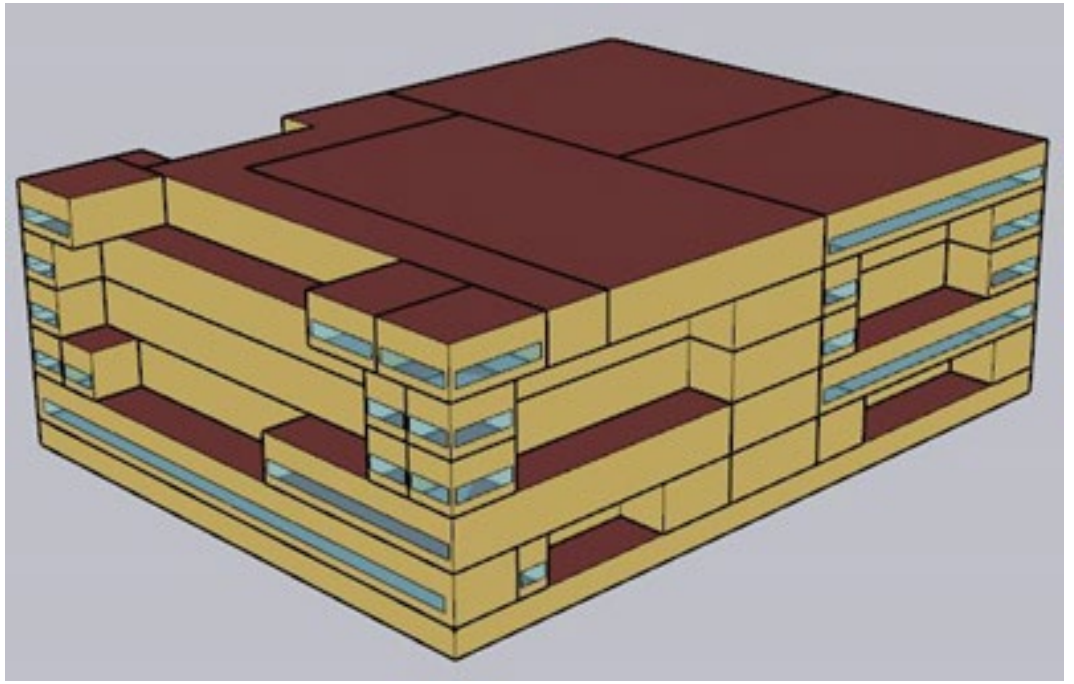


Proposed 2025 Prototypes

2026 Forecast Building Type	2022 Prototype	2025 Prototype
High-rise Multifamily Dwelling Unit	10-story Apartment	10-story Apartment
Mid-rise Multifamily Dwelling Unit	5-story Apartment	5-story Apartment
Low-rise Multifamily	Low-rise Garden Style, Low-rise Loaded Corridor	Low-rise Garden Style, Low-rise Loaded Corridor
Single-family	Single-family	Single-family
Large Office	Large Office	Large Office
Medium Office	Medium Office	Medium Office
Small Office	Small Office	Small Office
Large Retail	Large Retail	Large Retail
Medium Retail	Medium Retail	Medium Retail
Strip Mall	Strip Mall	Strip Mall
Mixed-use Retail	Mixed-use Retail	Mixed-use Retail
Large School	Large School	Large School
Small School	Small School	Small School
Non-refrigerated Warehouse	Warehouse (no cooling)	Warehouse (cooling in Fine Storage)
Hotel	Hotel	Hotel
Assembly	Assembly (CASE Team developed)	Assembly (new)
Hospital	Hospital (CASE Team developed)	Hospital (new)
Laboratory	Laboratory (“Medium Office”)	Laboratory (renamed)
Restaurant	Small Restaurant	Small Restaurant
Enclosed Parking Garage	Part of 10- and 5-story Apartment	Part of 10- and 5-story Apartment
Open Parking Garage	None	Open Parking Garage (new)
Grocery	None	None
Refrigerated Warehouse	None	None
Controlled-environment Horticulture	None	None
Vehicle Service	None	None
Manufacturing	None	None
Miscellaneous	None	None

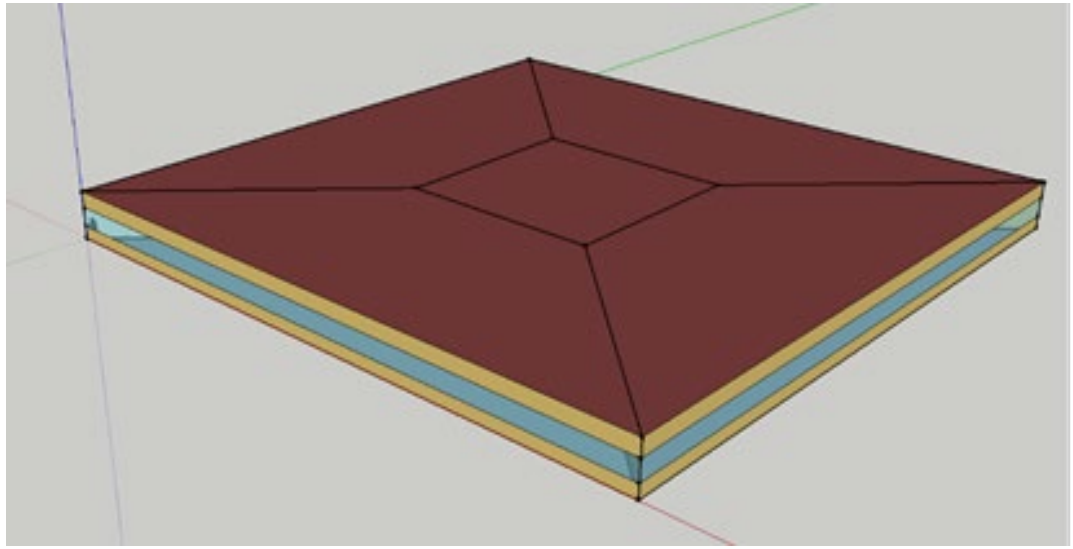
New Prototype: Hospital

- Incorporates HCAI, CMC, Title 24, and AIA guidelines
- Program and geometry based on DOE prototype
- Follows HCAI/CMC pressurization and exhaust flow requirements
- DCV, supply temperature reset, economizer, and other measures incorporated based on guidelines and best practices
- Specification follows Title 24 requirements, where applicable



New Prototype: Open parking garage

- Not represented in any other prototype but occupies significant floor area in the building stock
- Two-way ramp with one-way floor configuration selected
- 3-stories, 91,875 sf, concrete walls
- CBECC space type: **unconditioned** parking zone and ramp
- Includes daylight adaptation zone, rooftop hardscape



Open Parking Garage Prototype

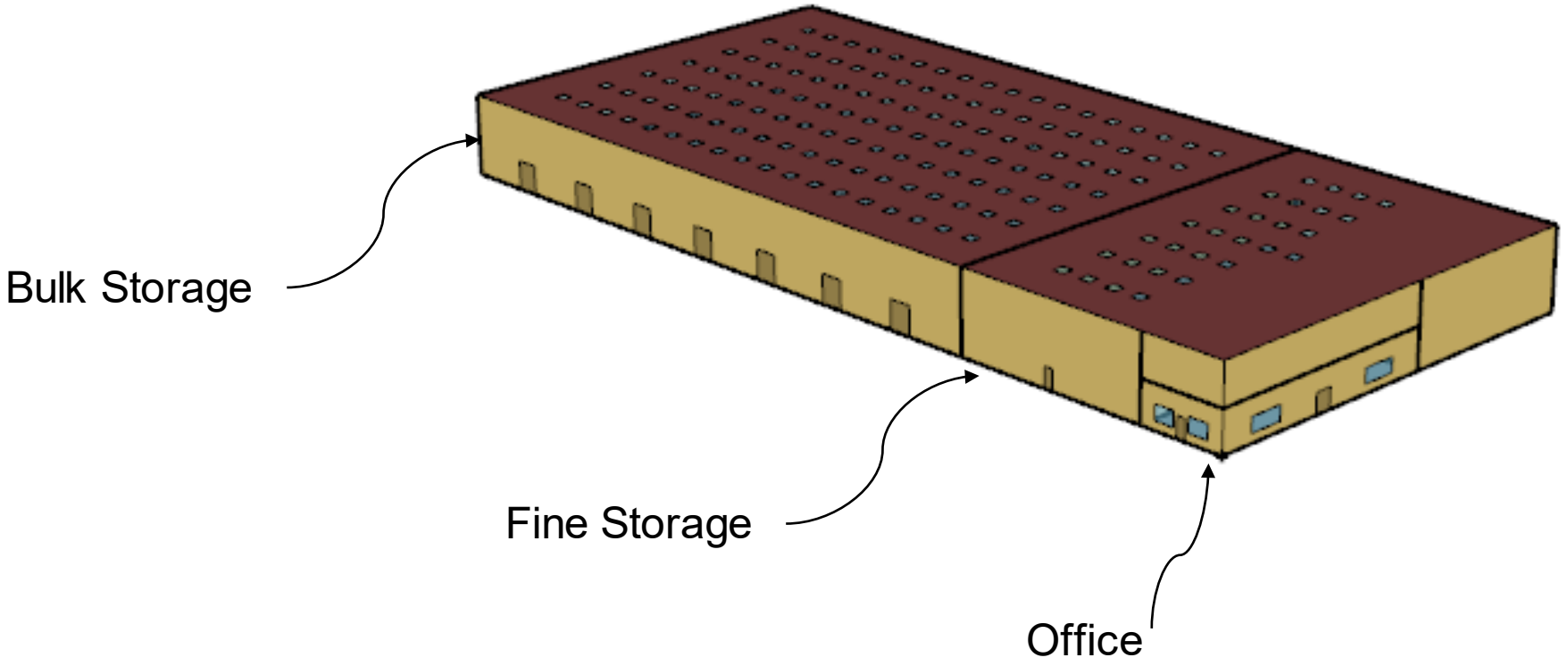
New Prototype: Assembly

- Assembly building type represents religious, sports and rec, event spaces, and libraries
- Prototype to include the above spaces plus supporting spaces: office, restroom, corridor, conference room, etc.
- Geometry development underway

Dodge Building Category	Total Dodge Floor area [ksf]	Total Dodge Project Count	Average Floor Area [ksf]	Portion of Total Building Category Floor Area
Religious	60,996	5,620	10.85	20%
Sports & Recreation	102,107	10,072	10.14	34%
Library	28,885	1,137	25.40	10%
Exhibits & Events	110,231	5,223	21.11	36%

Revised Prototype: Warehouse

- Warehouse – added cooling to fine storage space



Summary

- Three new prototypes
  - Hospital
  - Open Parking Garage
  - Assembly (under development)
- Revised prototypes
  - Warehouse
- Prototypes delivered as CBECC model input files (.cibd)
- Prototype models to be used with construction forecast to determine 2025 statewide savings

Final 2025 Prototypes
5-story Apartment
10-story Apartment
Low-rise Garden Style, Low-rise Loaded Corridor
Single-family (2,100 and 2,700 sf)
Assembly (new)
Hospital (new)
Small Hotel
Laboratory (renamed)
Small Office
Medium Office
Large Office
Open parking garage (new)
Small Restaurant
Medium Retail
Large Retail
Stripmall
Mixed-use
Small School
Large School
Warehouse (cooling in Fine Storage)

Period of Analysis

Recap

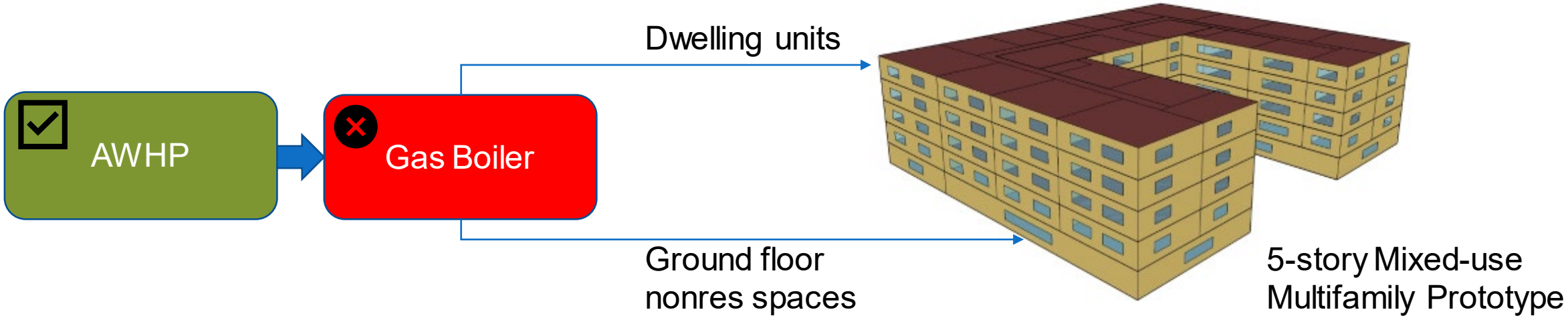
- In the 2022 cycle
  - 30-year period for all single-family and multifamily building measures
  - 30-year period for envelope measures for nonresidential buildings
  - 15-year period for all other measures for nonresidential buildings
- Limitations of previous approach:
  - 15-year period does not fully incorporate California's long-term outlook
  - Mixed-use buildings can be problematic to evaluate
  - Different measures are evaluated over different study periods

Approach for 2025

Use 30-year period of analysis to calculate cost-effectiveness of any proposed measure

- LCC analysis steps
  1. Calculate benefits:
     - Use 30-year LCC factors
  2. Calculate incremental measure costs:
     - Incremental first cost
     - Incremental maintenance cost
     - Incremental replacement cost
     - Incremental residual value
  3. Calculate benefit to cost ratio (B/C ratio)

Example measure: Mixed-Use Multifamily Buildings



- Measure: replace gas boiler serving both residential and nonresidential spaces with air-to-water heat pump (AWHP)
- New approach of using a single period of analysis simplifies cost-effectiveness calculations for this measure

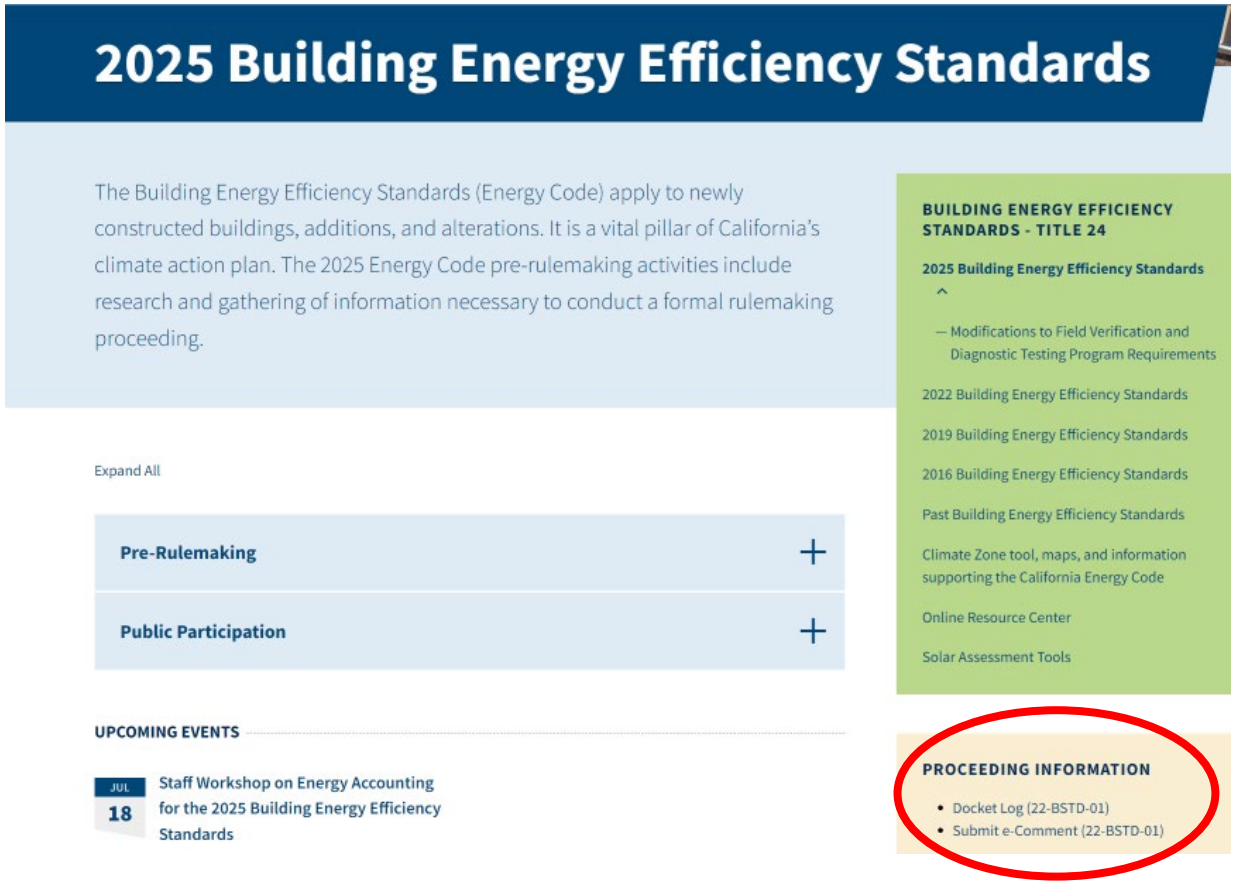
Example Cash Flow Calculation

- Period of analysis = 30 years
- Measure life = 20 years
- Replacement cost may be be less than first cost
- Estimate residual value (straight line depreciation used in the example)
- When B/C > 1, measure is cost-effective

Year	Incr. First Cost	Incr. Replacement	Incr. Maintenance	Incr. Residual	Total Incr. Costs	Present Value Total Costs
0	$1,000				$1,000	$1,000.00
1			$50		$50	$48.54
2			$50		$50	$47.13
3			$50		$50	$45.76
4			$50		$50	$44.42
5			$50		$50	$43.13
19			$50		$50	$28.51
20		$1,000	$50		$1,050	$581.36
21			$50		$50	$26.88
29			$50		$50	$21.22
30			$50	($500)	($450)	($185.39)
					Total Present Value Costs	**$ 2,327.70**

2025 Energy Code Page

- 2025 Energy Code pre-rulemaking and rulemaking events and documents
- Docket 22-BSTD-01



https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2025-building-energy-efficiency

Submitting Comments

- Efiling: https://efiling.energy.ca.gov/Ecomment/Ecomment.aspx?docketnumber=22-BSTD-01
- Email:
  Include docket number 22-BTSD-01 and "2025 Energy Code Accounting" in the subject line and email to docket@energy.ca.gov.
- Paper mail:
  California Energy Commission
  Docket Unit, MS-4
  Docket No. 22-BSTD-01
  715 P Street Sacramento
  CA 95814

2025 Energy Code Development

- Javier Perez – Project Manager
- Payam Bozorgchami – Technical Lead, Envelope, Additions and Alterations, ADUs
- Haile Bucaneg – Demand Response, Covered Process, ACM
- Muhammad Saeed – Solar Photovoltaic and Energy Storage Systems
- Bach Tsan – HVAC Systems, Refrigeration
- Danny Tam – Weather Data, Water Heating
- Erik Jensen – Energy Accounting
- Bill Pennington – Senior Advisor, Efficiency Division
- Che Geiser – Supervisor, Standards Tools Development Unit
- Chris Olvera – Supervisor, Outreach and Education Unit
- Will Vicent – Manager, Building Standards Branch
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Public Comments on Weather, Construction Projections, Prototypes, and Period of Analysis

Danny Tam, California Energy Commission
Rahul Athalye and Eric Shadd, NORESCO

Thank You!