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CALIFORNIA NATURAL RESOURCES AGENCY

California Energy Commission

DRAFT COMMISSION REPORT

California Building Energy Action Plan

Gavin Newsom, Governor

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ABSTRACT

The CEC published the *Existing Buildings Energy Efficiency Action Plan* in 2015 to fulfill the requirements of Assembly Bill 758 (Skinner, Chapter 470, Statutes of 2009). The action plan was updated in 2016 and 2019. For 2021, the action plan was incorporated into the *Integrated Energy Policy Report* as a separate volume. The *2025 California Building Energy Action Plan* (*2025 Energy Action Plan*) updates statewide strategies for existing building decarbonization. The *2025 Energy Action Plan* presents a statewide, multiagency perspective on ways to achieve greater decarbonization of existing buildings through improved energy efficiency, electrification, and supporting strategies. The analysis that supports the recommendations is broken into 21 topics.

The *2025 Energy Action Plan* fulfills the mandates in California Public Resources Code Sections 25310(c), 25403(c), and 25943(f) and incorporates the status report on CEC's Equitable Building Decarbonization program, required by Senate Bill 306 (Caballero, Chapter 387, Statutes of 2023), as an appendix.

Keywords: Energy efficiency, electrification, existing buildings, building decarbonization, equity, greenhouse gas, GHG, SB 350, residential buildings, commercial buildings, bill impacts, tenant protections, manufactured housing, hard-to-reach communities, local workforces, labor, residential panel optimization, residential panel upsizing, embodied carbon, benchmarking, building performance standards, heat pump, code compliance, load flexibility, electric vehicle supply equipment, data, refrigerant use.

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EXECUTIVE SUMMARY

Introduction

Buildings are responsible for one quarter of California's greenhouse gas (GHG) emissions. For California to reach its climate goals, the building sector must do its part. In a letter to the California Air Resources Board (CARB) in 2022, Governor Gavin Newsom recognized that "[b]uildings are a large source of carbon pollution, and decarbonization of California's buildings must be accelerated to achieve our climate targets". The letter established "a goal of 3 million climate-ready and climate-friendly homes by 2030 and 7 million homes by 2035, which shall be supplemented through the deployment of 6 million heat pumps statewide by 2030."

However, buildings are unlike other sources of emissions — they are where Californians work, recreate, and most importantly, live. As such, a comprehensive strategy is needed to decarbonize the building sector, one that considers the varied types and uses of buildings and prioritizes energy affordability, equity and the needs of California's most vulnerable residents. California cannot achieve an equitable transition without reducing energy burden and increasing energy affordability. Significant, multiagency work is underway to achieve this goal, but the path to success is a long one that will require an enduring investment in California's people and its buildings.

The primary technological pathway to achieve the necessary GHG reductions in the building sector is clear — efficient, electric heat pumps that leverage carbon-free electricity must replace fossil fuel equipment as the primary means of providing space and water heating. The California Energy Commission (CEC) is working with other government agencies and the private sector to achieve the goal to install 6 million heat pumps by 2030. The cost of installing and running heat pumps is a barrier to adoption in many cases and strategies are needed to bridge this gap in affordability. This report presents strategies to encourage stakeholders and policymakers to address affordability effectively.

Unlocking the power of private finance will be key to widespread adoption of heat pumps, but for California's neediest, public incentives will play a critical role in ensuring a just transition to combustion-free buildings. Accordingly, the CEC is implementing the Equitable Building Decarbonization Program and other home retrofit programs to provide incentives that prioritize decarbonizing the buildings of those most in need. Similarly, other state and local agencies are developing building decarbonization policies that prioritize justice communities.

In partnership with industry and other state agencies, the CEC has created the California Heat Pump Public-Private Partnership, a consortium with heat pump manufacturers and other key stakeholders that is addressing barriers to widespread adoption of heat pumps. California's energy codes and standards are also encouraging new and existing buildings to decarbonize. These are just a few of the key activities the CEC is engaged in to decarbonize buildings.

Energy efficiency must remain a key strategy to make the clean energy transition affordable and cost-effective. Increased building energy efficiency will allow Californians to heat and cool their homes using less energy, helping keep utility bills affordable. At the grid level, increased energy efficiency will also lessen the need for new generation and help offset distribution upgrades, further helping with utility bill affordability. California is leading the way to use

active energy efficiency — energy efficiency combined with load flexibility — which maximizes cost savings and reliability benefits.

Decarbonizing California's buildings will lead to many co-benefits, including reductions in pollution, improved public health, and more jobs in construction, manufacturing, and related industries. The *2025 California Building Energy Action Plan* (*2025 Energy Action Plan*) is intended to provide an updated road map to achieve the state's building decarbonization goals equitably and, in doing so, improve the health and well-being of all Californians.

Purpose and Format of Report

The *2025 Energy Action Plan* is intended to provide a comprehensive clean energy strategy for California's buildings by responding to the following statutory reporting requirements related to buildings:

- Assembly Bill 758 (Skinner, Chapter 470, Statutes of 2009) requires the CEC to develop and periodically update a comprehensive program to achieve energy savings in existing buildings.
- Senate Bill 350 (De León, Chapter 547, Statutes of 2015) requires the CEC to periodically update targets to achieve a statewide, cumulative doubling of energy efficiency savings by 2030 and adds a low-income focus to the CEC's reporting requirements.
- Assembly Bill 3232 (Friedman, Chapter 323, Statutes of 2018) directed the CEC to analyze pathways for California's buildings to achieve a 40 percent reduction in GHG emissions from the state's building stock compared to 1990 levels. The CEC develops and updates strategies that align with these emission reduction goals and to satisfy the statewide reduction goals most recently updated in Senate Bill 32 (Pavley, Chapter 249, Statutes of 2016).
- Senate Bill 306 (Caballero, Chapter 387, Statutes of 2023) requires the CEC to report on progress in decarbonizing households through the Equitable Building Decarbonization Direct Install Program.

Chapter 1 of the *2025 Energy Action Plan* provides an explanation of past CEC policy reporting in this area and goes further in depth on the statutory underpinnings of the report. Chapter 2 explores the barriers to building decarbonization and present opportunities for resolutions. Chapter 3 provides updated targets toward the goal of SB 350 to achieve a statewide, cumulative doubling of energy-efficiency savings by 2030. Appendix A provides additional details on progress achieved in establishing the Equitable Building Decarbonization Program.

Summary of Findings

The following findings are summarized from the body of the report, where additional details can be found. These findings describe policy and program approaches to make heat pumps and energy efficiency affordable for a majority of Californians.

Efficient Electrification of Existing Buildings Is the Primary Pathway to GHG Reduction

California's buildings are responsible for about 26 percent of the state's GHG emissions. About half of these emissions are offsite and come from electricity generation, while the other half comes from on-site combustion of gas, mainly for space and water heating. California's electricity providers have made great strides in decarbonizing the electric grid. Switching from gas to electricity for space and water heating by installing heat pumps is the least cost pathway for achieving deep reductions in GHG emissions in California's existing buildings. Combining fuel switching and fuel substitution with efficiency measures will help reduce utility bill costs. Updated modeling by the CEC in response to SB 350, AB 3232, and SB 32 confirms that aggressive, efficient electrification — as articulated by the aspirational 6-million-heat-pump goal — is the only scenario that will achieve GHG emission reductions from buildings consistent with the state's 2045 climate and efficiency goals.

Several barriers complicate the ability to decarbonize existing buildings, chief among them high upfront costs and low or negative payback. Replacing furnaces, gas water heaters, and air conditioners with electric heat pumps at end of life is an obvious strategy, since it uses an existing workflow and adds a comparatively small incremental cost. However, replacing these appliances is complicated by the emergency nature of these interventions, that is, the immediate need for hot water when a gas water heater breaks down, and lack of knowledgeable, trained contractors in many areas of the state. Several technology and program approaches are being developed to overcome this "emergency replacement" barrier. Targeted early retirement of aging combustion equipment in California's existing buildings is a good strategy to help achieve market transformation but will require significant ongoing targeted incentives to achieve scale and lower costs. Strategic alignment across agencies, particularly on incentives and regulations, will ensure all communities benefit from California's building decarbonization efforts.

Maximizing Equity in Building Decarbonization Investments Is Key

Many Californians will not be able to afford the upfront costs of decarbonizing their buildings. A sustained, multiyear investment in California's low-income housing will be required to ensure that the benefits of building decarbonization are distributed equitably. The CEC is implementing the Equitable Building Decarbonization Direct Install Program, authorized by Assembly Bill 209 (Committee on Budget, Chapter 251, Statutes of 2022) that will provide no-cost building decarbonization upgrades in disadvantaged communities statewide.

The CEC is also using federal funds from the Inflation Reduction Act Home Efficiency Rebates Program, subject to U.S. DOE approval of implementation plans, to support the Equitable Building Decarbonization Program. Currently, $413 million in state funds and is allocated to the Equitable Building Decarbonization Statewide Direct Install Program, with an additional $30 million allocated to the Tribal Direct Install Program. Implementation of the Statewide Direct Install Program began in early 2025, while the Tribal Direct Install Program is expected to begin in 2026. The CEC requires program implementers to partner with community-based organizations and analyze energy usage patterns to target candidate communities and households that can benefit most from the program.

The CEC was awarded $290 million in the Inflation Reduction Act Home Electrification and Appliance Rebates (HEEHRA) Program funds in June 2024. Per federal statute, these funds are limited to low- to moderate-income households for rebates on equipment, such as residential air source heat pumps. The state split the HEEHRA program into two phases to benefit income-eligible Californians sooner. The HEEHRA Phase I program provides $80 million in rebate funds, leveraging the TECH Clean California program, a statewide home electrification market transformation initiative established by the CPUC pursuant to Senate Bill 1477 (Stern, Chapter 378, Statutes 2018). The CEC is developing HEEHRA Phase II of the HEEHRA Program.

Financing Is Essential to Achieving Overall Market Transformation

The scale of investment needed to decarbonize all of California's buildings means that subsidies alone are not enough. Unlocking financial markets will be key to raising the necessary capital. Strict eligibility requirements and high interest rates may cause conventional financing mechanisms, such as credit cards and home equity lines of credit, to be unmanageable for many Californians. Alternative financing models, such as inclusive utility investments and credit enhancements, may be more attractive. Inclusive Utility Investments are a class of financing in which repayment of the loan is tied to the meter itself, not the individual. This model is particularly helpful in the context of rental housing.

The CEC is developing a stand-alone report on Inclusive Utility Investments as directed by Senate Bill 1112 (Becker, Chapter 834, Statutes of 2022). Use of public funds for credit enhancements such as loan loss reserves, interest rate buydowns, and loan guarantees can improve accessibility to credit for building decarbonization. GoGreen Financing, administered by the California Alternative Energy and Advanced Transportation Financing Authority, is a longstanding program that works with private lenders to provide low-interest financing. GoGreen Financing is funded from ratepayer public goods charges, and the CEC is augmenting the program with funds from the Equitable Building Decarbonization statewide incentive program.

New Policy Approaches Are Needed to Tackle Existing Buildings

The CEC and other institutions are exploring novel policy approaches that would provide significant momentum to achieve building decarbonization at scale:

- **Building energy efficiency standards for HVAC change-outs to include heat pumps:** Traditional air conditioners (which are capable of only cooling) and heat pumps (which are capable of both heating and cooling) are similar mechanically. A relatively straightforward way to make significant progress toward the state's goals would be to encourage or require heat pump installations in existing buildings when new space-conditioning systems are installed or replaced. Accordingly, the 2025 Energy Code includes pathways for heat pumps to be installed as the standard when space-conditioning systems are replaced in certain nonresidential buildings.
- **Pursue residential electric panel optimization strategies to avoid unnecessary panel and service upsizing:** As existing buildings aim for electrification at scale, state policies must ensure that to the greatest extent possible building electrification does not trigger expensive electric grid infrastructure upgrades. This goal can be accomplished

by adopting policies that allow or favor power-efficient devices (that is, devices that minimize panel load) and by properly sizing appliances, thus avoiding unnecessary electrical panel and service upsizing. Preventing building electrification from adding out-of-pocket costs to customers and triggering upstream infrastructure upgrades that add costs to all ratepayers will require innovation in low-voltage appliances, circuit-sharing devices, and meter-socket adapters, as well as educating field technicians on panel optimization strategies.

- **Regulating space and water heaters as emissions sources:** Zero-emission standards for space and water heaters are part of California's climate strategy as laid out in the *2022 Climate Change Scoping Plan*. The *2022 Climate Change Scoping Plan* set targets for appliance sales to transition to zero-emissions by certain years. CARB committed to developing zero-emission standards for space and water heaters when the board approved the *2022 State Strategy for the State Implementation Plan* for meeting health-protective federal ozone standards. CARB staff is in the prerulemaking phase of developing the zero-emission space and water heater standards. If adopted by CARB, the regulation would require that new space and water heaters sold in California be zero-GHG emitting starting as early as 2027. The requirements would likely be staggered by size of equipment, with larger equipment required to be zero-emission in later years. The Bay Area Air Quality Management District is implementing a zero-NOx rule to end the sale or installation of new furnaces and water heating equipment that emit nitrogen oxides (NOx). NOx emissions are harmful to human health and contribute to the formation of smog.
- **Building performance standards**: Building energy benchmarking programs allow building owners and the public to track the energy use of large buildings over time and compare them to other buildings. Benchmarking gives visibility into which buildings are most in need of upgrades and the impacts of building decarbonization measures over time. Building performance standards set targets for individual buildings, potentially adding a mandatory retrofit element to benchmarking programs.

  The CEC administers a statewide building energy benchmarking program as required by Assembly Bill 802 (Williams, Chapter 590, Statutes of 2015). This program applies to large commercial and multifamily buildings in the state and is supplemented by local benchmarking ordinances in Los Angeles and other California cities. Senate Bill 48 (Becker, Chapter 378, Statues of 2023) requires the CEC to publish a strategy to use this benchmarking program to reduce energy use and emissions of covered buildings. The report will explore a framework for a potential statewide building performance standard.
- **Whole-house energy rating systems**: It is difficult for potential home buyers and home renters to assess the energy performance and GHG emissions of a home for sale or for rent. The CEC has instituted a rulemaking to develop a voluntary whole-house energy rating and labeling program that could provide this important information to potential homebuyers and renters.

Bill Impacts Must Be Carefully Considered

Because building electrification reduces gas consumption and increases electricity consumption, electrification initiatives must carefully consider the bill impacts to consumers. Building electrification can trigger upstream electric infrastructure upgrades if it is not optimized for the grid, increasing the cost of electricity service for all ratepayers.

The landscape of California's electric rates is highly variable. Relatively high electric rates in investor-owned utility service territories have been caused by wildfire risk mitigation costs, high penetration of rooftop solar generously compensated per legislation, unfavorable building terrain, supply chain bottlenecks, and a lack of skilled workers. Publicly owned utility service territories, including Sacramento Municipal Utility District and Los Angeles Department of Water and Power, have significantly lower electric rates, partly because smaller, urban centric service territories have lower fire risk and lower penetration of rooftop solar, which is generally less generously compensated.

Even with discounted rates for low-income residents, the bill impacts of building electrification for customers in investor-owned utility service territories must be carefully considered. Electrification-friendly rates, envelope and appliance efficiency, and demand flexibility measures along with fuel substitution, can help make electrification affordable. Furthermore, transportation electrification and home-based charging could reduce energy costs even as the electric utility bill increases.

Tools are being refined to help program implementers design building decarbonization programs that minimize the possibility of increasing customer bills, especially for low-income customers. These tools should use individual building energy meter data to be most accurate. The CEC requires implementers of the Equitable Building Decarbonization Direct Install Program to use meter data to help target communities and households that will benefit most. For example, such analysis can help identify communities with older, inefficient air conditioners and determine the buildings most suitable for efficient heat pump upgrades. The summer efficiency savings from a newer, more efficient air conditioner partly offsets electricity bill increases in the winter resulting from switching from gas to electric heating.

In addition, electrification of water heating tends to have less of a risk of increasing customer bills than electrifying space heating. Using data to guide program development could lower the risk of bill increases in communities where HVAC upgrades may not be ideal. Initial modeling by CEC staff concluded that bill savings are possible in nearly all climate zones and utility service territories in California after building decarbonization retrofits if electrification measures are correctly paired with efficiency and rate discounts.

Although a narrow focus on bill impacts of building decarbonization measures helps provide programmatic safeguards, it is also helpful to be aware of the broader context of comfort, health, and overall household energy costs within these programs. For example, households that did not have air conditioning previously will gain access to cooling for the first time if their gas furnace is replaced with an electric heat pump as part of a building decarbonization program. For these households, summer electric bills will likely increase as they make use of these new cooling services, but that increase is not necessarily a bad thing because it is providing an upgrade to safety and comfort.

Programs Must Balance Considerations

The following are key considerations that building decarbonization programs must balance against a strict emphasis on GHG savings:

- **Tenant protections:** About 46 percent of Californians are renters. Rental housing has long suffered from a split incentive problem, whereby the landlord does not have a financial incentive to invest in capital improvements that will benefit only the tenants, unless the landlord can raise rent. A key challenge for low-income building decarbonization programs is trying to prevent program upgrades from resulting in excessive rent increases or tenant displacement. Building decarbonization programs have increasingly tried to provide tenant protections, though enforcement of these protections can be challenging.
- **Remediation costs:** Improving the overall condition of housing is an important equity goal. Building decarbonization programs have historically tried to balance the need to address building deficiencies, such as outdated electrical wiring, mold, and other issues, with the need to treat the maximum number of interventions within the program budget.
- **Electric infrastructure:** Building electrification can affect electric infrastructure within a building and on the electricity grid. The ability of older electric service panels to handle the incremental load from heat pumps and electric vehicle charging is important to consider. Electric service panel upgrades are costly and can be complicated, using up building decarbonization program budgets. Innovative solutions to minimize the need to upgrade electric service panels are being developed and field validated. California will also need to optimize the distribution grid for transportation electrification and building electrification to avoid increasing electricity rates caused by increased infrastructure costs.

Equity Considerations Require an Emphasis on California Native American Tribes and Justice Communities

The following communities require special emphasis and intentional program design:

- **California Native American tribes:** Tribes have historically been disenfranchised and dispossessed in California. Addressing these historical wrongs is a priority. The CEC has granted more than $100 million to tribal governments, and in 2023 adopted a resolution supporting California tribal energy sovereignty. As sovereign nations, tribes require and deserve concerted government-to-government engagement on building decarbonization. The CEC is developing a separate, stand-alone Equitable Building Decarbonization Direct Install Program dedicated to tribes.
- **Low-income communities:** People in low-income communities experience high energy cost burdens, and may experience uncomfortable indoor temperatures because they cannot maintain, replace, or upgrade the equipment in their buildings. Low-income communities may also experience higher summer indoor temperatures because low-income neighborhoods lack trees and urban areas experience the heat island effect.

- **Hard-to-reach communities:** The benefits of building decarbonization must accrue to all Californians. Program design and implementation must ensure effective engagement with underserved communities. These include non-English speakers, since more than 40 percent of Californians speak a language other than English at home, and rural communities, who generally have a higher energy burden than urban communities and often lack a properly trained network of contractors.
- **Manufactured housing:** California's manufactured housing communities are an important sector of affordable housing but have often been underserved by programs because of a unique regulatory environment and architectural challenges. The Equitable Building Decarbonization authorizing statute required the program to include existing manufactured housing and CEC provided a 5 percent funding set aside to this housing segment.

Building Decarbonization Presents Opportunities to Expand California's Clean Energy Workforce

California will need to expand its clean energy workforce to meet its building decarbonization goals. With roughly 300,000 Californians working in energy efficiency, the building decarbonization workforce is already the largest category of the clean energy workforce in California. Decarbonizing California's buildings could increase this number by 42,000 — 81,000 additional jobs on average annually through 2045. This effort will require increasing the current network of apprenticeship and other workforce programs.

Health Benefits of Building Decarbonization

An emerging body of research is expanding knowledge on the health benefits of removing combustion from buildings. Fossil fuel combustion in buildings is a significant source of indoor and outdoor air pollution. Gas stoves, in particular, are major sources of nitrogen dioxide and fine particulate matter that contribute to heart disease, respiratory disease, and the formation of smog and ground-level ozone. Studies have found a strong connection between gas stoves and asthma. Older wall furnaces can leak combustion by-products and are a potential source of health impacts in multifamily and affordable housing. In addition to improving health, eliminating combustion in buildings would be expected to yield significant health system cost reductions.

Increased Standards Compliance Is an Important Pathway to Building Decarbonization

The California Building Standards Code (also known as Title 24) is a comprehensive set of regulations that govern the design, construction, and maintenance of buildings in California. Of the twelve parts of Title 24, the CEC is the state adopting agency for the Energy Code (Title 24, Part 6), and voluntary energy efficiency standards in CALGreen (Title 24, Part 11). While compliance with the Energy Code in new construction is understood to be high, compliance in existing construction is lower and less understood. The CEC's Energy Code also applies to the change-out of HVAC systems in existing buildings and is intended to ensure that new HVAC systems are installed and commissioned properly. Unpermitted work using unlicensed labor is a persistent problem in existing buildings and may undermine the effectiveness of

decarbonization measures, create health and safety risks, and cultivate an unfair market for honest contactors.

Enforcement is generally the responsibility of local building departments, however, various government agencies, including the Contractors State Licensing Board, California Building Standards Commission, the Department of Housing and Community Development, the CEC, and many others, play supporting roles.

The CEC is making efforts to increase the usability of the Energy Code, most recently with the discontinuation of portions of the code that are outdated, reductions in supporting reference manuals, and compliance-focused improvements adopted in the 2025 Energy Code update. The CEC will continue to assess the scale of the opportunity and potential strategies to improve compliance and increase the usability of the code in consultation with the various state and local enforcement agencies.

Strengthened Building Standards Continue to Decarbonize New Buildings

The authority to implement energy efficiency standards for new construction is foundational to the CEC's mission. The CEC issued its first Building Energy Efficiency Standards (Energy Code) in 1978 and updates the code triennially. Energy Code updates are a core strategy for affordability and decarbonization because designing efficient buildings at construction is cheaper than retrofitting them. In addition, buildings constructed according to the updated Energy Code have lower utility bills than buildings built to less stringent codes used in other states. Statute requires the Energy Code to be cost-effective when taken as a whole. The CEC analyzes proposals for mandatory and voluntary measures in an open process supported by work from California utilities as part of the ratepayer-funded Codes and Standards Program overseen by the CPUC and informed by input from many knowledgeable stakeholders. Measures are often introduced and then incrementally strengthened as technology costs come down and builders gain familiarity with new construction practices and technologies. For the last several code cycles, the Energy Code has been focused on energy efficiency and conservation measures that also maximize GHG emission reductions from new construction. Significant recent requirements in the code include the following:

- The 2019 update included a residential solar requirement that could be met by either rooftop solar or participation in a CEC-approved community solar program.
- The 2022 update included a heat pump baseline that encouraged use of heat pumps for space or water heating, in addition to expanded solar and storage requirements, electric readiness, and strengthened ventilation standards.
- In the 2025 update, effective January 1, 2026, all new single-family homes will include two heat pumps (for space conditioning and water heating) as the standard design. The update also encourages heat pumps to replace certain end-of-life HVAC systems in existing nonresidential buildings.

Aiming to maximize the speed of the rebuild of homes destroyed by the devastating Los Angeles wildfires and recognizing the robustness of the 2022 Energy Code, Governor Newsom issued Executive Order N-29-25 in July 2025, which adapts the general applicability of the 2022 Energy Code for buildings impacted by the fires. The Executive Order also suspended the

solar and battery requirements, recognizing the Legislature's granting of similar exemptions for rebuilds after previous wildfires. Additionally, Assembly Bill 130 (Committee on Budget, Statutes of 2025) limits the 2028 Energy Code update to nonresidential buildings, recognizing the significant progress to improve efficiency and limit GHG emissions in residential buildings up to and through the 2025 residential Energy Code.

Increasing Load Flexibility Will Reduce Costs

Load flexibility is a key resource to reduce the cost of the electricity generation, transmission, and distribution system upgrades needed to electrify transportation and buildings. The CEC has established a goal of achieving 7 gigawatts of flexible demand by 2030, which would equate to about a doubling of available resources.

The CEC is pioneering efforts to make electric end uses capable of responding to price and GHG signals. These responses encourage shifting the use of electric appliances from times of day when demand and prices are highest or supply is dirtiest or both to when clean energy is abundant and electricity production costs are low.

Under new authority granted by Senate Bill 49 (Skinner, Chapter 697, Statutes of 2019), the CEC has adopted its first Flexible Demand Appliance Standards for pool controls. CEC staff is investigating electric storage water heaters and a range of other appliances for future Flexible Demand Appliance Standards rulemakings. Deployment of electric vehicle supply equipment represents a significant load flexibility opportunity if existing barriers to deployment can be overcome, including a lack of standardization around charging protocols, lack of interface between electric vehicle supply equipment and building decarbonization programs, and barriers around bidirectional charging.

In 2022, the CEC adopted updated Load Management Standards (Title 20 California Code of Regulations), requiring utilities to offer more time-dependent rates and update these rates into a centralized database, the Market Informed Demand Automation Server. These innovations will make it easier for customers to save money and respond to time-of-use rates. In addition, the CPUC opened a rulemaking to advance demand flexibility through electric rates (R.22-07-005) in July 2022.

Increased Use of Data Will Allow for More Effective Building Decarbonization Programs

The CEC is required by statute to serve as the central data repository for the state for energy planning and has been modernizing its data collection and analysis efforts to make use of the large set of energy data available from utilities via advanced metering infrastructure. A main focus is development of an energy data warehouse to house the consumption data of most buildings in the state and leverage other data sets, such as information on rates and building decarbonization programs, to target communities and households that would benefit most from building decarbonization. The energy data warehouse will also underpin analysis of bill impacts and GHG impacts from building decarbonization programs, and track progress toward the state's building decarbonization goals.

Data can also be used to create new types of incentives. For instance, the CEC is developing a new program using Inflation Reduction Act Home Efficiency Rebates Program funds that uses

elements of pay-for-performance — a program concept that provides monetary incentives to contractors for well-performing upgrades, with effects measured using actual project-site energy data. The CEC is also developing a protocol to anonymize individual energy use data, allowing researchers and other agencies to analyze these data while preserving customer confidentiality. There still are data gaps that limit the ability of the CEC to measure progress toward the Governor's goal of installing 6 million heat pumps by 2030 — in particular, heat pump sales and installation data.

In addition, the CPUC started a distributed energy resource (DER) data working group in 2023 to improve DER data access for customers and planning entities.

Other GHG Emission Sources From Buildings, Including Refrigerants and Embodied Emissions, Must Be Addressed

Developing and bringing to market low-global warming potential refrigerants, and ensuring proper management and recovery of refrigerants in existing equipment, are key strategies to realizing the GHG reduction potential of building electrification. CARB regulates the sale, management, and recovery of refrigerants. Furthermore, CARB is leading, and the CEC is providing assistance in, the development of a strategy to transition the state's economy away from high-global warming potential refrigerants by 2035, as called for by Senate Bill 1206 (Skinner, Chapter 884, Statutes of 2022). The CEC is also investing in research and development of equipment that uses low-global warming potential refrigerants. Efforts to enhance proper management of refrigerants in existing systems may be focused on contractor training, incentives, and enforcement.

Beyond direct emissions (on-site emissions from buildings) and indirect emissions (emissions from electricity generation), buildings are also responsible for emissions associated with building materials, construction, and demolition. Emissions associated with building materials, often called *embodied emissions,* are significant, especially for concrete, plasterboard (also called drywall), and steel. Accounting for these emissions is complicated and requires significant supply-chain analysis and verification. CARB is developing a framework to measure and reduce embodied carbon in building materials under Assembly Bill 2446 (Holden, Chapter 352, Statutes of 2022) and Assembly Bill 43 (Holden, Chapter 316, Statutes of 2023). CARB is also specifically tasked with focusing on achieving net-zero GHG emissions in cement by 2045 under Senate Bill 596 (Becker, Chapter 246, Statutes of 2021). The CEC is also investing in reducing embodied carbon through industrial decarbonization investments in the Electric Program Investment Charge program.

In addition, the Department of General Services is implementing the Buy Clean California Act. The Buy Clean California Act requires the Department of General Services to establish global warming potential limits for concrete-reinforcing steel, structural steel, flat glass, and insulation. Since 2022, CALGreen has contained standards for conserving building materials and decreasing emissions associated with deconstruction. As California decreases emissions from direct and indirect sources, embodied emissions and emissions from the construction and deconstruction of buildings will become increasingly important.

Transportation emissions are the largest overall source of GHG emissions in California. Since the location of new buildings affects transportation emissions, land-use policies that encourage

transit-oriented and infill development are important strategies for economywide GHG reduction that can also help achieve equity goals and improve the overall quality of life of Californians. While outside the scope of this report, these land-use policies are complementary to the recommendations and opportunities identified in this report.

Summary of Recommendations

The following 14 summary recommendations combine the most impactful and public-facing opportunities listed in the subsequent chapters of this report. These summary recommendations are intended to be a concise list of takeaways to inform stakeholders of the overall policy direction recommended by this report. For more detailed information, please refer to the technical sections.

These recommendations attempt to reconcile the massive scale of building decarbonization needed to meet the state's goals, with the limited availability of public funds needed to activate these markets. At a cost of $20,000 per home — likely a low estimate — it would cost roughly $200 billion dollars to decarbonize California's residential buildings. These recommendations use new and existing approaches to address existing barriers, advance new technologies, and make good use of existing programs.

1. **Continue to prioritize funding for incentives to achieve GHG targets**. Targeted direct install and incentive programs have played an essential role in energy use reductions in California and remain essential for market transformation and increased equity. Programs should retain a focus on electrification and heat pump installation, coupled with energy efficiency, as the primary pathway to decarbonize buildings. If funding is available, programs should expand to include new approaches to contain overall costs, such as panel optimization. Data from programs are needed to guide future regulatory changes, and continued commitment to program support provides market certainty that enables private companies to invest and scale building decarbonization initiatives over time.
2. **Maintain focus on Equity**. Programs should focus the majority of funding on low-income and disadvantaged communities, which face the highest energy cost burdens, may not be able to afford the costs associated with building decarbonization, and may not have access to financing. Tenant protections should be a strong consideration in decarbonization programs. Low-income homeowners and landlords need broad access to low-cost financing to support projects and alleviate residents' energy burden. The CEC should continue developing targeted programs that focus on tribal needs, such as the Equitable Building Decarbonization Tribal Direct Install program.
3. **Prioritize energy efficiency investments to improve affordability.** Programs should combine electrification measures with energy efficiency to ensure energy affordability and strategic peak demand reduction. State agencies and program administrators should use data from decarbonization programs and the CEC's energy data repository to identify and recommend effective, low-cost solutions across various building types, climate zones, and utility territories. Reducing energy use through energy efficiency measures such as insulation, air sealing, and energy management and controls is essential for affordability. In addition, energy efficiency measures improve

the performance of heat pumps by eliminating or reducing the need for backup heat sources which also reduces first costs and operating costs.

4. **Continue investing in technology innovation**. Reducing first costs of heat pump installations and operating costs requires technology innovation. For example, 120 Volt indoor air handlers can eliminate the cost of running electrical wiring to attics. Dual fuel heat pumps can also reduce the cost of installations by avoiding the need for new electrical capacity for backup resistance heating, while providing customers with heat at the lowest operating cost. Innovative thermostatic controls that minimize the use of gas in dual fuel systems reduce GHG emissions. Technologies such as low-voltage appliances, circuit-sharing devices, and meter socket adapters, as well as educating field technicians on panel-optimization strategies, should be used to minimize electrical panel and service upsizing and electric grid infrastructure upgrades.
5. **Increase equitable access to low-cost and zero-cost financing**. The CEC and other agencies should further explore barriers and opportunities to capital mobilization such as fostering private sector partnerships, reducing the cost of capital, and ensuring geographical availability of affordable financing products. Financing options should not burden low- and moderate-income homeowners excessively, and should be easily accessible at convenient times and places for customers. Standardizing reporting and performance assessments for loans will increase market confidence. Contractor education can improve the quality, transparency and appropriateness of the financial products offered to homeowners.
6. **Expand the decarbonization workforce with well-paid jobs**. Develop a better understanding of the business barriers contractors face to expanding their decarbonization services, including training and upskilling needs along with business issues such as customer acquisition and project pipeline management. If funding is available, decarbonization programs could support contractors in overcoming these barriers, require competence in refrigerant management and recovery, and focus on bringing in workers from California Native American tribes and justice communities. Workforce development boards already provide funding and wrap-around support for trainees and apprentices which could be expanded if funding is available. Continue to invest in training for high-road jobs such as the Training for Residential Energy Contractor Program. The glossary at the end of this report provides a definition for "high-road" jobs.
7. **Empower homeowners and building owners with decision-making resources**. The state should enhance its outreach and education offerings for decarbonization best practices, data, and tools through resources such as the Building and Home Energy Resource Hub and the Heat Pump Public-Private Partnership. Ensure that programs meet the needs of building owners while protecting tenants by understanding tenant outcomes and researching the barriers to program participation among landlords, such as long-term limitations on the ability to recoup the costs of decarbonization projects. Ensuring that California's most burdened communities benefit from decarbonization requires prioritizing disadvantaged and low-income communities and supporting building owners and occupants to choose to decarbonize even for an emergency replacement.

8. **Strengthen alignment across agencies and levels of government to maximize the benefits of building decarbonization for all Californians.** Thoughtfully integrating a portfolio of building decarbonization strategies, including strong alignment across incentives and regulatory actions, offers the greatest potential to achieve the benefits of building decarbonization while uplifting California's most burdened communities. Local leadership and innovation is needed for the energy transition, so the state should continue to empower local governments to take actions that exceed statewide minimum standards and policy targets. If state or federal funding is available, the CEC should provide incentives for targeted local planning projects, support local program evaluations, and ramp up technical assistance for local code enforcement.
9. **Enhance Energy Code compliance strategies**. The CEC should continue to improve the usability of the Energy Code compliance systems, track heat pump installations and rates of compliance in new construction and existing buildings, and increase stakeholder awareness of the potential impacts of noncompliance. The CEC can address these tasks by collecting datasets in the field that are more representative of a state as large and diverse as California. State agencies should coordinate technical assistance and support for local enforcement agencies. The CEC should quantify unpermitted and noncompliant retrofit work.
10. **Design building performance standards for large commercial and multifamily buildings**. Building performance standards are an established method for achieving decarbonization. The CEC is developing a strategy for using benchmarking data to track and manage the energy usage and greenhouse gas emissions of large commercial and multifamily buildings, in accordance with Senate Bill 48 (Becker, Chapter 378, Statutes of 2023). This strategy should balance affordability with achieving the state's GHG reduction goals. The strategy must reflect the needs of California's diverse building types, geography, and citizenry, with particular focus on minimizing adverse outcomes for the most needy Californians.
11. **Implement an accessible home energy rating and labeling program**. The CEC should continue revamping California's voluntary Home Energy Rating and Labeling Program (Public Resources Code Section 25942) in coordination with other state, local, and federal agencies. An effective home energy rating and labeling program could inform building owners of potential upgrades and convey the value of decarbonization measures to the market. Home energy rating and labeling programs have been implemented in jurisdictions inside and outside the United States and have driven market differentiation around building performance. Consider how California's program may be expanded from voluntary to mandatory applications once it is implemented.
12. **Develop automated load flexibility programs to support grid reliability and energy affordability**. Automated demand flexibility within appliances and buildings is an effective way to reduce consumer bills, support grid reliability, reduce GHG emissions, and avoid costly upgrades to the grid and building infrastructure. The CEC should continue to expand the Load Management Standards and Market Informed Demand Automation Server toward these objectives while developing additional flexible demand standards for appliances. Utilities and community choice aggregators should ensure electricity rate information or tariffs are kept up to date in the Market Informed

Demand Automation Server and implement automatic load-flex programs. The CEC should engage with stakeholders to explore how to ensure interoperability across a range of DERs.

13. **Collect and analyze actionable data to guide the energy transition**. Data on the costs and impacts of decarbonization are still limited. The CEC should address data gaps and update its data collection authority as needed. The CEC should collect more detailed data on the costs of measures and building remediation and the impacts of decarbonization on energy use and bills, and analyze this information to guide program and policy development. The CEC should develop program metrics that quantify the impacts on equity and augment the approach, timing, and categories of field data for surveys such as the *Residential Appliance Saturation Survey,* while considering the availability of interval meter data. The glossary at the end of this report provides a definition for "interval meter data."
14. **Create market conditions that position heat pumps as the leading technology for decarbonizing buildings.** The state should create productive relationships with heat pump manufacturers and other market actors, including through the Heat Pump Public-Private Partnership, to leverage the resources of private companies to develop new products, reduce costs, ensure installation quality, and support contractors in the development of heat pump business models.

CHAPTER 1:
History and Scope of the California Energy Efficiency Action Plan

Statutory Authority

The statutory authority for the California Energy Action Plan comes from Assembly Bill 758 (Skinner, Chapter 470, Statutes of 2009). AB 758 required the California Energy Commission (CEC) to develop a comprehensive program to achieve energy savings in existing buildings. The bill gave specific instruction on how to develop that program, including a requirement to coordinate with specified agencies, utilities, and other stakeholders and update the program periodically to improve or refine the program requirements. AB 758 also required the CEC to report on the status of the program in the *Integrated Energy Policy Report* (IEPR).

The *Existing Buildings Energy Efficiency Action Plan* was published in 2015 to fulfill AB 758 and updated in 2016 and 2019. For 2021, the action plan was not published as a separate document, but was incorporated into the Integrated Energy Policy Report (IEPR) as a separate volume called Volume I: Building Decarbonization (*2021 IEPR Action Plan*).

In 2015, Senate Bill 350 (De León, Chapter 547, Statutes of 2015) established additional reporting requirements and directed the CEC to establish targets to achieve a statewide, cumulative doubling of energy efficiency savings by 2030. The SB 350 reporting requirements were and continue to be fulfilled through the action plan from 2019 onward.

Progress on Previous Action Plan Recommendations

In many cases, the CEC or other agencies have acted on recommendations in previous action plans through rulemakings and proceedings. In some cases, shortly after the action plan was published, California lawmakers passed legislation that addressed the recommendations. Examples include:

- The *2021 IEPR Action Plan* recommended prioritized funding for "decarbonization retrofits and supporting resources in low-income and disadvantaged communities" and included a recommendation for "active engagement" with those communities. These recommendations were closely echoed in the statutory requirements for the $433 million Equitable Building Decarbonization (EBD) Program. The EBD Program was established the following year to provide direct installation and incentives to:
    - Reduce GHG emissions in homes.
    - Encourage resiliency to extreme heat.
    - Improve indoor air quality.
    - Improve energy affordability.
    - Provide electric grid support.
    - Increase payment of prevailing wage to the implementing workforce.

- The *2021 IEPR Action Plan* included a recommendation to "consider statutory changes to enable the CEC to leverage the statewide benchmarking program to develop and establish building performance standards for existing buildings." The Legislature passed Senate Bill 48 (Becker, Chapter 378, Statutes of 2023) the following year, establishing the authority to move toward that goal.
- The *2021 IEPR Action Plan* recommended the state should "provide a statewide information campaign to familiarize consumers with, and promote, high-efficiency electric appliances and all-electric buildings." Senate Bill 68 (Becker, Chapter 720, Statutes of 2021) became law, establishing that authority and leading to the creation of the Building and Home Energy Resource Hub.
- The *2021 IEPR Action Plan* recommended the CEC and California Air Resources Board (CARB) should "explore regulatory and programmatic approaches to increase the adoption of low-global warming potential (GWP) refrigerant technologies and minimize refrigerant leakage." The statutory requirements set by Senate Bill 1206 (Skinner, Chapter 884, Statutes of 2022) directed CARB and the CEC to explore these approaches, as recommended in the *2021 IEPR Action Plan*.

Six-Million-Heat-Pump Goal and Public-Private Partnership

Another recommendation from the *2021 IEPR Action Plan* was that the state should establish a goal of installing 6 million heat pumps by 2030. This recommendation was based on analysis in the *California Building Decarbonization Assessment*.[1] In 2022, Governor Gavin Newsom established this as a goal for California in a letter sent to CARB.[2] The CEC estimates there were more than 1.5 million residential and small commercial space- and water-heating heat pumps in California in 2018.[3] By increasing the market share for a range of heat pump technologies, the state aims to make them more affordable for a wider range of consumers.

In Fall 2023, 10 of the world's largest manufacturers, distributors, and suppliers of building heating and cooling equipment met to discuss California's ambitious heat pump goal. At this meeting, participants discussed creating the manufacturing capacity to help achieve the state's goal, enhancing efficiency and incorporating load flexibility to ensure the heat pumps are good citizens of the electric grid, and collaborating with the CEC to develop a public-private partnership to promote policy and market support to bring heat pumps into the mainstream. Partnership Advisory Board members convene quarterly to strategize reaching the 6 million

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1 Kenney, Michael, et al. 2021. *California Building Decarbonization Assessment*.

2 Governor Gavin Newsom. 2022. News Release. "Governor Newsom Calls for Bold Actions to Move Faster Toward Climate Goals," https://www.gov.ca.gov/2022/07/22/governor-newsom-calls-for-bold-actions-to-move-faster-toward-climate-goals/.

3 CEC. Accessed May 2024. "2019 Residential Appliance Saturation Study," Web page, https://www.energy.ca.gov/data-reports/surveys/2019-residential-appliance-saturation-study.

Barioant, Sasha, Daniel Mort, Taghi Alereza, Don Dohrmann (ADM Associates, Inc). 2023. *2022 California Commercial End-Use Survey (CEUS)*, California Energy Commission. Publication Number CEC-200-2023-017, https://www.energy.ca.gov/sites/default/files/2024-02/2022%20CEUS%20Final%20Report_ada.pdf.

heat pump installation goal, including investing in outreach and marketing tools to support homeowners and contractors.

Figure 1: Founding Members of the Heat Pump Public-Private Partnership

Includes: CEC Commissioner Andrew McAllister (left), CEC Chair David Hochschild (right), and representatives from Lennox, A. O. Smith, Carrier, Daikin, Johnson Controls, LG Electronics, and Rheem. Photo taken at the CEC's Building Decarbonization Summit, October 10, 2023.

Source: CEC press release: "Top Global Building Appliance Manufacturers and Distributors Commit to Help California Achieve Six Million Heat Pump Goal"

Technical Scope

As the scope of emissions reductions in buildings has expanded, so has the technical scope of the action plan. The *2015 Existing Buildings Energy Efficiency Action Plan* focused almost exclusively on energy efficiency and demand response, along with associated efforts such as sources of financing, agency coordination, and workforce training. Since then, other topics have increased in relevance, such as electrification, load flexibility beyond demand response, refrigerants, as well as a heightened focus on equity. The scope of the action plan has expanded to cover these issues; new and expanded topics within the *2025 Building Energy Action Plan* (*2025 Energy Action Plan*) include:

- An increased focus on financing, especially the availability of financing to low- and moderate-income homeowners.
- Topics that were highlighted in the legislation that led to the EBD Program, namely manufactured housing, rural communities, tenant protections, remediation costs, tribal buildings and communities, and bill impact estimation.
- Three emerging topics that have been added because of the importance of reducing the cost of decarbonization and making it more equitable: bill impact estimations, equity metrics, and residential panel optimization and upsizing.

- The health benefits of building decarbonization, especially in regard to reductions in indoor and outdoor air pollution.
- Topics that have been added because they are the subject of current proceedings and rulemakings at the CEC and CARB:
    - Building energy performance strategies for large commercial and multifamily buildings. The CEC has been tasked with addressing these strategies by Senate Bill 48 (Becker, Chapter 378, Statutes of 2023).
    - Refrigerant use, recovery, and recycling. CARB has been tasked with developing a strategy to transition California to zero and very low-GWP refrigerants under Senate Bill 1206 (Skinner, statutes of 2022). The CEC has provided CARB with research on the refrigerant market to support the development of that strategy.
    - Voluntary whole-house home energy rating and labeling. The CEC is conducting a rulemaking proceeding under existing authority set out in Title 204 to develop a rating and labeling system.
- Electric vehicle supply equipment (EVSE). The 2025 Energy Action Plan focuses narrowly on the links between EVSE and building decarbonization measures.
- An update on the status of the EBD Program. This update is provided to fulfil the statutory requirement created by Senate Bill 306 (Caballero, Chapter 387, Statutes of 2023) and is provided as an appendix to this report.

4 California Code of Regulations, Title 20, Public Utilities and Energy. Sections 1670–1675, https://www.energy.ca.gov/sites/default/files/2021-07/Title%2020%20Updated%20July%2023%2C%202021.pdf.

CHAPTER 2:
Major Issues in Building Decarbonization

Chapter 2 discusses 21 topics that present major issues to building decarbonization. Each discussion includes an analysis with summaries of the barriers and opportunities identified in the analysis. The lists of barriers and opportunities are not intended to be exhaustive.

Affordable Building Decarbonization Financing

High upfront costs for building decarbonization projects are a barrier to market adoption. Affordable financing aims to lower the upfront costs of energy upgrades by allowing small monthly payments for the equipment. Current state, federal, and ratepayer financing programs are not decarbonizing the building stock at a fast enough rate to meet statewide greenhouse gas (GHG) reduction goals. Building decarbonization financing strategies can help ensure that every dollar invested leads to the greatest possible reduction in GHG emissions while maximizing equity.

Expanding access to affordable capital requires financial and nonfinancial market-building strategies, including decreasing the risk of energy loans, ensuring that loans are widely available, and fostering community partnerships. Investing in well-designed financing programs would expand access to the benefits of building decarbonization — such as lower energy bills, healthier homes, and increased grid reliability — and spur a self-sustaining financial industry. California can overcome market barriers and increase the rate of decarbonization by leveraging its leadership in climate policy, world-class innovation, and sheer market size.

Affordable financing for energy upgrades uses savings on energy bills to pay back capital loans, making it important to include measures that reduce energy bills in any financing package. The energy upgrade measures have to save enough money to support the loan repayments, especially for low- to moderate-income customers. Split incentives present a challenge for financing for affordable housing and disadvantaged communities because property owners must make the investments, but tenants receive the benefits of reduced energy bills. Overcoming this split incentive challenge requires innovative housing finance structures that incorporate energy efficiency incentives within the Low Income Housing Tax Credit system and layering incentives and tax credits for affordable housing owners. Enacting policy to reverse the current trend for individual tenant meters when implementing decarbonization retrofits in multifamily buildings with master metering could help overcome the split incentive challenge.

California can overcome market barriers and increase the rate of decarbonization by leveraging its leadership in climate policy, world-class innovation, and sheer market size.

The complexity of implementing energy upgrades makes nonfinancial market-building strategies important in enhancing the customers' ability to adopt affordable financing products. Activities such as fostering local partnerships, empowering contractors, and aligning private

sector interests with state goals can promote participation from justice communities.[5] In addition to technology, capital, and awareness, strong policy leadership is needed to coordinate government and private sector activities to encourage capital mobilization.

The *2019 Energy Efficiency Action Plan* (*2019 Energy Action Plan*) recommended that utilities should "[i]mplement tariffed on-bill repayment programs statewide to open new financing mechanisms for low-to-middle-income households and multifamily units, with eligibility not based on credit score or income."[6] This recommendation will be partially met with the CPUC Inclusive Utility Pilot. The *2021 IEPR Action Plan* recommended that "[f]ederal, state, and local agencies should coordinate incentives and various funding sources to enable diverse financing options for building decarbonization."[7] The *2022 CARB Scoping Plan* recommended to "expand financing assistance programs focused on existing buildings and appliance replacements."[8]

Existing Programs

California has several programs that pilot or implement affordable financing.

California's Joint Tariff-on-Bill Proposal

Since 2020, the CPUC has directed utilities and community choice aggregators (CCAs) to evaluate the potential implementation of a statewide tariff-on-bill (TOB) program, although there have not been any large-scale deployments.[9] The CPUC directed the investor-owned utilities (IOUs) and Silicon Valley Clean Energy (SVCE) to collaborate and file a joint proposal for tariff-on-bill pilots by May 2024. This joint proposal was reviewed by CPUC[10] and approved for SCE but not for the other joint filers in October 2025.[11] The SCE TOB pilot is expected to include a few hundred homes, enough to demonstrate participant benefits and cost metrics. However, the pilot will not play a significant role in statewide decarbonization unless it is

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5 Justice communities include disadvantaged communities, under Senate Bill 535 (De León, Chapter 830, Statutes of 2012); low-income communities and households, under Assembly Bill 1550 (Gomez, Chapter 369, Statutes of 2016), underserved communities, under Assembly Bill 841 (Ting, Chapter 372, 2020); and people living with disabilities, as defined by American Disabilities Act.

6 Kenney, Michael, Heather Bird, and Heriberto Rosales. 2019. *2019 California Energy Efficiency Action Plan,* pg. 8. California Energy Commission. Publication Number: CEC400-2019-010-CMF, https://efiling.energy.ca.gov/GetDocument.aspx?tn=231261&DocumentContentId=62916.

7 Kenney, Michael, Jacob Wahlgren, Kristina Duloglo, Tiffany Mateo, Danuta Drozdowicz, and Stephanie Bailey. 2022. *Final 2021 Integrated Energy Policy Report, Volume I: Building Decarbonization,* pg. 181. Publication Number: CEC-100-2021-001-V1, https://efiling.energy.ca.gov/GetDocument.aspx?tn=241599.

8 California Air Resources Board. 2022. *2022 Scoping Plan for Achieving Carbon Neutrality,* p. 215, https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf.

9 California Public Utilities Commission August 27, 2020. Rulemaking 20-08-022 - R.20-08-022, p. 3.

10 Dunsky Energy and Climate Advisors, 2024. *Joint Tariff On-Bill Proposal Assessment*. California Public Utilities Commission, https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M562/K975/562975610.PDF

11 CPUC. October 31 2025, *Proposed Decision on Tariif On-Bill Finance Proposals.* https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M585/K815/585815581.PDF

expanded into a larger program. Senate Bill 1112 (Becker, Chapter 834, Statutes of 2022) authorizes the CEC to evaluate how to maximize federal funds for financing or investment solutions. One option the CEC is considering is implementing a TOB through inclusive utility investment (IUI). CEC staff expects to release a report in Quarter 1 2026.

California's GoGreen Financing Program

The California Hub for Energy Efficiency Financing (CHEEF), known as GoGreen Financing, was authorized by the CPUC in 2013 and funded through Public Purpose Program funds paid for by ratepayers of the California IOUs. The funds are used to administer the program and offer credit enhancements to participating lenders that help them offer more advantageous terms to borrowers for energy efficiency loans. The CHEEF has encouraged private finance companies to enter the residential decarbonization market and improve terms or expand credit criteria to finance projects.[12]

A CPUC Decision in 2021 authorized the California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA) to add sources of funding to the GoGreen program, beyond IOU ratepayer funds, to expand the program and simplify eligibility requirements. Since 2021, CAEATFA has entered into "agreements to collaborate" with the CPUC TECH program, City of Palo Alto Utilities, and the CEC EBD Program. These agreements provided more funds and covered other measures critical for electrification, such as EVSE and energy storage.[13]

A recent quarterly report from the GoGreen program has shown that credit enhancements can leverage private capital efficiently.[14] Credit enhancements using loan loss reserve funds provide reserve capital for private lenders in the event of default, acting as a safety net to risky loans. The report stated that as of March 31, 2025, 12,104 Californians had made home energy efficiency improvements totaling $204.8 million using standard loans and microloans for HVAC systems, insulation, and ENERGY STAR® appliances. The report also stated:

- The average interest rate for GoGreen Home loans was 4.4 percent, while standard loans were 10.1 percent.
- Borrowers with GoGreen Home loans paid an average of $1,608 in interest, whereas those with standard loans paid $4,003 on average.
- The average monthly payment for GoGreen Home loans with an extended term was $225, while the average payment for similar standard loan products was $508.

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12 California Alternative Energy and Advanced Transportation Financing Authority. March 31, 2025. *Energy Efficiency Financing Programs Quarterly Report & Program Status Summary*, https://www.treasurer.ca.gov/caeatfa/cheef/quarterly/2025/20250331.pdf .

13 California Alternative Energy and Advanced Transportation Financing Authority. Accessed April 2024. "GoGreen Home: Additional Funding to Expand Financing Eligibility," web page, https://www.treasurer.ca.gov/caeatfa/cheef/additionalfunding.asp.

14 California Alternative Energy and Advanced Transportation Financing Authority. *Energy Efficiency Financing Programs Quarterly Report & Program Status Summary*.

- Borrowers with a credit score lower than 600 seeking $15,000 could obtain an unsecured personal loan with an interest rate of 21.88 percent, 5-year term length, and a monthly payment of $418. GoGreen Home Energy Loans have an interest rate of 7.88 percent, 15-year term length, and a monthly payment of $142.

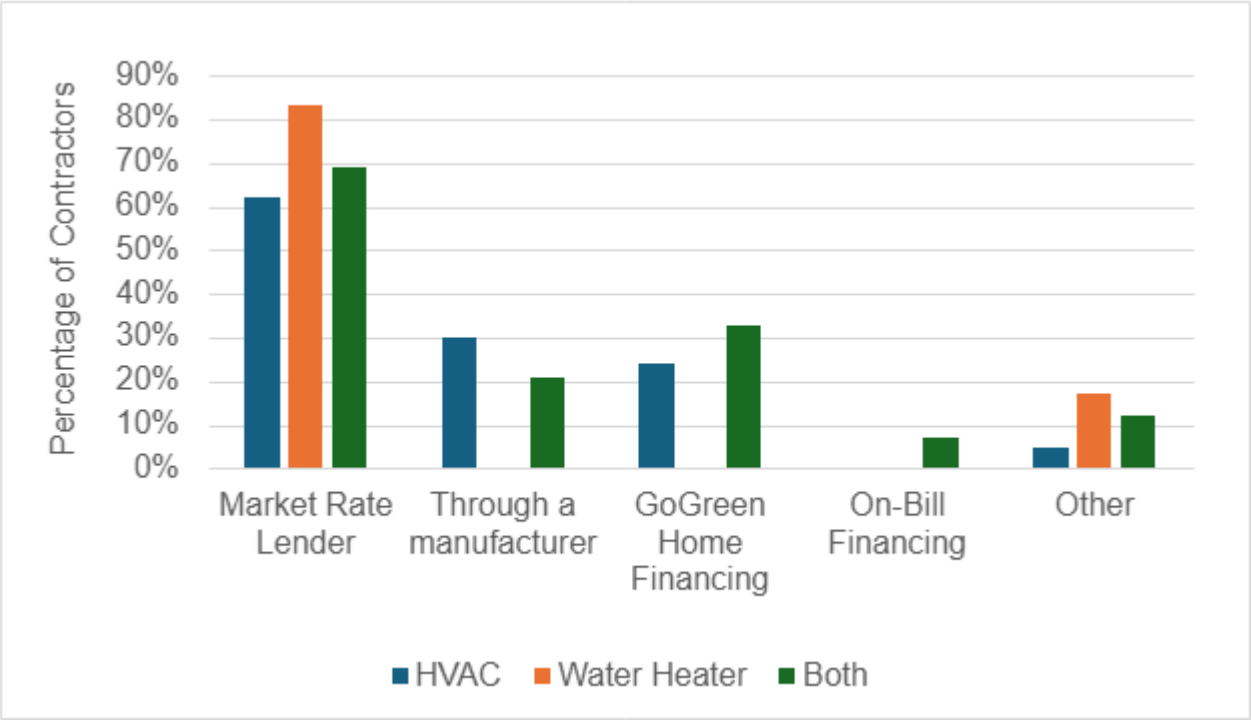
TECH Clean California

TECH Clean California is a statewide incentive program to accelerate the adoption of clean space- and water-heating technology. As part of the evaluation of TECH Clean California, Opinion Dynamics surveyed program participants and found that most financing offered to participants in utility programs is from conventional market-rate lending, such as financing offered by the contractor, local bank, pay-day loan providers, credit cards, or similar. Figure 2 shows that 40 percent of contractors surveyed in the TECH Clean California program offered some form of financing. Of those contractors, 70 percent offered market rate financing, and 30 percent offered below market rate financing through GoGreen.[15] An evaluation of the TECH program found that about 30 percent of customers used financing to purchase a heat pump HVAC, but almost 46 percent did not know about financing options besides credit cards or standard bank loans.[16]

15 GoGreen Financing provides participating private lenders with a credit enhancement paid for with ratepayer or public funds, which allows lenders to thus reduce rates, extend terms, offer larger amounts of capital, or broaden credit approvals.

16 Opinion Dynamics. 2024. *TECH Clean California: Time 1 Market Assessment Final Report,* pg. 58, https://techcleanca.com/public-data/evaluation-studies/. The figure of "about 30 percent" is derived from a CEC staff analysis of the weighted average of the responses shown in the Opinion Dynamics report, which yielded a figure of 29 percent.

Figure 2: Types of Financing Offered to Residential Customers



Source: Opinion Dynamics

Low- and moderate-income households are less likely to participate in energy programs than high-income households. Many demographic factors appear to affect program participation, but a study by Lawrence Berkeley National Laboratory (LBNL) found "[e]ducation stands out as a consistent predictor of participation. Income and race/ethnicity may be the first factors that spring to mind when considering equity in program participation. Our results, and those in the literature, are not as clear for these factors as for post-secondary education but do suggest reason to attend to them in program delivery."[17]

The latest cost estimates from the TECH Clean California program indicate that the median total cost of replacing an existing central air-conditioning and gas furnace system with a central, ducted heat pump is $18,657 and $6,382 for a heat pump water heater.[18] Upfront costs are frequently identified as a major barrier to purchasing heat pumps, and with only 30 percent of those surveyed through TECH Clean California program obtaining financing, that means 70 percent of adopters are funding projects with savings which low- and moderate-income customers do not have.[19]

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17 Pigman, Margaret, Jeff Deason, and Sean Murphy. 2021. *Who Is Participating in Residential Energy Efficiency Programs?* Lawrence Berkeley National Laboratory, https://eta-publications.lbl.gov/sites/default/files/ee_program_participation.pdf.

18 Steiner, Ellen and Jen Loomis. 2024. *TECH Clean California Incremental Cost Study Final Phase I Findings*, Opinion Dynamics, https://techcleanca.com/public-data/evaluation-studies/.

19 Opinion Dynamics. 2024. *TECH Clean California: Time 1 Market Assessment Final Report*.

California Infrastructure and Economic Development Bank

The California Infrastructure and Economic Development Bank (IBank) was created in 1994 to finance public infrastructure and private development that promotes a healthy climate for jobs, contributes to a strong economy, and improves the quality of life in California communities. IBank is positioned to serve as the state's all-purpose "green bank," which leverages federal, state and private capital to mobilize clean energy and energy efficiency financing..[20]

As of July 2024, the GGRF allocated $7 billion to the United Climate Fund, $5 billion to the Coalition of Green Capital, and $2 billion to Power Forward Communities, totaling $14 billion to create a nationwide green bank network.[21] To maximize the impact of the GGRF, the IBank and other state-supported building decarbonization programs must align financing and market transformation activities to catalyze private sector investment.[22] At the time of this report, the status and availability of GGRF funding is uncertain because of shifts in federal energy policy, and may be affected by ongoing litigation, executive action, or federal legislation.

Financial Market Building

This section describes activities the state could conduct to support financial services providers in developing affordable financing products and services.

Expanding Access to Below-Market-Rate Loans

Below-market-rate loans are designed to help individuals and businesses finance energy upgrades with reduced interest rates, longer payback periods, and lower monthly payments that better align with expected energy savings. Most lenders do not issue loans to consumers with Fair Isaac Corporation (FICO) credit scores below 650. Research by the Inclusive Solar Finance Framework estimates that 30 percent of all consumers in the United States have credit scores below 650.[23]

Securitization and coinvesting strategies can increase access to affordable building decarbonization financing in hard-to-reach markets by decreasing the cost of capital and catalyzing private sector investment. Securitization is the process of pooling multiple income-producing loans into a single security to reduce risks and costs, and to allow them to be traded as a single entity. Coinvesting involves partnerships where green banks invest alongside private sector investors to attract greater private capital. Public funds can reduce the perceived or actual risk for private investors through guarantees, credit enhancements, or subordinated debt, which makes the project more attractive by lowering the risk profile. For

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20 U.S. Environmental Protection Agency. April 2024. *Narrative Proposal: Climate United Fund,* https://www.epa.gov/system/files/documents/2024-04/cuf_narrative_proposal1.pdf.

21 U.S. EPA. "National Clean Investment Fund (NCIF)," web page, https://www.epa.gov/greenhouse-gas-reduction-fund/national-clean-investment-fund.

22 U.S. Environmental Protection Agency. *Narrative Proposal: Climate United Fund*.

23 AB 32 EJ Advisory Committee. *2022 Scoping Plan Recommendations*, NF30, https://ww2.arb.ca.gov/sites/default/files/barcu/board/books/2022/090122/finalejacrecs.pdf.

example, loan loss reserves are a pool of funds lenders can leverage to recover the losses if borrowers default.

Coinvesting can also include subordinate debt positions where green banks take on the riskier portion of the debt to allow for the private investors to be paid back first. Coinvesting strategies can reduce the perceived risk of energy loans further, which have lower default rates compared to other financing products like auto loans and credit cards.[24] When financial products are standardized, invested parties can evaluate the estimated revenue and risk of building decarbonization projects on similar terms quickly.[25] The aggregation, or gathering, of standardized projects provides predictable returns that allow large capital providers to participate in many smaller projects, reducing the cost of capital for borrowers in hard-to-reach-markets.[26] This aggregation increases investor confidence and streamlines capital deployment, leading to a self-sufficient financing ecosystem that prices building decarbonization loans appropriately.

Many borrowers may not be well-suited to take on debt either due to credit obligations or site energy savings potential. Marketing debt obligations to low-income customers can lead to issues with personal finances. Therefore, financial products such as pay-for-performance models that do not add debt could be effective.

Inclusive Utility Investment

IUI is a meter-based financing instrument that allows utility customers to finance decarbonization projects through their utility bill where payments are less than or equal to the bill savings generated by the energy conservation measures. TOB is a form of IUI. The repayment requirement moves to the new bill payer when occupancy or tenancy is transferred and is tied to their ability to pay their utility bill, not to personal credit or equity in the home. Therefore, the consequences of defaulting are lower. IUI programs in other states have reached low-income populations successfully where levels of postsecondary education are below the national average.

In addition, the U.S. EPA found that IUI has shown that customers who receive an IUI program offer accept it more than half of the time, accepting the program offer at five times

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24 Deason, Jeff, Greg Leventis, and Sean Murphy. March 2022. *Long-Term Performance of Energy Efficiency Loan Portfolios.* Lawrence Berkeley National Laboratory, https://emp.lbl.gov/publications/long-term-performance-energy.

25 Coalition for Green Capital. *Strategy Regarding Speed and Scale to Achieve Securitization,* https://www.epa.gov/system/files/documents/2024-04/cgc_narrative_proposal1_0.pdf.

26 Buehler, Kevin, Jason Eis, Nick Kingsmill, and Cindy Levy. April 20, 2023. *Delivering Impact From US Green Bank Financing*. McKinsey Sustainability, https://www.mckinsey.com/capabilities/sustainability/our-insights/delivering-impact-from-us-green-bank-financing.

the rate of a loan program. These findings indicate more customers who are risk-averse or debt-constrained can participate.[27]

An important limitation of IUI is that the amount loaned cannot exceed the expected lifetime savings from the energy conservation measure, and in many cases is capped at 80 percent of expected savings. Additional loans or incentives are often required to fund a project because of this limitation to IUI. Therefore, IUI should be stacked or bundled with federal tax credits, direct install, and other incentive programs.

Monetizing and layering other opportunities that arise from building decarbonization, such as grid resilience through load flexibility and eliminating risks of respiratory disease by eliminating nitrogen dioxide, could add monetary value. Layering this monetary value requires an analysis of the benefits and costs of those opportunities, which could identify sources of capital from institutions that can improve energy and nonenergy benefit outcomes.

Combining IUI with credit enhancements can reduce upfront project costs while low-interest loans can cover the remaining project cost. IUI gives customers more access to capital, including customers that are disqualified because of high debt-to-income ratios, poor credit, low home equity, or renter status.

Nonfinancial Market Building

Nonfinancial market-building activities that support awareness, generate demand, and support business model deployment are needed to increase market adoption of affordable financing products. Without these activities, real and perceived upfront cost barriers will prevent progress in doubling energy efficiency by 2030.

Foster Local Organization Outreach

Most California residents are unaware of building decarbonization programs and related benefits. As previously mentioned, 46 percent of surveyed respondents within the TECH Clean California program did not know about financing options besides credit cards or standard bank loans. With GoGreen enabling 12,104 loans to date, market awareness is needed.

Local organizations have the expertise and existing relationships needed to tailor decarbonization outreach to the specific needs within their community. Given the diversity of California's communities, a uniform statewide approach is unlikely to be sufficient.[28] By supporting outreach of local organizations, the state can ensure trusted advisors are available

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27 U.S. Environmental Protection Agency. "ENERGY STAR's Overview on Inclusive Utility Investment." ENERGY STAR, https://www.energystar.gov/sites/default/files/asset/document/EPA%20ENERGY%20STAR%E2%80%99s%20Overview%20on%20Inclusive%20Utility%20Investment_508.pdf.

28 Solis, A., Antonio Díaz, Carmelita Miller, Caroline Farrell, Catherine Garoupa White, Jamie Katz, Jessica Tovar, and Martha Dina Arguello. March 1, 2022. *Community Priorities for Equitable Building Decarbonization*, https://ww2.arb.ca.gov/sites/default/files/2022-03/BEEP%20Letter%20and%20Report_Equitable%20Decarb%20March%202022.pdf.

to provide accurate and up-to-date information about programs and benefits of building decarbonization.

Empower Contractors and Program Implementers

In addition to local organizations, energy service firms, contractors, one-stop shops, CCAs, and local jurisdictions can be empowered to implement building decarbonization projects. These implementers could maximize the effectiveness of existing building decarbonization programs by providing services besides preferential financing, such as readily available and up-to-date state and federal program materials, building modeling and business planning tools, and comprehensive project design tools. For example, in the event of voluntary zonal building decarbonization programs, project implementors could be ready with a program toolkit that streamlines project implementation.

Forge Industry Buy-In and Partnerships

California is home to a world-class private sector with unique technology and innovation capabilities. Partnerships with green capital providers, customer relationship management software, and building energy modeling software are essential to promoting building decarbonization financing. The state can create consistent project pipelines and make deploying capital more efficient by providing strategic alignment among public and private finance, technology companies, and energy contractors. A task force and public private partnerships that identify and prioritize bottlenecks to building decarbonization financing can help create consistent flow of opportunities to investors, and make it more efficient to deploy capital.

Targeted Market Approach

Targeting retrofit programs at high-impact buildings with the highest energy consumption, GHG emissions, and cost-saving potential would help a self-sustaining market for financing to grow more quickly. For instance, retrofit demonstrations of public buildings, voluntary zonal building decarbonization, and bundled high-impact commercial buildings could be used to achieve early success, reduce market barriers, and build momentum for affordable building decarbonization financing.

Barriers and Opportunities: Affordable Building Decarbonization Financing

Barriers

- Available market rate energy loans rely on credit scores that come with high interest rates and are not affordable to at least 30 percent of California residents who have credit scores below 650.
- Developing business models for owners of affordable housing that enable positive cash flow for loan repayments on decarbonization retrofits.
- Building decarbonization projects in hard-to-reach markets are deemed too risky by lenders because of a lack of robust data on financial product performance.
- Many building decarbonization programs are complex, have a higher first cost, and have uncertain utility bill impacts. These issues take decarbonization off the table before preferential decarbonization financing can even be discussed.

Opportunities

- Coordination between agencies, and engagement with private finance companies would allow assessment of opportunities to mobilize capital, such as fostering private sector partnerships, reducing the cost of capital, and ensuring geographical availability of affordable financing products. This assessment could be used to spark private sector investment in building decarbonization.
- Well-designed financing programs that include securitization, coinvesting strategies, and credit enhancements can reduce the risks and costs inherent in project finance to scale affordable financing. These strategies make energy projects more accessible than rebates alone by increasing the pool of borrowers and reducing upfront cost requirements.
- Allocating capital for inclusive utility investment could make decarbonization projects more achievable for building owners by overcoming creditworthiness barriers and reducing upfront project costs. Inclusive utility investment can spark other opportunities for the building owner, such as participation in load flexibility programs.
- Fostering local organization outreach to launch comprehensive engagement, workshops, and planning initiatives is key. It can also create trust and expand awareness of affordable building decarbonization financing programs.
- A one-stop project development program complete with affordable financing services, business planning tools, and up-to-date state program materials could empower energy contractors and local organizations to implement decarbonization projects by simplifying the process to obtain financing.
- Financing demonstration projects that target high-energy-use-intensity or state-owned buildings could encourage rapid market adoption of affordable building decarbonization financing programs.

CEC Building Decarbonization Incentive Programs

The CEC is committed to delivering quality and timely building decarbonization programs that reduce GHG emissions and advance energy equity. While the state's financial challenges forced difficult decisions in the 2024–2025 State Budget, the CEC is addressing the effect of reductions to program budgets by leveraging existing programs and federally funded building decarbonization opportunities.

Equitable Building Decarbonization Program

The CEC is addressing the challenge of decarbonizing low-income residential buildings through the $525.5 million EBD Program, authorized by Assembly Bill 209 (Committee on Budget, Chapter 251, Statutes of 2022). The EBD Program will advance the state's goals of 6 million heat pump installations by 2030, 3 million "climate-ready and climate-friendly" homes by 2030, and 7 million climate-ready and climate-friendly homes by 2035, along with other goals defined in statute and by the program guidelines. A more detailed status on the EBD Program is available in Appendix A of this report. The EBD Program includes the following subprograms:

- **Statewide Direct Install Program**. This program will encourage resiliency to extreme heat, air-quality improvements, energy affordability, grid reliability, and local

workforce opportunities by providing building decarbonization upgrades for low-income households in single-family, multifamily, and manufactured homes in underresourced communities. Upgrades may include heat pumps, heat pump water heaters, other efficient electric appliances, weatherization measures, electrical capacity upgrades, and remediation and safety improvements.

The CEC adopted guidelines for the Statewide Direct Install Program in October 2023.[29] In April 2024, the CEC released a competitive solicitation to select three regional program administrators in three regions to ensure broad distribution of funds.[30] Table 1[31] shows the underresourced community population and the percentage of funds allocated to each region.

Table 1: Regional Funding Allocation

Region	Population of Underresourced Communities (millions)	Percentage of Statewide Direct Install Program Funds (%)
Northern Region	5.3	23
Central Region	4.3	19
Southern Region	13.6	58

Source: CEC staff

The CEC is supplementing state funding for the Statewide Direct Install program with $154 million in federal funds through the federal Inflation Reduction Act (IRA) HOMES Program. Retrofits will begin in winter 2025.

- **Tribal Direct Install Program**. Recognizing the unique needs of tribes and tribal communities, the CEC has set aside $30 million for a separately administered Tribal Direct Install Program to serve housing owned or managed by California Native American tribes, tribal organizations, and tribal members. Draft guidelines for the Tribal Direct Install Program were released in August 2025 following consultation and engagement with tribes.
- **GoGreen Financing Program.** The CEC directed $30 million to the existing CAEATFA GoGreen Financing Program, which provides affordable and accessible financing options

29 Maneta, Diana. 2023. *Equitable Building Decarbonization Direct Install Program Guidelines*. California Energy Commission. Publication Number: CEC-400-2023-003-CMF, https://www.energy.ca.gov/publications/2023/equitable-building-decarbonization-direct-install-program-guidelines.

30 "Grant Funding Opportunity GFO-23-404," released April 30, 2024, https://www.energy.ca.gov/solicitations/2024-04/gfo-23-404-equitable-building-decarbonization-program-direct-install.

31 Maneta, Diana. 2023. *Equitable Building Decarbonization Direct Install Program Guidelines*.

for homeowners to implement energy efficiency improvements. This funding will reduce interest rates and provide a loan loss reserve to support loans for low- and moderate-income households to install low-carbon building technologies. This funding will expand the GoGreen Financing Program statewide and complement California's HEEHRA Phase I and Phase II appliance rebate programs.

Inflation Reduction Act Programs

The IRA was signed into law August 16, 2022, providing $391 billion across the United States to support clean energy and address climate change. The IRA created three programs to encourage home energy retrofits: the HOMES program, the HEEHRA program, and the Training for Residential Energy Contractors (TREC) program. These programs support California's broader efforts to address climate change, improve energy efficiency, and reduce GHG emissions in buildings.

- **HOMES program**. In January 2025, the DOE awarded California $291 million in HOMES program funding to provide performance-based rebates for energy efficiency and resiliency improvements in single-family and multifamily homes. Projects must achieve certain thresholds of energy savings. Energy efficiency measures may include insulation, HVAC upgrades, energy-efficient windows and doors, and other building envelope enhancements. Resilience strategies include protecting homes from wildfire risks, improving air quality, and ensuring homes can withstand and recover from natural disasters more effectively.

  The CEC plans to allocate about $154 million of the funding to the EBD Program to address reductions in state funding. Moreover, $102 million in HOMES funds will be applied to a pay-for-performance program that will reward outcomes through a measured savings approach. The performance pathway will encourage investments for grid reliability and resilience.

- **HEEHRA program**. The HEEHRA equipment and appliance rebates program will help low- to moderate-income households electrify their homes. California split HEEHRA into a two-phase program to accelerate consumer access to incentives. After approval of the CEC's application in June 2024, the DOE awarded the CEC $290 million in funding.

  HEEHRA Phase I launched in fall 2024 and leveraged the existing statewide network of registered and trained installation contractors from the TECH Clean California program to distribute $80 million in residential rebates. It is estimated that about 10,000 single-family and multifamily homes will be upgraded under Phase I.

  The CEC is developing the HEEHRA Phase II program and held a public workshop to gather feedback. CEC plans to submit an amended application for HEEHRA Phase II to the DOE in 2026.

- **TREC program**. The DOE awarded the CEC $10 million in December 2024 to develop and implement the TREC program. The program will develop the workforce needed to install and maintain residential electrification and efficiency improvements and support other building decarbonization programs. CEC released a grant solicitation in November 2025.

Barriers and Opportunities: CEC Building Decarbonization Incentive Programs

Barriers

- Budget constraints. Reductions in state or federal funding could limit the scale or effectiveness of incentive programs.
- Program implementation and coordination. Developing guidelines to meet federal and state requirements, and engaging the public, tribes, community-based organizations, contractors, and other stakeholders takes careful planning and can extend timelines.
- Equity and access. Ensuring equitable access across income levels and geographic areas requires tailored outreach, culturally sensitive approaches, and inclusive administrative processes.
- Technical and market challenges. Implementing technologies and integrating them into buildings may face technical hurdles. Furthermore, stimulating the market will require education, training, and incentives.
- Performance and accountability. Requiring projects to meet performance targets to receive funding adds complexity to programs.
- Administrative coordination. Managing multiple programs simultaneously requires organization and resources. Furthermore, administrative requirements and timelines for federal funds affect program delivery.

Opportunities

- Federal funding. Additional federal funding would expand the scope and reach of decarbonization efforts.
- Equity and inclusion. Specifically targeting tribes and justice communities, including low-income households, improves equitable access to clean energy technologies and benefits and reduces energy burden.
- Technological innovation and adoption. The programs drive technological innovation, adoption of technologies, and overall market transformation that reduces GHG emissions and improves energy resilience, air quality, and grid reliability.
- Performance-based incentives. Measurable outcomes encourage homeowners and contractors to invest in durable, effective solutions that contribute to long-term energy savings, emissions reductions, and environmental benefits.
- Workforce development. Workforce readiness supports job creation and ensures skilled workers can install and maintain clean energy technologies which benefits communities.

Bill Impact Estimation and Electricity Rates

Electrification of single-family homes presents a significant opportunity for GHG reductions. Electrification can lead to utility bill savings for the average customer, but many customers may see their utility bills increase. This section discusses the need for tools to estimate bill impacts for single-family homes.

California electric utility rates are the second highest in the country per kilowatt-hour (kWh). Low-income residents pay a greater percentage of their income toward their electric bill than higher earners,[32] although they receive discounts through the CPUC programs California Alternate Rates for Energy (CARE) and Family Electric Rate Assistance (FERA).[33] According to the *2021/2022 Annual Affordability Report* (*2021/2022 Affordability Report*), most areas of California that face challenges with affordability of utility bills are low-income.[34] IOU residential rates increased by 81 percent for PG&E and 67 percent for Southern California Edison (SCE) between 2021 and 2024.[35] Table 2 shows the approved residential electricity rate increases for San Diego Gas & Electric Company (SDG&E), SCE, PG&E, and Sacramento Municipal Utility District (SMUD) in 2024 with the impact to monthly bills for CARE and average residential customers.[36]

32 Borgeson, Merrian. 2024. "Equitable Rate Reform Is Required to Meet Our Climate Goals." Blog. NRDC, https://www.nrdc.org/bio/merrian-borgeson/equitable-rate-reform-required-meet-our-climate-goals.

33 California Public Utilities Commission. "CARE/FERA Program," web page, https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-costs/care-fera-program.

34 CPUC. October 2023. *2021/2022 Annual Affordability Report,* https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/affordability-proceeding/2021-2022/2021-and-2022-annual-affordability-report.pdf.

35 Borgeson, Merrian. 2024. "Equitable Rate Reform Is Required to Meet Our Climate Goals."

36 Pacific Gas and Electric. April 1, 2024. "Electric Rate Advisory." https://www.pge.com/assets/pge/docs/account/rate-plans/electric-rate-advisory-0424.pdf.

Southern California Edison. "SCE Rate Advisory," https://www.sce.com/residential/rates/rateadvisory.

Table 2: Bill Impacts Resulting from Electricity Rate Increases for Four Utilities in 2024

IOU	Type of Customer	Percentage Change From Previous Rate (%)	Impact ($)	Previous Monthly Bill ($)	New Monthly Bill ($)
SDG&E	Non-CARE	+5.3	8	157	165
SDG&E	CARE	+5.4	5	101	107
SCE	Average Residential	-1.6	2	180	178
SCE	CARE	-1.2	1	122	120
PG&E	Average Residential	+1.4	3	223	226
PG&E	CARE	+1.4	2	142	143
SMUD	Average Residential	+5.5	4	131	139

Sources: SDG&E, SCE, PG&E, and SMUD[37]

Table 3 shows average electric rates charged by SDG&E, SCE, PG&E, the Los Angeles Department of Water and Power (LADWP), and SMUD in 2024, demonstrating the variability of available rates which leads to customers across the state experiencing different bill impacts from electrification.[38]

37 Sacramento Municipal Utility District. "2023 Rate Proposal," https://www.smud.org/-/media/Documents/Rate-Information/2023-Rate-Action/0561-23_RatesAction_Factsheet-revAug_Final.ashx.

38 Sacramento Municipal Utility District. August 26, 2024. Personal Communication.

Los Angeles Department of Water and Power. September 3, 2024. Personal Communication.

San Diego Gas & Electric. "Total Electric Rates," https://www.sdge.com/total-electric-rates. Average annual rate derived from CEC staff analysis using rates available on SDG&E website.

San Diego Gas & Electric. February 29, 2024, "Bundled Electric Rate Change Alert," https://www.sdge.com/sites/default/files/S2480009-SDGE-March-Electric%20Rate%20Change%20Alert-FINAL2a.pdf.

Southern California Edison. "Time-of-Use Residential Rate Plans," https://www.sce.com/residential/rates/Time-Of-Use-Residential-Rate-Plans. Average annual rate derived from CEC staff analysis using rates available on SCE website.

Southern California Edison. "Tiered Rate Plan," https://www.sce.com/residential/rates/Standard-Residential-Rate-Plan. Average annual rate derived from CEC staff analysis using rates available on SCE website.

Table 3: Average Annual Residential Electricity Rates for Major IOUs and POUs

Utility	Customer	Average Annual Rate ($)
SDG&E	Non-CARE	0.4578
SDG&E	Low-Income (CARE)	0.298
SCE	Average Residential	0.4319
SCE	Low-Income	N/A
PG&E	Average Non-CARE Residential	0.412
PG&E	Low-Income (CARE)	0.261
LADWP	Residential (without discounts)	0.242
LADWP	Low-Income (EZ Save)	0.204
SMUD	Average Residential	0.190
SMUD	Low-Income (EAPR & EAPRMED)	0.133

Sources: SDG&E, SCE, LADWP, and SMUD

High electricity rates are a key barrier to electrification, especially in the residential sector.[39] Surveys and studies have found upfront costs of electrification and energy efficiency measures pose the greatest barrier to decarbonization[40] and adoption of energy-efficient technologies in homes.[41] Electrification reduces customer bills in areas with lower volumetric (per-kWh of usage) electric rates such as LADWP and SMUD.

In a nationwide survey, *Regional Assessment of Household Energy Decision-Making and Technology Adoption in the United States*, researchers surveyed households nationwide to understand the barriers to energy-efficient technology adoption in different regions of the United States. Upfront cost was cited as the largest barrier (63–68 percent of households), while unclear costs and benefits were a barrier in about 30 percent of households.[42] The survey also found households in the western region of the United States considered energy expenses when making decisions to change household energy use, such as installing or

39 Walker, Iain S., Brennan D. Less, Núria Casquero-Modrego, and Leo I. Rainer. 2022. *The Cost of Home Decarbonization in the US*. Lawrence Berkeley National Laboratory, https://eta-publications.lbl.gov/sites/default/files/the_costs_of_home_decarbonization_9.13.22.pdf.

40 Less, Brennan, Iain S. Walker, Núria Casquero-Modrego, and Leo I. Rainer. 2021. *The Cost of Decarbonization and Energy Upgrade Retrofits for US Homes.* Lawrence Berkeley National Laboratory, https://buildings.lbl.gov/publications/cost-decarbonization-and-energy.

41 Antonopoulos, Chrissi, Tracy L. Fuentes, Kieren H. McCord, Adrienne L. S. Rackley, and Saurabh Biswas. February 2024. "Regional Assessment of Household Energy Decision-Making and Technology Adoption in the United States." Energy Policy, Vol. 185, https://www.sciencedirect.com/science/article/pii/S0301421523005256.

42 Ibid.

replacing appliances, further illustrating the concern about costs.[43] In nearly all regions, households with higher incomes were more likely to adopt decarbonization technologies.[44]

Expected Bill Impacts of Decarbonization

The *2019 Energy Action Plan* recommended that utilities implement affordable electric rates designed for the electrification of low-income homes.[45] This recommendation was echoed in *Appendix F Building Decarbonization* (*2022 CARB Scoping Plan*), which noted that supportive energy rates are needed to reduce the cost burden on households that may experience increased bills with electrification.[46] The CPUC approved a new billing structure in May 2024 that introduces an income-graduated fixed charge and reduces the volumetric rate, as mandated by Assembly Bill 205 (Committee on Budget, Chapter 61, Statutes of 2022). This new billing structure will lower overall electricity bills on average for lower-income households and those living in regions most impacted by extreme weather events, which could reduce the bill impacts of electrification of home appliances and vehicles.[47]

To assess the likely bill impacts of electrification, the CPUC estimated the change in monthly utility bills (electricity, gas, and gasoline) based on average usage in a typical home after electrification measures are implemented. The parameters of the model included:

- Two electrification scenarios: full-home electrification, vehicle-only electrification.[48]
- Two rate structures: existing default time-of-use (TOU)[49] and the new income-graduated fixed charge TOU rate structure.
- Three large utilities: PG&E, SCE, and SDG&E.
- Two climate zones: inland and coastal.

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43 Ibid.

44 Ibid.

45 Kenney, Michael, Heather Bird, and Heriberto Rosales. 2019. *2019 California Energy Efficiency Action Plan*.

California Air Resources Board. 2022. *2022 Scoping Plan for Achieving Carbon Neutrality*.

46 California Air Resources Board. 2022. *Appendix F - Building Decarbonization*, 2022 Scoping Plan for Achieving Carbon Neutrality, https://ww2.arb.ca.gov/sites/default/files/2022-11/2022-sp-appendix-f-building-decarbonization.pdf.

47 California Public Utilities Commission. May 9, 2024. News Release. "CPUC Approves A New Billing Structure That Will Cut Residential Electricity Prices And Accelerate Electrification," web page, https://www.cpuc.ca.gov/news-and-updates/all-news/cut-residential-electricity-prices.

48 *Full-home electrification* involves switching gas appliances such as water heaters and stoves to electric appliances. *Vehicle-only electrification* refers to switching from a traditional gas-powered vehicle to an electric vehicle.

49 *Time-of-use* (TOU) rate structure charges a consumer for energy based on the time of day they use it, categorized as on-peak, off-peak, and midpeak. TOU rates change throughout the day as energy demand and cost to produce energy changes.

The bill impacts of these electrification scenarios and rate structures, shown in Table 4, illustrate how the income-graduated fixed charge can lower the barrier to electrification for an average or representative home.

Table 4: Monthly Bill Savings After Electrification With an Income-Graduated Fixed Charge for Inland and Coastal Climate Zones

Electrification Scenario	PG&E	SCE	SDG&E
Full Home Electrification	$12.05 to $14.19	$11.24 to $12.17	$14.74 to $18.57
Vehicle Electrification	$17.43 to $17.52	$16.87 to $16.93	$25.11
Home + Vehicle Electrification	$29.56 to $31.62	$28.17 to $29.04	$39.85 to $43.68

Source: California Public Utilities Commission

LBNL also studied the bill impacts of time-based rates for residential customers across the United States adopting building decarbonization technologies. LBNL applied four rate designs (TOU, event-based pricing, coincident demand charges, and real-time pricing) across 40,000 simulated building energy profiles and found bill savings ranging from less than 2 percent to 6 percent.[50] Overall, the study found reducing the average volumetric rate coupled with an income-graduated fixed charge resulted in the greatest savings when implementing decarbonization measures.[51]

Tools to Estimate Bill Impacts and Project Costs

Studies to understand the decision-making process for adopting energy-efficient technologies in the home concluded that policies that are tailored to meet consumers' needs can be more effective in encouraging technology uptake. Policy mechanisms to lower barriers to adopt home decarbonization technologies should consider the needs of the building occupants, as well as their budgetary constraints and priorities. Given high electricity rates, bill impact estimators are an important tool to reduce ratepayer hesitation of building electrification.

Public programs have limited resources for homeowners and building owners to calculate how decarbonization will impact utility bills. The U.S. DOE's Building Technologies Office offers the Home Energy Score, a report that estimates home energy use and associated costs and suggests cost-effective energy solutions to improve home energy efficiency based on the most recent utility rates and the source energy for heating, cooling, and hot water. Heat pumps could benefit consumers and utilities through reduced energy use and bills, however, data on heat pump performance are lacking, making it difficult to determine which consumers would benefit most from a heat pump. The TECH Clean California Innovative Customer Targeting

50 Kahn-Lang, Jenya, Cesca Miller, Andrew J. Satchwell, and Elaina Present. 2024. *Building Efficiency, Electrification, and Distributed Solar PV Bill Savings Under Time-Based Retail Rate Designs.* Lawrence Berkeley National Laboratory, https://emp.lbl.gov/publications/building-efficiency-electrification.

51 Ibid.

Pilot used meter-based data to identify customers that would benefit the most and save on utility bills by electrifying their heating and cooling with heat pumps.[52]

The CPUC is working with the consulting firm Guidehouse to create a public-facing customer electrification estimator tool that enables home and building owners to estimate their future bills after decarbonization measures. The CPUC is finalizing this customer electrification estimator tool that residential IOU customers can use to estimate the impacts on their gas and electric bills after installing an appliance that substitutes electric for gas.

The private sector is interested in developing and commercializing tools to estimate bill impacts from decarbonization measures. Some tools available to the public can produce individual models for a homeowner to estimate the impacts of decarbonization upgrades on their bills or create models for utilities to estimate impacts on the grid.

One such tool develops models for homeowners to estimate the bill impacts of energy upgrades. The modeling tool uses the U.S. DOE EnergyPlus™ simulation engine and publicly available data — such as property assessment data, building permits, and three-dimensional geographic information system (GIS) data — to develop detailed energy models based on a representative home in the area. The models provide homeowners with customized energy efficiency upgrade recommendations and potential bill impacts.

Another impact modeling tool uses interval meter data from smart meters that utilities can use to measure energy use and the impact of efficiency and demand flexibility on the grid accurately. The tool uses population-level customer-meter data for planning and forecasting behind-the-meter potential to create more cost-effective programs and promote demand flexibility that can be used any time.

Accuracy of Predicted Bill Impacts

The *2019 Energy Action Plan* recommended using meter-based decarbonization program results to improve utility potential and goal studies. Better data can be used to refine the annual goals set by the CPUC by measuring the bill impacts of those decarbonization upgrades more accurately.

CEC staff is conducting an analysis using models and historical data to determine the impact of decarbonization measures on utility bills. These data typically represent the average home for a given region, rather than a ratepayer's unique home. Consumers may be more inclined to electrify and decarbonize if presented with bill impact estimates based on the energy-use patterns of their home or building, or similar, rather than estimates based on model data.

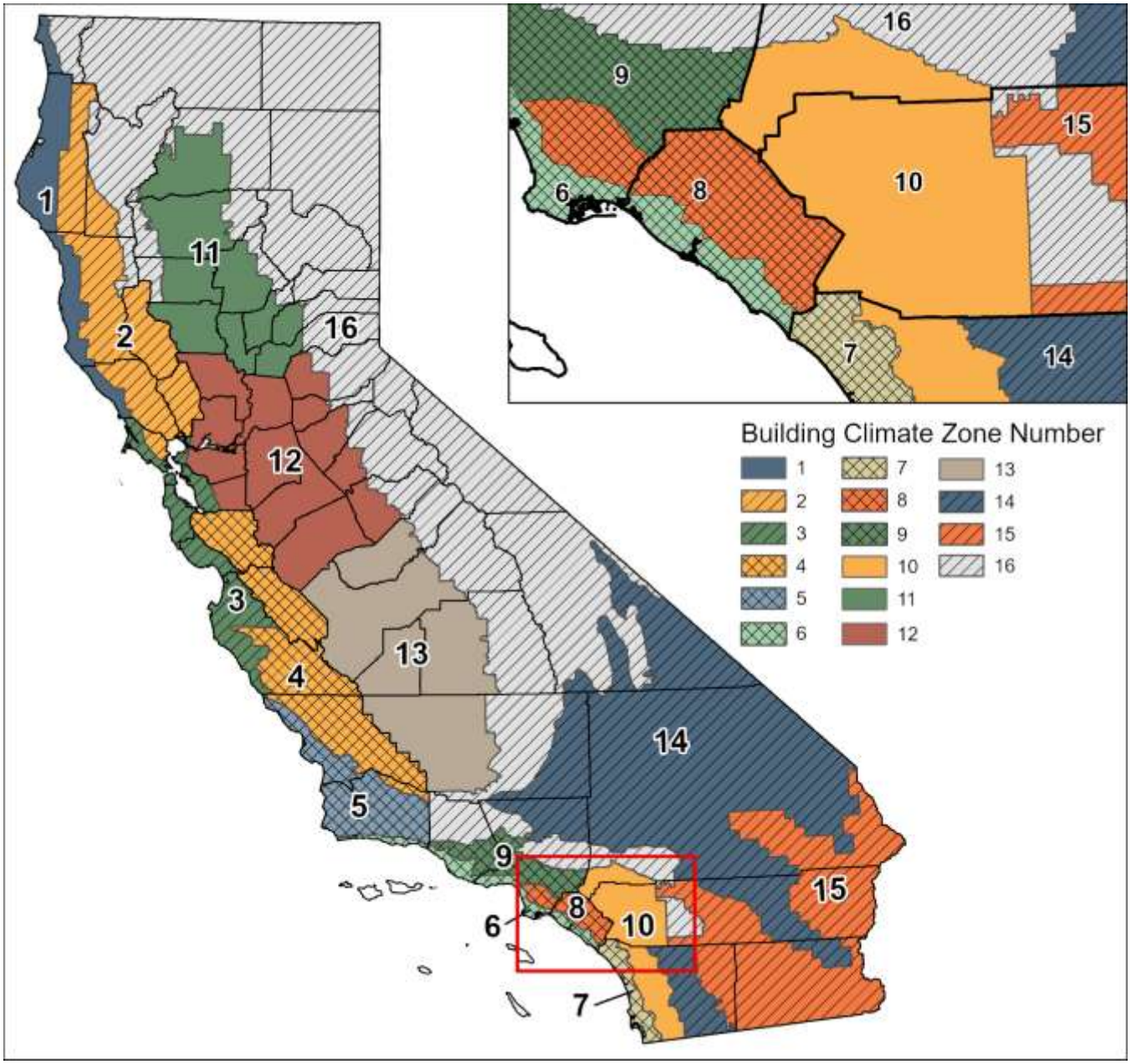
Modeling and analysis using California's Building Energy Code Compliance Software (CBECC) suggest that there may be a combination of decarbonization retrofit measures that could achieve on average for various housing types in each of California's 16 climate zones, which are displayed in Figure 3. CEC staff continues to refine this modeling and plans to release a

52 TECH Clean California. Accessed December 3, 2025. "Innovative Customer Targeting Pilot," web page, https://techcleanca.com/pilots/strategic-customer-targeting/.

report detailing the results in 2026. Preliminary results, using utility rates from March 2022 to February 2023, suggest that bill impacts vary by climate zone more than by building type. In particular, high-cooling-load climate zones have high bill savings after heat pump heating, ventilation, and air-conditioning (HVAC) retrofits during summer but only slight savings during winter.[53]

53 California Energy Codes and Standards. 2025. *2025 Cost-Effectiveness Study: Single Family AC to Heat Pump Replacement*. https://cpareachcodes.org/wp-content/uploads/2025/07/2025-Single-Family-AC-to-HP-Cost-eff-Study.pdf.

Figure 3: California's 16 Climate Zones



Source: California Energy Commission. https://cecgis-caenergy.opendata.arcgis.com/documents/eaf3158767674e6cb14f4407186d3607/explore

A study conducted by LBNL analyzed costs for decarbonization measures by creating a database of household metadata (location, vintage, and so forth), cost of measures, the performance of measures, and pre- and postenergy consumption data. LBNL concluded that large datasets are necessary for studies to predict bill impacts accurately.[54] The database produced from this study is limited in relevancy and accuracy of bill impacts for Californians as

54 Less, Brennan, et al. 2021. *The Cost of Decarbonization*.

many of the measures were not specific to decarbonization and spanned the entire United States.[55]

Utility usage and rate data are needed to estimate utility bill impacts accurately, but there is no centralized source for gas and electric utility usage and rate data updated regularly. These data, which are not easily accessible to consumers, are found in published utility tariffs that can be difficult for most homeowners to understand. The published information includes one tariff per rate, formatted by each utility differently. Given the many utilities in California and multiple rates offered by each utility, reading tariffs manually would be time-consuming, making it difficult for state agencies and private companies to extract the data and nearly impossible for consumers to conduct their own bill impact analysis.

The Market Informed Demand Automation Server (MIDAS), hosted by the CEC and developed to support the 2022 update to the Load Management Standards (LMS), is a database that provides consumers and aggregators access to optional time-dependent rates utility rates, GHG emission signals, and California Independent System Operator Flex Alerts.[56] Historical data on the time-dependent rates offered by utilities via MIDAS could be used to refine estimates of bill impacts from consumer participation in load-flex programs.

OpenEI, an open energy information organization, hosts the Utility Rate Database (URDB), which provides rate structure information checked and updated by the National Renewable Energy Laboratory (NREL). The URDB allows users to search for rates by utility, customer sector, and service type. While the URDB includes most electric utility companies, it does not include gas utilities and is not updated consistently, sometimes missing when a new rate is available to customers. While OpenEI offers rate data consumers may use to estimate their bill impacts, it is not a comprehensive or regularly updated centralized rate database.

The CEC's energy data repository can be used to improve bill impact estimation. The CEC's energy data repository collects billing and meter data for all gas and electric retail customers from PG&E, SCE, Southern California Gas Company (SoCalGas), SDG&E, SMUD, and LADWP. Data include billing-level charges and energy consumption; characteristics of accounts, meters, and bills; and granular interval-level data for smart electric meters from utilities that use them. The energy data repository contains data for almost all California utility customers, it is large enough to meet the size requirements for statistical accuracy, as LBNL suggested in the study previously mentioned.

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55 Ibid.

56 *Time-dependent rate* means a rate that can vary depending on the time of day to encourage off-peak electricity use and reductions in peak electricity use. Time-of-use, hourly, and sub-hourly rates are time-dependent rates.

GHG emission signals are real-time and forecasted estimates of GHG emissions for 11 regions in California, obtained from WattTime. Data Signals Overview - WattTime

A *Flex Alert* is a call to consumers to voluntarily cut back on electricity and shift electricity use to off-peak hours (normally after 9 p.m.). As part of an educational and emergency alert program, Flex Alerts inform consumers about how and when to conserve electricity.

The energy data repository can be used to statistically verify and enhance other data collection efforts, studies, and statewide program data. For instance, the CPUC is using the energy data repository to develop a customer electrification estimator tool to enable customers to estimate the impact that fuel substitution (electrification) will have on their monthly utility bill. Pairing meter data with modeling tools could allow consumers in each climate zone to predict how their electric bills will be impacted by housing type or vintage.

TECH Clean California conducted a preliminary analysis on the bill impacts of heat pump HVAC systems for homes in their program by measuring electricity and gas meter interval data and billing data from 143 homes in PG&E's gas service area beginning in 2018.[57] The results of the analysis found gas usage decreased by 44 percent, while electricity usage increased by 17 percent, resulting in an annual utility bill savings of $154. Single-family homes with the highest cooling load saw greater benefits and utility bill savings. The TECH program used a targeting method to identify high-usage homes that would likely save the most money through heat pumps, so this should not be considered a representative sample of homes, but could be considered representative of a program population.

Barriers and Opportunities: Bill Impact Estimations and Electricity Rates

Barriers

- Consumers do not have access to online, user-friendly tools that use utility usage data, rate information, or other information needed to estimate the bill impacts of decarbonization measures in their home. Some tools that are available only calculate the bill impacts to an average home but do not provide an individualized estimate tailored to a customer's home.
- Current analyses used to predict bill impacts can account for the average home, rather than every unique building, which does not provide customers with accurate bill savings estimates tailored to their home.
- Studies and models analyzing the impacts of decarbonization measures on bills are not comprehensive, fail to account for factors like the unique energy-use patterns of the occupants of a specific building, and do not have a large enough sample size to develop accurate methods for calculating bill impacts.

Opportunities

- Combining existing tools, databases, and models that contain utility billing and meter data in a centralized repository accessible to the public could help building owners estimate bill impacts more accurately. These estimates should include project costs, be tailored to each building and the energy-use patterns of the occupants and be based on building meter data. State agencies and utilities are well-positioned and have the

57 Kursman, Jess. May 16, 2024. "Decarbonizing California: Updates and Opportunities," Presentation, pg. 72, TECH Clean California. https://cedmc.org/wp-content/uploads/2024/05/PDF-FULL-SLIDE-DECK-2024-CEDMC-Spring-Symposium-finalv2.pdf.

resources to conduct ongoing research to determine the usefulness of these tools for consumers.

- Research, analyses, models, and studies using comprehensive data, including cost of decarbonization measures, utility bills, rate data, other factors like climate zone, season, and building type or vintage, could determine the impact of decarbonization measures on electric utility bills more accurately for every building.
- Expanding MIDAS, a centralized database, to include all electricity flat and gas rates will capture most of the energy price data needed to estimate changes to a customer's utility bills. The CEC and CPUC can work with the utilities to support this additional data collection and updates to rate information as soon as a rate is offered or available to customers.
- Historical meter data, the CEC's energy data repository, standardized open-source methods, and energy modeling tools can be used to develop analytical methods for bill impact estimation. The analytical methods that are developed and the data used can foster innovation if made public, while protecting personally identifiable information (PII).

Health Benefits of Building Decarbonization

Combustion of fossil fuels in buildings is a substantial source of indoor air pollution. For example, the use of gas cooking equipment has been shown to generate harmful pollutants such as nitrogen dioxide (NO_2) and fine particulate matter ($PM_{2.5}$).[58] These are criteria air pollutants with demonstrated health impacts, including respiratory illness, cardiopulmonary disease, and premature birth.[59]

Despite the known health implications of combustion-generated air pollutants, the use of gas stoves remains widespread in California buildings. In 2020, 9.2 million households out of 13.2 million households in California (70 percent) had a gas cooking appliance.[60] With millions of families at risk of elevated exposure, there is growing concern about the health impacts to children, whose developing respiratory systems are more vulnerable.

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58 Chan, Wanyu R., Yang-Seon Kim, Brennan D. Less, Brett C. Singer, and Iain S. Walker. *Ventilation and Air Quality in New California Homes with Gas Appliances and Mechanical Ventilation*. California Energy Commission. Publication Number: CEC-500-2020-023, https://www.energy.ca.gov/publications/2020/ventilation-and-air-quality-new-california-homes-gas-appliances-and-mechanical.

Singer, Brett C., Wanyu Rengie Chan, William W. Delp, Iain S. Walker, and Haoran Zhao. *Effective Kitchen Ventilation for Healthy Zero Net Energy Homes With Natural Gas*. California Energy Commission. Publication Number: CEC-500-2021-005, https://www.energy.ca.gov/publications/2021/effective-kitchen-ventilation-healthy-zero-net-energy-homes-natural-gas.

59 Rocky Mountain Institute. Accessed August 2024. *Gas Stoves: Health and Air Quality Impacts and Solutions — RMI,* https://rmi.org/insight/gas-stoves-pollution-health. Rocky Mountain Institute. Accessed August 2024. , https://rmi.org/insight/gas-stoves-pollution-health.

60 United States Energy Information Administration. March 2023. "Highlights for Appliances in U.S. Homes by State, 2020," https://www.eia.gov/consumption/residential/data/2020/state/pdf/State%20Appliances.pdf.

A meta-analysis conducted in 2013 of 41 studies found that children who live in homes with gas stoves have a 42 percent increased risk of having current asthma, a 24 percent increased risk of lifetime asthma, and an overall 32 percent increased risk of having current and lifetime asthma compared to children who do not live in homes with gas stoves.[61] Further, children living in smaller units of multifamily buildings that predate the state's current health-protective energy code and have inadequate ventilation face higher risks from living with a gas stove compared to children in larger homes that comply with current building code.[62]

Electrification has been identified as a clean, relatively low-cost strategy that would not only decarbonize buildings,[63] but improve indoor air quality and public health by eliminating emissions from indoor fossil fuel combustion. One study performed by School of Medicine at Johns Hopkins University found that replacing a gas stove with an electric stove decreased median NO_2 concentrations by 51 percent in the kitchen.[64]

Continued research is needed to better understand the effectiveness of such interventions and substantiate the connection between electrification and improved health. The CEC is committed to continuing to support this emerging field of research.

Quantifying Benefits of Improved Air Quality in Buildings

For more than 15 years, the CEC has funded research to better understand and measure the relationship between indoor air quality and energy use in buildings. For example, one of the first major field efforts to investigate residential indoor air quality in California resulted in revisions to the *2008 Residential Building Energy Efficiency Standards* after establishing the need for mechanical ventilation in tightly sealed new homes.[65] A subsequent study estimated that the annual health impact of residential indoor air pollutants in California was $400 to $1,100 per person ($15 billion to $40 billion total) and identified improved ventilation, air

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61 Lin W., B. Brunekreef, and U. Gehring. August 20, 2013. "Meta-Analysis of the Effects of Indoor Nitrogen Dioxide and Gas Cooking on Asthma and Wheeze in Children." *Int J. Epidemiology,* https://pubmed.ncbi.nlm.nih.gov/23962958/

62 Wolstein, J., Y. Meng, and S. H. Babey. 2010. *Income Disparities in Asthma Burden and Care in California*. UCLA Center for Health Policy Research, https://escholarship.org/uc/item/9pw681gq.

63 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.

Billimoria, Farhad, Olumide Adisa, and Robert L. Gordon. 2018. "The Feasibility of Cost-Effective Gas Through Network Interconnectivity: Possibility or Pipe Dream?" *Energy,* https://www.sciencedirect.com/science/article/abs/pii/S0360544218319911?via%3Dihub.

64 Paulin L.M., G. B. Diette, M. Scott, M. C. McCormack, E. C. Matsui, J. Curtin-Brosnan, D. L. Williams, A. Kidd-Taylor, M. Shea, P. N. Breysse, and N. N. Hansel. August 24, 2014. "Home Interventions Are Effective at Decreasing Indoor Nitrogen Dioxide Concentrations." *Indoor Air*, https://pubmed.ncbi.nlm.nih.gov/24329966/.

65 Public Interest Energy Research. November 2009. *Ventilation and Indoor Air Quality in New Homes.* November 2009. California Energy Commission, California Air Resources Board. Publication Number: CEC-500-2009-085, http://www.iee-sf.com/pdf/CEC-500-2009-085.pdf.

cleaning, and source control options as primary strategies to reduce that cost.[66] These efforts and subsequent studies have guided the CEC's approach to ensuring that the building energy code results in indoor environments that are healthier and safer for all.

In recent years, CEC-funded research continued exploring health benefits associated with building electrification and ventilation.[67] To build on these important findings, the CEC continues to create new research opportunities that will generate timely data on the impact of building electrification. Related ongoing and forthcoming CEC-funded research projects include:[68]

- EPC-21-033 — Cooking Energy and Ventilation Impacts on Children's Asthma (LBNL)[69]
- EPC-24-042 — Tri-County Benefits of Electrification for Air Quality, Comfort, and Health (County of Ventura)[70]
- PIR-24-001 — Cooking and Clean Air in California Homes Study (LBNL)
- PIR-24-002 — Assessing Exposure to Residential Air Pollution for Low-Income Families with Gas and Electric Cooking Technologies (Berkeley Air Monitoring Group)

CEC-funded research on air quality contributes to, and is guided by, efforts made by the scientific community to understand the health impacts of indoor combustion and building

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66 Sherman, M., et al. 2013. *Residential Energy Savings from Air-Tightness and Ventilation Excellence (RESAVE).* California Energy Commission. Publication Number: CEC-500-2014-014. Report available upon request.

67 Fournier, Eric Daniel, Diane Garcia-Gonzales, Danielle Zamora, David Diaz, Marc Costa, Alex Ricklefs, Felicia Federico, Michael Jerrett, Craig Perkins, and Stephanie Pincetl. May 31, 2023. *A Holistic Assessment of Building Energy System Transition Pathways in Under-resourced Communities.* California Energy Commission. Publication Number: CEC-500-2023-034, https://www.energy.ca.gov/publications/2023/holistic-assessment-building-energy-system-transition-pathways-under-resourced.

Singer, Brett C., et al. January 21, 2021. Effective Kitchen Ventilation for Healthy Zero Net Energy Homes with Natural Gas. California Energy Commission.

Pistochini, Theresa, Mande, Caton, Modera, Mark, et al. (U.C. Davis). July 7, 2020. *Improving Ventilation and Indoor Environmental Quality in California K-12 Schools*. California Energy Commission. Publication Number: CEC-500-2020-049, https://escholarship.org/content/qt1jp1q4xb/qt1jp1q4xb.pdf.

Alexander, Marcus, Ana Alvarez-Gomez, Daniel Bowermaster, John Grant, Brandon Johnson, Eladio Knipping, Sreenidhi Krishnamoorthy, Coco Liu, Uarporn Nopmongcol, Perry Stephens, AND Baskar Vairamohan. June 13, 2019. *Air Quality Implications of an Energy Scenario for California Using High Levels of Electrification.* California Energy Commission. Publication Number CEC-500-2019-049, https://www.energy.ca.gov/publications/2019/air-quality-implications-energy-scenario-california-using-high-levels#:~:text=The%20results%20show%20that%20there,most%20heavily%20affected%20by%20pollution.

68 California Energy Commission. Accessed December 2025. "Healthy, Equitable Energy Transition (HEET) Working Group," web page, https://www.energy.ca.gov/programs-and-topics/topics/research-and-development/healthy-equitable-energy-transition-heet.

69 "The Cooking Electrification and Ventilation Improvements for Children's Asthma." California Energy Commission, https://ceqanet.lci.ca.gov/2022080544.

70 California Energy Commission. Accessed December 2025. "Healthy, Equitable Energy Transition (HEET) Working Group."

electrification. A 2020 study from the Massachusetts Institute of Technology (MIT) shows that buildings are responsible for considerable indoor air pollution and health impacts (as demonstrated by CEC-funded research) and are the dominant source of outdoor air pollution health impacts in the United States. Studies found that over the past two decades, the residential and commercial buildings sectors have surpassed transportation and electricity generation as the leading cause of mortality associated with outdoor air pollution in California, producing emissions that were associated with more than 6,000 premature deaths in 2018.[71]

Quantifying Benefits of Improved Outdoor Air Quality

In addition to the health impacts of indoor air pollution, fossil fuel combustion in buildings impacts health through outdoor air pollution. Modeling the health outcomes of reductions in outdoor air pollution from building decarbonization in the *2022 CARB Scoping Plan* predicted improvements in the estimated avoided incidence of mortality, cardiovascular and respiratory disease, work loss days, and hospital admissions.[72] For detailed results of the model, see Tables 3–7 on page 143 of the *2022 CARB Scoping Plan*.

Barriers and Opportunities: Health Benefits of Building Decarbonization

Barriers

- Longer-term studies (beyond the typical time horizon of CEC-funded grants) are needed to resolve health impacts.
- It is difficult to access a representative sample of homes, including multifamily units or units in justice communities or both.
- Modeling tools struggle to quantify and value the health impacts of indoor air quality. The models are complex and can vary significantly based on home characteristics and resident health profiles.
- Mechanical ventilation systems in low-income housing often do not have sufficient airflow to reduce criteria pollutant levels.

Opportunities

- Support for epidemiological research relevant to decarbonization policy could provide an improved scientific foundation for policy and programs to improve the health of residents and benefit energy ratepayers, while supporting the building energy transition in California.
- Partnerships with community-based organizations can help access homes and increase participation rates in studies.
- Developing metrics and improving technical modeling tools can help access the impacts of indoor air pollution, characterize the health risk reduction resulting from building

71 Dedoussi, I. C., S. D. Eastham, E. Monier, et al. February 12, 2020. "Premature Mortality Related to United States Cross-State Air Pollution." *Nature,* https://www.nature.com/articles/s41586-020-1983-8.

72 California Air Resources Board. 2022. *2022* Scoping Plan for Achieving Carbon Neutrality*,* pg. 143.

electrification, and allow the health benefits of decarbonization to be quantified financially to support programs and regulation.

- Empirical field data from new California buildings could help validate new building energy efficiency standards for residential and commercial kitchen ventilation.

Remediation Costs for Residential Buildings

Remediation refers to several types of repairs or upgrades associated with decarbonization, which can include:

- Repairs or alterations required to accommodate equipment, such as enlargement of return ducts or alterations to closet spaces.
- Optional upgrades that improve energy performance or health and safety outcomes, such as air sealing or vent hood installation over cooktops that vent to the outside.
- Health, building code, and safety upgrades such as asbestos mitigation to resolve problems that are not directly related to energy upgrades.

Some measures improve energy performance and health and safety. For example, improved air sealing can reduce a household's energy consumption and allow HVAC systems to be downsized while improving indoor air quality and reducing exposure to harmful pollutants from outside the building.[73] Energy upgrades such as new heating and air-conditioning systems can be modified to require high-quality air filters, which remove more airborne particles.[74] Energy upgrades may also require specific health and safety upgrades such as roof repairs to install a rooftop solar photovoltaic (PV) system or require an electric panel upgrade.

Remediation is an important equity concern and is frequently necessary to enable energy upgrades that help achieve California's climate and energy goals. Low-income energy program participants may not be able to afford all the remediations required to enable subsidized energy upgrades. The incomplete remediation work could disqualify willing participants from receiving incentivized decarbonization measures and result in the household purchasing inefficient combustion-fuel equipment. California energy program administrators and environmental justice advocacy groups recognize this issue and are working to adjust existing programs and create new programs that address remediation needs at the time of energy upgrades.

The *2021 IEPR Action Plan* recommended, "The CEC should assess the potential remediation needs and costs associated with building retrofits. These include the typical added upfront costs due to mold, asbestos, lead pipes, and water damage, where it is an obstacle to the installation of electric equipment."[75] The CEC's programs, such as the EBD Program and other

73 California Department of Community Services and Development. January 2021. *Assembly Bill 1232 Report & Action Plan,* https://www.csd.ca.gov/Shared%20Documents/AB1232-Report.pdf.

74 Ibid.

75 Kenney, Michael, et al. 2022. *Final 2021 Integrated Energy Policy Report*.

non-CEC-administered programs, are moving toward meeting this recommendation, as described below. The program funds include set-asides for remediation and allow leveraging of other funding sources to address health and safety remediation needs.

It is challenging to determine which remediation measures to fund in programs because data to quantify the expected costs and benefits are limited and there is no common basis to quantify and trade off energy vs. nonenergy benefits. The perceived trade-off between providing more comprehensive energy upgrades for a smaller number of households or a narrow set of measures that benefit a greater number of households presents another challenge. If programs install decarbonization measures but do not address preexisting problems such as drafts and mold, public perception of decarbonization could suffer. Conversely, high expenditures on remediation could lead to perceptions of poor stewardship of public funds. Thus, achieving the right balance around remediation is important.

Existing Efforts and Policies

Addressing remediation is important in helping ensure broad participation in the clean energy transition. Energy and decarbonization incentive programs fund remediation to limited extents. For example, while the Low-Income Weatherization Assistance Program Multifamily Component administered by the California Department of Community Services and Development (CSD) requires an assessment of preexisting health and safety issues, it requires the property owner to pay for or secure other funding to remediate identified issues.[76] The U.S. DOE Weatherization Assistance Program (DOE WAP), administered by CSD, allows the use of funding for limited home repairs and enables the leveraging of other funding sources to address remediation. If remediation needs are cost-prohibitive, weatherization may be completed partially or abandoned.

Research shows that national deferral rates, when homes are not weatherized or weatherized partially because remediation is needed, are about 19 percent and can vary from 5 percent to 63 percent in some places.[77] In 2022, the Weatherization Readiness Funding (WRF) program was established and provided $15 million to address remediation and support completion of

76 California Department of Community Services and Development. May 2022. *Low-Income Weatherization Program Guidelines*, https://www.csd.ca.gov/Shared%20Documents/LIWP-2022-Multi-Family-2.0-Draft-Program-Guidelines.pdf.

77 American Council for an Energy Efficient Economy. June 2025. *Estimating the Impacts of Weatherization Readiness Programs*, https://www.aceee.org/research-report/b2504.

Rose, Erin, Beth Hawkins, Lauren Ashcraft, and Carolyn Miller. February 2015. *Exploratory Review of Grantee, Subgrantee and Client Experiences With Deferred Services Under The Weatherization Assistance Program.* Oak Ridge National Laboratory, https://weatherization.ornl.gov/wp-content/uploads/pdf/WAPRecoveryActEvalFinalReports/ORNL_TM-2014_364.pdf.

Green and Healthy Homes Initiative. October 2010. *Identified Barriers and Opportunities to Make Housing Green and Healthy Through Weatherization,* https://www.greenandhealthyhomes.org/wp-content/uploads/GHHI-Weatherization-Health-and-Safety-Report1.pdf.

DOE WAP projects.[78] The WRF also requires that states track deferral issues and costs, providing useful data to guide remediation in other programs.

Table 5 provides an overview of decarbonization and weatherization programs that provide remediation. Some programs include a maximum cap on the allowed expenditure toward remediation measures, and others include an average remediation cap, which, while adding complexity, also allows greater flexibility for program implementors. Some incentive programs that are not designed to pay for remediation costs explicitly, may cover them informally or inadvertently. When program participants submit receipts to verify that the value of the work conducted met the threshold needed to receive the incentive amount, some of the invoiced work may include remediations in addition to the decarbonization measures themselves.

Table 5: Remediation in California Energy Programs

Program	Sample Eligible Remediation Measures (Nonexhaustive List)	Remediation Cap
DOE Weatherization Readiness Funding	Roof, floor, wall, ceiling, foundation, exterior drainage, plumbing, electrical, and other clean up and repairs, including sewage, pest remediation, lead, and asbestos-containing materials.	$13,000 average
San Joaquin Valley Pilot Program (2018–2024)	Water line and water heater relocation, cabinet modification, exhaust vent installation, new conduit and electrical wiring trenching, and patchwork needed after removal of equipment.	Maximum of $5,000 per unit with program funds and up to $20,000 with external funding
Equitable Building Decarbonization Program	Roof or envelope leak/damage repair, galvanized pipe, lead paint, asbestos, and/or mold remediation, smoke and carbon monoxide alarm installation, ventilation, construction to create space for decarbonization measures, and other work to bring property up to code.	$6,000 average for single-family and multifamily units and $7,200 for mobile and manufactured homes

78 Graham, Molly. 2022. *Income-Qualified Program Innovations to Reduce Deferral Rates*, Midwest Energy Efficiency Alliance, https://www.mwalliance.org/sites/default/files/meea-research/deferrals_aceee_paper.pdf.

Program	Sample Eligible Remediation Measures (Nonexhaustive List)	Remediation Cap
Energy Savings Assistance Program	Ceiling, floor, and wall repairs; window and door repairs and replacements; exhaust fan and venting repairs.	Maximum of $2,500 per unit (or 150% of the average cost) and $1,700 average cost (adjustable based on program averages)

Source: CEC staff

Tracking and Categorizing Costs

The San Joaquin Valley (SJV) program tracks remediation costs and is used by other programs to help establish remediation budgets. In December 2018, the CPUC authorized the SJV program, which encompassed disadvantaged communities in the Central Valley that did not have access to gas and relied on propane and wood for cooking and heating.[79] The SJV program replaced all gas and propane appliances with electric appliances for participating households or, in some cases, extended gas lines.

The program included a budget of $5,000 per household for remediation needs and allowed implementors to leverage additional funding from other sources, if needed. The remediation budget was sufficient for most program participants — about 76 percent of PG&E customers and 79 percent of SCE customers.[80] However, this budget did not include the additional average electrical upgrade costs[81] of about $4,500, which most homes received.

The initial remediation cap was also generally insufficient for mobile homes on private lots.[82] Nonprogram funding addressed remediation needs of up to $20,000 in the remaining homes. Some homes could not participate in the SJV program because remediation costs exceeded the $20,000 cap amount. PG&E and SCE noted that customers were generally not interested in

79 California Public Utilities Commission. December 2018. *Decision 18-12-015,* https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M252/K522/252522682.PDF.

80 Gleicher, Cliff and Jennifer C. Reyes Lagunero. December 2023. *2023 Annual Report of Pacific Gas and Electric Company (U 39 M),* http://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=521572762.

Valdberg Anna and R. Olivia Samad. December 2023. *Southern California Edison Company's (U338-E) Quarterly Progress Report on San Joaquin Valley Pilot Projects,* http://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=525333816.

81 Electrical upgrades include panel upgrades, subpanel upgrades, and new circuits.

82 Evergreen Economics. October 2022. *SJV DAC Pilot Process Evaluation Report,* https://www.calmac.org/publications/SJV_DAC_Process_Evaluation_Final_Report_102022.pdf.

using financing options that required repayment for remediation that exceeded the $5,000 cap.[83]

Energy programs do not uniformly track remediation expenditures. For example, the SJV program included the costs of digging trenches to run new wiring and conduit needed in electric upgrades as a remediation expenditure. However, the EBD Program does not allow remediation funding to be used for utility-side electric service upgrades. Even within a single program, it can be challenging to determine if a cost should be counted toward the program measure installation costs or remediation budget.[84] How programs categorize costs should be carefully considered to avoid perceptions of reduced cost-effectiveness where remediation is counted toward the measure cost.

In an analysis of decarbonization opportunities and barriers, LBNL stated that decarbonization programs cannot fix all injustices or address all legacy health and safety issues. However, getting to scale with energy upgrades will likely require addressing some remediation needs, which programs should have the budget and flexibility to address.[85] This assessment reflects California's energy programs as they aim to include historically left-behind communities in publicly subsidized decarbonization programs.

Barriers and Opportunities: Remediation Costs for Residential Buildings

Barriers

- Some remediation costs are too high to address in existing energy programs and by low-income consumers that are reluctant to take on additional debt.
- There are limited data on the costs of remediation in existing buildings and the variability of different building types, vintages, climate zones, and states of disrepair. This lack of data poses challenges in accurately budgeting for remediation efforts.
- Within programs, categorizing costs between measure installation and remediation can be challenging, potentially affecting perceptions of cost-effectiveness and complicating budget allocation.

Opportunities

- Learn from the existing programs that include flexibility in expenditure caps for remediation measures, allowing greater adaptability for program implementors to address diverse needs.

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83 Gleicher, Cliff and Jennifer C. Reyes Lagunero. December 2023. *2023 Annual Report of Pacific Gas and Electric Company (U 39 M)*

Valdberg Anna and R. Olivia Samad. December 2023. *Southern California Edison Company's (U338-E) Quarterly Progress Report on San Joaquin Valley Pilot Projects*.

84 Evergreen Economics. October 2022. *SJV DAC Pilot Process Evaluation Report*.

85 Walker, S. Iain, Núria Casquero-Modrego, and Brennan D. Less. March 2023. *Challenges and Opportunities for Home Decarbonization.* Lawrence Berkeley National Laboratory, https://buildingdecarb.org/wp-content/uploads/home_decarbonization_8.14.23.pdf.

- Requirements to track remediation costs and deferral issues provide useful data to guide remediation in new programs.
- The state could improve categorization of remediation costs in homes by categorizing buildings into housing type, vintage, and other relevant variables.

Tenant Protections

Research shows that properties with higher energy efficiency features command higher rents.[86] The Urban Displacement Project, a research initiative of the University of California, Berkeley, and University of Toronto, found that investments to reduce GHG emissions and improve climate resilience could accelerate gentrification and displacement of low-income residents by increasing property values.[87] Ensuring tenant protection is crucial. Low-income tenants in naturally occurring affordable housing — low-rent housing not covered by affordability covenants inherent in deed-restricted and subsidized affordable housing — may struggle to afford increased rent or relocation costs and lack special protection from rent increases or eviction.

Rental Housing Challenges

Tenants are often considered a hard-to-reach demographic for energy programs because of the tenant-landlord split incentive. The split incentive refers to the fact that building owners pay for the installation of measures but do not receive direct benefits such as bill reductions, increased comfort, or air-quality improvements. Conversely, tenants benefit from bill reductions and comfort improvements from decarbonization measures but do not pay for those measures.

Out of 13 million households in California, about 6 million, or roughly 44 percent, live in rental housing.[88] Nearly half of renter households are lower-income, defined as having an income at or below 80 percent of the area median income.[89] Rental properties use 15 percent more energy per square foot than owner-occupied housing. About 21 percent of renters in the

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86 American Council for an Energy-Efficient Economy. November 2022. *Responding to Renter Challenges with Integrated Energy Efficiency and Anti-Displacement Strategies,* https://www.aceee.org/sites/default/files/pdfs/toolkit_1._energy_efficiency_and_anti-displacement_11-15-22.pdf.

87 Cash Anna, Karen Chapple, Nicholas Depsky, Renee Roy Elias, Melisa Krnjaic et. al. April 2020. *Climate Change and Displacement in the U.S. – A Review of the Literature*. The Urban Displacement Project, https://www.urbandisplacement.org/wp-content/uploads/2021/08/climate_and_displacement_-_lit_review_6.19.2020.pdf.

88 American Community Survey. Accessed December 2025. 2023: ACS 5-Year Estimates Data Profiles, Selected Housing Characteristics. https://data.census.gov/table/ACSDP5Y2023.DP04.

California Housing Partnership. March 2025. *California Affordable Housing Needs Report 2022,* https://chpc.net/wp-content/uploads/2025/03/CHP_State-Housing-Needs-Report-2025.pdf.

California Housing Partnership. March 2022. *California Affordable Housing Needs Report 2022*.

89 Ibid.

Pacific region of the United States (Alaska, California, Hawaii, Oregon, and Washington) have high energy burden, defined as spending 6 percent of income or more on energy.[90]

The Harvard Joint Center for Housing Studies estimates that about 76 percent of all rental housing in California is in census tracts with at least moderate expected financial annual losses because of likely environmental hazards.[91] This finding suggests that rents could increase if the supply of rental units diminishes because of environmental hazards or if landlords recoup building upgrade costs because of environmental hazards through higher rents. Nationwide, roughly 80 percent of the available affordable housing stock is naturally occurring affordable housing.[92] This housing stock type constitutes about 62 percent of California's multifamily affordable housing stock.[93]

Existing law requires landlords in California to provide tenants with a heating system capable of maintaining a minimum of 70 degrees, but the law does not require units to have air conditioning.[94] About 38 percent of California-occupied rental homes do not have air conditioning, compared to 24 percent for owner-occupied housing units.[95] About 13 percent of renter households in Climate Zone 12 and 16 percent of renter households in Climate Zone 14, both of which are characterized by hot and dry summers and therefore the highest risk of heat-induced illness, do not have air conditioning.[96]

Statewide and Municipal Tenant Protection Laws

A patchwork of laws to protect tenants (and prevent tenant protections) exists at the state and municipal levels. There are roughly 30 cities in California with rent stabilization ordinances in

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90 Samarripas, Stefen and Alexander Jarrah. August 2021. *A New Lease on Energy: Guidance for Improving Rental Housing Efficiency at the Local Level*. American Council for an Energy-Efficient Economy, https://www.aceee.org/sites/default/files/pdfs/u2102.pdf.

91 Wedeen, Sophia. March 2022. Blog. "The Threat of Environmental Hazards to The Rental Stock," Joint Center for Housing Studies of Harvard University, https://www.jchs.harvard.edu/blog/threat-environmental-hazards-rental-stock.

92 Corso, Abigail, Pat Coleman, Claire Oleksiak, and John Viner. September 2022. *Making Naturally Occurring Affordable Housing More Efficient: Outreach to Upgrade,* https://www.elevatenp.org/publications/making-naturally-occurring-affordable-housing-more-efficient-outreach-to-upgrade/.

93 *Naturally occurring affordable housing* is defined as apartment buildings with five or more units where at least half of the apartments have rents affordable to households earning 80 percent of the median income for that zip code.

Alvarez-Nissen, Matt. March 2023. *California Naturally-Occurring Affordable Homes At Risk Report 2023*. California Housing Partnership, https://chpc.net/resources/california-naturally-occurring-affordable-homes-at-risk/.

94 Petek, Gabriel. April 2022. *Climate Change Impacts Across California: Housing*. Legislative Analyst's Office, https://lao.ca.gov/Publications/Report/4584.

95 California Energy Commission. Accessed November 2022. "2019 DNV RASS Database," https://www.energy.ca.gov/data-reports/surveys/2019-residential-appliance-saturation-study.

96 Ibid.

addition to the statewide Tenant Protection Act of 2019.[97] The California Tenant Protection Act of 2019 limits rent increases for many properties; however, the law permits landlords to establish a higher rent if a new tenant moves in.[98] Furthermore, the law does not apply to single-family properties or properties less than 15 years old.

The Tenant Protection Act of 2019 requires just cause for evicting tenants in specific property types built before 2005 in California. However, just cause usually allows landlords to terminate a tenancy if they intend to substantially remediate a property.[99] In other words, a landlord who chooses to complete comprehensive decarbonization upgrades can potentially evict tenants for this purpose and then charge higher rents once the upgrades are complete. On the contrary, some municipalities such as Sacramento, San Diego, and Los Angeles prohibit evictions for capital improvements, except under specific conditions.[100] Whether or not tenants are evicted, landlords may be able to increase rent beyond the typical annual increase allowed by local and state regulations, if they can demonstrate to the municipality that the increase is necessary for them to achieve a "fair rate of return", due to exceptional circumstances such as major renovations.

In Sacramento, capital improvements cannot be used to justify a rent increase. While this prohibition protects tenants from eviction and rent increases, it may also discourage landlords from completing comprehensive upgrades and demonstrates that tenant protections may not always align with state climate goals. Careful consideration is required to enact policies that protect housing stability for low-income renters while encouraging decarbonization upgrades.

The California Department of Housing and Community Development (HCD) recommended to the Legislature that the state should consider a "general maximum safe indoor air temperature of 82 degrees…for residential dwelling units".[101] The recommendations recognize it will be expensive to bring existing dwellings up to that standard. The recommendation further suggests the state use existing or new incentive programs to encourage use of low-cost

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97 Kirk, Chelsea. October 2023. *Decarbonizing California Equitably: A Guide to Tenant Protections in Building Upgrades/Retrofits Throughout the State*. Strategic Actions for a Just Economy, https://www.saje.net/wp-content/uploads/2023/09/Decarbonizing-California-Equitably-Report-1.pdf.

98 California Civil Code Section 1947.12, https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?sectionNum=1947.12.&lawCode=CIV.

99 California Civil Code Section 1946.2 (Assembly Bill 1482, Chiu, Chapter 597, Statutes of 2019), https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?sectionNum=1946.2.&lawCode=CIV.

100 San Diego Municipal Code Section 98.0704(b)(1)(4). https://docs.sandiego.gov/municode/MuniCodeChapter09/Ch09Art08Division07.pdf.

Los Angeles Municipal Code Section 151.09 (A)(9). https://codelibrary.amlegal.com/codes/los_angeles/latest/lamc/0-0-0-195761#JD_151.09.

Sacramento City Code Section 5.156.070. https://www.cityofsacramento.gov/content/dam/portal/cdd/Code-Compliance/TPP/Sacramento-City-Code-Chapter-5156--Tenant-Protection.pdf.

101 California Department of Housing and Urban Development. 2025. *Policy Recommendations: Recommended Maximum Safe Indoor Air Temperature*. https://www.hcd.ca.gov/sites/default/files/docs/policy-and-research/plan-report/ab-209-policy-recommendations.pdf.

technologies such as room fans, whole-house fans, and weatherization measures, along with air conditioning where feasible. In 2025, Senate Bill 655 (Stern, Chapter 522, Statutes of 2025) added a maximum indoor temperature as official state policy, but did not set a value for that maximum temperature.[102]

Tenant Protections in Energy Programs

State agencies, local governments, and utilities offer incentives to decarbonize rental housing. While many energy programs can be used in the rental housing market, few are designed to protect tenants, because tenant protections are generally outside the expertise of program administrators and implementers. In addition, tenant protections are often less emphasized for programs serving single-family and small multifamily properties, which can be perceived to have smaller risk of tenant displacement.

Programs treating multifamily properties generally include more tenant protections because displacement can occur on a larger scale. Some multifamily programs prioritize deed-restricted affordable housing because of the inherent tenant protections, ensuring that incentives do not cause evictions or affordability issues for low-income tenants. While other programs allow naturally occurring affordable housing to participate if the property meets affordability requirements, they may also include additional tenant protections embedded in program design or through a written agreement among the program administrator, property owner, tenant or a combination.

Some tenants, especially nonnative English speakers, may not be aware of existing tenant protections. Energy programs can educate tenants and help hold landlords accountable by providing information in multiple languages that outline project information, tenant rights, and landlord responsibilities. For example, the EBD Program guidelines require administrators to provide landlords and tenants with information about the measures that will be installed, construction hours, benefits of the project, eviction restrictions, rent increase limitations, and a phone number for tenants to contact if they have any concerns.[103]

The Solar on Multifamily Affordable Housing Program (SOMAH), which serves deed-restricted affordable housing, also requires participating property owners to provide tenants with program-approved information.[104] This information includes energy efficiency benefits, guidance on interpreting bills, understanding time-of-use rates, and access to additional support and information resources. The program website also dedicates a web page to tenant information and provides contact information for any questions.

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102 Senate Bill 655. https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202520260SB655.

103 Maneta, Diana. 2023. *Equitable Building Decarbonization Direct Install Program Guidelines*. California Energy Commission. Publication Number: CEC-400-2023-003-CMF, https://www.energy.ca.gov/publications/2023/equitable-building-decarbonization-direct-install-program-draft-guidelines.

104 "Solar on Multifamily Affordable Housing," Accessed May 2024, https://calsomah.org/resources/program-handbook.

Decarbonizing existing housing may include improvements that require tenants to relocate temporarily. Some programs like EBD and DOE WAP require, if possible, program administrators to design programs in a way that avoids temporary displacement. Temporary housing, like hotel lodging and short-term rentals, may be too expensive for some low-income households. In addition, tenants may face uncertainty that their dwelling unit will be rented to them after upgrades are complete. This uncertainty is addressed in some energy programs by requiring tenants to be guaranteed the opportunity to reoccupy the dwelling after renovations are complete, known as the *right of first return.*

The Strategic Growth Council[105] (SGC) administers the Affordable Housing Sustainable and Communities (AHSC) program, which funds large infrastructure and capital projects such as compact infill developments. This program includes the right of first return for displaced residents.[106] State agency representatives may inspect the DOE WAP and AHSC projects for violations. Data do not exist on how often tenants are temporarily displaced in energy programs and if they return to their homes.

Some programs include limitations on annual rent increases. For example, the SJV pilots required landlords to sign an agreement limiting rent increases to 3.6 percent for five years, unless they were due to increased property taxes, operating, and maintenance costs.[107] The EBD Program guidelines state that property owners of market-rate housing cannot increase rent by more than 3 percent per year for 5 to 10 years, depending on the property size.[108] Unlike the SJV pilots, the EBD Program specifies that the increase includes property taxes, operation, and maintenance costs, as well as the amortization of other improvements made to the property.[109] Other energy programs depend on an honor system that requires property owners to commit, in writing, to refraining from increasing rent or utility allowances because of measures provided through the program, without specifying a percentage cap.

Without additional protections, energy improvements could price out low-income tenants and diminish the supply of affordable housing by attracting higher-income tenants. The Energy Savings Assistance (ESA) and Massachusetts LEAN Multifamily programs require non-deed-restricted multifamily property owners to agree to maintain at least 50 percent of the building

105 The California Strategic Growth Council is a cabinet-level committee that is tasked with coordinating the activities of state agencies to improve air and water quality, protect natural resources and agricultural lands, increase the availability of affordable housing, and other purposes.

106 California Strategic Growth Council. December 2023. *Affordable Housing and Sustainable Communities Round 8 Program Guidelines,* https://sgc.ca.gov/grant-programs/ahsc/docs/20231214-AHSC_Round_8_Program_Guidelines.pdf.

107 California Public Utilities Commission. April 2020. *Resolution E-5043,* https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M333/K595/333595009.PDF.

108 Maneta, Diana. 2023. *Equitable Building Decarbonization Direct Install Program Guidelines*.

109 Ibid.

tenants below a specified income threshold for up to 10 years following the measures received.[110]

Enforcing Tenant Protections

Most energy programs are administered by agencies and utilities that may lack the experience, regulatory authority, or resources to enforce tenant protections. It is unknown how often tenant protections are enforced in California, if at all.

The consequences of violating the agreed-upon tenant protections are not always stated in program documentation. The SJV pilot split incentive agreement and the SOMAH tenant benefit affidavit bar landlords from future program participation if they violate the agreements. The Massachusetts LEAN multifamily program also requires property owners to reimburse the administering agency for the cost of the program measures, including labor and overhead and any attorney and court fees. Consistent tenant protection requirements and enforcement across programs can help reduce program complexity for participants, landlords, and program implementors.

The party responsible for enforcement of tenant provisions also differs throughout programs. In some cases, it is unclear who is responsible for enforcing the agreements, thus placing the burden on tenants to document and report violations. The National Housing Law Project reviewed DOE WAP programs across different states and concluded that they generally rely on tenants to report violations. The review recommends programs institute screening and auditing procedures to detect rent increases, evictions, or property sales.[111] Agents for programs like the SJV pilots, SOMAH, and DOE WAP have enforcement authority and investigate tenant complaints to monitor compliance with the tenant agreements. Clear enforcement mechanisms are needed to ensure tenant protections in energy programs are effective. Careful consideration is also needed to ensure that tenant protections do not adversely affect landlord participation in decarbonization programs.

A study conducted by Portland State University on landlords of naturally occurring affordable housing in California and Oregon found that about 20 percent of landlords were not willing to accept any rental covenant agreement to receive public funds, and a 10-year covenant agreement resulted in a 50 percent landlord acceptance rate.[112] The study concluded that rental agreements longer than five years may result in many landlords choosing not to enroll in energy efficiency retrofit programs. In 2019, the Urban Displacement Project compiled a list

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110 California Public Utilities Commission. June 2021. *Decision 21-06-015*, https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M387/K107/387107687.PDF.

Lean Multifamily. 2025. *MASS Save Income-Eligible Multifamily Retrofits Program Guide*, https://leanmultifamily.org/wp-content/uploads/2025/11/IEMF-Program-Guide-5-29-25.pdf.

111 Sitkin, Lisa and James Grow. 2018. *Survey of State Tenant Protection Policies for the Weatherization Assistance Program*. The National Law Housing Project, https://www.nhlp.org/wp-content/uploads/2019.02.14-WAP-Tenant-Protection-Memo-with-Appendices.pdf.

112 Nelson T. Hal, Alex Brey, and Paul Ahrns. 2022. *Nothing for Us, Without Us: What Do Households of Color Actually Want (And What Are Their Landlords Willing to Do)?*

of displacement policies in Los Angeles County and the Bay Area. CARB commissioned an update and statewide expansion of the map so policymakers can better understand the state's policy landscape and the public can see which cities and counties have protective policies.

Barriers and Opportunities: Tenant Protections

Barriers

- Varied laws at state and municipal levels create complexity and inconsistency, potentially discouraging landlords from participating in decarbonization projects.
- Some tenant protection ordinances, such as those prohibiting evictions for capital improvements, may make landlords less likely to undertake decarbonization upgrades, creating a conflict between housing stability and climate goals.
- Agencies and utilities administering energy programs may lack the resources or regulatory authority to enforce tenant protections effectively.

Opportunities

- Implementing policies to ensure that rental housing is safe and resilient to climate change impacts could reduce the risk of financial losses for landlords and ensure tenant safety.
- Establishing consistent tenant protection requirements and enforcement mechanisms across programs could simplify compliance for participants and ensure effective protection for tenants.
- Statewide guidance for program implementers and municipalities on best practices for tenant protection, enforcement, and data collection could help improve the consistency and quality of program implementation across the state.
- Research into the perception of program benefits and barriers among landlords and the effect of municipal tenant protection ordinances may help improve program design and increase landlord participation in state programs while balancing tenant protections with the need for rapid and widespread decarbonization.

Decarbonizing Manufactured Housing

Manufactured housing collectively refers to the state's mobile and manufactured housing stock. Manufactured housing and mobile home parks have been historically disinvested in, are classified as hard-to-reach communities by the CPUC,[113] and were not extensively discussed in previous action plans. Most decarbonization programs do not distinguish manufactured homes from other forms of housing. Generally, programs underserve manufactured housing partly because of the failure to account for the unique regulatory environment and construction characteristics of manufactured housing. Simultaneously, manufactured homes are home to

113 California Public Utilities Commission. June 2023. *Decision 23-06-055 Authorizing Energy Efficiency Portfolios for 2024–2027 and Business Plans for 2024–2031,* https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M512/K907/512907396.PDF.

some of the most socioeconomically and medically vulnerable populations who likely need subsidized decarbonization upgrades to participate in the clean energy transition.

Regulatory Landscape

Unlike site-built homes and partially prefabricated forms of housing, manufactured homes are not subject to the Energy Code or local construction standards. In federal and California law, manufactured homes are constructed according to the National Manufactured Home Construction and Safety Standards, established by the United States Department of Housing and Urban Development (HUD) in 1976. These standards are commonly referred to as the HUD Code.[114] Manufactured homes built before the HUD Code was implemented are known as mobile homes and were not constructed to a uniform national code. The HCD enforces the HUD Code for manufactured homes in California. Alterations inside a manufactured home must be permitted and inspected by HCD rather than a local building department.

California's Manufactured Housing Stock

California has about 540,000 manufactured home units, making up about 4 percent of the state's housing stock.[115] The average date of manufacture for these units is 1979.[116] Table 6 displays the general characteristics of California's manufactured housing stock and site-built single-family homes. In 2022, the average sales price of new manufactured homes sold or intended for sale in California was $153,400.[117] Single-wide manufactured homes averaged $82,600, whereas the average for a double-wide, consisting of two or more manufactured housing coaches, was $169,100.[118] In 2022, nationwide, the average price per square foot was $88, considerably less than the national average price of $168 per square foot for a new

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114 California Legislative Information. Accessed May 2024. "Manufactured Housing Act: California Health and Safety Code § 18000 et seq.," https://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=HSC&division=13.&title=&part=2.&chapter=1.&article=.

Office of the Law Revision Counsel, U.S. Code. National Manufactured Housing Construction and Safety Standards Act of 1974: 42 U.S.C. § 5401 et seq., https://uscode.house.gov/view.xhtml?path=/prelim@title42/chapter70&edition=prelim.

In addition to the HUD Code, newly constructed manufactured homes will be subject to the forthcoming U.S. Department of Energy (DOE) energy conservation standards adopted May 31, 2022. A compliance date is not yet determined as U.S. DOE is establishing enforcement procedures.

115 State of California Department of Finance. Accessed May 2023. "E-5 Population and Housing Estimates for Cities, Counties, and the State, 2020–2025," https://dof.ca.gov/Forecasting/Demographics/Estimates/e-5-population-and-housing-estimates-for-cities-counties-and-the-state-2020-2025/.

116 American Housing Survey. Accessed May 2024. "2021 California General Housing Data — All Occupied Units," https://www.census.gov/programs-surveys/ahs/data/interactive/ahstablecreator.html?s_areas=00006&s_year=2021&s_tablename=TABLE1&s_bygroup1=4&s_bygroup2=1&s_filtergroup1=1&s_filtergroup2=1.

117 Unites States Census Bureau. Accessed June 2024. "Manufactured Housing Survey Annual Data," https://www.census.gov/data/tables/time-series/econ/mhs/annual-data.html.

118 Ibid.

single-family home (excluding the cost of land).[119] The average size of a manufactured home in California is 1,308 square feet, and a manufactured home has, on average, 2.3 residents.[120]

Table 6: Snapshot of California's Manufactured Housing Stock

Characteristics	Manufactured Homes	Single-Family Homes
Quantity	562,223	8,341,577
Percentage of Total Housing Stock	3.9%	60%
Average Size	1,308 ft^2	1,888 ft^2
Average Sales Price in 2022	$153,400	$820,308
Average Number of Occupants	2.3	3.1
Average Age of Home in 2019	40	47

Source: Compiled by CEC staff from Residential Appliance Saturation Study (RASS), DOF, California Association of Realtors, and U.S. Census Bureau

The location of a manufactured home can have implications for program and policy design because of different landlord-tenant and ownership structures. While most manufactured homes are owner-occupied, some mobile home park owners own some or all manufactured homes in their community. This ownership structure may present an opportunity for decarbonization programs as permission to upgrade numerous housing units can be obtained from one authorized person. However, this approach should also be balanced with proper tenant protections to ensure the mobile home park remains affordable after upgrades.

About 69 percent of manufactured homes are within manufactured home communities, commonly referred to as *mobile home parks*.[121] There are nearly 4,500 active mobile home parks in the state containing on average 87 manufactured homes.[122] Figure 4 shows the locations of mobile home parks in California.[123] Nearly 53 percent of mobile home parks are small (containing fewer than 50 manufactured homes), 20 percent are medium-sized (between 51 to 100 manufactured homes), and 27 percent are large (more than 100 manufactured

119 Ibid.

120 California Energy Commission. Accessed November 2022. "2019 DNV RASS Database."

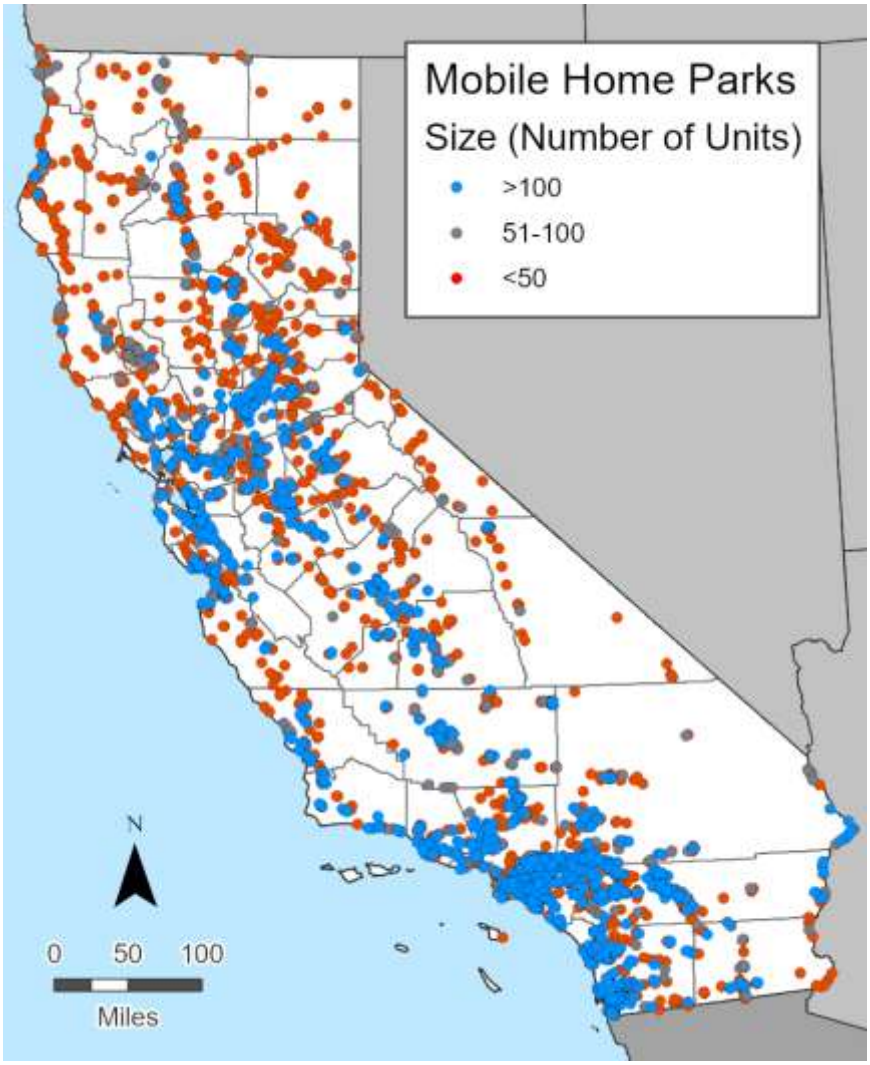
121 Leon, Warren, Kat Burnham, Nate Hausman, and Laura Schieb. April 2021. *Solar for Manufactured Homes: Volume 1*. Clean Energy States Alliance, https://www.cesa.org/wp-content/uploads/solar-for-manufactured-homes-volume1.pdf.

122 California Department of Housing and Community Development. September 2023. *Mobilehome Park Maintenence Task Force Inspection Task Force Member Briefing Document,* https://www.hcd.ca.gov/sites/default/files/docs/manufactured-and-mobilehomes/mpm-taskforce-briefing-document-0925.pdf.

123 United States Department of Homeland Security. Accessed May 2024. "Homeland Infrastructure Foundation-Level Data." Interactive Map, https://www.dhs.gov/gmo/hifld.

homes). While mobile home parks exist throughout the state, unsurprisingly, large mobile home parks tend to be near densely populated cities.

Figure 4: Distribution of Mobile Home Parks in California



Source: Homeland Infrastructure Foundation-Level Data, U.S. Department of Homeland Security

There is a preconception that manufactured housing is predominantly concentrated in rural and remote areas of the state. However, more than half of California's manufactured housing stock is concentrated in six populous counties, although it is disproportionately located in some rural counties. Table 7 displays the counties with the most manufactured homes in descending order. Riverside County has the greatest number of manufactured homes at 80,251, followed by Los Angeles County at 59,035.[124]

124 State of California Department of Finance. Accessed May 2023. "E-5 Population and Housing Estimates for Cities, Counties, and the State, 2020–2025."

Table 7: Location of Manufactured Homes by County — January 2022

County	Total Housing Units	Manufactured Homes	Manufactured Homes as % of Housing Units
Riverside	863,764	80,215	9.3%
Los Angeles	3,635,136	69,035	1.6%
San Diego	1,244,854	46,636	3.7%
San Bernardino	740,654	44,097	6.0%
Orange	1,142,380	33,743	3.0%
Kern	305,853	24,331	8.0%
California	14,583,996	562,223	3.9%

Source: State of California Department of Finance

Manufactured homes make up more than one-fifth of the housing stock in some rural counties such as Inyo, Trinity, Mariposa, Lake, and Tehama. In Inyo and Trinity counties, more than one in four housing units are manufactured homes.[125] Table 8 displays six counties, all considered rural by the California State Association of Counties, with the highest proportion of manufactured homes relative to total housing stock.

Table 8: Highest Proportion of Manufactured Homes by County

County	Manufactured Homes	Manufactured Homes as % of Housing Units
Inyo	2,583	27.1%
Trinity	2,087	26.0%
Mariposa	2,266	23.0%
Lake	7,830	22.8%
Tehama	6,205	22.6%
Del Norte	2,496	22.3%

Source: State of California Department of Finance

125 Ibid.

Manufactured Home Energy Profile

Manufactured homes consume, on average, 77 percent of the energy of an average single-family home in California.[126] Table 9 displays the energy use and energy-use intensities of the dwelling types.

Table 9: California Manufactured Home Energy Profile

Dwelling Type	**Average Size** (ft^2)	**Average Number of Residents**	**Average Energy Consumption** (kBTU/yr)	**Average Energy-Use Intensity** ($kBTU/yr/ft^2$)	**Average Energy Use Per Capita** (kBTU/yr/person)
Single-Family	1,888	3.1	68,166	36.1	21,989
Manufactured Housing	1,308	2.3	52,180	39.9	22,687

Source: CEC staff

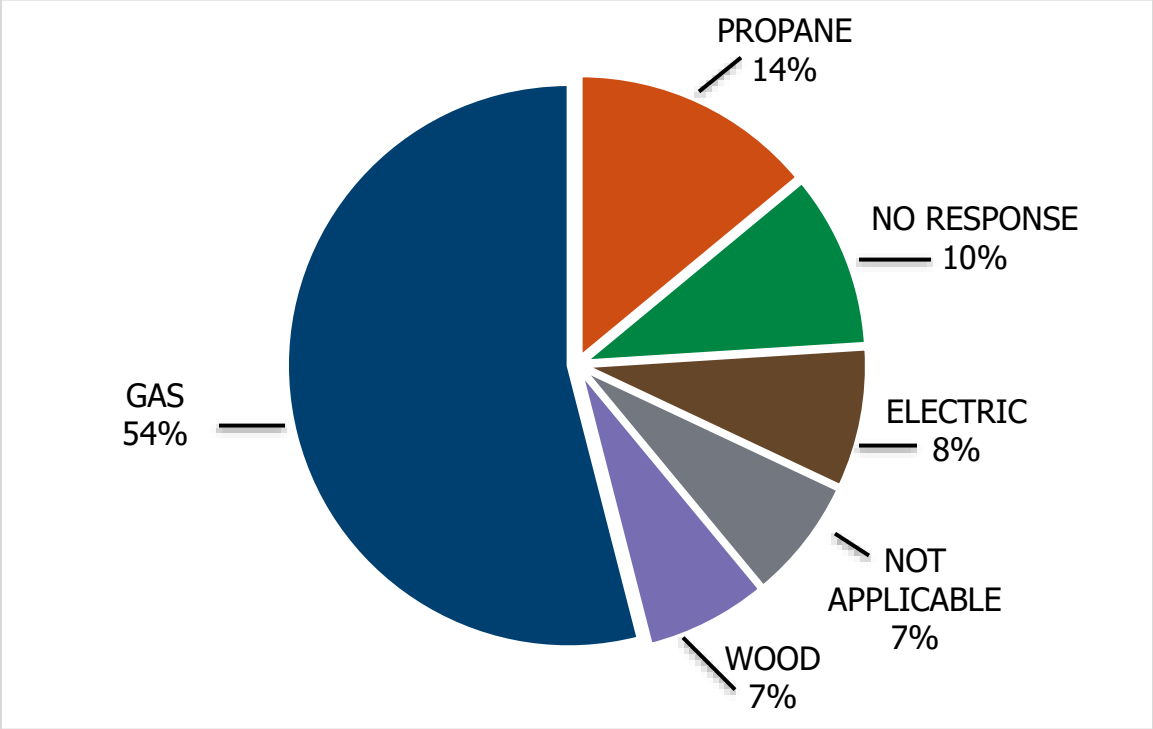
Manufactured homes are more likely to rely on combustion fuel for some energy-intensive end uses, making them important candidates for decarbonization programs. Figure 5 displays the primary fuel types used in manufactured homes for space heating. In California, 54 percent of manufactured homes use primarily gas for space heating, most commonly using a central forced-air gas furnace.[127] This use is largely due to the abundance of gas infrastructure in the state and outdated electrical infrastructure in mobile home parks that has insufficient capacity for building electrification.

Conversely, manufactured homes in other states generally use electric resistance space heating elements, such as baseboard heaters and electric resistance forced air furnaces. Although electric resistance heating is inefficient, it is easier to make the business case to transition these homes to heat pump space heating due to potential bill savings. However, transitioning from a gas furnace to electric heat pump space heating creates uncertainty about bill impacts and may not be possible in some manufactured homes without substantial electrical infrastructure upgrades either in front of the meter, behind the meter, or both.

126 DNV GL Energy Insights USA, Inc. 2021. *2019 California Residential Appliance Saturation Study*. California Energy Commission. Publication Number: CEC-200-2021-005-PO, https://www.energy.ca.gov/sites/default/files/2021-08/CEC-200-2021-005-PO.pdf.

127 California Energy Commission. Accessed November 2022. "2019 DNV RASS Database."

Figure 5: Manufactured Home Primary Space Heating Fuel



Source: CEC staff

Manufactured homes use propane more often than single-family homes for heating fuel and water heating fuel. As shown in Table 10, about 18.5 percent of manufactured homes use propane as the primary water heater fuel and 14.1 percent as the primary heating fuel, four times more than single-family homes that use propane for these uses.[128] Unlike gas, propane is generally more expensive than electricity. Therefore, electrifying these manufactured homes will likely reduce energy bills for residents.

Table 10: Manufactured Home Propane Use

Building Type	Primary Heating Fuel Propane	Primary Water Heater Fuel Propane
Single-Family	3.4%	4.4%
Manufactured Home	14.1%	18.5%

Source: 2019 California Residential Appliance Saturation Study

Equity Considerations

Manufactured homes are an important source of affordable housing and often house low-income residents and other vulnerable populations. In 2021, the median household income of occupants of manufactured homes in California was $48,000, or 60 percent of the statewide

128 California Energy Commission. Accessed November 2022. "2019 DNV RASS Database."

median income.[129] Manufactured housing is often seen as naturally affordable since it is within reach for households earning 60–80 percent of the area median income. In California, the median age of the primary owner or renter of a manufactured home is 60, which is 12 years older than for all housing types combined.[130] This finding is in part because nearly 18 percent of mobile home parks in the state are restricted to residents older than 55.[131] Manufactured housing residents are also more likely to rely on retirement or other fixed income. However, younger people are increasingly purchasing manufactured homes, with the most concentrated buyer age group in 2021 being 25–34 years old.[132]

Despite programs including manufactured homes as an eligible building type, the risk of underserving this housing type persists. To encourage contractors to serve manufactured homes and ensure quality installations, the Energy Trust of Oregon provides incentives ranging from $3,500 to $4,000 to a trained group of contractors for installing ducted or ductless heat pumps in manufactured homes.[133]

The U.S. Energy Information Administration found that in 2020, nearly half of manufactured home residents surveyed experienced energy insecurity,[134] and 37 percent of those cut back on food or medicine to pay energy expenses. In comparison, only 27 percent of all household types experienced energy insecurity and 20 percent reported giving up food or medicine to pay energy costs.[135]

Manufactured homes are more likely to house individuals with permanent disabilities compared to other housing types. According to the *2019 California Residential Appliance Saturation Study* (RASS), more than one-third of manufactured home occupants surveyed indicated having a

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129 American Housing Survey. "2021 California Income Characteristics – All Occupied Units," https://www.census.gov/programs-surveys/ahs/data/interactive/ahstablecreator.html?s_areas=00006&s_year=2021&s_tablename=TABLE9&s_bygroup1=3&s_bygroup2=1&s_filtergroup1=1&s_filtergroup2=1.

130 California Energy Commission. Accessed November 2022. "2019 DNV RASS Database."

131 Leon, Warren, Kat Burnham, Nate Hausman, and Laura Schieb. April 2021. *Solar for Manufactured Homes: Volume 1*.

132 Consumer Financial Protection Bureau. 2021. *Manufactured Housing Finance: New Insights From the Home Mortgage Disclosure Act Data*. Office of Research and Mortgage Markets, https://files.consumerfinance.gov/f/documents/cfpb_manufactured-housing-finance-new-insights-hmda_report_2021-05.pdf.

133 Energy Trust of Oregon. Accessed June 2024. "Special Offer for Ducted and Ductless Heat Pumps," https://www.energytrust.org/incentives/limited-time-promotion-for-ducted-and-ductless-heat-pumps/#tab-three.

134 Household energy insecurity includes only those issues collected as part of the Residential Energy Consumption Survey questionnaire, including forgoing food or medicine to pay energy costs, leaving home at unhealthy temperatures, receiving disconnect or delivery stop notice, and inability to use heating or air-conditioning equipment. Other factors, such as energy costs as a percentage of household income, could be considered as household energy insecurity, but they are not included here.

135 U.S. Energy Information Administration. May 2022. "Household Energy Insecurity, 2020," https://www.eia.gov/consumption/residential/data/2020/hc/pdf/HC%2011.1.pdf.

person with a permanent disability in their household.[136] Table 11 summarizes the characteristics of manufactured housing residents and those in all housing combined.

Table 11: California Manufactured Home Occupant Demographics

Characteristics	Manufactured Housing	All Housing Combined
2021 Median Household Income	$48,000	$80,000
Caucasian White	57%	49%
Median Age of Primary Resident	60	48
Resident With Permanent Disability	34%	12%
Social Security or Railroad Retirement Income	40%	24%
Energy Insecurity in 2020	47%*	27%*
Foregoing Food and Medicine to Pay for Energy in 2020	37%*	20%*

***Indicates this value is for the United States**
Source: CEC staff

Manufactured homes are less expensive to purchase than site-built homes, but financing them tends to be more expensive. The Consumer Financial Protection Bureau states that manufactured home buyers are frequently subject to higher financing rates and shorter repayment periods compared to site-built homes.[137] In 2019, 42 percent of manufactured home purchases were funded through personal loans, known as chattel loans, with an average interest rate of 4 percentage points higher than traditional mortgages.[138]

Chattel loans have fewer protections and are generally not eligible for acts like the Real Estate Settlement Procedures Act and Coronavirus Aid, Relief, and Economic Security Act.[139] Considering the relatively low median household income of manufactured home residents, fixed incomes, and expensive financing, many manufactured home residents may need subsidized upgrades to decarbonize their homes.

136 California Energy Commission. Accessed November 2022. "2019 DNV RASS Database,"

137 Consumer Financial Protection Bureau. 2021. *Manufactured Housing Finance: New Insights From the Home Mortgage Disclosure Act Data*. Office of Research and Mortgage Markets.

138 Ibid.

139 Ibid.

Decarbonization Challenges

Other decarbonization challenges exist in addition to limited income. Mobile homes built before the HUD Code are less energy-efficient and more expensive to retrofit. Because of high costs to retrofit, some decision models recommend replacing rather than retrofitting these homes.[140]

Manufactured home owners must be up to date on registration fees and provide the title to the home for HCD to issue an alteration permit. However, many residents lack proper documentation or are unaware of registration requirements and may owe years of registration back fees and penalties.[141]

Low electric service capacity can be an obstacle to decarbonization. In many cases, panel optimization strategies can be used to address capacity constraints without upsizing panels. In some circumstances, panel upsizing may be required, such as with the addition of higher amperage EV charging or onsite solar PV systems. It is common for mobile home parks to have 100-amp service capacity and in older parks, as low as 30-amp service.[142] Although the Legislature prohibited the construction of master-metered parks beginning January 1, 1997,[143] master-metered parks are still a common configuration today. These parks are more prone to reliability and safety issues because the electric infrastructure is not always properly maintained by the park owner, who is largely responsible for maintenance rather than the utility.

The CPUC Mobilehome Park Utility Conversion Program is replacing master meters with individual meters, with a goal of converting 50 percent of remaining parks by 2030.[144] In converting parks, the program updated utility infrastructure to 100-amp electric service and adopted a 200-amp standard in 2024.[145] While it is difficult to electrify manufactured homes with low electric service capacity, the Mobilehome Park Utility Conversion Program provides an opportunity to enable electrification in mobile homes.

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140 McGrath, Kevin, Leslie Badger, Katey Beaton, Alyssa Annino, Anzel Nichols, et. al. December 2023. *Mobile and Manufactured Housing Market Characterization Study*, https://www.veic.org/Media/Default/Reports/CalNEXT - Mobile and Manufactured Housing Market Characterization Study_Revised.pdf.

141 Halbrooke, Claire. September 2021. "Lessons Learned (So Far) In Targeted Building Electrification," https://gridworks.org/2021/09/lessons-learned-so-far-in-targeted-building-electrification/.

142 McGrath, Kevin, et al. December 2023. *Mobile and Manufactured Housing Market Characterization Study*.

143 California Public Resources Code Section 2791 prohibits the construction of master-metered mobile home parks. *Master-metered* park refers to mobile home parks where the utility maintains infrastructure leading up to the park. The park owner is generally the utility customer and is responsible for maintaining intrapark utility infrastructure leading to park lots.

144 California Public Utilities Commission. Accessed May 2024. "Mobilehome Park Utility Conversion Program," https://www.cpuc.ca.gov/regulatory-services/safety/mhp/mobilehome-park-utility-upgrade-program.

145 California Public Utilities Commission. December 2024. *Decision 24-12-037 Decision Adopting a 200-AMP Electrical Service Standard and Establishing Program Evaluation Criteria For The Mobilehome Park Utility Conversion Program*, https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M551/K015/551015446.PDF.

Interior space constraints may prohibit the installation of some equipment.[146] Electric heat pump water heaters, while highly efficient, are generally taller and wider than gas or electric resistance water heaters. Installation could require extensive modifications to smaller existing utility closets that would encroach on the existing living space and increase project costs. HCD required water heaters to remain within the envelope of the manufactured home previously and did not allow installing water heaters in an alternative location such as a metal enclosure next to the manufactured home.[147] However, in October 2025, HCD proposed regulatory text to allow this installation which could enable more heat pump water heaters installations to serve manufactured homes.[148]

Current and Planned Activities

The CEC considers, evaluates, or advances the decarbonization of manufactured homes in the following ways:

- Funds research and development projects for newly constructed manufactured homes.[149] These projects include about $2 million awarded to develop energy-efficient manufactured homes using fire-resistive silica vacuum insulation panels, $2 million to develop all-electric manufactured homes with advanced building envelopes that meet site-built Title 24 requirements, and $2.8 million to build all-electric, energy efficient, fire-resistive, and cost-effective manufactured homes.
- Sets manufactured housing apart in the RASS data and informing energy forecasting models.[150]

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146 McGrath, Kevin, et. al. December 2023. *Mobile and Manufactured Housing Market Characterization Study*.

147 Samad, R. Olivia and Joel M. Mallord. December 2022. *Southern California Edison Company's (E338-E) 2022 Annual Progress Report on San Joaquin Valley Pilot Projects,* https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M500/K048/500048296.PDF.

148 California Department of Housing and Community Development. Accessed December 2025. Modified Express Terms Additional 15-Day Comment Period California Code of Regulations Title 25. Housing and Community Development Division 1. Chapters 1, 2, and 2.2. https://www.hcd.ca.gov/building-standards/title-25-rulemaking/current-rulemaking.

149 Energize Innovation. "Advanced Energy-Efficient and Fire-Resistive Envelope Systems Utilizing Vacuum Insulation for Manufactured Homes." California Energy Commission. EPC-19035, https://www.energizeinnovation.fund/projects/advanced-energy-efficient-and-fire-resistive-envelope-systems-utilizing-vacuum-insulation.

Energize Innovation. "Advancing Energy Efficiency in Manufactured Homes Through High-Performance Envelope." California Energy Commission. EPC-19035, https://www.energizeinnovation.fund/projects/advancing-energy-efficiency-manufactured-homes-through-high-performance-envelope.

California Energy Commission. "GFO-22-305 Advanced Prefabricated Zero-Carbon Homes." Solicitation web page, https://www.energy.ca.gov/solicitations/2023-01/gfo-22-305-advanced-prefabricated-zero-carbon-homes.

150 California Energy Commission Energy Assessments Division forecasted the quantity of several building types separately, including mobile homes, from 1990 through 2035 and provided these data to California Air Resources Board for modeling when gas appliances will need to be replaced to estimate electric demand.

- The EBD Direct Install Program guidelines require administrators to direct at least 5 percent of their budgets to manufactured housing. To support this focus on manufactured housing, the EBD program will fund in-home efficiency and electrification measures as part of the CPUC Electrification Pilot Initiative for Mobilehome Parks established in November 2025.[151]

Manufactured housing is often an eligible building type in energy efficiency, weatherization, and utility rate discount programs provided through government and utility programs. Table 12 is a nonexhaustive list of state and federal programs for which existing manufactured housing is eligible.

Table 12: Programs Available for Existing Manufactured Housing

Program	Description	Eligibility
EBD Program (CEC)	Low- to no-cost direct install measures.	Income at or below 80% of the area median income and located in an underresourced community.
HEEHRA Phase I Rebate Program (CEC)	Provides up to $8,000 in rebates for heat pump HVAC systems.	Income at or below 120% of the area median income. Rebate value alters based upon income.
Mobilehome Park Utility Conversion Program (CPUC)	Converts master-metered mobile home parks to direct utility service. Simultaneously upgrades electric infrastructure.	Mobile home parks in IOU territory.
Electrification Pilot Initiative for Mobilehome Parks (CPUC)	Fully electrify and convert master-metered parks to direct utility service. No-cost replacement of existing gas appliances with efficient electric appliances. Includes in-home remediation measures.	For mobile home parks participating in the CPUC Mobilehome Park Utility Conversion Program. Mobilehome parks must meet criteria for both the Utility Conversion Program and EBD Direct Install program guidelines. Parks will be selected by CEC EBD staff and program administrators.

151 California Public Utilities Commission. November 20, 2025. Decision 25-11-009 Decision Establishing An Electrification Pilot Initiative for Mobilehome Parks, https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M588/K329/588329387.PDF.

Program	Description	Eligibility
Manufactured Housing Opportunity and Revitalization Program (HCD)	Funding for acquisition, conversion, rehabilitation, and replacement of mobile home parks and individual mobile homes.	Resident organization, qualified nonprofit housing sponsor, or local public entity. Private mobile home park owners and nonprofit corporations are eligible to apply under limited circumstances.
Energy Savings Assistance Program (CPUC)	No-cost weatherization direct install measures.	Income at or below 250% of the federal poverty level
Comprehensive Manufactured Home Program (SCE, SoCalGas)	Low- to no-cost measures included.	No income requirements, and preapproved measures based on climate zones.
Low Income Home Energy Assistance Program (CSD)	One-time payment to help pay heating or cooling bills and provides weatherization services.	Income at or below 60% of the state median income.
Low-Income Weatherization Program Farmworker Housing Component (CSD)	Direct no-cost installation of energy efficiency measures and solar PV systems.	Income at or below 80% of county area or state median, whichever is higher.
U.S. DOE Weatherization Assistance Program (CSD)	Installation of weatherization and energy efficiency measures for low-income homeowners and renters.	Income at or below 200% of the federal poverty level, $8,000 cap per home.

Source: CEC staff

Barriers and Opportunities: Decarbonizing Manufactured Housing

Barriers

- Manufactured homes operate under different regulatory standards than site-built homes and other prefabricated housing, making it challenging to integrate them into existing decarbonization programs.
- Residents of manufactured housing tend to have lower incomes with likely limited discretionary spending available for voluntary energy and building decarbonization upgrades.
- Many older mobile and manufactured homes have small utility closets that do not fit heat pump water heaters.

Opportunities

- The concentration of manufactured homes within mobile home parks, particularly those owned by a single entity, provides an opportunity for efficient deployment of decarbonization upgrades.

- Manufactured homes are more likely to rely on propane, providing an opportunity for improving indoor air quality and reducing GHG emissions while substantially reducing the occupants' energy bills.
- Providing contractor incentives or requiring funding set-asides for mobile and manufactured homes, such as in the EBD Program, could help ensure mobile and manufactured homes are served by programs.
- Improving coordination among decarbonization programs, CPUC's Mobilehome Park Utility Conversion program, and other programs that could provide EVSE, solar, or storage retrofits, could lower costs, and avoid missed opportunities for home upgrades.
- Manufacture compact heat pump space heating, heat pump water heating, and other building decarbonization technologies (for example, PV solar). Manufacturers could develop technologies and guidelines specific to manufactured homes and other homes with space and structural constraints.

Hard-to-Reach Communities

California must ensure that all communities participate fully in reaching its decarbonization goals. Previous research shows that white, college-educated homeowners and English speakers are overrepresented in California's nonequity-focused energy efficiency programs.[152] The *2019 Energy Action Plan* established a goal to remove barriers to energy efficiency participation within low-income households, disadvantaged communities, and rural regions.[153] The *2021 IEPR Action Plan* also recommended the CEC, CPUC, and CARB prioritize and fund decarbonization retrofits in low-income and disadvantaged communities including efforts to:

- Identify opportunities and best methods of communication.
- Research and collaborate to reduce energy burden.
- Develop programs that meet the needs of low-income and disadvantaged communities.
- Conduct targeted outreach and engagement to educate communities on programs.
- Streamline and simplify decarbonization program applications.[154]

The term "hard-to-reach customers" generally refers to residential and nonresidential energy users who historically have not participated in decarbonization programs. The definition of

152 Marti, F., and S. Nowak. 2016. *Who's Participating and Who's Not? The Unintended Consequences of Untargeted Programs.* American Council for an Energy-Efficient Economy, www.aceee.org/files/proceedings/2016/data/papers/2_542.pdf.

153 Kenney, Michael, et. al. 2019. *2019 California Energy Efficiency Action Plan*.

154 Kenney, Michael, et. al. 2022. *Final 2021 Integrated Energy Policy Report, Volume I: Building Decarbonization*.

hard-to-reach varies by location. Different and sometimes contradictory groups are included in definitions of what constitutes hard-to-reach customers worldwide.[155]

The CPUC defines hard-to-reach customers as those who "do not have easy access to program information or generally do not participate in energy efficiency programs due to a language, income, housing type, geographic, or home ownership (split incentives) barrier."[156]

The CPUC's definition includes California Native American tribes and customers meeting two to three specific geographic, language, housing type, and income criteria.[157] In 2023, the CEC adopted the policy to "prioritize efforts to increase resources, benefits, and opportunities to, while measurably reversing existing disparities and inequities for California Native American tribes (tribes) and justice communities."[158] Disadvantaged communities and low-income residents are more thoroughly discussed in other policy reports, so the focus of this section is on rural communities, tribes, and non-English speakers.

Research shows that trust, access (access geographically or access to technology), language and literacy, knowledge or efficacy, and competing life priorities are common barriers to participating in energy programs for many hard-to-reach customers.[159] In addition, decarbonization programs may not meet the needs of all residents because of differences in the building stock and fuel types, access to specialist contractors, differing demographics, household incomes, and attitudes to decarbonization. A better understanding of the barriers and opportunities for different hard-to-reach sectors is needed to provide effective solutions.

Rural Households

More than 2 million Californians, about 6 percent of the state's population, live in rural areas.[160] Previous research shows that rural households have higher energy burdens than

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155 Ashby, Kira, Jennifer Smith, Sea Rotman, Luis Mundaca, Joseph Reyes, et. al. 2020. *Who Are Hard-to-Reach Energy Users? Segments, Barriers and Approaches to Reach Them,* https://userstcp.org/wp-content/uploads/2020/10/Ashby-et-al-2020_ACEEE-summer-study.pdf.

156 California Public Utilities Commission. June 2023. *Decision 23-06-055 Authorizing Energy Efficiency Portfolios for 2024–2027 and Business Plans for 2024–2031,* https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M512/K907/512907396.PDF.

157 Ibid.

158 *Justice communities* include disadvantaged communities, under Senate Bill 535 (De León, Chapter 830, Statutes of 2012); low-income communities and households, under Assembly Bill 1550 (Gomez, Chapter 369, Statutes of 2016), underserved communities, under Assembly Bill 841 (Ting, Chapter 372, 2020); and people living with disabilities, as defined by American Disabilities Act.

California Energy Commission. February 2023. *Justice Access Equity Diversity Inclusion (JAEDI) Framework.* Publication Number: CEC-100-2022-001-CMF-APA, https://www.energy.ca.gov/sites/default/files/2023-11/CEC-JAEDI-Framework_ada.pdf.

159 Ibid.

160 U.S. Census Bureau. December 29, 2022. News Release. "Nation's Urban and Rural Populations Shift Following 2020 Census." Accessed November 7, 2023, https://www.census.gov/newsroom/press-releases/2022/urban-rural-populations.html.

metropolitan and other households.[161] In June 2023, the CPUC approved the creation of a Rural Regional Energy Network to provide energy efficiency programs that address specific needs of rural communities.[162] The decision acknowledged lower participation rates in energy efficiency programs, socioeconomic factors, vulnerability to climate impacts, and high costs of serving rural regions.

Limited contractor presence in rural areas, accompanied by long travel distances for contractors, can increase building decarbonization costs for rural households. An analysis of data from the TECH Clean California program found that a greater number of TECH-enrolled contractors serving a county correlated with a lower cost of heat pump installation. For example, heat pump installations in counties served by 100 TECH-enrolled contractors cost about $1,000 less, on average, than heat pump installations in counties served by only 10 TECH-enrolled contractors.[163]

Some rural areas of the state are not served by gas infrastructure and rely on other heating fuels, such as propane and wood.[164] Due to the high cost of propane, households that rely on this fuel may be good candidates for electrification.[165] Replacing propane appliances with efficient electric appliances can reduce a household's energy costs and improve air quality while allowing the household to avoid the inconvenience of propane delivery and additional emissions associated with the transportation of propane. While some households may use propane and wood out of necessity, other households favor it because of factors such as reliability concerns of the electric grid. Research shows that power outages occur more often and last longer in rural areas.[166] Policy makers working on decarbonization strategies would benefit from more information about the geographic areas and number of households that do not have access to electrical grid infrastructure. To decarbonize rural households successfully, program administrators should develop tailored approaches based on customer attitudes toward electrification and reasons for using fossil fuels.

The San Joaquin Valley (SJV) Disadvantaged Communities Pilot Program provided single-family building decarbonization retrofits with a largely rural focus. The program used Community Energy Navigators[167] to reach out to potential participants and help them with program

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161 Lauren, Ross, Ariel Drehobl, and Brian Stickles. July 2018. *The High Cost of Energy in Rural America: Household Energy Burdens and Opportunities for Energy Efficiency*. American Council for an Energy-Efficient Economy, https://www.aceee.org/sites/default/files/publications/researchreports/u1806.pdf.

162 California Public Utilities Commission. June 2023. Decision 23-06-055.

163 TECH Clean CA. October 12, 2023. "Clean California Data Webinar," https://techcleanca.com/events/data-webinar/.

164 Kenney, Michael, et. al. 2021. *California Building Decarbonization Assessment*.

165 Billimoria, Sherri, Leia Guccione, Mike Henchen, and Leah Louis-Prescott. 2018. *The Economics of Electrifying Buildings*. Rocky Mountain Institute. https://rmi.org/insight/the-economics-of-electrifying-buildings/.

166 Patrick Madamba. October 2, 2024. "How Do Power Outages Affect Households?" United States Census Bureau, https://www.census.gov/library/stories/2024/10/power-outages.html.

167 *Community Energy Navigators* were community-based organizations and local community leaders who lived in or had experience working with local communities.

enrollment. A process evaluation completed in October 2022 found that program participants had a high degree of trust in the Community Energy Navigators and that this feature of the program was partly responsible for high participant satisfaction.[168]

The EBD Direct Install Program will provide efficient electric appliances, energy efficiency measures, and related upgrades at no cost to low-income households.[169] The first phase of the program will serve initial community focus areas, which have been selected to ensure the inclusion of urban and rural communities.[170] The program guidelines include several criteria relevant in rural areas, such as communities underserved by existing energy and building decarbonization programs, communities with high fire risk, and communities with higher-than-average energy burdens.[171]

Within each initial community focus area, program administrators are required to partner with community-based organizations for culturally appropriate outreach, education, and support for participating households and communities. This element of the program echoes the Community Energy Navigator model used in the SJV Program.

California Native American Tribes

California Native American tribes[172] are sovereign nations that are characterized as hard to reach in energy programs because of the "historic disenfranchisement and dispossession of California Tribes."[173] The CEC has provided more than $100 million in grant funding to California Native American tribes[174] and in 2023 adopted a resolution committing to support California tribal energy sovereignty.[175] The CEC involves tribes in policy making through tribal consultations in alignment with the Tribal Consultation Policy, requiring early, often, and meaningful tribal consultation, as well as various engagement methods such as tribal

168 Evergreen Economics. October 2022. *SJV DAC Pilot Process Evaluation Report*.

169 *Disadvantaged communities* are designated by the California Environmental Protection Agency for the purposes of SB 535. *Low-income census tracts* include census tracts with median household incomes at or below 80 percent of the statewide median income and/or at or below the threshold designated as low-income by the Department of Housing and Community Development. A map of these areas is available from the California Air Resources Board at https://webmaps.arb.ca.gov/PriorityPopulations/.

170 EBD Program administrators and their partners have identified specific underresourced communities to be served in the initial phase of the program, known as *initial community focus areas*. The list of initial community focus areas is available on the EBD Statewide Direct Install Program webpage.

171 Maneta, Diana. 2023. *Equitable Building Decarbonization Direct Install Program Guidelines.*

172 *California Native American tribe* is defined by California Public Resources Code Section 21073 as a Native American tribe located in California that is on the contact list maintained by the Native American Heritage Commission.

173 California Public Utilities Commission. June 2023. *Decision 23-06-055.*

174 U.S. Environmental Protection Agency. 2023. "California Energy Commission Tribal Program," https://www.epa.gov/system/files/documents/2024-01/tribal-program-profile_2024-01-26_508.pdf.

175 California Energy Commission. March 2023. News Release. "CEC Adopts Resolution Supporting California Tribal Energy Sovereignty," https://www.energy.ca.gov/news/2023-03/cec-adopts-resolution-supporting-california-tribal-energy-sovereignty.

roundtables. Tribal roundtables were used to help guide development of the *2025 Energy Action Plan*.

There are several barriers and opportunities to helping California tribes decarbonize. As sovereign nations, tribes are not subject to the California's Energy Code and the Green Building Standards Code,[176] except in specific cases related to fees, trusts, and gaming contract agreements. This situation highlights an opportunity for increased government-to-government knowledge sharing on decarbonization strategies. Tribes and other hard-to-reach communities may lack staff capacity and resources to apply to government-administered energy programs. There is a need for more funding to provide technical assistance, enable capacity building, and promote tribal participation.[177]

Non-English Speakers

California is an ethnically and linguistically diverse state with more than 40 percent of the state's population speaking a language other than English at home.[178] About 7 million people, or 19 percent of the state's population, speak English less than very well and may be more vulnerable to fraudulent and predatory practices.[179] Undocumented non-English speakers may have additional apprehension toward applying to government programs. Energy programs commonly provide outreach and education in multiple languages. However, stakeholders could take additional steps to ensure that messaging is culturally appropriate and effective.

The CEC funded a multiyear study on the effects of social, cultural, and behavioral factors on the adoption of energy efficiency measures for Latino households.[180] Findings showed that different imagery used in marketing materials affected sign-up rates for energy audits. The study recommendations suggest using imagery that resonates with the audience, addressing concerns in an individualized way, and researching opportunities and limitations of housing stock and behavior patterns in different communities.[181] In addition to formal research, partnering with community-based organizations is another way to help ensure messaging and approaches to program implementation are culturally appropriate.

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176 U.S. Environmental Protection Agency. December 2023. "Tribal Green Building Code Guidance," https://www.epa.gov/green-building-tools-tribes/tribal-green-building-code-guidance.

177 U.S. Environmental Protection Agency. 2023. "California Energy Commission Tribal Program."

178 Dietrich, Sandy, and Erik Hernandez. August 2022. *Language Use in the United States: 2019 American Community Survey Reports*. U.S. Census, https://www.census.gov/content/dam/Census/library/publications/2022/acs/acs-50.pdf.

179 State of California Department of Justice. "Limited English Proficient Consumers," https://oag.ca.gov/consumers/limited-english.

180 Parsons, Laura, Georgina Arreola, Linda Dethman, Mithra Moezzi, and Edward Vine. August 2018. *California Latino Households and Energy Efficiency Upgrades*. California Energy Commission. CEC Publication Number: CEC-500-2018-018, https://www.energy.ca.gov/sites/default/files/2021-06/CEC-500-2018-018.pdf.

181 Ibid.

Continuity of Engagement for Hard-to-Reach Communities

Hard-to-reach customers require meaningful and inclusive outreach and engagement. Broad outreach and marketing of energy programs may not reach underserved groups because diverse customer bases have unique needs, are receptive to different approaches, and may lack trust and familiarity toward the implementing organization.[182] Typically, outreach and engagement are funded by incentive program contracts, which means that the outreach and engagement will end when those programs end because of expiration or interruptions in funding. Consequently, when new programs are established, outreach and engagement strategies need to be redesigned, and trust and brand recognition must be re-established. Establishing outreach and engagement for hard-to-reach communities that is independent of any particular program would provide continuity over time and help people navigate available options.

There is limited funding to help include these communities in energy policy development. The CPUC's Equity and Access Grant Program initially appropriated $30 million in 2022 to compensate tribes and community-based organizations for their involvement in energy policy-making and related activities.[183] However, the funding was reduced to $10 million in January 2024.[184] Energy programs often rely on the expertise of community-based organizations for outreach and engagement to hard-to-reach communities.

Barriers and Opportunities: Hard-to-Reach Communities

Barriers

- Limited availability of contractors in rural areas and long travel distances increase decarbonization costs.
- Tribes and other hard-to-reach communities lack the staff capacity and resources to apply to government-administered energy programs.
- Messaging may not always be culturally appropriate or effective, hindering outreach efforts. Undocumented, non-English speakers may face additional apprehension toward accessing government programs.

Opportunities

- Developing a better understanding of different hard-to-reach communities and identifying why they are hard to reach could help tailor programs in partnership with

182 Bean, G. Meghan and Marjorie McRae. 2016. *Power to the People: Using Community-Based Approaches to Deliver Efficiency and Sustainability to Hard-to-Reach Populations*, https://www.aceee.org/files/proceedings/2016/data/papers/11_943.pdf.

183 California Public Utilities Commission. "Equity and Access Grant Program," https://www.cpuc.ca.gov/about-cpuc/divisions/news-and-public-information-office/business-and-community-outreach/equity-and-access-grant-program.

184 Ibid.

community-based organizations to meet specific needs of different communities and increase participation.

- Establishing ongoing outreach efforts independent of specific programs could build trust and engagement over time.
- A centralized funding source for engagement and outreach to hard-to-reach communities could prevent duplicative efforts and enable continuity of outreach.

Building Local Workforces

Building local workforces is essential to ensure that the benefits of the energy transition are shared equitably, and that money spent in justice communities remains in those communities. Building local workforces is a multifaceted process that involves:

- Providing education, training, and support services to create a skilled workforce.
- Creating high-road job opportunities[185] to increase recruitment and retention of skilled workers.
- Providing local support to maintain these jobs and training opportunities within the community.[186]

A robust workforce is needed to install new wiring and panels, heat pumps, EVSE, and load flexibility technology to meet the 2030 goal to install 6 million heat pumps, advance building decarbonization actions in the *2022 CARB Scoping Plan,* and achieve the state's GHG reduction goals.[187]

According to the U.S. DOE's 2025 *United States Energy and Employment Report*, California had 941,496 energy jobs in 2024.[188] The energy efficiency sector in California employed 312,090 workers in 2024,[189] the largest class of clean energy workforce in the state. Figure 6 shows the energy efficiency sector added 9,914 jobs in 2024, a 3 percent increase from 2023.[190]

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185 *High-road jobs* are those that pay a living wage, provide opportunities for promotion, guarantee safe working conditions, and may offer other benefits.

186 Schneider, Jordan, Elizabeth Ridlington, and Bernadette Del Chiaro. 2011. *Building a Clean Energy Workforce: Preparing Californians for New Opportunities in the State's Green Economy*. Environment California Research & Policy Center, https://environmentamerica.org/california/resources/building-a-clean-energy-workforce-preparing-californians-for-new-opportunities-in-the-states-green-economy/.

187 Ibid.

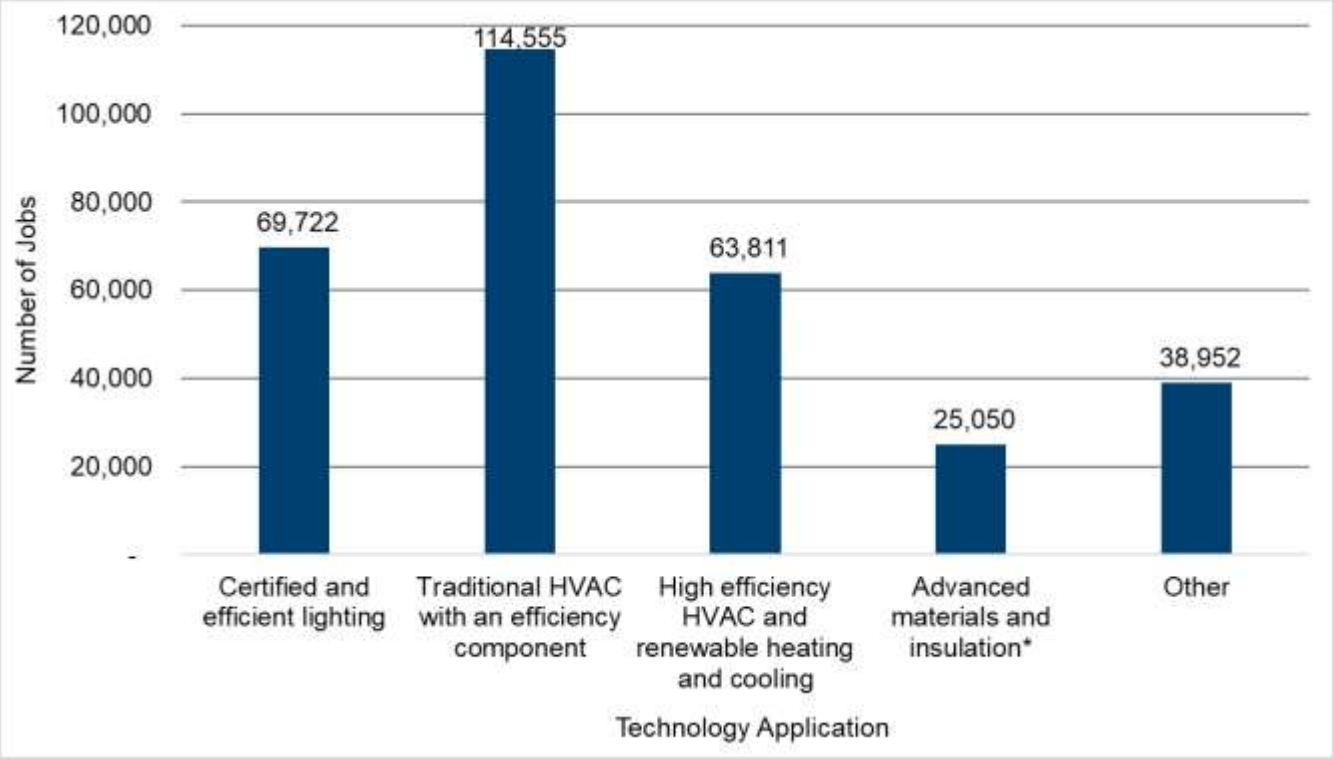
188 United States Department of Energy. 2025. *2025 United States Energy and Employment Report*. https://www.energy.gov/sites/default/files/2025-09/USEER%202025%20States%20090825_Fnl.pdf.

189 Ibid.

190 United States Department of Energy. 2025. *2025 United States Energy and Employment Report*.

United States Department of Energy. 2024. *2024 United States Energy and Employment Report*. https://www.energy.gov/sites/default/files/2024-09/USEER%202024%20States_0913.pdf.

Figure 6: Energy Efficiency Employment by Detailed Technology Application in 2024



***Advanced materials and insulation includes air sealing.**
Source: 2025 United States Energy and Employment Report

The *2021 IEPR Action Plan* recommended that the CEC and other state agencies engage with stakeholders representing worker interests, including organizations such as associations of community-based organizations, labor unions, utilities, vocational and technical schools, and community colleges. This engagement would focus on setting decarbonization priorities, identifying best practices, developing programs that meet the needs of these entities, and simplifying program access.

Research by the University of California, Los Angeles (UCLA) Luskin Center, predicted job gains and job losses as California electrifies buildings as part of decarbonization.[191] Specifically, electrification is expected to spur growth in the electric utility sector, adding 5,000 to 7,000 additional workers in roles related to electric generation, transmission, distribution, and other utility jobs potentially.[192] Conversely, the gas infrastructure and delivery workforce may decline by a similar amount, as shown in Table 13. According to the research by UCLA, plumbers and pipefitters will not be needed as much for all-electric new construction. In addition, the number of utility workers may decrease because an increase in fully electric buildings would

191 Jones, Betony, Jason Karpman, Molly Chlebnikow, and Alexis Goggans. 2019. *California Building Decarbonization: Workforce Needs and Recommendations*. UCLA Luskin Center, https://innovation.luskin.ucla.edu/wpcontent/uploads/2019/11/California_Building_Decarbonization.pdf.

192 Ibid.

lead to a reduced need for gas.[193] More than half of the additional jobs predicted by UCLA are in building decarbonization retrofits, which are expected to create an annual average of 42,000—81,000 additional jobs from 2020 to 2045,[194] with more than half in the housing sector, shown in Table 13 and Table 14.

Table 13: Employment Impacts by Industry, Low and High Estimates (Average Annual) 2020–2045

Industry	Low Estimate	High Estimate
Building Retrofits	42,012	80,600
New Construction	-3,100	-3,600
Renewable Energy Construction	20,300	23,200
Manufacturing	3,200	4,900
Electricity Generation, Transmission, and Distribution	5,356	6,448
Gas Distribution	-3,536	-4,264
Gas Production	N/A	-3,224
Total	64,232	104,060

Source: UCLA Luskin Center

Table 14: Estimates of Changes in Energy Workforce Employment, 2020–2045

Type of Work	Sector	Average Annual Change in Employment (2020– 2045)
Existing Building Electrification Construction Activity	Residential Retrofits	26,000–39,000
Existing Building Electrification Construction Activity	Small and Medium Commercial Retrofits	1,700–4,500

193 Ibid.

194 Jones, Betony, et al. 2019. *California Building Decarbonization: Workforce Needs and Recommendations*.

Type of Work	Sector	Average Annual Change in Employment (2020– 2045)
Existing Building Electrification Construction Activity	Large Commercial and Municipal, University, School, and Hospital Retrofits	11,000–30,900
Existing Building Electrification Construction Activity	Direct Energy Systems	3,300–5,900
Existing Building Electrification Construction Activity	Subtotal	42,000–80,600
All-Electric New Building Construction Activity	All-Electric New Residential Construction	-3,100 – -3,600
Renewable Energy Construction Activity	Solar Photovoltaic	16,000–18,800
Renewable Energy Construction Activity	Land-Based Wind	1,000–1,100
Renewable Energy Construction Activity	Geothermal	600–700
Renewable Energy Construction Activity	Infrastructure for Grid Connectivity	2,300–2,600
Renewable Energy Construction Activity	Subtotal	20,300–23,200
Construction Total	All Sectors	59,200–100,200

Source: UCLA Luskin Center

The expected increases in building decarbonization retrofit and residential sector jobs were not reflected in the number of licensed contractors in California in 2024, although the workforce grew since 2018, as shown in Table 15. Licensed contractors such as general contractors, electricians, sheet metal and HVAC workers, and plumbers and pipefitters are the trades most needed for building decarbonization retrofit work.[195] Electrification work, such as installing heat pump water heaters, would require various licensed contractors, including a C-20 HVAC contractor, C-36 plumber, and a C-10 electrician.[196]

195 Jones, Betony, et al. 2019. *California Building Decarbonization: Workforce Needs and Recommendations*.

196 Ibid.

According to the study by UCLA, three out of five jobs needed for building electrification are in high-road sectors, which require a skilled and trained workforce, pay higher wages, offer benefits, and provide opportunities for career growth.[197] The remaining two out of five jobs needed for electrification would be in traditionally "low-road" sectors, which have low barriers to entry and high turnover, with cost being the primary driver of competition for employers hiring for low-road jobs.[198] The researchers assert that changing the competitive dynamics in these low-road sectors may improve job quality, ensure higher-quality work, and increase the availability of skilled workers.[199]

Table 15: Active Contractor Licenses in California by Type, 2018 vs. 2024

License Type	2018	2024	Percentage Change (%)
B (General Contractor)	103,955	105,619	+2
C10 (Electrical)	25,519	27,875	+9
C20 (HVAC)	11,903	12,032	+1
C36 (Plumbing)	15,676	17,137	+9
Total B, C10, C20, C36 Licenses	157,053	162,663	+4

Source: California Contractors State License Board[200]

Existing Activities to Build Workforces

For years, many institutions and entities throughout California have administered programs to train and employ workers in emerging fields related to clean energy, electrification, and building decarbonization. These programs include multiyear apprenticeships, community college programs for career entry, and short-term certification-preparation courses for unemployed or underemployed workers. Short-term training programs can teach underemployed construction workers new skills and help them obtain certification for HVAC retrofits and installing other equipment needed to meet California's decarbonization goals.[201]

The California Workforce Development Board (CWDB) oversees 49 Local Workforce Development Boards (LWDB) in 15 regional planning units to continuously improve California's

197 Ibid.

198 Jones, Betony, et al. 2019. *California Building Decarbonization: Workforce Needs and Recommendations*, pg. ES-vii.

199 Ibid.

200 Contractors State License Board. Accessed May 2024. "CSLB's Public Data Portal, Contractor List By Classification." https://www.cslb.ca.gov/onlineservices/dataportal/ListByClassification.

201 Schneider, Jordan, et. al. 2011. *Building A Clean Energy Workforce: Preparing Californians for New Opportunities in the State's Green Economy*.

workforce development system.[202] These LWDBs make up the statewide workforce development system and are used to tap into local workforces, are mandated to provide opportunities for all workforce needs, and oversee One-Stop Career Centers.[203] Through the Unemployment Insurance Code Section 14200–Section 14531 and the Workforce Innovation and Opportunity Act, the CWDB has authority to carry out the tasks necessary for furthering a high-road workforce.

Another well-established approach to local workforce development is to use project labor agreements (PLAs). PLAs are incorporated into construction contracts through negotiations between construction unions and construction employers to ensure that contractors use local, credentialed labor for a specific construction project.[204] The primary goal of PLAs is to ensure the use of local labor, set wages and benefits, and establish no-strike, no-lockout clauses. PLAs may also ensure other goals are met, such as requiring a certain percentage of workers are apprentices or meet other criteria. PLAs are typically applied to union or prevailing wage contracts but may also be applicable to market-rate contracts.[205] A notable use of PLAs is in the City of Los Angeles, which entered into a PLA with the Los Angeles/Orange County Building and Construction Trades Council for the construction of affordable housing under its Proposition HHH.[206]

The California Department of Industrial Relations (DIR) engages in and administers workforce development activities that help create and maintain local high-road jobs through the Division of Apprenticeship Standards (DAS) and the California Apprenticeship Council (CAC). The DAS administers California apprenticeship law and establishes apprenticeship standards for wages, hours, working conditions and the specific skills required for state certification as a journeyperson in an apprenticeable occupation. The DAS promotes apprenticeship training, consults with program sponsors, and monitors programs to ensure high standards for on-the-job training and supplemental classroom instruction. A contractor that is awarded a public works project is required to notify the relevant apprenticeship committees, employ apprentices, and make training fund contributions to an approved apprenticeship committee or to the CAC.

Opportunities for Workforce Development

California is pursuing several building decarbonization programs that create opportunities to develop the decarbonization workforce. Four notable programs are the Building Initiative for

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202 "California Workforce Development Board," Web page, https://cwdb.ca.gov/.

203 California Workforce Development Board. "Local Boards." Web page, https://cwdb.ca.gov/local_boards/.

204 U.S. Department of Labor. December 2025. "Project Labor Agreements: Best Practices for Both Project Success and Increasing Inclusion of Women in Construction Trades." https://www.commerce.gov/sites/default/files/2025-01/Updated-PLA-Best-Practices-DOE-DOC-DOT.pdf.

205 Ibid.

206 City of Los Angeles. 2018. *Project Labor Agreement With Los Angeles/Orange County Building and Construction Trades Council,* https://bca.lacity.gov/Uploads/labor/Proposition%20HHH%20Project%20Labor%20Agreement%202018.pdf.

Low-Emissions Development (BUILD) Program, the TECH program, the EBD Direct Install Program, and the TREC program.

The TECH program provides consumer, contractor, and vendor training to help meet the local need for a skilled and trained workforce. The EBD Direct Install Program requires program administrators to "propose, implement, and measure results of a workforce plan with the goal of ensuring high-quality installations and creating local, high-quality jobs in the communities served."[207] The EBD program also requires administrators to provide preference for contractors that source workers from local areas.[208] California received a $10 million allocation to administer the TREC program, which will provide training and education to support contractors installing residential electrification improvements. The workforce training will help support the HOMES, HEEHRA, and the EBD Direct Install Program.[209]

The *2019 Energy Action Plan* recommended developing a statewide plan for the future of the gas system that protects workers, communities, and ratepayers. As the electric utility sector grows, the gas infrastructure and delivery workforce may decline by a similar amount, as shown in Table 13. Retraining workers from gas utilities, and contractors who specialize in gas equipment, may be one way to provide a pipeline of new but experienced workers who can conduct decarbonization retrofits.

Barriers and Opportunities: Building Local Workforces

Barriers

- There is a shortage in the workforce needed to install decarbonization retrofits to meet California's 2045 decarbonization goals.
- Decarbonization programs may be less cost-effective if contracts with high-road jobs, such as union labor or prevailing wage jobs, are part of program requirements.

Opportunities

- The anticipated growth in jobs statewide can be used to leverage the funding required to support apprenticeships, retraining, and upskilling workers.
- Existing approaches such as PLAs can be used to ensure that new jobs are kept in justice communities. Apprentices can benefit from career pathways leading to growth in job opportunities.
- An existing system of workforce development programs, including community colleges, nonprofit organizations, local workforce investment boards, and job placement agencies, can be leveraged to prepare students to join the clean energy workforce.

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207 Maneta, Diana. 2023. *Equitable Building Decarbonization Direct Install Program Guidelines*.

208 Ibid.

209 California Energy Commission. November 2025. California Training for Residential Energy Contractors. https://www.energy.ca.gov/sites/default/files/2025-11/00_GFO-25-901_Application_Manual_ada.docx.

- Establishing partnerships and agreements between decarbonization programs and local workforce development boards could maximize participation in decarbonization programs.
- LWDBs could use funding to improve their effectiveness and help meet upcoming needs for decarbonization retrofits.

Developing a better understanding of how programs can support housing contractors on topics like cash flow, pipeline management, bridge loans, sales leads, apprenticeships, training, marketing, business management, and administration could grow the decarbonization workforce.

Residential Panel Optimization and Sizing

The electric service panel is the connection between the electrical wiring of a building and the utility grid service. The panel splits the incoming electricity into multiple circuits, each with a circuit breaker sized to protect building wiring.

The California Electrical Code requires the electric panel and the utility service line to be sized to accommodate the estimated maximum combined instantaneous electricity draw (or peak load) of the building. The peak load of a building is calculated using standardized methods and is a conservative estimate based on the scenario where most of the loads operate at the same time. If the peak load exceeds the rating of the main breaker of the panel, the breaker will trip and safely cut power to the building. Tripping the breaker to cut power protects the building wiring because breakers are sized based on how much electricity the wiring can carry, which ensures they will not experience a peak load that could risk damage.

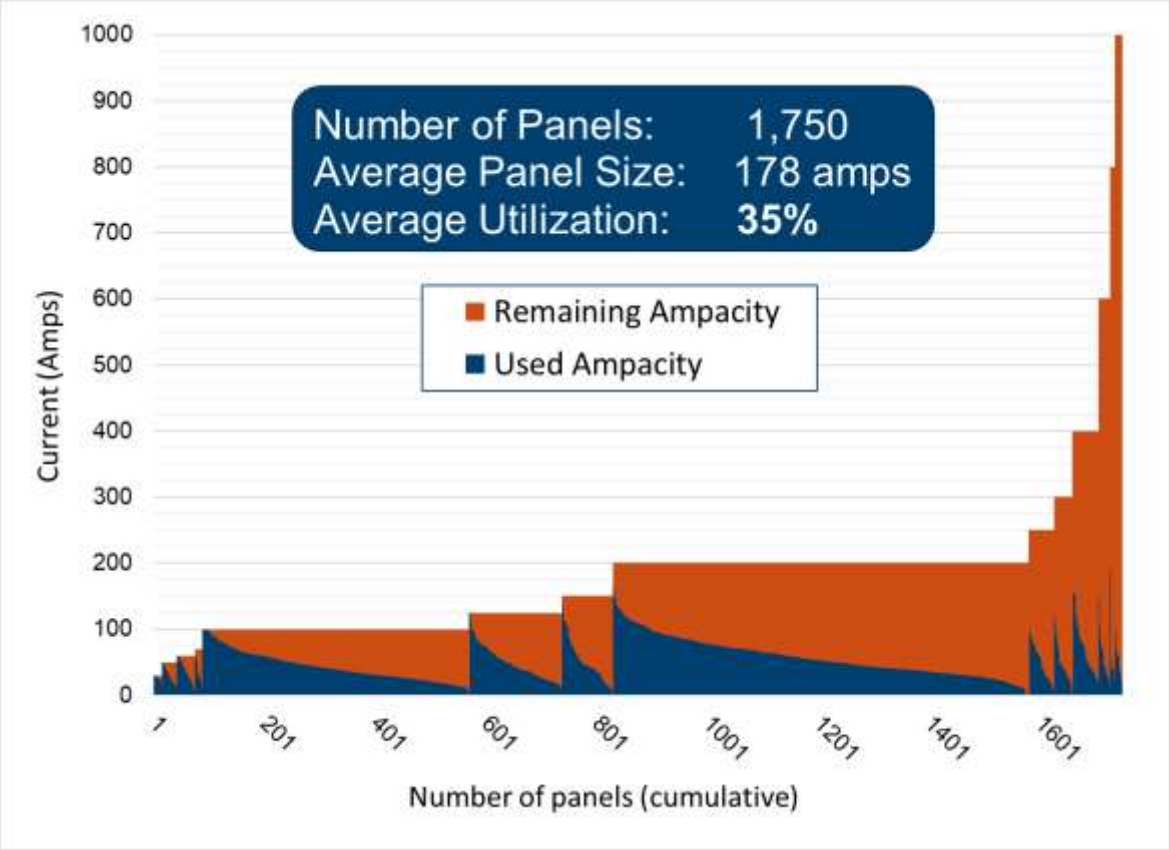
An electric panel upgrade is any modification or improvement to the electrical panel and associated hardware, including the addition of a subpanel. A panel may need to be upgraded because it is damaged and unsafe, out-of-date, or too small and needs room for additional circuit breakers to support new loads. An electric panel upsize is an upgrade where the existing panel is replaced with a panel capable of carrying a higher peak load. Upsizing the panel typically triggers an upsize of the electrical service wire as well, and in some cases, utilities may need to upsize distribution transformers or transformer secondary wiring.

Over the past 50 years, the expected building peak load and the default residential panel size have more than doubled from less than 100 amps to 200 amps.[210] When older buildings are decarbonized by installing new electric appliances, or when large electric loads, such as electric vehicle charging or solar generation, are added to a building, the electric panel may need to be upsized to accommodate the higher peak load. However, many electrification projects include a panel upsize without confirming it is necessary.

210 Fournier, Daniel, Robert Cudd, Samantha Smithies, and Stephanie Pincetl. September 2024. "Quantifying the electric service panel capacities of California's residential buildings." https://doi.org/10.1016/j.enpol.2024.114238

A recent analysis of TECH Clean California program data showed that of 1,764 homes with a 100-amp panel, 96 percent could add a heat pump water heater, heat pump HVAC, or both without upsizing the panel.[211] Other analyses of panel peak loads have shown that many panels are significantly underloaded; for example, the data in Figure 7 by Home Energy Analytics in 2022 show an average peak usage rate of 35 percent.

Figure 7: Electric Panel Size and Used Capacity (amps)



Source: HEA.com Electric Panel Analysis per NEC 220.87 Optional Method (HEA Panel Data 2024-01-09.xlsx). January 2024. https://corp.hea.com/about

The Cost of Electric Panel Upsizing

Electric panel upgrades are expensive and can significantly increase the time and complexity of a building electrification project. While panel upsizing is sometimes necessary, unnecessarily upsizing electric panels wastes time and money in two ways:

- Increased project costs and a longer permitting and construction timeline, and the risk of triggering an expensive electric service connection upsize.
- Upsizing utility service connections results in additional distribution infrastructure costs borne by all ratepayers, especially when the service wire is underground.

211 Feinstein, Laura, Sam Fishman, Jenny Low, and Edward Randolph. May 2024. *Solving the Panel Puzzle (SPUR Policy Brief)*, https://www.spur.org/publications/policy-brief/2024-05-14/solving-panel-puzzle.

Upsizing all existing building panels in California single-family and multifamily buildings to 200 amps would cost tens of billions of dollars. Avoiding this cost where it is not necessary will be critical to successfully decarbonizing buildings and minimizing upward pressure on utility rates.[212] A recent analysis of electric panel and service upgrades showed that most projects cost more than $3,000, and a quarter cost more than $13,000.[213] Any modification to an existing panel will require bringing it up to the current code and utility safety rules, which may require relocating the panel to a different location.

Avoiding Electric Panel Upsizing

Building owners, contractors, utilities, and building officials can avoid upsizing electrical panels unnecessarily by assessing the need for panel upsizing accurately at the beginning of an electrification project and selecting building electrification and energy efficiency measures that minimize peak loads. Avoiding upsizing electrical panels requires accurate peak load calculations, and measures that minimize peak loads including efficient loads, low power loads, load flexibility, and load sharing, as discussed below.

Peak-Load Calculations

The California Electrical Code includes two pathways for calculating the necessary panel and service capacity for an existing building. The bottom-up approach (Section 220.83 for single-family dwellings and Section 220.84 for multifamily dwellings) estimates load using appliance nameplate ratings (the maximum operating power of the appliance) and a demand factor that estimates of how often the device is expected to be on at the same time as other devices. The metered-demand approach (Section 220.87) relies on recent measured energy use in the building to identify the peak load for the building.[214]

The metered-demand approach (Section 220.87) can be advantageous because it provides an accurate representation of peak loads based on actual consumption and usage. This approach usually results in a lower calculated peak load than the bottom-up calculations. However, this approach requires installing data collection hardware unless the meter data can be obtained from the utility. Applying the metered-demand approach is technically challenging and time-consuming for most building owners since they must obtain and analyze their hourly consumption data. Better access to these data for building owners would support more realistic estimates of existing building peak power and help reduce unnecessary panel and service capacity upgrades.

Efficient and Low Power Loads

Adding energy efficiency measures and selecting power-efficient appliances and equipment can reduce the peak load of a building. Sizing new equipment properly reduces peak demand

212 Feinstein, Laura, et. al. May 2024. *Solving the Panel Puzzle (SPUR Policy Brief).*

213 Ibid.

214 Ibid.

and long-term energy costs. For example, heat pump (rather than electric resistance) clothes dryers reduce long-term energy costs, 120-volt heat pump water heaters reduce peak demand, and properly sized energy-efficient heating and air-conditioning systems reduce long-term energy costs and peak demand.[215]

Air sealing and improving the insulation in the building envelope can reduce peak loads on the building, as well as improving comfort and reducing energy burden. Integrating thermal or energy storage can reduce short-term peaks further while improving end-user satisfaction. An example of thermal storage is larger hot water tanks for heat pump water heaters, which reduce the use of backup resistance heating elements. Relatively small battery storage integrated directly into appliances, such as electric induction cooktops, allows short-peak consumption while avoiding the need for more expensive wiring and reducing the overall cumulative building peak draw.

Load Management and Sharing

Where larger peak loads are necessary, a range of technologies can reduce the peak or allow a single circuit to share energy between multiple loads within the building in a way that maintains customer service quality. Newer technologies may face inconsistent responses from contractors and building officials, however, so education will help improve acceptance.

Circuit splitters and circuit pausers limit electricity draw for a load based on the demand of another large load within the building or the overall building peak load. Many large loads, especially electric vehicle charging, require large peak power draw but operate infrequently. By automatically coordinating those loads with other large loads, the overall peak draw of the building can be capped, reducing the likelihood of panel and service upsizing.

Meter socket adaptors (also known as "meter collars") are a technology that measures the total load on the panel using a current transformer that is physically inserted between the utility meter and the meter socket. The load measurement from the meter socket adapter can be used in a variety of ways, for instance, to switch off a subpanel or switch off specific circuits or devices. These devices can be significantly less expensive than a panel upgrade. However, utility rules limit the widespread use of meter socket adaptors because each model must be individually approved by each utility. Other states have successfully implemented minimum specifications for these devices, allowing for greater market penetration.[216]

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215 Walker, Ian, Núria Casquero-Modrego, and Brennan D. Less. March 2023, *Challenges and Opportunities for Home Decarbonization*.

216 New Jersey S3092. September 2022. An Act Concerning Certain Electrical Equipment Used on Residential Electric Meters and Supplementing Title 48 of the Revised 2 Statues, https://pub.njleg.state.nj.us/Bills/2022/S3500/3092_R3.PDF.

Barriers and Opportunities: Residential Panel Optimization and Sizing

Barriers

- Building decarbonization projects may be delayed if a utility service upsize is triggered by an electric service panel upgrade or upsize.
- Electric service panels are often unnecessarily upsized, adding cost and time to electrification projects.

Opportunities

- Energy efficiency, load-sharing, and energy-storage technologies can allow many more buildings to electrify fully without upsizing the building panel or electric service connection.
- Educating contractors and building officials about electric panel optimization could reduce project costs for building owners and utilities.
- Decarbonization incentive programs and public policies could include guidance for building owners, contractors, and permitting officials to help avoid unnecessary panel upsizing by using accurate peak-load calculations, high-efficiency appliances and building design, and load flexibility technologies.
- Electrification readiness incentive programs should include incentives for wiring upgrades and panel improvements to support replacing fossil fuel systems with heat pumps, particularly when systems fail unexpectedly.
- Meter socket adapters could allow the addition of large loads without a main panel upgrade. Utilities should set minimum specifications for allowable installation and operation of meter socket adaptors, rather than requiring manufacturers to obtain approval of each model from each utility.
- Utilities should provide these data to customers in a format suitable for use by electricians and building department staff to simplify electrical code-compliant load calculations.

Equity Metrics

An *energy equity metric* is a measure or indicator used to assess disparities in access or outcomes in relation to affordable, reliable, and clean energy resources among different communities. These types of metrics can be used to:

- Create policies. Equity metrics can guide the design of energy policies and programs, ensuring the prioritization of justice communities.
- Guide investments. Investors or program administrators can use equity metrics to target investments in energy projects that benefit justice communities, promoting economic development and environmental justice.
- Engage communities. The data-driven insights from equity metrics can reveal disparities and encourage conversations on how to address them effectively.
- Evaluate and monitor. Equity metrics can help evaluate the effectiveness of energy programs over time and monitor progress toward achieving outcomes.

Many of California's decarbonization programs include set-aside amounts for equity purposes. However, approaches to evaluating and monitoring equity metrics to assess program success are still in the early stages of development. Policy and program developers have found it challenging to determine, measure, and track equity metrics.

The *2021 IEPR Action Plan* recommended three items relating to equity metrics: [217]

- "The CEC and other relevant agencies should work to quantify the nonenergy benefits of reducing building emissions, for example, improved public health, where possible, encouraging monetization of the energy-related externalities." It is thought that addressing these externalities can increase access to capital for decarbonization projects.
- "The CEC and CPUC should support strategic design of building decarbonization projects and programs to maximize health cobenefits and affordability in low-income and disadvantaged communities."
- "The CEC should support other agencies — federal, state, local, and tribal — in pursuing public health and safety-oriented regulatory updates to reduce GHG emissions statewide (local ordinances, Title 24 Part 11)."

These three recommendations have been met to some degree. In September 2022, Governor Newsom issued Executive Order N-16-22 which directs state agencies and departments to design and deliver state programs to advance equity and address existing disparities in opportunities and outcomes so all Californians may reach their potential.[218]
In 2023, the CEC published the *Justice Access Equity Diversity Inclusion (JAEDI) Framework,*[219] which outlines the CEC's commitment to embedding energy equity and environmental justice in the energy future. The *JAEDI Framework* describes how to include energy equity in program and policy work. One of the 15 best practices within the framework is to track qualitative and quantitative data that can help evaluate programs, policies, and projects with an equity lens. The framework states that nonenergy benefits[220] should be considered within an analysis: "Incorporating nonenergy benefits may produce greater benefits to all Californians by increasing the societal benefits produced by public funds.

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217 Kenney, Michael, et al. 2022. *Final 2021 Integrated Energy Policy Report, Volume I: Building Decarbonization*.

218 Executive Order N-16-22. September 13, 2022, https://www.gov.ca.gov/wp-content/uploads/2022/09/9.13.22-EO-N-16-22-Equity.pdf?emrc=c11513.

219 Bailey, Stephanie, Jane Berner, David Erne, Noemí Gallardo, Quentin Gee, Akruti Gupta, Heidi Javanbakht, Hilary Poore, John Reid, and Kristen Widdifield. 2023. *Final 2022 Integrated Energy Policy Report, Justice Access Equity Diversity Inclusion (JAEDI) Framework, Appendix A.* California Energy Commission. Publication Number: CEC-100-2022-001-CMF-APA, https://www.energy.ca.gov/sites/default/files/2023-11/CEC-JAEDI-Framework_ada.pdf.

220 *Nonenergy benefits* represent the array of diverse effects of energy programs and projects beyond the generation, conservation, and transportation of energy.

Incorporating and tracking these benefits supports investments essential to California's transition to a clean energy economy."[221]

There are three overarching categories of nonenergy benefits:[222]

- Participant nonenergy benefits include reduced costs, housing stability, time savings, improved health, safety, energy reliability, and comfort.
- Utility nonenergy benefits include improved on-time bill payment, reduced arrears, and enhanced infrastructure.
- Societal nonenergy benefits extend to broader impacts like job creation, economic development, environmental improvements, and community resilience.

Collecting and tracking these data can increase understanding of the needs of communities and ways to deliver solutions effectively.

At the March 13, 2024, CEC Business Meeting, CEC Commissioners voted to open a rulemaking to address nonenergy benefits and societal costs comprehensively.[223] The CEC held an initial workshop for the Non-Energy Impacts Informational Proceeding on October 7, 2024. The discussion focused on including nonenergy impacts in energy system planning to better understand how nonenergy benefits and social costs impact investments and decisions.[224]

On September 16, 2024, the CEC adopted the JAEDI Informational Proceeding to develop a comprehensive JAEDI Action Plan. This JAEDI Action Plan will outline a strategic approach to embedding justice, equity, diversity, and inclusion across all aspects of the CEC's operations and programs.[225] The JAEDI Action Plan will set clear objectives, action items, and metrics for success to ensure all Californians, especially tribes and justice communities, have equitable access to the benefits of the CEC's energy policies and programs. The informational proceeding noted that equity is at the heart of CEC's policies and programs.

Energy Affordability Metrics

Several methods of measuring energy affordability have been proposed and put into use in California and other states. Although these metrics are used to measure outcomes at a societal

221 Bailey, Stephanie, et al. 2023. *Final 2022 Integrated Energy Policy Report, Justice Access Equity Diversity Inclusion (JAEDI) Framework, Appendix A.*

222 Ibid.

223 California Energy Commission. 2024. "March 13, 2024 Energy Commission Business Meeting" Web page, https://www.energy.ca.gov/event/meeting/2024-03/energy-commission-business-meeting.

224 California Energy Commission. 2024. "Presentations for Non Energy Impacts OIIP Kick Off Workshop," https://efiling.energy.ca.gov/GetDocument.aspx?tn=259480&DocumentContentId=95586.

225 California Energy Commission. September 16, 2024. Justice, Access, Equity, Diversity, and Inclusion (JAEDI) Informational Proceeding Workshop. https://www.energy.ca.gov/event/workshop/2024-09/jaedi-proceeding-workshop

level, they could form the basis for, or part of, an equity metrics approach that measures outcomes for program participants.

In 2023, the LBNL Energy Markets and Policy Department and Pacific Northwest National Laboratory completed a national study, *Assessing the Current State of U.S. Energy Equity Regulation and Legislation.* The study found nearly half of the states took equity actions focused on finance, reliability, affordability, rate design, education, and the creation of working groups.[226] California was one of six states to identify energy equity metrics. The specific metrics identified in the study are:

- Hours at minimum wage required to pay for essential utility services.
- Vulnerability index of various communities in California.
- Ratio of essential utility service charges to nondisposable household income.

The CPUC uses three metrics to examine the impact of energy, water, and communications services in homes:[227]

- **Affordability ratio:** measures the percentage of a representative household's income used to pay for essential utility services after deducting nondiscretionary expenses, like housing. Higher affordability ratio values indicate less affordability.
- **Hours at minimum wage:** quantifies the hours of minimum wage employment necessary for a household to cover essential utility service changes.
- **CalEnviroScreen:** an independent metric composed of 21 indicators used to identify disadvantaged communities based on negative environmental impacts.

The CEC developed *Energy Equity Indicators*[228] in response to SB 350, aiming to identify opportunities and monitor progress in improving access to clean energy technologies, increasing clean energy investment, and enhancing community resilience. These indicators cover topics such as high energy bills, energy efficiency, rooftop solar systems, clean energy jobs, and more. However, the Energy Equity Indicator tool is used infrequently, and the data have not been updated since creation of the tool in 2018.

Given developments in California's energy system and the heightened importance of an equitable clean energy transition, there is an opportunity to revisit and revitalize the Energy Equity Indicators. The *2022 IEPR Update* explored whether to invest resources to update or revise the indicators to reflect shifts in energy equity and inform efforts to embed energy

226 Hanus, Nicole, Jay Barlow, Andrew Satchwell, and Peter Cappers. 2023. *Assessing the Current State of U.S. Energy Equity Regulation and Legislation.* Lawrence Berkeley National Laboratory and Pacific Northwest National Laboratory, https://emp.lbl.gov/publications/assessing-current-state-us-energy.

227 California Public Utilities Commission. Accessed April 2024. "Affordability Rulemaking," web page, https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/affordability.

228 California Energy Commission. "Energy Equity Indicators," web page, https://www.energy.ca.gov/rules-and-regulations/energy-suppliers-reporting/clean-energy-and-pollution-reduction-act-sb-350-3.

equity in its work. Based on the literature review and workshops, "CEC staff determined there was potential for updated indicators to add value. Data access and responsible data usage are pivotal to advancing equity and the backbone of ground-truthing[229] at the state agency level, and the CEC must make energy equity data available, accessible, and understandable."[230]

The efforts by the CEC and CPUC will ensure environmental justice considerations are integrated into energy and environmental policies, aiming to reduce the disproportionate burdens caused by pollution, climate change impacts, and energy-related health hazards.

Barriers and Opportunities: Equity Metrics

Barriers

- Limited data on the effects of the equitable distribution of program benefits limit efforts to monitor progress and identify areas for improvement.
- Existing metrics used to capture financial burdens and assess households' ability to cope with energy price increases vary across the country and are used inconsistently in program development or to assess impacts at the program level.
- Programs lack standardized metrics for tracking the equity of outcomes or assessing equity relative to other outcomes, like energy savings, GHG reductions, or cost-effectiveness.

Opportunities

- Access to timely and relevant data can advance efforts.
- Existing program metrics can serve as a foundation for an equity metrics approach, providing valuable insights into energy affordability and equity at a societal level.
- Creating metrics to describe equity outcomes that can be used by all programs, not just by equity-focused programs, could allow outcomes to be compared among different program types. Making metrics quantitative would allow them to be evaluated alongside other metrics, such as cost-effectiveness.
- Tracking diversity and equity outcomes in programs and sharing these data with researchers and policy makers could support equitable distribution of benefits. Outcomes could include program workforce diversity, outcomes for participants, and community benefits.

Voluntary Whole-House Home Energy Rating and Labeling

In the 1990s, the CEC recognized the need for a standardized home energy rating system that the state, utility incentive programs, and others could use to create an asset rating of homes.

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229 *Ground-truthing* is the process of gathering objective, directly observed data as opposed to data gained through inference.

230 Bailey, Stephanie, et al. 2023. *Final 2022 Integrated Energy Policy Report, Justice Access Equity Diversity Inclusion (JAEDI) Framework, Appendix A.*

An asset rating assesses the energy performance of the building itself, independent of the behavior of the occupants. Public Resources Code Section 25942, titled the Home Energy Rating Program, directed the CEC to "establish criteria for adopting a home energy rating program for residential dwellings."[231] Key components of the voluntary Home Energy Rating Program defined by statute include:[232]

- A consistent, accurate, and uniform rating based on a single statewide scale.
- Estimates of utility bill savings and recommendations on energy efficiency improvements, training, and certification procedures for home raters.
- A centralized reporting database.
- Effective labeling that meets the needs of consumers.

To fulfill this statutory requirement, the CEC created the California Home Energy Rating System (HERS) Program in 1999 in Title 20 of the California Code of Regulations.[233] The program was intended to help homeowners, homebuyers, renters, the real estate industry, mortgage lenders, and others understand the relative energy performance of a home. The rating enabled users to compare the energy efficiency or energy features of a home with other homes. The rating also provided cost-effective energy efficiency recommendations to encourage homeowners to make improvements to save money on their energy bills.

Despite development of the HERS Program, this voluntary program did not gain traction among homeowners and suffered from high administrative and modeling burdens. Resources shifted to other CEC programs, and the HERS Program regulations have not been updated since 2009.

Although home energy ratings are common in European countries, these ratings are not mandated for use by any state in the United States. As of April 2025, the Washington state legislature has a bill proceeding that would allow cities to mandate that "the owner of a single-family residence obtain and make available a home energy performance report before the residence may be publicly advertised for sale."[234] The bill sets out requirements for how the rating should be conducted and what should be contained in the report. Several U.S. cities require home energy reports at the time of sale or are piloting their use, including Bend, Oregon; Ann Arbor, Michigan; Carbondale, Colorado; Austin, Texas; Minneapolis, Minnesota; and Boston, Massachusetts.

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231 California Public Resources Code §25942(a).

232 California Public Resources Code §25942(a)1-5.

233 California Code of Regulations, Title 20, Public Utilities and Energy. Sections 1670–1675, https://www.energy.ca.gov/sites/default/files/2021-07/Title%2020%20Updated%20July%2023%2C%202021.pdf.

234 House Bill 1433, https://legiscan.com/WA/bill/HB1433/2023.

California Home Energy Rating and Labeling Rulemaking Proceeding

In October 2023, the CEC instituted a rulemaking proceeding to update and improve the HERS Program. This rulemaking is titled the "Whole-House Home Energy Rating and Labeling Program" and aims to "better support state energy efficiency, climate action, and GHG reduction goals."[235] The CEC issued a request for information in December 2023[236] and hosted public workshops in April and September 2024 to gather stakeholder input. The workshops presentation stated that the rating and labeling system sought to "[generate] market value for energy efficiency improvements and clean energy features in real estate through labeling."[237]

Real estate agents play a crucial role in reaching homebuyers and renters. However, the seller's agent does not have a reason to provide information on energy performance to the buyer if it reflects poorly on the property because the agent has primary fiduciary responsibility to the seller, not the buyer. Creating a home energy rating system that avoids conflicts of interest for real estate agents and is perceived as beneficial, or at least not burdensome, will increase the likelihood of success of the program. The National Association of Realtors Sustainability Advisory Group, which researches issues that affect real estate agents, has a mandate to "[integrate] sustainability into all aspects of residential and commercial real estate."[238] Working with the National Association of Realtors and leveraging its significant research and education capabilities could improve program design and effectiveness.

Cost of Home Assessments

Minimizing the cost of assessments while preserving accuracy and usefulness is a key goal of the CEC's rulemaking on voluntary whole-home energy rating systems. Calculating the cost of assessments is challenging and home energy assessments in the United States are subsidized, which masks the actual cost of the assessment. Consumers in Minneapolis pay $225 for a home assessment, whereas the estimated cost is $1,000 in Denmark.[239] State agencies or program implementers incur additional administrative and data processing costs to create the ratings and certificates. Getting clarity on the actual cost of implementing a rating system, and ways to minimize those costs, is an essential first step in developing a program.

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235 California Energy Commission. 2023. *Order Instituting Rulemaking Whole House Home Energy Rating and Labeling*, https://efiling.energy.ca.gov/GetDocument.aspx?tn=252656&DocumentContentId=87730.

236 California Energy Commission. 2023. "Request for Information on Home Energy Rating and Labeling," https://efiling.energy.ca.gov/GetDocument.aspx?tn=253699&DocumentContentId=88952.

237 California Energy Commission. 2024. April 30, 2024. "Presentation — Home Energy Rating and Labeling Prerulemaking Workshop," https://efiling.energy.ca.gov/GetDocument.aspx?tn=256119&DocumentContentId=91900. Slide 10.

238 California Energy Commission. "Modifications to Field Verification and Diagnostic Testing Program Requirements." Web page. Accessed May 2024, https://www.energy.ca.gov/proceeding/modifications-field-verification-and-diagnostic-testing-program-requirements.

239 California Energy Commission. April 2024. "Home Energy Rating and Labeling Workshop," https://www.energy.ca.gov/event/workshop/2024-04/home-energy-rating-and-labeling-workshop.

In the United States, home energy rating programs use the U.S. DOE Home Energy Score (HES) system developed by the U.S. DOE. A significant cost element in calculating HES is the need for an in-person assessment of the home by a trained technician. A 2021 study looked into the effectiveness of remote assessments using video conferencing with the homeowner as an alternative to an in-person assessment. The study estimated that a remote assessment could reduce time and cost for the assessor and program administrators by 35 percent, attributed primarily to shorter travel times.[240] On average, there was a 13 percent difference in the predicted energy consumption of a home between the remote and in-person assessments. Fifty percent of the scores showed no difference in the HES, and 81 percent of homes were within a 1-point difference.

The study found that overly complex homes (homes with complex roofs, copious glazing, or multiple HVAC systems) posed a challenge and relied heavily on the homeowner's knowledge of the home or any available documentation. Homeowners who participated in the study expressed satisfaction with the process and endorsed a remote assessment option.

Effectiveness of Home Energy Rating Systems

Since 2006, the Danish Energy Agency has implemented an Energy Performance Certificates (EPC) program, which provides a common scale for rating the energy performance of new and existing homes. The EPC program applies to all single-family and multifamily homes and certain commercial and institutional buildings. It requires rating at the time of construction, sale, or lease and requires the building owner to make the information available to prospective buyers and tenants. Program certificates follow a standard format for ease of interpretation, and ratings must be carried out by certified energy consultants. Each certificate is valid for 10 years from the date of issue.

In 2023, the EPC program had 1.5 million single-family homes and 110,000 multifamily homes with active EPCs (about 35 percent of all homes in Denmark). A presentation by the Danish Energy Agency cited analysis that showed homes that had better energy ratings had increased sale prices and fewer days on the market.[241]

Recent research shows that HES is statistically positively correlated with home sale price and mortgage performance (rates of default). The study found that these relationships were statistically significant only in places with a mandatory HES assessment at the time of sale. The study found that "[a] one-point increase in HES in these locations was associated with a 0.5 percent increase in sale price", and "an increase in $100 of estimated annual energy bills was associated with a 0.4 percent decrease [in sales price]."[221]

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240 Elton J., M. Winchel, A. Roy, W. Millard, C. A. Holly, and E. Louie. 2021. *Remote Home Energy Score Assessments, A Feasibility Study*. Pacific Northwest National Laboratory, https://www.pnnl.gov/publications/remote-home-energy-score-assessments-feasibility-study.

241 California Energy Commission. April 30, 2024. "Presentation — Home Energy Rating and Labeling Pre-rulemaking Workshop." Slide 10.

Evidence suggests that home energy rating systems effectively support sales of efficient homes by informing buyers about their energy use and likely utility bills. However, program designers should also consider other information that a rating system could provide, including the following:

- Energy features such as central AC, low-emissivity windows, air sealing, and insulation are indicators of thermal comfort.
- The presence of electrified systems in a home means that homeowners will not be faced with the future expense of electrification.
- The magnitude of the GHG emissions of a home is important to some buyers who want to lower their environmental impact.

Incorporating this or other information into a rating system could offer prospective homeowners additional valuable guidance about upgrades that have already been made to the home, which could affect their purchase or leasing decision.

Barriers and Opportunities: Voluntary Whole-House Home Energy Rating and Labeling

Barriers

- Home energy rating systems need to meet the needs of homeowners, real estate professionals, and lenders who may have no incentive to provide information that could reduce the selling price or prospects of a buyer.
- Home energy rating systems based on projected utility bills may not align well with the state's GHG reduction goals, and vice-versa. Ratings that separate electricity and gas use would more accurately capture GHG impacts. Another path may be needed to reconcile these competing metrics.
- The cost of conducting in-house assessments and analyzing data for home energy ratings is unclear and may need to be reduced for a program to be feasible.

Opportunities

- Home energy rating systems have been implemented in the European Union and United Kingdom for almost two decades, are extensively used, are viewed as effective in adding value to efficient homes, and have been refined and evaluated over several program cycles.
- A statewide home energy rating program that is mandatory at time of sale or rental and available to all homeowners as a voluntary program could add significant value to decarbonization improvements. Real estate professionals would be essential partners in developing, refining, and promoting a program.
- A home energy rating program that can quantify new and existing homes on the same performance spectrum would allow home buyers to make educated decisions about the likely energy costs of all homes in their price bracket.

Embodied Carbon

California aims to reduce GHG emissions by 40 percent below 1990 levels by 2030 and achieve carbon neutrality by 2045. Measuring and reducing the carbon footprint of a building uses three types of emissions sources:

- Scope 1 includes direct on-site emissions from refrigerants and fuel combustion.
- Scope 2 includes indirect emissions from electricity generation for use by equipment.
- Scope 3 includes all emissions not within an organization's Scope 1 and 2 emissions.

Scope 3 emissions, sometimes referred to as value chain emissions, represent upstream and downstream emissions. Downstream emissions, which are not considered in this report, are the emissions from a company's products. This report considers upstream emissions only, which are the emissions produced from extracting, manufacturing, transporting, installing, using, maintaining, and disposing of building materials referred to as "embodied carbon."[242] Embodied carbon is beginning to make up a higher percentage of GHG emissions in buildings as operational carbon (Scope 1) levels in buildings decline because of energy efficiency and electrification.[243]

Progress to Reduce Embodied Carbon

The *2021 IEPR Action Plan* recommended the relevant state agencies, including CARB, the Department of General Services (DGS), the California Building Standards Commission (CBSC), the CEC, and the HCD, collaborate to achieve goals around embodied carbon, including agreeing on agency roles, establishing a framework for reductions, and developing standards. The *2021 IEPR Action Plan* also recommended the agencies investigate the authority needed to communicate to the construction industry about carbon intensity metrics and develop regulatory proposals focused on low-embodied carbon construction goals based on existing authority.

Lastly, the *2021 IEPR Action Plan* recommended the state provide grant funding for California-based manufacturers or producers to develop and test technologies to decarbonize cement, steel, and other products with high- GWP.[244] The Buy Clean California Act (BCCA) (Public

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242 California Air Resources Board. Accessed 2024. "Embodied Carbon," https://ww2.arb.ca.gov/our-work/programs/embodied-carbon/about#_ftn1.

Climate Portal. "Scope 1, 2 and 3 Emissions," https://climate.mit.edu/explainers/scope-1-2-and-3-emissions.

World Resources Institute. *Corporate Value Chain (Scope 3) Accounting and Reporting Standard,* https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporing-Standard_041613_2.pdf.

243 World Business Council for Sustainable Development. July 8, 2021. *Net-Zero Buildings: Where Do We Stand?* https://archive.wbcsd.org/contentwbc/download/12446/185553/1.

244 *Global warming potential* is the amount of carbon dioxide associated with the warming effect of a given quantity of a GHG. Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs) are types of GHGs. While all GHGs have the effect of trapping heat, each gas has a different amount of impact over the lifetime of the gas. The BCCA GWP limits are based on a 100-year lifetime.

Contract Code Sections 3500–3505) required DGS to set GWP limits for the supply, transport, and manufacturing of certain building materials to reduce overall levels of embodied carbon in public buildings.[245]

The BCCA took effect in 2022, followed by other legislation about embodied carbon, including Assembly Bill 2446 (Holden, Chapter 352, Statutes of 2022), Assembly Bill 43 (Holden, Chapter 316, Statutes of 2023), and an update to the 2022 California Green Building Standards Code, Title 24, Part 11 (CALGreen). Each piece of legislation aims to reduce GHG emissions associated with buildings and building materials.

Buy Clean California Act

The BCCA was signed into law in 2017 and became effective July 1, 2022, targeting carbon emissions associated with public works projects. The BCCA covers four major construction materials:[246]

- Structural steel
- Concrete reinforcing steel
- Flat glass
- Insulation

The BCCA requires DGS to set limits for the GWP of those materials as another tool in California's toolbox to address climate change.[247] DGS further identified subcategories for those building materials and set GWP limits for each, as a single limit for each material would fail to achieve the goals of the BCCA to reduce embodied carbon in state buildings.[248]

The BCCA uses environmental product declarations (EPDs) to ensure raw construction materials used in public works projects comply with GWP limits. EPDs are independently verified reports that disclose the environmental impact of a product.[249] EPDs are developed using product category rules (PCR) which are guidelines managed by third-party organizations that provide a set of requirements and are written to ensure compliance with the International

245 Department of General Services. "BCCA EPD Compliance Guide," https://www.dgs.ca.gov/-/media/Divisions/PD/Engineering/EPP/Buy-Clean-California-Act/BCCA-EPD-compliance-guide-final-1-23-23.pdf.

246 Department of General Services. July 2023. *Buy Clean California Act Obstacles and Effectiveness Report.* Accessed May 2024, https://www.dgs.ca.gov/-/media/Divisions/DGS/LegReports/Accessible-Reports/2023/Buy-Clean-California-Act-Obstacles-and-Effectiveness-Report-FINAL.pdf.

Department of General Services. "Buy Clean California Act" web page, https://www.dgs.ca.gov/PD/Resources/Page-Content/Procurement-Division-Resources-List-Folder/Buy-Clean-California-Act.

247 Department of General Services. January 2022. *Buy Clean California Act Legislative Report.* https://www.dgs.ca.gov/-/media/Divisions/DGS/LegReports/Accessible-Reports/2022/BCCA-Legislative-Report_final.pdf.

248 Ibid.

249 Ibid.

Organization for Standardization standards.[250] State agencies and universities that award contracts for public works projects (known as *awarding authorities*) are responsible for ensuring the construction materials do not exceed GWP limits calculated in EPDs.[251] EPDs are a key element in monitoring and regulating GWP limits in public works projects with several types of EPDs available to contractors. The BCCA, however, is concerned only with manufacturer, or facility-specific, EPDs.[252]

The *Buy Clean California Act Obstacles and Effectiveness Report*[253] identified several challenges stakeholders faced in complying with the BCCA. Although the BCCA was signed into law in 2017, stakeholders still have difficulty understanding the technical terms and applications, such as the differences in EPDs and GWP limits.[254] There is also a discrepancy between the EPDs required by the BCCA and those submitted by stakeholders. DGS used industrywide EPDs to establish the maximum GWP and requires facility-specific EPDs for compliance, which disclose the environmental impacts for a single manufacturer and single manufacturing facility.[255] Few facility-specific EPDs exist, limiting the availability of compliant materials for stakeholders and forcing awarding authorities to exempt a project or material from compliance.[256]

Moreover, the types of materials typically used in construction projects vary from what the BCCA regulates. For example flat glass[257] is a regulated material in the BCCA, but a survey revealed that processed glass, flat glass that goes through additional processing and is not regulated, is typically used for public works projects.[258]

On August 2, 2023, the CBSC approved final express terms for the proposed building standards of the 2022 CALGreen. The 2022 CALGreen includes new mandatory and voluntary measures to conserve materials and use resources during deconstruction efficiently.[259] Conserving building construction materials and employing resources efficiently by recycling

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250 Ibid.

251 Ibid.

252 Ibid.

253 Department of General Services. July 2023. *Buy Clean California Act Obstacles and Effectiveness Report*.

254 Ibid.

255 Ibid.

256 Ibid.

257 Ibid.

258 Ibid.

259 CALGreen. "Chapter 4 Residential Mandatory Measures, Division 4.4 – Material Conservation and Resource Efficiency," https://codes.iccsafe.org/content/CAGBC2022P1/chapter-4-residential-mandatory-measures#CAGBC2022P1_Ch04_SubCh4.4.

2022 CALGreen. "Chapter 5 Nonresidential Mandatory Measures," https://codes.iccsafe.org/content/CAGBC2022P1/chapter-5-nonresidential-mandatory-measures#CAGBC2022P1_Ch05_SubCh5.4.

and diverting construction waste can reduce GHG emissions from the embodied carbon found in the high-GWP structural components like steel, glass, and insulation.

Assembly Bill 2446

Assembly Bill 2446 (Holden, Chapter 352, Statutes of 2022)[260] and Assembly Bill 43 (Holden, Chapter 316, Statutes of 2023) require CARB to develop a framework, by December 31, 2026, to measure and reduce embodied carbon in building materials.[261] As part of the framework, CARB may include a tracking and reporting mechanism to monitor the carbon intensity of buildings and track progress toward any established reduction targets. CARB may also establish an embodied carbon trading system. The bills set a goal of 40 percent net reduction by December 31, 2035.[262] The bills require CARB to develop a comprehensive strategy to ensure feasible and low-cost-impact alternatives to achieve these targets. AB 43 directs CARB to develop a strategy, by December 31, 2028, to reduce GHG emissions from building materials used in the state to 40 percent below an established baseline. AB 43 also authorizes CARB to impose civil penalties for these violations, rather than criminal penalties as originally established by the Global Warming Solutions Act.[263]

Senate Bill 596 (Becker, Chapter 246, Statutes of 2021), approved and signed September 23, 2021, required CARB to develop a strategy to achieve net-zero GHG emissions of cement used in the state by December 31, 2045.[264] As part of the strategy, CARB was required to define a metric for GHG intensity and establish a baseline to measure reductions based on data submitted by cement manufacturing plants. The bill requires CARB to establish interim targets for reductions relative to the average GHG intensity of cement used in 2019, with the goal of achieving reductions of 40 percent below average 2019 levels by December 31, 2035. By July 1, 2028, CARB is required to evaluate the feasibility of these interim targets and adjust the targets to achieve these goals. The bill also requires CARB to support economic and workforce development in communities neighboring cement manufacturing plants and evaluate measures to support market demand and incentives to encourage the production and use of low-GHG cement.

Barriers and Opportunities: Embodied Carbon

Barriers

- The on-site emissions generated by materials are difficult to measure, potentially leading to significant unquantified GHG emissions.

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260 Assembly Bill 43. Accessed May 2024, https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202320240AB43.

261 California Air Resources Board. Accessed 2024. "Embodied Carbon."

262 Ibid.

263 Assembly Bill 43. Accessed May 2024, https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202320240AB43.

264 Senate Bill 596. Accessed May 2024, https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220SB596.

- EPDs cover different life-cycle scopes and use different data sources. This variation in EPDs leads to difficulties with comparing products and emissions reduction.
- There are gaps in the number of products that have established PCRs, making it impossible to generate EPDs for many building materials.
- There is variability of PCRs, and new PCRs take time to develop. The variability and development time have made it difficult to compare life-cycle GHG emissions for different products directly.
- Stakeholders find it challenging for to find EPDs for building materials with established GWP limits under BCCA.

Opportunities

- Information from tracking and monitoring progress to reduce embodied carbon can be used to guide future regulations and enforcement. To guide CARB's development of regulations on embodied carbon, the CEC can collect data and monitor the impacts of the embodied carbon regulation in CALGreen by:
    - Evaluating how well buildings are complying with these requirements.
    - Assessing any indirect consequences of the regulations on building design, operational energy use, or material transportation.
    - Recommending improvements to the regulatory requirements to support enforcement and compliance, minimize compliance costs, and maximize GHG reductions.

Benchmarking and Building Performance Standards

Benchmarking requires building owners to collect and report energy use and other specified data to a public database. Benchmarking allows current and future building owners to analyze how the performance of their building changes over time and identify opportunities to reduce building energy consumption and costs. Building owners and the state benefit from benchmarking as it provides detailed information about individual building performance, as well as insights into the statewide building stock. California has a benchmarking program but does not have building performance standards. Building performance standards are outcome-driven policies that set minimum performance standards for existing buildings and typically allow building owners flexible options for how their building achieves the specified targets. Once a new building goes into service, and throughout its useful life, there are no regulatory oversights of building operations, and only certain maintenance and repair updates are regulated by the Energy Code. Building benchmarking combined with building performance standards aim to fill the gap in regulatory requirements. SB 48 requires the CEC to develop a strategy for using benchmarking data by 2026, which could include building performance standards.

California's Building Energy Benchmarking Program

Assembly Bill 802 (Williams, Chapter 590, Statutes of 2015) requires the CEC to manage a building energy benchmarking and disclosure program. The bill requires utility companies to provide building-level data for covered buildings to owners or their representatives upon

request. AB 802 defined *covered buildings* as any buildings with no residential utility accounts and any buildings with five or more active utility accounts, residential or nonresidential.[265] The CEC adopted regulations in 2018 that defined a subset of covered buildings, known as disclosable buildings, that are required to submit benchmarking reports to the CEC annually. *Disclosable buildings* are covered buildings larger than 50,000 square feet (ft^2) and multifamily residential buildings with more than 50,000 ft^2 and 17 or more utility accounts.[266]

The Building Energy Benchmarking Program has been in effect since 2018. Owners of disclosable buildings are required to report the energy usage and characteristics of their building every year by June 1.

The state regulations allow buildings reported under a local benchmarking program to be exempted from reporting to the state, and building owners within these jurisdictions follow local rules for reporting and compliance.[267]

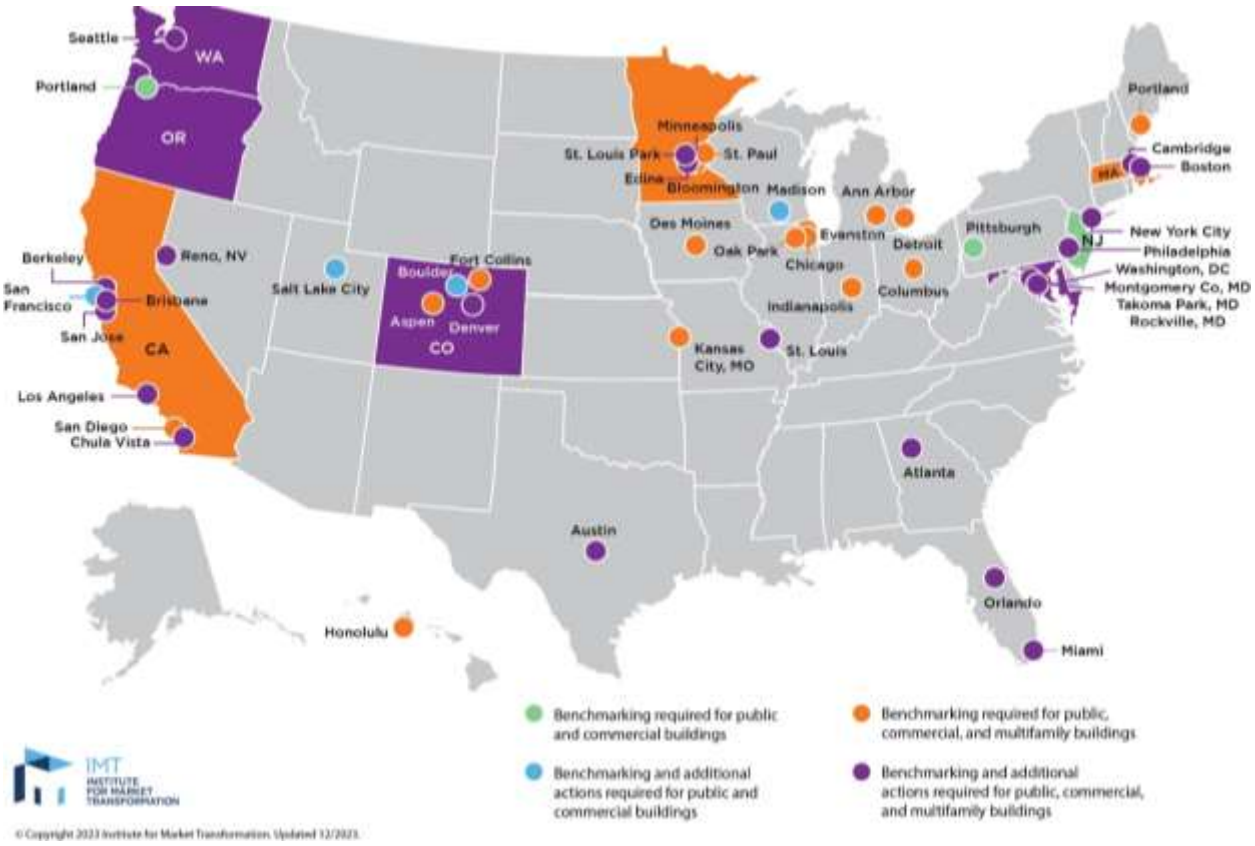
Figure 8 shows benchmarking programs for cities, counties, and states in the United Sates. Each jurisdiction has slightly different requirements. The states of Washington, Oregon, Colorado, and Maryland require benchmarking and additional actions for public, commercial, and multifamily buildings. California is one of three state benchmarking programs (along with Minnesota and Massachusetts) that include public, commercial, and multifamily buildings. One state (New Jersey) requires benchmarking for public and commercial buildings.

265 Public Resources Code section 25402.10(a)(2).

266 California Code of Regulations section 1681(d).

267 California Energy Commission. Accessed May 2024April 2025. "Exempted Local Benchmarking Ordinances," https://www.energy.ca.gov/programs-and-topics/programs/building-energy-benchmarking-program/exempted-local-benchmarking.

Figure 8: U.S. City, County, and State Policies for Existing Buildings Benchmarking, Transparency, and Beyond



Source: Institute of Market Transformation

Once the building owner reports their data to the CEC, the data are imported, processed, and curated in an interactive dashboard available to the public. The dashboard displays each property, and users can filter it as needed.[268] The main outcome metric is *energy use intensity* (EUI), which is the energy use per unit area of building space at a property. The EUI provides a baseline for each building-use type and allows owners and operators to compare the efficiency of different-sized buildings of the same use type.

CEC staff maintains a list of buildings covered by the benchmarking requirements and compares the list to available assessor parcel data to verify building data. The program seeks to improve compliance rates and use the data to guide program improvements and regulatory updates. CEC benchmarking staff report that ongoing challenges include:

- Accuracy of the covered buildings list. A comprehensive covered building list is in progress. Once complete, upkeep will not be as time-intensive. CEC staff will have a

268 California Energy Commission. "Public Disclosure Dashboard," https://tableau.cnra.ca.gov/t/CNRA_CEC_PUBLIC/views/EnergyEfficiencyBenchmarkingDashboard/BenchmarkingDashboard?%3AshowAppBanner=false&%3Adisplay_count=n&%3AshowVizHome=n&%3Aorigin=viz_share_link&%3AisGuestRedirectFromVizportal=y&%3Aembed=y.

better understanding of the number of buildings covered and the percentage of those that are within compliance.

- Building owner contact information. Once a building is identified, the property owner's information needs to be obtained and maintained throughout the life of the building. This information needs to be updated whenever the property changes ownership.
- Educating building owners on their responsibility. CEC staff conducts regular outreach to educate building owners and collaborate with stakeholders to collect and disclose data and improve compliance with reporting requirements. Communications are sent via physical mail to building owners, emails to those who opt-in on the CEC website, and emails associated with buildings that have been reported on in the past.
- Enforcement. The CEC has the authority to issue fines for noncompliance after allowing 30 days to correct a violation. The CEC has not yet used the enforcement arm of the Benchmarking Program but is exploring options and plans to initiate a proceeding soon.
- Benchmarking itself does not improve building energy usage. However, coupled with comparisons, it can influence building management decisions.

Building Performance Standards

Building performance strategies, policies, and standards are designed to maintain and improve existing building operations by linking to the benchmark of a building. Such policies complement new construction building codes to ensure performance over the life of the building. In 2022, California joined the National Building Performance Standards Coalition, an initiative to accelerate building performance standards across the country. State and local governments joining the coalition are committed to inclusively designing and implementing equitable building performance standards and complementary programs and policies through legislation or regulations.[269]

Within California, the City of Chula Vista adopted the first building performance standards in 2021. According to the city, "Building performance standards paired with complementary programs and policies will enable the city to meet its health, equity and climate goals."[270] Seven other cities (Berkeley, Los Angeles, Sacramento, San Diego, San Francisco, Santa Monica, and West Hollywood) and one county (the County of Los Angeles) are working on adopting building performance policies.

SB 48 requires the CEC to develop a statewide strategy for using benchmarking data to track and manage the energy use and GHG emissions of a covered building. The CEC intends to

269 California Energy Commission. December 2022. "California Joins National Coalition of States and Local Governments Strengthening Building Performance Standards," News release, https://www.energy.ca.gov/news/2022-12/california-joins-national-coalition-states-and-local-governments-strengthening.

270 City of Chula Vista. 2022. "Chula Vista Announces Participation in Building Performance Standards Coalition," News release, https://www.chulavistaca.gov/Home/Components/News/News/3427/.

adopt the final report on or before July 1, 2026, and then submit it to the Legislature on or before August 1, 2026.[271]

California's Building Energy Benchmarking Program establishes a strong foundation for building performance standards because it provides the analytical basis for assessing building performance and a feedback mechanism for providing building owners with actionable information. A report by the American Council for an Energy-Efficient Economy (ACEEE) outlines ongoing challenges:[272]

- Cost of improvements. Building owners often need to pay for the cost of upgrades before they receive program funds. Some programs require reporting for a set amount of time before payback. Finding the capital upfront for energy efficiency improvements can be a barrier.
- Technical expertise. Owners want to be sure they are completing projects in the correct order to maximize the cost and minimize occupant disruption. An overall strategy can be a barrier in an emergency or when working with a contractor who may specialize in one part of a building.
- Other building updates. It is possible that other ancillary updates need to take place before electrifying a building or implementing energy efficiency measures.
- Split incentive. Landlords can overcome the split incentive by passing on the cost of the upgrade to the building tenants. Policies may be needed to protect low-income renters or tenants from excessive rent increases. For example, Chula Vista's BPS ordinance requires property owners to spread the cost of the energy efficiency improvements evenly over the entire expected lifetime of the upgrades.[273]

The *2019 Energy Action Plan* recommended that California should "[e]stablish a ... low-to-zero-emission building policy"[274] and stated, "[T]here is a disconnect between the metrics required to show compliance for new buildings versus existing buildings. The CEC will aim to create a building performance standard with metrics using data from utility interval meters, the statewide building benchmarking program, and other data sources. The goals of the new metric will be to show new and existing buildings on the same spectrum of performance and

271 California Energy Commission. "California Building Energy Performance Strategy Report," Web page, Accessed May 2024, https://www.energy.ca.gov/data-reports/reports/california-building-energy-performance-strategy-report.

272 Jarrah, Alexander, Emily Garfunkel, and David Ribeiro. January 2024. "*Nobody Left Behind: Preliminary Review of Strategies to Support Affordable Housing Compliance With Building Performance Standards.*" ACEEE, https://www.aceee.org/research-report/b2401.

273 Jarrah, Alexander. 2024. "Affordable Housing Needs More Support to Comply With Building Performance Standards." Blog post, https://www.aceee.org/blog-post/2024/01/affordable-housing-needs-more-support-comply-building-performance-standards.

274 Kenney, Michael, Heather Bird, and Heriberto Rosales. 2019. *2019 California Energy Efficiency Action Plan*.

support energy modeling used in developing building standards, forecasts, and programs."[275] Creating a common metric for the performance of new and existing buildings remains important because it allows purchasers and leasers to compare new and existing buildings side by side.

Barriers and Opportunities: Benchmarking and Building Performance Standards

Barriers

- Creating and keeping an up-to-date comprehensive building list and owner contact information.
- Holding noncompliant building owners accountable without a meaningful enforcement mechanism.
- Addressing split incentives to protect low-income renters or tenants from excessive rent increases.

Opportunities

- Understanding energy use is the first step to improving efficiency and reducing the GHG emissions of buildings. The benchmarking program provides a foundation from which to start.
- The CEC has existing authority to explore a statewide strategy to track and manage covered building energy use and GHG emissions (Public Resources Code Section 25402.16).
- The California Building Energy Performance Strategy Report, to be published in 2026, will have recommendations to strengthen benchmarking compliance.
- Implementing a statewide benchmarking enforcement process, including penalties, would improve compliance.
- Lessons learned from benchmarking programs in other municipalities and countries could be applied to improve the state's benchmarking program.

Building Energy Efficiency Standards

California's Building Energy Efficiency Standards[276] 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,

275 Kenney, Michael, et. al. 2022. *Final 2021 Integrated Energy Policy Report, Volume I: Building Decarbonization,* pg. 51–52.

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

uneconomic, inefficient, and unnecessary energy consumption in the state.[277] 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 CEC. Since 1978, the Building Energy Efficiency Standards have exemplified California's strategy to reduce energy consumption cost-effectively, pioneer methods that conserve resources, and act as a world leader in energy efficiency and clean energy.

Code Cycle and Rulemaking Process

A fair, robust, and transparent public process is the lifeblood of California's Building Energy Efficiency Standards. Each three-year code cycle, the CEC receives numerous proposals 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 are predicted to have the largest societal cost 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.

The Warren-Alquist Act requires energy utilities to support the development of the Building Energy Efficiency Standards.[278] Accordingly, development of the Building Energy Efficiency Standards is supported by the Statewide Codes and Standards (C&S) Program, which is paid for by a portion of electricity and gas rates included in customer utility bills.[279] This program is regulated by the CPUC. This support includes providing appropriate research, development, and implementation training, if funds are made available to the utilities for that purpose. PG&E, SCE, SDG&E, LADWP, and SMUD administer the C&S program. This mechanism provides a uniquely collaborative framework in California that encourages the state's largest utilities and other funded programs to support work done by the CEC to advance California's Building Energy Efficiency Standards.

Each code cycle, the CEC hosts a series of public workshops to present the most important information pertaining to that code cycle. 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.

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277 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.

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

279 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.

The CEC then conducts a rulemaking proceeding in accordance with procedures set out in the Administrative Procedures Act,[280] culminating in adoption by the CEC at a business meeting adoption hearing.

Building Energy Efficiency Standards for New Construction

After the CEC adopts amendments to the Building Energy Efficiency Standards, the amendments are submitted to the CBSC for approval and inclusion with all other parts of the California Building Standards Code (Title 24).[281] Since the last Building Energy Action Plan, there have been two revisions to the Building Energy Efficiency Standards — in 2022 and 2025. Both updates are described in this section.

In 2021, the CEC adopted the *2022 Building Energy Efficiency Standards* for newly constructed and renovated buildings that will produce benefits to support the state's public health, climate, and clean energy goals. The 2022 Energy Code focuses on four key areas in newly constructed homes and businesses, including:

- **Encouraging electric heat pump technology** for space and water heating, which consumes less energy and produces fewer emissions than gas-powered units.
- **Establishing electric-ready requirements** for single-family homes to position owners to use cleaner electric heating and cooking options, whenever they choose to adopt those technologies. The CEC established electric-ready requirements for multifamily new construction in 2022 with requirements for heat pump space heaters, electric cooktops, and electric clothes dryers.
- **Expanding solar PV system and battery storage standards** to make clean energy available onsite and complement the state's progress toward a 100 percent clean electricity grid.
- **Strengthening ventilation standards** to improve indoor air quality.

Over the next 30 years, the 2022 Energy Code is estimated to provide $1.5 billion in environmental benefits and reduce 10 million metric tons of GHGs, equivalent to taking nearly 2.2 million cars off the road for a year.[282] Expanded adoption of new energy-efficient technologies will help reduce costs of the technology over time. These standards went into effect January 1, 2023.

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280 California Administrative Procedure Act, https://oal.ca.gov/publications/administrative_procedure_act/.

281 "California Building Standards Commission Guidebooks on Rulemaking," Web page, https://www.dgs.ca.gov/BSC/Resources/Page-Content/Building-Standards-Commission-Resources-List-Folder/Guidebooks-on-Rulemaking.

282 California Energy Commission. *Final Environmental Impact Report*. August 4, 2021. Publication Number: CEC-400-2021-007-F, https://efiling.energy.ca.gov/GetDocument.aspx?tn=239176&DocumentContentId=72629.

California Energy Commission. Appendix B – Combined Emissions and Energy Savings. August 2, 2021. Docket Number: 21-BSTD-02. TN#: 239152, https://efiling.energy.ca.gov/GetDocument.aspx?tn=239152&DocumentContentId=72605.

The *2025 Building Energy Efficiency Standards* were adopted September 11, 2024, with a targeted effective date of January 1, 2026. This update encourages heat pumps for space conditioning and water heating in newly constructed single-family, multifamily, and select nonresidential building types. Each of these new buildings built across the state will include at least two heat pumps as the standard design, building off the single heat pump standard introduced in the previous update. This update is expected to result in the deployment of at least 500,000 new heat pumps over the next three years, at total energy cost savings of $4.8 billion.[283]

Barriers and Opportunities: Building Energy Efficiency Standards

Barriers

- California's diversity of climate zones, building types, and utility rate offerings make it challenging to develop broad statewide standards in support of building decarbonization.
- Some building types present unique considerations from an Energy Code perspective. For example, large nonresidential buildings are typically served by complex space-conditioning systems, which can be challenging to electrify cost-effectively while preserving designer flexibility.
- Current electric rates and equipment and labor costs raise affordability issues when considering standards for heat pump replacements in existing buildings. This barrier is further discussed in the Regulatory Standards for Heat Pump Retrofits section below.

Opportunities

- Partnerships with local jurisdictions and other industry partners that generate data about real-world costs and savings could help the CEC to find cost-effective and technically feasible opportunities to advance energy-efficient technologies.
- Expanding the analytical basis of the Building Energy Efficiency Standards to include the monetary benefits of reducing harmful air pollutants such as NOx and CO2e could support zero-emission technologies. This inclusion would be in line with the findings of the informational rulemaking the CEC is conducting on nonenergy benefits and social costs to meet the goals of SB 100.284
- Performance-based and prescriptive energy use targets in the Energy Code could be reduced to encourage the use of higher-performance HVAC and water-heating systems that use A2L refrigerants.285

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283 California Energy Commission. September 2024. Press Release: "Energy Commission Adopts Updated Building Standards Expanding Requirements for Heat Pumps and Electric-Ready Buildings," https://www.energy.ca.gov/news/2024-09/energy-commission-adopts-updated-building-standards-expanding-requirements-heat.

284 California Energy Commission. "2025 Senate Bill 100 Report Non-Energy Benefits Workshop." April 16, 2024, https://www.energy.ca.gov/event/workshop/2024-04/2025-senate-bill-100-report-non-energy-benefits-workshop.

285 California Air Resources Board. 2022. *2022 Scoping Plan for Achieving Carbon Neutrality,* p. 238. https://ww2.arb.ca.gov/sites/default/files/2022-12/2022-sp_1.pdf.

- A compliance credit for nonresidential HVAC systems that can be controlled by third-party demand management applications in the 2028 Building Energy Efficiency Standards could help grow the market for load flexibility.

Regulatory Standards for Existing Buildings

California is pursuing several parallel tracks to encourage heat pumps as the preferred technology when fossil fuel combustion equipment needs to be replaced within buildings. One of these tracks is to encourage heat pump installations when replacing air conditioners or fossil fuel systems; this track may be the most cost-effective way to bring the benefits of low-carbon building technologies to all consumers. Similar transitions have happened in the past for other technologies such as low-emissivity windows, duct insulation and sealing, electric resistance heating, cool roofs,[286] and light-emitting-diode (LED) lighting.

Building Energy Efficiency Standards for Existing Buildings

The 2025 Energy Code introduces standards for heat pumps to replace end-of-life single-zone rooftop HVAC units less than 65,000 British thermal units (BTU) per hour for existing medium retail, small schools, and most small offices and libraries.

The CEC also adopted a voluntary measure in 2025 updates to CALGreen that would establish heat pumps as the prescriptive baseline standard when replacing existing space-conditioning systems in single-family homes and when replacing pool-heating equipment. Since these measures are voluntary, only residents in locations where a local ordinance including this measure has been adopted would need to comply. These voluntary requirements are expected to result in significant GHG savings in local jurisdictions where they are adopted, and they provide a potential path for a statewide requirement for retrofits in a future code cycle. According to the CEC's *2025 Single-Family Heat Pump Replacements Report*,[287] this measure is cost-effective across all California climate zones, except for Climate Zone 15. Climate Zone 15 includes the desert regions of Imperial County and parts of Riverside and San Bernardino Counties. This zone is characterized by hot summers and mild winters, typical of desert climates.

The CEC will continue to explore opportunities to promote a transition from standard air conditioners to heat pumps to improve efficiency, reduce emissions, and consider overall customer costs. These measures, combined with strong statewide heat pump standards for new construction adopted in the 2025 Energy Code, aim to accelerate the heat pump market and will support the deployment of 6 million heat pumps by 2030.

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286 "Cool roofs" is a colloquial term for roofing materials that have a high solar reflectance and high thermal emittance, and therefore reduce the rate of heat absorption into the home through the roof.

287 California Energy Commission. January 2024. *2025 Single-Family Heat Pump Replacements Report,* Docket 24-BSTD-02. TN#: 256432-2, https://efiling.energy.ca.gov/GetDocument.aspx?tn=256432-2&DocumentContentId=92250.

Various municipalities have explored or implemented ordinances to remove existing regulatory barriers to heat pump installations. For example, Palo Alto's Residential Electrification Ordinance amended noise and setback requirements to encourage heat pump retrofits.[288] No city in California has implemented a mandatory or prescriptive requirement for any existing equipment to be replaced with a heat pump. When the new voluntary requirements in CALGreen go into effect, the CEC plans to collaborate closely with local governments, air quality management districts (AQMDs), equipment manufacturers, and other stakeholders to promote this measure where conditions are favorable.

To guide potential consideration of additional heat pump retrofit measures in a future code cycle, the CEC will continue to monitor the heat pump market and assess information gaps, including the following topics:

- Making the cost of heat pump systems and panel and wiring alterations more predictable.
- Gathering more accurate and nuanced data to measure costs and payback periods, which vary across systems and home characteristics, to allow code measures to be targeted at lower-cost homes.
- Establishing a plan to cover the costs through rebates, financing, or other sources of funding.

Regional and Statewide Zero-Emission Space and Water Heater Standards

The Bay Area Air Quality Management District (BAAQMD) and the South Coast Air Quality Management District (SCAQMD) have adopted and proposed regulations to eliminate NO_x appliance emissions, complementing statewide efforts by CARB. BAAQMD Rules 9-6 and 9-4, which establish zero-NO_x-emission limits for water heaters starting in 2027 and space heaters starting in 2029, will contribute to improved air quality in the San Francisco Bay Area.[289] SCAQMD's Rule 1146.2 requires large water heaters, small boilers, and process heaters to meet zero-NO_x emission standards starting in 2026 for new buildings and 2029 for existing buildings. SCAQMD proposed amending Rules 1111 and 1121 to require zero-NO_x-emission limits for furnaces and small water heaters starting in 2026 for new construction and 2027 for existing buildings.

CARB is in the prerulemaking phase to develop a regulation that would eliminate all direct emissions from a range of residential and commercial space and water heaters. Buildings account for about 26 percent of GHG emissions in California and contribute to smog and respiratory issues. The regulation is intended to reduce GHG emissions to help meet California's climate goals but will also reduce smog-forming NO_x emissions as a cobenefit to

288 City of Palo Alto. 2023. Ordinance No. 5601, https://portal.laserfiche.com/Portal/DocView.aspx?id=68792&repo=r-704298fc.

289 Bay Area Air Quality Management District. 2021. "Regulation 9, Rule 6: Nitrogen Oxides Emissions From Natural Gas-Fired Water Heaters (2021 Amendment)," https://www.baaqmd.gov/rules-and-compliance/rules/reg-9-rule-6-nitrogen-oxides-emissions-from-natural-gasfired-water-heaters?rule_version=2021%20Amendment.

achieve federal air-quality standards.[290] More than half of Californians live in areas that do not attain health-protective federal air quality standards despite significant improvements in air quality over the past few decades.

These regional regulations, which complement CARB's statewide GHG standards by establishing stricter emissions limits for residential and commercial appliances, form a comprehensive approach to reducing NO_x emissions. California aims to encourage the widespread adoption of low-emission technologies, improving air quality and public health while advancing the state's environmental goals by combining efforts at the state and regional levels.

Barriers and Opportunities: Regulatory Standards for Existing Buildings

Barriers

- The initial costs of heat pump systems can be a significant financial barrier for homeowners, particularly low- and moderate-income households even when alterations can be shown to be cost-effective over the life of the measure.
- Contractors and homeowners may need support to determine whether existing electrical panels are able to support the electrical load of the home.
- The "split incentive" problem discourages some building owners from conducting energy upgrades because the building owners bear the upfront costs and tenants benefit from the savings, which limits the adoption of heat pump systems in rental properties.

Opportunities

- Progressive local governments can take advantage of voluntary measures adopted in CALGreen and address regulatory barriers and implement ordinances to encourage heat pump installations, setting a precedent for broader adoption.
- Consideration of additional nonresidential prescriptive building standards in the 2028 Energy Code cycle could encourage the installation of heat pumps during air-conditioning and water-heater replacements, provided these retrofits are deemed cost-effective and technically feasible. Energy Code requirements could be aligned with local and statewide standards that are in development, such as zero-NOx furnace and water heater standards by AQMDs that would in effect require heat pump retrofits and a zero-GHG-emission space and water heater standard from CARB.
- The continuation of federal tax credits and utility incentives for low- and middle-income homeowners even when heat pumps are required under code could help reduce the financial burden of heat pump installations.
- If heat pump retrofits become a prescriptive standard, utility incentives could remain robust, ensuring they cover the typical incremental cost over equivalent fossil fuel

290 California Air Resources Board. "Zero-Emission Space and Water Heater Standards," Web page, https://ww2.arb.ca.gov/our-work/programs/zero-emission-space-and-water-heater-standards.

systems, with adjustments for differences in running costs from efficiency or utility rates. Regulatory changes may be required to allow incentives to continue for technologies that are prescriptively required.

- Research to better understand the costs of measures and market wide reductions in heat pump prices resulting from higher installation volume may inform further heat pump standards opportunities for existing nonresidential buildings starting in 2028.
- Program implementers could gather and analyze detailed cost data to assist code developers in identifying the most cost-effective circumstances for heat pump retrofits and targeting code measures at such buildings.

Code Compliance for Existing Building Retrofits

Code compliance in new construction and commercial projects is generally considered high, but there are opportunities for compliance improvement in existing buildings. Obtaining a permit to replace certain equipment in existing buildings is required by the building code.

Nonpermitted construction in existing residential buildings is a problem for two major reasons:

- First, if newly installed systems are not permitted and inspected by the local building department, there is no guarantee of meeting the safety, health, and efficiency standards that are required by code.
- Second, many heat pumps are installed in California through incentive programs that require a permit. This permit requirement increases the cost of installing heat pumps compared to replacing an existing gas appliance, making them less appealing to consumers.

The additional labor required from contractors to attend inspections and remediate any code violations flagged by the building inspector may also lead some contractors to persuade customers away from pulling permits, which favors gas equipment over electric because many contractors will replace gas equipment without pulling a permit. Increasing the rate of permit compliance for gas equipment or reducing the cost of permitting for electric equipment, or both could reduce the disparity in permitting costs between gas and electric equipment.

The *2021 IEPR Action Plan* underlined the critical need for code compliance to achieve energy efficiency targets within California's building sector. It proposed a wide range of improvements, including making compliance easier, enhancing enforcement via the Contractors State License Board, and providing alternative ways of demonstrating compliance, for instance, through program participation. It also proposed expanding the collection of permitting and sales data to identify noncompliance.[291]

291 Kenney, Michael, et. al. 2022. *Final 2021 Integrated Energy Policy Report, Volume I: Building Decarbonization,* pg. 183.

Since 2021, there has been progress toward enhancing compliance oversight. Mandatory requirements for using an acceptance test technician for nonresidential building mechanical systems came into effect October 1, 2021. These requirements are an expansion of the incorporation of third-party providers into the compliance verification process, aiming to extend oversight capabilities and increase efficiency of enforcement. However, challenges persist, particularly with unpermitted construction, which continues to undermine energy efficiency efforts.

Rates of Permit Compliance and Code Compliance

There are limited data on rates of permit compliance and whether the resulting installations comply with code or perform optimally. The *2014–16 HVAC Permit and Code Compliance Market Assessment Report*[292] estimates that between 8 percent and 29 percent of single-family residential HVAC installations are permitted and states that the research team is "confident that the true permit rate lies between the two estimates."[293] The report cites previous studies that estimate the compliance rate between 10 percent and 38 percent, based on smaller sample sizes. The report did not investigate compliance rates for water heaters.

The report also investigated the consequences of nonpermitted work and found "[t]here are few statistically significant differences in the energy efficiency of permitted and non-permitted installations."[294] For permitted and nonpermitted work, the rate of code compliance was between 58 percent and 100 percent for most code requirements. However, for duct leakage requirements, compliance was 56 percent for permitted installations (n=84) and 47 percent for non-permitted installations (n=64); for airflow requirements, compliance was 26 percent for permitted installations (n=39) and 14 percent for nonpermitted installations (n=22).

The low compliance rate for airflow requirements and the difference between permitted and nonpermitted installations could be explained by the change in airflow requirements in the Building Energy Efficiency Standards in 2013, from 300 cubic feet per minute (cfm) per ton to 350 cfm per ton. Contractors who typically pull permits may be more aware of code changes because they are more likely to receive written guidance or have conversations with local building officials. Code compliance may therefore be more important for issues where the code requirements change from one cycle to the next.

There are no studies on the amount of work done by unlicensed contractors or the reasons why many licensed contractors do nonpermitted work. The reasons plausibly include the costs and time required to apply for a permit, the time required to attend inspections, the cost of

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292 California Public Utilities Commission. September 22, 2017. *Final Report: 2014–16 HVAC Permit and Code Compliance Market Assessment (Work Order 6) Volume I – Report*. https://www.calmac.org/publications/HVAC_WO6_FINAL_REPORT_VolumeI_22Sept2017.pdf.

293 California Public Utilities Commission. September 22, 2017. *Final Report: 2014–16 HVAC Permit and Code Compliance Market Assessment (Work Order 6) Volume I – Report*, pg. 3.

294 California Public Utilities Commission. September 22, 2017. *Final Report: 2014–16 HVAC Permit and Code Compliance Market Assessment (Work Order 6) Volume I – Report*, pg. 7.

carrying out any corrective work flagged by the inspector, lack of perceived value, and the absence of an effective enforcement mechanism.

The CEC's Standards Compliance Branch intends to conduct research to better understand rates of permitted versus unpermitted work by licensed and unlicensed contractors, the costs of compliance, the reasons for noncompliance, and the consequences of noncompliance, particularly in relation to HVAC. The research will focus on who is making noncompliance decisions, what factors led to those decisions, and what changes could be made to the code or the permitting process to simplify compliance.[295]

Approaches to Increasing Rates of Permitted Work

Several states, cities, and programs have attempted to increase the rate of permitted work using a variety of approaches, including:

- Simplifying the permit process by simplifying the requirements, streamlining the process, or enhancing the expertise of building department staff.
- Increasing enforcement.
- Creating alternative processes.

A pilot study from the TECH program investigated the permitting process for heat pump water heaters and found that heat pump water heater permits were issued in 5.9 days on average. In contrast, permits for gas water heater replacement are available over the counter the same day they are requested. The study also revealed that permitting timelines and challenges vary widely by jurisdiction and identified that "the most common permitting barriers faced were a lack of technical knowledge about heat pump water heaters by building department staff, the lack of a standardized permitting process across jurisdictions, and the difficulties that contractors face when managing differing permitting rules and guidelines."[296]

In Boulder, Colorado, the 2024 Boulder Energy Conservation Code introduced several significant updates, including simplified code compliance pathways for home energy performance.[297] A change to the municipal code allows third-party inspectors, including certified International Energy Conservation Code Residential Energy Code Inspectors and HERS raters, to perform Energy Code inspections for homes, which the city believes will enhance compliance. While commercial inspections remain the responsibility of city inspectors, the city is considering allowing third-party inspections for commercial projects in the future.[298]

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295 California Energy Commission Standards Compliance Branch staff. Personal communication. May 2024.

296 TECH Clean California. 2024. *Streamlining Permitting and Installation of Heat Pump Water Heaters: Final Pilot Report*, https://techcleanca.com/documents/4721/TECH_StreamliningPermittingPilot_Report_v2403_1.pdf.

297 City of Boulder. 2024. "2024 Energy Conservation Code Update," https://bouldercolorado.gov/projects/2024-energy-conservation-code-update.

298 Email correspondence with City of Boulder — Planning and Development Services

In Ohio, specialized housing and environmental divisions have been established within municipal courts to enforce permitting regulations, such as those in Cleveland and Toledo. The Housing and Environmental Court in Toledo has implemented several successful programs to manage the increasing caseload of housing-related issues.

These programs include the Community Control program, which assists defendants with coming into compliance with housing codes. The First Offender's Program also helps eligible individuals correct property conditions and avoid criminal convictions by completing necessary repairs. These divisions have the authority to enforce local building, housing, air pollution, sanitation, health, fire, zoning, and safety codes. They can issue temporary and permanent injunctions and handle various legal and equitable remedies, ensuring comprehensive enforcement of standards.[299] The additions to the state code to allow increased enforcement and support for permitting include:

- Section 1901.011 creates housing and environmental divisions in the Cleveland, Toledo, and Franklin County municipal courts.[300]
- Section 1901.131 grants these divisions jurisdiction to determine, preserve, and enforce all rights involved in actions or proceedings, including the issuance of temporary and permanent injunctions.[301]
- Section 1901.181 details the exclusive and concurrent jurisdiction of these divisions over local building and safety codes.[302]
- Section 1901.183 expands the courts' jurisdiction to execute and adjudicate their own judgments and properties.[303]
- Section 1901.331 specifies the appointment and duties of officers and employees within these divisions, ensuring they are knowledgeable in the maintenance, repair, and rehabilitation of dwelling units and relevant laws.[304]

The City of Davis has a "Resale Program" that is unique in California and requires that any alterations, repairs or modifications, or both, requiring a building permit that were made since the last time the home was sold must have been permitted at the time the work was

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299 Ohio Revised Code. 2001. Section 1901.331: Housing or Environmental Division Officers and Employees, https://codes.ohio.gov/ohio-revised-code/section-1901.331.

300 Ohio Revised Code. 1991. Section 1901.011: Housing Divisions — Environmental Division, https://codes.ohio.gov/ohio-revised-code/section-1901.011.

301 Ohio Revised Code. 1991. Section 1901.131: Jurisdiction of Housing or Environmental Division, https://codes.ohio.gov/ohio-revised-code/section-1901.131.

302 Ohio Revised Code. 2022. Section 1901.181: Exclusive and Concurrent Jurisdiction of Housing or Environmental Divisions, https://codes.ohio.gov/ohio-revised-code/section-1901.181.

303 Ohio Revised Code. 2013. Section 1901.183: Environmental Division Additional Jurisdiction, https://codes.ohio.gov/ohio-revised-code/section-1901.183.

304 Ohio Revised Code. 2001. Section 1901.331: Housing or Environmental Division Officers and Employees, https://codes.ohio.gov/ohio-revised-code/section-1901.331.

performed. Compliance with past permit requirements is confirmed by performing a check of historical permit records and an in-person inspection by a building official. Any nonpermitted items uncovered in the inspection must be brought up to standards in place at the time of inspection.

This program has been in effect for several decades, which has resulted in building owner awareness of the need to do permitted work and near-perfect adherence to the building code.[305] This targeted approach, combined with a streamlined online permitting process for minor projects, is intended to make compliance easier and support the city's broader sustainability goals without placing undue burdens on homeowners.[306]

This structure could serve as a model for California, particularly in addressing barriers to permitting and enhancing regulatory adjustments to streamline processes for compliance. Implementing similar judicial support and specialized enforcement divisions could significantly reduce local administrative burdens and improve code compliance.

Barriers and Opportunities: Code Compliance for Existing Building Retrofits

Barriers

- The prevalence of unpermitted construction undermines decarbonization efforts, as these practices bypass the necessary oversight and compliance verification.
- The permitting process for new and emerging technologies, such as heat pump water heaters, varies widely by jurisdiction, creating inconsistencies and challenges for contractors.
- The financial burden of conducting work legally, along with the lack of effective enforcement mechanisms, contributes to noncompliance.
- There is no mechanism to identify noncompliance, which limits the ability to understand the reasons for noncompliance among homeowners and contractors.

Opportunities

- The CEC's planned research on the rates and reasons for noncompliance will provide valuable insights into the factors driving noncompliance, enabling more targeted and effective interventions.
- Legislative and regulatory reforms, informed by public engagement, can play a critical role in reducing the costs and administrative burdens of compliance, making it easier for building professionals to adhere to energy codes. These include alternative means of compliance, streamlined permitting and documentation, enhanced enforcement, requirements for permit compliance inspection at the time of the sale of a building, and the incorporation of third-party providers into the compliance verification process.

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305 Email correspondence with the City of Davis — Building Department, 2023.

306 City of Davis. (n.d.). "Building," web page, https://www.cityofdavis.org/city-hall/community-development-and-sustainability/building.

- Developing comprehensive training programs for contractors and inspectors can strengthen their ability to issue and enforce compliance with energy codes, thereby improving overall compliance rates and consistency.
- Increasing public awareness and engagement around the benefits of energy code compliance, with a focus on long-term energy savings and environmental impacts, can drive higher rates of compliance and support broader energy efficiency goals.

Advancing Load Flexibility

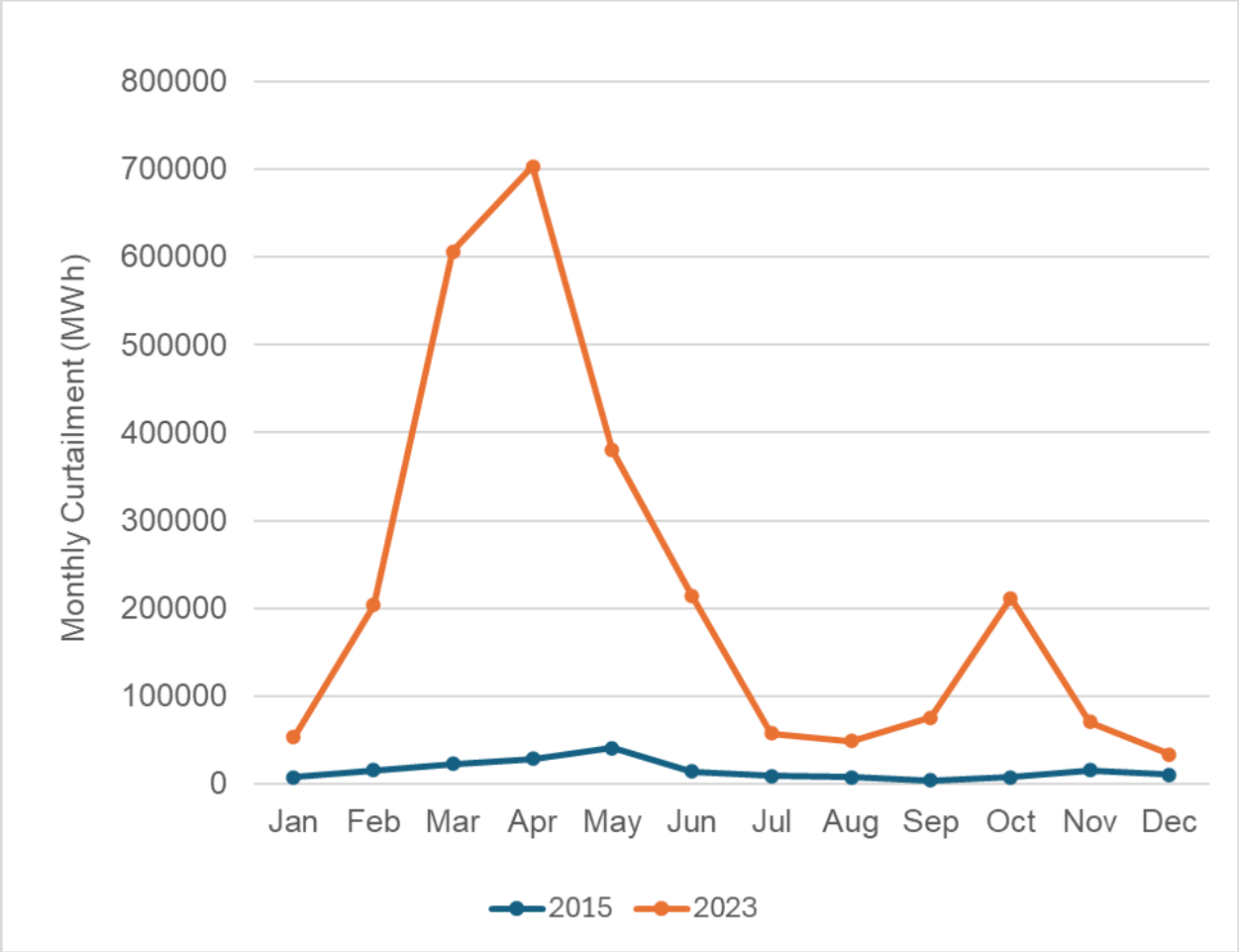
Load flexibility, also known as *load management and demand flexibility,* enables electrical equipment to shift or shed load or demand automatically away from times when electricity is expensive, polluting, and scarce, and redirect it to times when it is inexpensive, clean, and plentiful. Load flexibility helps minimize electricity costs by reducing peak demand, aligning customer demand with clean energy, reducing strain on the grid, and minimizing rate increases.

Without demand flexibility, excess renewable electricity is often curtailed, or wasted, by reducing solar generation or exporting it to other markets at a financial loss, rather than being used to power homes and businesses. Figure 9 shows the California Independent System Operator (California ISO) curtailed up to 700 gigawatt-hours (GWh) per month in the first half of 2023 — enough to power a million California homes and 15 times the 2015 peak electrical usage.[307] The amount of electricity needed to charge EVs can be as much as the peak electricity demand of a whole home, and excess solar generation is pushed back onto a distribution grid that was not originally designed to absorb energy.

Between now and 2045, grid operators expect hundreds of millions of new EVs, heat pumps, batteries, and other electric loads, creating an opportunity to minimize grid impacts by using load flexibility. By addressing electricity rate structures, energy storage, and load automation, California can expand load flexibility as a large-scale planning and reliability resource. The CEC has identified opportunities to optimize demand patterns using its existing load management standards authority.

307 California Independent System Operator. May 2024. "Managing the Evolving Grid," https://www.caiso.com/about/our-business/managing-the-evolving-grid.

Figure 9: California ISO Renewable Curtailments



Source: CEC staff based upon California ISO renewable curtailments

The *2021 IEPR Action Plan* made four recommendations about load flexibility:

1. The CPUC and CEC should support the installation and use of load-shifting technologies (such as connected smart thermostats or load-flexible heat pump water heaters) in existing homes, with a focus on low-income and disadvantaged communities to ensure they have equitable opportunities to benefit from new load flexibility programs.
2. The CEC, CPUC, and California ISO should use load management and demand flexibility as tools as the state decarbonizes buildings to support grid reliability, expand equitable access to the decarbonized future, and reduce future energy costs.
3. The CEC and California ISO should collaborate to measure the impact and appropriately expand the use of flexible demand as a grid management tool and reliability resource.
4. The CEC should complete development of regulations under its LMS and FDAS authorities that enable scale-up of load flexibility as a resource and complement the expansion and evolution of time-based rates by the IOUs and CPUC.

The EBD Program will meet the first of these recommendations by installing load-shifting technologies. The second recommendation will be met by the LMS and specifically MIDAS, described below. The third recommendation will be acted upon once load flexibility programs are implemented. The fourth recommendation is in progress, via the FDAS described below.

Flexible Demand Appliance Standards

The FDAS program, authorized by Senate Bill 49 (Skinner, Chapter 697, Statutes of 2019), empowers the CEC to adopt and periodically update standards for appliances to promote the deployment of flexible demand technologies. These standards aim to reduce GHG emissions by scheduling, shifting, or curtailing appliance operations to align energy use with times when electricity is cheaper and cleaner. The standards focus on ensuring consumer consent and cybersecurity while being feasible and cost-effective.[308]

CEC staff initially studied a range of appliances to understand technical readiness and benefit potential. The preliminary analysis identified pool controls — a device that sets the daily schedule of the pool filter pump, pool heater, chlorinator, and pressure cleaner booster pump — as an ideal candidate for the first California flexible demand appliance standards.

Pool control requirements were adopted to all pool controls manufactured on or after September 29, 2025, that are sold or offered for sale, rented, imported, distributed, or leased for use in California. These pool controls must be certified as compliant with the CEC's Flexible Appliance Database. The pool controls must come with a programmed default schedule and be capable of two-way communication connecting to the internet. They must also meet cybersecurity and consumer consent requirements specified in the regulatory language.

CEC staff identified other existing and emerging technologies as priorities for future flexible demand appliance standards. The CEC has started work on creating flexible demand appliance standards for electric storage water heaters, residential thermostats, and electric vehicle service equipment. Future work may include dishwashers, clothes dryers, and battery storage.[309]

Load Management Standards

The LMS (Title 20 California Code of Regulations Sections 1621–1623.1) form the foundation for a statewide system that will help customers lower their electricity bills by automatically shifting appliance use to less expensive times of day. The CEC is developing a system to give customers access to time-varying electricity rates to help them shift appliance use to less expensive times. This system automates the publication of time- and location-dependent signals. These signals can then be used by end-use automation technologies to offer real-time load flexibility on the electric grid. The combination of statewide signals and robust responsive automation markets will enable customer-supported load management on a mass-market

308 California Energy Commission. October 18, 2023. News release. "California Energy Commission Adopts Flexible Demand Appliance Standards for Pool Controls," https://www.energy.ca.gov/news/2023-10/california-energy-commission-adopts-flexible-demand-appliance-standards-pool.

309 California Energy Commission Load Flexibility Branch. Personal communication May 2024.

scale. MIDAS was developed to support implementation of the LMS as a statewide method that will allow customer-authorized third parties easy access to rate information.

The standards require large utilities and CCAs to:[310]

- Develop retail electricity rates that change at least hourly to reflect locational marginal costs and submit those rates to the utility's governing body for approval. If approved by ratemaking authorities, these rates will provide customers with options for automating responses to hourly and subhourly price signals.
- Update the time-dependent rates in MIDAS whenever a rate is approved or modified. The time-dependent rates in MIDAS are accessible by third-party service providers to help customers automate responses to electricity prices, Flex Alerts, and GHG signals.
- Implement a statewide standard method for providing customers and automation service providers with access to customer rate information. Service providers need to have customer-specific rate information to help customers optimize consumption patterns and bill savings.
- Develop a list of cost-effective automated price response programs for each sector and integrate information about time-dependent rates and automation technologies into existing customer education and outreach programs. Utilities must reevaluate existing programs and consider new ones to leverage the economic and organizational efficiencies supported by MIDAS. Education programs must also be updated, as most customers are unaware of price-responsive automation technologies and services.

Load Shift Goal

Senate Bill 846 (Dodd, Chapter 239, Statutes of 2022) directed the CEC to develop a goal for shifting load to reduce net-peak electrical demand and policies to increase demand response and load shifting. In May 2023, the CEC adopted a 2030 load-shift goal of 7 gigawatts (GW) of demand flexibility during the 100 hours of net-peak system demand.[311] CEC staff estimates that there is 3.1 to 3.6 GW[312] of demand flexibility. This goal equates to about a doubling of the current capacity. The load shift goal consists of two categories:

1. Load-modifying (customer-controlled) response, such as from TOU rates, dynamic pricing, and voluntary demand response for large commercial and industrial customers (3 GW)

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310 California Code of Regulations. 2023. California Code of Regulations, Title 20, Division 2, Chapter 4, Article 5, https://govt.westlaw.com/calregs/Document/I29EE5BD09D4311EDA65FDF2B31A571F6?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default).

311 California Energy Commission. May 2023. News release. "California Adopts Goal to Make More Electricity Available Through Smarter Use," https://www.energy.ca.gov/news/2023-05/california-adopts-goal-make-more-electricity-available-through-smarter-use.

312 Neumann, Ingrid, and Erik Lyon. May 2023. *Senate Bill 846 Load Shift Goal Report*. California Energy Commission, https://www.energy.ca.gov/publications/2023/senate-bill-846-load-shift-goal-report. Publication number CEC-200-2023-008

2. Supply-side demand response (California ISO-controlled) programs and incremental and emergency backup generation programs (4 GW)

Consumer Opportunities to Participate in Load Flexibility

Today, load management in California is typically achieved through utility programs that reward customers for reducing energy use, or demand response, during infrequent system events that occur only a few days each year, such as heat waves or failure of major electricity generators. Utility programs include the large commercial and industrial interruptible programs, residential air-conditioning load-control programs, and Flex Alerts that have been used for decades to reduce peak loads when the state's electricity supply is close to the limit.

In California's clean energy future, businesses, households, and other customers can save or even earn money for actions that contribute to a clean, reliable, affordable electric grid. Interested customers will choose among approaches to load shifting, including enrolling in dynamic time-varying rates, supply-side demand response programs, and load-modifying resource programs such as voluntary demand response for large commercial and industrial customers. As these programs develop, it will be essential to understand how and why consumers are choosing to participate to maximize participation rates and the effect of programs.

The gold standard for realizing load flexibility opportunities is dynamic rate design, where the price of electricity changes at least hourly to reflect the carbon intensity of the grid and the need to conserve in support of local and system reliability. Under this system, customers who install technologies like smart thermostats, battery storage, or other web-connected appliances are rewarded by buying energy when it is least expensive — and cleanest — and exporting energy to the grid when the need is greatest. These technologies require an investment to allow devices to receive price signals and optimally respond to the customer and the grid, with limited customer interaction. Understanding customer preferences for interacting with load-shifting devices and the perceptions of the rewards and benefits of load shifting will support program improvements.

Barriers and Opportunities: Advancing Load Flexibility

Barriers

- There is a lack of awareness and understanding among consumers about price-responsive automation technologies, the benefits of load shifting, and ways that load flexibility differs from previous peak-curtailment programs. This lack of awareness and understanding limits participation in load flexibility programs.
- There is a limited presence of smart thermostats, battery storage, and other web-connected appliances in the market today. Due to the gradual nature of market turnover, achieving a substantial quantity of these technologies needed for effective load flexibility will take many years.

Opportunities

- The CEC's development of regulations under the LMS and FDAS authorities promotes the large-scale deployment of flexible-demand technologies, aligning energy use with times when electricity is cheaper and cleaner.
- The implementation of automated load management systems and bidirectional charging for EVs or residential batteries, or both, can significantly reduce grid impact and shift energy use to times when rates are lower, offering cost benefits.
- The transition toward dynamic rates, where the price of electricity changes at least hourly to reflect grid needs, provides a strong financial incentive for consumers to adopt load-shifting technologies and participate in load flexibility programs, leading to a more reliable and affordable electric grid.
- The transition to dynamic rates, consistent with the LMS and CPUC's California Flexible Unified Signal (CalFUSE) proposal, can be further supported by ensuring that utilities are adequately compensated for implementing load flexibility programs that align energy use with grid needs.
- Further adoption of flexible demand appliance standards, particularly for electric-storage water heaters, EVSEs, and low-voltage thermostats, can enhance the capability to shift, schedule, or curtail operations, supporting the broader deployment of load flexibility technologies.
- There is the potential to cross-promote load-shifting and electrification programs by encouraging preenrollment at the point of sale for thermostats and offering additional rebates for technologies with substantial load-shifting capabilities.
- Evaluating the impact of flexible demand programs on grid management and reliability offers a pathway to refine load flexibility goals. As the grid advances toward zero GHG emissions, focusing on grid reliability and cost-efficiency metrics can maximize participation and optimize communication strategies.
- Deploying communication infrastructure like MIDAS can play a critical role in supporting load shifting by effectively conveying hourly rates, marginal GHG emissions, and grid status to consumers and their flexible devices.

Electric Vehicle Supply Equipment Retrofits

The *2021 IEPR Action Plan* recognizes the growing need for EVSE installations in all buildings. The *2021 IEPR Action Plan* focuses primarily on reducing barriers and costs associated with EVSE installations and recommends the integration of EVSE with building decarbonization efforts, because EVSE programs and building decarbonization programs often target the same users and decision-makers in the same buildings for similar reasons. Utilities and state agencies in California have implemented EVSE programs for more than five years but have not taken steps to create synergies between these two types of programs.

The *2021 IEPR Action Plan* states, "Senate Bill 68 (Becker, Chapter 720, Statutes of 2021) requires the CEC to provide information to building owners, the construction industry, and local governments to help overcome the barriers to building electrification and electric vehicle charging. The CEC will work in coordination with relevant state agencies and stakeholders to

gather and publish a variety of tools such as best practices, guides, and information on equipment, incentives, permitting, and financing."[313]

Since 2021, significant regulatory and market movements have expanded EVSE infrastructure. California has updated building standards to mandate EV charging infrastructure in new residential and nonresidential buildings, a step that significantly drives the expansion of EVSE installations. Furthermore, CALGreen[314] was amended to incorporate more stringent requirements for EV charging infrastructure. The *Assembly Bill 2127 Second Electric Vehicle Infrastructure Assessment* outlines the necessary steps to support the state's zero-emission vehicle goals and identifies specific requirements and timelines for EVSE deployment.[315] Senate Bill 59 (Skinner, Chapter 765, Statutes of 2024) was signed into law in 2024. This law defines terminology around bidirectional charging and authorizes the CEC, in coordination with CARB and the CPUC, to require EVs sold in California to have bidirectional charging capability.

California has made significant progress expanding EVSE infrastructure in single-family, multifamily, and commercial buildings through programs including utility incentive programs, many of which are funded via the Low Carbon Fuel Standard.[316] The state has more than 150,000 public EV chargers, including installations at various residential and commercial sites.[317]

Despite the growth of EVSE, there are challenges in cost management and integrating retrofits with other building decarbonization measures. According to a fiscal impact report produced by CARB in collaboration with CBSC, there are significant financial and logistical barriers, caused primarily by the high costs of electrical panel and wiring upgrades necessary to accommodate EVSE.[318]

However, there is the potential to decrease these costs through innovative approaches. These approaches could include reducing the amount of conduit or the number of wiring connections required at a multifamily building by using the same electrical infrastructure for EVSE that is

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313 Kenney, Michael, et al. 2022. *Final 2021 Integrated Energy Policy Report, Volume I: Building Decarbonization*.

314 California Department of General Services. (n.d.). CALGreen. California Building Standards Commission, https://www.dgs.ca.gov/BSC/CALGreen.

315 Davis, Adam, Tiffany Hoang, Thanh Lopez, et al. March 2024. *Assembly Bill 2127 Second Electric Vehicle Charging Infrastructure Assessment: Assessing Charging Needs to Support Zero-Emission Vehicles in 2030 and 2035,* https://www.energy.ca.gov/publications/2024/assembly-bill-2127-second-electric-vehicle-charging-infrastructure-assessment.

316 California Air Resources Board. Accessed November 2024. "Low Carbon Fuel Standard Utility Rebate Programs," web page, https://ww2.arb.ca.gov/resources/documents/lcfs-utility-rebate-programs.

317 Richardson, Jake. September 6, 2024. "More Than 150,000 EV Chargers Are Now Installed in California" Blog, CleanTechnica, https://cleantechnica.com/2024/09/06/more-than-150000-ev-chargers-are-now-installed-in-california/.

318 California Building Standards Commission. 2024. "Electric Vehicle Supply Equipment Standards Regulation: Background and FAQs," web page, https://ww2.arb.ca.gov/resources/documents/electric-vehicle-supply-equipment-standards-regulation-background-and-faqs.

used for electrification upgrades. Alternatively, they could employ load-management technology to decrease the size of electrical infrastructure needed to supply the EVSE and other electric end uses. Implementing EVSE and building improvements at the same time through the same contractor could reduce overhead and labor costs. Both approaches would require integrating building decarbonization and EVSE programs.

The CPUC removed barriers to interconnection, including allowing direct current chargers to use Rule 21[319] requirements and permitting nonutility meters to measure electricity consumption for vehicle charging for customer billing.[320] The assessment notes that "further evolving interconnection policies may bolster industry confidence in bidirectional charging and streamline deployment."[321]

Barriers and Opportunities: Electric Vehicle Supply Equipment Retrofits

Barriers

- The financial and logistical barriers associated with panel and wiring upgrades necessary for accommodating EVSE, particularly in existing multifamily buildings, create significant challenges for widespread adoption.
- There is a lack of synergy between EVSE programs and building decarbonization efforts, despite targeting the same users and buildings, resulting in missed opportunities for cost and efficiency gains.
- Current permitting processes for utility interconnection and EVSE retrofits are often complex and fragmented, adding to the logistical hurdles building owners and contractors face.

Opportunities

- SB 59 authorizes the CEC, in coordination with CARB and CPUC, to require EVs sold in California have bidirectional charging capability.
- Enhanced coordination between EVSE programs and building decarbonization efforts can maximize program participation and reduce costs by promoting simultaneous vehicle and building upgrades, thereby reaching more customers with lower overall expenses.
- Regulatory advancements, such as updates to the building standards and CALGreen, and the implementation of AB 2127 have created a robust framework for expanding EVSE infrastructure across various building types.

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319 California Public Utilities Commission. 2024. "Electric Rule 21: Generating facility interconnections," web page. https://www.cpuc.ca.gov/rule21.

320 Davis, Adam, et al. March 2024. *Assembly Bill 2127 Second Electric Vehicle Charging Infrastructure Assessment: Assessing Charging Needs to Support Zero-Emission Vehicles in 2030 and 2035.*

321 Ibid.

- Streamlining permitting for utility interconnection and integrating building and interconnection permitting for certain EVSE retrofits can remove significant barriers and accelerate the adoption of EVSE infrastructure.
- Employing load-management technology and reducing the amount of conduit or wiring connections needed can significantly lower the costs of EVSE installations. Integrating these efforts with building decarbonization upgrades can further streamline the process and reduce overhead.
- Exploring and integrating technologies such as automated load management systems, solar and battery storage, and vehicle-to-grid solutions can further reduce the grid impact of EV charging and building electrification, making installations more efficient and cost-effective.

The CPUC's removal of barriers to interconnection and the potential for evolving policies to support bidirectional charging can enhance industry confidence and promote more efficient deployment of EVSE infrastructure.

Data Standardization and Sharing

The analysis required to track and guide California's energy transition and foster private-sector energy innovation must be guided by data from programs, energy bills, market surveys, and other sources. The *2019 Energy Action Plan* acknowledged that tracking decarbonization will become harder to achieve as more buildings are decarbonized. Solving that problem will require innovative methods based on data shared between agencies and outside stakeholders and integrated with other datasets such as health, equity, and economic data.[322] The *2021 IEPR Action Plan* recommended the CEC, CPUC, CARB, and California ISO coordinate to standardize energy accounting methods for building decarbonization and load flexibility. The *2021 IEPR Action Plan* also recommended the CEC, in coordination with the CPUC, should gather data on equipment sales, building retrofits, permitting trends, and decarbonization programs to provide further insight into adoption rates, GHG impacts, barriers to equitable access and deployment, and potential for program targeting and layering.[323]

Since the previous Energy Action Plan, there have been three major developments in data collection and sharing in California, which are described below:

- **The CEC's energy data repository**: The CEC supports data analysis and collection by managing the state's energy data repository, which combines interval meter data from most buildings in the state with other data sources, such as customer utility rates and decarbonization program data. Combining the interval data with rate data allows bill impacts to be calculated.

322 Kenney, Michael, et al. 2019. *2019 California Energy Efficiency Action Plan*.

323 Kenney, Michael, et al. 2022. *Final 2021 Integrated Energy Policy Report, Volume I: Building Decarbonization*.

- **Collection of more detailed contextual program data by TECH**: The CPUC's TECH program for decarbonization retrofits is required to collect and publish data at regular, predictable intervals. The program also collects deeper information from follow-ups with consumers than what has been typical with incentive programs.[324]
- **Development of large existing building datasets by private companies**: Many private companies have linked permit and assessor data to other data such as GIS data, light detection and ranging (lidar) data, building permit data, program data, and socioeconomic data.

Although many of these developments are happening in California, the usefulness of these datasets could be enhanced by linking them with extraneous datasets from organizations such as distributors and manufacturers, or energy and program data from other states. Voluntary standardization of data collection and reporting would help create larger datasets that would be demographically and geographically representative, be more statistically powerful, and allow users to draw statistical conclusions faster and with higher certainty.

One stated goal of CEC's data repository is exploration. Some of the major developments are introduced in the following sections.

CEC's Role as a Central Repository for Statewide Energy Data

The *2022 IEPR Update* set out objectives for CEC's role as a repository for statewide energy data, including "access, organization, exploration, and analysis."[325] The *2022 IEPR Update* stated that "data access is the CEC's most fundamental data-related role, allowing policy makers and other stakeholders to analyze data to meet their needs,"[326] and committed to making the data available to a wide variety of users. The CEC is defining the exact parameters of this role and solicited public input on various options through the Energy Data Modernization and Analytics workshop in January 2023.[327]

Public Resources Code Section 25216.5(d) requires the CEC to "serve as a central repository within the state government for the collection, storage, retrieval, and dissemination of data and information on all forms of energy supply, demand, conservation, public safety, research, and related subjects." The code also states that "data and information shall be derived from all sources […] that the commission determines is necessary to carry out its objectives under this

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324 TECH Clean California. Accessed May 2024. "TECH Public Data Evaluation Studies" web page, https://techcleanca.com/public-data/evaluation-studies/.

325 Bailey, Stephanie, et. al. 2023. *Final 2022 Integrated Energy Policy Report*.

326 Ibid.

327 California Energy Commission. Accessed May 2024. "Commissioner Workshop on Energy Data Modernization and Analytics," Web page, https://www.energy.ca.gov/event/workshop/2023-01/commissioner-workshop-energy-data-modernization-and-analytics.

division."[328] This role encompasses a range of existing activities, including energy planning, equity indicators, and insights into trends and issues.

The CEC's energy data repository role includes a new function defined in Title 20, Section 1353, for Disaggregated Demand Data Reporting.[329] In this context, "disaggregated" means data from individual meters that is not aggregated, or collected, geographically or by building type. Section 1353 defines a minimum set of data to be included in the data repository, which includes interval meter data for each premise, program participation data, and contextual data such as building types and rate schedules.

Residential Appliance Saturation Study Data Collection

The CEC's RASS is a periodic survey that takes a comprehensive and statistically significant look at home energy use, residential energy systems, and housing characteristics. The study is implemented as a survey and collects information from residents.[330] RASS surveys were performed in 2003, 2009, and 2019. The results of the RASS support several important statewide activities, including:

- CEC's residential forecast model as part of the California Energy Demand (CED) Forecast: The CED forecasts electricity and gas demand for the state. Forecast products directly guide state-sponsored system and reliability planning efforts, including resource adequacy, the CPUC Integrated Resource Plan, and the California ISO Transmission Planning Process.
- CEC's rulemakings for the California Appliance Efficiency Regulations (Title 20) and California Building Energy Efficiency Standards (Title 24): Both rulemakings rely on information about energy systems and usage patterns that is available only from the RASS. The RASS can also be used to provide a retrospective assessment of the effectiveness of these regulations.

These activities and others rely on the RASS being updated regularly enough to provide statistically accurate information about population data and trends. In the case of the Building Energy Efficiency Standards, rulemakings are conducted on a defined three-year cycle, so updating the RASS in preparation for those cycles (for instance, every six years) would ensure that policy makers have the best available data.

Since the last RASS, the focus of building decarbonization has expanded from energy efficiency to load flexibility and electrification. There has also been interest from other state agencies to update the study on which the RASS is based to collect additional data. Examples

328 California Legislative Information. Accessed May 2024. "Public Resources Code, Chapter 3. State Energy Resources Conservation and Development Commission," Web page, https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=PRC&sectionNum=25216.5.

329 California Energy Commission. 2021. *California Code of Regulations Title 20,* https://www.energy.ca.gov/sites/default/files/2021-07/Title%2020%20Updated%20July%2023%2C%202021.pdf.

330 California Energy Commission. Accessed May 2024. "2019 Residential Appliance Saturation Study".

of additional data include additional subsample data on equipment locations within the building, electrical panel state, more accurate demographic data, and possibly EV chargers. This information would enable state agencies to make more accurate and refined cost projections for programs and code and better understand the potential impacts of electrification on equity and the electric distribution grid.

Another important reason for updating the RASS is to track the rate of decarbonization in California, and which communities and demographic groups are receiving benefits. Much of this information will be available from program data, but the RASS provides additional information about the impacts on individuals and communities that are not being reached by programs. Quantifying these impacts more frequently will allow course correction of the state's policies, regulations, and programs.

CEC staff in the Energy Assessments Division began the scoping process for the next RASS in 2025. Before the survey is launched, Energy Assessments Division staff need to determine whether to add or remove fields in the next RASS, which will benefit from stakeholder input. After this scoping process, Energy Assessments Division staff will develop the Request for Proposal. The survey is anticipated to launch in 2027.

Collection of More Detailed Contextual Program Data by TECH

The TECH Clean California program has collected highly detailed data on the ways that measures are put into action, the ways consumers use equipment, customer satisfaction, troubleshooting efforts, and the characteristics of participating homes and customers.[331] TECH program staff can link these data to energy and cost data for each participant. However, the program protects participant privacy by not making the information available to third parties.

The TECH program administrator continually collects data from TECH and publishes it regularly. The CPUC required the administrator to consider a broad range of success metrics, including customer demographics, satisfaction, contractor performance and training, bill savings, and refrigerants.[332] This list includes more success metrics compared to those typically used in IOU programs in California.

The TECH program launched in late 2021. Opinion Dynamics[333] interviewed the first participants in November and December 2022 and reported on customer experience and satisfaction in September 2023.[334] This is a significantly faster turnaround time than is typical

331 TECH Clean California. Accessed May 2024. "TECH Heat Pump Public Data," Web page, https://techcleanca.com/public-data/.

332 Batjer, Marybel, Liane M. Randolph, Martha Guzman Aceves, Clifford Rechtschaffen, and Genevieve Shiroma. 2020. *Decision Establishing Building Decarbonization Pilot Programs.* California Public Utilities Commission, https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M331/K772/331772660.PDF.

333 Opinion Dynamics is a leading consulting firm specializing in energy evaluation, energy advising, and market research. Home – Opinion Dynamics

334 TECH Clean California. Accessed May 2024. "TECH Public Data Evaluation Studies," Web page, https://techcleanca.com/public-data/evaluation-studies/.

for evaluation, measurement, and verification studies of California IOU programs. Shorter time frames mean that data must be collected from more participants to reach statistical significance. This frequent reporting schedule matches well with the regulatory requirements for the CEC's data repository, which call for a quarterly reporting schedule, with a minimum 90-day lag to allow utilities to true up missing data caused by communication lapses or customer connections.

Development of Large Existing Building Datasets by Private Companies

Private companies' repositories of contextual information about the state's building stock have steadily evolved and can be integrated with other datasets. These data can enable innovations and improvements in program targeting, delivery, follow-up, and evaluation. If state agencies standardized data collection and reporting through voluntary standards or regulation, larger, more powerful, and more representative datasets could be created. These improved datasets could lead to greater innovation and the development of more powerful analytic and predictive tools by private industry.

Barriers and Opportunities: Data Standardization and Sharing

Barriers

- Protecting personally identifiable information (PII) must be considered while sharing data with the public, but rules for PII sometimes make data aggregation challenging, especially in sparsely inhabited areas.
- Availability of funding could affect the timeline for the next RASS or the possibility of more frequent RASS updates or both.

Opportunities

- More detailed information collected by the TECH program has already led to additional insights about measure costs and customer experience that have guided program development.
- The CEC already has authority and capacity to conduct extensive data collection from utilities and programs, and the infrastructure to store those data and make it available to the public. Leveraging the CEC data repository supports innovation and provides program designers with actionable information.
- Sharing actionable information continuously between California programs could allow more rapid improvements to program design and identification of specific problems during implementation.
- Using data to track developments in the decarbonization market such as equipment sales, building retrofit rates, customer satisfaction, permitting trends, and program activity could provide information on equity targets that are being met and on regional or socioeconomic differences in rates of adoption.
- Better support for benchmarking, building performance standards, incentive programs, and bill impact estimation will be feasible by mapping building meter data to unique building identifiers.

- Regular updates with survey studies such as RASS could provide actionable information about desired use cases, such as the progress of the heat pump transition or the need for panel upgrades.

Refrigerant Use, Recovery, and Reclamation

California regulates the use of high-GWP refrigerants — primarily hydrofluorocarbons (HFC) — through programs and policies. This suite of measures is an important pillar of the state's effort to reduce GHG emissions. CARB's regulations prohibit the use of higher-GWP HFCs in new and existing equipment in various sectors. SB 1206 requires the use of reclaimed refrigerants for servicing existing equipment based on a phased schedule depending on the GWP of refrigerants. HFCs with a GWP greater than specified levels used for servicing existing equipment must be reclaimed based on a phased schedule:

- HFCs with a GWP greater than 2200 must be reclaimed starting in 2025.
- HFCs with a GWP greater than 1500 must be reclaimed starting in 2030.
- HFCs with a GWP greater than 750 must be reclaimed starting 2033.

SB 1206 also requires CARB to publish an assessment report, with the CEC's support, evaluating the use of ultra-low-GWP (GWP < 10) or no-GWP refrigerants in HFC sectors no later than 2035. Implementing SB 1206 requires CARB, with support from the CEC, to develop a strategic approach to transition to these refrigerants by 2035 and increase refrigerant recovery and reclamation. To support CARB's work, the CEC is developing a report that will describe and measure current practices for refrigerant recovery and reclamation and the structure of the refrigerant market. The report is expected to be ready in the first quarter of 2026 and will be added as Appendix B to the *2025 Energy Action Plan*.

CARB also administers the Refrigerant Management Program, which aims to ensure that fluorinated refrigerants in existing refrigeration systems are properly managed in systems with a full charge capacity more than 50 pounds of refrigerant.[335]

Refrigerant recovery, reclamation, and reuse from existing systems are important because of the high number of systems and the high GWP of refrigerant that is already installed. In 2022, data reported to the U.S. EPA showed an increase of more than 40 percent in the total volume of HFCs reclaimed compared to 2021. As the supply of virgin HFCs declines in response to the national phasedown in effect via the American Innovation and Manufacturing (AIM) Act, the demand for reclaimed HFCs is expected to increase. Starting January 1, 2024, total production and consumption of virgin HFCs was required to reduce to 60 percent of the baseline for the United States established in the AIM Act, with further phasedown steps through 2036.[336]

335 California Air Resources Board. Accessed May 2024. "Refrigerant Management Program | California Air Resources Board," Web page, https://ww2.arb.ca.gov/sites/default/files/2020-07/finalfro_0.pdf.

336 United States Code, Accessed November 2024. "American Innovation and Manufacturing," Web page, https://uscode.house.gov/view.xhtml?req=granuleid:USC-prelim-title42-section7675(a)&num=0&edition=prelim.

Refrigerant recovery is closely linked to other building decarbonization programs and regulations. HVAC technicians who handle refrigerants often work on various parts of the building HVAC system, such as furnaces, ducts, fans, and control systems. Technicians can also offer advice to building owners on upgrading these systems. Recovery occurs during servicing and replacement of site-built refrigeration systems and the disposal of packaged systems. If the refrigerant is not recovered, it may be vented into the atmosphere, where it functions as a potent GHG. After recovery, most refrigerants need to be checked and returned to the original composition and industry purity standard during refrigerant reclamation, which can be done only at a small number of facilities around the state that are certified by the U.S. EPA.[337]

Training, certification, and licensing are key to a technician's ability to handle refrigerants properly. A U.S. EPA 608 certificate is required for technicians who handle refrigerant recovery. However, there is no requirement to renew or recertify once a technician obtains a certificate. The California State Licensing Board requires technicians to maintain a C-20 Warm-Air Heating, Ventilating and Air-Conditioning Contractor license or C-38 Refrigeration Contractor license. However, companies need only one license that covers all employees. Another good practice would be to enhance enforcement by requiring proof of practical refrigerant recovery skills to complement a U.S. EPA 608 certification and stronger onsite enforcement with high fees for noncompliance.

The *2021 IEPR Action Plan* recommended that the CEC and CARB should "explore regulatory and programmatic approaches to increase the adoption of low-GWP refrigerant technologies and minimize refrigerant leakage."[338] The report also recommended that state agencies and the U.S. EPA "should identify strategies and tools to ensure refrigerants are properly recaptured and recycled upon equipment replacement."[339] These suggestions were echoed in SB 1206 statutory requirements.[340]

Refrigerant Reclamation and Recovery Practices

CARB emphasizes that recovery often does not happen when appliances enter the municipal waste stream. Therefore, recovery should be focused on HVAC contractors, to remove the refrigerant before equipment is taken to a disposal site.

Disposal from consumers may cover only products that a consumer directly replaces, such as refrigerators or small wall and window air-conditioning units. The amount of refrigerant contained in these units is small (~115–500 grams [g]). Therefore, CARB suggests focusing on

337 United States EPA. Accessed November 2024. "EPA-Certified Refrigerant Reclaimers," Web page, https://www.epa.gov/section608/epa-certified-refrigerant-reclaimers.

338 Kenney, Michael, et al. 2022. *Final 2021 Integrated Energy Policy Report, Volume I: Building Decarbonization*.

339 Ibid.

340 California Legislative Information. Accessed May 2024. Bill Text — SB 1206 Hydrofluorocarbon Gases: Sale or Distribution, web page, https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220SB1206.

larger units such as residential central HVAC units (~5-8 pounds [lbs]) and commercial refrigeration and HVAC systems, which are installed and replaced by contractors and technicians.

One incentive idea is to help contractors with the cost of purchasing the appropriate refrigerant recovery equipment. Outdated recovery equipment operates more slowly and less efficiently than newer equipment. Not all contractors have the equipment necessary to recover refrigerants easily or effectively, or one company may share just one piece of equipment for several technicians.

Development of Heat Pumps With Low-GWP Refrigerants

The *2021 IEPR Action Plan* recommended that "the state and utilities should support research into heat pump technologies optimized for California climate zones."[341]

CARB and the U.S. EPA require the use of lower-GWP refrigerants in space-conditioning heat pumps. CARB requires a GWP less than 750 with an effective date of January 1, 2025,[342] and the U.S. EPA requires a GWP less than 700, effective January 1, 2026.[343] This is a marked decrease of about two-thirds of the GWP of existing refrigerant technology in heat pumps and will preserve the GHG benefits of large-scale heat pump adoption, although refrigerant technologies need further improvement.

The CEC Energy Research and Development Division (ERDD) released a grant funding opportunity through the Electric Program Investment Charge (EPIC) for "developing next generation all electric heat pumps using low-GWP refrigerants, defined as having a GWP less than 150."[344] A notice of proposed assessment was posted to the CEC website in November 2025.[345]

This solicitation considers funding three groups of electric heat pump technologies: water heating, combination water and space conditioning, and space-conditioning systems using low-

341 Kenney, Michael, et al. 2022. *Final 2021 Integrated Energy Policy Report, Volume I: Building Decarbonization*.

342 California Air Resources Board. Accessed November 2024. *Final Regulation Order,* https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2020/hfc2020/frorevised.pdf.

343 United States Federal Register. Accessed November 2024. "Phasedown of Hydrofluorocarbons: Restrictions on the Use of Certain Hydrofluorocarbons Under the American Innovation and Manufacturing Act of 2020." Web page, https://www.federalregister.gov/documents/2023/10/24/2023-22529/phasedown-of-hydrofluorocarbons-restrictions-on-the-use-of-certain-hydrofluorocarbons-under-the.

344 California Energy Commission. Accessed May 2024. "Developing Next Generation All Electric Heat Pumps Using Low Global Warming Potential Refrigerants." Solicitation Web page, https://www.energy.ca.gov/solicitations/2024-04/developing-next-generation-all-electric-heat-pumps-using-low-global-warming.

345 California Energy Commission. November 10, 2025. "NOTICE OF PROPOSED AWARD (NOPA) Developing Next Generation, All Electric Heat Pumps Using Low Global Warming Potential Refrigerants GFO-24-305." https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.energy.ca.gov%2Fsites%2Fdefault%2Ffiles%2F2025-11%2FGFO-24-305_NOPA_Cover_Letter_2025_11_10_ada.docx&wdOrigin=BROWSELINK.

GWP refrigerants for use in California. Each funded project will aim to accelerate the technology development of electric heat pumps that use low-GWP refrigerants (GWP < 150) while maximizing energy efficiency and equipment performance, maintaining cost-effectiveness, and meeting customer needs.[346] The solicitation totals $11.743 million in available funds. The anticipated release date is December 2024. The final *2025 Energy Action Plan* will include an update on the status of this topic as a follow-up to the recommendation made in the *2021 IEPR Action Plan*.

Successfully demonstrating heat pump technologies using low-GWP refrigerants will benefit California's building decarbonization efforts and will help push California's market in the direction of ultra-low-GWP refrigerants as directed by SB 1206.

Barriers and Opportunities: Refrigerant Use, Recovery, and Reclamation

Barriers

- The economic value of recovered refrigerant is often lower than the cost of recovering it. The difference in economic value of recovered refrigerant and recovery costs is changing under U.S. EPA law, California law, and CARB regulations, which aim to increase the use of reclaimed refrigerants and require the use of lower-GWP refrigerants.
- Recovering used appliances from consumers does not guarantee refrigerant recovery and reclamation because there is uncertainty about what happens to appliances once they enter the municipal waste stream.
- Not all contractors have the necessary equipment to recover refrigerants properly or rapidly, particularly for newer refrigerants in the market. Even if recovered, transporting recovered refrigerant to a reclamation facility may be challenging because there is a small number of facilities.

Opportunities

- Educating contractors and technicians about the financial opportunities of refrigerant recovery and proper recovery methods could expand participation in recovery programs. Providing incentives to help contractors with the cost of the appropriate refrigerant recovery equipment could be helpful.
- Requiring program implementers to provide incentives to return recovered refrigerant to a recycling center could ensure that the refrigerant is not only recovered, but also makes its way to the refrigerant drop-off center or reclamation facility.
- Various strategies could be used to increase compliance with the existing Refrigerant Management Program, such as contractor education, accountability, simplification of regulatory requirements, and strong enforcement.

346 Ibid.

- Requiring periodic continuing education and evaluation of technician refrigerant handling techniques could ensure technicians are accountable and competent. The relevant state agencies could mandate training for recertification and continuing education in addition to U.S. EPA 608 certification requirements.
- Very-low-GWP equipment specific to California that is under development could allow programs to offer incentives for these products ahead of CARB's implementation of refrigerant sales regulations. One example is CARB's F-gas Reduction Incentive Program, which offers incentives to replace high-GWP refrigerants with ultra-low-GWP alternatives for large commercial and industrial refrigeration facilities. [347]

347 California Air Resources Board. Accessed November 15, 2024. "F-gas Reduction Incentive Program," https://ww2.arb.ca.gov/our-work/programs/FRIP.

CHAPTER 3:
Progress Toward Doubling Energy Efficiency Savings in Electricity and Gas by 2030

In 2015, California set an ambitious goal to achieve a statewide cumulative doubling of annual energy efficiency savings and demand reductions in electricity and gas end uses by January 1, 2030, as far as is feasible and cost-effective. As required by SB 350, the CEC regularly assesses the state's progress toward this goal.[348] In addition to traditional efficiency programs, electrification and load-flex programs offer energy, GHG, and demand savings.

SB 350 savings are cumulative, meaning the first year's savings, which started in 2015, and those in every year thereafter are summed over the lifetime of the end uses addressed by the energy efficiency measure or program. This summation means that the first nine years of the analysis are historical, and the remaining six years include future projected savings from measures already installed. The future projected savings are similar to those described in Chapter 3 of the *2023 IEPR Forecast Volume*.[349] The *2023 IEPR Forecast Volume* adds the forecasted energy efficiency and electrification load modifiers[350] onto a baseline forecast, while the SB 350 analysis independently measures cumulative savings potential from 2015 through 2029. The results of the SB 350 analysis are then compared to the goal of doubling savings by January 1, 2030.

California's efforts at energy efficiency have led to reduction in both source and site energy use intensities over this period, with additional source EUI reductions resulting from greater clean energy generation on California's grid. Similar to California, the DOE's National Buildings Blueprint called for doubling of energy efficiency by 2045 using site EUI as a metric, with a target of reducing it by half from 1990 levels.

In 2021, the *California Building Decarbonization Assessment* highlighted the significant opportunities for energy and emissions savings from electrifying newly constructed and

348 Sathe, Amul (Navigant), Karen Maoz (Navigant), Kristin Landry (Navigant), Suraj Patel (Navigant), Megan McEnaney (Navigant), Wikler, Greg (Navigant), John Arent (NORESCO), Abhijeet Pande (TRC), and Floyd Keneipp (Tierra Resource Consultants). 2019. *SB 350 Doubling Energy Savings by 2030 Method Report*, California Energy Commission. Publication Number: CEC-800-16-006, https://efiling.energy.ca.gov/GetDocument.aspx?tn=231528&DocumentContentId=63338).

Kenney, Michael, et. al. 2022. *Final 2021 Integrated Energy Policy Report, Volume I: Building Decarbonization*.

349 Bailey, Stephanie, Jennifer Campagna, Mathew Cooper, Quentin Gee, Heidi Javanbakht, and Ben Wender. 2023. *2023 Integrated Energy Policy Report*, California Energy Commission. Publication Number: CEC-100-2023-001-CMF, https://efiling.energy.ca.gov/GetDocument.aspx?tn=254463.

350 The *load modifiers* include behind-the-meter distributed generation and storage, additional achievable energy efficiency, additional achievable fuel substitution, and additional achievable transportation electrification.

existing buildings with efficient equipment.[351] Achieving energy efficiency doubling by 2030 while reducing GHG emissions from buildings requires the continued success of traditional efficiency programs, as well as new efforts to electrify end uses. To this end, CEC staff has modeled an aggressive or aspirational scenario that seeks to achieve that goal while striving to meet GHG reduction benchmarks introduced by Assembly Bill 3232 (Friedman, Chapter 373, Statutes of 2018). The aspirational scenario was modeled in addition to a reference scenario that described business-as-usual projections of energy efficiency and building electrification. The objective is to illustrate that additional effort is needed to move from the current business-as-usual track to the track that achieves energy and GHG savings goals.

Analysis Method

To update on the progress toward doubling energy efficiency savings in electricity and gas, CEC staff used the same method and tools from the *2019 Energy Action Plan* for accounting, aggregating (collecting), and projecting energy efficiency savings. This method was improved in 2021 to include new efficiency programs and electrification efforts.[352] CEC staff updated historical data and projected potential savings based on recent program activities and on changes adopted in the 2022 and 2025 Building Energy Efficiency Standards.[353] CEC staff used data from IOUs and POUs to update historical savings. For future savings, CEC staff relied on projections from the Additional Achievable Energy Efficiency (AAEE) and Additional Achievable Fuel Substitution (AAFS) in the *2023 IEPR*.[354]

Besides IOU and POU programs, another major contributor to energy efficiency savings is California's building and appliance codes and standards. CEC staff analyzed the Energy Code to identify the energy savings from each measure attributed to each building sector and market segment. Expected savings from codes and standards are modeled out to 2030, based on assumptions about the code measures that will likely be implemented in the intervening years. The details of these and other assumptions used in the analysis are described in a consultant report on the SB 350 doubling method.[355]

CEC staff updated the modeled compliance pathway that will most likely be chosen by builders to meet requirements of the Energy Code because the 2022 Energy Code encourages efficient electric heat pumps. The options considered were enhanced energy efficiency measures via a performance calculation or electrification measures based on the climate zone. CEC staff also modeled updates to the building energy savings attributed to California's Appliance Efficiency

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351 Kenney, Michael, et al. 2021. *California Building Decarbonization Assessment*.

352 Sathe, Amul et. al. 2019. *SB 350 Doubling Energy Savings by 2030 Method Report*.

353 The analysis does not include any projections for municipalities adopting 2025 Part 11 requirements.

354 CPUC. June 22, 2023. Accessed May 2024. *2023 Energy Efficiency Potential and Goals Study*, https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/energy-efficiency/2023-potential-goals-study/final-2023-group-e-pg-study-report.pdf.

Bailey, Stephanie, et. al. 2023. *2023 Integrated Energy Policy Report*.

355 Sathe, Amul, et. al. 2019. *SB 350 Doubling Energy Savings by 2030 Method Report*.

Regulations (Title 20) and the Federal Appliance Energy Efficiency Standards, where the federal standards may preempt state standards. Some additional program modeling was revised based on newly available historical data. Notably, CEC staff developed a more robust analysis of non-utility-sponsored programs, which were initially evaluated in the *2021 IEPR Action Plan*. Furthermore, CEC staff established modeling for additional programs not previously included in the *2021 IEPR Action Plan*. Important examples include:

- California EBD Programs — Direct install and incentives.
- IRA — HEEHRA and HOMES rebate programs.
- Locally targeted electrification impacts driven by local government ordinances.
- Load-serving entity decarbonization programs.
- California Electric Homes Program.
- Wildfire and Natural Disaster Resiliency Rebuild Program.
- Affordable housing and sustainable communities.

CEC staff sought to eliminate overlap in customer segments targeted by different programs. CEC staff also analyzed market-based activities that could generate energy efficiency savings that were not captured elsewhere.

SB 350 exists within the wider policy context of building decarbonization, which includes building electrification. CEC staff included programmatic fuel substitution and zero-emission appliance standards-based fuel substitution in the update because the SB 350 language allows fuel substitution, provided that overall energy consumption is reduced. In 2021, CEC staff developed a new forecasting tool to add building electrification as a load modifier into the baseline demand forecast. This forecasting tool allowed CEC staff to integrate new data into the analysis such as data from utility pilot programs and other on-the-ground incentive programs that support building electrification, in addition to modeling emerging programs.

Statewide and local agencies are working on zero-emission space and water heater regulations. The potential effect of these regulations was modeled and included in the *2023 IEPR* using the CEC's Fuel Substitution Scenario Analysis Tool. The CEC's Fuel Substitution Scenario Analysis Tool was first implemented for the AB 3232 building decarbonization analysis and has been updated continuously.[356] The regulations in the model include the following:

- Zero-emission space and water heater standards are part of California's climate strategy as laid out in the *2022 CARB Scoping Plan*. CARB committed to exploring developing zero-emission space and water heater standards when the board adopted the *2022 State Strategy for the State Implementation Plan* (*2022 State SIP Strategy*). The original concept for zero-emission space and water heater standards included a 2030

356 Sathe, Amul Sathe (Guidehouse), Karen Maoz (Guidehouse), John Aquino (Guidehouse), Abhijeet Pande (TRC), and Floyd Keneipp (Tierra Resource Consultants). 2020. *Fuel Substitution Reporting Tools*. California Energy Commission. Publication Number: CEC-200-2020-001. https://efiling.energy.ca.gov/GetDocument.aspx?tn=233106&DocumentContentId=65590.

compliance date for all new sales of space and water heaters to meet zero-GHG emission limits. In 2023, CARB began the public engagement process [357] to require all new space and water heaters sold in California to comply with a statewide zero-emission GHG standard. CARB anticipates bringing a proposed regulation to the board for consideration in 2026, following continued public engagement and technical analysis throughout 2025.[358]

- Local AQMDs are working to accelerate the timeline to implement zero-emission NO_x appliance regulations with their own set of adopted rules and proposals. The BAAQMD has adopted two amendments to its air district rules, which establish a zero-emission standard for NO_x from furnaces and water heaters.[359] The SCAQMD approved updates to Rule 1146.2 that requires new and existing buildings to transition to zero-emission residential and commercial building large water heaters, small boilers, and process heaters. For the first time, gas-fired pool heaters, larger water heaters, small commercial water heaters, boilers, and process heaters must meet a zero-emission NOx standard when replaced. For new buildings, the rule aligns with building standards that require zero-emission units.[360] SCAQMD also proposed Amended Rule 1111 for reduction of NO_x emissions from natural-gas-fired furnaces and Amended Rule 1112 in November 2024 for reduction of NOx emissions from residential-type, natural-gas-fired water heaters. However, in June 2025, the SCAQMD governing board voted not to adopt the proposed amendments to Rules 1111 and 1121, citing cost and equity concerns. This rejection means the previously amended rule language remains in effect, and further regulatory action is under consideration.[361] The proposals may be revisited in the future as CARB and other entities such as BAAQMD find ways to effectively address building retrofit cost and equity hurdles.

The details of the method described above are available in a consultant report prepared for CEC by Navigant.[362]

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357 California Air Resources Board. June 2024. *2022 State SIP Strategy for the State Implementation Plan,* https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf.

358 California Air Resources Board. Accessed December 2025. "Zero-Emission Space and Water Heater Standards," web page, https://ww2.arb.ca.gov/our-work/programs/zero-emission-space-and-water-heater-standards.

359 Bay Area Air Quality Management District. March 15, 2023. "Rules 9-4 and 9-6 Building Appliances," https://www.baaqmd.gov/rules-and-compliance/rule-development/building-appliances.

360 Air Quality Management District. Accessed December 2025. "Proposed Amended Rule 1111 and Proposed Amended Rule 1121," web page, https://www.aqmd.gov/home/rules-compliance/rules/scaqmd-rule-book/proposed-rules/rule-1111-and-rule-1121.

361 Air Quality Management District. November 2024. Proposed Amended Rule 1111 and Proposed Amended Rule 1121. https://www.aqmd.gov/home/rules-compliance/rules/scaqmd-rule-book/proposed-rules/rule-1111-and-rule-1121#.

362 Sathe, Amul et. al. 2019. *SB 350 Doubling Energy Savings by 2030 Method Report*.

High-Electrification Scenarios

For the 2024 update on progress toward doubling energy efficiency savings in electricity and gas, CEC staff constructed two scenarios in line with the two high-electrification scenarios that were created for the 2021 SB 350 update. As in 2021, the energy efficiency savings from gas and electricity can be separated, while the impacts from fuel substitution are fundamentally inseparable. In 2021, much of the modeling did not account for the suggested phaseout of gas energy efficiency and the shift of focus from energy efficiency to fuel substitution. These factors were addressed in the 2021 SB 350 analysis by creating a high-electrification sensitivity for the business-as-usual scenario and the aggressive energy efficiency/fuel substitution case. Starting with the SB 350 analysis in the *2023 IEPR*, all conceivable scenarios occur in a high-electrification future. For the 2024 SB 350 update:

- Scenario One uses historical or committed energy efficiency savings and fuel substitution impact data and business-as-usual energy efficiency and fuel substitution projections.
- Scenario Two uses the same committed energy efficiency savings and fuel substitution impact data but projects more aggressive electric energy efficiency savings, as well as more aggressive fuel substitution impacts to anticipate a high-electrification future.

The elements for the 2024 SB 350 Scenarios are summarized in Table 16.

Table 16: SB 350 Scenario Elements

Included Element	Scenario One Business-as-usual in high-electrification future	Scenario Two Aggressive energy efficiency in a very high electrification future
Historical energy efficiency and fuel substitution savings	Committed savings*	Committed savings*
Projected electric energy efficiency savings	Business-as-usual** energy efficiency	Aggressive*** energy efficiency
Projected gas energy efficiency savings	Business-as-usual** energy efficiency	Business-as-usual** energy efficiency
Projected programmatic fuel substitution impacts	Business-as-usual** fuel substitution	Aggressive*** fuel substitution
Projected zero-emission appliance standard as by Fuel Substitution Scenario Analysis Tool fuel substitution impacts	Business-as-usual** fuel substitution	Aggressive*** fuel substitution including local AQMDs

***Committed savings are savings that have accrued and will continue to accrue from efficiency measures that have already been implemented.**

****Business-as-usual assumes that programs will continue in the present form and present level of activity into the future**

*****Aggressive savings assume a range of additional decarbonization activities, as determined by CEC staff, as described in the SB 350 Doubling Energy Savings by 2030 Method Report**

Source: CEC staff

Results — Energy Impacts

Results of the analysis are based on the two scenarios described above. In both scenarios, the projections show the savings that are expected to accrue in that year. Measures implemented in a given year will accrue savings over subsequent years, until the deemed end of the life of a measure, meaning savings are not counted exclusively in the year that a measure is implemented. The goal of a "cumulative doubling" means that the savings achieved in 2030 should be twice the savings that were achieved in 2015.

When examining the results of this analysis, CEC staff emphasizes that SB 350 interprets energy efficiency savings and fuel substitution impacts from a savings perspective. This interpretation means that while energy efficiency reduces electricity and gas demand, as expected, fuel substitution and building electrification displace gas and add incremental electric demand, thus saving gas but adding electricity consumption as negative savings.

The modeled electricity and gas savings are shown in the blue areas of Figure 10 and Figure 11. In Figure 10, the incremental electricity that is added by business-as-usual fuel substitution efforts is shown in solid orange for programmatic fuel substitution and yellow for zero-emission standards fuel substitution contributions. In Figure 11, the additional gas displaced

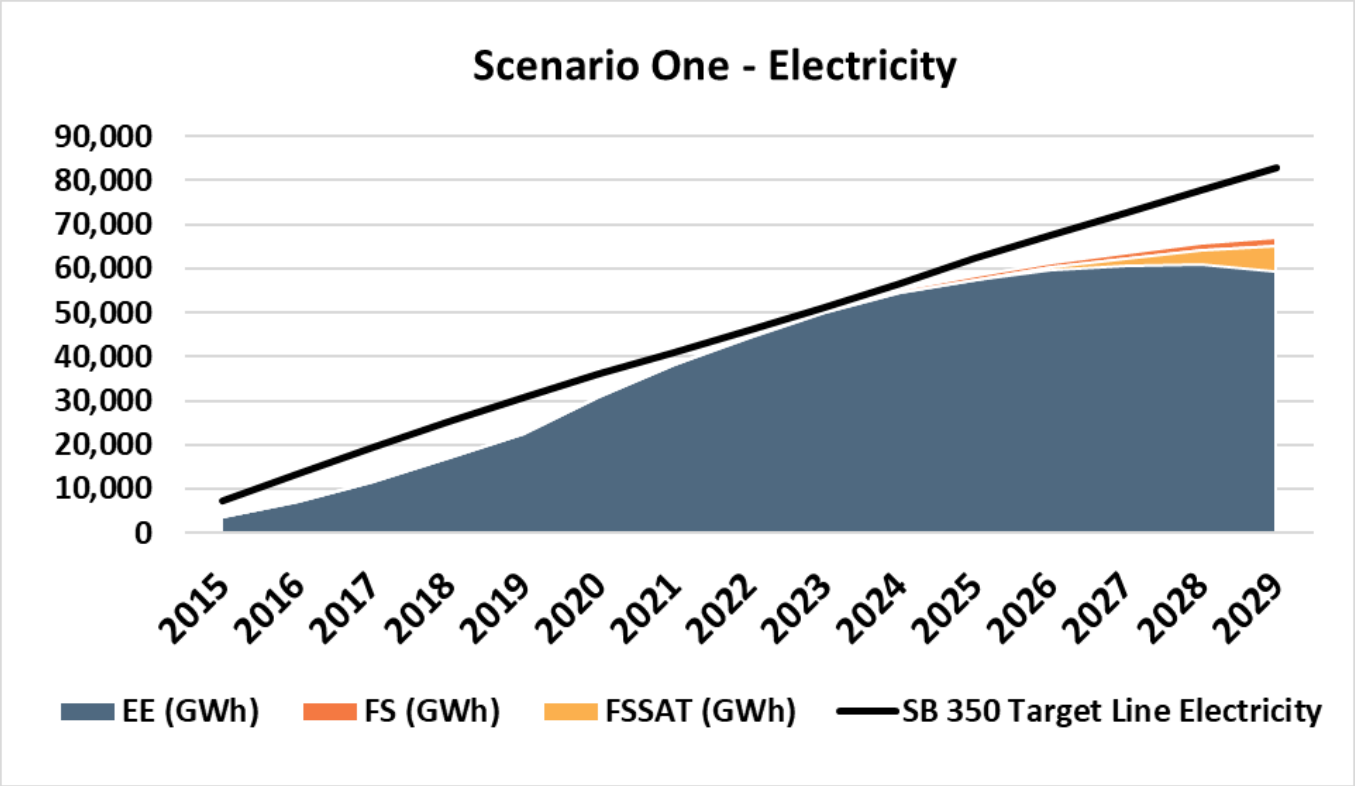
by business-as-usual fuel substitution efforts is shown in solid orange for programmatic fuel substitution and yellow for zero-emission standards fuel substitution contributions. The SB 350 target lines for electricity and gas are shown in black in Figure 10 and Figure 11 show that in the business-as-usual SB 350 Scenario One, only 72 percent of targeted electricity savings are expected to be met. However, Figure 11 shows gas savings are expected to exceed the target at 169 percent. Both graphs show that traditional energy efficiency, shown in blue, becomes more difficult to add at the same rate as in earlier years.

Less traditional energy efficiency is being added because gas energy efficiency programs are being phased out in favor of electrification or fuel substitution programs. Figure 10 illustrates this difficulty in adding traditional energy efficiency by the negative slope that starts to appear in the blue area after 2028. The flattening of the blue area in Figure 11 also demonstrates the phaseout of energy efficiency programs, leading to difficulty in adding traditional energy efficiency.

The combination of business-as-usual energy efficiency and business-as-usual fuel substitution makes electricity savings/impacts flat after 2026. However, gas savings grow more than projected in the 2021 SB 350 update because of the emphasis on fuel substitution (138 percent in Figure 11 vs. 126 percent in the 2021 SB 350 update).[363]

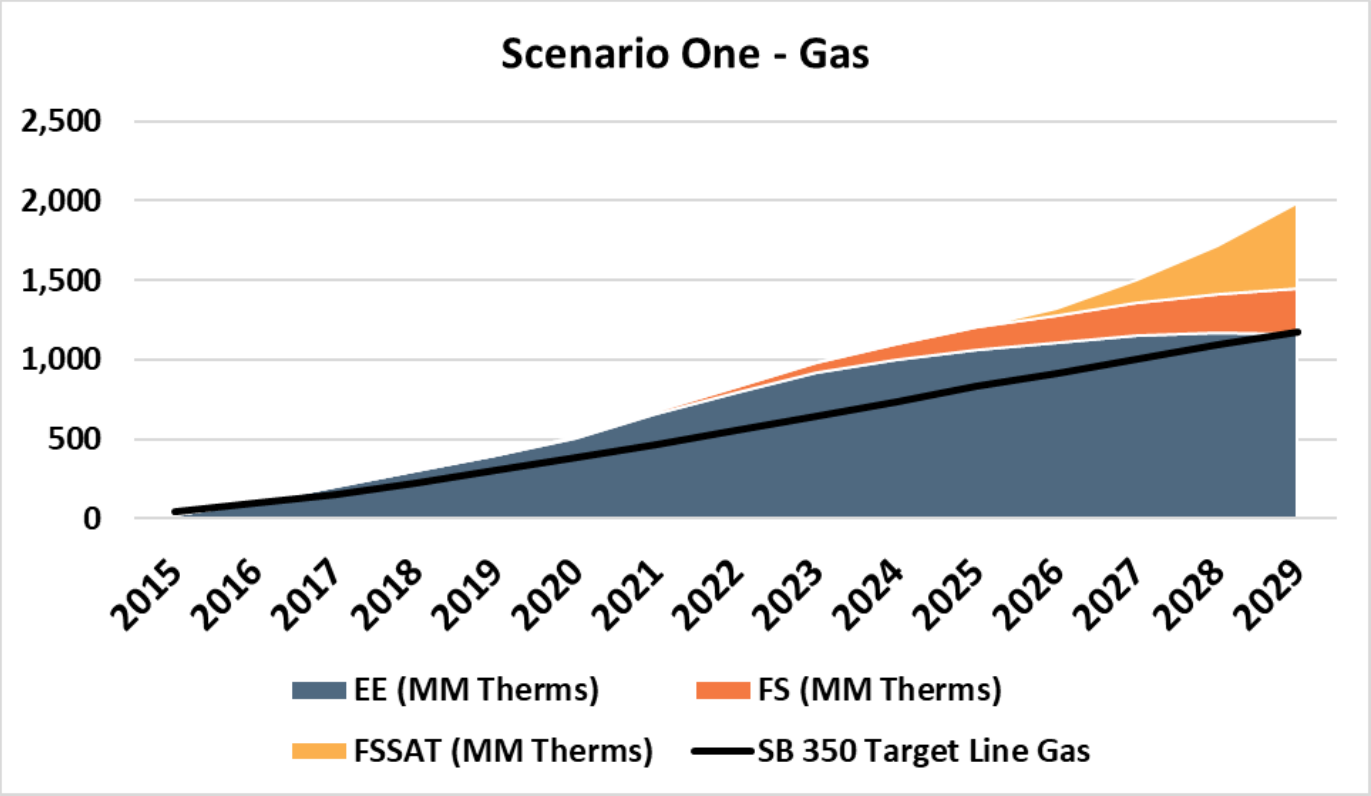
363 Kenney, Michael, et. al. 2022. *Final 2021 Integrated Energy Policy Report, Volume I: Building Decarbonization*.

Figure 10: SB 350 Scenario One Electricity Business-As-Usual



Source: CEC staff

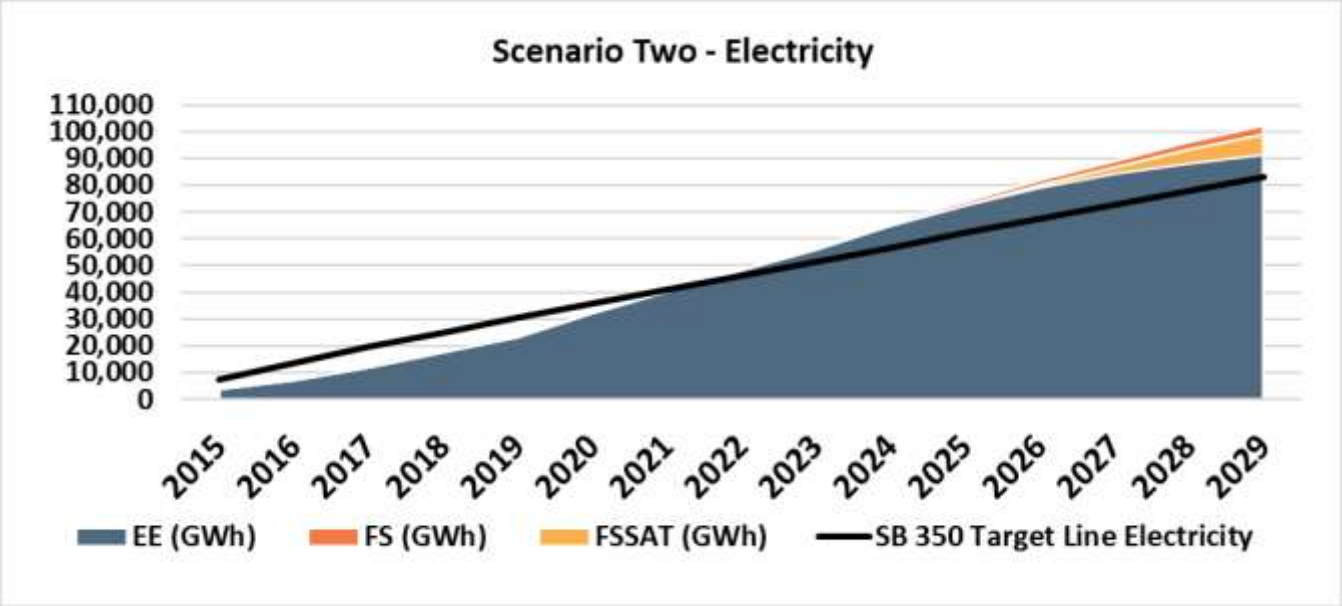
Figure 11: SB 350 Scenario One Gas Business-As-Usual



Source: CEC staff

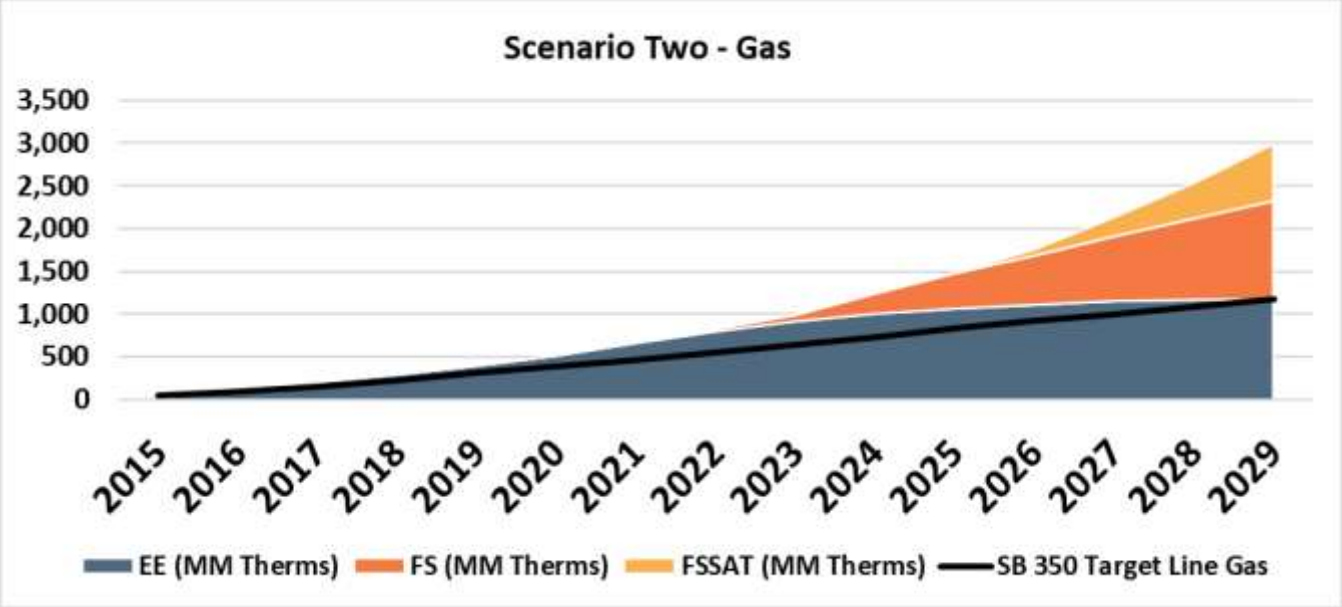
Figure 12 shows that in the SB 350 Scenario Two, 110 percent of targeted electricity savings are expected to be met, while Figure 13 shows the gas target is expected to be exceeded at 255 percent. The difference between the business-as-usual Scenario One and the aspirational Scenario Two is that Scenario Two assumes a more aggressive level of electric energy efficiency and electrification.

Figure 12: SB 350 Scenario Two Electricity



Source: CEC staff

Figure 13: SB 350 Scenario Two Gas

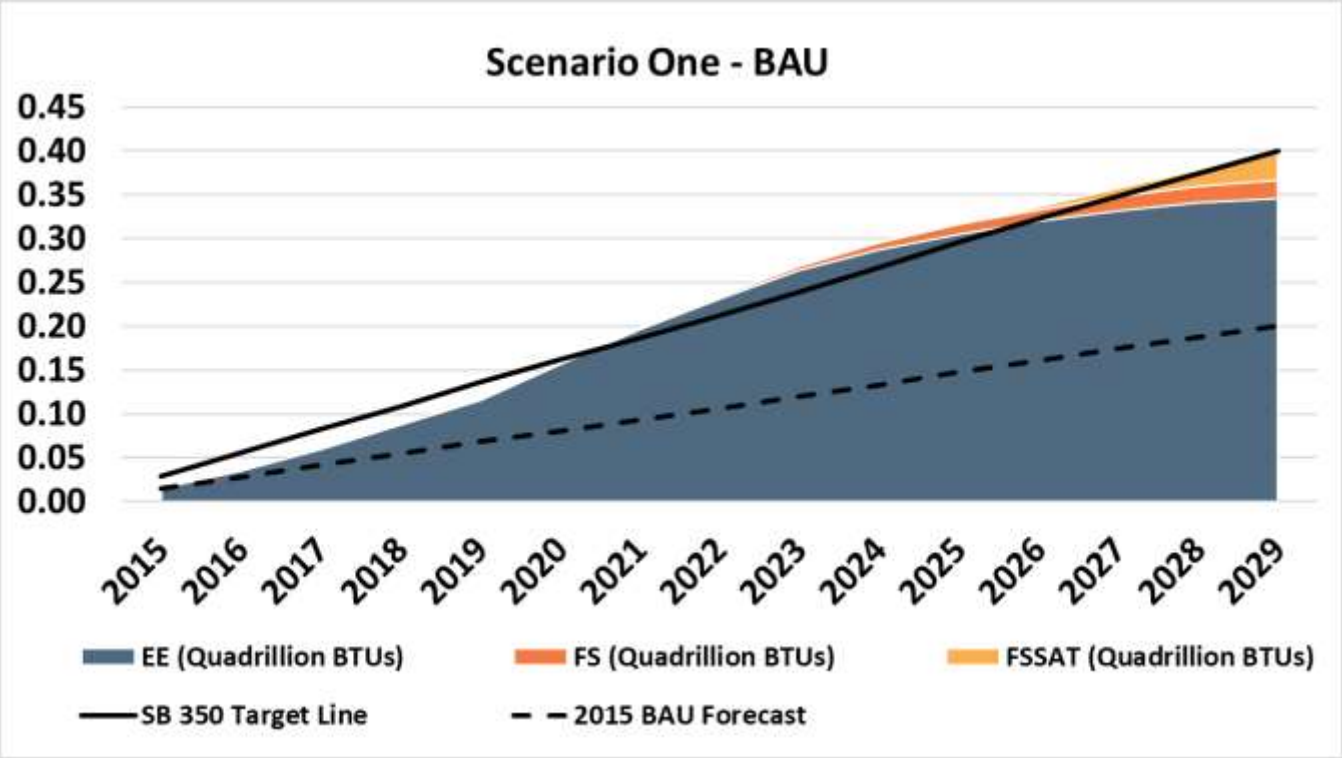


Source: CEC staff

Results — Source Energy Impacts

To visualize which of the 2024 SB 350 scenarios might meet the January 1, 2030, doubling target, CEC staff converted electricity in GWh and gas in Mthm to a common energy metric of BTU savings. This conversion allows a comparison of the combined effect of traditional energy efficiency and fuel substitution toward the SB 350 targets. As illustrated in Figure 14, the 2024 SB 350 Scenario One business-as-usual meets 100 percent of combined SB 350 target savings by 2030.

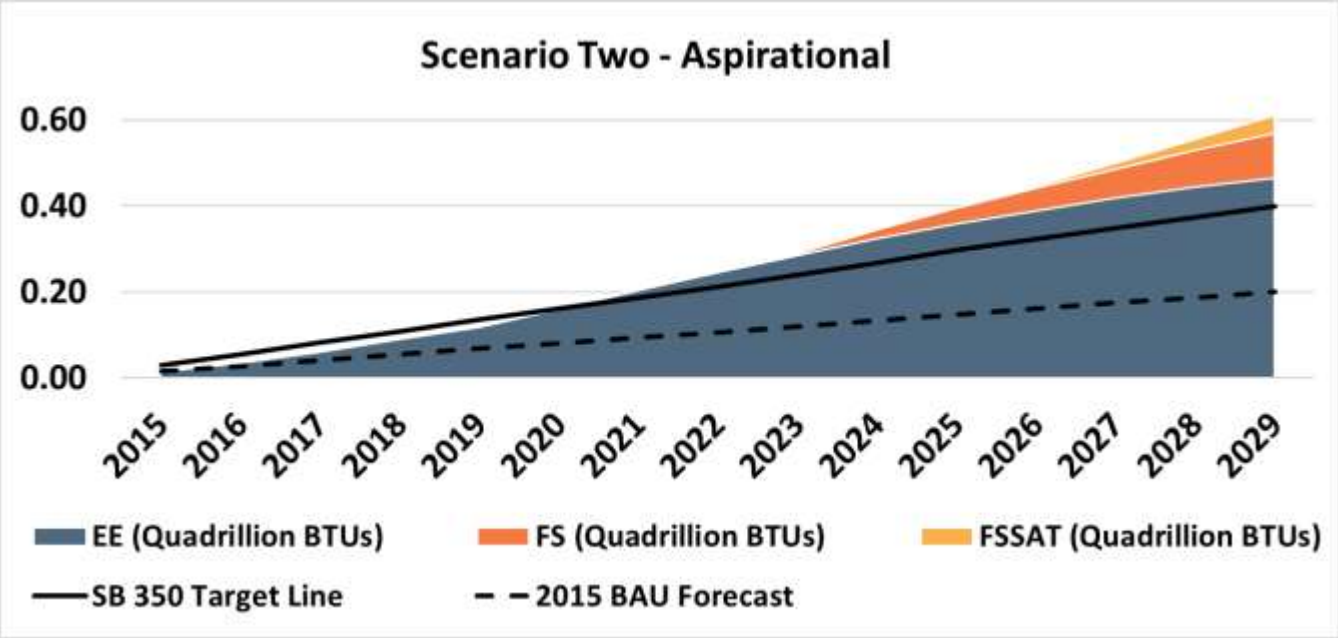
Figure 14: SB 350 Scenario One
Combined Energy Compared to the Doubling Target



Source: CEC staff

Figure 15 shows the aspirational SB 350 Scenario Two aggressive energy efficiency in a very high electrification future, which exceeds the combined SB 350 target savings (152 percent) by 2030. This projection exceeds the aggressive SB 350 scenario from 2021 because of the addition of new electrification programs and local Zero Emission Appliance Standards.

Figure 15: SB 350 Scenario Two
Combined Energy Compared to the Doubling Target



Source: CEC staff

Results — Impact on Low-Income and Disadvantaged Communities

CEC staff also updated an analysis of the impacts of SB 350 on low-income and disadvantaged communities of the residential sector. In 2019, a version of this update was incorporated into an analysis based on data from CalEnviroScreen 3.0. In 2023, multipliers for each group were updated for populations living below 200 percent of the federal poverty level (as found in the update to CalEnviroScreen 4.0 in 2021) using 2015–2019 estimates from the American Communities Survey.[364] Disadvantaged community factors also use the updated data from the Senate Bill 535 (De León, Chapter 830, Statutes of 2012) Disadvantaged Communities report, released in May 2022.[365]

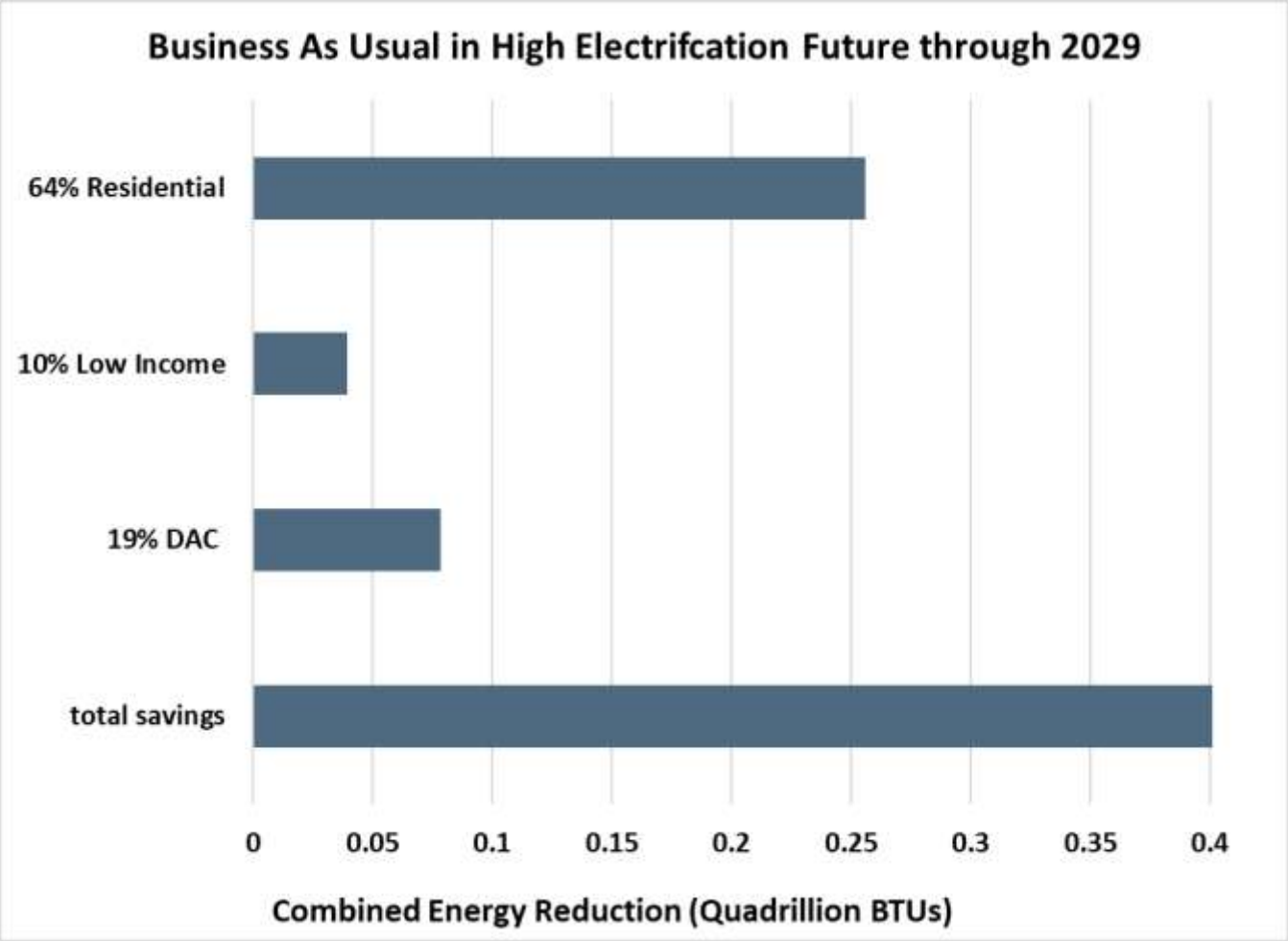
Figure 16 illustrates residential energy savings from Scenario One in disadvantaged communities and low-income populations, and Figure 17 illustrates the same savings for Scenario Two. Low-income is only a portion of the residential market sector and makes up 10 percent of total energy savings for the business-as-usual Scenario One and 8 percent of total energy savings for the aspirational Scenario Two. This reduction in energy savings is due, in part, to an assumption that fuel substitution programs for the low-income sector will end on

364 California Office of Environmental Health Hazard Assessment. Accessed May 2024. "CalEnviroScreen 4.0," https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-40.

365 California Office of Environmental Health Hazard Assessment. Accessed May 2024. "Disadvantaged Communities Map," https://oehha.ca.gov/calenviroscreen/sb535.

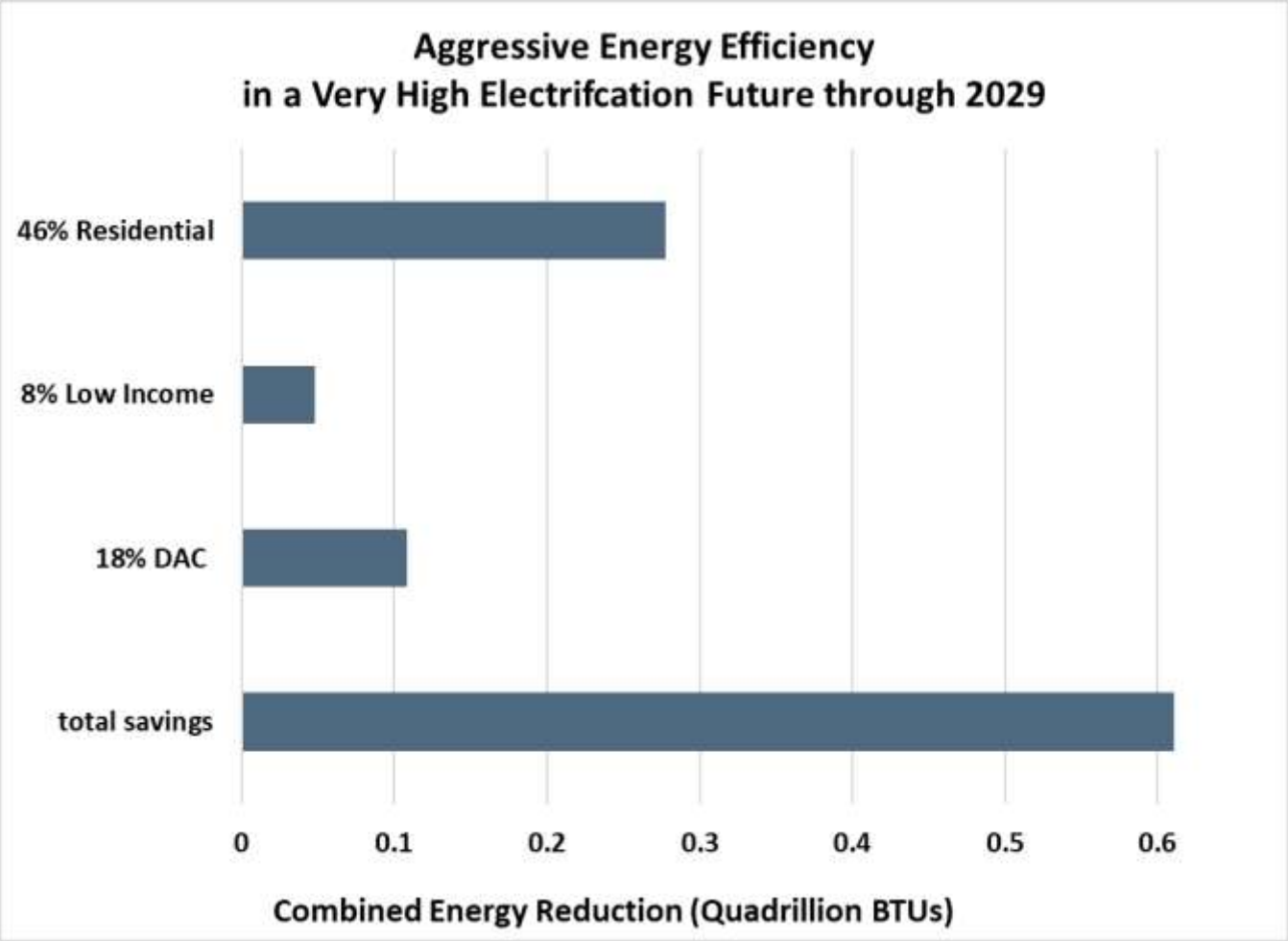
the current expiration dates, and the larger zero-emission appliance standards will be applicable to all sectors, not just low-income populations.

Figure 16: SB 350 Scenario One Percentage of Impact on Low-Income and Disadvantaged Communities



Source: CEC staff

Figure 17: SB 350 Scenario Two Percentage of Impact on Low-Income and Disadvantaged Communities



Source: CEC staff

Results — GHG Impacts

Finally, comparing the 2024 SB 350 scenarios to broader decarbonization goals requires converting combined energy savings in BTUs to GHG emissions in metric tons carbon dioxide equivalent (Mt CO_2e) averted from these savings. Since SB 350 and SB 32 consider targets and goals in the relatively near term (that is, through 2029 or by January 1, 2030), CEC staff examined which SB 350 scenarios met the SB 32 emissions goals.

AB 3232 required the CEC to assess the potential to reduce existing building emissions in California by 40 percent below 1990 levels by 2030, in line with the overall 40 percent reduction requirement set in SB 32. The *California Building Decarbonization Assessment*

describes how GHG emissions from California's buildings can be reduced in line with that goal.[366]

The *California Building Decarbonization Assessment* set out two baselines for calculating GHG reductions from building decarbonization:

- The standard "systemwide" GHG emissions baseline which includes direct emissions from the residential and commercial sectors and indirect emissions from electricity generation used to serve these sectors.
- The alternative "direct" GHG emissions baseline which includes only direct (that is, on-site) emissions from the residential and commercial buildings themselves.

Most GHG emissions reductions from buildings to date are from decarbonization of the electricity supply.[367] For more information about the definition of the two baselines (systemwide and direct), see Table ES-1 on page 8 of the *California Building Decarbonization Assessment*.[368]

CEC staff calculated the amount of GHG emissions reduction needed to reach the 40 percent target using these baselines compared to a current (2024) business-as-usual projection of GHG emissions. An additional 5.5 Mt CO_2e reductions would be needed to reach the systemwide emissions baseline, and an additional 22.1 Mt CO_2e reductions are needed for the alternative direct emissions baseline to achieve the scenarios set out in the *California Building Decarbonization Assessment*. The reason for this difference is that most GHG emissions reductions from buildings to date are from decarbonization of the electricity supply, and these reductions are reflected in the "systemwide" baseline but not the "direct" baseline.

When comparing SB 350 scenarios to the AB 3232 benchmark, CEC staff considered only the combined energy savings from the residential and commercial sectors. These sectors dominate the business-as-usual Scenario One combined energy savings, but the other three sectors (industrial, agricultural, and mining) gain importance in aspirational Scenario Two. Because the AB 3232 emissions reduction benchmark was set relative to a business-as-usual projection containing business-as-usual energy efficiency and negligible fuel substitution, all GHG savings here are also computed the same way as seen in Table 17.

366 Kenney, Michael, et al. 2021. *California Building Decarbonization Assessment*.

367 Ibid.

368 Ibid.

Table 17: SB 350 Scenario GHG Emissions Reduction

Combined Savings Type	**Scenario One** Business-as-usual in high-electrification future	**Scenario Two** Aggressive energy efficiency in very high electrification future
Traditional future energy efficiency savings	N/A	Additional aggressive electric energy efficiency savings
New projected programmatic fuel substitution impacts	Business-as-usual fuel substitution	Aggressive fuel substitution impacts
Projected zero emission appliance standards as by Fuel Substitution Scenario Analysis Tool fuel substitution impacts	Business-as-usual fuel substitution	Aggressive fuel substitution including local AQMDs
Combined GHG reduction	3.35 Mt CO_2e	9.60 Mt CO_2e

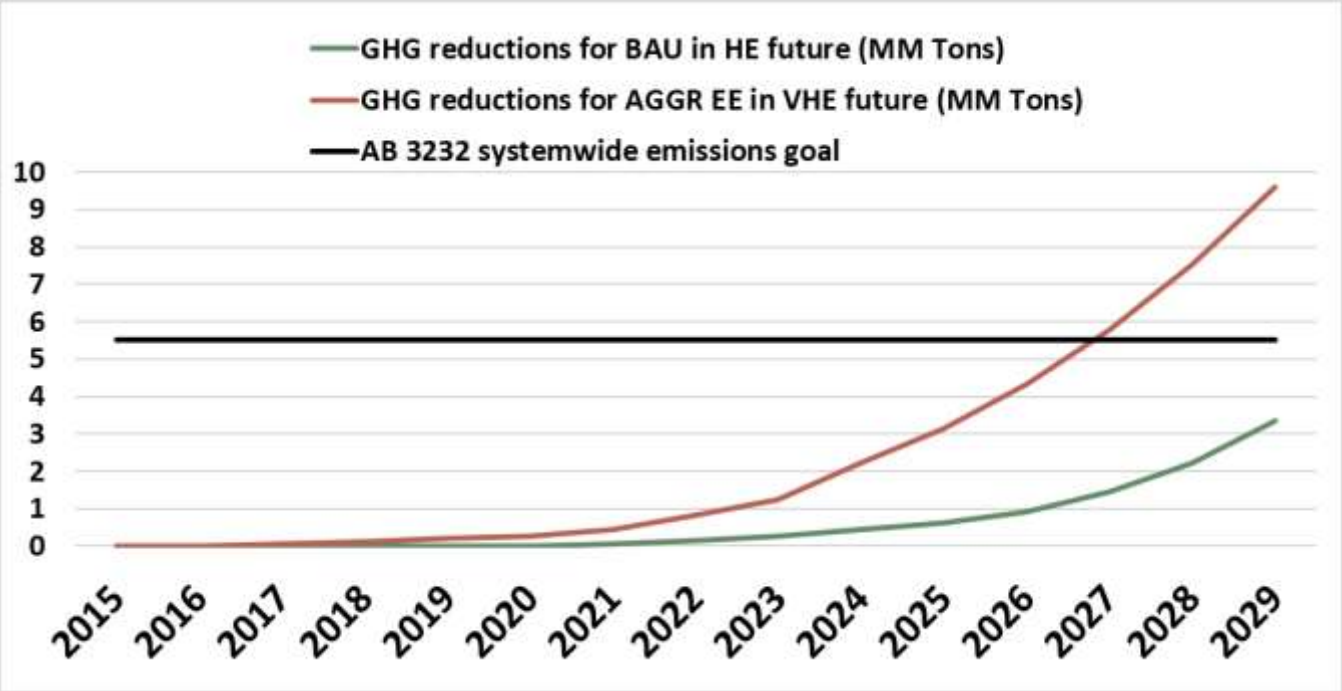
Source: CEC staff

While the combined energy savings of both 2024 SB 350 Scenarios are lower than projections made in 2021, the GHG savings are substantially higher than the savings projected in the 2021 SB 350 update:

- The green line in Figure 18 representing Scenario One "Business-As-Usual in High-Electrification Future" shows a savings of 3.35 Mt CO_2e compared to 2.7 Mt CO_2e projected in 2021.
- The red line in Figure 18 representing aspirational Scenario Two "Aggressive Energy Efficiency in Very High Electrification Future" shows a savings of 9.60 Mt CO_2e, while the 2021 SB 350 update projected 7.1 Mt CO_2e.
- This substantial difference is the result of the rapid decarbonization of electricity generation. For a more detailed comparison, see Table 3 on page 39 of the *2021 IEPR Volume I: Building Decarbonization*.

Figure 18 shows the 2024 SB 350 Scenario One business-as-usual (green line) meets 61 percent of the AB 3232 systemwide emissions reduction goal (up from 49 percent in 2021). Aspirational Scenario Two, representing a very high electrification future (red line), exceeds the AB 3232 systemwide emissions reduction goal (175 percent), meeting it prior to 2027.

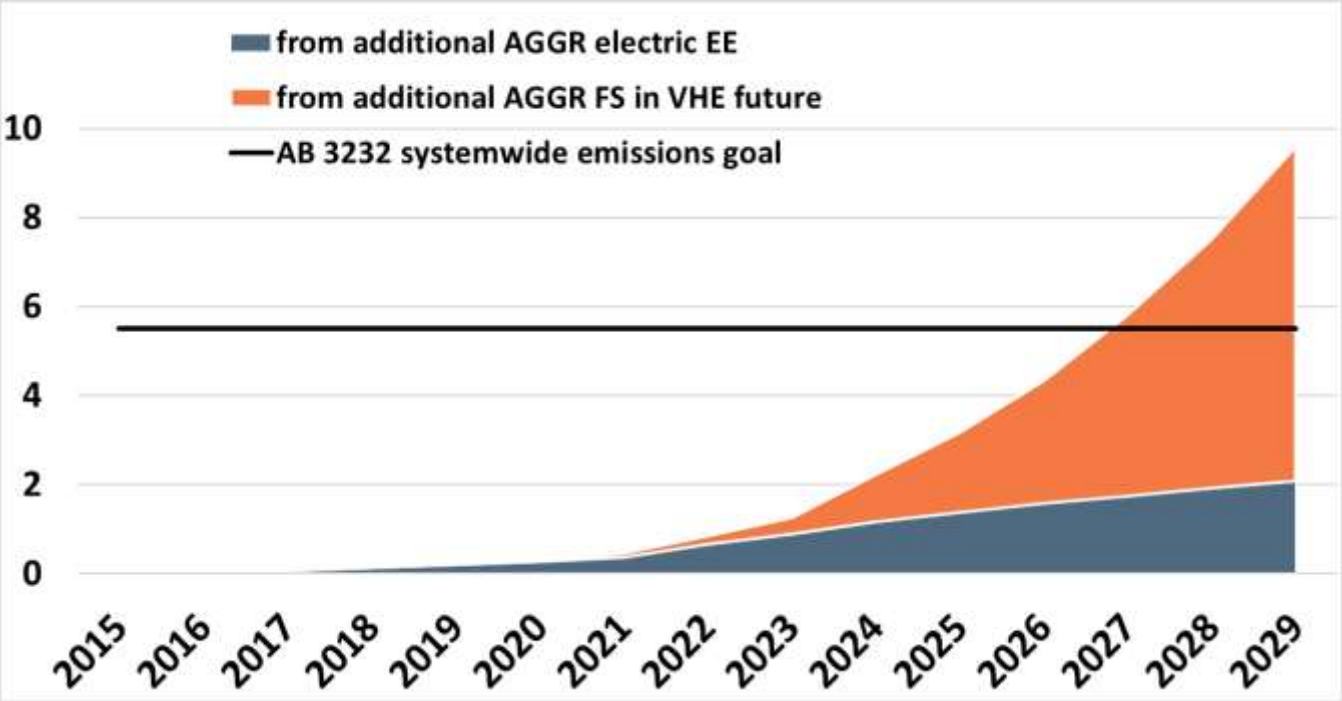
Figure 18: SB 350 Scenario Combined GHG Emissions Reductions Compared to AB 3232 Systemwide Goal



Source: CEC staff

The orange area in Figure 19 shows that electrification by additional aggressive fuel substitution can achieve more GHG savings than traditional energy efficiency. In Scenario Two, 78 percent of GHG reductions come from electrification, and the remaining 22 percent come from additional energy efficiency, represented by the blue area.

Figure 19: Comparing GHG Savings From Additional Energy Efficiency and Additional Aggressive Fuel Substitution



Source: CEC staff

The scenarios analyzed to support this SB 350 tracking and projection update do not meet the additional 22.1 Mt CO_2e reduction needed to reach a 40 percent reduction in GHG emissions using the AB 3232 direct emissions baseline. This additional emissions reduction goal is important because it sets the path for homes and businesses to achieve economywide carbon neutrality by 2045, as outlined in the *California Building Decarbonization Assessment*.[369] The CEC's Long-Term Energy Demand Scenarios Project, which was introduced in the *2021 IEPR Forecast Volume* and will be updated in 2025 to support the SB 100 analysis, will discuss potential futures and progress toward economywide midcentury decarbonization goals.

369 Bailey, Stephanie, et. al. 2023. *2023 Integrated Energy Policy Report*.

GLOSSARY

Advanced metering infrastructure is an integrated system of smart meters, communications networks, and data management systems that enables two-way communication between utilities and customers. The system provides the ability to automatically and remotely measure electricity use, connect and disconnect service, detect tampering, identify and isolate outages, and monitor voltage.

The **Affordable Housing and Sustainable Communities Program** funds projects that implement land-use, housing, transportation, and agricultural land preservation practices that reduce greenhouse gas (GHG) emissions. The Greenhouse Gas Reduction Fund (GGRF), an account established to receive cap-and-trade auction proceeds, funds the program.

The **affordability ratio** measures the percentage of a representative household's income used to pay for essential utility services after deducting nondiscretionary expenses, like housing. Higher affordability ratio values indicate less affordability.

Air quality management districts, or air districts, are responsible for regional air quality planning, monitoring, and stationary source and facility permitting. The districts administer air quality improvement grant programs and are the California Air Resources Board's primary partners in efforts to ensure that all Californians breathe clean air.

The **asset rating** of a home is the rating of the energy performance of the building itself and is independent of the behavior of the occupants.

Awarding authorities are state agencies and universities that award contracts for public works projects.

Benchmarking entails measuring the current energy use of a building and comparing it against standards, past data, or similar-sized buildings.

A **British thermal unit** is a measure of heat, which is a form of energy. A British thermal unit represents the amount of heat needed to raise one pound of water at maximum density through 1 degree Fahrenheit, equivalent to 1.055 × 10 joules.

Building decarbonization refers to activities that reduce or eliminate greenhouse gas emissions in buildings, including replacing fossil fuel burning appliances with efficient electric appliances, improving energy efficiency, incorporating demand flexibility, and reducing refrigerants or switching to climate-friendly refrigerants.

Building electrification is the replacement of fossil fuel equipment with electric equipment. An example is the replacement of gas heating equipment with electric heating equipment.

Building performance standards are outcome-driven policies that buildings must meet over time.

California Climate Investments is an umbrella term and associated logo developed for the purpose of communication with funding recipients and the general public to identify programs or projects funded in whole or in part by the GGRF.

CalEnviroScreen is an independent metric composed of 21 indicators used to identify disadvantaged communities based on negative environmental impacts.

The **California Electric Homes Program** provides technical assistance and financial incentives to residential developers and builders constructing new, market-rate homes with all-electric appliances and equipment. The program supports all-electric new construction practices, drives energy savings, and supports California's advanced energy efficiency policy goals.

California Flexible Unified Signal (CalFUSE) is a new framework for demand flexibility proposed by CPUC. CalFUSE is part of the wider Demand Flexibility Rulemaking.]

A **California Native American tribe** means "a Native American tribe located in California that is on the contact list maintained by the Native American Heritage Commission" per Public Resources Code Section 21073. The Native American Heritage Commission maintains a list of contacts among California Native American tribes for the purposes of Chapter 905 of the Statutes of 2004 and the California Environmental Quality Act.

Carbon neutrality means that all greenhouse gas (GHG) emissions emitted into the atmosphere are balanced in equal measure by GHGs that are removed from the atmosphere, either through carbon sinks or carbon capture and storage.

The **Clean Energy Reliability Investment Plan (CERIP)** addresses a requirement in Senate Bill 846 (Dodd, Chapter 239, Statutes of 2022) for the California Energy Commission to develop a $1 billion investment plan for clean energy resources. This plan provides justification and recommendations for clean energy investments that accelerate the deployment of clean energy resources, support demand response, assist ratepayers, and increase energy reliability. The plan considers California's anticipated supply and demand needs for near-term (the summer ahead) and midterm (2–10 years) reliability, advancement of the state's policies toward 100 percent zero-carbon and renewable energy resources by 2045, and the state's greenhouse gas emissions reduction targets for the electricity sector.

Community-based organizations are organizations run by a majority of local residents in the communities they serve. Their priorities and proposed solutions are identified by residents, who are involved in the design, implementation, and evaluation of services offered.

Community choice aggregators (CCAs) are programs that allow local governments, including cities, counties, and other qualifying governmental entities, to procure power from investor-owned utilities on behalf of residents and businesses in their community. CCAs allow local governments to aggregate, or gather, electricity demand for their jurisdiction, exert more control over the sources of electricity, and negotiate better rates.

A **covered building** is any building, other than a condominium development, that receives energy from a utility, has no residential accounts, or has five or more active utility accounts of any one energy type, at least one of which is residential, or a combination thereof.

Criteria air pollutants are air pollutants for which acceptable levels of exposure can be determined and for which an ambient air quality standard has been set. Examples include ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, and PM10 and $PM_{2.5}$

Demand flexibility refers to building technologies and policies that enable and provide incentives to reduce, shift, and shed energy consumption.

Demand response refers to changes in electric use by the end user in response to price signals or incentive programs.

Direct installation is a type of energy efficiency program that involves an installer coming to the customer to provide the energy upgrade as opposed to a utility providing only a rebate.

Disadvantaged community refers to an area identified as disadvantaged by the California Environmental Protection Agency per Senate Bill 535 (Chapter 830, Statutes of 2012) based on geographic, socioeconomic, public health, and environmental hazard criteria. View a map of disadvantaged communities at: https://calepa.ca.gov/EnvJustice/GHGInvest/.

Disaggregated means meter-level data that is not aggregated geographically or by building type.

Disclosable buildings are covered buildings larger than 50,000 square feet and multifamily residential buildings with more than 50,000 square feet and 17 or more utility accounts.

An **electric panel upsize** is an upgrade where the existing panel is replaced with a panel capable of carrying a higher peak load.

Embodied carbon refers to the GHG emissions resulting from the extraction, manufacturing, transportation, installation, maintenance, and disposal of building materials.

End user refers to the person or entity that purchases and consumes energy. An end user differs from a user or consumer in that the end user is both the purchaser and final user of the product or service.

Energy equity recognizes the historical and cumulative burdens of the energy system borne by tribes and justice communities and by Black, Brown, and Native people, in particular.

Energy burden refers to poor air quality and increased health hazards due to proximity to polluting facilities (such as fossil fuel power plants), disproportionately high energy bills as compared to income, and difficulty accessing clean energy technologies due to financial and other barriers.

Energy equity indicators is a CEC tool developed in 2018 to measure access to clean energy technologies and benefits. The *2021 IEPR* recommends updating this tool.

EUI is the energy use per square foot at a property (energy divided by square foot). EUI enables you to compare different-sized buildings.

Fiscal year refers to a 12-month period during which fiscal transactions are recognized. In California State government, the fiscal year begins July 1 and ends the following June 30.

Fuel substitution refers to the replacement of one fuel for another.

The **Greenhouse Gas Reduction Fund (GGRF)** funds California Climate Investments through proceeds from the sale of state-owned allowances from quarterly Cap-and-Trade auctions that are deposited into the GGRF. The California Legislature appropriates money from the GGRF to agencies to administer California Climate Investments programs. For more

information visit About California Climate Investments at: https://www.caclimateinvestments.ca.gov/about-cci.

Ground-truthing refers to the process of gathering objective, directly observed data as opposed to data gained through inference.

A **heat pump** is a machine that uses electricity to move heat from one place to another. In buildings, heat pumps are used to heat water and heat or cool spaces.

High-road jobs are those that pay a living wage, provide opportunities for promotion, guarantee safe working conditions, and may offer other benefits.

Hours at minimum wage quantifies the hours of minimum wage employment necessary for a household to cover essential utility service changes.

Initial Community Focus Areas are underresourced communities that will be served in the first phase of the EBD Direct Install Program.

Interval meter data are meter data collected at defined intervals, typically every 15 minutes or hourly. It used to be that you had to install submeters and manage an on-site database to capture interval data.

Justice communities include disadvantaged communities, under Senate Bill 535 (De León, Chapter 830, Statutes of 2012); low-income communities and households, under Assembly Bill 1550 (Gomez, Chapter 369, Statutes of 2016), underserved communities, under Assembly Bill 841 (Ting, Chapter 372, 2020), and people living with disabilities, as defined by American Disabilities Act.

Lidar is a device that is similar in operation to radar but emits pulsed laser light instead of microwaves.

Load flexibility, also known as load management and demand flexibility, is the capability to shift or shed electric load or demand away from times when electricity is expensive, polluting, and scarce to times when it is inexpensive, clean, and plentiful.

Load-Flex Program. Load flexibility, also called *demand flexibility*, is the practice of adjusting load (or energy usage) to match the supply of electricity. Electricity customers with smart devices can automatically shift their energy usage to when electricity is cheaper and clean and use less energy when the grid is under stress or running polluting power plants.

Loan loss reserves are a pool of funds from which financial institutions can recover a portion of their losses in the event of borrower defaults. Interest rate buydowns are a form of a payment provided by financing program administrators directly to the private capital provider to reduce the interest rate a customer pays for a financial product.

Low-emissivity windows are windows that use spectrally-selective coatings to reduce the transmission of infrared radiation (radiated heat) relative to the amount of visible light admitted by the window.

A **low-income community** is a census tract with a median household income at or below 80 percent of the statewide median income, or a census tract with a median household income at

or below the threshold designated as low-income by the California Department of Housing and Community Development.

A **low-income household** is a household at or below 80 percent Area Median Income (AMI), per Guidelines. For HOMES funded projects, low-income household is defined as a household below 80 percent AMI.

A **manufactured home** is constructed to the National Manufactured Home Construction and Safety Standards, established by the U.S. Department of Housing and Urban Development (HUD) in 1976.

$MTCO_2e$ or metric tons of carbon dioxide equivalent is a metric measure used to compare the emissions from different greenhouse gases based upon the associated global warming potential.

Naturally occurring affordable housing is defined as apartment buildings with five or more units where at least half of the apartments have rents affordable to households earning 80 percent of the median income for that zip code.

Nonenergy benefits represent the array of diverse impacts of energy programs and projects beyond the generation, conservation, and transportation of energy.

The **peak load** is the estimated maximum combined instantaneous electricity draw.

Regional energy networks (RENs) are networks of local governments collaborating to deliver energy programs to local communities.

A **split incentive** occurs when the party paying for the upgrades and the party benefitting from utility bill savings are different. In this scenario, the property owner pays the upgrade costs but does not reap the energy savings, whereas the tenant pays nothing toward the improvements but sees a reduction in their utility bills.

An **underresourced community** is a disadvantaged community or a low-income community.

The **Wildfire and Natural Disaster Resiliency Rebuild Program,** administered by the CPUC, helps homeowners impacted by wildfire rebuild all-electric homes and reduces costs for adoption of electric heat pump space and water heaters.

Zonal decarbonization is the geographically targeted decommissioning of gas infrastructure in specific zones.

ACRONYMS

AAEE	Additional Achievable Energy Efficiency
AAFS	Additional Achievable Fuel Substitution
AB	Assembly Bill
ACEEE	American Council for an Energy-Efficient Economy
AHSC	Affordable Housing Sustainable Communities
AIM Act	American Innovation and Manufacturing Act
amps	amperes
AQMD	Air Quality Management District
BAAQMD	Bay Area Air Quality Management District
BCCA	Buy Clean California Act
BTU	British Thermal Unit
BUILD	Building Initiative for Low-Emissions Development
C&S	Statewide Codes and Standards
CAC	California Apprenticeship Council
CAEATFA	California Alternative Energy and Advanced Transportation Financing Authority
CalFUSE	California Flexible Unified Signal
CALGreen	California Green Building Standards Code, Title 24, Part 11
California ISO	California Independent System Operator
CARB	California Air Resources Board
CARE	California Alternate Rates for Energy
CBECC	California's Building Energy Code Compliance Software
CBSC	California Building Standards Commission
CCA	community choice aggregator
CEC	California Energy Commission
CED	California Energy Demand
cfm	cubic feet per minute
CH_4	methane
CHEEF	California Hub for Energy Efficiency Financing
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COP	Communities of Practice
CPUC	California Public Utilities Commission
CSD	California Department of Community Services and Development
CWDB	California Workforce Development Board
DAS	Department of Apprenticeship Standards
DGS	Department of General Services
DIR	Department of Industrial Relations
DOE WAP	United States Department of Energy Weatherization Assistance Program
EBD	Equitable Building Decarbonization Program
EPC	Energy Performance Certificates
EPD	environmental product declaration
EPIC	Electric Program Investment Charge
ERDD	Energy Research and Development Division

ESA	Energy Savings Assistance
EUI	energy use intensity
EV	electric vehicle
EVSE	electric vehicle supply equipment
FERA	Family Electric Rate Assistance
FICO	Fair Isaac Corporation
ft^2	square feet
FY	fiscal year
g	grams
GGRF	Greenhouse Gas Reduction Fund
GHG	greenhouse gas
GIS	geographic information systems
GW	gigawatt
GWh	gigawatt-hours
GWP	global warming potential
HCD	Department Housing and Community Development
HEEHRA	Home Electrification and Appliance Rebates
HERS	Home Energy Rating System
HES	United States Home Energy Score
HFC	hydrofluorocarbons
HOMES	Home Efficiency Rebates Program
HVAC	heating, ventilation, air conditioning
HUD	United States Department of Housing and Urban Development
IBank	Infrastructure and Economic Development Bank
IEPR	Integrated Energy Policy Report
IOU	investor-owned utility
IRA	Inflation Reduction Act
IUI	inclusive utility investment
JAEDI	Justice Access Equity Diversity Inclusion
kBTU	kilo-British Thermal Unit
kW	kilowatt
kWh	kilowatt-hour
LADWP	Los Angeles Department of Water and Power
LBNL	Lawrence Berkeley National Laboratory
lbs	pounds
LED	light-emitting-diode
lidar	light detection and ranging
LMS	Load Management Standards
LWDB	Local Workforce Development Boards
MIDAS	Market Informed Demand Automation Server
MIT	Massachusetts Institute of Technology
Mt	metric tons
MMT	million metric tons
NO_2	nitrogen dioxide

NOx	oxides of nitrogen
NREL	National Renewable Energy Laboratory
PACE	property assessed clean energy
PAYS	Pay As You Save®
PCR	product category rule
PG&E	Pacific Gas and Electric
PII	personally identifiable information
PLA	project labor agreement
$PM_{2.5}$	fine particulate matter
POU	publicly owned utility
PV	photovoltaic
RASS	Residential Appliance Saturation Study
REN	regional energy network
SDG&E	San Diego Gas & Electric Company
SB	Senate Bill
SCAQMD	South Coast Air Quality Management District
SCE	Southern California Edison
SGC	Strategic Growth Council
SJV	San Joaquin Valley
SMUD	Sacramento Municipal Utility District
SoCalGas	Southern California Gas Company
SOMAH	Solar on Multifamily Affordable Housing Program
SGC	Strategic Growth Council
SVCE	Silicon Valley Clean Energy
TECH	Technology and Equipment for Clean Heating
TOB	tariff on-bill financing
TOU	time-of-use
TREC	Training for Residential Energy Contractors
UCLA	University of California, Los Angeles
U.S.	United States
U.S. DOE	United States Department of Energy
U.S. EPA	United States Environmental Protection Agency
URDB	Utility Rate Database
WRF	Weatherization Readiness Funding
yr	year

APPENDIX A:
Senate Bill 306: Equitable Building Decarbonization Program Status Report

Introduction

This report describes the status of the Equitable Building Decarbonization (EBD) Program, as directed by Senate Bill 306 (Caballero, Chapter 387, Statutes of 2023).[370] This report reflects the status of the EBD Program through the end of 2024. Program updates will be available on the EBD website.[371]

The EBD Program was authorized by Assembly Bill 209 (Committee on Budget, Chapter 251, Statutes of 2022)[372] and includes three primary components: a Statewide Direct Install Program focused on decarbonizing existing homes in underresourced communities, a Tribal Direct Install Program, and a Statewide Incentive Program to accelerate deployment of low-carbon building technologies. The primary goals of the EBD Program are to reduce greenhouse gas emissions and advance energy equity. The program will also encourage resiliency to extreme heat, air-quality improvements, energy affordability, grid reliability, and local workforce opportunities. In addition, the program will advance the state's goals of 6 million heat pumps installations by 2030, 3 million climate-ready and climate-friendly homes by 2030, and 7 million climate-ready and climate-friendly homes by 2035.

SB 306 requires the California Energy Commission (CEC) to submit an annual status report on the EBD Program containing, at a minimum, the following information:

- Selected administrators.
- Number of residents and buildings provided with low- and zero-cost projects.
- Number of each project type implemented.
- Estimated reductions of greenhouse gas (GHG) emissions.
- Locational distribution of expenditures by county and region.

As this report describes, the CEC has developed the EBD Program through a public and transparent process to ensure the program will provide benefits and meaningful results that will help California reach its decarbonization goals.

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370 Senate Bill 306. 2023. Climate change: Equitable Building Decarbonization Program: Extreme Heat Action Plan, https://legiscan.com/CA/text/SB306/id/2813934.

371 The Equitable Building Decarbonization Program website can be found at https://www.energy.ca.gov/programs-and-topics/programs/equitable-building-decarbonization-program

372 Assembly Bill 209. 2022. Energy and Climate Change, https://legiscan.com/CA/text/AB209/id/2606026.

Program Budget

The 2022–2023 Budget[373] appropriated $922 million from the state's General Fund over four years to the CEC to develop and implement the EBD Program, as shown in Table A-1. The 2023–2024 Budget[374] maintained the original funding amount, extended the program to five years, and adjusted the funding sources to $405 million appropriated from the California Climate Investments Program Greenhouse Gas Reduction Fund (GGRF) and $517 million from the General Fund, shown in Table A-2. The 2024–2025 Budget reduced the EBD Program budget by $396.5 million for a total funding amount of $525.5 million through the 2027–2028 fiscal year (FY), shown in Table A-3.

Table A-1: EBD Program Budget as of FY 2022–2023 (millions)

Funding Source	FY 22–23	FY 23–24	FY 24–25	FY 25–26	Total
General Fund	$112	$665	$53	$92	$922
GGRF	$0	$0	$0	$0	$0
Total	**$112**	**$665**	**$53**	**$92**	**$922**

Source: CEC staff

Table A-2: EBD Program Budget as of FY 2023-2024 (millions)

Funding Source	FY 22–23	FY 23–24	FY 24–25	FY 25–26	FY 26–27	Total
General Fund	$2	$87	$213	$165	$50	$517
GGRF	$60	$345	$0	$0	$0	$405
Total	**$62**	**$432**	**$213**	**$165**	**$50**	**$922**

Source: CEC staff

373 Assembly Bill 179. Budget Act of 2022, https://legiscan.com/CA/text/AB179/id/2606008.

374 Assembly Bill 102. Budget Act of 2023, https://legiscan.com/CA/text/AB102/id/2833538.

Table A-3: EBD Program Budget as of FY 2024–2025 (millions)

Funding Source	FY 22–23	FY 23–24	FY 24–25	FY 25–26	FY 26–27	FY 27–28	Total
General Fund	$2	$0.5	$0	$0	$0	$0	$2.5
GGRF	$60	$345	$25	$0	$0	$93	$523
Total	**$62**	**$345.5**	**$25**	**$0**	**$0**	**$93**	**$525.5**

Source: CEC staff

The legislative direction under SB 306 requires the CEC to provide an update specifically on budget Items 3360-002-0001 and 3360-102-0001 of Section 2.00 of the Budget Act of 2022. Those budget Items appropriated a total of $112 million for the EBD Program for the 2022-2023 fiscal year. However, the Budget Act of 2023[375] included language that reverted a portion of the $112 million appropriated in the previous year's budget. That language was later amended by Assembly Bill 102 (Ting, Chapter 38, Statutes of 2023) to increase the amount of funds that would be reverted. The final result was a reversion of $110 million, leaving a total of $2 million from the appropriations in Items 3360-002-0001 and 3360-102-0001.

As of this report date, Item 3360-002-0001 has been fully expended, with $200,000 supporting the CEC's development of the EBD Direct Install Program Guidelines and Regional Administrator Solicitation. The remaining appropriation of $1.8 million in Item 3360-102-0001 for Local Assistance was committed in November 2024 as part of grant agreements with three regional administrators for the Statewide Direct Install Program.

Program Funding Allocations

The CEC initially allocated EBD Program funding to four components or subprograms based on public input from the program scoping and guideline development processes. Those subprograms were the Statewide Direct Install Program, the Tribal Direct Install Program, the Statewide Incentive Program, and Support for Existing Programs. Table A-4 shows the funds allocated to each subprogram in the EBD Guidelines (based on the 2023–2024 Budget) and adjusted amounts reflecting the reduced 2024–2025 Budget. The CEC took the following approaches to minimize overall impacts from reduced funding to the program:

- Maintained $30 million funding allocation for a Tribal Direct Install Program based upon statutory direction for the EBD Direct Install Program to provide a preference for buildings owned or managed by a California Native American tribe or a California tribal organization, and buildings owned by a member of a California Native American tribe.
- Combined support for existing programs and Statewide Incentive Program and reduced the total amount to $30 million. This approach offered the CEC the opportunity to provide funding for the California Alternative Energy and Advanced Transportation

375 Senate Bill 101. Bill Text: CA SB101 | 2023-2024 | Regular Session | Chaptered. https://legiscan.com/CA/text/SB101/id/2831243.

Financing Authority (CAEATFA) GoGreen Financing Program and meet the statutory requirement to offer a statewide incentive for low-carbon building technologies. In addition, the CEC leveraged the concurrent development of the federally funded Home Electrification and Appliance Rebates (HEEHRA) Phase I residential retrofit program to offer heat pump incentives to low- and moderate-income households. The HEEHRA Phase I incentives will be available statewide, support low-carbon building technologies, and advance the EBD program goals of GHG reduction and energy equity.

- Supplemented the budget of the Statewide Direct Install Program with federal funding through the U.S. Department of Energy (DOE) Home Efficiency Rebates (HOMES) Program. The DOE approved the CEC's HOMES Program application in January 2025 for $154.25 million in HOMES funding to support the Statewide Direct Install Program. The total funding amount available for the EBD Program is shown in Table A-5.
- Reduced administrative activities to align with an administrative budget of $52.55 million.

Table A-4: Changes to Subprogram Budget Allocations (millions)

EBD Subprogram	23-24 Budget (EBD Guidelines)	24-25 Budget
Statewide Direct Install Program	$689.8	$412.95
Tribal Direct Install Program	$30	$30
Statewide Incentive Program	$80	$30
Support for Existing Programs	$30	Merged with Statewide Incentive Program
CEC Administrative Budget	$92.2	$52.55
Total	**$922**	**$525.5**

Source: CEC staff

Table A-5: EBD Program State and Federal HOMES Funding (millions)

EBD Subprogram	State Funding	HOMES Funding	Total
Statewide Direct Install Program	$412.95	$154.25	$567.20
Tribal Direct Install Program	$30	$0	$30
Statewide Incentive Program	$30	$0	$30
CEC Administrative Budget	$52.55	$0	$52.55
Total	**$525.5**	**$154.25**	**$679.75**

Source: CEC staff

EBD Program Implementation Status

The EBD Program includes three key subprograms — Statewide Direct Install, Tribal Direct Install, and Statewide Incentive Programs. Each subprogram is discussed below.

Statewide Direct Install Program

Program Scoping and Guidelines

In developing the EBD Program, the CEC has been committed to a transparent public process that encourages participation and feedback. The CEC gathered input from the public through numerous avenues over 16 months, beginning with the release of a request for information and a scoping workshop in December 2022. From this effort, CEC staff received 68 stakeholder comments that guided the decisions to prioritize public engagement in developing the program; focus implementation at the community level; and allocate a portion of funds to a separate Tribal Direct Install Program to be developed in partnership with tribes. Stakeholder comments received in this phase also helped guide the initial draft guidelines for the Statewide Direct Install Program, which were released in May 2023.

Public engagement on the draft guidelines commenced with a virtual workshop, followed by two tribal roundtables in May 2023. CEC staff hosted seven subsequent workshops in June 2023, including five hybrid regional workshops held in Fresno, Indio, Los Angeles, San Francisco, and Santa Rosa, and two virtual workshops to accommodate those who could not attend in person. The CEC provided language translation and interpretation at each workshop. More than 250 members of the public participated, and the CEC received more than 100 comments on the draft guidelines.

The final program guidelines were adopted in October 2023. Some changes made between the draft and final guidelines based on public input included more robust tenant protections, stronger workforce standards, more funding for remediation, safety and electrical improvements in homes, and an expanded role for community-based organizations in the implementation of the program.

In addition to formal public workshops, the CEC met with stakeholders during development of the EBD Program. Table A-8 includes the dates of outreach activities and milestones completed by CEC staff since the initiation of the EBD Program.

Regional Approach and Administrator Competitive Solicitation

The Statewide Direct Install Program will be administered by three program administrators selected competitively in three regions: Northern, Central, and Southern California. Each administrator will partner with at least two community-based organizations for culturally appropriate outreach, education, and support to participating households and communities. Table A-6 lists the counties included in each region.

Table A-6: Counties by EBD Region

Region	Counties
Northern	Alameda, Amador, Butte, Colusa, Contra Costa, Del Norte, El Dorado, Glenn, Humboldt, Lake, Lassen, Marin, Mendocino, Modoc, Napa, Nevada, Placer, Plumas, Sacramento, San Francisco, San Mateo, Santa Clara, Shasta, Sierra, Siskiyou, Solano, Sonoma, Sutter, Tehama, Trinity, Yolo, Yuba
Central	Alpine, Calaveras, Fresno, Inyo, Kern, Kings, Madera, Mariposa, Merced, Mono, Monterey, San Benito, San Joaquin, San Luis Obispo, Santa Barbara, Santa Cruz, Stanislaus, Tulare, Tuolumne, Ventura
Southern	Imperial, Los Angeles, Orange, Riverside, San Bernardino, San Diego

Source: CEC staff

Funding amounts for each region are based on the relative proportion of underresourced communities in each region. Table A-A-7 shows the amount of state funding and HOMES funding (subject to DOE approval) that will be available for each region.

Table A-7: Regional Funding Allocation

Region	Population of Underresourced Communities	Percent of Program Funds	State Funding (millions)	DOE HOMES Funding (millions)	Total Funding (millions)
Northern	5.3 million	23%	$94.98	$35.48	$130.46
Central	4.3 million	19%	$78.46	$29.31	$107.77
Southern	13.6 million	58%	$239.51	$89.47	$328.98
Total	23.2 million	100%	$412.95	$154.25	$567.20

Source: CEC staff

To ensure retrofits are provided to households that will benefit the most from this program, the CEC required program administrators to identify specific communities, referred to as Initial Community Focus Areas, to be served in the initial phase of the Statewide Direct Install Program. Proposed Initial Community Focus Areas must demonstrate diversity in terms of geography, climate zone, urban and rural areas, type of housing stock, and other characteristics. Program administrators were strongly encouraged to propose at least one "rapid start" Initial Community Focus Area. Rapid start locations will have the capacity to begin EBD-funded projects within six to nine months from the start date of the program, allowing EBD funds to provide benefits to community members as quickly as possible. In addition, administrators will develop a process for communities not included as Initial Community Focus Areas to apply for participation in the program.

The CEC held a pre-solicitation workshop in March 2024 to gather input on the proposed solicitation for the Statewide Direct Install regional administrators. A final solicitation was released April 30, 2024. As indicated previously, the release of the solicitation was delayed because of the process of incorporating federal HOMES funding into the EBD Program budget.

The application period for program administrators closed June 28, 2024, the CEC evaluation team met in July to review and score proposals, and a notice of proposed awards (NOPA) was posted to the CEC website August 7, 2024. The proposed awardees are as follows:

- Association for Energy Affordability for the Northern Region.
- Center for Sustainable Energy for the Central Region.
- Los Angeles County for the Southern Region.

Following release of the NOPA, CEC staff worked with the proposed awardees to finalize all grant agreement documents. The grant agreements went before commissioners at a CEC business meeting in November 2024 and were signed by all parties in December 2024.

Program Data and Performance Metrics

SB 306 requires the CEC to report, at a minimum, on the number of residents and buildings that were provided low- and zero-cost projects, the number of each project type implemented, the estimated reductions of GHG emissions, and the locational distribution of the expenditures by county and region. Following the program launch, data will be collected to quantify and qualify project outcomes. Since homes have not yet been retrofitted, there are no data to report. Examples of data that will be collected in each of these categories are listed below. In addition to meeting legislative reporting requirements, this data will be used to track the progress of the program, support continuous program improvement, and report to the California Air Resources Board and DOE.

- **Number of residents and buildings receiving low- and zero-cost projects**

  Administrators will be responsible for collecting data on household demographic info, including number of residents and income level, as well as the type, location, and energy data of buildings receiving retrofits. Eligible buildings include single-family, multifamily, and manufactured/mobile homes, as well as mixed-use buildings with residential spaces. Eligible households are limited to low-income communities, disadvantaged communities, and households within one-half mile of a disadvantaged community.

- **Number of each project type implemented**

  Administrators and contractors will be required to collect data and report on the types of projects and equipment installed. Examples include equipment replaced, heat pumps and other efficient electric appliances installed, other retrofits or remediation, and projected energy, GHG, and bill savings.

- **Estimated reductions of the emissions of greenhouse gases**

  A primary goal of the program is reducing GHG emissions. The program will reduce GHG emissions by replacing fossil fuel-burning equipment with efficient electric equipment and appliances, and installing weatherization measures that allow homes to

maintain comfortable temperatures while reducing energy use. The CEC will use utility meter data to measure changes in energy use pre- and post-project retrofits, and calculate the associated reductions in GHG emissions.

Additional types of data to be collected include:

- Cost information for projects, region, and program.

  The CEC will collect project cost data for each retrofitted home, including the costs of equipment, appliances, remediation, and all other installed measures, installation labor costs, and permitting costs. Costs for associated activities such as outreach, enrollment, quality control, and program administration will also be collected and closely monitored.

- Customer satisfaction surveys.

  The CEC will gather feedback from customers through post installation surveys to gauge satisfaction with the program and identify areas of improvement.

Tribal Direct Install Program

In summer 2024, the CEC held tribal roundtables and shared a scoping document with California Native American tribes to gather feedback on the Tribal Direct Install program design and unique tribal needs and concerns. The CEC plans to release draft guidelines for public review in summer 2025 and bring final program guidelines to the CEC for consideration by the end of 2025.

Following adoption of the guidelines, the CEC will develop and issue any solicitations needed to implement the program and begin decarbonization retrofits. Once the program is implemented, data on household, location, equipment, energy, GHG emissions, cost, and customer satisfaction will be collected to quantify and qualify project outcomes.

Incentive Programs

To implement the statutory direction to develop a statewide incentive program, move funds quickly through existing programs, and account for budget reductions, the CEC allocated $30 million to leverage the existing GoGreen Financing Program administered by CAEATFA. GoGreen Financing promotes home decarbonization retrofits by leveraging private capital. Leveraging capital is achieved by providing a loan loss reserve, which reduces risk for private lenders and allows them to offer more attractive loan terms (such as lower interest rates and longer repayment terms) and provide loans to customers who would not otherwise qualify. GoGreen Financing has historically been funded through investor-owned utility ratepayer funds, so customers who receive electricity from publicly owned utilities have not been eligible for financing for retrofits related to their electricity use.

EBD funds are being used to expand the GoGreen Financing loan loss reserve offering statewide, and to offer a new interest rate buydown for low-income households in underresourced communities. The EBD-funded loan loss reserve was available beginning in October 2024, and the interest rate buydown was available beginning in March 2025. Project and program data will be collected to quantify and qualify project outcomes, inform program oversight, and fulfill reporting requirements.

Program Milestones

Table A--8 summarizes the efforts to date on each of the EBD subprograms.

Table A-8: EBD Program Milestones

Date	Program	Milestone
December 9, 2022	EBD all	Release of request for information on program development
December 13, 2022	EBD all	Scoping workshop on EBD Program
May 5, 2023	Statewide Direct Install	Draft EBD Direct Install Program Guidelines posted for public review and comment. Spanish translation also posted.
May 17, 2023	Statewide Direct Install	Workshop on Draft EBD Direct Install Program Guidelines with comment period until June 30, 2023. More than 200 stakeholders attended the workshop.
May 24-25, 2023	Tribal Direct Install	Tribal roundtables on EBD Direct Install Program Guidelines
June 6, 9, 10, 12, 15, 21, and 23, 2023	Statewide Direct Install	Five regional workshops in Fresno, Indio, Los Angeles, San Francisco, and Santa Rosa, and two virtual workshops to solicit input on the design and implementation of the direct install program. Over 250 stakeholders attended and more than 80 comments received on the guidelines.
October 5, 2023	Statewide Direct Install	Proposed EBD Direct Install Guidelines released for notice of CEC consideration
October 18, 2023	Statewide Direct Install	EBD Direct Install Guidelines adopted by CEC
March 14, 2024	Statewide Direct Install	Workshop on draft solicitation for regional administrators
April 30, 2024	Statewide Direct Install	Solicitation released to select regional administrators
June 28, 2024	Statewide Direct Install	Regional administrator applications due
August 7, 2024	Statewide Direct Install	Notice of proposed awards posted
September 5, 2024	Incentives	Agreement between CEC and CAEATFA for EBD GoGreen Program ($30 million)
October 2024	Incentives	EBD GoGreen Program launch

Date	Program	Milestone
November 2024	Statewide Direct Install	Agreements with regional administrators approved at CEC Business Meeting
Quarterly	EBD All	Meetings with environmental justice groups and local governments to understand the concerns and needs of their communities
Ongoing	Tribal Direct Install	Development of the Tribal Direct Install Program Guidelines and tribal roundtables

Source: CEC staff