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STAFF REPORT

2025 Energy Code Accounting Methodology

2025 Energy Code Rulemaking Docket Number 24-BSTD-01

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California Energy Commission

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ABSTRACT

This is the first edition of the Energy Code Accounting Methodology Report. This report documents the technical methods and tools used to assess energy efficiency proposals for the 2025 California Building Energy Efficiency Standards. California's Building Energy Efficiency Standards include building energy efficiency requirements in the Energy Code (Title 24, Part 6) and voluntary building energy efficiency standards in CALGreen (Title 24, Part 11).

In previous code cycles CEC staff and contractors relied on publishing separate reports covering the topics addressed in this report. This report seeks to combine these topics into one cohesive report. Additionally, this report seeks to present these complex topics in a manner which can be understood by a broader audience of building energy professionals such as architects, engineers, building scientists, and building energy modeling consultants.

With these two goals, this report seeks to increase understanding of these fundamental topics within the building energy industry and thereby improve public engagement with the Energy Code.

Topics covered in this report include building energy modeling compliance metrics (Long-term System Cost and Source Energy), weather data for California's 16 climate zones, building energy modeling prototypes, and California statewide construction forecasts. These energy accounting methods and tools are the basis for evaluating energy efficiency proposals for the 2025 update to California's Building Energy Efficiency Standards.

Much of the content summarized in this report was presented publicly during two CEC-hosted workshops on July 18, 2022, and November 10, 2022. Public feedback from these workshops has been incorporated into this report.

Keywords: Compliance metrics, Long-term System Cost (LSC), Source Energy, building energy modeling prototypes, California climate data, California statewide construction forecasts.

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The first edition of the Energy Code Accounting Methodology Report documents the technical methods and tools used to assess energy efficiency proposals for the 2025 California Building Energy Efficiency Standards update.

Introduction to Energy Code Accounting

California's Building Energy Efficiency Standards include building energy efficiency requirements in the Energy Code (Title 24, Part 6) and voluntary building energy efficiency standards in CALGreen (Title 24, Part 11). Together these serve to reduce wasteful, uneconomic, inefficient, and unnecessary consumption of energy in the state.

The Building Energy Efficiency Standards are updated every three years. With each update CEC staff receives and proposes numerous energy efficiency proposals (also called "measures") which seek to advance the state's nation-leading building standards. CEC staff are responsible for determining which measures will be developed and proposed for code adoption.

To thoroughly vet and prioritize measure ideas, CEC staff assess them for completeness, technical feasibility, and cost-effectiveness. As required by California law, staff must assess the package of Energy Code updates for cost-effectiveness when taken in its entirety.

Cost-effectiveness is fundamental to determining appropriate Energy Code measures. This report describes the technical methods and tools used to calculate the costs and benefits components of cost-effectiveness. These tools include climate data, building energy modeling prototypes, metrics, and construction forecast data. Combined, these tools allow for the calculation of energy-cost savings for individual measures and for the full package of measures.

For the 2025 code cycle, the following notable updates were made to Energy Code accounting methods and tools.

Climate Data

- Updates typical meteorological year data to the year range 2000-2020.
- Assigns new representative weather locations for Climate Zones 4 and 6 because previous locations lacked data.
- Incorporates data from 117 additional California weather locations to expand locations usable for performance compliance.
- Adds data from 33 weather locations outside of California to be used for grid and emissions impacts analysis for locations outside California.

Building Energy Modeling Prototypes

- Updates prototypes to account for 2022 Energy Code requirements to set the comparative baseline for the 2025 code evaluation.
  - Notable changes include single zone air conditioners changed to heat pumps, dwelling unit water heaters changed to heat pumps, new heat recovery systems, and the expansion of PV and battery systems to new building categories.

- Creates new prototypes for assemblies, hospitals, and open parking garages.

Metrics

- Updates terminology for the Energy Code cost-effectiveness metric from Time Dependent Valuation (TDV) to Long-term System Cost (LSC).
- Simplifies Energy Code cost-effectiveness units from TDV (kBtu/kWh and kBtu/therm) to LSC ($/kWh and $/therm).
- Changes demand scenario to new "High Electrification Policy Compliance" scenario from the CEC Demand Scenarios Project which aligns with current policy and includes relatively high economywide electrification.
- Uses eight percent annual growth rate for residential gas price models to forecast future residential gas retail rates.
- Enhances building electrification load shapes by using National Renewable Energy Laboratory's ResStock and ComStock databases to incorporate more load diversity.
- Improves vehicle electrification load shapes using hourly loads from the 2021 Integrated Energy Policy Report (IEPR).
- Modernizes marginal electric capacity costs to be based on energy storage resources, rather than from a combination of combustion gas turbine, renewable energy, and energy storage resources.
- Updates nonresidential retail rate adder to include more time dependence from 15 percent to 25 percent.

Construction Forecast Data

- Maps prototype buildings to construction starts data from 2022 Dodge Data Analytics (Dodge) resulting in more accurate representation of building construction forecasts and statewide savings estimates.
- Maps construction starts by climate zone using U.S Census Bureau and Dodge construction data.
- Coordinates construction forecast data with CEC Demand Analysis Office (DAO) for all building types except parking garages and certain manufacturing building categories.

CHAPTER 1: Energy Code Fundamentals

California's Building Energy Efficiency Standards[1] include building energy efficiency requirements in the Energy Code (Title 24, Part 6) and voluntary building energy efficiency standards in CALGreen (Title 24, Part 11). Together these serve to reduce wasteful, uneconomic, inefficient, and unnecessary consumption of energy in the state.[2] The Energy Code details statewide requirements for residential and nonresidential buildings, whereas CALGreen contains only voluntary energy efficiency standards. The voluntary standards in CALGreen are meant to serve as examples for local governments seeking to adopt reach code ordinances going beyond the Energy Code. Together, the Building Energy Efficiency Standards are updated every three years and are maintained, developed, proposed, and adopted by the California Energy Commission (CEC). Since 1978, the Building Energy Efficiency Standards have exemplified California's strategy to cost-effectively reduce energy consumption, pioneer methods that conserve resources, and act as a world leader in energy efficiency and clean energy.

Building Energy Efficiency Measures

The Building Energy Efficiency Standards are updated every three years. With each update CEC staff receives and proposes numerous energy efficiency proposals (also called "measures") which seek to advance the state's nation-leading building standards. CEC staff are responsible for determining which measures will be developed and proposed for code adoption.

This report documents the energy accounting technical methods and tools used to assess energy efficiency proposals. This report does not evaluate or describe any specific measures. Rather, this report seeks to broaden public engagement and provide transparency in the overall Energy Code accounting process. This includes elucidating the technical methods and primary resources used to update these fundamental tools for the 2025 code cycle.

Much of the content summarized in this report was presented publicly during two CEC-hosted workshops on July 18, 2022,[3] and November 10, 2022.[4] Public feedback from these workshops has been incorporated into this report.

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1 "California's Building Energy Efficiency Standards," https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards.

2 California Public Resources Code 25000 (also called the Warren-Alquist Act) requires California to reduce wasteful, uneconomic, inefficient, and unnecessary consumption of energy in the state.

3 "First CEC-Hosted 2025 Energy Code Accounting Workshop," https://www.energy.ca.gov/event/workshop/2022-07/staff-workshop-energy-accounting-2025-building-energy-efficiency-standards.

4 "Final CEC-Hosted 2025 Energy Code Accounting Workshop," https://www.energy.ca.gov/event/workshop/2022-11/final-staff-workshop-energy-accounting-2025-building-energy-efficiency.

Supplemental to this report, the CEC developed and published a 2025 Energy Code Measure Template,[5] intended to aid anyone who wishes to submit specific energy efficiency measures to the CEC for possible inclusion in future code updates. This template outlines the minimum information necessary to ensure completeness of energy efficiency proposals. Measures submitted to the CEC are considered, may be modified, and are assembled by the CEC into comprehensive regulatory packages.

Public Process

A fair, robust, and transparent public process is the lifeblood of California's Building Energy Efficiency Standards. Each code cycle, the CEC receives numerous proposals that attempt to advance the state's nation-leading building standards. To thoroughly vet and prioritize these ideas, CEC staff assesses measures for completeness, technical feasibility, and cost effectiveness. Measures that appear to have the largest savings to the state, while remaining technically feasible, are shortlisted by CEC staff for further vetting through a process that invites commentary and scrutiny from the public.

Each code cycle, the CEC hosts a series of public workshops where the most important information pertaining to that code cycle is presented. Concurrently, the CEC hosts an online docketing system that keeps a running list of all public comments and sends regular notifications to interested parties. Only measures that pass screenings for completeness, satisfy concerns raised through CEC technical reviews, and persist through public workshops are included in draft rulemaking documents by CEC staff. A *rulemaking* is a formal process through which regulations, rules, and standards are developed, amended, or repealed by a government agency.

CEC staff uses the drafted rulemaking documents — including marked-up regulatory language (Energy Code and CALGreen), statements to justify the amendments, references to documents relied upon, statements of economic and fiscal impact to the state, and documentation complying with the California Environmental Quality Act — to initiate a formal rulemaking. The CEC then conducts a rulemaking proceeding in accordance with procedures set out in the Administrative Procedures Act, culminating in adoption by the CEC at a business meeting adoption hearing.

After the CEC adopts amendments to the Building Energy Efficiency Standards, the amendments are submitted to the California Building Standards Commission for approval and inclusion with all other parts of the California Building Standards Code (Title 24).[6] Figure 1 highlights some of the key milestones for the development of the 2025 Energy Code.

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5 "CEC 2025 Energy Code Measure Template," https://www.energy.ca.gov/media/3538.

6 For more information on the building standards rulemaking process, see "California Building Standards Commission Guidebooks on Rulemaking," https://www.dgs.ca.gov/BSC/Resources/Page-Content/Building-Standards-Commission-Resources-List-Folder/Guidebooks-on-Rulemaking.

Table 1: 2025 Energy Code Development Milestones

Milestone	Target Dates
CEC Kickoff Workshop on Compliance & Templates	March 22, 2022
Deadline to Submit New Measures	April 15, 2022
Research Version of Energy Code Compliance Software	October 2022
CEC Finalization of Energy Code Accounting	November 2022
Utility-Sponsored Workshops	August 2022 – April 2023
CEC Preliminary Rulemaking Workshops	June 2023 – October 2023
Preliminary Rulemaking Language Public Comment Period	November 2023
CEC Development of Formal Rulemaking Documents	December 2023 – March 2024
Start 45-Day Public Comment Period	March 2024
Start 15-Day Public Comment Period	July 2024
CEC Adoption	August 2024
California Building Standards Commission Approval	December 2024
Effective Date	January 1, 2026

Source: California Energy Commission

Compliance Flexibility

If public process is the lifeblood of the Building Energy Efficiency Standards, compliance flexibility is the backbone. Recognizing the wide range of diversity in a state of nearly 40 million people, the Building Energy Efficiency Standards are intentionally structured to provide options and flexibility. At the building design phase, demonstrating compliance with the Energy Code can occur using either the prescriptive method or the performance method.

The *prescriptive method* is the simpler but more limited way of demonstrating compliance. This method requires building projects to meet all applicable mandatory and prescriptive requirements detailed in the Energy Code. No trade-offs can occur. This is the checklist method.

Conversely, the *performance method* allows a more customized, flexible, way of demonstrating compliance. Proposed designs are allowed to make design trade-offs using any Building Energy Modeling (BEM)[7] software that is approved by the CEC for Energy Code compliance.[8] This method allows building designers to use a myriad of alternative design strategies to comply with the Energy Code by comparing a proposed design with the designated standard design. The standard design is a building having the same characteristics and location of the proposed building but assumes minimal compliance with the prescriptive and mandatory requirements. When using the performance method, a project will comply with the Energy Code if the energy budget for a proposed design is equal to or less than the energy budget for the standard design. In California, the performance method is the more popular compliance method because it provides building designers with the most flexibility.

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7 Department of Energy's description of building energy modeling, https://www.energy.gov/eere/buildings/about-building-energy-modeling.

8 Building energy modeling software approved for compliance with the Energy Code. https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/online-resource-center/compliance.

Statewide Utility Codes and Standards Enhancement Program

The Statewide Utility Codes and Standards Enhancement Program is one of many publicly funded programs paid for by a portion of electricity and gas rates included in customer utility bills.[9] These energy efficiency programs are regulated by the California Public Utilities Commission (CPUC). The CPUC is responsible for verifying programs are meeting goals, achieving cost-effectiveness metrics, and maintaining compliance with statutory requirements. The CPUC ensures public funds are well-spent.

One of the main roles of the Statewide Codes and Standards Program is supporting the advancement of the state's Building Energy Efficiency Standards. The same law that requires the reduction of wasteful, uneconomic, inefficient, and unnecessary consumption of energy in the state (Warren-Alquist Act) also requires energy utilities to support the development of the Building Energy Efficiency Standards.[10] This support includes providing appropriate research, development, and implementation training, if funds are made available to the utilities for that purpose. The program is administered by Pacific Gas and Electric Company, Southern California Edison, San Diego Gas & Electric Company, Los Angeles Department of Water & Power, and Sacramento Municipal Utility District.

This mechanism has long provided a uniquely collaborative framework in California that encourages the state's largest utilities and other funded programs to support, supplement, and amplify work done by the CEC to advance California's Building Energy Efficiency Standards.

Cost Effectiveness

California law requires the Building Energy Efficiency Standards be cost-effective.[11] Consistent with this statute, measures assessed by the CEC are considered cost-effective when the life-cycle savings are greater than the life-cycle costs of the measure. This occurs when the benefit-cost ratio (BCR) is 1.0 or greater. Equation 1 shows how measure cost-effectiveness is evaluated: when the present value of Long-term System Cost (LSC) savings are greater than the present value of incremental measure costs (including first costs, replacement costs, and maintenance costs), over the economic life of the structure, the measure is determined to be cost-effective.

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9 California Public Utilities Commission. February 2016. *Regulating Energy Efficiency: A Primer on the CPUC's Energy Efficiency Programs,* https://www.cpuc.ca.gov/-/media/cpuc-website/files/uploadedfiles/cpuc_public_website/content/news_room/fact_sheets/english/regulating-energy-efficiency-0216.pdf.

10 California Public Resources Code 25000, § 25402.7 requires electric and gas utilities to provide support for building standards.

11 California Public Resources Code 25000, § 25402 (b)(3) defines cost-effectiveness for the consumer.

Equation 1: Measure Cost-Effective Determination

$$\frac{\boldsymbol{LSC\ Savings}\ (\$)}{\boldsymbol{Incremental\ Measure\ Costs}\ (\$)} > \mathbf{1}$$

Cost-effectiveness must consider the value of energy when "… amortized over the economic life of the structure compared with historic practice."[12] This means all measures are assessed over the economic life (also called "period of analysis") of 30 years, and that both the benefits and the costs are assessed incrementally — meaning in comparison to the latest adopted version of the Energy Code. Measures considered for the 2025 Energy Code are analyzed in comparison to the minimum requirements in the 2022 Energy Code.

When assessing the total dollar cost of a measure, first costs, replacement costs, and maintenance costs are considered. First costs include equipment, labor, and soft costs such as design fees or permit costs. Determining the benefits of a measure is more involved and often requires the use of BEM software to help account for the measure in the context of a whole building. For example, increasing the performance of windows in the Energy Code also impacts energy accounting for mechanical heating and cooling loads. BEM software is used to understand the net effects of measures and helps better understand the daily and seasonal impacts of the measure through hourly results.

Energy Code Accounting

Cost-effectiveness is fundamental to determining appropriate Energy Code measures. This report describes the technical methods and tools used to calculate the costs and benefits components of cost-effectiveness. These tools include climate data, building energy modeling prototypes, metrics, and construction forecast data. Combined, these tools allow for the calculation of energy-cost savings for individual measures and for the full package of measures.

Climate Data

Accurate, detailed, and up-to-date climate data are critical for adopting technically feasible, cost-effective building standards. Building energy savings depend greatly on weather, and this dependence makes typical, overly generalized BEM weather data inadequate for analyzing energy efficiency measures. To solve this, the CEC develops weather data for 16 different California climate zones – rather than one climate zone for the whole state – and revises these datasets before analyzing measures for each code cycle. CEC-approved code compliance BEM software is required to come inherently with weather data that have been developed specifically for California's climate zones to ensure accurate representation of a building's location. More information on California climate data and the methods used to update it are described in Chapter 2 of this report.

Building Energy Modeling Prototypes

An accurate representation of California's buildings (also called "building stock") through representative building energy models helps to create accurate and defensible analysis for the Building Energy Efficiency Standards. To ensure an accurate representation of California's

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[12] California Public Resources Code 25000, § 25402 (b)(3) defines cost-effectiveness for the consumer.

building stock, every code cycle the CEC updates prototype models using best available data. For the 2025 Energy Code best available data included large sets of building survey data from multiple sources, cross-referenced and coordinated with other reputable organizations and agencies. The methods for developing CEC's prototype models is detailed in Chapter 3 of this report.

Metrics

An output that is common to users of BEM software is hourly energy use or hourly energy consumption. These predicted outputs are typically generated by BEM tools for each hour of a representative calendar year, and thus sometimes referred to as 8,760 datasets. However, these outputs typically represent the anticipated energy use for the first year of operation and do not typically account for rising costs over time, such as inflation, or other dynamic economic factors. Additionally, BEM software typically predicts energy use at the site of the building and does not typically account for the total energy costs systemwide that are caused by that building. This includes the cost of energy losses resulting from the generation, transmission, and distribution of energy consumed, among other costs.

To ensure the Building Energy Efficiency Standards consider the statewide long-term value of energy and not just the near-term value of energy, total dollar benefit (shown in Figure 2) is determined using a method called *Long-term System Cost* (LSC), previously referred to as *Time-Dependent Valuation*. The LSC method helps the state account for the long-term benefits of policies needed to meet its climate actions goals, such as 100 percent renewable generation, proliferation of electric transportation, and drastic reductions in fossil fuel combustion occurring in buildings. Today's energy costs do not adequately account for these long-term benefits to California's energy system. Accordingly, each code cycle, the CEC develops and publishes LSC hourly conversion factors. LSC hourly factors are used to convert predicted site energy use (an output common to BEM software[13]) to a 30-year present value cost to California's energy system. This method is detailed in Chapter 4 of this report.

In addition to LSC, the Building Energy Efficiency Standards use a secondary compliance metric called Source Energy. This metric helps ensure alignment with the state's goal to reduce greenhouse gas emissions aggressively from the building sector.[14] Source Energy is an energy metric that has been found to strongly correlate with statewide greenhouse gas emissions. This method is detailed in Chapter 4 of this report.

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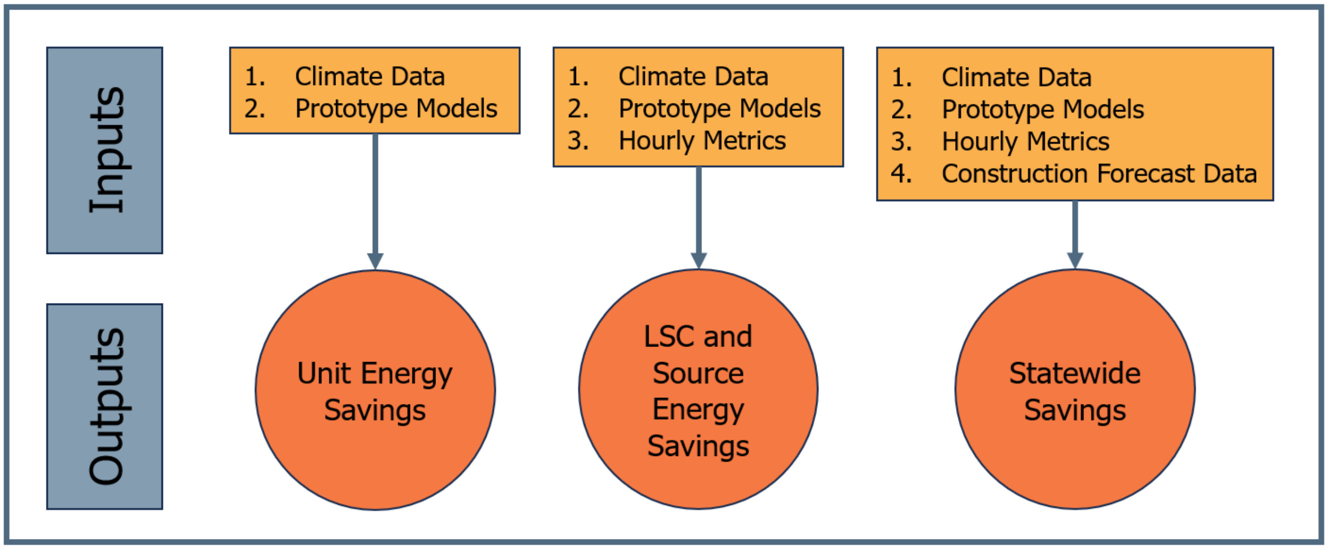
13 Department of Energy's description of building energy modeling, https://www.energy.gov/eere/buildings/about-building-energy-modeling.

14 "California's Climate Plan," https://www.gov.ca.gov/2022/11/16/california-releases-worlds-first-plan-to-achieve-net-zero-carbon-pollution/.

Figure 1: Inputs and Outputs of Energy Code Accounting



Source: California Energy Commission

Construction Forecast Data

Construction forecasts combined with BEM weather data, prototype models, and metrics allows for the calculation of statewide impacts of energy efficiency measures. Each code cycle, construction forecast data must be updated using best available data to allow for accurate projections of savings, statewide, over the lifetime of energy efficiency measures. This method is detailed in Chapter 5 of this report.

CHAPTER 2: Climate Data

California’s energy codes, dating back to 1978 and the Warren Alquist Act, specify efficiency requirements that differ based on the climate of various regions within California. For example, the envelope requirements for coastal regions differ from those for the mountainous regions. Accurate, detailed, and up-to-date climate data are critical for adopting cost-effective building standards, which includes setting performance compliance energy budgets and objective cost-effectiveness evaluations of new code change proposals.

California has several weather regions. The CEC has developed detailed maps that divide California into 16 climate zones.[15] Each climate zone represents a region of relatively uniform annual weather conditions. The climate zones were established based on historical records of average dry bulb temperature. Average dry bulb temperature was used because it serves as a good indicator of several weather factors such as cloud cover, solar radiation, and presence or absence of strong winds. Though the climate zone boundaries have undergone a few updates over the years, the climate zones have remained relatively fixed since inception.

For each climate zone, a weather location (and associated weather data) within the climate zone is identified to represent the characteristics of the climate zone. These locations are chosen to represent both mean weather and population for the climate zone. This process seeks to find a location with typical weather for a climate zone which also has a relatively dense population where construction using the new measures is most likely to occur. Representative locations are used only for code measure impact analysis; for performance compliance, the weather station nearest the project is used.

Energy accounting uses two metrics, LSC and Source Energy, that enable hourly system cost and hourly marginal source energy, which is correlated with greenhouse gas impacts, to be evaluated over long, 30-year, time horizons. These metrics are closely tied to the forecasted energy demand in California and are therefore directly tied to the weather data that is used in the demand forecasts. Thus, the weather data and the metrics are closely coupled and intended to be used together to determine the code impacts. When the underlying set of weather data is updated for a code cycle, the metrics must also be updated.

Weather data are typically updated before the start of every code development cycle. New weather data and files were generated for the 2019, 2022, and 2025 code cycles. These updates capture recent climate trends seen in the weather across California. These trends have a direct impact on the heating and cooling consumption of buildings and on the electricity and natural gas demand, thereby affecting the metrics and cost-effectiveness of measures.

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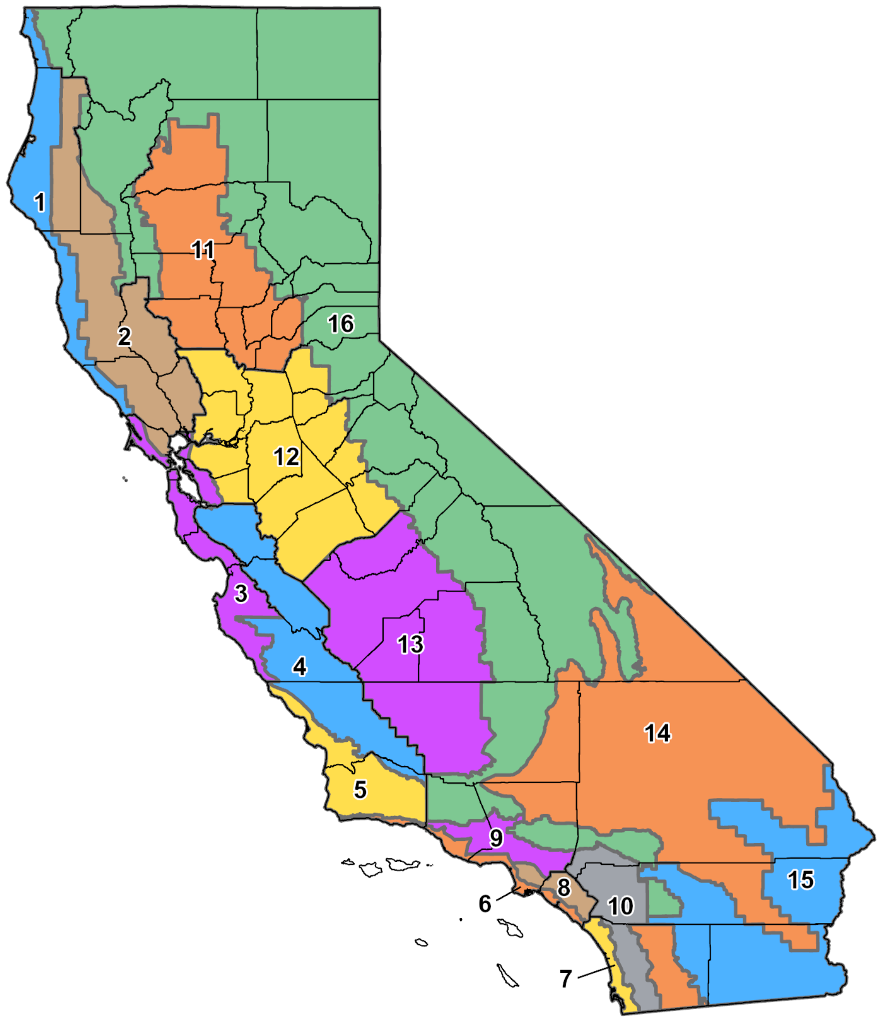
15 California Climate Zone Descriptions. 1981. California Energy Commission, Conservation Division. P-400-81-041, https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/climate-zone-tool-maps-and.

California Building Climate Zones

Figure 3 shows an overlay of building climate zones over the state map. There are 16 building climate zones, dividing the state along the lines of uniform climate patterns. The climate zones are composed mainly of coastal climates zones (1, 3, 5, 6, and 7), inland climate zones (2, 4, 8, 9, and 10), Central Valley climate zones (11, 12, 13), dry and hot climate zones (14 and 15), and mountainous climate zones (16). Detailed climate zone maps, as well as location-based climate zone mapping, are available from the CEC website.[16]

Figure 2: California Building Climate Zones Map



Source: California Energy Commission

16 California Energy Commission. "Climate Zone Tool, Maps, and Information Supporting the California Energy Code," https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/climate-zone-tool-maps-and.

Table 2 shows the weather stations chosen to represent individual climate zones for the 2025 code cycle. Representative locations for two climate zones were changed for the 2025 code cycle: Climate Zone 4 changed from San Jose to Paso Robles, and Climate Zone 6 changed from Torrance to Los Angeles International Airport (LAX). The previous weather station locations are no longer maintained by the National Weather Service and could not be used for the 2025 update. The updated weather locations still represent the climate zones, and the respective weather stations have complete data sets that will be maintained in the future.

Table 2: World Meteorological Organization (WMO) Weather Stations Representing California's 16 Climate Zones

CZ	WMO #	Weather Station Name
1	725945	Arcata Airport
2	724957	Sonoma County Airport
3	724930	Metro Oakland International Airport
4	723965	Paso Robles Airport
5	723940	Santa Maria Airport
6	722950	Los Angeles International Airport (LAX)
7	722900	San Diego International Airport
8	722976	Fullerton Municipal Airport
9	722880	Hollywood Burbank Airport
10	722869	Riverside Municipal Airport
11	725910	Red Bluff Airport
12	724830	Sacramento Executive Airport
13	723890	Fresno Yosemite International Airport
14	723820	Palmdale Regional Airport
15	722868	Palm Springs International Airport
16	725845	Blue Canyon Nyack Airport

Source: California Energy Commission

Updates to Climate Data for the 2025 Energy Code

This section briefly describes the updates to the climate data for the 2025 Energy Code. APPENDIX A: 2025 Climate Data Update details additional information on the 2025 updates. The process for developing the weather files started with a selection of the period (past years) for formulating the typical meteorological year (TMY) for a given location. For each month in the TMY file, CEC staff evaluated the weather data from every month of the selected years to determine the most representative month of the collective, or aggregated, weather conditions for that location.

The key updates to the 2025 weather data are as follows:

- The TMYs were based on the years 2000–2020 (inclusive), representing a period of 21 years. For each of the 21 years of weather data, a month-by-month analysis was performed using the standard "TMY3" procedures.[17] Starting with January, all 21 January months were investigated, and the one found to be most "typical" was selected. CEC staff repeated this process for each month to select representative monthly data for all 12 months. Because the data from adjacent months are rarely from the same year, the data were blended for 6 hours on each side of the month boundary.
- New representative weather locations were assigned for Climate Zones 4 and 6 because previous locations lacked the required data.
- Updates to weather data inevitably result in changes to modeled consumption and, in this case, led to changes in simulated cooling and heating energy for single-family residential and commercial building prototype models. These changes are due to the change in the underlying data (different years and months represented in the TMY data, and two new weather station locations) and changes in the method used to derive the weather data.
- In addition to the primary 16 California climate zone weather locations, additional weather files were generated for 117 California locations to represent locations within each climate zone (to be used for performance path compliance analysis) and 33 locations outside California (to be used as part of the metrics update to account for grid and emissions impacts from locations outside California).

17 Wilcox, S, and W. Marion. May 2008. *Users Manual for TMY3 Data Sets.* National Renewable Energy Laboratory, Golden, Colorado, https://www.nrel.gov/docs/fy08osti/43156.pdf.

CHAPTER 3: Building Energy Model Prototypes

California has nearly 14 million homes and 7.4 billion square feet of existing commercial floor area, producing a quarter of the state's greenhouse gas (GHG) emissions.[18] Reducing emissions in this sector is a vital pillar of California's climate action plan. Building energy modeling is a long-standing, industry-standard approach for determining the impact of efficiency, renewable energy, and other building measures, and it has been used in the development of California's building standards almost since inception.

An accurate representation of the building stock through representative building energy models allows analysis of energy savings measures and related impact on the building stock, which ultimately results in accurate and defensible building standards. Therefore, it is crucial to develop representative models, called "prototype models," representing the building stock for developing building standards.

CEC-established prototype models have been created using large sets of survey data. These prototypes are published by the CEC ahead of each code cycle and are integral to research versions of CEC's reference Energy Code compliance software, California Building Energy Code Compliance (CBECC) and CBECC residential (CBECC-Res). CBECC and CBECC-Res are the CEC-recommended BEM software tools for assessing energy savings of proposed code change measures. While CBECC and CBECC-Res also serve as a CEC-approved compliance software option for projects pursuing performance compliance, the prototype models are used only in the development of the Building Energy Efficiency Standards, not during project compliance.

The impact of a measure must be evaluated in terms of savings at the state level across building types and climate zones. This analysis, summarized in Chapter 5, is done by using forecasts of construction floor area by prototype and climate zone. Using the forecasted floor area, the total statewide savings from a measure can be estimated. Thus, the prototype models and the construction forecast must be tightly coupled with each other to produce accurate predictions of statewide measure savings.

Prototype Models for Measure Evaluation

Prototype models that represent the building stock have been developed for nonresidential, multifamily, and single-family buildings. Table 3 shows the nonresidential, multifamily, and single-family prototype models used for measure evaluation. These prototype models are intended to represent California's building stock, particularly the forecasted new construction stock in 2026. The prototypes cover major building categories including single-family homes, multifamily buildings, offices, retail, education (K-12 and higher), lodging, warehouses, laboratories, assembly buildings, food service, and data centers.

Prototype models have features that make them representative of the building stock. For example, the Small Office prototype has punched windows, whereas the Large Office prototype has ribbon-style windows. The Standalone Retail prototype has tall ceilings and

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rooftop heating, ventilation, and air conditioning (HVAC) units serving the spaces, whereas the Strip Mall Retail prototype has windows on just one façade (just like strip malls) and the spaces are served by split systems. The envelope, lighting, water heating, and HVAC systems of the prototype are typical of those found in the building type represented by the prototype. These variations in the building features allow measure impacts to be appropriately captured. For example, a proposed change to variable-air-volume (VAV) multizone systems would be applied to those prototypes where VAV multizone systems are typically used (Medium Office, Large Office, Secondary School, and so forth) and not to those prototypes that use other systems (Small Office, Primary School, and so forth). Measure impact can then be appropriately scaled to the state level by using forecasted construction floor area.

There are instances where a proposed code change affects certain features in a building type that are not included in the prototype. In such cases, the measure authors can adjust the prototype models, include the feature, and then evaluate the impact. An adjustment factor that accounts for the prevalence of the new building feature may be applied to scale the measure impact appropriately to the statewide level. For example, interlocking of the HVAC system with balcony door opening would be a measure that results in savings in hotels and multifamily buildings. If balcony door opening has not been included in the prototype models, it could be included as part of the measure analysis. If the measure is adopted, the new balcony door opening modeling would become part of the prototypes to be used for the next code cycle. In this way, the prototypes represent the energy efficiency components of the new Energy Code and are used in the next code development cycle.

Table 3: Description of Nonresidential Prototype Models

Prototype Name	Number of Stories	Floor Area (ft^2)	Description
Hospital	3	241,374	3-Story Hospital prototype model, identical to the DOE Hospital prototype model.
Small Hotel	4	42,554	4-story Hotel with 77 guest rooms. Window-to-wall ratio (WWR)-11%
Large Office	12	498,589	12-story + 1 basement office building with 5 zones and a ceiling plenum on each floor. WWR-40%
Medium Office	3	53,628	3-story office building with 5 zones and a ceiling plenum on each floor. WWR-33%
Laboratory	3	52,628	3-story office building with 5 zones and a ceiling plenum on each floor. WWR-33%
Small Office	3	5,502	3-story, 5 zone office building with pitched roof and unconditioned attic. WWR-24%

Prototype Name	Number of Stories	Floor Area (ft^2)	Description
Fast Food Restaurant	1	2,501	Fast food restaurant with a small kitchen and dining areas. WWR-14%. Pitched roof with an unconditioned attic.
Large Retail	1	240,000	Big-box type retail building with WWR-12% and skylight-to-roof ratio (SRR)-0.82%
Mixed-Use Retail	1	9,375	Retail building with WWR -10%. Roof is adiabatic
Standalone Retail	1	24,563	Similar to a Target or Walgreens.WWR-7% on the front façade, no windows on other sides. SRR-2.1%
Retail Strip Mall	1	9,375	Strip mall building. WWR-10%
Primary School	1	24,413	Elementary school. WWR-36%
Secondary School	2	210,866	High school and university buildings. WWR-35% and SRR-1.4%
Warehouse	1	49,495	Single story high ceiling warehouse. Includes one office space. WWR-0.7%, SRR-5%
Assembly	1	68,013	Assembly building with WWR of 19.0% equally distributed on all four facades
Data Center (Computer Room)	1	2,280	12′ ceiling, adiabatic walls and roof, internal loads from CBECC Computer Room space type. For containment, 7 tile spacing: 5 cold aisles, 4 hot aisles

Source: California Energy Commission

Table 4: Description of Multifamily Prototype Models

Prototype Name	Number of Stories	Floor Area (ft^2)	Description
Midrise Multifamily	5	113,100	88-unit building with 4-story residential plus first floor common areas. Concrete podium construction with wood framed wall construction, and flat roof. Window to Wall Ratio-0.10 (ground floor) 0.25 (residential floors). Individual space-conditioning systems and a central domestic hot-water system.
High-Rise Multifamily	10	125,400	117-unit building with 9-story residential + first-floor common areas. Concrete podium construction with steel framed wall construction, and a flat roof. window-to-wall ratio-0.10 (ground floor) 0.40 (residential floors). Individual space conditioning systems and a central domestic hot water system.
Low-Rise Loaded Corridor Multifamily	3	39,372	36-unit residential building with slab on-grade foundation, wood framed wall construction, and a flat roof. Window-to-wall ratio 0.25. Dwelling units flank central corridor and common area spaces included on bottom floor. Individual space-conditioning systems and shared DHW system.
Low-Rise Garden Multifamily	2	7,320	8-unit residential building with slab on-grade foundation, wood framed wall construction and a sloped roof. Individual space conditioning serving each unit. Window to Wall Ratio 0.15. Each dwelling unit has HVAC and DHW systems.

Source: California Energy Commission

Table 5: Description of Single-Family Prototype Models

Prototype Name	Number of Stories	Floor Area (ft^2)	Description
Single-Family	1	2,100	1-story detached single-family home with an attached garage, slab on-grade foundation, wood framed wall construction and a vented attic.
Single-Family	2	2,700	2-story detached single-family home with an attached garage, slab on-grade foundation, wood framed wall construction and a vented attic.
Single-Family Existing Home	1	1,665	1-story existing single-family house for evaluation of alteration measures. 2 variations: steep-sloped roof above attic with ducts in attic; low-sloped roof with ducts in conditioned space

Source: California Energy Commission

Updates to Prototype Models for the 2025 Energy Code

New requirements within the 2022 Energy Code were incorporated into prototypes, including updates to the envelope, lighting, equipment efficiencies, and water-heating and HVAC system types. There were substantial updates to HVAC and water-heating system types, as well as a new requirement for photovoltaic (PV) and battery storage systems for nonresidential and multifamily occupancies. The major changes include:

- Single-zone systems being changed to heat pumps (SZHP and SZVAVHP).
- Dwelling unit water heaters being changed to heat-pump water heaters (HPWH).
- The addition of heat recovery for certain qualifying systems.
- The addition of PV and battery systems.

Table 4 shows where major updates were applied to various prototypes. In addition to these updates to existing prototypes, two new prototypes with conditioned floor area were created to better represent the building stock: Assembly and Hospital. An unconditioned Open Parking Garage prototype was added because the parking garage floor area within the building stock was high and there is a substantial lighting load in unconditioned parking garages. Details about the changes to the Assembly, Hospital, Open Parking Garage, and Large School prototype are provided in the APPENDIX B: 2025 Prototype Models Update.

Table 6: Updates to Prototype Models for the 2025 Energy Code

Prototype	Envelope, Lighting, Equipment Efficiency	Single-zone heat pumps	PV	Battery	Heat Recovery	Comments
High-rise Multifamily	✓	✓	✓	✓	✓	Wood-framed residential.
Mid-rise Multifamily	✓	✓	✓	✓	✓	
Large Office	✓		✓	✓	✓	
Medium Office	✓		✓	✓		
Small Office	✓		✓	✓		
Large Retail	✓	✓	✓	✓		
Medium Retail	✓	✓	✓	✓		
Strip Mall	✓	✓	✓	✓		
Mixed-use Retail	✓	✓	✓	✓		
Large School	✓		✓	✓		
Small School	✓	✓	✓	✓		
Non-refrigerated Warehouse	✓	✓	✓	✓		Cooling was added to the Fine Storage zone.
Hotel	✓		✓	✓		
Assembly	✓	✓ (Library)	✓	✓		New prototype is a composite of several building types.
Hospital	✓					New prototype.
Laboratory	✓					Renamed from MediumOfficeLab
Restaurant	✓		✓	✓		
Open Parking Garage	✓ (Lighting)					New prototype.

Source: California Energy Commission

CHAPTER 4: Metrics

One of the principal goals of the Warren-Alquist Act is to "… minimize the cost to society of the reliable energy services that are provided by natural gas and electricity, and to improve the environment and to encourage the diversity of energy sources through improvements in energy efficiency and development of renewable energy resources…."[19] In developing and enacting building standards, an appropriate set of metrics allow the CEC to measure and quantify progress toward this principal goal of minimizing cost to society in providing reliable energy services. Simply evaluating the site kilowatt-hour (kWh) and British thermal unit (Btu) savings are not enough to address the cost to society of providing reliable energy services.

The CEC uses two metrics — Long-term System Cost (LSC) and Source Energy — to evaluate measure impacts. When a proposed code change is evaluated, it is usually modeled using the prototype models, and the LSC and Source Energy metrics are applied to the model energy consumption to calculate the LSC and Source Energy impact. The LSC is a cost metric, with units of $/kWh and $/therm for electricity and natural gas, respectively, with unique values for every hour of the year. Source Energy has units of Btu/kWh and Btu/therm for electricity and natural gas, respectively, and has unique values for every hour of the year. The metrics are used to convert site kWh and therms to dollars (LSC) and source Btus (Source Energy).

The LSC represents hourly long-term costs to the energy system over 30 years and does not represent annual utility bill savings from a measure. Similarly, Source Energy represents hourly long-term marginal source energy over 30 years. Both metrics are updated every three years and have been coupled to the weather files of the 16 representative cities, resulting in 16 sets of hourly LSC and Source Energy values. The process of developing the LSC and Source Energy metrics is described in the sections below.

Both the LSC and Source Energy metrics provide unique conversion values to every hour of the year. This approach appropriately captures the value of energy and emissions at different times of the day and at different times of the year. For example, the price of electricity is much higher on a summer evening than midday during spring. This hourly weighting enables measure impact to be quantified with respect to California's decarbonization, electrification, and emission reduction objectives and values measures that "minimize the cost to society" of providing reliable energy services at all times of the day and year.

Prior to the 2005 Building Energy Efficiency Standards, a flat (time-invariant) source energy metric was used for measure evaluation. A cost-based time-dependent metric was introduced in the 2005 Building Energy Efficiency Standards and was known as the time-dependent valuation or TDV metric until the 2022 Building Energy Efficiency Standards. TDV has been renamed to LSC for the 2025 Building Energy Efficiency Standards to more clearly signal the initially intended purpose of representing the long-term cost to the energy system. Beginning with the 2022 Standards, a second metric — Source Energy — was added to fully evaluate the

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impact a measure has in lowering long-term marginal source energy, which is correlated to emissions from generation sources.

Both LSC and Source Energy are used for Energy Code development. LSC is used in the evaluation of cost-effectiveness of proposed code changes, and new code change measures must also provide Source Energy savings. Moreover, LSC and Source Energy are used as metrics for determining compliance for projects using the performance approach. To comply with the performance approach proposed building projects must meet or exceed the LSC and Source Energy thresholds set by the standard design building.

Development of Metrics

Long-Term System Cost

A bottom-up approach is used to develop each hour's energy valuation (for gas, a monthly timescale is used). The key components of the electricity LSC factors are summarized below:

- **Marginal cost of electricity (varies by the hour):** The shape of the hourly marginal cost of generation is developed using the Commission's PLEXOS production simulation dispatch model. The price shape from the production simulation model is then adjusted to reflect the natural gas price forecast as well as the following non-energy costs of energy: transmission & distribution costs, emissions costs, ancillary services, and peak capacity costs.
- **Revenue neutrality adjustment (fixed cost per hour):** The remaining, fixed components of total annual utility costs that go into retail rates (taxes, metering, billing costs, and so forth) are then calculated and spread over all hours of the year.

For a given hour, the components of the cost of energy are summed and then scaled up such that, over a year, the values are equal to the average retail price. When the fixed-cost component is added to the hourly marginal cost of electricity, the result is an annual total electricity cost valuation that corresponds to the total electricity revenue requirement of the utilities.

While the details of the LSC method can be complex, at root, the concept of LSC is simple. It holds the total cost of energy constant at forecasted retail price levels but gives more weight to on-peak hours and less weight to off-peak hours. This means that energy efficiency measures that perform better on-peak will be valued more highly than measures that do not. To evaluate the LSC or cost benefit of a measure, each hour's electricity savings is multiplied by that hour's LSC value. As shown below, this equation yields an annual savings figure in terms of 30-year NPV dollars.

Equation 2: Annual LSC Electricity Savings

$$\text{Annual LSC Electricity Savings} = \sum_{h=1}^{8,760} \text{Electricity Savings}_h \text{ [kWh]} \times \text{LSC Factor}_h \left[\frac{\$}{\text{kWh}}\right]$$

Equation 3: Annual LSC Gas Savings

$$\text{Annual LSC Gas Savings} = \sum_{h=1}^{8,760} \text{Gas Savings}_h\ [\text{Therm}] \times \text{LSC Factor}_h \left[\frac{\$}{\text{Therm}}\right]$$

In summary, LSC factors are used to convert predicted site energy use to long-term dollar costs to California's energy system. The time-dependent nature of LSC reflects the underlying marginal cost of producing and delivering an additional unit of energy, similar to a time-of-use retail tariff. The resulting economic signal aligns energy savings in buildings with the cost of producing and delivering energy to consumers. The LSC of energy reflects a 30-year net present value cost of energy to the statewide energy system. This cost differs from a first-year utility bill in that the LSC is constructed from a long-term forecast of hourly costs, whereas the first-year utility bill reflects only today's rates.

Source Energy

Source Energy, in this application, is defined as the long-run hourly marginal source energy of fossil fuels that are combusted as a result of building energy consumption either directly at the building site or caused to be consumed to meet the electrical demand of the building considering the long-term effects of changes in Commission-projected energy resource procurement to meet future energy demand. There have been significant changes in state emissions targets and clean energy procurement policy, and the Source Energy metric takes into account these changes and how they impact the building over the long term, 30-year economic life evaluation period. This metric focuses specifically on the amount of fossil fuels that are combusted in association with demand-side energy consumption. Including this as a metric provides a pathway for state regulators to align building codes and standards with the state's environmental goals. Long-run marginal Source Energy is calculated differently for electricity, natural gas, and propane consumption, based on the planned resource changes for a given fuel.

While LSC is a financial metric, and represents the time-value of money, Source Energy is strictly defined by lifetime fossil fuel consumption of the utility system. Unlike LSC, Source Energy does not discount future years. To calculate Source Energy for a given hour, the value in that hour for each forecasted year is averaged to get a lifetime average source energy. To get lifetime source energy consumption, one simply multiplies each hour's value by the lifetime of the building (30 years in this analysis).

Equation 4: Annual Source Energy Electricity Savings

$$\text{Annual Source Energy Elect. Savings} = \sum_{h=1}^{8,760} \text{Elect. Savings}_h\ [\text{kWh}] \times \text{Source Energy Factor}_h \left[\frac{\text{Btu}}{\text{kWh}}\right]$$

Equation 5: Annual Source Energy Gas Savings

$$\text{Annual Source Energy Gas Savings} = \sum_{h=1}^{8,760} \text{Gas Savings}_h\ [\text{Therm}] \times \text{Source Energy Factor}_h \left[\frac{\text{Btu}}{\text{Therm}}\right]$$

Update to the Metrics for the 2025 Energy Code

The method of developing the 2025 LSC and Source Energy metrics was largely the same as for the 2022 code cycle; however, the assumptions used for 2025 have been updated, and these changes are described in this section.

1. **Terminology:** Updated terminology for the Energy Code cost-effectiveness metric from Time Dependent Valuation (TDV) to Long-term System Cost (LSC).
2. **Units:** Historically, an extra step was conducted at the end of the process, converting the NPV cost from a cost-per-unit energy ($/kWh and $/therm) to an energy-only unit (kBtu/kWh and kBtu/therm). For the 2025 code cycle, this step has been removed, with LSC units remaining in $/kWh and $/therm.
3. **Scenario selection:** To begin developing LSC factors, a demand scenario must be selected that includes specific strategies to achieve economywide decarbonization, which dictate sectoral emissions budgets and policy landscape. The selected demand scenario is intended to represent a realistic future scenario aligned with existing and anticipated future policy. This scenario, in turn, determines building electrification load, EV load, decarbonized gas, and renewable generation procurement for the LSC modeling.

   In the 2022 code cycle, the selected demand scenario was recently developed for a CEC-funded study *The Challenge of Retail Gas in California's Low-Carbon Future,*[20] named the "Slower Building Electrification" scenario. The selected demand scenario incorporated policies and targets including reducing greenhouse gas emissions by 80 percent from 1990 levels by 2050 ("80x50 emissions target"), and Senate Bill 100 goals of 100 percent Renewables Portfolio Standard (RPS) by 2045.

   For the 2025 code cycle, CEC staff evaluated several demand scenarios from publicly available scenario analysis, including the CEC Demand Scenarios Project, CARB Scoping Plan, Integrated Energy Policy Report (IEPR), and Low Carbon Future study. Ultimately, the CEC chose a demand scenario from the CEC Demand Scenarios Project named the "High Electrification Policy Compliance" scenario. This demand scenario is aligned with current policy and includes relatively high economywide electrification.
4. **Gas rate calculation:** In the 2022 code cycle, CEC staff took the natural gas retail price forecast from the study titled *The Challenge of Retail Gas in California's Low-*

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20 Aas, Dan, Amber Mahone, Zack Subin, Michael Mac Kinnon, Blake Lane, and Snuller Price. 2020. The Challenge of Retail Gas in California's Low-Carbon Future: Technology Options, Customer Costs and Public Health Benefits of Reducing Natural Gas Use. California Energy Commission. Publication Number: CEC-500-2019-055-F. https://www.energy.ca.gov/sites/default/files/2021-06/CEC-500-2019-055-F.pdf

Carbon Future and updated the forecast to be consistent with recent recorded rates and final 2021 IEPR wholesale natural gas prices. For the 2025 code cycle, the natural gas retail price forecast was developed using the gas throughput forecast from the "High Electrification Policy Compliance" scenario, gas revenue requirements from the latest utility general rate cases, and revenue requirement escalation rates from the *2021 IEPR*. With a high electrification demand scenario, there is a significant reduction in residential gas throughput through the gas distribution system. Fixed costs of the natural gas distribution system are spread across a smaller amount of volumetric consumption which drives up the residential gas retail rate. To ensure that residential gas retail rates did not balloon to an unrealistic degree, the CEC incorporated an 8 percent annual growth rate cap on residential gas price into the model.

5. **Building electrification load shapes:** To estimate the impacts of new building electrification loads in the 2022 code cycle, the CEC created load shapes by performing parametric building simulations, using the prototype models included with CBECC and CBECC-Res. For the 2025 code cycle, the CEC created load shapes using aggregate end-use load profiles from NREL's ResStock and ComStock databases. This method adequately incorporates load diversity and, therefore, provides a more accurate aggregate load profile than what was used in the 2022 code cycle.
6. **Vehicle electrification load shapes:** In the 2022 code cycle, the CEC produced aggregated regionally specific load shapes for personal light-duty electric vehicles and then scaled them by EV adoption forecasts for California. For the 2025 code cycle, to generate hourly incremental electrification loads on the grid, EV load shapes were used from the *2021 IEPR*[21], which provides hourly electric load from charging electric vehicles across California from 2021 to 2035. Due to the IEPR data being limited to 2035, it was assumed that EV load shapes remain the same for all years after 2035.
7. **Marginal capacity resource:** Generation capacity avoided costs are calculated based on the estimated value of a marginal generation capacity resource. The 2022 LSC analysis considered a combustion turbine to be the near-term marginal capacity resource, transitioning to a combination of renewable generation and energy storage by the late 2020s, and to existing combined-cycle gas turbines beyond 2030. In the 2025 LSC, the marginal generation capacity resource is determined to be a battery storage resource in the near term and midterm.
8. **Retail rate adder time dependence:** For the 2022 code cycle, 15 percent time dependence of the retail rate was used for residential and nonresidential LSC factors. For the 2025 code cycle, residential LSC factors will maintain a retail rate adder time dependence of 15 percent, while nonresidential LSC factors will increase retail rate adder time dependence to 25 percent to better align with future TOU rates.

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[21] Javanbakht, Heidi, Cary Garcia, Ingrid Neumann, Anitha Rednam, Stephanie Bailey, and Quentin Gee. 2022. Final 2021 Integrated Energy Policy Report, Volume IV: California Energy Demand Forecast. California Energy Commission. Publication Number: [CEC-100- 2021-001-V4](). https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2021-integrated-energy-policy-report.

CHAPTER 5: Construction Forecast Data

To calculate the statewide impact of a proposed measure, the measure applicability to prototype models and climate zones must be evaluated. Unit savings from each prototype and climate zone can then be scaled in proportion to the forecasted construction floor area of the prototypes in each climate zone. Assessing the impact of a measure at the state level allows comparison with other measures, enables prioritization of measures with the largest savings, and provides a convenient method to track progress toward the state's broader goals.

To calculate the statewide impact, a forecast of building floor area is needed. This type of building floor area forecast is needed across several Divisions within the CEC for various policy-making analyses, such as the Integrated Energy Policy Report (IEPR), as well as for building energy benchmarking and other purposes. Therefore, the CEC develops this forecast and makes it available so that the same assumptions of future building floor area are used across various Divisions within the CEC. The CEC's Demand Analysis Office (DAO) is responsible for developing this forecast. The forecast is developed using Dodge Data Analytics[22] (Dodge) permits data coupled to econometric models of major building categories. A range of economic scenarios are evaluated, resulting in three major forecast scenarios: low, mid, and high. The "mid" scenario forecast is used in Energy Code accounting; this scenario is also used in the IEPR.

The DAO forecast is binned into building categories deemed appropriate for the DAO's forecasting. For standards development, the building categories within the DAO forecast must be mapped to prototype models so they can be used for measure evaluation and other analyses. This process of mapping the DAO forecast to prototypes used in Energy Code accounting is key. The 2025 update to the construction forecast focused on updating the mapping of prototypes to DAO building categories. While the forecast provides data several years into the future, measure impact is calculated in the year of Energy Code adoption (for example, 2026 for the 2025 Energy Code).

Construction Forecast Data

Table 7 and Table 8 show floor area for new and existing commercial buildings, respectively, by prototype and climate zone. Table 9 and Table 10 show the multifamily new construction starts and existing buildings by prototype and climate zone. Table 11 shows the single-family new construction starts and existing building stock by climate zone. These data are used in Energy Code accounting to scale unit savings from a given prototype and climate zone to the statewide savings estimate.

[22] 2022 Dodge Data Analytics *Construction Starts Data 1968-2020.*

Table 7: 2026 Forecasted Nonresidential New Construction Floor Area

New Construction Floor Area [Millions of Square Feet]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Climate Zone	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Prototype	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Large Office	0.000	0.000	3.234	1.578	0.000	1.422	0.825	2.288	4.152	0.392	0.109	0.575	0.000	0.200	0.013	0.050
Medium Office	0.130	0.476	1.372	0.744	0.371	1.201	0.805	1.646	3.184	1.174	0.269	2.799	0.586	0.348	0.263	0.102
Small Office	0.013	0.437	0.187	0.020	0.064	0.148	0.234	0.159	0.360	0.417	0.093	0.544	0.385	0.044	0.105	0.033
Large Retail	0.000	0.000	1.097	0.550	0.149	0.698	0.375	0.832	1.664	0.633	0.300	1.303	0.356	0.144	0.180	0.055
Medium Retail	0.084	0.348	0.795	0.446	0.086	0.603	0.286	0.864	1.424	0.822	0.142	0.627	0.379	0.180	0.124	0.081
Strip Mall	0.001	0.154	0.504	0.226	0.007	0.563	0.488	0.986	1.065	1.345	0.072	0.593	0.325	0.321	0.100	0.060
Large School	0.006	0.127	0.876	0.442	0.036	0.594	0.608	0.905	1.421	0.854	0.355	1.152	0.615	0.166	0.086	0.068
Small School	0.067	0.270	0.457	0.229	0.140	0.316	0.294	0.352	0.658	0.348	0.099	0.776	0.303	0.107	0.037	0.045
Non-ref. Warehouse	0.062	0.367	2.160	1.118	0.178	1.363	0.711	1.948	3.010	1.360	0.632	2.844	0.820	0.362	0.367	0.138
Hotel	0.036	0.215	1.033	0.531	0.110	0.553	0.482	0.784	1.183	0.572	0.153	0.803	0.256	0.138	0.125	0.044
Assembly	0.010	0.394	1.583	0.557	0.059	0.787	0.799	1.431	1.824	1.144	0.167	1.414	0.304	0.245	0.118	0.084
Hospital	0.029	0.175	0.842	0.436	0.080	0.329	0.549	0.441	0.789	0.813	0.146	0.825	0.273	0.142	0.115	0.048
Laboratory	0.001	0.053	0.631	0.363	0.021	0.073	0.053	0.102	0.121	0.062	0.008	0.050	0.010	0.011	0.006	0.004
Restaurant	0.014	0.083	0.327	0.167	0.034	0.337	0.204	0.493	0.819	0.413	0.071	0.314	0.141	0.102	0.047	0.030

New Construction Floor Area [Millions of Square Feet]	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Climate Zone	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Prototype	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Encl. Parking Garage	0.000	0.009	1.830	1.245	0.005	2.585	0.706	2.265	1.527	0.051	0.002	0.041	0.003	0.015	0.004	0.007
Open Parking Garage	0.002	0.118	2.474	1.682	0.059	3.648	1.201	3.197	2.155	0.654	0.021	0.532	0.038	0.197	0.048	0.094

Source: California Energy Commission

Table 8: 2026 Forecasted Nonresidential Existing Construction Floor Area

Existing Const. Floor Area [Millions of Square Feet]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Climate Zone	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Prototype	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Large Office	0.13	3.10	139.80	72.35	1.83	99.54	72.71	162.60	303.10	58.48	2.61	78.61	9.26	20.27	4.43	4.66
Medium Office	3.38	30.99	78.79	42.28	13.32	47.81	43.87	59.11	86.34	66.69	16.94	101.70	25.18	13.33	10.25	4.06

Existing Const. Floor Area [Millions of Square Feet]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Climate Zone	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Prototype	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Small Office	4.18	12.75	22.19	11.33	7.50	13.22	8.52	13.28	20.88	24.43	10.60	43.94	21.47	4.99	6.18	2.68
Large Retail	1.00	8.67	58.68	26.90	4.20	31.96	25.34	43.46	66.53	53.31	11.40	58.16	22.51	10.91	9.40	3.21
Medium Retail	1.18	13.11	44.52	25.74	5.43	44.27	34.66	66.72	108.20	66.89	10.37	60.50	24.15	15.53	8.77	5.17
Strip Mall	3.34	9.84	37.42	18.43	5.10	40.23	28.29	55.76	83.70	66.92	12.25	48.37	24.18	15.27	8.70	4.59
Large School	0.76	8.02	34.83	13.95	2.07	28.37	22.54	42.91	73.58	56.01	10.13	53.38	26.41	12.06	7.62	3.59
Small School	2.23	11.13	25.57	9.98	6.06	25.69	14.96	34.44	54.31	33.03	13.50	42.08	23.44	8.72	4.25	3.65
Non-ref. Warehouse	3.33	20.22	108.30	53.43	9.80	89.98	51.48	128.40	207.30	182.70	33.73	148.30	51.08	38.87	29.05	11.63
Hotel	1.77	10.52	48.10	24.73	5.01	30.49	32.66	41.97	66.01	37.09	7.22	40.53	13.08	8.01	5.88	2.44
Assembly	4.33	18.18	91.34	45.06	6.59	57.25	40.90	89.14	120.20	91.75	16.35	69.72	30.13	18.95	11.83	6.44
Hospital	1.87	11.09	48.33	24.67	5.06	28.25	27.15	40.77	69.88	39.60	11.11	53.18	22.49	8.80	5.03	3.23
Laboratory	0.18	4.01	36.93	28.06	1.53	12.21	17.19	15.61	19.31	10.81	0.68	12.14	4.40	1.72	0.39	0.57

Existing Const. Floor Area [Millions of Square Feet]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Climate Zone	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Prototype	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Restaurant	0.61	3.62	14.72	7.49	1.55	16.46	10.73	23.78	40.00	32.41	3.52	16.95	7.74	6.86	3.45	1.90
Encl. Parking Garage	0.02	0.54	40.71	30.94	0.30	29.15	20.67	58.41	72.53	2.67	0.35	3.09	0.49	0.85	0.17	0.43
Open Parking Garage	0.22	7.02	55.03	41.82	3.86	41.14	35.17	82.44	102.40	34.57	4.46	39.96	6.31	11.05	2.16	5.62

Source: California Energy Commission

Table 9: Multifamily New Construction Housing Unit Projections by Climate Zone

CZ	Low-Rise Garden Style	Low-Rise Loaded Corridor	Mid-Rise Mixed Use	High-Rise Mixed Use
1	11	87	154	13
2	63	519	912	79
3	305	2518	4425	382
4	159	1312	2306	199
5	28	233	409	35
6	135	1112	1955	169
7	145	1196	2101	181
8	190	1564	2748	237
9	445	3671	6452	556
10	157	1297	2279	197
11	45	370	651	56
12	253	2091	3674	317
13	74	610	1072	92
14	34	277	487	42
15	22	181	317	27
16	14	112	197	17
TOTAL	**2,079**	**17,149**	**30,140**	**2,598**

Source: California Energy Commission

Table 10: Multifamily Existing Building Stock Estimates by Climate Zone

CZ	Low-Rise Garden Style	Low-Rise Loaded Corridor	Mid-Rise Mixed Use	High-Rise Mixed Use
1	6,850	3,083	3,083	4,110
2	40,688	18,310	18,310	24,413
3	212,036	95,416	95,416	127,221
4	111,414	50,136	50,136	66,848
5	17,926	8,067	8,067	10,756
6	126,314	56,841	56,841	75,788
7	116,722	52,525	52,525	70,033
8	195,735	88,081	88,081	117,441
9	434,680	195,606	195,606	260,808
10	126,554	56,949	56,949	75,932
11	32,728	14,728	14,728	19,637
12	182,106	81,948	81,948	109,264
13	61,619	27,729	27,729	36,972
14	31,657	14,246	14,246	18,994
15	16,013	7,206	7,206	9,608
16	11,002	4,951	4,951	6,601
TOTAL	**1,724,043**	**775,819**	**775,819**	**1,034,426**

Source: California Energy Commission

Table 11: Single-Family New Construction Starts and Existing Buildings by Climate Zone

CZ	New Construction Starts	Existing Buildings
1	266	43,798
2	1,579	260,224
3	6,072	963,408
4	3,056	489,254
5	613	95,423
6	3,227	589,387
7	2,584	488,748
8	4,813	913,789
9	6,643	1,237,621
10	8,676	1,043,549
11	2,509	317,948
12	9,717	1,275,153
13	4,286	612,938
14	1,658	236,635
15	1,653	168,190
16	699	92,126
TOTAL	**58,052**	**8,828,191**

Source: California Energy Commission

Updates to Construction Forecast for the 2025 Energy Code

The DAO analysis is based on econometric models and bins the forecast into broad building categories. As done in previous code cycles, forecast building categories were mapped to prototype models. For the 2025 code cycle, the method of mapping the DAO forecast to building prototypes was significantly improved by directly mapping building permit data to the prototypes. This resulted in a more accurate representation of building construction in California and more accurate statewide savings estimates. This method and the resulting new construction forecast are described below.

The DAO forecast is based on historical construction starts data from Dodge (Dodge, 2022). The new mapping approach started with mapping the construction starts data from Dodge to building categories directly related to prototype models. The construction starts data have location information specified at the county level, which was used for mapping the county data to climate zones. Finally, the construction starts-to-prototype mapping was combined with the total forecasted square footage by building category from the DAO forecast to develop the final forecasted square footage by prototype and climate zone. Dodge new construction starts data from 1968 to 2021, national nonresidential building prototype analysis developed by Pacific Northwest National Laboratory, population data from the U.S. Census Bureau, and the DAO forecast were the primary data sources used for this construction forecast update.

The following steps describe the process of developing the forecast using the new approach:

1. **Mapping construction starts to prototypes.** Dodge permits data include a "structure code" that identifies the type of building that is being permitted. These structure codes have brief titles and descriptions and serve as the primary mapping mechanism for mapping from construction starts to building prototypes. Upon examining data, it was found that nearly all the raw construction starts data could be grouped into 17 building types. (See APPENDIX B for more details.)
2. **Mapping construction starts location to California climate zones.** Using tools available from the CEC, a mapping of counties and zip codes into California climate zones (CZ) was created. A single county may contain several CZs. The CEC used population data by zip code from the U.S. Census Bureau to distribute the floor area to CZs within counties. Using this mapping, the floor area for each record in the Dodge data was apportioned to CZs.
3. **Incorporating the 2026 DAO Forecast.** The DAO forecast is the standard to be used for all CEC forecasts. Therefore, the objective for developing the forecasted construction floor area for 2026 was to use the improved construction starts-to-prototype mapping together with the total DAO forecasted floor area. The forecasted floor area for 2026, the first year the 2025 code will be in effect, was used for all building types except parking garages and certain manufacturing building categories. Dodge's building stock database and new construction starts were used to forecast parking garages and certain types of manufacturing. See APPENDIX B for more details.

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GLOSSARY

Term	Definition
Dry-bulb temperature	Temperature of an ordinary thermometer when exposed to atmospheric air and shielded from solar radiation.
Climate zones	The 16 geographic areas of California for which the Commission has established typical weather data, prescriptive packages and energy budgets. Climate zones are defined by ZIP code and listed in Reference Joint Appendix JA2. FIGURE 100.1-A is an approximate map of the 16 Climate Zones.
Compliance approach	Any one of the allowable methods by which the design and construction of a building may be demonstrated to be in compliance with Part 6. The compliance approaches are the performance compliance approach and the prescriptive compliance approach. The requirements for each compliance approach are set forth in Section 100.0(e)2 of Part 6.
Energy budget	The maximum energy consumption, based on Long-term System Cost (LSC) and Source Energy, that a proposed building, or portion of a building, can be designed to consume, calculated using Commission-approved compliance software as specified by the Alternative Calculation Method Approval Manual. The Energy Budget for newly constructed, low-rise residential buildings is expressed in terms of the Energy Design Rating.
Long-term System Cost (LSC)	The present value of energy costs over a 30-year period for California's energy systems. LSC does not represent a prediction of individual utility bills.
Performance approach	Compliance approach using an energy budget in terms of LSC and Source Energy. Using this approach, a proposed building complies if the energy budget for the proposed design building is no greater than the standard design building.

Term	Definition
Prescriptive approach	Compliance approach where each component of the proposed building must meet a prescribed minimum efficiency or design characteristic. This approach offers little flexibility but is easy to use. If the design fails to meet even one requirement, then the system does not comply with the prescriptive approach.
Proposed design	A building that is simulated by Commission-approved compliance software to determine the energy consumption resulting from all of the characteristics and energy consuming features that are actually proposed for a building, as specified by the Alternative Calculation Method (ACM) Approval Manual.
Source Energy	The long-run hourly marginal source energy of fossil fuels that are combusted as a result of building energy consumption either directly at the building site or caused to be consumed to meet the electrical demand of the building considering the long-term effects of changes in Commission-projected energy resource procurement to meet future energy demand.
Standard design or baseline building	A building that is automatically simulated by Commission-approved compliance software to establish the Energy Budget that is the maximum energy consumption allowed by a Proposed Design Building to comply with the Title 24 Building Energy Efficiency Standards. The Standard Design building is simulated using the same location and having the same characteristics of the Proposed Design building, but assuming minimal compliance with the mandatory and prescriptive requirements that are applicable to the proposed building, as specified by the Alternative Calculation Methods Approval Manual.
Time-dependent valuation (TDV) energy	The time-varying energy caused to be used by the building to provide space conditioning and water heating and for specified buildings lighting. TDV energy accounts for the energy

Term	Definition
	used at the building site and consumed in producing and in delivering energy to a site, including, but not limited to, power generation, transmission, and distribution losses.

APPENDIX A: 2025 Climate Data Update

Changes to Method Compared to Previous Update

Some important changes to the weather data development process were made during this current round of updates. Those changes are presented here and discussed in later sections of this report to help explain differences in simulation results between the 2025 and earlier weather data sets.

New Weather Stations for Climate Zones 4 and 6

As previously discussed, Climate Zones 4 and 6 are now represented by different weather station data. While the new locations still represent the climate zones and similar on average, there are significant differences in hour-by-hour data between the previous and current weather stations.

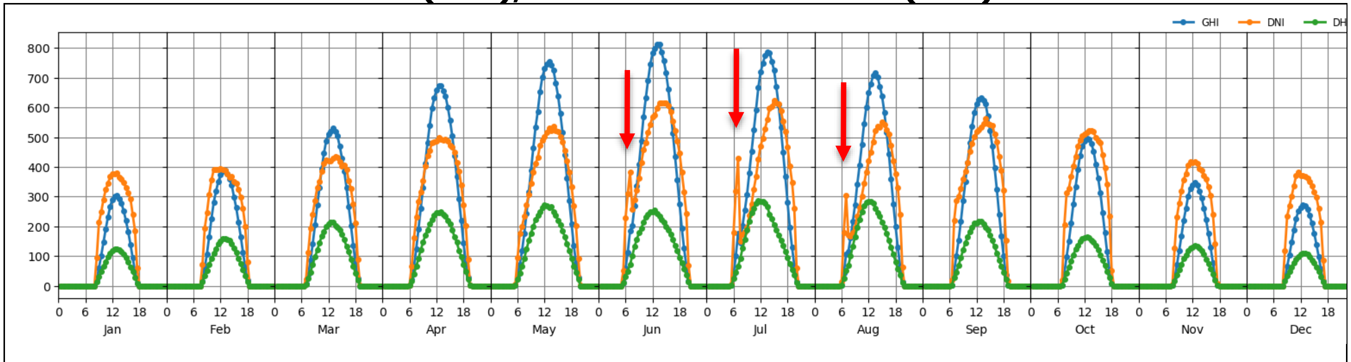
Updates to Solar Data

During the previous round of weather data update (for the 2022 Standards), CEC staff recognized that the solar data (PSM v3) misrepresented conditions in coastal locations for high zenith (near sunrise or sunset). Because of the difficulty of retrieving accurate cloud information for these zeniths, the PSM assumes clear-sky solar conditions during early morning in these locations. This assumption results in an anomalously high solar radiation as coastal California locations often see early morning fogs during the summer months. In the later morning hours, the PSM is better able to resolve clouds. When plotting the average conditions at a given coastal location, this data quirk is seen as an early morning "spike" in solar radiation. (See Figure 2[a]). While this quirk was identified and addressed in the previous 2022 update, CEC staff has refined the method.

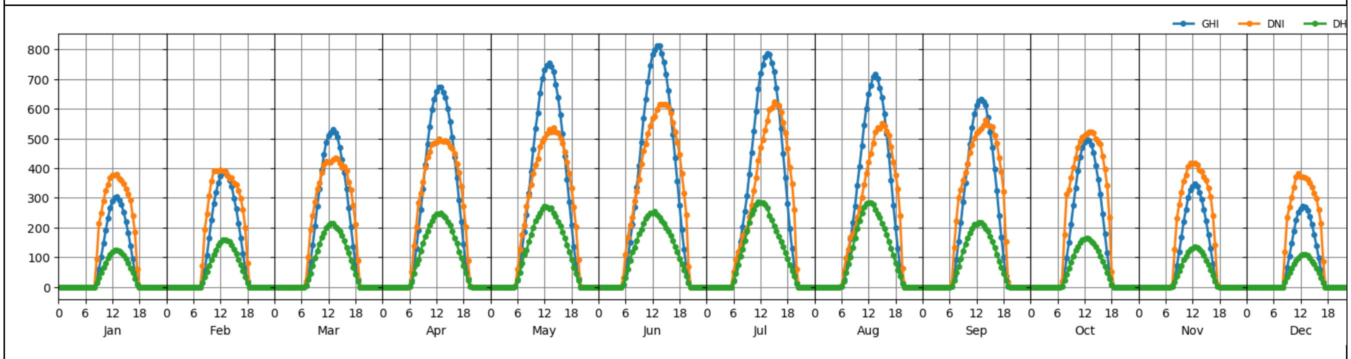
To correct these early morning conditions, CEC staff first examined the average conditions for each station. If there was a visible solar radiation spike, this station was flagged for further attention. Each day's early morning solar radiation was examined in the early hours and compared to late morning. If early morning showed clear-sky while late morning showed clouds, staff corrected the early morning clear-sky conditions, assuming the same level of cloudiness. Algorithmically, the late morning all-sky to clear-sky global horizontal irradiance (GHI) ratio was transferred to the early morning. Multiplying this ratio by the early morning clear-sky GHI resulted in a new early morning all-sky GHI. Using a standard direct-diffuse splitting scheme, the direct and diffuse components of early morning all-sky solar radiation were determined.

For comparison, the uncorrected and correction average solar conditions are shown in Figure A-1.

Figure A-1: Average Monthly Solar Irradiance Values of Global Horizontal (GHI), Direct Normal (DNI), and Diffuse Horizontal (DHI) for Arcata



(a) Raw PSM v3 (uncorrected)



(b) Corrected

Note the early morning spikes in June, July, and August

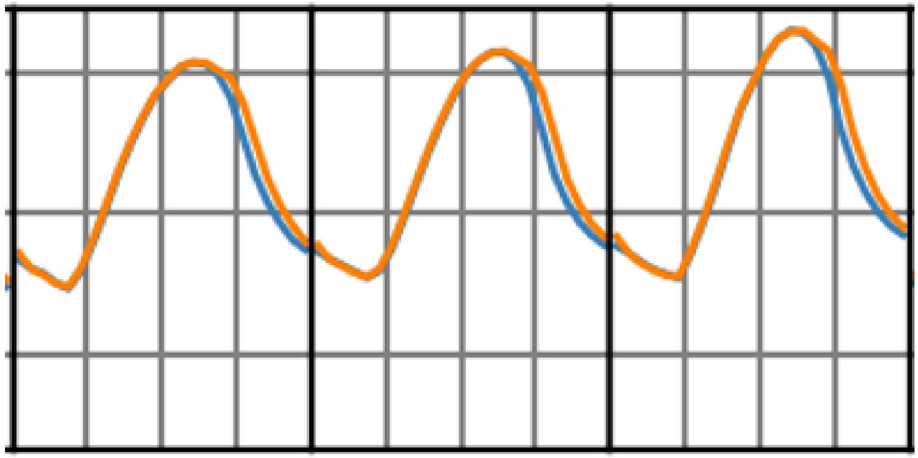
Source: California Energy Commission

Fixes to Data Errors in Previous Weather Data

CEC staff made two key corrections to the processing of weather data:

- For some stations and some years, CEC staff discovered additional cloud cover information in NOAA's Integrated Surface Database (ISD), which was not available in the 2022 update. This additional cloud cover information affects the representation of longwave (infrared) radiation, important especially during nighttime cooling.
- The previous set of hourly data was improperly "shifted" such that peaks occur slightly later and warmer temperatures last slightly longer compared to the new data. This shift can be seen in Figure 4, where the old method is shown plotted with an orange line and the new method is shown in blue. CEC staff corrected this issue during the update.

Figure A-2: Climate Zone 12 Average Hourly Dry-Bulb Temperature (June, July, August)



Source: California Energy Commission

Fixes to Infilling Missing Data

Some years and months from the collection of historical weather data have missing meteorological information. For this update, a custom-made system was developed to "infill" the time series:

- Reanalysis: An alternative time series, representative of an approximately 25×25-kilometer region near a given station, was extracted from the ERA5 reanalysis.[23] A reanalysis is simply a weather model that has been rerun for historical weather but has been constrained to better fit all available observational data. The result is a long-term, hourly, physically consistent, representation of the global atmosphere for previous years. However, any reanalysis suffers from error, largely in a warm or cold bias or misrepresentation of the daily cycle.
- Learning: The reanalysis time series is compared to the available hourly observational station data to build a "model" that can transfer reanalysis information to the station. This model aims to eliminate any bias inherent in the reanalysis, that is, "bias correction."
- Application: The bias correction model is applied to the reanalysis for all the missing hours in the original observational time series, resulting in a 100 percent complete time series.

23 Hersbach, Hans, Bill Bell, Paul Berrisford, Shoji Hirahara, András Horányi, Joaquín Muñoz-Sabater, Julien Nicolas, et al. "The ERA5 Global Reanalysis." *Quarterly Journal of the Royal Meteorological Society 146*, No. 730 (July 2020): 1999–2049. https://doi.org/10.1002/qj.3803.

APPENDIX B: 2025 Prototype Models Update

Prototype Model Data Sources

The major data sources used for the analysis were as follows:

1. Construction starts: Dodge Data Analytics' (Dodge) new construction starts data (CAS) consists actual permits pulled for new construction within a given month. The CAS data extend from 1968 to 2021, with 2020 being the final full year of data. CAS data cover a wide variety of residential and nonresidential buildings.
2. National construction weighting factors: Weighting factors for nonresidential building prototype analysis were developed by Pacific Northwest National Laboratory . PNNL used a subset of Dodge data at the national level, and some of the techniques and derivations developed in the report were used as the basis of assumptions in this analysis.
3. U.S. Census Bureau: Population data from the U.S. Census Bureau (U.S. Census Bureau 2020) were used to perform mapping between construction starts data by county to the California climate zones. This process is described below.
4. DAO forecast: The forecast from the DAO serves as the primary construction forecast used in various analysis by the CEC. It was important that the final construction floor area by building category and climate zone matched this DAO forecast.

Data Mapping

Construction Starts to Prototypes

Each entry in the construction starts (CAS) data from Dodge represents a new permit issued for the construction of a building. Each entry has various pieces of information associated with it, including the square footage, number of stories, county location, whether it is a new project, addition, or alteration, and so forth. Also included is a "structure code" that identifies the type of building that is being permitted. These structure codes have brief titles and descriptions and serve as the primary mapping mechanism for mapping from construction starts to building prototypes.

Table 1 shows the mapping of CAS structure codes (STC) to "forecast building types." Each of these forecast building types, in all but a few instances, is directly mapped to a single prototype. In the few instances where a building type listed in Table 1 is not directly mapped to a prototype, the prototype situation is one of the following:

- The prototype does not exist because the forecasted floor area is too small, or the impact was not considered significant by consensus of the CEC and stakeholders (for example, Vehicle Service).
- The prototype is part of other prototypes (that is, Enclosed Parking Garage is represented in the mid- and high-rise multifamily prototypes).
- The floor area is being mapped to the Miscellaneous category.

In some instances, the STC names were insufficient in categorizing the building type for this analysis, and the NORESCO team discussed such items with Dodge staff to understand the building type and define the mapping. Upon examining data, it was found that nearly all the raw construction starts data could be grouped into 17 building types.

A few key mapping approaches are described below:

- Building subcategories: PNNL's national construction forecast analysis and the *2022 Alternative Compliance Manual (ACM)* (California Energy Commission 2022) rules were used in certain instances to bin broad building types into subcategories by floor area and number of stories. For example, offices were split into large, medium, and small office building types based on system type floor area thresholds in the ACM and number of story thresholds from the PNNL analysis.
- Controlled environment horticulture (CEH) has been identified as a growing building sector. In conversations with Dodge, construction post-1996 in the Animal/Fish/Plant Facilities STC Name Category was assigned to CEH. The year 1996 was chosen as the cutoff because it was the year medicinal cannabis use was legalized in California.
- The Mixed-Use Retail prototype was not forecasted. In conversations with Dodge staff, it was determined that it would not be possible to separate mixed-use retail properties from other retail properties within the available data package.
- Parking garages were not part of the analysis in the past, but the statewide floor area was found to be significant enough such that even small per-unit-area savings could translate to notable statewide savings and were therefore added to the forecast.
- Unassigned category: Armories/Military Buildings are not subject to Title 24 and were classified to an unassigned category.

Table B-1: Mapping of Dodge CAS Data to Forecast Building Types

Forecast Building Types	Dodge STC Names	Number of Stories	Floor area [ft^2]	Notes
Assembly	*Arenas/Coliseums (Non-School/Univ); *Auditoriums (Non-School/College); *Railroad Terminals; *Religious Bldgs. now in STC 53; 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	Any	Any	
Controlled-environment Horticulture	Animal/Fish/Plant Facilities	Any	Any	Only construction in this category after 1996 is included. According to Dodge, recent construction in this STC is almost entirely due to controlled-environment horticulture. 1996 was the year that California legalized medicinal cannabis use.
Hospital	Hospitals, Clinics/Nursing Convalescent Facilities	Any	Any	
Hotel	Hotels/Motels 1-3 Stories, Hotels/Motels 4+ Stories, Hotels/Motels (Stories Unknown or Alts)	Any	Any	
Laboratory	Laboratories/Testing/R&D	Any	Any	

Forecast Building Types	Dodge STC Names	Number of Stories	Floor area [ft^2]	Notes
Large Office	Offices, 4+ stories; *Offices and Banks/Financial Bldgs. (incl all owner); Banks/Financial, 1-3 stories; Banks/Financial, 4+ stories; Capitols/Court Houses/City Halls; Police/Fire Stations; Post Offices	≥ 5	if no Story data in Dodge, then if the floor area is ≥ 150k sf it is Large Office	5 stories is the boundary used by PNNL between Large and Medium Offices . The alternative boundary of 150k sf is taken from the changes in system mapping for offices and other spaces in the 2022 NR ACM (California Energy Commission 2022).
Medium Office	Offices, 1-3 stories; Offices, 4+ stories; *Offices and Banks/Financial Bldgs. (incl all owner); Banks/Financial, 1-3 stories; Banks/Financial, 4+ stories; Capitols/Court Houses/City Halls; Police/Fire Stations; Post Offices	2 - 4	if no story data in Dodge, then if the floor area is ≥ 25k and < 150k then it is Medium Office	2 - 4 stories is the range used by PNNL for Medium Offices . The boundaries of 25k and 150k sf are taken from the changes in system mapping for offices and other spaces in the 2022 NR ACM.

Forecast Building Types	Dodge STC Names	Number of Stories	Floor area [ft²]	Notes
Small Office	Offices, 1-3 stories; Offices, 4+ stories; *Offices and Banks/Financial Bldgs. (incl all owner); Banks/Financial, 1-3 stories; Banks/Financial, 4+ stories; Capitols/Court Houses/City Halls; Police/Fire Stations; Post Offices	1	if no story data in Dodge, then if the floor area is < 25k then it is Small Office	1 story is the boundary used by PNNL for Small Offices. The boundaries of 25k and 150k sf are taken from the changes in system mapping for offices and other spaces in the 2022 NR ACM.
Restaurant	Food/Beverage Service	Any	Any	
Large Retail	Stores; *Stores and Other Mercantile Bldgs.	Any	≥ 50k	The average Target is around 130k sf, Home Depot is 105k sf.
Medium Retail	Stores; *Stores and Other Mercantile Bldgs.	Any	< 50k	Assumption. The average Walgreens is around 13.5k sf. See Grocery for how this type is split.
Grocery	Stores; *Stores and Other Mercantile Bldgs.	Any	< 50k	Used PNNL's ratio of Supermarket to Medium Retail by IECC climate zone. Mapped IECC CZs to CA CZs, then applied same ratio to CA.
Strip Mall Retail	Shopping Centers	Any	Any	

Forecast Building Types	Dodge STC Names	Number of Stories	Floor area [ft^2]	Notes
Large School	Primary Schools; *Schools-Educational/ Science bldgs.; *Sunday Schools now in STC 53; Colleges/Universities Except Community; Community Colleges; Junior High Schools; Senior High Schools; Special Schools; Vocational Schools	Any	≥ 50k	
Small School	Primary Schools; *Schools-Educational/ Science bldgs.'; *Sunday Schools now in STC 53; Colleges/Universities Except Community; Community Colleges; Junior High Schools; Senior High Schools; Special Schools; Vocational Schools	Any	< 50k	
Warehouse	Warehouses (Non-Refrigerated); *Freight Terminals, Air; *Freight Terminals, Marine; *Freight Terminals, Trucks; Freight Terminals, Truck Rail and Marine	Any	Any	
Refrigerated Warehouse	Refrigerated Warehouses	Any	Any	
Vehicle Service	Aircraft Service; Auto Service; Bus and Truck Service; Railroad/Boat/Other Vehicle Service; *Truck Service	Any	Any	
Manufacturing	All 88 STCs beginning with "Mfg."	Any	Any	

Forecast Building Types	Dodge STC Names	Number of Stories	Floor area [ft^2]	Notes
Enclosed Parking Garage	Parking Garages	Any	Any	Split with Open Parking Garage is based on publicly available parking garage data[24]
Open Parking Garage	Parking Garages	Any	Any	Split with Enclosed Parking Garage is based on publicly available parking garage data[24]
Miscellaneous	Miscellaneous Non-Residential Buildings, Communications Buildings, Animal/Fish/Plant Facilities before 1996	Any	Any	
Unassigned	Armories/Military Buildings,	Any	Any	Not subject to T24

Source: California Energy Commission

[24] Parkopedia: https://en.parkopedia.com/

2026 Forecast

The DAO forecast is the standard that is to be used for all CEC forecasts. Therefore, the objective for developing the forecasted construction floor area was to use the improved construction starts-to-prototype mapping together with the total forecasted floor area by the DAO. The DAO forecasted floor area for 2026, the first year the 2025 code will be in effect, was used for all building types except parking garages and certain manufacturing building categories. Dodge's building stock database and new construction starts were used to forecast parking garages and certain types of manufacturing.[25]

The DAO forecast also uses the same Dodge CAS database and because the forecast building types (developed here) and the DAO building categories both mapped to the STCs, there was a correspondence between the DAO building categories and the forecast building types. However, the correspondence was not one-to-one. As described, the DAO analysis groups STCs into broad building categories appropriate for an econometric model, and this grouping is different from the forecast building types developed here that are suitable for code analysis.

To map the DAO forecasts into forecasted building types, the following steps were taken:

1. The proportions of CEC forecasted building types within DAO forecast building types were calculated using common aggregate groups. For example, the annual new construction square footage for the small, medium, and large office forecast building types were averaged from 2014 to 2020 for new construction. For existing buildings, annual new construction square footage was summed for the entire database (1968 through 2021). These results were then totaled into an office aggregate. It was then possible to calculate the percentage make up of small, medium and large office within that single office aggregate group.
2. The DAO's square footage for 2026 for its large and small office[26] for new construction and existing building were then also summed into a single office aggregate group. This 2026 Office forecast was multiplied by the percentages of small, medium, and large office from the previous calculation to calculate the small, medium, and large office 2026 forecast for new construction and existing buildings.
3. For the parking garage and certain manufacturing building types, Dodge's building stock database (BSD) was used. The BSD database forecasts to 2025. However, it contains building stock data and not new construction starts. To calculate new construction starts, a year over year change could be calculated. But this year-over-year change would also include demolitions and conversions. Conversions were not accounted for

[25] DAO forecasts use a multi-variable econometric model for forecasting. The BSD database estimate involves a benchmark of existing building activity which is then updated over time based on new Dodge construction starts lagged to building completion along with an estimated removal/conversion rate for any demolition or conversion to an alternative building end use. The initial benchmark was established using multiple government sources (U.S Census, U.S. Department of Energy) along space requirement estimates. Space requirement estimates cover student enrollment along with space per pupil, employment data, along with other population-based information.

[26] The DAO's criteria for Large and Small Office meant that buildings that the CEC forecast would consider Medium Office fell into both the DAO's Large and Small Office building types.

because it was assumed that parking garages and manufacturing plants do not often convert into other building types, nor vice versa.

To account for demolitions, a demolition rate was calculated. Completed constructions from Dodge's construction completions database were subtracted from the year over year changes from BSD. This gave the square footage of demolitions for that year. That square footage was then divided by the total building stock to create a demolition rate. For example, according to BSD, in 2017 in CZ 2 there was an increase in the building stock of about 220,000 sf for parking garages. But the CASC database showed that in fact around 240,000 sf of parking garage area was constructed in 2017 in CZ 2. So, there was a net of 20,000 sf that were demolished in 2017. There were 6,740,000 square feet of parking garages at the end of 2016. This would give a demolition rate of 0.3 percent for 2017. These rates were then averaged from 2001 through 2020 for each climate zone to get a typical demolition rate.

The year-over-year change from 2025 to 2024 was calculated and summed with the demolition rate multiplied by the 2024 square footage to get the final 2025 new construction forecast. For existing buildings, the BSD database 2025 forecast was used directly. Finally, the 2026 new construction forecast was assumed to be the same as the 2025 forecast.