DOCKETED	
Docket Number:	23-DECARB-02
Project Title:	Inclusive Utility Investments
TN #:	251370
Document Title:	UC Berkeley Center for Law, Energy & the Environment Comments - The Future of California Consumer Energy Finance
Description:	N/A
Filer:	System
Organization:	UC Berkeley Center for Law, Energy & the Environment
Submitter Role:	Public Agency
Submission Date:	7/28/2023 3:17:50 PM
Docketed Date:	7/28/2023

Comment Received From: Ted Lamm - UC Berkeley Center for Law, Energy & the Environment
Submitted On: 7/28/2023
Docket Number: 23-DECARB-02

UC Berkeley Policy Report - The Future of California Consumer Energy Finance

On behalf of UC Berkeley's Center for Law, Energy & the Environment and Haas Energy Institute (and my co-authors Andrew Campbell and Katherine Hoff) I am pleased to submit for the record our June 2023 policy report "The Future of California Consumer Energy Finance," attached to this comment and available here: https://www.law.berkeley.edu/research/clee/research/climate/energy-efficiency/financing/.

The report is based on expert interviews and analysis of California's energy efficiency and building decarbonization policy landscape, the GoGreen financing program and parallel programs in other states, and alternative mechanisms to promote decarbonization retrofits. It includes policy recommendations for state leaders on questions relating to program structure, funding sources, IUI, federal programs, and more. We hope it is informative in answering the questions posed by this RFI.

Additional submitted attachment is included below.

THE *Future* OF CALIFORNIA CONSUMER ENERGY FINANCE

Strategies to Improve Program Performance and Accelerate Building Decarbonization

JUNE 2023
Policy Report

CLIMATE & ENERGY
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ENERGY INSTITUTE AT HAAS

JUNE 2023 | POLICY REPORT

THE FUTURE OF CALIFORNIA CONSUMER ENERGY FINANCE

Strategies to Improve Program Performance and Accelerate Building Decarbonization

Berkeley Law | Center for Law, Energy, & the Environment

ENERGY INSTITUTE AT HAAS

ABOUT THIS REPORT

This report was prepared by UC Berkeley's Center for Law, Energy and the Environment (CLEE) and Energy Institute at Haas with funding provided by the California Public Utilities Commission (CPUC) and support from UC Berkeley's California Institute for Energy and Environment (CIEE). The authors thank Ethan Elkind of CLEE for his thoughtful contributions throughout the research and writing process; Kevin Feizi and Sasha Merigan of the CPUC for their strategic guidance of the project; and Eric Lee and Terry Surles of CIEE for their support.

ABOUT THE CENTER FOR LAW, ENERGY & THE ENVIRONMENT

The Center for Law, Energy & the Environment (CLEE) channels the expertise and creativity of the Berkeley Law community into pragmatic policy solutions to environmental and energy challenges. CLEE works with government, business, and the nonprofit sector to help solve urgent problems requiring innovative, often interdisciplinary approaches. Drawing on the combined expertise of faculty, staff, and students across the University of California, Berkeley, CLEE strives to translate empirical findings into smart public policy solutions to better environmental and energy governance systems.

ABOUT THE ENERGY INSTITUTE AT HAAS

The Energy Institute at Haas helps create a more economically and environmentally sustainable energy future through research, teaching and policy engagement. To support current and future energy sector leaders in making important decisions, the Energy Institute trains the business and policy leaders of tomorrow on market, policy, and technology commercialization challenges in the energy industry; and produces research and analysis backed by rigorous empirical evidence and the frontiers of economic research so that energy and environmental policy and business decisions are based on sound economic and business principles. CLEE strives to translate empirical findings into smart public policy solutions to better environmental and energy governance systems.

AUTHORS

Andrew Campbell
EXECUTIVE DIRECTOR
ENERGY INSTITUTE AT HAAS

Ted Lamm
SENIOR RESEARCH FELLOW - CLIMATE
CENTER FOR LAW, ENERGY & THE ENVIRONMENT

Katherine Hoff
RESEARCH FELLOW - CLIMATE
CENTER FOR LAW, ENERGY & THE ENVIRONMENT

DESIGN

Template design and layout:
Jordan Rosenblum

Document design and layout:
Odd Moxie

Image credits:
Adobe Stock

ACKNOWLEDGMENTS

The authors thank the following experts who contributed their thoughts and time to this effort through interviews, review and feedback, and the October 2022 roundtable that informed this report's analysis and recommendations. All affiliations are given as of the date of initial engagement with the authors.

Tammy Agard
EETILITY

Kaylee D'Amico Allen
CAEATFA

Elaine Allyn
SAN DIEGO GAS & ELECTRIC

Chad Asay
SONOMA CLEAN POWER

Panama Bartholomy
BUILDING DECARBONIZATION COALITION

Joe Buonannata
INCLUSIVE PROSPERITY CAPITAL

Martha Campbell
RMI

Deana Carrillo
CALIFORNIA ENERGY COMMISSION

Derek Chernow
CAEATFA

Michael Colvin
ENVIRONMENTAL DEFENSE FUND

Claire Coughlan
PACIFIC GAS & ELECTRIC

Rory Cox
CALIFORNIA PUBLIC UTILITIES COMMISSION

Noelani Derrickson
TESLA

Ethan Dornhelm
FICO

Jill Ferguson
STANFORD UNIVERSITY

James Fine
ENVIRONMENTAL DEFENSE FUND

Jacob Frigard
PACIFIC GAS & ELECTRIC

Al Gaspari
PACIFIC GAS & ELECTRIC

Luis Gutierrez
SOUTHERN CALIFORNIA EDISON

Jamie Hall
GENERAL MOTORS

Darren Hanway
SOCALGAS

Rick Hollander
RMI

John Howat
NATIONAL CONSUMER LAW CENTER

Holmes Hummel
CLEAN ENERGY WORKS

Bert Hunter
CONNECTICUT GREEN BANK

Jon Kochik
SAN DIEGO GAS & ELECTRIC

Geoff Larson
CAEATFA

Gwen Yamamoto Lau
HAWAII GREEN INFRASTRUCTURE AUTHORITY

Michael Levy
TRAVIS CREDIT UNION

Commissioner Andrew McAllister
CALIFORNIA ENERGY COMMISSION

Cynthia McGuire
TRAVIS CREDIT UNION

Anne Arquit Niederberger
ENERVEE

Derek Okada
SOUTHERN CALIFORNIA EDISON

Madeline Priest
INCLUSIVE PROSPERITY CAPITAL

Brian Prusnek
SOCALGAS

Srinidhi Sampath Kumar
RMI

Alison Seel
VERMONT ENERGY INVESTMENT CORPORATION

Michael Sokol
CALIFORNIA ENERGY COMMISSION

Maria Stamas
INITIATIVE FOR ENERGY JUSTICE

Elizabeth Stein
ENVIRONMENTAL DEFENSE FUND

Camille Stough
THE UTILITY REFORM NETWORK

Cody Taylor
SOUTHERN CALIFORNIA EDISON

Mary Templeton
MICHIGAN SAVES

Peter Thompson
PACIFIC GAS & ELECTRIC

Lucas Toffoli
RMI

Dylan Voorhees
VERMONT ENERGY INVESTMENT CORPORATION

Francesca Wahl
TESLA

Tom White
EDEN HOUSING

Delia Williams
SOUTHERN CALIFORNIA EDISON

Amber Wood
AMERICAN COUNCIL FOR AN ENERGY-EFFICIENT ECONOMY

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EXECUTIVE SUMMARY

California leaders have established ambitious state goals to reduce greenhouse gas emissions to 40 percent below 1990 levels by 2030 and to 85 percent below 1990 levels by 2045, along with statewide carbon neutrality by 2045.

These goals build on decades of decarbonization efforts across multiple sectors, including measures to address emissions from energy consumption in buildings, which are responsible for over 10 percent of statewide greenhouse gas emissions and are one of the most difficult to decarbonize sectors for a host of financial, technical, and structural reasons. They present a high-priority opportunity to couple emissions reduction efforts with strategies to promote indoor air quality, reduce energy cost burdens, and improve quality of life for millions of Californians.

These strategies include, for example, a statewide target of doubling building energy efficiency savings by 2030, direct state investments in home weatherization and electrified space and water heating, ambitious Title 24 standards for new construction and substantial renovations, and emerging on-bill repayment models. They also include state-supported financing programs designed to incentivize property owners to take on retrofit projects using private capital, with state funds dedicated to lowering the cost of capital and creating a project pipeline through incentive access and contractor management. The State of California's flagship energy efficiency financing initiative, GoGreen Financing, enables financial institutions to provide low-cost loans and other financing options for qualifying energy efficiency retrofit projects, with state support via a loan loss reserve fund that protects lenders from costly defaults.

This report focuses on strategies to reduce building energy use and greenhouse gas emissions, including both energy efficiency and electrification measures. The report also recognizes that investments in home electric vehicle charging will be important due to the state policy requiring that 100% of new vehicle sales are zero emissions by 2035. See Appendix I for definitions of key terms and programs.

Nearly a decade after its initial conception and over six years since the first issuance of loans, GoGreen Financing has experienced some success, enrolling over 3,000 loans and facilitating over $55 million in residential retrofit projects. However, California needs to significantly accelerate the pace of retrofits across 14 million existing homes and units if the state is to achieve its 2045 decarbonization target—and expand the suite of available low-cost tools in order to meet the needs of lower- and moderate-income residents in that timeframe. The scale and the timeline, as well as the tens of billions of dollars in retrofit costs, will require a step-change increase in activity.

Similarly structured programs in other states have financed greater project volumes over the same period, suggesting program design elements that could expand GoGreen Financing's reach, but California's total need stretches well beyond the scale of current state financing programs. At the same time, the 2022 federal Inflation Reduction Act created and expanded incentives for residential decarbonization—from tax credits for heat pump installation to a greenhouse gas reduction fund to support state and local lending strategies—that have the potential to rapidly accelerate the building electrification market but will still rely heavily on state programs that operate effectively and at scale. This report seeks to analyze the future of consumer energy finance in California and discuss strategies to improve program reach, integrate with new models to serve lower- and moderate-income Californians, and accelerate progress in pursuit of the state's long-term decarbonization goals.

RESEARCH QUESTIONS

This report considers the following questions:

- What role can and should consumer energy finance play in advancing California's building decarbonization and statewide carbon neutrality targets?
- What is the purpose and design of the state's GoGreen Financing programs and how do they compare to similar programs in other states?
- What other program structures, revenue sources, and financing strategies could state leaders consider adopting to improve performance and advance equity?
- Is state-supported financing a viable option for lower-income residents and multifamily building owners and tenants to carry out retrofit projects? How can state leaders prioritize the needs of these Californians?
- What revenue sources and institutional structures are most appropriate for financing programs?
- How can state leaders incorporate experimental evaluation and consumer data analysis into future program designs?
- How can state leaders design programs to accommodate market and technology shifts between now and 2045?

SUMMARY OF FINDINGS

Based on program analysis, literature review, expert interviews, and an October 2022 expert roundtable, this report identifies a set of conclusions and recommendations for California policymakers. We offer recommendations in distinct but overlapping areas:

- Expanding consumer energy financing programs
- Addressing the needs of lower- and moderate-income residents
- Accelerating building decarbonization toward California's 2045 goal
- Ensuring equity in program revenue sources
- Improving program design through learning

These recommendations all reflect a core insight developed from the research and outreach process: that the enormous size of California's building decarbonization need calls for significant infusions of private capital, and financing programs can be a mechanism to attract some of this capital. However, consumer energy finance programs are not yet operating on a scale that matches the challenge. Even at their most robust and effective these programs will likely only fund a portion of the needed retrofits and are not always appropriate for lower-income residents, who will require access to alternative measures involving minimal or zero repayment obligations. And effectively taking advantage of newly available federal Inflation Reduction incentives will rely on state programs that facilitate layering of funds from an array of sources.

A central recommendation across this report's sections is that state legislators and financing program administrators consider alternatives to utility ratepayer funds as the core revenue source for credit enhancement. Shifting from ratepayer funds to alternative sources including taxpayer funds, federal funds, and philanthropic sources could potentially help scale up the GoGreen Financing programs' reach and flexibility across utility service territories, fuel sources, and eligible measures; facilitate more seamless integration with other state programs; reduce procedural barriers to rapid adaptation to market and technology developments; and advance equity by relying on a more progressive revenue source.

Other recommendations include (but are not limited to):

- Further cultivate a robust contractor network and focus on designing program offerings for ease of use by contractors at the point of sale.
- Emphasize incremental (rather than comprehensive retrofit) approaches for lower-income residents, including through appliance microfinance.
- Reduce loan loss reserve requirements to help increase program scale relative to public funding levels.
- Conduct randomized experiments to test program efficacy, in particular for emerging tariffed on-bill strategies.

See Section II, Section III, and Section IV for all conclusions and recommendations.


STOP

I. INTRODUCTION

California has established ambitious targets of reducing state greenhouse gas emissions to 40 percent below 1990 levels by 2030 and 85 percent below 1990 levels by 2045, with a goal of achieving statewide carbon neutrality by 2045 and net negative emissions thereafter.[1]

Reducing emissions from residential buildings—which were responsible for over 10 percent of state emissions in 2018, including both direct combustion of fossil fuels and consumption of electricity—will be vital to achieving these targets.[a] State lawmakers have recognized this priority through a range of legislation, including most prominently a requirement to double statewide energy efficiency savings from both electricity and natural gas consumption in buildings by 2030,[2] and a suite of incentive, rebate, and financing programs for building owners and residents.

California's building emission reduction efforts will rely on both increases in energy efficiency and rapid building decarbonization. The California Air Resources Board has stated that "[a]chieving carbon neutrality must include transitioning away from fossil gas" in buildings and this effort "will rely primarily on advancing energy efficiency while replacing gas appliances with electric alternatives," noting that building decarbonization provides not only climate

a. According to California Energy Commission (CEC) data, residential buildings were responsible for approximately 49.5 million metric tons of carbon dioxide equivalent ($MMTCO_2e$) emissions in 2018 in California, when statewide emissions totaled approximately 410 $MMTCO_2e$. Residential direct emissions (i.e., from onsite combustion of fossil fuels) were approximately 7 percent of state GHG emissions in 2020. While emissions from electricity consumption will generally decline as California's grid obtains an increasing percentage of power from zero-carbon sources, direct emissions can only be addressed through electrification and will require additional focus. See Michael Kenney et al., CEC, *California Building Decarbonization Assessment* (August 2021), pp. 12, 26, available at https://www.energy.ca.gov/publications/2021/california-building-decarbonization-assessment; see also California Air Resources Board (CARB), *California Greenhouse Gas Emissions from 2000 to 2020: Trends of Emissions and Other Indicators* (October 2022), pp. 6, 8-9, 20-21, available at https://ww2.arb.ca.gov/sites/default/files/classic/cc/inventory/2000-2020_ghg_inventory_trends.pdf.

but also public health and quality of life benefits from the reduction of indoor air pollution.[3]

State and local leaders have begun to address the challenge for new buildings. California's statewide Title 24 Building Energy Efficiency Standards require newly constructed homes to be electric-ready, and future iterations of those standards (beginning in 2025) may require all-electric new construction.[4] Dozens of California cities have also adopted electrification ordinances for new construction in various forms.[5] However, these requirements do not cover the 14 million existing residential homes and units in California, which will constitute the majority of the state's housing stock and building greenhouse gas emissions for decades to come, given the slow rate of new construction.[6] While some jurisdictions including the European Union and New York City have instituted existing-buildings strategies such as energy performance grades[7] and performance standards for existing large residential and commercial buildings,[8] and some California cities are exploring retrofit strategies such as time-of-replacement and time-of-sale requirements,[9] at the state level, improving existing buildings will likely rely on a mosaic of policies designed to "generate demand" for efficiency and electrification by incentivizing voluntary investments.

Retrofitting these existing buildings, both to increase their energy efficiency and to convert fossil fuel appliances to full electrification, will be essential to rapid building decarbonization. It will also cost many tens of billions of dollars statewide—for example, the California Energy Commission has estimated a "moderate electrification scenario" for residential buildings would cost over $26 billion in upfront technology expenses through 2030 (partially offset by fuel savings), while San Francisco has estimated that electrifying all of the city's approximately 240,000 housing units would cost between $3.45 billion and $5.86 billion.[10] Another analysis estimates a cost of up to $150 billion for statewide space and water conditioning electrification measures through 2050.[11] While some Californians can afford (and will voluntarily undertake) a retrofit project on their own, financial support from taxpayer and utility ratepayer funds will be crucial to drive these retrofits for many residents throughout the state, particularly for lower- and moderate-income households.

As a result, California leaders have established a suite of initiatives to promote building energy efficiency and electrification upgrades, including rebates, incentives, and direct-install programs primarily designed for lower-income residents and operated by state and local agencies, electric and gas utilities, and nonprofits. These include the Low-Income Weatherization Program (which provides no-cost solar and efficiency upgrades for low-income residents); the SOMAH program (which provides incentives for solar on affordable multifamily housing); the TECH initiative (which provides rebates for heat pump installation); and more.

Leaders have also established financing programs to provide residents with access to low-cost capital for qualifying energy retrofits, with the goal of using state and utility resources to accelerate private investment in building upgrades—recognizing that private capital will ultimately need to serve as the primary source of funds for these projects around the state, particularly given

the tens and potentially hundreds of billions of dollars needed for efficiency and decarbonization in the coming decades.

The state's GoGreen Financing programs, administered by a unit of the State Treasurer's Office in collaboration with the California Public Utilities Commission and the investor-owned utilities, are California's leading state effort in consumer energy finance and have facilitated tens of millions of dollars in loans since their inception. Given the tens of billions of dollars in installation costs that will be needed to achieve building decarbonization in California, these programs will likely need to expand significantly in the coming years.

CALIFORNIA'S EXISTING BUILDING DECARBONIZATION CHALLENGE

As noted above, residential buildings in California are responsible for over 10 percent of statewide greenhouse gas emissions; total building energy use (including both residential and commercial buildings) accounts for 25 percent of systemwide state emissions.[12] Reducing emissions from buildings is therefore critical if the state is to meet its decarbonization goals.[13]

"Energy efficiency—measures that reduce the energy use (electricity or fossil fuel) needed to deliver the same energy services—has traditionally been the first and least expensive method of existing building decarbonization. These measures range from building envelope upgrades that reduce space heating and cooling demand to efficient appliances that the California Energy Commission has identified as "essential" to building decarbonization efforts.[14] (See Appendix II for an overview of efficiency and decarbonization measures.) Energy efficiency improvements including lighting upgrades and efficient appliances reduce electricity consumption, lowering costs for residents, lessening pressure to develop new energy capacity, and building grid stability.[15] Energy efficiency can also improve health outcomes and comfort for residents.[16] In addition, energy efficiency projects can produce jobs—for example, one study found that energy efficiency measures had the potential to generate 380 jobs per terawatt hour (TWh) of electricity saved, compared to 110 jobs per TWh generated by new coal-fired power plants.[17]

However, as California's grid has integrated more renewable sources and many property owners have adopted efficient appliances and lighting, remaining efficiency gains are increasingly concentrated in more expensive weatherization retrofits. Retrofitting existing buildings is far more expensive and challenging than decarbonizing new construction (which dozens of California local governments have mandated and the Energy Commission has begun to consider in the Title 24 process) because replacing old appliances and infrastructure, while crucial, is inherently costly and disruptive.[18] And for all building types, a transformational shift from fossil fuel-powered to electricity-powered homes and appliances—including millions of retrofits and replacements—will be essential to meet the state emissions reduction goals established by the Legislature and detailed in the California Air Resources Board's (CARB) most recent Scoping Plan.[19] Figure 1 shows CARB's anticipated building fuel mix shifting to nearly 100 percent

electricity by 2045, while Figure 2 shows CARB's anticipated transition to 100 percent electric sales of new home heating appliances.

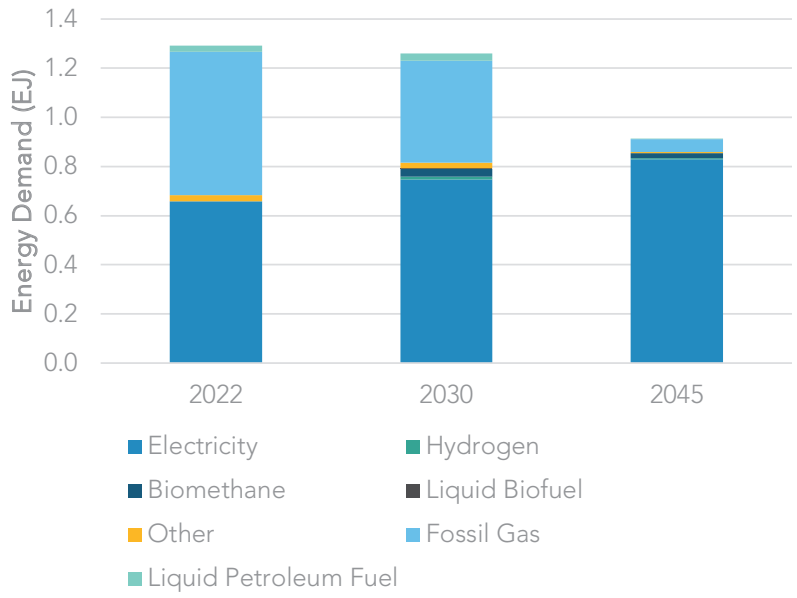

Figure 1: Building energy demand in the CARB Scoping Plan Scenario (40 percent GHG emissions reduction by 2030, 85 percent reduction and statewide carbon neutrality by 2045). Source: CARB, 2022 Scoping Plan.

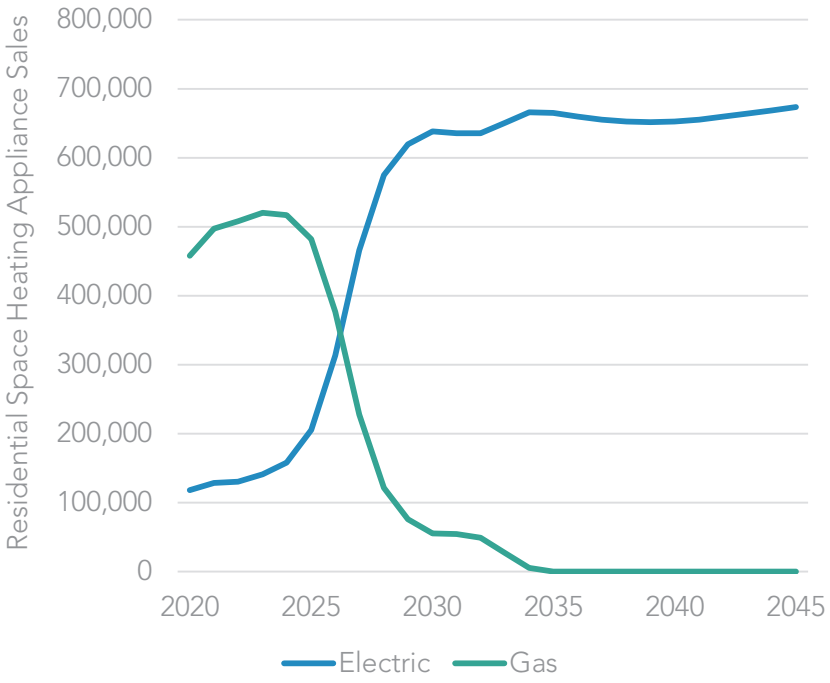

Figure 2: Residential space heating appliance sales in the CARB Scoping Plan Scenario (40 percent GHG emissions reduction by 2030, 85 percent emissions reduction and statewide carbon neutrality by 2045). Source: CARB, 2022 Scoping Plan.

As these two figures demonstrate, statewide decarbonization targets will require a nearly complete transition to residential electrification across California. California has nearly 14 million single-family homes and multifamily building units, and these currently existing buildings will still be responsible for the large majority of greenhouse gas emissions from buildings in 2030.[20] As the Energy Commission has stated, "aggressive decarbonization" of buildings will be needed to meet state emissions reduction targets—an effort that will cost well into the tens (if not hundreds) of billions of dollars statewide by 2045.[21]

Recognizing this need in California and throughout the nation, Congress passed and President Biden signed the Inflation Reduction Act of 2022 (P.L. 117-169) which provides tens of billions of dollars in direct grants, tax credits, and funds for state and local governments to attract private capital to building decarbonization investments—creating a generational opportunity for state leaders to expand initiatives with federal funds. Programs such as the new federal Greenhouse Gas Reduction Fund (which provides federal funds to state and local programs designed to leverage private capital for decarbonization) and extended energy efficiency home improvement tax credits (which support investments in heat pumps, building envelope upgrades, and more) will generate billions of dollars for decarbonization. Effective implementation will further require state programs to streamline consumer access and maximize project scale.[22]

But the need for greater efficiency and decarbonization investment faces significant and well documented technical, financial, logistical, and social barriers. For example, the California Energy Commission identified the following barriers to electrifying existing buildings in California:

- Project financing
- Program design
- Building age
- Scheduling retrofits
- New construction practices and costs
- Retrofit costs
- Available low-global warming potential refrigerants and heat pumps
- Electric system and panel upgrades
- Gas cooking preferences
- Utility bill changes
- Renewable gas supply and cost
- Existing programmatic and regulatory restrictions
- Affordable internet access
- Workforce training regarding installation and maintenance practices
- Landlord/tenant responsibilities in rental buildings[23]

Comprehensive (i.e., "deep") retrofit and decarbonization projects in particular face technical challenges (such as the inability to achieve substantial energy savings without significant tenant disruption), high project costs (typically in the multiple tens of thousands of dollars), and a shortage of qualified contractors and electricians during a time of high demand for upgrade projects.[24]

Lower-income, rural, and Native American Californians may face enhanced and additional barriers due to systemic inequalities, lower access to capital and financing, and lower overall rates of home ownership.[25] And continued building (and transportation) electrification raises significant concerns around utility rates, which have steadily increased in recent years and are anticipated to grow approximately 4.5 percent annually over the coming decade. While electrification will not necessarily lead to higher energy costs, together with necessary grid upgrades and wildfire resilience investments it could lead to bill increases—a particular concern for lower-income Californians who already face high energy burden (energy costs relative to income) and rate assistance needs.[26]

In addition, experts at the American Council for an Energy-Efficient Economy (ACEEE) have noted that as long as the market continues to offer cheap fossil fuels, electrification adoption will move forward at a slow pace: "Policies—including research and development, education and marketing, minimum efficiency standards, incentives and grants, restructuring electric (and perhaps gas) rates, clean heat standards, and a price on carbon—will all be needed to accelerate this transition."[27]

The gap between California's statewide decarbonization target and its current rate of efficiency and electrification retrofits of existing buildings is significant. The state has made significant progress in reducing the emissions profile of its electricity supply in recent years, and thus in total emissions per housing unit, as depicted in Figure 3.

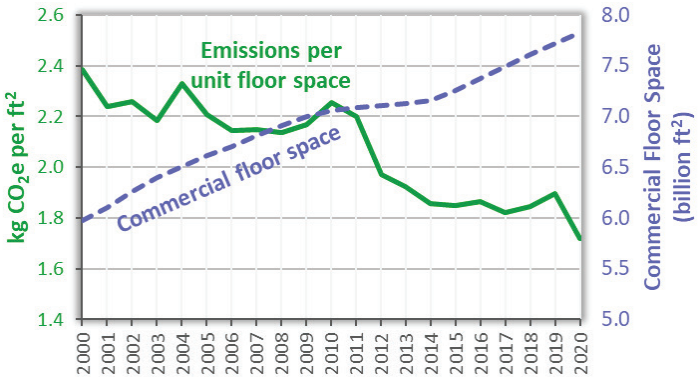

Figure 3: Emissions per residential housing unit in California. Source: CARB, California Greenhouse Gas 2000-2020 Emissions Trends and Indicators Report.

But direct emissions from building combustion of fossil fuels have remained flat, and significantly accelerated reductions in both will be necessary to achieve 2045 targets. Figures 4 and 5 show the Energy Commission's anticipated trajectories needed to achieve statewide decarbonization by 2045, with only the steeply sloped "aggressive electrification" scenario capable of meeting the goal.

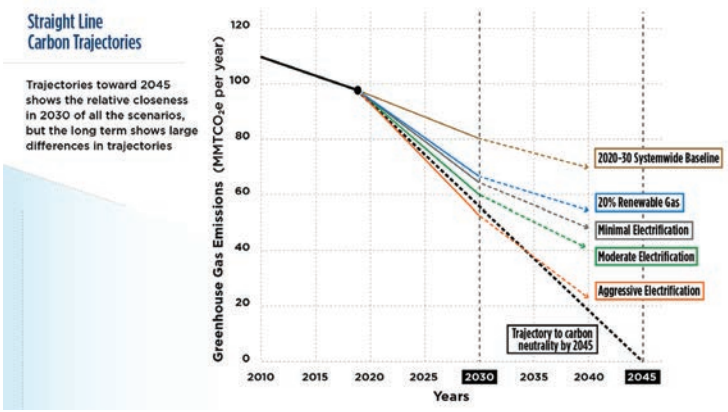

Figure 4: Systemwide straight-line building emission trajectories of scenarios compared to 2045 carbon neutrality. Source: California Energy Commission (CEC), California Building Decarbonization Assessment.

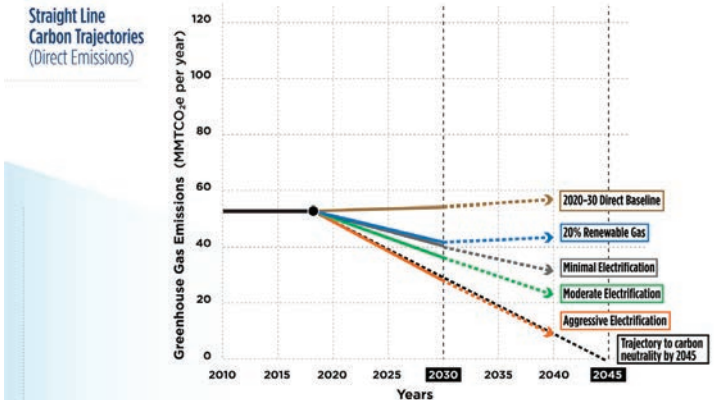

Figure 5: Direct straight-line building emission trajectories of scenarios compared to 2045 carbon neutrality. Source: CEC, California Building Decarbonization Assessment.

As these Energy Commission trajectories demonstrate, a significant gap exists between current investment pathways and the sharp decline needed to achieve the 2045 target. New and expanded strategies are needed to achieve state climate goals.

II. EXPANDING CONSUMER ENERGY FINANCING PROGRAMS AND ACCELERATING BUILDING DECARBONIZATION

Based on an analysis of existing California and out-of-state programs, a review of leading literature, and expert interviews, as well as UC Berkeley's October 2022 roundtable, financing programs are clearly one solution among many needed to comprehensively and equitably address California's building decarbonization needs.

State-supported financing programs have the potential to help address the gap between state targets and current investment pathways by increasing access to cost-effective building upgrades for a range of owners and residents, recognizing that limited public (i.e., taxpayer and utility ratepayer) funding will be inadequate to meet the full cost in the coming decades.

To maximize the ability of financing programs to attract private capital to retrofit projects while meeting the needs of lower-income Californians and driving toward decarbonization by 2045, state leaders should approach these as a matrix of overlapping but distinct goals and solutions.

Leading consumer energy financing and building decarbonization experts and advocates broadly agree on the need for rapid acceleration of retrofit efforts and on the fact that financing programs are very important to that acceleration, but also agree that these measures need to be complemented by other policies. As ACEEE analysts noted, "favorable financing alone will not be enough to scale deep residential energy retrofits; some form of accessible and upfront incentive will also be needed for the majority of households to invest in a major energy retrofit."[28] But among advocates and experts, including those interviewed for this report, some divergence exists on key program design priorities such as:

- **Efficiency first vs. decarbonization now:** All stakeholders recognize the deep connection between energy efficiency

Katherine Hoff and Ted Lamm were lead authors for this section.

and building decarbonization investments—overall reductions in energy use will be crucial to fully electrified buildings served by a fully renewable grid, and many electrified appliances are highly efficient. But some believe that the cost-saving and quality of life-improvement benefits of efficiency measures mean that (at least with respect to state programs and incentives) they should take precedence over fuel-switching investments that may increase near-term energy costs for some residents, particularly for lower-income Californians with the greatest need for energy bill savings. Others argue that the state's short timeline for carbon neutrality and the logistical challenge of performing retrofits for millions of structures call for an immediate shift to comprehensive decarbonization projects.

- **Financing vs. on-bill vs. direct-install/zero-cost:** Some consumer advocates argue that any program with a repayment obligation (whether traditional personal debt, a Property-Assessed Clean Energy loan, or tariffed on-bill/inclusive utility investment structures that are tied to the dwelling unit and not the customer) is likely inappropriate for lower-income households that already face disproportionately high energy burdens and challenges affording essentials. Rather, these households should have access to fully subsidized direct-install and grant opportunities. Some inclusive utility investment and tariffed on-bill advocates, however, believe that these programs are appropriate for lower-income households with adequate protections such as limitations on utility shut-off abilities. Most experts agree that financing and tariffed on-bill/inclusive utility investment strategies are appropriate and effective for moderate- and upper-income households, and that public subsidies for these groups should generally be focused on credit enhancement that increase private lending and direct grants only where needed to facilitate market development for emerging technologies.[b]

Figure 6 below depicts the appropriateness and effectiveness of different program types for different income groups:

TOB AND IUI

Tariffed on-bill (TOB) programs (also known as inclusive utility investment or IUI) allow property owners and renters to access energy efficiency improvements without paying upfront costs or accumulating traditional loan-based debt, repaying project costs through a monthly surcharge (or tariff) on the utility bill that runs with the property rather than with the resident.

b. California's investor-owned utilities and the GoGreen Business program currently offer on-bill repayment options for commercial customers, which are distinct from tariffed on-bill and inclusive utility investment strategies.

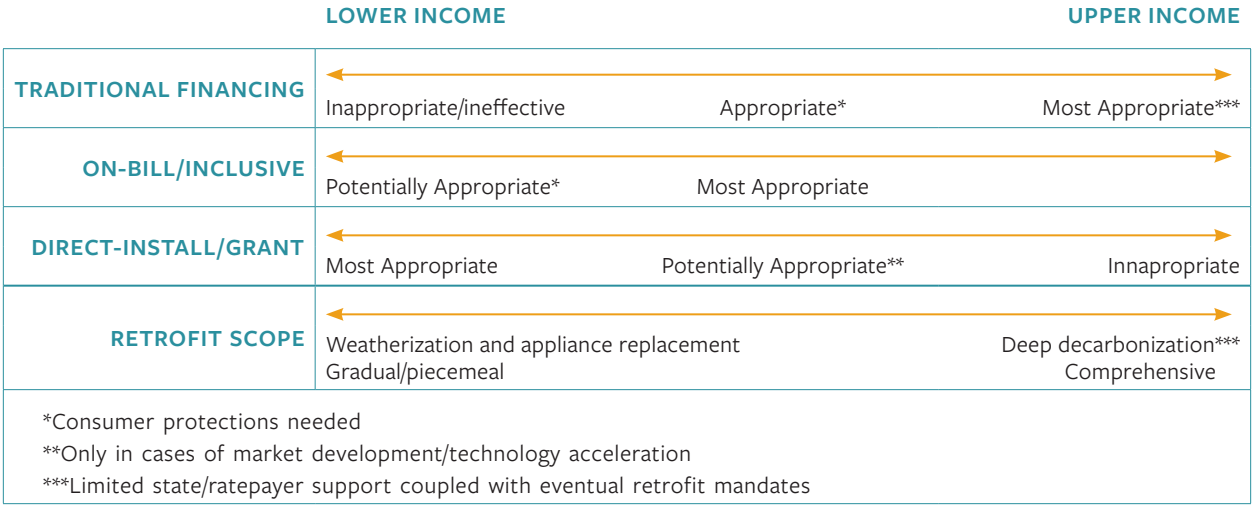

Figure 6: Appropriateness and effectiveness of retrofit investment types by income.

This figure is intended to illustrate how a comprehensive approach to efficiency and decarbonization investments—maximizing public and private capital—could reach residents across the state, offering a rough prioritization for policymakers in program design. The categories are intended to be representative and not strictly defined. As the figure demonstrates, financing programs fit alongside other policy types. But given the tens of billions of dollars of investments that will be needed to achieve state targets, well-structured financing programs could play a central role in ensuring adequate private capital is marshaled to the effort.

A. STATE CONSUMER ENERGY FINANCING PROGRAMS

California and other states analyzed in this report operate residential programs that provide government-supported financing for energy efficiency and decarbonization retrofits, primarily through two mechanisms: loan loss reserve programs that enable private financial institutions to offer low-cost loans for qualifying residential projects by protecting them against default; and on-bill programs that enable customers to repay project costs via their utility bills. This section describes loan loss reserve programs, including an analysis of California's GoGreen Financing consumer energy financing program and an overview of similar programs in Connecticut and Michigan that may offer models for California policymakers to consider:

- **California's GoGreen Financing** consumer finance programs are operated by the California Hub for Energy Efficiency Financing (CHEEF). CHEEF is a unit of the California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA), an authority of the California State Treasurer's Office, and is administered in collaboration between the California State Treasurer's Office and the California Public Utilities Commission. GoGreen Financing operates

programs for residential, commercial, and multi-family customers. The GoGreen Financing programs began operation in 2016 and use a loan loss reserve model to help lenders offer preferential rates, extended payback terms, expanded underwriting criteria, and other benefits to a broad range of customers and incentivize Californians to take on retrofit projects. GoGreen Financing is currently authorized to support building energy efficiency, decarbonization, and demand response measures (but does not cover measures such as rooftop solar, battery storage, or electric vehicle charging).

- **Connecticut's Smart-E** program is run through the Connecticut Green Bank, a quasi-public agency established by the state legislature in 2011. The Smart-E program also uses a loan loss reserve model for homeowners to take on residential retrofit projects including efficiency, decarbonization, and distributed generation measures (the Connecticut Green Bank offers distinct programs for commercial building owners and multifamily residential properties).
- **Michigan Saves** is a third-party, nonprofit green bank for residential and commercial building energy efficiency and renewable energy financing that also uses a loan loss reserve for private lenders to finance energy retrofits and improvements, including efficiency, decarbonization, and distributed generation measures. The residential program, targeted toward lower- and moderate-income single-family homeowners, began in 2010.

The table on the following page offers an overview of these programs' core single-family residential offerings. Detailed information on the California, Connecticut, and Michigan programs and a discussion of program successes and barriers follows. While the programs share similar core structures, the greater flexibility afforded by taxpayer (rather than utility ratepayer) funding and the greater reach of a contractor-oriented model offer potential "lessons learned" for California policymakers. However, the relatively small scale (as compared to total existing residential units) of all state consumer energy financing programs to date indicates that these programs are at most a partial solution to building decarbonization needs.[c]

c. This section includes program eligibility criteria and loan terms that are subject to change based on market conditions, and program performance data that are regularly updated as more loans are enrolled. The data in this section is based on information available in spring 2023.

STRUCTURE	ELIGIBLE UPGRADES	POPULATION SERVED	KEY NUMBERS	FUNDING
CALIFORNIA GOGREEN HOME				
Loan loss reserve for participating financial institutions to enable preferential loan terms for qualifying retrofit projects.	Appliances, building envelope measures, HVAC measures, and water heating measures.[29]	The minimum qualifying credit score is 580 and the minimum debt-to-income ratio is 55% (individual lenders may set stricter criteria). Through March 2023, excluding microloans, 57 percent of loans and 53 percent of loan volume were made in lower- and middle-income census tracts, 17 percent of loans financed upgrades in CalEnviroScreen-designated disadvantaged communities, and 20 percent of borrowers had credit scores of 700 or lower. Percentages are higher for microloans.[30]	**Volume:** 3,102 loans totaling over $55 million plus 496 microloans totaling $700,000 (between program inception in 2016 and March 2023).[31] **Average Loan** (excluding microloans): Approximately $18,000.[32] **Approved Contractors:** Nearly 700.[33]	Investor-owned utility ratepayer funds.
CONNECTICUT SMART-E				
Loan loss reserve for participating financial institutions to enable preferential loan terms for qualifying retrofit projects.	Over 40 measures including heat pumps and other heating and cooling options, window replacement, solar panels and batteries, EV charging stations, and related energy improvements.[34]	The minimum qualifying credit score is 580 and the minimum debt-to-income ratio is 50%.[35]	**Volume:** Over 6,300 projects totaling over $97 million of financing (2012-2022).[36] **Average Loan:** Approximately $15,000.[37] **Approved Contractors:** Nearly 400 (in 2021).[38]	Utility bill surcharge (plus American Recovery and Reinvestment Act seed funds at creation).
MICHIGAN SAVES				
Loan loss reserve for participating financial institutions to enable preferential loan terms for qualifying retrofit projects.	Efficiency measures (insulation, windows, HVAC and water heater upgrades) as well as rooftop solar, EV battery charging and battery storage, electrical service upgrades, and water efficiency measures.[39]	The minimum qualifying credit score is 600 and the minimum debt-to-income ratio is 50%.	**Volume:** Over $460 million in financing (2009-2022) for over 36,000 residential projects.[40] **Average Loan:** Approximately $10,900 (2009-2022), $13,500 (2022).[41] **Approved Contractors:** Approximately 950 (combined for residential and commercial programs).[42]	Annual legislative appropriations, program fees, and external grants (plus an $8 million seed grant from state public utility commission).

Table 1: Comparison of California, Connecticut, and Michigan programs.

1. California's Climate Change and Energy Efficiency Goals

The GoGreen Financing programs are part of California's comprehensive approach to greenhouse gas emissions reduction, which includes regulatory and incentive programs across all major sources of emissions. California's nation-leading climate change laws, AB 32 (Nunez, Chapter 488, Statutes of 2006) and SB 32 (Pavley, Chapter 249, Statutes of 2016), call for a 40 percent greenhouse gas emission reduction below 1990 levels by 2030.[43] In order to achieve these ambitious goals, the state has enacted a suite of policies, including SB 350 (De Leon, Chapter 547, Statutes of 2015), which requires a doubling of energy efficiency savings in buildings by 2030.[44] As the California Energy Commission has recognized, improving the energy efficiency of existing buildings will be essential to achieving this required increase in statewide efficiency goals.[45] Assembly Bill 1279 (Muratsuchi, Chapter 337, Statutes of 2022), which builds on AB 32 and SB 32 by establishing a state policy of achieving net zero emissions by 2045, will require even greater increases in efficiency and electrification.[46]

In response to these mandates and targets, the state legislature, the Energy Commission, and the California Public Utilities Commission have developed a number of initiatives to improve and align the state's existing energy efficiency programs and incentives in order to increase energy efficiency markets and improve customer access and uptake. These include the GoGreen Financing programs.

2. California GoGreen Financing

The GoGreen Financing programs (which are administered by CAEATFA's California Hub for Energy Efficiency Financing or CHEEF) were created to encourage financial institutions to lend money to households at reasonable rates for building energy upgrades. The GoGreen Financing programs are premised on the fact that government and utility ratepayer dollars and households cannot provide sufficient up-front capital to upgrade all of California's residential and commercial properties but limited public funds, leveraged in well-structured programs, can attract significant amounts of capital from financial institutions to cover up-front costs via financing agreements.[47]

The CHEEF programs originate with AB 758 (Skinner, Chapter 470, Statutes of 2009), which directed the California Public Utilities Commission (CPUC) to investigate energy efficiency financing options as part of a comprehensive program to achieve greater building energy savings.[48] In CPUC Decision 13-09-044 (D. 13-09-044), the Commission authorized private capital mechanisms to finance energy efficiency upgrades and created the CHEEF to carry out the new programs.[49] The goal of the CHEEF was to provide an "administrative hub" to "manage flow of funds and data, and provide a simple, streamlined structure through which energy users, financial institutions, energy efficiency providers and IOUs can participate in a standardized 'open market' that facilitates [energy efficiency] financing in California."[50] The CPUC requested that CAEATFA take on the administration of CHEEF programs (noting that as "a state agency, CAEATFA provides transparency and accountability through public rulemaking

and procurement processes"[51]) and charged the state's major investor-owned utilities (IOUs)—Pacific Gas & Electric (PG&E), Southern California Gas Company (SCG), San Diego Gas & Electric (SDG&E), and Southern California Edison (SCE)—and CPUC staff with aiding in implementation.[52]

CPUC authorized the use of a subset of IOU ratepayer funds (known as Public Purpose Program funds) to be used for CHEEF program administration and credit enhancement for participating lenders (i.e., to create the loan loss reserve fund).[53] All three GoGreen Financing programs use the same model, offering participating lenders the ability to access a loan loss reserve fund that may cover up to 90% of losses on outstanding principal if a loan applicant should default. This credit enhancement enables lenders to provide more favorable financing terms for qualifying upgrades and finance a wider range of borrowers and projects than they would otherwise be able to.[54]

In 2021, the Commission also approved the CHEEF program to begin incorporating monies outside of these Public Purpose Program ratepayer funds in order to increase access for those who receive gas service through an investor-owned utility but electricity service through a Publicly Owned Utility (POU) or cooperative. Since the CPUC originally restricted participation in the GoGreen Financing programs to those served by investor-owned utilities, this update allows CAEATFA to scale the GoGreen Financing programs beyond IOU territories and make them accessible to a wider group of Californians.[55]

The guiding policies for all the GoGreen Financing programs include the following components and principles, among others:

- A loan loss reserve model, which provides security for lenders against potential defaults and enables lenders to offer lower interest rates to a wider audience.
- Loans independent from real estate, so that borrowers do not risk losing their property should they default.
- A commitment that at least one third of credit enhancement dollars be designated for loans to low- and moderate-income customers.[56]

The GoGreen Financing program model is designed so that borrowers participating in the programs are able to access lower interest rates, secure longer repayment times (which helps to keep monthly payments low), obtain financing for the entire cost of their energy upgrade, and access financing not traditionally extended to credit-challenged borrowers.[57] The state-supported loan loss reserve allows participating lenders to recoup up to 90% of the outstanding loan amount through the reserve should a loan go into default.[58] By providing lenders with a substantial amount of security should loans default, the loan loss reserve program allows them to extend preferential loan terms to a broader set of borrowers for qualifying investments, making it easier to finance energy efficiency upgrades.

The GoGreen Financing programs include:

- GoGreen Home Energy Financing for single-family homes, duplexes, triplexes, and fourplexes.

- GoGreen Business Energy Financing for small businesses and nonprofits.
- GoGreen Affordable Multifamily Energy Financing for multifamily properties where at least 50 percent of units are restricted to low- and moderate-income households.d

GoGreen Home was launched as a pilot in 2016 and became a permanent program in April 2020, after the CPUC approved that transition.[59] GoGreen Business and GoGreen Multifamily both started as pilots in 2019 and now operate as full programs.[60]

a. GoGreen Home

GoGreen Home involves two main program components: the core GoGreen Home program and a microloan product launched in 2021.

Core GoGreen Home Program

GoGreen Home's loan loss reserve enables access to low-cost capital for energy efficiency upgrades like HVAC systems, heat pumps, cool roofs, appliances, insulation, windows, and other equipment for homeowners and renters of properties that contain one to four units, including single-family homes, townhomes, condos, and manufactured and mobile homes with site-built foundations.[61] The dwelling must be one for which an investor-owned utility provides energy or a community choice aggregator procures energy.

GoGreen Home was designed to:

- Reach underserved populations including low-income and credit-challenged borrowers, as well as renters, non-English speakers, and those in manufactured homes. The minimum credit score for program participation is 580.
- Include consumer financial protections such as an interest rate cap (the 10-year Treasury bonds rate plus 750 basis points, or 11.07% as of April 2023), and a maximum debt-to-income ratio of 55 percent.
- Offer flexibility by supporting a broad list of qualified retrofits, not requiring bill neutrality, and not requiring pre-project audits.[62]

In March 2022, following the funding authorization changes described above, GoGreen Home expanded to cover residents who receive gas service from an IOU but electrical service from a public or municipal utility or co-op using funds from the statewide TECH Initiative. Participants must use an enrolled contractor to access the program, and financing is currently available through eight credit unions (two statewide, six regional).[63] Other banks and financial institutions are eligible for the program but only credit unions have participated in the core program to date. Terms vary by lender, but those offered, for example, by Travis Credit Union—loans between $1,000 and $50,000, with

d. Before program updates in 2021, GoGreen Home was known as the Residential Energy Efficiency Loan Assistance Program (REEL), GoGreen Business was known as the Small Business Energy Efficiency Financing Program (SBF), and GoGreen Multifamily was known as the Affordable Multifamily Energy Efficiency Financing Program (AMF).

3.99%-7.99% interest rates (higher for loans beyond 48 months), and a 600 minimum credit score—are fairly typical.[64]

Between the start of GoGreen Home and March 2023, the program facilitated 3,102 loans totaling over $55 million in total financing. The average loan amount is approximately $17,840, with an average loan term just over 100 months and an average interest rate just over 5.5%.[65] The vast majority of projects (87 percent) are "finance-only," meaning they were initiated without purchase or installation rebates or incentives. The most common measures include HVAC equipment, windows, cool roofs, HVAC ductwork, and insulation. Sixty-one decarbonization projects installed heat pump and heat pump water heaters; approximately half of loans finance single-measure upgrades, though hundreds of borrowers have completed multi-measure and comprehensive projects. Each dollar in credit enhancement funds for the GoGreen Home program leverages nearly $6.50 in private capital.[66]

Between 2016 and March 2023, 57 percent of loans and 53 percent of loan volume were made in lower- and middle-income census tracts, 17 percent of loans financed upgrades in CalEnviroScreen-designated disadvantaged communities, and 20 percent of borrowers had credit scores of 700 or lower.[67]

Microloan Program

In 2021, GoGreen Home initiated a microloan program for energy-efficient appliances, offered through online marketplace provider Enervee and lender Lewis & Clark Bank.[68] The goal of the microloan program is to create an online retail approach with point-of-sale financing approval for individual appliance upgrades, allowing all customers to access incentives through their normal purchasing behavior rather than—or as a complement to—whole-home retrofit projects. The program is especially designed for lower- and moderate-income residents who need to replace an appliance but lack capital to undertake larger retrofit projects. The microloans are set at fixed rate, five-year loan terms. Customers can apply online and receive instant financing approval. The first microloans were made in the third quarter of 2021 and by the end of 2021, 237 microloans totaling $321,190 in value (an average loan size of $1,375) had been issued. Twenty-seven percent of the microloans made between 2021 and June 2022 were granted to renters and lessees, and more than half of participants (48%) had a credit score between 580 and 640.[69] These customer profile data demonstrate the potential for the microloan approach to reach a higher proportion of lower-income residents than the traditional large-scale retrofit approach of the core GoGreen offering. Through March 2023, the microloan program totaled over $700,000 across nearly 500 loans.

b. GoGreen Business and GoGreen Multifamily

GoGreen Business "was designed to address multiple challenges to energy efficiency retrofits in the small business sector, including the lack of time and capital business owners are able to put towards energy upgrades, the limited access to attractive financing options for small businesses (which are often viewed as greater credit risks by finance companies), and the mixed incentives for property owners and tenants."[70] The program uses a loan loss reserve, pre-approved contractors and project developers, and a list of eligible appliance, HVAC, and building envelope

upgrades in the same model as the GoGreen Home program. Eligible small businesses must have 100 or fewer employees or less than $15 million in annual revenue or meet Small Business Administration industry guidelines.[71] The program served its first borrower in 2019.

The GoGreen Business credit enhancement is structured to provide a 20 percent loan loss reserve for the first $50,000 of each loan (including traditional loans and equipment leases/finance agreements) and 5 percent for the next $950,000, with financing agreements up to $5,000,0000 and a maximum loss reserve contribution per project of $57,500.[72] Between mid-2019 and late 2022, the program had facilitated 20 loans for a total of $2.4 million in financing, with approximately 100 contractors and project developers enrolled and eight lenders participating. CAEATFA reported that each $1 in credit enhancement leveraged over $10 in private capital.[73] Given the fact that commercial buildings are responsible for over one third of California's building greenhouse gas emissions,[74] the program's limited uptake presents a significant challenge to state leaders seeking to accelerate privately financed commercial projects. The next section will discuss the challenges in detail.

GoGreen Multifamily "targets a critical but hard-to-reach element of the state's existing building stock: multifamily buildings and complexes that house low-income Californians" and is intended to build on existing state and investor-owned utility programs to finance energy efficiency retrofits in multifamily buildings.[75] GoGreen Multifamily can work with other state and utility programs such as Solar on Multifamily Affordable Housing (SOMAH) by enabling property owners to finance necessary energy efficiency upgrades that are required before solar panel installation can commence.[76] Qualifying properties must have five or more units with a minimum of 50 percent of the units designated for households at low to moderate income (80-120% of Area Median Income), at least five years left on an affordability deed restriction or covenant, no outstanding liens or judgments, and no owner occupation.[77]

The Multifamily program uses a credit enhancement structure (at 15 percent loan loss reserve for the first $1 million financed) and pre-qualified energy measure list similar to the other two GoGreen Financing programs, but there are no limits on loan size and no contractor restrictions. As with the other two GoGreen Financing programs, credit enhancement-eligible projects may include non-energy improvements such as play equipment or landscaping (up to 30 percent of the total loan value) and lenders can finance solar, battery storage, and other distributed energy systems using standard loan terms alongside the GoGreen loan.[78] To date, two finance companies participate in the program and offer equipment finance agreements up to $250,000 and efficiency service agreements up to $10 million, respectively.[79] However, no loans have yet been issued through the GoGreen Multifamily program, despite CAEATFA's additional offer of promotional funds at zero percent interest in Spring 2022.[80] CAEATFA staff cited a number of factors to explain the lack of uptake, including complex debt structures, strict cash flow requirements, legal limitations on property owner savings for in-unit upgrades, and lack of time and capacity to plan projects that often hinder efficiency investment in the multifamily segment.[81] The next section will discuss the challenges in detail.

3. Connecticut Smart-E

The Connecticut Green Bank was the first green bank to operate at full scale in the US, founded by the Connecticut Legislative Assembly in 2011 and launched in 2013.[82] The bank operates programs for homeowners (SMART-E), building owners (The Commercial Property Assessed Clean Energy program or C-PACE) and multifamily residential properties with five or more units (the Loans Improving Multifamily Efficiency or LIME program).

The Smart-E program facilitates low interest energy efficiency and renewable energy financing for homeowners with flexible terms and no property lien. The program functions through a loan loss reserve that covers a portion of lender losses in case of borrower default. A network of pre-approved contractors constitutes the main entry point by which homeowners participate in the program.[83]

Eligible upgrades include efficiency measures such as heat pumps and other heating and cooling options, window replacement, and related energy improvements, as well as decarbonization-only measures like rooftop solar, batteries, and electric vehicle charging stations. To participate in the program, a property must be an owner-occupied one-to-four-unit residential building (condominiums are eligible but must be individually metered); customers must have a minimum credit score of 580 and a maximum debt-to-income ratio of 50 percent.[84] The program focuses primarily on middle-income homeowners; the average credit score for participating customers is around 740, and renters are not eligible to participate.[85]

Consumer protection measures including using established financial institutions, requiring third party inspection of contractor installation for the first three completed projects, and regular customer surveys. The program also issues periodic progress payments to contractors to increase willingness to participate.[86]

The Connecticut Green Bank has also made a concerted effort to expand deployment of rooftop solar in lower income communities, launching a Solar for All program in 2014 that based eligibility solely on utility bill repayment history, and as of 2019 the program had reached demographic parity in solar deployment (i.e., the demographics of program participants mirrored the demographics of the state as a whole).[87]

Through 2022, the Smart-E program had facilitated over $100 million in loans and over 6,000 projects at an average total amount of approximately $15,000 and a public-to-private leverage ratio of nearly 19:1. (Connecticut is home to approximately 1.5 million residential units.[88]) Program leaders estimate over $80 million in lifetime customer savings have been generated through the projects financed. The program has approved approximately 73% of the more than 12,000 applications received since 2013.[89]

KEY TAKEAWAYS

Based on a review of program structure and interviews with program staff, key elements of the Smart-E program's success (measured in terms of total number of projects facilitated, total loan volume, and estimated savings) include:

- A contractor user-friendly program structure that allows and incentivizes contractors to present financing options to residents at the point of sale. This includes real-time technical approvals and lender notifications via a workflow management tool, and immediate contractor receipt of one-third of loan funds.
- The ability to finance renewable energy projects alongside traditional efficiency retrofits increases the overall likelihood that a resident will encounter workable financing options, and potentially take up additional measures, through the financing program. However, over 80 percent of projects through 2022 have been efficiency-only.

4. Michigan Saves

Michigan Saves is a third-party, nonprofit green bank for residential and commercial building energy efficiency and renewable energy financing. The Michigan Public Service Commission (MPSC) created Michigan Saves in 2009 to help achieve statutory energy efficiency targets established by 2008's Act 295, which required electricity and natural gas providers to achieve annual efficiency savings of 0.3% (2016 amendments increased the requirements to 1% and 0.75% of retail sales, respectively).[90] Recognizing the need for financing to achieve these targets, the Commission issued a request for proposals for an $8 million grant to set up and seed a program. The Michigan Saves proposal focused on gap-filling credit enhancement via a loan loss reserve, based on stakeholder feedback that while both lenders and contractors were eager to do financing and retrofit work, a significant customer segment needed additional financial support and contractor coordination to take on new projects.[91] The program has extended over $460 million in loan loss reserve credit enhancement financing since its founding in 2010.[92] (Michigan is home to approximately 4.6 million residential units.[93])

Michigan Saves is structured as a loan loss reserve for private lenders to finance energy retrofits and improvements, with the reserve set at 4% of total outstanding private loan value and 75% coverage of losses in case of a default. The program has found initial success with credit union lenders and single-family residential customers (approximately 75% of loan value) but the commercial and multifamily programs, through larger commercial lenders, are growing.

The residential program is targeted to lower- and middle-income single-family homeowners, with a minimum credit score of 600 and maximum debt-to-income ratio of 50%; over 50% of loans are issued in low-to-moderate income (LMI) census tracts, and the program approves approximately 75% of residential loan applications (versus 90% of commercial). The participating credit unions offer maximum loans of $50,000 to $100,000 and minimum interest rates between 5.90% and 6.49%, with loan terms up to 180 months.[94] Eligible improvements include traditional efficiency measures (insulation, windows, HVAC and water heater upgrades) as well as rooftop solar, electric vehicle charging and battery storage, electrical service upgrades, and water efficiency measures.[95]

The original seed funding for the loss reserve came from the MPSC using ratepayer funds, but the state legislature has subsequently appropriated funds, and neither funding source has been prescriptive about customer or project eligibility, utility or service type. The program has built a network of over 800 approved contractors who handle a significant portion of the program outreach and serve as the first point of contact for consumers; building a strong and expansive contractor network has been key to reaching customers and developing trust in the cost-effectiveness and value of retrofits.

KEY TAKEAWAYS

Based on a review of program structure and interviews with program staff, key elements of the Michigan Saves program's success (measured in terms of total number of projects facilitated and total loan volume) include:

- The initial open-ended grant/RFP process that originated the program allowed for a third-party nonprofit administrative structure, which in turn (unlike a utility- or public utility commission-based structure) allows it to access any state resident regardless of utility service area or type.
- Legislative appropriations and transaction fees (unlike utility ratepayer fees) allow significant flexibility across different types of approved energy measures

The Michigan Saves team consists of eight full-time staff employed by a third-party consultant, funded primarily through an administrative fee (2.49% for residential loans and 1.99% for commercial loans) that contractors pass through to customers.

5. Analysis: Expanding and Improving California's Consumer Energy Financing Programs

This section offers lessons learned from efficiency and decarbonization programs gleaned from the literature, California's GoGreen Home program, and expert interviews. The section begins by reviewing key findings and best practices from literature, such as the challenge of cost-effective deep decarbonization in moderate climates like California's. This section also compares GoGreen to other state financing programs, discussing the challenges of achieving scale and offering suggestions from efficiency and decarbonization advocates and experts.

a. Best practices for residential decarbonization in literature

Researchers have pointed to several best practices for residential deep energy reductions in moderate climates like California's, including adjusting programs to encourage participation in deep retrofits and emphasizing measures like heat pumps that may reduce emissions more cost-effectively.

Incentive program design: Key strategies to make decarbonization approachable

While whole home retrofits can seem daunting for homeowners, bundling retrofit options into standardized packets, sequencing retrofits, completing electrification, and offering financing and incentives can help increase uptake.[96] Affordability and convenience—not just for homeowners but also for contractors and capital providers—are crucial to decarbonization programs' success and ability to achieve scale.[97] If state-supported financing programs are to make a significant dent in the millions of homes in need of retrofit work in the coming decades in California, maximizing convenience of access—in particular by engaging contractors to introduce financing programs (and more ambitious decarbonization retrofit and replacement projects) at the point of sale for routine replacements—will be vital.

Because utility bill savings will not fully compensate for the cost of full deep decarbonization and energy efficiency upgrades, some researchers believe that a convenient-to-access incentive at the beginning of the process will likely be necessary to ensure that homeowners embark on major retrofit projects.[98] Public-private partnerships and strategies that use public programs and funds to attract private capital will likely be crucial to providing these incentives and assisting the state in reaching ambitious climate goals.[99]

Researchers have also highlighted the following approaches to achieve greater decarbonization program enrollment:

- Creating a unified program/project contact point for the customer
- Offering post-project follow-up with the customer
- Combining new projects with remodeling and other projects/transactions
- Advertising the manifold advantages of efficiency and decarbonization
- Updating and broadening available direct-install measures
- Folding smart features into projects to boost results
- Synthesizing with other program offerings including marketplace and behavior program offerings[100]

Deep decarbonization project considerations: Climate zone affects savings potential, but heat pumps and other measures can increase cost-effectiveness

Regional climates and temperature variability have a significant impact on the effectiveness and cost savings potential of different efficiency and decarbonization investments—higher temperature highs and lower lows will generally require more energy use for space heating and cooling and lead to greater benefits from insulation and building envelope investments.[101] Using a hypothetical 1990s-era Sacramento home as an analytical baseline (based on US Department of Energy climate zone maps), ACEEE concluded that in hot-dry climates like California, newer houses benefit from a mixture of updated equipment and specific envelope upgrades, like attic insulation.[102] These measures, ACEEE found, can lower heating and cooling loads and minimize energy costs while maximizing decarbonization goals. Heat pump water heaters in particular represent the largest electrification energy savings for many California homes because space heating needs are generally lower than in colder regions. An incremental approach, where homeowners phase in projects one at a time beginning with envelope efficiency measures and targeted equipment replacement, can be a useful strategy in this environment. Regardless of climate zone, replacing HVAC systems with high-efficiency heat pumps in conjunction with targeted envelope upgrades can reduce electricity use for cooling needs by at least half in this analysis.[103] However, it is important to note that the state is geographically and climatically diverse, with extreme heat in summers for many Southern California and Central Valley homes and winter cold and snow for many in the state's eastern mountains. As a result, state leaders might also consider targeting financing programs (which rely in part on the ability of efficiency investments to generate savings over time) toward areas of the state with greater temperature swings and greater potential savings.

Space and water heating and cooling needs and lighting have historically accounted for the largest energy uses, and decarbonization projects usually consist of upgrades to both the building envelope and the heating and cooling equipment within the home. However, because appliances, electronics, and plug loads now account for the largest energy end-use in homes in temperate climates, upgrading heating and cooling systems may generate savings of less than fifty percent of total use in these areas. Other approaches are required for deep savings, including drain water heat recovery, window treatments, and ceiling fans for space cooling, as well as supporting equipment that reduces plug load usage (for example, energy efficient home electronics).[104] Because

deep retrofits can be disruptive and costly, these alternative measures can offer some energy savings without the inconvenience and price tag of deep retrofits, while also increasing comfort and improving health.[105] Because newer single-family homes are likely to have central air systems, increased energy efficiency, and other features that make it easier to decarbonize, policymakers will likely focus first on low and moderate income residences, which are frequently older and more difficult to decarbonize.[106]

b. Lessons learned from GoGreen Financing and other financing programs

GoGreen Home has expanded since the program's inception, but in many ways it has not yet achieved full scale. Conversations with agency staff and experts yielded key learnings on the reasons for this and on whether GoGreen Home has the ability to transform California's existing residential building stock if given more resources.

While GoGreen Financing has grown, some advocates have pointed out that the total loan volume (approximately 1,300 standard loans and 250 microloans in 2022 and over 3,100 standard loans and 500 microloans total since July 2016[107]) falls far short of the overall volume needed to achieve widespread building energy efficiency (and decarbonization) for California's 14 million existing residential homes and units. CAEATFA staff have attributed the relatively low loan volume in part to limits on the type of upgrades GoGreen Financing can support and the geographic range of residents it can serve due to the constraints of IOU service territories and fuel sources.[108] But decarbonization advocates have remarked that the GoGreen Financing programs would need to expand exponentially even to meet the performance levels of sister programs in Michigan and Connecticut, let alone statewide need for retrofits by 2045.[109]

Leaders from the Connecticut and Michigan energy financing programs pointed to key features that may distinguish their relative successes. For example, Michigan has software that qualifies customers almost immediately,[110] and Connecticut's program takes a contractor-led approach to ensure that the project intake and development process is streamlined for contractors, who then conduct outreach to customers and bring them into the program.[111] Furthermore, the funding sources for Michigan and Connecticut's programs are different. Michigan's loan loss reserve is funded by grants and legislative appropriations whereas Connecticut's was initially funded by American Recovery Act funds[112] and is currently funded through a mix of public and earned revenues (for example, from renewable energy certificate sales and interest from the programs loans and fees).[113] The flexibility in funding allows Michigan's program to access any customer regardless of service area or type. In contrast, because California programs are funded with utility ratepayer funds, retrofits are limited to utility service territories and to energy efficiency (rather than fuel-switching) measures, and California Public Utilities Commission procedures can take years to update program components.

One consideration for GoGreen Financing to achieve greater loan volumes is its deep loan loss reserve. Agency staff have reported that California provides a

larger loan loss reserve (with more protection against default for private lenders) than other states, and that the risk to lenders may not justify maintenance of such a robust reserve fund relative to total program volume. While the original intent was to jumpstart lending to low- and moderate-income families, anecdotal evidence is that lenders rely heavily on credit scores when deciding whether to make loans—contributing to the program's very low overall default rate—so there is little need for an excess of reserve funds to attract private capital.[114] As program leaders seek to expand total volume in the coming years, they may consider smaller increases in the total loan loss reserve to maximize leverage of public funds. For more discussion of the differences in loan loss reserve levels, see Section III.

Aside from the specifics of each program, however, almost all financing programs in the US fall short in reaching a large proportion of residents. A 2022 Lawrence Berkeley National Laboratory study found that even four well established financing programs, including those in Michigan and Connecticut as well as New York and Pennsylvania, together finalized a total of only 52,511 loans across a combined 37 program-years studied between 2006 and 2020.[115] Many of the programs served those with "very good" credit scores (averaging 740), and over 60% of program enrollees were located in census tracts in which incomes were 80% of area median income or higher.[116] However, the report found that "borrowers from low-income areas who have strong credit and pass household-level debt-to-income screens are likely to repay loans or other extended financing at a reasonable rate" and that such borrowers "are not uncommon."[117] As a result of the overall strong performance of efficiency loan programs, the report called for lenders to provide more favorable terms (e.g., lower interest rates and/or longer repayment terms) in the future.[118] The strong performance of the loan portfolios compares with the overall low penetration of the retrofits they support—tens of thousands of projects have been completed in states with tens of millions of existing residential units.

Even if lenders were to provide more favorable loan terms or loosen debt-to-income ratio eligibility requirements, the GoGreen Financing programs would still not meet the needs of every Californian. Nor are they intended to. GoGreen Financing is primarily designed for Californians who are not affluent enough to fund a retrofit project entirely in cash and do not have access to a favorable home equity or other loan, but have the financial capacity and interest to take on additional debt (on favorable terms) for a voluntary project—a widely recognized coverage gap in the efficiency and decarbonization space.[119] The program should avoid competing not only with private financing options that serve other customers' home improvement project needs, but also with publicly funded programs that offer direct installation and rebates for lower-income residents.[120]

While few experts consulted in this analysis highlighted interest rates as a key factor impeding program expansion, competitiveness of rates may become more significant in an overall higher interest rate environment (which the Federal Reserve began to initiate in 2022). In general, larger loan loss reserves may help lenders to provide lower interest rates, and programs that lend public and/or utility ratepayer dollars may have greater flexibility in setting rates than purely private capital providers.[121] As a result, programs like GoGreen

Financing that use public funds and administration to facilitate favorable loan terms may become more appealing to consumers in a market with higher prevailing rates.

Because of the limited reach of financing programs, and in order to try to reach customers who are neither low income enough for rebates nor high income enough for GoGreen Financing programs, many advocates have urged an all-of-the-above strategy encompassing state-supported financing programs alongside direct-installation, rebate, and other programs for residents in greater need of financial support and purely private approaches for more affluent Californians.[122] This approach is necessary because even programs targeted at low-income customers, such as the Energy Savings Assistance (ESA) program, will not reach enough customers to achieve California's decarbonization goals.[123] An all-of-the-above approach could include stacking programs and incentives, expanding microloans, and implementing tariffed on-bill programs and other inclusive utility investment initiatives.

B. FINANCING ALTERNATIVES AND MEETING THE NEEDS OF LOWER-INCOME CALIFORNIANS

While state- and ratepayer-supported traditional financing programs have the ability to facilitate thousands of retrofit projects, additional tools are necessary to reach the millions of existing California residences in need of efficiency and decarbonization upgrades. This is the case in particular for lower-income Californians who may lack the capital to take on substantial new loan debt for home retrofit projects even at the preferential rates offered by GoGreen Financing and similar programs. These tools include on-bill repayment programs—tariffed on-bill and inclusive utility investment models—that allow residents to finance project costs through their utility bill (rather than personal loan debt) and direct-install programs that straightforwardly subsidize all or part of the purchase and installation cost of one or more appliances. This section provides an overview of these programs.

1. Tariffed On-Bill Programs

Tariffed on-bill (TOB) programs (also known as inclusive utility investment or IUI) allow property owners and renters to access energy efficiency improvements without paying upfront costs or accumulating traditional loan-based debt, repaying project costs through a monthly surcharge (or tariff) on the utility bill. Most TOB programs are structured with the presumption that the cost savings of energy efficiency improvements and modern appliances will exceed the cost of installation and maintenance, but programs typically do not guarantee this bill neutrality (rather, implementers aim to match the project scale to zero net cost or net savings). The equipment—and the monthly fee for the equipment—run with the property and not with the customer, such that, for example, if a tenant vacates a property, the monthly fee will transfer to the next occupant. Advocates generally do not consider the fee/tariff to constitute a loan since it is only associated with a customer through their occupancy (rather than until repayment), but some financial institutions may

still consider it as part of a customer's debt profile (as a part of monthly expenses) when assessing credit decisions. Regardless, if a resident's overall bill decreases, TOB and IUI can be suitable for customers with lower credit scores or other factors limiting their capacity to take on debt and can serve renters as well as homeowners.[124]

The Pay As You Save® (PAYS)[e] system is a leading example that requires on-bill repayment assigned to a meter rather than a customer, disconnection in case of nonpayment, and use of independent third-party certification of projects and estimated costs and savings.[125] Some PAYS implementers, for example, require certification of an 80 percent likelihood of bill neutrality or net savings (but not a guarantee of neutrality) in order to approve a project. This certification, plus the meter rather than customer home for the repayment obligation, can make the system viable for lower-income customers and support the inclusive utility investment label.[126]

The California Public Utilities Commission initiated Rulemaking 20-08-022 "to examine options to assist electricity and natural gas customers with investments in residential and commercial buildings and at industrial and agricultural sites designed to decrease energy use, reduce greenhouse gas (GHG) emissions, and/or produce clean energy to support customers' on-site needs."[127] The commission intended the rulemaking "to examine options that encourage larger-scale and deeper investments in one or more clean energy resources at customer sites," recognizing that past ratepayer-funded programs were often limited to single investment types and that "new options" are needed to make investments affordable for customers who face barriers to accessing capital.[128]

In 2022, several California investor-owned utilities (IOUs) proposed TOB programs as part of the proceeding, including Pacific Gas & Electric (PG&E) and Southern California Edison (SCE). CCAs, other IOUs, and the Local Government Sustainable Energy Coalition also submitted proposals. In a proposed decision dated March 6, 2023, the CPUC proposed to extend the timeline of the rulemaking to allow for additional workshops, proposal refinement and deliberations. The final decision is expected prior to June 30, 2024.[129]

Here we summarize the PG&E and SCE proposals:

- **SCE's TOB Program** would allow residential customers (owners and renters) to finance efficiency, electrification, solar plus storage, and other distributed energy resource projects (except for EV charging) through a utility bill tariff.[130] The tariff would be attached to the meter, rather than the customer, with equipment owned by the property owner and subsequent occupants obligated to complete the TOB charge (with robust advance notice).[131] SCE would contract with a third-party program implementer to conduct marketing, energy assessments, cost and savings projections, and contractor engagement.[132] SCE would fund the program with ratepayer capital raised in the normal course of business but would seek outside sources

e. PAYS is not a stand-alone TOB program but rather a trademarked system for implementing TOB mechanisms, currently employed in multiple states across the country.

for subsequent program expansion.[133] SCE projects would attempt to achieve, but would not guarantee, bill neutrality and net savings for customers, utilizing a combination of all available incentives and consideration of total energy bill savings (not just electricity bills) to capture fuel substitution benefits.[134] Customer eligibility would be based on bill repayment history (not credit scores) and standard utility disconnection rules would apply in case of nonpayment of the TOB charge.[135]

- **PG&E's TOB Program** would require third-party Financial Program Implementers (FPIs) to offer residential customers (owners and tenants) an option to repay retrofit project costs through a tariffed service charge on their monthly utility bills. FPIs would be responsible for program marketing, contractor oversight, and confirmation of customer affordability and performance guarantees. Outside debt funding would provide the upfront capital for projects. Upon a change of resident, the remaining tariff obligation would transfer to a new resident "with their consent, until the costs are recovered."[136] Landlords, whose approval would be required to initiate a TOB project, would be obligated to facilitate transfer of obligations (and potentially to assume obligations for rental customers who do not) and would have the option to prepay the obligation during refinancing.[137] The TOB offerings would be included in PG&E's finance platform, discussed below. FPIs would be responsible for determining customer eligibility; the proposal indicates that FPIs would be required to evaluate customer repayment history and that PG&E does not contemplate using credit scores to determine eligibility.[138] The program would not guarantee bill neutrality[139] and customers would be subject to "the same collection processes that are documented in the PG&E tariffs" with no external credit reporting planned.[140]
- **PG&E's Finance Platform** would consist of an online platform for FPIs to offer consumer financing mechanisms to utility customers using outside debt funding, including PG&E's new TOB program for residential customers. The participating FPIs would be responsible for financing program development and proposal (subject to stakeholder comment and utility and CPUC approval) as well as for marketing, affordability reviews, project verification, and contractor oversight.[141] PG&E would operate the platform to connect consumers with financing options, but would not directly provide financing (other than through the new TOB program), with upfront project costs funded by non-IOU financial institutions and customer and/or public funding used for repayment guarantees or in supplemental cases.[142] Other program components—including customer qualification, retrofit measure eligibility, bill neutrality and consumer protection, and oversight and enforcement—would be determined by participating FPIs.

2. Hawaii Green Infrastructure Authority and GEM$

Customer rates for electricity in Hawaii are the highest in the country,[143] reflecting the islands' limited access to energy sources and driving significant interest in rooftop solar and energy efficiency measures. The Hawaii Green

Infrastructure Authority (HGIA) offers multiple energy improvement financing products, including direct loans to homeowners, small businesses, project sponsors, and state agencies. Among other programs, HGIA manages the Green Energy Money Saver (GEM$), an on-bill program for residential and commercial rooftop solar, solar water heaters, heat pump water heaters, and other commercial energy efficiency measures.[144] In 2011, the state legislature directed the Hawaii Public Utilities Commission (HPUC) to explore on-bill financing of renewable energy and energy efficiency investments, and the HPUC found on-bill financing to be a viable option in 2013.[145] The legislature created the Green Energy Market Securitization (GEMS) Program 2013 and authorized the issuance of bonds secured by a non-bypassable fee on Hawaii utility ratepayer bills; the program received its initial funds through a $150 million bond issuance approved by the HPUC in November 2014.[146] The program, which initially launched with only a direct financing program, had a slow start. However, following the HPUC's directive to the investor-owned utility to work with HGIA to design and implement an on-bill repayment mechanism, HGIA launched the GEM$ on-bill program in 2019.[147]

The program uses TOB financing to enable renters and low- and moderate-income homeowners to access rooftop solar and energy efficiency upgrades through low-cost financing. As with other TOB programs, the customer does not pay any money up front or obtain a traditional loan; rather, the cost of the energy equipment is added as a line item on the customer's bill and repayment is linked to the meter rather than the individual customer.[148] The tariff stays on the utility bill for the dwelling and transfers to any subsequent inhabitants until HGIA has recovered the full cost of the upgrade.

HGIA uses proceeds from the GEMS bond to fund upfront installation costs; the program ensures repayment through the potential for utility service disconnection due to non-payment, the senior position of the GEM$ repayment charge on the utility bill, and the placement of a Uniform Commercial Code (UCC-1) lien and security agreement on financed equipment.[149] To date, there have been no disconnections due to non-payment.[150]

HGIA does not evaluate credit scores as part of eligibility; customers must have a history of at least 12 consecutive months of on-time utility bill repayment with no disconnection notices and must meet the US Department of Housing & Urban Development and Hawaii Housing Finance & Development Corporation definitions of Low and Moderate Income (less than 140% of Area Median Income) to qualify for GEM$.[151] Qualifying projects must be estimated to lower the applicant's annual energy costs by at least 10 percent (including the TOB charge) and approved measures include residential solar thermal hot water heaters, residential heat pump water heaters, commercial energy efficiency measures, solar PV water heaters, and solar PV systems. Contractors must be pre-approved (including registration as a Hawaii Clean Energy Ally for energy efficiency measures) to

KEY TAKEAWAYS

Based on a review of program structure and interviews with program staff, key elements of the GEM$ program's success include:

- Income qualification criteria ensure that the program serves low- and moderate-income households, as compared to other financing programs that focus more on middle- and upper-income households.
- The TOB structure allows HGIA to set loan terms at a fixed 5.5% for a relatively long period of 20 years with the potential to cover multiple tenants, reducing average monthly payments (but program administrators calculate payments over 18 years, to give landlords repayment flexibility in case of vacancies).
- The underlying GEMS bond allows HGIA to fund a range of programs including TOB and affords flexibility in qualifying efficiency and distributed generation measures, creating a robust green bank for local residential and commercial customers' needs. HGIA calculates that the combined programs have been responsible for over 282,000 metric tons of carbon dioxide avoided and have driven over $276 million in combined lending, tax revenue, and job impact benefits (based on an "economic multiplier impact" of $2.11 for each dollar of investment).

participate in the program.[152] The minimum project cost for GEM$ residential customers is $5,000 and financing is offered at a fixed rate of 5.5 percent for terms of up to 20 years.[153] Since its inception, the GEM$ program has served 277 residential on-bill customers with an application acceptance rate of approximately 80 percent.[154]

3. Zero-Cost, Grant, and Direct-Install Programs

While on-bill and financing strategies present an opportunity to substantially expand access to efficiency projects, proponents note that they "need not replace or diminish existing grant or free direct-installation programs for lower income residents."[155] Grant and direct-install programs provide upfront rebates to reduce the cost of appliance replacements and retrofits (including zero-cost upgrades for qualifying customers in some instances). As such, these programs have the potential to offer the most affordable and equitable way for lower-income Californians to upgrade their homes.

However, because these programs use public funds rather than private or blended capital to cover the cost of a project, they can only serve a limited portion of the millions of existing structures in need of upgrades in the state. As a result, these programs should generally be reserved for the Californians who are least able to marshal private capital—and on-bill and financing programs should be designed as much as possible to complement grants to accelerate comprehensive projects.[156] California's Low-Income Weatherization Program and TECH program are two programs that can inform financing program design and play key roles in broader decarbonization initiatives.

a. Low-Income Weatherization Program

California's Low-Income Weatherization Program (LIWP) provides zero-cost solar PV and energy efficiency upgrades for qualifying lower-income residents of multifamily buildings and agricultural workers living in one-to-four-unit buildings. (Prior program iterations included single-family and community solar program funding.) The program, which is managed by the California Department of Community Services & Development (CSD) through a third-party administrator, is intended primarily to reduce greenhouse gas emissions—its revenue source is the cap-and-trade-funded California Climate Investments (CCI) program—but it also seeks to reduce costs and improve quality of life for residents.[157] (The cap-and-trade and CCI programs are legislatively authorized through 2030.) Since inception, the program has received $227 million in cumulative appropriations from CCI and supported over 28,000 total projects.[158] In a 2021 analysis, CSD cited the whole-building approach (which can encompass a complete suite of efficiency measures, appliance upgrades, and rooftop solar, but not all fuel-switching measures), easy layering with other incentive

programs, and the requirement that building analysts identify and property owners remedy immediate health and safety concerns before commencing work as key sources of success for the multifamily program.[159]

b. TECH Clean California

The Technology and Equipment for Clean Heating (TECH) Initiative is designed to help California achieve its 2045 carbon neutrality goals by pushing market adoption of low-emission space and water heating technologies for the existing residential housing landscape. The pilot program was created by the California Public Utilities Commission pursuant to Senate Bill 1477 (Stern, Chapter 378, Statutes of 2018) and allocated $120 million from the CCI fund for the initial 2019-2023 period.[160] The program offers direct incentives for installation of heat pump water heaters and HVAC systems in order to accelerate decarbonization and spur market development for the appliances with at least forty percent of funds reserved for low-income and disadvantaged communities (it also supported six pilot programs, including one focused on technical support for an IUI/TOB program in the Silicon Valley Clean Energy service territory).[161]

Through August 2022, Tech Clean California had enrolled nearly 1,000 contractors and accepted over 13,000 incentive applications[162]—a near-complete exhaustion of program funds ahead of schedule, while program leaders noted the need for a 600 percent participation increase to meet the state target of 6 million heat pumps installed by 2030.[163] Analysts concluded that the TECH financial incentive was pivotal to many (but not all) customers' decisions to upgrade and that the majority of customers did not use financing to complete their project.[164] In September 2022, the Legislature allocated an additional $50 million for TECH incentives, including expansion to cover all California residents (rather than just customers of CPUC-regulated gas utilities).[165]

In the program's first annual report, managers noted greater-than-anticipated contractor interest, based in part on the value of comprehensive and easy-to-understand training materials, uniform incentives statewide, and a centralized information source and web platform.[166] The rapid uptake of TECH incentives demonstrates the effectiveness of streamlined, grant-based programs in accelerating retrofit uptake and promoting market development. However, the cost of the program relative to the total number of projects statewide suggests a need for a highly targeted approach focused on the highest-need customers and layering with on-bill programs and federal incentives.

4. Analysis: Serving California's Lower-Income Residents and Customers

To achieve the state's climate goals, California must pursue strategies that meet the needs of low- and moderate-income households, which account for more than 40 percent of the population.[167] In its Senate Bill 350 Low-Income Barriers Study, the California Energy Commission (CEC) identified structural barriers restricting low-income customers' access to clean energy, including:

- Low home ownership rates
- Complex needs, ownership, and financial arrangements for low-income multifamily housing
- Insufficient access to capital
- Building age
- Location in emote or underserved communities.[168]

In addition, CEC described the "split incentives" problem—a common barrier for rental properties where an owner is responsible for the upfront costs of in-unit retrofits and appliance replacements, but a tenant is responsible for (and benefits from savings on) energy bills.[169] The report noted that "[t]he issue is particularly acute among the low-income multifamily housing sector, as low-income Californians are 39 percent more likely to live in multifamily housing than the general population."[170] These barriers present fundamental challenges with respect to all efforts to bring energy efficiency upgrades to low- and moderate-income Californians, and in particular to financing-based programs like GoGreen Home that rely on participants' ability to commit capital. Some additional challenges and lessons learned with respect to reaching low- and moderate-income families have also become apparent as various entities have tried different strategies.

Bill affordability and the limitations of debt-based programs

Tariffed on-bill and inclusive utility investment strategies could be key to meet the needs of low- and moderate-income Californians,[171] as could microloan programs for individual appliances. Michigan Saves' customer interface automatically redirects applicants who do not qualify for financing to other programs—a strategy that GoGreen leaders could adopt to bring low- and moderate-income customers to TOB, IUI, and microloan offerings. However, some advocates warn that any programs that feature debt, including programs that run with the meter rather than the individual resident, can be extremely problematic for low-income households who lack enough income to pay for basic necessities.

Indeed, some data show that a subset of California families will not be able to afford any additional bill costs. The state legislature approved over $2 billion utility ratepayer debt forgiveness following the COVID-19 pandemic. Hundreds of thousands of low-income Californians are enrolled in IOU arrearage management plans to forgive unpaid utility bill debt in exchange for on-time payments over a 12-month period, but even these customers have faced challenges in obtaining debt relief. According to PG&E, fewer than 3,000 customers had completed a successful 12-month payment cycle out of over 145,000 enrolled between early 2021 and mid-2022.[172] For these residents (and their landlords), only zero-cost programs such as LIWP may be an appropriate solution—a key limitation of financing and financing-adjacent approaches that program leaders need to account for as they seek to achieve 2045 targets across all population segments.

Rebates alone are not enough to realize building energy transformation for the state, but stacking funding can help

Analysts estimate that a rebate-only approach to decarbonizing space conditioning and water heating in the state's low- and moderate-income homes could require a cumulative 25-year, $72–150 billion investment of taxpayer and ratepayer monies, which "would dwarf any public expenditure the state of California has made for energy efficiency or renewable energy programs."[173] By contrast, the state's cumulative investment to date in the TECH Initiative for heat pumps alone has totaled $170 million. There are simply not sufficient funds to provide grants and direct-install support for all Californians who need them.

However, combining rebates and grant solutions with financing will create more holistic building decarbonization approaches and will multiply public funds and achieve greater results.[174] Some advocates argued that low-income families should always be first in line to use rebates and grants, followed by financing and on-bill solutions. Others pointed to the Inflation Reduction Act (IRA) as an important source of incentives that can be layered with state rebates and with financing, for those who qualify. Clear state leadership in obtaining and distributing IRA funds, and in directing consumers to new federal tax incentives for home energy improvements, will be crucial to the retrofit effort over the next decade.

Energy efficient appliance microloans can be a productive strategy for some families

Another strategy to increase energy efficiency in homes in the short term—and one which requires less initial investment than financing—is the purchase of energy efficient appliances. Programs like Enervee's online marketplace facilitate low-interest microloans and energy efficiency scores so that customers can compare the long-term benefits of efficient appliances including refrigerators, dishwashers, and washing machines without taking on whole-home retrofit projects. Enervee's partnership involving Best Buy and utilities such as SoCal Gas provide customer access to a one-stop shop, rebate-enabled online marketplace that includes delivery, installation, and haul-away services.[175] By integrating with the GoGreen Financing program, the microloan platform is starting to bring more customers into the state's building decarbonization incentive ecosystem through gradual, rather than comprehensive, building upgrades. (Microloan programs could also prove vital if state leaders phase out the sale of new fossil fuel appliances in certain product classes.)

The special challenge of multiunit dwellings

As discussed, the GoGreen Multifamily offering has generated minimal customer interest to date, and somewhat more successful programs in Connecticut and Michigan also largely reach single-family homeowners. This limited success in the multifamily space demonstrates the extent to which the incentive structures of financing programs do not align neatly with the incentive structures of multifamily property management. Researchers at ACEEE have noted that in multifamily buildings with five or more units, the costs of electrification are steep (and split incentive barriers limit even long-term investment benefits), although some strategies such as using alternative fuels in condensing boilers can decrease life cycle costs.[176] Fuel-switching and electrification might even

be prohibitively expensive for some buildings. For example, upgrading to more efficient equipment offers limited financial savings in old buildings with poor envelopes and leaky ducts, and it is challenging to electrify older properties without upgrading transformers, main service, and subpanel circuitry.[177] For these older multiunit buildings—many of which are also "naturally occurring" affordable housing—state leaders may need to seek alternatives to financing-based approaches that rely on bill savings.

Other strategies for reaching low-and moderate-income households

The Building Decarbonization Coalition, a policy advocacy group among those interviewed for this report, has concluded that reaching low- and moderate-income customers will require program elements such as:

- Financing terms of 10 to 15 years, and terms that provide for changes in tenancy.
- Using utility bill savings rather than home equity to reduce upfront costs.
- Upgrades that result in cash positive outcomes.
- Features that can be scaled up, in order to service millions of customers state-wide.[178]

The Building Decarbonization Coalition also recommends that policy makers implement a unified program to encourage combined, larger scale investment and roll multiple projects into one (for example, energy efficiency tasks, electrification upgrades, and solar projects) in order to maximize public funds in various decarbonization programs and enhance the financial viability of each project.[179] This combination of strategies suggests that a one-stop-shop type approach with an emphasis on directing lower-income residents to stackable or sequential direct-installation, microloan, and on-bill products could prove fruitful alongside more traditional financing programs for higher-income residents.

C. CONCLUSIONS AND RECOMMENDATIONS

The following findings and recommendations are based on literature review, expert interviews, and the October 2022 expert roundtable. Findings are broken into distinct but overlapping groups: expanding financing programs, serving lower-income residents, and accelerating decarbonization. This grouping is based on a central insight obtained from the authors' research and expert outreach: that the scale of California's residential building retrofit need in light of the state's 2045 carbon neutrality target is monumental and will rely largely on private capital; state-supported strategies to marshal private capital such as GoGreen Financing can play a key role in this effort but are only a partial solution; and additional approaches will be needed to meet the needs of lower-income residents and achieve state targets.

1. Expanding and Improving California's Consumer Energy Financing Programs

Program flexibility is important to meet customer needs

While some programs operate with a strict "efficiency first" philosophy, experts have found that flexibility is critical for engaging customers. If a homeowner's hot water heater fails, the most effective programs help the homeowner replace the hot water heater, rather than obligating the homeowner to participate in an energy home analysis before buying new equipment. In other words, tailoring programs to the current needs of customers is crucial. In order to achieve scale and facilitate overlap with other funding streams, GoGreen Financing could fund (and has requested CPUC authorization to fund) a wider array of eligible measures beyond pure efficiency (such as solar plus storage) and change requirements from project-specific to portfolio-wide energy.

Federal, state and philanthropic funding rather than ratepayer funding can drive success

Other states' financing programs have achieved greater loan and project volume through less reliance on ratepayer funds. Michigan Saves, for example, is funded primarily through legislative appropriations from the state budget. This means that there are no strings limiting which customers can receive funds, and contractors do not have to worry about whether a resident is a customer of different gas and electric utilities when considering fuel-switching projects.[180] This taxpayer/state budget-funded model has the potential to draw more customers from all utility service territories, facilitate more comprehensive projects regardless of fuel source and utility, and make revenue generation more equitable by relying on more progressive tax sources rather than regressive utility charges.[181] While taxpayer funded programs could be politically difficult to achieve and more precarious if the legislature withdraws support, more money would reach consumers more quickly through this funding mechanism. The availability of federal funding through the IRA can achieve similar goals, as could philanthropic support.

A robust, certified contractor network to market and implement programs is crucial

CAEATFA's current contractor recruitment and training program is user friendly and minimizes the barriers to program entry. Through a third-party vendor, CAEATFA offers self-paced training and certification, conducts marketing for recruitment, and manages contractor compliance and quality control. The team also communicates with enrolled contractors to seek input on potential program improvements. However, policy makers need to ensure that contractors in the program network are trained and active in recruiting customers.[182] Experts interviewed for this report have stated that a financing program's contractor outreach and network is the make-or-break factor for a financing program.[183] Some programs have found particular success by orienting their offerings such that contractors, rather than homeowners, are their customers. State leaders could increase outreach to identify technologies contractors need to make financing easier to access at the point of transaction and offer more

targeted sales training to ensure that contractors are maximally effective in enrolling new customers.

Program participants need education: state to contractors, state to consumers, and contractors to consumers

The Michigan Saves program features a team of marketers focused exclusively on contractors. Because there is substantial turnover in the contractor pool, the marketers execute a tremendous amount of training, retraining, and engagement with contractors to arm them with the tools to explain and sell the Michigan Saves program.[184] Lessons from the TECH program also support this finding[185] and ACEEE has similarly echoed the importance of education.[186]

Financing programs should cultivate data-sharing opportunities to avoid emergency equipment replacement situations and automation of approvals to increase contractor and customer ease-of-use

Most residents conduct home improvements and appliance repairs when necessary upon equipment failure, rather than in a proactive fashion—meaning replacements are often done in an emergency context when efficiency considerations are not top of mind for customers or contractors. But new smart metering and smart appliance technologies could offer utilities and program administrators the ability to know in advance when an appliance is nearing end-of-life, creating an opportunity to engage residents immediately before equipment failure rather than after. Program leaders should work directly with utilities and technology providers to ensure this data is shared and acted upon, although customer and proprietary data protection requirements at the CPUC and individual investor-owned utilities can present significant barriers to data access.

2. Serving California's Lower-Income Residents and Customers

Traditional state-supported financing is valuable for middle-income customers but has limited use for low-income residents; continuing to expand the range of electrification and decarbonization program types will help move the state forward

Numerous experts interviewed for this report have expressed concern over burdening low-income families with yet more energy costs, whether traditional debt or increased utility bills.[187] For this reason, the GoGreen Financing programs are targeted at a specific section of the population—those who can afford to repay financing on energy efficiency measures but lack the resources to pay out of pocket for upgrades.[188] In general, direct install and zero-cost programs that do not require out-of-pocket expenditures or ongoing payment obligations—such as California's LIWP—and high-subsidy programs like TECH are likely more appropriate for lower-income families than traditional financing. Tariffed on-bill and inclusive models can also serve this population segment at lower risk of creating burdensome long-term debt although not without potential bill increases. Continuing to expand the range of available program options beyond financing will help the state reach customers at every income level.

Microloan marketplace programs can expand lower- and moderate-income residents' access to efficient and electrified appliances

While many lower- and moderate-income residents lack the financial and time resources to undertake comprehensive home retrofits, microloan marketplace programs offer a way to finance single appliance purchases that can increase household efficiency and electrification in a piecemeal fashion. By mirroring a traditional consumer/retail experience while integrating with state decarbonization initiatives, programs like Enervee's can increase lower- and moderate-income customers' access to improvements and to financing.

Inclusive utility investment and tariffed on-bill approaches can accelerate lower- and moderate-income residents' and renters' uptake while leveraging private capital

Tariffed on-bill and inclusive utility investment models have the potential to increase access for all residents, and lower- and moderate-income residents in particular, due to the placement of payment obligations on the utility bill (rather than with the individual) and greater possible certainty regarding long-term bill neutrality. Leaders should focus on implementing the bill neutrality mechanisms of programs like Pay-As-You-Save.

Financing programs should automatically redirect customers who do not meet eligibility criteria (if any) into alternative financing programs and direct-install options

Many experts interviewed noted that consumer contact points with retrofit financing programs are vital (and often rare) engagement opportunities that programs need to maximize—hence the importance of arming contractors with onsite retrofit design and borrower approval applications, for example. Another key strategy to take advantage of customer engagement is to ensure that if a customer's financing application is denied, the customer is automatically redirected to alternative programs that meet their needs. For example, the Detroit Loan Fund program directs any Detroit resident who applies for Michigan Saves financing but does not meet credit criteria to an alternative underwriting program operated directly by Michigan Saves (rather than the participating credit unions).[189] The loan fund is funded through an outside philanthropic source. This type of program—including automatic redirects to utility TOB programs and direct-install offers—could offer a key method to retain customers, particularly as GoGreen leaders seek to incorporate Inflation Reduction Act and other federal funds.[190]

3. Accelerating Building Decarbonization Toward California's 2045 Carbon Neutrality Goal

Scaling up existing programs is needed to achieve maximum impact in California

In order to reach the over 10 million existing California residential units in need of retrofit work by 2045, policy makers will have to significantly expand existing programs. Increasing the amount of funding available for direct-installation and high-subsidy programs like LIWP and TECH can help customers with the

greatest financial need, while ramping up GoGreen could draw more private capital into the system. State leaders should consider public-private partnership strategies to bring more large private lenders and national banks—which have greater ability to make low-cost capital available at scale by bundling loans—to the table. These large banks also have consumer outreach platforms and staff to market financing programs to a broader audience.

Expanding the GoGreen Financing programs to reach all Californians regardless of IOU service territory and all greenhouse gas emissions-reducing measures could assist in this effort but might require a shift away from utility ratepayer funds as a primary revenue source. Program infrastructure such as online workflow tools can also help CAEATFA increase impact even with limited funds by automating some operations, increasing ease of use for contractors, and ensuring that if a customer is rejected for financing, they are directed to another program for which they qualify. GoGreen leaders are actively considering these program updates. Some experts have also suggested that making certain pre-defined upgrade packages available could simplify the retrofit process for customers and increase the reach of various electrification and decarbonization programs.

A one-stop shop model has the potential to increase uptake of energy efficiency financing

Research by ACEEE has found that a one-stop shop model, which simplifies application processes, financing, and information sharing, can provide important support for low- and moderate-income customers and can also be important for streamlining processes for contractors, making it easier for them to connect customers to financing programs.[191] CAEATFA leaders could consider implementing a comprehensive information, financing, and administrative hub to reduce barriers to entry for contractors and help them connect to utilities, program administrators, financing companies, equipment suppliers, and customers.

Stacking funding sources is critical but customer access should be centralized

Because programs like tariffed on-bill may not always result in actual bill savings, policy makers will need to layer in various types of assistance and rebates to help customers maximize energy retrofits. For example, homeowners may not gain enough bill savings in a TOB program for pricier upgrades, like HVAC systems or insulation, and so may incur expenses for these items. However, rebates and state and federal funding sources can help subsidize the out-of-pocket costs for these more expensive projects, and for those who can afford it, financing may also be an option. In addition, some areas have experimented with layering in funds from third parties (for example, health insurance companies) for measures that improve air quality and health (such as gas stove replacements). But, as noted above, the state will need one central location enabling customers to access the full range of funding options available to them and maximize savings.

State leaders should employ Infrastructure Investment and Jobs Act and Inflation Reduction Act funds strategically to maximize the total capital infused into the retrofit effort while focusing on residents with the greatest need

The Infrastructure Investment and Jobs Act of 2021 (IIJA) and Inflation Reduction Act of 2022 (IRA) are landmark federal investments in clean energy and greenhouse gas emissions reduction, with the IRA in particular providing billions of dollars for building decarbonization efforts.[192] These include expanded federal tax credits for residential energy efficiency installations, such as up to $2,000 for heat pumps and $1,200 for envelope improvements;[193] and over $4 billion for states to establish whole-home retrofit programs.[194] The IRA also created a $27 billion "Greenhouse Gas Reduction Fund" designed to mobilize financing and leverage private capital for emissions reduction investments including home retrofit programs.[f] The majority of funds are carved out for low-income and disadvantaged communities, and both states and nonprofits that leverage private capital are eligible to receive funds.[195] This federal Greenhouse Gas Reduction Fund presents a potentially transformative opportunity—California, with over ten percent of the US population, could receive billions of dollars—to infuse substantial federal funds into retrofit financing programs. Leaders at CAEATFA, the California Infrastructure and Economic Development Bank (IBank) and the California Pollution Control Financing Authority, with input from the California Energy Commission and California Air Resources Board, have organized to pursue funding from the US Environmental Protection Agency's Greenhouse Gas Reduction Fund once the grantmaking process has been announced. Such a coordinated effort, with clear direction to channel funds into retrofit efforts targeted for lower- and moderate-income residents (including expanded financing initiatives, TOB and IUI pilots, and direct-install programs) could be vital to accelerating retrofit efforts in line with the state's 2045 targets.

An incremental approach can be a good alternative if deep retrofits are not possible

Because most areas of California experience milder winters, space heating needs (and associated energy expenditures) are lower than average. As a result, it can be more difficult to generate cost savings from heating/cooling and building envelope retrofits, and heat pump hot water systems can represent the largest electrification energy savings for California homes.[196] An incremental approach, where homeowners phase in projects one at a time, can be a useful strategy and in that instance, a good initial step can include some envelope efficiency measures and equipment replacement. [197] For homeowners less able to or inclined to plan, programs that encourage efficient equipment replacement at the time of failure—paired with targeted load-reduction measures—can help accelerate turnover of less climate-friendly equipment. Regardless of climate zone, replacing HVAC systems with high-efficiency heat pumps and building envelope upgrades can reduce electricity use by at least half.[198]

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f. The federal Greenhouse Gas Reduction Fund is distinct from California's Greenhouse Gas Reduction Fund, which supports the statewide California Climate Investments program and other cap-and-trade investments.

Strategies to quantify and account for public health and quality-of-life co-benefits of efficiency and electrification investments will be crucial to accelerate progress

Home energy efficiency and electrification improve indoor air quality, extreme heat and cold resilience, and quality of life. However, research on the dollar value of these benefits is limited, and traditional state and utility programs do not quantify them alongside energy and financial savings, undercounting the benefits of many potential projects as a result. Clearer methods to count these improvements toward the total projected benefit of a project could increase the scope of financeable measures. State leaders can also consider partnering efficiency programs with the health and health insurance sectors to identify additional funding sources based on the clear health benefits (and attendant reduced health risks and costs) of many efficiency investments.[199]

III. EQUITABLE RECOVERY OF CONSUMER ENERGY FINANCE PROGRAM COSTS

Consumer energy financing strategies could be an important enabler and accelerator of customer-side investments that are critical to meeting the state's decarbonization goals. For residential customers, financing programs can catalyze projects by providing up-front funding that may be difficult or prohibitively costly for households to access through other channels.

To enable a robust consumer energy finance program, the program administrator will need to sustain important administrative functions. The administrator needs to collect or otherwise receive revenues to cover these costs. Additionally, the program needs funding to support the credit enhancements that are key to motivating lenders to participate and agree to attractive interest rates and loan periods.

The costs of consumer energy financing programs in California have, thus far, been funded as part of the investor-owned utility energy efficiency portfolios. The program costs have been funded in the same way as other energy efficiency programs, which is through charges on utility bills. These financing program costs have represented a small fraction of overall portfolio costs. Program costs, however, could grow substantially between now and 2045, when the state is aiming for a carbon neutral economy. The CPUC, program leadership, and legislature should take this moment to reconsider whether current cost recovery methods for this program are appropriate for the coming decades. Recent research has shown that they may not be.

This section reviews the types of costs that go into supporting a successful consumer energy finance program. It then estimates how costs could increase over time. Next, the chapter discusses how finance program costs are funded today and the implications for affordability and decarbonization. Finally, the section makes recommendations to fund consumer energy finance programs equitably and in ways that further electrification goals.

Andrew Campbell was lead author for this section.

A. COSTS OF EXISTING CONSUMER FINANCE PROGRAMS

1. Operating expenses and transaction expenses

Any consumer energy finance program requires expenditures to administer the program. The California Hub for Energy Efficiency Financing (CHEEF), the CAEATFA organization that runs the GoGreen Financing programs, reports administrative expenses described as including "start-up costs, CHEEF administration, direct implementation, outreach and training."[200] CHEEF also reports Marketing, Education and Outreach (MEO) costs. According to CAEATFA, almost all operating costs are fixed whatever the size of the program, e.g., website and marketing, data collection, and regulatory compliance. Only a small portion of costs vary with the number of loans and projects. Scale-driven expenses include enrollment review and, to a lesser extent, quality assurance desktop reviews and quality control site inspections.[201]

One way to look at the program's administrative costs is to divide the total costs over the total number of loans issued to calculate the administrative cost per loan. This metric could be useful to compare a lending program to other policies, such as rebate or direct install programs. The metric can also be used for comparisons across programs in different jurisdictions. The table below draws from CAEATFA reports and covers the calendar years 2020, 2021 and 2022. Total administrative costs over this period stayed relatively constant while loan volumes and the amount financed increased significantly. These trends show the importance of program scale. The administrative cost per loan declined from nearly $7,500 per loan issued to just over $3,000 per loan issued (including the GoGreen Home Marketplace Microfinance loans and GoGreen Business).

	2020	2021	2022
CHEEF Administration Costs, including Marketing, Education and Outreach	**$3,370,861**	**$3,806,012**	**$4,387,551**
Number of Loans			
GoGreen Home – Standard Loans	447	650	1091
GoGreen Home – Marketplace Microloans	0	237	259
GoGreen Business	4	3	10
Total Number of Loans	**451**	**890**	**1,360**
Amount Financed			
GoGreen Home – Standard Loans	$7,145,080	$11,285,324	$20,288,437
GoGreen Home – Marketplace Microloans	-	$321,190	$404,389
GoGreen Business	$1,041,203	$202,747	$683,451
Total Amount Financed	**$8,186,283**	**$11,809,261**	**$21,376,276**
Administrative Costs per Loan	**$7,474**	**$4,276**	**$3,226**
Administrative Costs per Amount Financed (%)	**41%**	**32%**	**21%**

Table 2: CHEEF administrative costs.[202]

We heard from interviewees that scaling up a program is important for the sustainability of an energy consumer lending program. The largest consumer energy finance programs in the US illustrate how administrative costs per loan drop for larger program. Michigan Saves, for example, has administrative costs equivalent to just over $400 per loan for the nearly 4,400 loans issued in 2019.[203] Auto loans offer another reference point. Lenders typically charge borrowers 1 to 2% of the loan amount as an up-front fee.[204] This presumably covers the lender's costs and generates a profit. For a $25,000 loan this is equivalent to a $250 to $500 fee. A target of $500 per loan seems appropriate for CAEATFA's GoGreen program given these reference points. CAEATFA could pursue this by significantly increasing the GoGreen loan volume to take advantage of the start-up investments made to date.

Interviewees also recommended cost-saving streamlining opportunities such as automating loan intake and review and offering real time income verification. CAEATFA has been undertaking efficiency efforts including launching an online loan and project management system to streamline loan enrollment

and facilitating batch enrollment of loans for higher volume lenders.[205] These efforts could lower the per loan administrative costs.

2. Credit enhancements

In the absence of a consumer energy finance program, interest rates for loans that fund home energy upgrades can be high. This is because lenders view providing these loans as a risky activity—riskier than lending to purchase a home or a vehicle. If a borrower cannot repay a home mortgage or auto loan, the lender can foreclose on the house or repossess the vehicle. This mitigates the lender's losses. A lender often cannot, however, repossess and resell energy improvements. Many investments such as energy efficiency upgrades and building electrification are integrated into a home and would be difficult and cost-prohibitive to remove once installed. In other words, the loans are not secured by the asset that was purchased. The authors of this report learned that lenders view such a loan as a risky, unsecured personal loan and charge relatively high interest rates and only offer very short-term loans. The high rates and short terms make the loans available in the market unattractive to borrowers, and rarely used for energy improvements.

Consumer energy finance programs lower consumer borrowing costs by reducing the risk faced by lenders through program features know as credit enhancements. The most common credit enhancement offered by US programs today is a loan loss reserve.[206] Through a loan loss reserve model, the program implementer sets aside a specified amount of funding in a reserve account to cover some, but not all, of the loss if a borrower defaults. Because the program is assuming some of the risk of a borrower defaulting, a lender can offer lower interest rates and a longer repayment term than would otherwise be the case for a given borrower. The lender still faces a portion of the loss, however, and so has an incentive to carefully evaluate the ability of borrowers to repay the loans.

The loan loss programs differ among the major US programs today. In particular, the programs vary in terms of how much funding is put into the loan loss reserve and how losses are shared between the lenders and reserve. The table below summarizes these parameters for California, Connecticut and Michigan:

	% OF LOAN VALUE DEPOSITED IN RESERVE	SHARING OF DEFAULT COSTS	LOAN SIZE
California GoGreen Home Energy Financing Program	20% for loans in low- or medium- income census tracts[g] 11% for other census tracts	Lender absorbs 10% of loss; program covers 90%. Program share is limited to amount in a particular. lenders total reserve account.[207]	$1000 to $50,000 (varies by lender)
Connecticut Smart-E	7.5% for borrowers with FICO credit score > 640 (Exceptional, Very Good, Good, upper Fair[208]) 15% for borrowers with FICO credit score of 580 to 640 (lower Fair)[209]	Lender responsible for first 1.5% of losses at the portfolio level. Reserve covers additional losses.	$500 to $40,000
Michigan Saves	4% of the loan portfolio	Lender responsible for 25%. Reserve covers 75% until 4% of loans default, then reserve covers none.[210]	$1,000 to $10,000

Table 3: Comparison of California, Connecticut, and Michigan program loan loss reserve parameters.

While all three programs share a similar framework, they vary significantly in terms of how much of a reserve is created for each loan and how the costs of defaults are shared. The program with the smallest reserve deposit, Connecticut, also covers the smallest fraction of default costs. California, on the other hand, deposits a large reserve for each loan and covers the largest fraction of losses. The different reserve amounts imply different levels of private funding per dollar of public or ratepayer funding in the reserve. The amount of private capital leveraged per dollar of credit enhancement is $6.50, $9.00 and $25.00 for California, Michigan and Connecticut respectively.[211] There is almost a four-times difference in leverage between California and Connecticut. As a result, scaling up the California program would require proportionately more reserve capital than a similar scale-up in Michigan or Connecticut.

The goal of the loan loss reserve is to lower the interest rate charged to a consumer and to encourage lenders to make available loans with longer terms. We would expect that by offering to cover 90% of any losses, lenders participating in California's program would offer lower interest rates than if the terms were similar to Michigan's. However, it is not straightforward to determine whether this is the case by comparing across the states since so many factors influence the rates offered the programs.

g. Low- and medium-income is defined as residents of census tracts with median income that falls below 120% of the Area Median Income. When the program was launched the larger reserve contribution was only for LMI households as opposed to census tracts. However, lenders could not reliably determine household income since only one member of the household typically applied for a loan and getting income data for other household members was difficult. The qualification was changed to the census tract for more practical implementation. See CPUC, *Assigned Commissioner's Ruling Seeking Party Feedback on Track 1 Issues Related to California Hub for Energy Efficiency Financing Program*, Attachment A (April 1, 2021), p. 6.

The capital that goes into creating a loan loss reserve is not a cost in the sense that the capital is transferred to a reserve account rather than being "spent." The money is not spent unless a loan defaults, in which case an amount equal to a fraction on the unpaid loan amount (90% of in California) is transferred to the lender to cover part of their loss. This funding is then no longer available to back up loans. The amount of the loan loss reserve that is not paid out remains and as loans are paid off, the reserve can become available to cover additional loans. As additional loans are made, more funds may need to be added to the loan loss reserve, so the administrator needs a source of funding for this reserve.

The program budget associated with the credit enhancements could be reduced by lowering the percentage of the loan value added to the reserve and increasing the percentage of losses borne by the lenders. Before making these kinds of changes, the program administrator would need to consider any impact on lender participation. Also, there could be a tradeoff between the amount of funding going into credit enhancements and the interest rate offered to consumers. Program administrators need to find the right balance between these factors. However, the experience of states such as Connecticut and Michigan show that lower reserve amounts and higher losses borne by lenders (particularly given low default rates to date) can continue to attract financial institutions that are willing to offer attractive interest rates.

If policy decisions are made to try to increase participation by lowering household credit standards (which this report is not expressly recommending), then credit enhancements may need to remain at higher levels than in other states.

3. The costs of underperforming DER investments

Households participating in consumer energy finance programs and investing in distributed energy resources (DERs) will often expect net cost savings that pay back the cost of the up-front investment. Increased comfort and safety and other considerations (non-energy benefits) could also be motivators for DER investments, so some households may not expect full financial repayment. Even though there are non-energy benefits, consumers will have some sort of initial expectations about how the DER assets will perform, e.g., bill savings from an energy efficiency or electrification investment.

Empirical research has shown real-world investments in DERs do not always meet expectations. Studies of energy efficiency programs have found energy savings can vary dramatically from one project to the next and this variation is difficult to anticipate in advance. A number of programs have also been found to generate less energy savings that projected before implementation.[212]

There are many reasons why actual cost savings could be less than expected by the household. For example, Property Assessed Clean Energy (PACE) financing for residential consumers has been widely criticized in California due to the unscrupulous practices of some lenders and contractors, including the exaggeration of DER benefits.[213] Models that estimate energy savings can

also systematically overstate energy savings, as shown in a study looking at energy efficiency investments in schools.[214]

Even with no bad actors involved and using the best available models, outcomes will often differ from expectations. For example, energy prices could change. If retail natural gas prices drop and electricity prices rise, building electrification projects will be less financially beneficial. The inverse if also true, if prices move in the other direction. Household composition, a major driver of energy use, could change over time. If children leave the house as they get older, energy use, and, thus, savings from a DER investment could drop. Savings could increase if a grandparent moves in and energy use climbs.

In the case of most consumer energy finance programs reviewed for this report, including GoGreen, costs due to unexpected under- or over-performance of DER investments are borne by the residents, not the lender, contractor or program administrator. Some programs, though, have made the policy choice to allow households or businesses to change their repayment terms if the program administrator determines energy savings are lower than expected.[215] For programs with this feature, a portion of the costs associated with the underperformance of the DERs is borne by the program administrator, and, thus, must be covered by a revenue source. However, a program design that allows for restructuring repayment would also be more expensive to administer due to the measurement and analysis requirements. It may not even be feasible, since the energy impacts of DER investments always involve many confounding factors and uncertainties. For example, a resident may attribute a bill increase to DER underperformance, but unexpected weather or changes in the number of occupants of the home could be the explanation for the bill change. Disentangling the causes could be very contentious and will be less clear cut than the resident or program administrator would like.

Any systematic underperformance of DER investments could also trickle through to the loan loss reserve if defaults increase. This could increase program funding requirements. If DER investments systematically overperform, i.e., generate more cost savings for the household than expected, default rates could drop, allowing the program administrator to reduce the size of the loan loss reserve and reducing overall program funding needs.

4. Unexpected defaults due to economic conditions

Very few customers have defaulted on their GoGreen Home loans. Just 1.39 percent of loans have been charged off (i.e., the borrowers of these loans have stopped paying their obligations and the lender has given up on collecting the remaining balances) since program inception.[216] These costs have been covered by the loan loss reserve.

GoGreen Financing and other consumer energy finance programs keep default rates low by setting credit quality requirements for potential borrowers using metrics that have been found to correlate with the likelihood that a borrower will repay. Lenders may add more stringent requirements. Programs and lenders typically use FICO Credit Scores and debt-to-income ratio to assess the riskiness

of lending to a particular applicant. Lenders of other types of loans, such as auto loans, use these same metrics. Auto loan defaults also tend to be low and have ranged from just 2 percent to 4 percent from 2007 to 2021, across a range of economic conditions, according to one analysis.[217]

Several stakeholders we interviewed suggested that this charge off rate is "too low," meaning that the program could approve more loans for lower credit quality households in order to increase program participation and, thus, program impact, without over-taxing the loan loss reserve. Some of these suggestions were motivated by the desire to increase the participation by lower income households. Some assume that credit quality and income are strongly correlated. Other interviewees pointed out that credit quality and household income are not well correlated, so lowering credit standards might not increase low-income household participation, but it could reduce consumer protections and increase defaults.

Some stakeholders also suggested that traditional metrics used to assess credit, including credit scores and debt-to-income ratios should be dropped and replaced by utilities reviewing the bill repayment history of potential program participants. This change would be intended to remove a barrier to participation and simplify program administration. Proponents of this change argue that DER investments will result in net utility bill decreases, so a household's bill repayment history is the appropriate credit metric. Also, some proposals, such as tariffed on-bill programs, would be utility-administered and the utilities want to use data that they already have access to in order to determine whether a customer is eligible. CAEATFA and GoGreen Home participating lenders, however, have no access to bill repayment information. We were not able to identify any analysis of the relationship between a customer's utility bill repayment history and their overall credit qualify, so cannot determine whether traditional credit metrics and bill repayment history are equivalent.

In considering any changes to credit criteria, program administrators should consider whether or how the changes could change the rate of defaults and how this could impact the funding required to maintain the loan loss reserve.

The recent history of few defaults is not necessarily a good indication of the future. Changing economic conditions and other external factors can put stress on householders and change the frequency of defaults. A downturn in economic conditions could increase the number of consumer energy loan borrowers that default, requiring the use of loan loss reserves and potentially increasing program costs to replenish the reserve. Conversely, strong economic conditions could reduce defaults and point toward lowering the reserve requirements. Since consumer energy finance loans are intended to be longer term, e.g., ten years, it is likely that general economic conditions will change and/or households will experience economic shocks sometime over the life of a loan.

Before adopting new participation screening criteria, we recommend performing an analysis of how changes to credit requirements, such as a shift to using bill repayment history, would change household participation and the risk of defaults.

5. Considerations as programs expand to new technologies

In the future, consumer energy finance programs could be expanded to include investments that electrify home space heating, water heating, and transportation. The household cost savings from investments in these new areas will show up differently than for energy efficiency since the cost savings from reducing use of natural gas or gasoline will be offset by increased electricity costs. However, we believe consumer energy finance programs could operate in the same way, with similar administrative and credit enhancement costs as for energy efficiency focused programs today. A caveat would be if electrification projects lower greenhouse gas emissions but increase household bills. If this occurs, the probability of defaults and, thus, the riskiness of the loans could increase.

B. HOW COSTS COULD CHANGE WITH PROGRAM GROWTH

The future of consumer energy finance programs is highly uncertain. Nonetheless, considering what a successful consumer energy finance market might look like can help policymakers assess whether today's cost recovery methods are well-suited for the future.

The target market for consumer energy finance are owners of existing buildings. California's Department of Finance provides estimates of the number of housing units in the state. The department's analysis estimates 9.3 million single-unit homes, 1.2 million units in two- to four-unit buildings, and 3.5 million units in buildings with more than four units. This sums to 13.9 million residential units in the state.[218]

The CEC estimates that at least half of the one- to four-unit buildings were built before California adopted energy standards, so the opportunity to increase energy efficiency through weatherization and other measures is immense. The report does not provide comparable information for larger multifamily units, but a national assessment estimates that nearly half of apartment units were built before 1980.[219] This means the opportunities (and need) for further energy efficiency are substantial for all housing types.

Not only is the opportunity large, but so are the statutory goals. As noted earlier, California's Clean Energy and Pollution Reduction Act of 2015 (SB 350) set 2030 goals for energy efficiency that require an increased pace of energy efficiency investments. The CEC has found the state is not on track to meet these goals.[220] Subsidized consumer energy finance could be a policy tool that could accelerate residential energy efficiency investments, alongside direct subsidies and building and appliance codes. A recent report from the Legislative Analyst's Office points out that the relative role of different programs and policies has not been articulated by policymakers, however.[221]

The state's goals to electrify homes are also substantial, as demonstrated by the CARB 2022 Scoping Plan's call for 3 million electric homes and 6 million installed heat pumps by 2030 and 7 million electric homes by 2035.[222] Far more will be needed by 2045.

Home vehicle charging is expected to be an important enabler to meet the state's zero emissions vehicle policies and the overall 2045 net zero goal. There are no robust studies about how many homes will want chargers and what the costs of these chargers and associated panel upgrades will be. However, it's reasonable to estimate that millions of homes will require investments in this area.

Consumer interest in distributed solar and home batteries could also grow, driven by green preferences and the desire for resiliency. Opportunities to participate in virtual power plants and get paid could also increase residential demand for these technologies.[223]

In the near-term, state and federal subsidies, such as those available through the Inflation Reduction Act, could bring down costs enough that the availability of consumer energy finance could be decisive in driving investments in a number of DER areas.

The need for customer-sited DER investments is clearly large, but the role of financing is uncertain. A review of other spending categories suggests financing could have a big role.

About 80 percent of home buyers financed their home purchases in 2021.[224] For vehicles, in 2021, 80 percent of new vehicle purchases and 40 percent of used vehicle purchases were financed.[225] Additionally, many consumers chose to finance the purchase of durables, such as consumer electronics and appliances. One recent survey found over half of consumers had financed at least one durable purchase in the prior year.[226]

We can use data from these other sectors to do some back-of-the-envelope calculations for consumer energy finance. If a home energy upgrade costs around the amount as a used vehicle, for which the average loan rate was $27,000 in the fourth quarter of 2021,[227] we could assume that a similar percentage of households, 40 percent, would choose to finance their upgrades if loans were readily available. If about half of homes could use energy efficiency upgrades, then about 1.9 million California single family households could be candidates for consumer energy finance.[228] Lowering the cost of upgrades through state and federal subsidies could increase the number of households that could make investments without financing, but the number could still be substantial.

The story could be very similar for whole home electrification, except that the potential market is even larger. Only 25 percent of California homes had electric heat in 2020.[229] The other 75 percent could have to make significant investments to go all-electric due to equipment costs and, in some cases, electrical upgrades. This could mean several million potential borrowers. Installing electric vehicle charging could also increase demand for financing.

If a financing program needed to support the issuance of 1.9 million loans over a 20-year period (roughly 2026 to 2045), it would need to support the issuance of about 95,000 loans per year. If the administrative costs-per-loan were $500 (a little more than Michigan Saves costs today), the program would cost $47.5 million per year to administer. Hopefully, at that scale the costs-

per-loan would be much less. Assuming CAEATFA's current administrative costs-per-loan of $3,000 does not seem appropriate for this reason.

If the average loan size were $25,000 and 95,000 loans were issued per year for 20 years, then $47.5 billion in loans would be issued over the life of the program. If the loans issued were 10-year loans, then the total outstanding loan balance could reach just over $14 billion, accounting for the amortization of loans during their life.[h] Given GoGreen Home's average loan loss reserve contribution of 15 percent, the program would need to commit $2 billion to the reserve between Year 1 and Year 10. In Year 1 a contribution of $356 million would need to be made to the reserve, with the contributions declining each year. If the reserve contribution were lowered to 5%, slightly higher than Michigan Saves, the maximum reserve would reach over $700 million and require annual contributions over $100 million in the initial years.

These numbers are orders of magnitude larger than today's GoGreen Home program. However, anticipating the potential costs of a large-scale program in the future is helpful to critically evaluate future program costs and how those costs should be recovered.

To put these back-of-the-envelope calculations in perspective, California utilities spent $1.1 billion on electric and gas energy efficiency program in 2021.[230] The back-of-the-envelope administrative costs for a large-scale financing program are modest relative to overall energy efficiency budgets, which makes sense since consumer energy finance is primarily leveraging third party capital, rather than spending energy efficiency budgets directly on upgrades. The additional loan loss requirements, however, are large relative to today's energy efficiency budgets, so the level of these requirements deserve extra scrutiny.

C. COST RECOVERY TODAY AND IMPLICATIONS

California's GoGreen Home program today is primarily funded as part of the CPUC-regulated utility energy efficiency portfolio. This funding is recovered from customers through electricity and natural gas rates. Because the program is funded by investor-owned utility customers, the program's loans are only available in the territories of the investor-owned utilities. In instances where a customer receives one energy source from an IOU and another from a publicly owned utility, the program can only lend toward projects that relate the IOU-delivered energy, limiting the ability to do more comprehensive projects.

Connecticut's Smart-E program is also funded through a surcharge on utility bills. The Michigan Saves has a different funding model. Michigan Saves is a standalone non-profit that has received periodic one-time appropriations from the state legislature, including $1.5 million in 2021.[231] The program also charges a fee on each loan to recoup its costs.

h. This calculation assumes an interest rate of 5% and that a borrower pays a constant monthly payment over the 10-year life of the loan, which works out to $265 per month or $3,182 per year. The maximum value of loans outstanding is reached in year 10 and the portfolio remains at that level until year 20, after which the total balance declines toward zero in year 30.

In California, funds to pay for the GoGreen program are collected by the state's investor-owned utilities through the retail rates that they charge to customers. Currently, residential electric and gas rates are entirely volumetric, i.e., customers pay an additional amount for each kilo-watt hour that they consume. In many jurisdictions outside of California, customers pay both a volumetric charge and a fixed charge per month that does not vary with the amount of energy consumed during a billing period. Paying for public purpose programs through volumetric rates has long been the practice in California, but recent research has shown how this practice can be regressive and puts a disproportionate burden on lower income households.[232]

Borenstein (February 2021) performs a detailed examination of the residential electricity rates that are paid by customers of each large investor-owned utility (IOU) in the state. They consider what kinds of costs are recovered through these rates and how the rates are structured. The study compares the rates paid by customers to estimates of the social marginal cost to produce an additional kilowatt-hour of electricity, including pollution costs. The social marginal cost includes the marginal energy costs, line losses, greenhouse gas compliance costs, unpriced pollution, ancillary services, marginal generation capacity costs, marginal transmission costs and marginal distribution costs. Together these costs represent the added societal costs of producing one more unit of electricity or the cost savings from consuming one less unit of electricity. They compare the social marginal cost to the cost paid by consumers. From a societal standpoint, if retail prices exceed social marginal cost then consumers are being charged an amount for electricity that exceeds the cost to society of producing the electricity. This is economically wasteful since consumers, faced with high prices, are likely forgoing beneficial electricity consumption. In the context of climate change policy, consumers would be discouraged from replacing their fossil fuel consumption with cleaner electricity use.

Borenstein (February 2021) finds that in 2019 the rates that consumers paid were two to three greater than the social marginal cost.[233] The authors describe how the gap between the social marginal cost and retail prices in California is due to regulators' decision to recover non-marginal costs, such as fixed infrastructure costs and public policy costs, including energy efficiency portfolio costs, from consumers through volumetric rates, rather than through fixed monthly charges or other sources.

Borenstein (2022) further finds that the current cost recovery method puts a much larger cost burden on lower-income households. They label the costs in excess of social marginal cost as the "residual cost burden" and find that the lowest income households pay on average 3% of their annual income to cover their share of the residual cost burden, while high income households pay less than 1 percent.[234] The study also considers how household costs would rise with an increase in the overall revenue requirement (the sum of all the costs that a utility is authorized by the CPUC to recover from its customers), as would occur if there were a large increase in consumer energy finance program costs. They estimate that a 10 percent increase in the revenue requirement would result in a $75 annual bill increase for the lowest income households and $125 for the highest income households. This is dramatically

less progressive than the state income tax, which results in the highest income households paying 40 times more than the lowest income households.[235]

This research shows that, as with other public policy programs with costs recovered through electricity rates, the recovery of program costs for the GoGreen programs has been effected through volumetric rates and has been regressive. Today, the total program costs are still small, so these programs are having little impact on rates. However, if policymakers expect consumer energy finance to accelerate in tandem with achievement of the state's decarbonization goals, then the regressivity of cost recovery would become problematic. State legislators and program leaders should consider putting alternative cost-recovery approaches in place in anticipation of this future.

Borenstein (2022) also analyzes how cost recovery through volumetric electricity rates works against policies to encourage the adoption of electric vehicles and electric heating. They find that in 2019, electric vehicle drivers were paying $600 per year for electricity more than they would have if prices were set at social marginal cost. Some high mileage drivers are paying $1,000 more per year. This is likely already slowing electric vehicle adoption. The picture for heating is similar, with volumetric rates adding $600 per year to the cost of electric heat based on 2019 prices.[236] Giving current cost recovery practices, the costs required to support a growing consumer energy finance program will add to this burden and somewhat undermine program goals by discouraging electrification.

The implications of cost recovery methods are often overlooked when policy programs are being designed or expanded. However, this recent research illustrates that the practice of cost recovery through volumetric rates has impacts on affordability and electrification that should not be ignored. Today's consumer energy finance programs are relatively modest, and are not yet major contributors to rates, but this will change as the programs grow. The California legislature and CPUC should consider alternative funding approaches now, prior to program growth.

Borenstein (2022) analyzes two alternatives to the current cost recovery approach for policymakers to consider. One alternative is paying for program costs through the state general budget and funding the programs with other sources of government revenues.[237] This has the advantage that rising program costs would not increase volumetric rates. The state could then collect revenues through progressive taxes to pay for the program. Cutting the link between the lending program and utility-based funding would also simplify the process for opening the program to addressing decarbonization for fuels that are not provided by an investor-owned utility. This could include building electrification projects where a homeowner gets natural service from an IOU but electrical service from a publicly owned utility. Projects that fund electric vehicle charging infrastructure could also become easier to include in the program, including in publicly owned electric utility territory. The Michigan Saves program has received state budget appropriations and could be model for this approach. However, a state budget-based approach would be subject to legislative appropriation processes, including potential two-thirds approval

requirements in both houses under Proposition 13 if the appropriations are made from new revenues.

A second approach discussed in Borenstein (2022) is continuing to recover costs through utility bills but restructuring rates by adding a fixed charge and lowering volumetric rates. This approach can reduce a disincentive to electrify buildings and transportation. To address the regressivity of a fixed charge, the report suggests varying fixed charge between households based on household income. In 2022, AB 205 mandated that the CPUC adopt income-graduated fixed charges for the utilities and this is currently being implemented in Rulemaking R.22-07-005.[238] Recovering consumer energy finance program costs through a fixed charge, however, would keep the program tied to the IOUs and not enable program expansion outside of IOU fuels and territories.

A third approach, not discussed by Borenstein (2022), is for the program to be self-funded. This could be accomplished by charging fees to borrowers, lenders and/or contractors to support program operating costs. The California Housing Finance Agency (CalHFA), which provides subsidized financing for low- and moderate-income renters and homebuyers, could be looked to as a model. The CalHFA programs charge fees to borrowers. This approach would also address the current utility territory barrier. However, imposing costs on program participants could lower participation.

Whatever the funding approach, the state can also pursue federal funding to support consumer energy lending in the near term, such as funding that will become available pursuant to the Inflation Reduction Act of 2022. An example of a hybrid approach would be for federal money to grow the loan loss reserve while lending fees pay for administrative costs.

D. CONCLUSIONS AND RECOMMENDATIONS

1. Manage Program Costs in Anticipation of Scaling

Increase program scale

Today, GoGreen Financing's administrative costs are high relative to the number of loans issued each year and when compared to peers. This is not a judgement on the appropriateness of the administrative costs, but a recognition that a large share of administrative costs are fixed relative to the number of loans. Increasing the number of loans issued is critical to making GoGreen an attractive program. Any new finance programs that are launched should also have an eye on achieving scale expeditiously. Section II discusses strategies to expand California's consumer energy finance programs.

Reevaluate credit enhancements

California's GoGreen Financing programs offer lenders more generous protections than programs in other states. These protections are significant cost drivers if the program expands. The CPUC and CAEATFA should reevaluate the credit protections now, prior to expansion. Specific recommendations are beyond the

scope of this study, but CAEATFA should start with a review of the percentage of loan value that is added to the loan loss reserve. California's reserve additions are four times greater than Michigan's. The sharing of losses between a lender and the program should also be reevaluated. These parameters are important for participating lenders, so CAEATFA should engage with current and potential lenders about any potential changes. The program's low charge-off rate of just 1.39% of loans since inception[239], and similarly low charge-off rates for programs outside of California may provide lenders comfort that CAEATFA can change these parameters.

2. Change Source of Funds to Promote Equity and Electrification

Pursue funding for administrative costs and credit enhancements from state and federal sources

The current approach of funding consumer energy finance programs by increasing consumer energy bills is a widely used practice in California that enabled CAEATFA to begin developing, piloting and growing consumer energy finance programs. However, this funding approach has a number of significant drawbacks as described in this report. An alternative approach is to fund both the administrative costs and credit enhancements with state and/or federal funding sources. Appropriating program funding through the state budget process would put less pressure on utility bills, thereby making rates more consistent with decarbonization goals. If the state continues its practice of using progressive taxes to collect revenues then moving costs to the state budget is also more progressive than keeping the costs on utility bills. While legislative approval and renewal could face political challenges, state budget funding would also provide a rationale for making the program truly state-wide, and not restricted to investor-owned utility provided fuels and territories. As discussed elsewhere, such a shift could remove a barrier to program growth and impact. However, the consistent availability of state funding could be subject to the state's overall budget outlook and changing legislative priorities.

Additionally, federal funding may become available to support consumer energy finance programs in California. The federal Inflation Reduction Act of 2022, for example, appropriates $27 billion for the federal Greenhouse Gas Reduction Fund grant program and authorizes the US Environmental Protection Agency to allocate some of this funding to capitalize organizations "designed to provide capital, leverage private capital, and provide other forms of financial assistance for the rapid deployment of low- and zero-emissions products technologies and services."[240] Securing federal funding such as this for California consumer energy finance efforts could decrease the pressure on utility customers or the state budget. As discussed previously, CAEETFA is collaborating with other programs to pursue this funding.

Recover program costs through income-graduated fixed charge

The current approach of funding GoGreen Financing and other energy efficiency programs administered by the investor-owned utilities is inequitable and undermines electrification because the costs increase volumetric (i.e., per kilowatt) energy rates. Alternative rates structures can avoid these negative

consequences. Collecting the program costs through a monthly fixed charge is a way to avoid undermining electrification. Then designing a fixed charge that varies based on household income can avoid the inequity of the current approach. The CPUC is working with stakeholders to develop income-graduated fixed charges in Rulemaking 22-07-005. Recovering program costs in this manner, however, does not address the utility-specific, geographic complexity of the current program, so should be seen as a second-best option.

Evaluate borrower fees as a funding source

Some government-supported lending programs generate revenues through fees charged to the borrowers. Self-funding is attractive since it avoids legislative or regulatory funding processes. On the other hand, adding fees could discourage participation, thus, undermining program goals. This option should be evaluated further. The evaluation should consider whether a fee could recoup some or all of the administrative and loan issuance costs. This would take some cost pressure off of other funding sources, such as utility bills or state and federal budgets.

IV. LEARNING THROUGH CONSUMER ENERGY FINANCE PROGRAM DESIGN

A recurring theme in our interviews is that consumer energy finance in California has not met expectations. The CPUC-regulated, CAEATFA-administered energy efficiency financing programs have grown slowly and remain small. Stakeholders have put forward a variety of potential responses, including investing into the expansion of GoGreen Financing and launching new, tariffed on-bill programs.

Andrew Campbell was lead author for this section.

An important priority during the upcoming period of policy experimentation will be to learn what works and what does not. Given the ambition and urgency of decarbonization goals, the state needs an expeditious cycle of learning and program improvement. This points towards the importance of measurement and evaluation.

Measurement and evaluation are a standard part of California energy efficiency policies. Evaluations are most typically observational or ex post studies where a program is designed and run, then an evaluator gets involved, assesses what data is available and does the best job they can to discern the impact of the policy. This approach often struggles to isolate program impacts from other external factors that also impact the outcomes of interest. The evaluation results can also be very delayed since the evaluation occurs after the fact. This could mean a less effective program remains in the field for longer than is ideal.

An alternative approach is to design the program as an "experiment," with the evaluation incorporated into program design. One experimental design, the randomized controlled trial (RCT), is a typical form of experiment that use used outside of the energy sector. Regulators assess the effectiveness of new drugs using RCTs, and technology companies use RCTs, referred to as A/B testing, to test new web marketing strategies. RCTs and other experimental approaches have been used to test the impact of energy efficiency programs but are not yet in widespread use.[241] Such an approach can lead to a virtuous cycle of program evaluation and improvement:

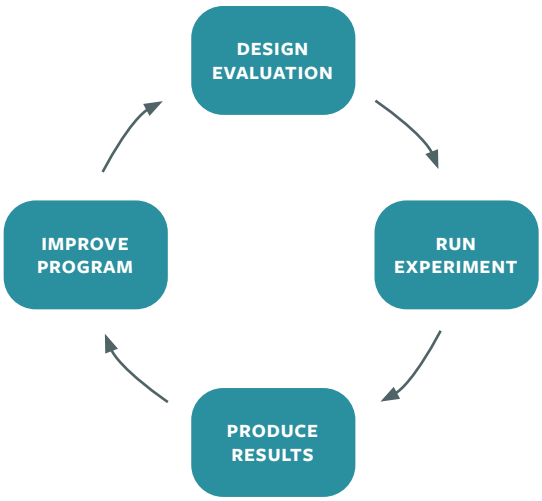

Figure 7: The virtuous cycle of evaluation.

Experimental program designs could be valuable for consumer energy finance programs for several reasons. First, consumer energy finance operates in a complex policy environment with consumer actions also being impacted by direct subsidies, subsidies to manufacturers and installers and energy efficiency codes for buildings and appliances. It will be difficult to discern the distinct impact of consumer finance relative to other policy interventions. Given limited public resources to commit to decarbonization programs, policymakers need to understand which policy channels are most effectives and merit further resources, and which are having less of an impact.

Second, consumer energy finance offers many design choices, and policymakers and administrators would benefit from understanding what the impacts of different policy changes are. For example, through interviews and research we heard that changes to credit cut-offs, the generosity of credit backstop and approval process efficiencies all merit focus. Well-designed experimental pilots may be able to discern the impacts of a given policy change. In the absence of rigorous experimentation, policymakers may observe overall program outcomes, but struggle to understand which policy design parameters matter most.

Third, the ambition of the state's decarbonization goals increases the urgency of determining program effectiveness and how to improve and accelerate the programs. The state does not have time to offer ineffective programs if 2030 and 2045 goals are going to be met.

KEY EVALUATION QUESTIONS

Before designing an effective experimental evaluation, policymakers need to articulate the desired program outcome, or outcomes. We understand the primary desired outcome of California's consumer energy finance programs is to increase DER adoption by customers.

Interview and research also illuminated that broadening access to DERs across income groups and demographic groups is an intended outcome from consumer energy finance programs.

Given these outcomes, evaluations should address several questions:

- How much does the availability of subsidized consumer finance increase DER adoption?
- What are the demographic characteristics of the additional households that adopt DERs relative to the households that would otherwise adopt DERs?

Evaluations should also address the quantitative energy, cost and environmental outcomes that the programs are addressing:

- How much additional energy do residential customers save due to DER investments that are caused by subsidized consumer finance?
- How much money do residential consumer save due to DER investments that are caused by subsidized consumer finance?
- How much are greenhouse gas emissions reduced due to DER investments that are caused by subsidized consumer finance?
- How cost-effective is subsidized consumer finance?
- How does subsidized consumer finance compare to other decarbonization policies on a dollar per carbon dioxide-equivalent basis?

PROGRAM DESIGN CONSIDERATIONS

In addition to the program impact questions, there are numerous program design questions that could potentially be answered by well-designed experiments. Some questions informed by stakeholder interviews are offered here:

- What impact does reducing the loan loss percentage have on lender participation and interest rates offered to consumers?
- How does changing GoGreen Home's minimum credit screening criteria (credit score and debt-income ratio) or lender credit criteria impact customers participation, contractor participation, lender participation and defaults?
- What impact does eliminating utility boundary barriers have on contractor and customer participation?
- How does coupling consumer finance with incentive programs such as TECH impact participation by households and contractors?
- How can consumer energy finance programs be designed so that they increase DER adoption among historically underrepresented groups?
- Entirely new program approaches, such as tariffed on-bill programs, likely raise additional questions that could be addressed through evaluations.

EXPERIMENTAL EVALUATION DESIGNS[i]

To understand a program, ideally the evaluator could compare outcomes of interest in a world where the program exists to the same outcomes in a world without the program. Similarly, if we want to understand the impact of a program change, we could compare outcomes in a world with the changed policy to world without the changed policy. No such counterfactual world exists, so evaluators deploy a variety of methods to estimate a counterfactual. Creating a credible counterfactual can be challenging because so many factors unrelated to the program can influence outcomes of interest. For example, a household may choose to electrify their home as part of a larger renovation that also impacts energy use. A child may leave for college or an older parent could move in. Weather variation can make is hard to compare the impact of climate control investments across different time periods.

Ideally, the evaluator can identify a comparison group that is identical to the group receiving the treatment and equally impacted by the external factors that affected the treatment group. With such a comparison group then outcomes such as changes in energy use or energy costs can be easily compared between the groups to determine program impact. Experimental and quasi-experimental evaluation designs are approaches that create, or identify, a control group that is valid. A valid group is one that is not subject to selection bias. Selection bias occurs when the reasons why participants chose to participate in a program are correlated with outcomes.

The graphic below depicts a variety of evaluation methodologies that can be used to estimate the impact of a policy.

i. This section draws heavily on an unpublished report titled "A roadmap for implementing experimental and quasi-experimental evaluation designs in EE programs" prepared for the CPUC by the E2e Project, a joint initiative of the University of California, Berkeley, the University of Chicago and the Massachusetts Institute of Technology. Project Title: The E2e Project Energy Efficiency Evaluations, Contract: 13IA5050. Available on request.

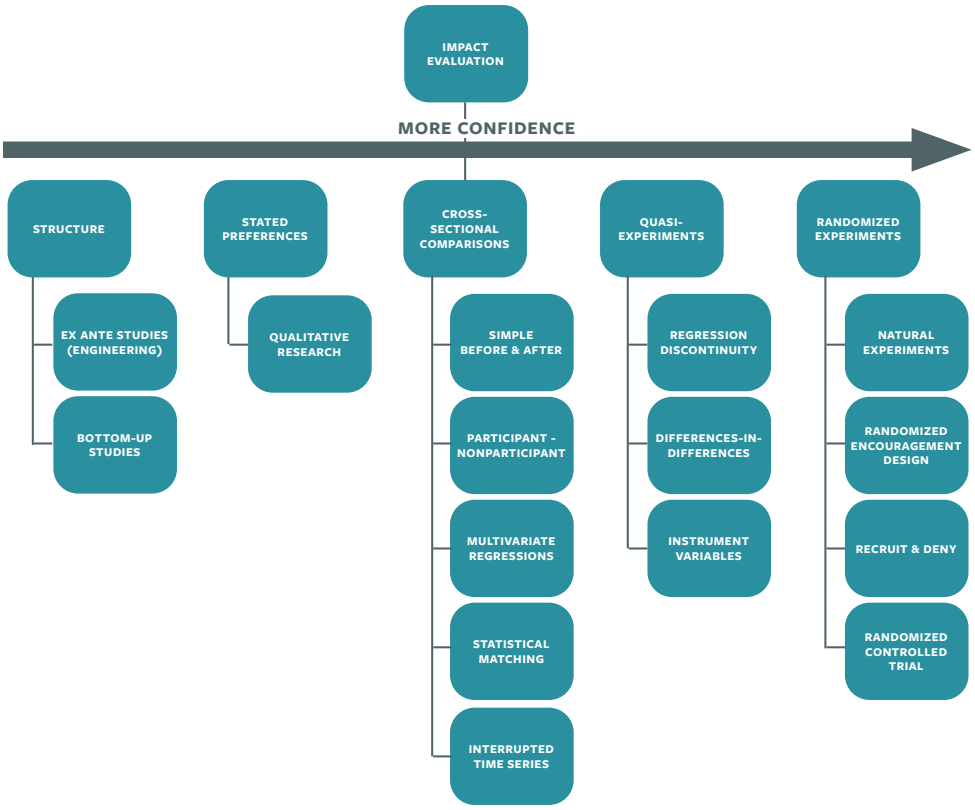

Figure 8: Policy impact evaluation methodologies.

The methodologies are ordered from left to right in order of the amount of confidence that an evaluator will have that an evaluation is producing an unbiased estimate of the impact caused by a program. At the left are engineering studies that are done in advance of a project to estimate impacts based on typical technical characteristics, potentially informed by lab data. These methods may incorporate some deployment-specific technical information, but do not fully account for human behavior and how behavior can change DER impacts even for otherwise identical projects at two different locations.

In the center are cross-sectional comparisons, such as regression analysis, that seek to identify outcomes by estimating changes over time or differences between participants and non-participants, for example. These methods have the advantage that they can often be used after the fact, but have the disadvantage that the methods may conflate program impacts with other factors such as selection bias, i.e., underlying, but perhaps unobserved, differences between participants and non-participants.

The methods in the last column, randomized experiments, produce more confident impact estimates because they allow the evaluator to identify a control group (i.e., a group that is not impacted by a policy) that is identical to the group receiving the treatment (i.e., a group that is exposed to the policy). With these randomized experiments the two groups are also equally affected by factors unrelated to the policy.

Randomized experiments allow the evaluator to create two statistically identical groups. Random assignment should result in two groups with no systematic differences between them. This means that any differences that emerge between the groups can be attributed to the program.

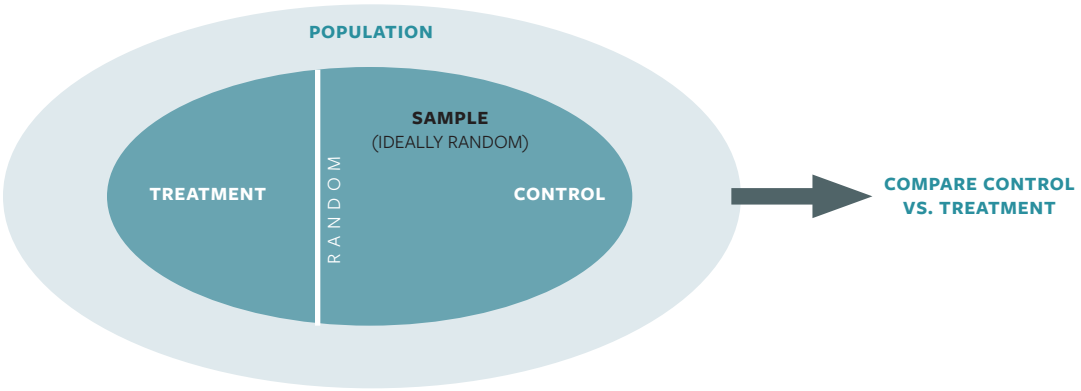

Figure 9: Creating groups from the population.

This graphic is a simple representation of how participants are segmented as part of a randomized-controlled trial. A subset of the total population are defined as the sample, and the sample are randomly divided into treatment and control groups. The treatment group is exposed to the policy and the control group is not.[242]

A number of randomized-controlled trials, cited previously, have been successfully run to estimate the impact of energy efficiency programs.

In contexts where participants cannot be mandated to be in a treatment or control group, other randomized methods can be used. In a method known as Recruit and Deny, interested participants express interest, then a lottery determines which customers are able to access the policy. When a program has capacity constraints, such as a limited budget of incentives or a limited amount of credit enhancements, this approach can be deployed as an alternative to the common first-come first-served approach. The lottery introduces randomization between participants and non-participants and this creates the ability to develop an unbiased estimate of the program impacts.

Another method known as Recruit and Delay is ideal when program delivery capacity constraints mean that not all potential participants can receive capacity at exactly the same time. If the order in which participants get access to the program is randomized then the participants who have received access can serve as the treatment group for participants who are still waiting. For example, if contractors are backlogged with potential projects, then the order of customers could be randomized. This approach was successfully used to evaluate the impact of an industrial energy efficiency program under a recent CEC-funded grant.[243]

In other instances, a Randomized Encouragement Design can be used. In this method, some, randomly selected, households are encouraged to participate in

a program. This design could be attractive when the program implementer does not want to deny participation to some potential households. The treatment group in this case are the households encouraged to participate while the control group are those who were not specifically encouraged, but still had access to the program. The outcomes for these two populations are compared to estimate the program effect.

DATA NEEDS

As part of designing an experimental evaluation, the evaluator will need to identify all data that is needed to design and evaluate an experiment. This needs to be addressed in advance to ensure that all the necessary data exists or can be created and collected during the experiment. All confidentiality and security considerations should be addressed in advance too.

Below are descriptions of types of data that may be required, drawing on the experience of Energy Institute-affiliated researchers who have implemented experiments:

Utility Data

- **Usage Data**: Changes in energy usage will generally be a key outcome of interest. The usage data that utilities collect for billing purposes will be sufficient in many cases. For analysis that is considering the time profile of changes in energy use, e.g., how electrification investments impact household demand during peak periods, hourly smart meter data will be important. If a household receives electric and gas service from different utilities, then data from each may be necessary. In some instances, there could be multiple utility meters for one household or multiple households for one meter. This is a major issue with commercial and industrial customers. The evaluator should determine whether this is a factor in the population of interest and determine how to take this into account. Usage data will be required from both the treatment group and a control group. The control group may have no direct involvement with the program, so asking for control group households to consent to data sharing is not practical.
- **Billing Data:** In addition to usage, the evaluator will generally need to applicable rate schedule for each household. These schedules are published, and the utility data will identify which rate schedule a given customer is on, e.g., CARE vs non-CARE, which baseline zone.
- **Program Participation Data:** Many evaluations will require information about participation DER programs, for both treatment and control groups.

The CPUC oversees robust data security and confidentiality rules that are critical to allowing contractors or other outside evaluators to perform evaluations. For academic researchers, data sharing is covered by the Energy Data Request

Program, approved by the CPUC in 2014 in Decision 14-05-016.[244] The program sets out strict rules to ensure confidentiality and data security.

Loan Data

Data related to borrowers and potential borrowers could be needed for some evaluations.

Contractor Data

- **Contractor Information**: Some experiments may require information about the contractor who implements each project.
- **Project Details:** An evaluation may also need details about the project that was implemented, including information about non-DER aspects of a project. Project costs will likely be important, but information about any incentives a contractor is receiving for a project.
- **On-Site Measurements:** Measurements or data collected by a contractor at a building could also be relevant. For example, the results of a blower door test for weatherization projects.

Other Data

- **Usage Data for Non-Utility Fuels:** Some DER projects may involve fuel-switching from a non-utility fossil fuel such as propane or gasoline to a utility fuel. In these cases the evaluator will need to determine a way to collect data about usage and prices for the non-utility fuel, or develop a strategy to do the evaluation without good data. The evaluator will need to consider how to address data for households in the control group who may not be interacting with the program at all.
- **Household Income**: If an evaluation is considering how program participation or DER impacts vary across household income groups, an estimate of household income will be needed. An evaluator will generally not have access to individual household income data, so will need to develop a strategy. Household addresses can be used to connect households to census block groups, for which median income data is publicly available. One recent study supplemented this analysis with data available through the CEC-administered Residential Appliance Saturation Survey to develop more fine-tuned estimates.[245] The CPUC is wrestling with how to estimate household income in an ongoing rulemaking, so potential methods may emerge there.[246]
- **Weather:** The effects of building electrification projects may be impacted by weather, so a source of sufficiently granular weather data will be needed.

CONCLUSIONS AND RECOMMENDATIONS

Conduct one or more experiments aimed at increasing GoGreen Home program uptake

While GoGreen Home has been in the California market for several years, it is not yet widely known and has not yet been a catalyst for DER investments by many California households. There are still ample opportunities to consider program changes and evaluate these changes through randomized experiments. We recommend that the CPUC and CAEATFA review the questions laid out in this chapter and consider carry out one or more randomized experiments to evaluate program changes and make further improvements, with an aim of increasing program take-up.

If the CPUC initiates a tariffed on-bill program, work with stakeholders to identify key questions and develop focused experiments

This study did not include a deep dive into TOB programs or potential program designs. However, the design and implementation of an entirely new program is the ideal time to experiment, analyze results, and implement results to improve the program impact.[j] If the CPUC initiates a TOB program, we recommend that the CPUC convene interested stakeholders to identify important evaluation questions and design experiments before a program is launched. Randomized experiments are best launched before a program is widely known by the target population. Also, since a new program often faces capacity constraints and is rolled out gradually, randomization can often be introduced in harmony with launch plans.

j. The value of experimentation and analysis may be particularly valuable in the case of utility-administered efficiency programs, which some analyses have historically identified as having high administrative costs relative to savings. *See* CPUC, *Decision re: Energy Efficiency Goals for 2016 and Beyond and Energy Efficiency Rolling Portfolio Mechanics*, D.15-10-028, R.13-11-005 (October 22, 2015), available at https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M155/K511/155511942.pdf.

V. CONCLUSION

With a target of statewide decarbonization by 2045, California leaders face a significant uphill climb to marshal the resources needed to facilitate efficiency and electrification in nearly 14 million residential homes and units. A diverse mix of programs will be necessary to bring together tens of billions of dollars in public and private capital and to incentivize property owners to take action.

State-supported financing programs like GoGreen Financing have the potential to play a significant role in this effort by leveraging limited public funds to overcome the hurdle of high upfront costs of major retrofit projects. Leading programs from other states demonstrate that the GoGreen Financing structure can serve more customers in California, but even these programs have achieved somewhat limited success relative to the total number of residential units, as well as with lower-income residents. This demonstrates the urgency of rapidly increasing scale and the need for a comprehensive suite of state programs with a structured approach to different population segments.

To reach building decarbonization targets, leaders in the state legislature and at key agencies will thus need to partner on a layered approach. Financing program reforms like shifting away from utility ratepayer funds as a revenue source, orienting more toward contractor-led efforts, and learning through experimental design could be crucial to increasing the effectiveness and reach of GoGreen. Supporting tariffed on-bill and microloan programs at the same time could accelerate the infusion of private capital into retrofit projects, particularly for lower-income Californians. Further, targeted investments in direct-installation, zero-cost, and high-subsidy programs like LIWP and TECH could play a key role in supporting these residents and speeding market development for clean technologies. And consolidating program access through a single coordinator or administrator, allowing customers to seamlessly stack all available rebates, incentives, and low-cost financing opportunities, could increase uptake while also furthering state efforts to obtain and distribute federal funds. These measures will not be simple to undertake—and they will require substantial public investment of capital and capacity—but they are commensurate with the scale and complexity of California's ambitions.

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APPENDIX I: KEY TERMS AND CONSUMER ENERGY PROGRAM DEFINITIONS

BUILDING DECARBONIZATION

A broad term describing efforts to reduce the energy consumption, fuel sources, and associated greenhouse gas emissions of buildings, including: **energy efficiency**, which refers to strategies to reduce the energy consumption of a building regardless of fuel source; **building electrification**, which refers to the transition from natural gas, propane, and other fuel sources to fully electrified buildings; and **deep decarbonization**, which refers to the gradual elimination of carbon emissions from building operations.[k]

BUILDING INITIATIVE FOR LOW-EMISSIONS DEVELOPMENT (BUILD)

A California program providing incentives for residential building decarbonization. Qualifying buildings must be new or undergoing substantial retrofits and must be free of gas service connections or cap/remove existing connections. Buildings must also meet low-income criteria (located in a state-identified disadvantaged community, located in a census tract where 50 percent of households are below 60 percent of area median income, or have 80 percent of households below 60 percent of area median income). Incentives are based on the decarbonization project's total avoided GHG emissions, efficiency improvements by unit, installed solar PV, and other components such as EV chargers and induction cooktops. The program is administered by the California Energy Commission (CEC) and co-managed by the California Public Utilities Commission (CPUC) with funds provided by natural gas utilities' emission allowances provided under the Air Resources Board's cap-and-trade program.[l]

CALIFORNIA ALTERNATIVE ENERGY AND ADVANCED TRANSPORTATION FINANCING AUTHORITY (CAEATFA)

A program of the California State Treasurer's Office intended to draw private capital for, and spur market transformation in, emissions-reducing and sustainable energy investments including through manufacturer tax exemptions, bond financing, property assessed clean energy support, and the California Hub for Energy Efficiency Financing (CHEEF) programs.[m]

k. See, e.g., CEC, "Building Decarbonization Assessment" (webpage), available at https://www.energy.ca.gov/data-reports/reports/building-decarbonization-assessment.

l. CEC, *Program Guidelines: Building Initiative for Low-Income Development (BUILD), First Edition* (February 2022), available at https://www.energy.ca.gov/sites/default/files/2022-03/CEC-300-2022-001-CMF.pdf; SB 1477 (Stern, Chapter 378, Statutes of 2018), Cal. Pub. Util. Code § 921.

m. CAEATFA, *2021 Annual Report to the California State Legislature* (March 2022), available at https://www.treasurer.ca.gov/caeatfa/annual/2021.pdf.

CALIFORNIA HUB FOR ENERGY EFFICIENCY FINANCING (CHEEF)

A set of energy efficiency financing pilot programs, administered by CAEATFA on behalf of CPUC and California's investor-owned utilities, that provide credit enhancement (via a loan loss reserve) to facilitate attractive financing by private lenders for qualifying efficiency projects. Eligible upgrades include a range of energy efficiency measures but vary by program. Programs include: **GoGreen Home**, available to single-family through fourplex homes and currently served by eight credit unions and one online lending marketplace; **GoGreen Business**, available to business customers and currently served by six finance companies and one credit union; and **GoGreen Affordable Multifamily**, available to multifamily properties with at least 50 percent of units restricted to residents between 80 and 120 percent of area median income, currently served by two finance companies.[n]

CREDIT ENHANCEMENT

Financial strategies to increase provision of and access to energy financing, either by reducing risks for lenders or reducing cost of capital for borrowers. Examples include:

- **Interest rate buy-down (IRB):** A form of credit enhancement involving an upfront payment (typically made by a government entity) to a lender to reduce the interest rate in a loan program to a level that makes the loan financially feasible for borrowers.
- **Loan loss reserve (LLR):** A form of credit enhancement in which lenders have access to a reserve fund (typically seeded by a government entity) to cover a predetermined portion of qualifying losses, mitigating the lender's risk in case of default and enabling the lender to extend credit to a wider range of borrowers.

DISADVANTAGED COMMUNITY (DAC)

A California community ranking in the top 25 percent of census tracts statewide in the CalEnviroScreen tool's assessment of environmental and population vulnerability criteria. Criteria include indicators of environmental exposure (e.g., pollution), environmental effects (e.g., toxic sites), sensitive populations (e.g., health data) and socioeconomic factors (e.g., poverty). California's Office of Environmental Health Hazard Assessment (OEHHA) is responsible for managing CalEnviroScreen and identifying DACs. Senate Bill 535 (De Leon, Chapter 830, Statutes of 2012) and Assembly Bill 1550 (Gomez, Chapter 369, Statutes of 2016) created the CalEnviroScreen program and DAC designation and require a portion of state cap-and-trade program revenues to fund projects that support or are located in DACs.[o]

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n. See CHEEF, *Energy Efficiency Financing Programs: Quarterly Report and Program Status Summary, Fourth Quarter 2021*, available at https://www.treasurer.ca.gov/caeatfa/cheef/quarterly/2021/20211231.pdf.

o. Cal. Health and Safety Code §§ 39711, 39713; OEHHA, *CalEnviroScreen 4.0 Report* (October 2021), available at https://oehha.ca.gov/media/downloads/calenviroscreen/report/calenviroscreen40reportf2021.pdf.

ENERGY SAVINGS ASSISTANCE (ESA) PROGRAM

A California program providing no-cost weatherization and efficiency improvements for residents who meet the low-income thresholds for the California Alternative Rates for Energy (CARE) discount program (i.e., 200 percent of the Federal Poverty Line or approximately $53,000 for a four-person household). Eligible upgrades include insulation and weather stripping, energy-efficient refrigerators and furnaces, and building envelope repairs. The ratepayer-funded program is governed by the California Public Utilities Commission (CPUC) and administered by the three investor-owned utilities along with a group of local and gas utilities.[p]

ENERGY SAVINGS ASSISTANCE COMMON AREA MEASURES (ESA CAM) PROGRAM

An extension of the ESA program for weatherization and efficiency improvements to common and exterior areas and communal energy systems for deed-restricted low-income multifamily residential buildings. Eligible upgrades vary by utility but include kitchen appliances, hot water equipment, HVAC, envelope repairs, lighting, and elevators. Building owners must certify that at least 65 percent of residents meet ESA program income guidelines.[q]

GREEN BANK

A public or quasi-public financial institution that uses direct lending, innovative financing mechanisms, credit enhancements, and other strategies (typically backed by public capital) to accelerate private investment in, and deployment of, clean energy technologies and upgrades.[r]

LOW-INCOME AND LOW-TO-MODERATE INCOME (LMI)

Income categories used to determine eligibility for certain home energy assistance programs, typically referring to households at or below 80 percent of area median income (AMI) (low-income) and between 80 and 120 percent of area median income (low-to-moderate income). AMI can vary widely in California, ranging from approximately $80,000 (Fresno, Kern, and 20 other largely rural counties) to over $165,000 (four Bay Area counties) for a family of four.[s]

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p. See, e.g., CPUC, *Statewide Energy Savings Assistance Program 2017-2020 Cycle Policy and Procedures Manual* (revised September 2019), available at https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/energy-efficiency/iqap/2019_statewide_esa_pp_manual_ver-1.pdf; Cal. Pub. Util. Code §§ 739.1, 2790.

q. See, e.g., PG&E, *Energy Savings Assistance Multifamily Common Area Measure Initiative Advice Letter per Decision (D.) 17-12-009* (March 28, 2018), available at https://www.pge.com/tariffs/assets/pdf/adviceletter/GAS_3943-G.pdf.

r. See, e.g., Coalition for Green Capital, *Green Banks in the United States: 2021 U.S. Green Bank Annual Industry Report* (May 2021), available at https://static1.squarespace.com/static/59bc05f0c534a543a9f96b0d/t/609a872db219bc4ce685a281/1620739886886/2021+Annual+Industry+Report+Final.pdf.

s. California Department of Housing and Community Development, "State Income Limits for 2022" (memorandum) (May 13, 2022), available at https://www.hcd.ca.gov/docs/grants-and-funding/inc2k22.pdf.

LOW-INCOME WEATHERIZATION PROGRAM (LIWP)

A California program providing no-cost solar PV and energy efficiency upgrades for residents of multifamily buildings (with at least 66 percent of residents at or below 80 percent of area median income) and agricultural workers in one- to four-unit buildings (at or below 80 percent of area or state median income). The program previously included single-family and community solar program components as well. Qualifying measures vary by sub-program but include a range of efficient appliances, HVAC, water heating, and envelope repairs. The program is managed by the California Department of Community Services & Development (CSD) and administered by the Association for Energy Affordability, with funding from annual budget allocations of cap-and-trade auction revenues through the California Climate Investments program.[t]

LOW-INCOME HOME ENERGY ASSISTANCE PROGRAM (LIHEAP)

A federal program administered in California by CSD providing bill assistance and no-cost weatherization upgrades for low-income residents below 60 percent of state median income (approximately $59,000 per year for a household of four). Eligible weatherization improvements include insulation and weather stripping, HVAC repairs, and efficient lighting.

ON-BILL FINANCING (OBF)

An energy finance strategy in which the capital costs of an energy project are repaid via the customer's utility bill rather than a separate loan and repayment obligation, typically in one of three different forms:

- **On-bill financing (OBF):** The utility provides direct energy project financing to the customer, who repays the loan via a line item on utility bills. This strategy is typically funded with ratepayer funds and may require utilities to obtain regulatory approval to act as a lender.
- **On-bill repayment (OBR):** A third party provides energy project financing to the customer, who repays the loan via a line item on utility bills, with the utility passing the payments through to the third-party lender. This strategy is typically funded with lender funds and avoids utility designation as a lender.
- **Tariff on-bill (TOB):** The utility provides direct energy project financing in the form of an additional utility tariff associated with the property's meter rather than the individual customer. The financing is not configured as a loan and the repayment obligation runs with the property rather than with the customer. Sometimes also described as **inclusive utility investment (IUI)**.

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t. CSD, *Low-Income Weatherization Program Guidelines: Multifamily (MF) Energy Efficiency and Renewables* (updated November 2019), available at https://www.csd.ca.gov/Shared%20Documents/LIWP-MF-Program-Guidelines-Amended-2019.pdf; CSD, *Low-Income Weatherization Program Final Program Guidelines: Single-Family Energy Efficiency and Solar Photovoltaics Program, Farmworker Housing* (April 2022), available at https://www.csd.ca.gov/Shared%20Documents/LIWP-2022-Farmworker-2.0-Final-Program-Guidelines.pdf; see generally AB 1532 (Perez, Chapter 807, Statutes of 2012) and SB 535 (De Leon, Chapter 830, Statutes of 2012), directing creation of CCI programs to benefit low-income residents.

- **Pay As You Save (PAYS®):** A TOB program with proprietary assessment software, minimum requirements, and implementation strategies that has been implemented by several rural electric co-ops.

PROGRAM ADMINISTRATOR (PA)

A third-party entity, typically a nonprofit but in some cases a government body, designated by a government agency to administer a public energy efficiency program. Responsibilities often include customer service and outreach, contractor coordination, energy audits, and financing coordination (though not direct financing).

SOLAR ON MULTIFAMILY AFFORDABLE HOUSING (SOMAH)

A California program providing incentives for installation of solar PV at affordable multifamily residential buildings in the service areas of the state's major IOUs as well as PacifiCorp and Liberty Utilities. The program's incentives exclusively fund solar PV installations but also requires building energy efficiency audits, retrofits, and referrals to the ESA program for qualification. Qualifying properties must have five or more deed-restricted units and either be located in state-designated disadvantaged community (DAC) or have at least 80 percent of residents earning at or below 60 percent of Area Median Income. The program is managed by CPUC using ratepayer funds and administered by a coalition of nonprofits including AEA, CSE, and GRID Alternatives.[u]

TECHNOLOGY AND EQUIPMENT FOR CLEAN HEATING (TECH)

A California program that provides direct financial incentives for installation of heat pump water heaters and HVAC systems with the goal of spurring market transformation for this decarbonized technology. The program also supported six decarbonization and capacity-building pilots around the state. In 2022, the CPUC (which oversees the program together with the CEC and administers it through multiple PAs) extended TECH with an additional $50 million allocated through the state budget. TECH was enacted together with BUILD by SB 1477 (Stern, Chapter 378, Statutes of 2018).

u. SOMAH Program Handbook (fourth edition), available at https://calsomah.org/sites/default/files/docs/SOMAH-Handbook_FourthEdition.pdf; see AB 693 (Eggman, Chapter 582, Statutes of 2015), Cal. Pub. Util. Code § 2870.

APPENDIX II: ENERGY EFFICIENCY AND BUILDING DECARBONIZATION MEASURES OVERVIEW

APPLIANCE UPGRADES

Energy efficient upgrades for the home can include equipment such as kitchen appliances and laundry machines.[v] Appliances consume 9 percent of the energy bill in the average US household, which is the third largest category of energy expenditure in the home behind space heating and cooling and water heating for laundry and showers.[w] But new, more efficient appliances are now available. New Energy Star washing machines consume a quarter less energy and 70 to 75 percent less water than they did two decades ago.[x] Many energy-efficient refrigerators are designed with advanced compressor technology called advanced adaptive compressors, which can reduce energy consumption by a minimum of 30%.[y] Energy-efficient appliances can add up to big energy savings. For example, if each new refrigerator and freezer sold in the US contained advanced adaptive compressors, it would lower greenhouse gas emissions by 1.2 million metric tons.[z]

BUILDING ENVELOPE UPGRADES

A home that leaks hot air in the winter or cold air in the summer uses more energy than necessary. Updating a home's building envelope – including its insulation, weatherproofing, and windows and doors – can help lower energy use and maximize energy efficient heating and cooling systems. A study by ACEEE found that retrofits including full envelope upgrades offer a superior approach to saving energy and reducing emissions in residential buildings.[aa] With sufficient weatherization and insulation measures, residents can install a lower capacity heating and cooling system than would otherwise be required.[ab]

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v. US Department of Energy, Office of Energy Efficiency & Renewable Energy, "Energy Saver Appliances and Electronics" (webpage), available at https://www.energy.gov/energysaver/appliances-and-electronics.

w. Consumer Reports, "Here's Why New Appliances Use Less Energy" (webpage), available at https://www.consumerreports.org/energy-efficiency/why-new-major-appliances-use-less-energy/.

x. Consumer Reports, "Here's Why New Appliances Use Less Energy" (webpage), available at https://www.consumerreports.org/energy-efficiency/why-new-major-appliances-use-less-energy/.

y. Energy Star, "Technology Breakthrough for Energy Efficient Refrigerators" (webpage), available at https://www.energystar.gov/products/ask-the-experts/technology-breakthrough-for-energy-efficient-refrigerators.

z. Id.

aa. Jennifer Amman et al., ACEEE, *Pathways for Deep Energy Use Reductions and Decarbonization in Homes* (December 2021), p. v, available at https://www.aceee.org/research-report/b2103.

ab. ACEEE, "Smarter House: Building Envelope" (webpage), available at https://smarterhouse.org/home-systems-energy/building-envelope.

ELECTRIC VEHICLE SUPPLY EQUIPMENT

EV charging systems that harness EVs as distributed energy resources can help balance electrical loads and better utilize renewable energy production, minimizing curtailment.[ac] For example, EV charging systems can be configured so that they charge vehicles when grid utilization is low and store excess energy lessening demand during peak load time.[ad] Installing energy efficiency technologies in buildings offers a cost-effective way to provide the increased electricity that EVs demand. It is also less expensive than building new power producing infrastructure, either fossil fuel or renewable.[ae]

HEAT PUMP AIR HEATING AND COOLING

Powered by electricity, heat pumps work by moving hot air to cool areas and cool air to warm areas.[af] During the summer, heat pumps move hot air outside, and in the winter, they do the reverse. Heat pump technology can use on average 50 percent less energy compared to other home heating technologies, because heat pumps shift heat rather than manufacturing it. Heat pumps also extract moisture from the air more effectively than standard central air conditioners, creating a more comfortable home environment with less energy use.[ag] Lastly, many heat pumps include inverter technology, which enables a user to exactly tailor the amount of energy needed to sustain comfort. A report by ACEEE determined that electric heat pumps constitute the least expensive and most climate-friendly method of heating and cooling US single family homes, with the exception of the most frigid parts of the country.[ah]

HEAT PUMP WATER HEATERS

Heating hot water is the second most energy intensive process in the home after space heating.[ai] Working on principles comparable to heat pumps used for space heating, heat pump water heaters move heat from the ambient air to a water tank.[aj] Heat pump water heaters are about four to six times more efficient than gas water heaters, and a heat pump water heater can reduce the average home's electrical use by approximately 25 percent.[ak]

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ac. Egerter et al., supra, pp. 16, 18.

ad. Id., pp. 16-17.

ae. Id., p. 15

af. US Department of Energy, Energy Saver Office, "Heat Pump Systems" (webpage), available at https://www.energy.gov/energysaver/heat-pump-systems.

ag. Id.

ah. ACEEE, "Analysis: Electric Heat Pumps Offer Cheapest Clean Heating Option for Most U.S. Houses" (Press release), available at https://www.aceee.org/press-release/2022/07/analysis-electric-heat-pumps-offer-cheapest-clean-heating-option-most-us; Steven Nadel and Layla Fadali, ACEEE, *Analysis of Electric and Gas Decarbonization Options for Homes and Apartments* (July 2022), p. vii, available at https://www.aceee.org/research-report/b2205.

ai. Natural Resources Defense Council, "Very Cool: Heat Pump Water Heaters Save Energy and Money" (webpage), available at https://www.nrdc.org/experts/pierre-delforge/very-cool-heat-pump-water-heaters-save-energy-and-money.

aj. Id. See also, Joe Wachunas, "A Heat Pump Water Heater Is The Energy Saving Equivalent Of 7 Solar Panels & Costs ⅙ The Price," CleanTechnica (April 8, 2022), available at https://cleantechnica.com/2022/04/08/a-heat-pump-water-heater-is-the-energy-saving-equivalent-of-7-solar-panels-costs-%E2%85%99-the-price/.

ak. Id.

INDUCTION COOKING

Gas stoves create indoor air pollution that is harmful to human health,[al] even when they're turned off.[am] They also run on fossil fuels that create and worsen climate change.[an] Induction stoves, on the other hand, create heat using magnets; electric currents underneath the cooktop produce a magnetic field within the pan on top.[ao] Because of this, induction cooking is more efficient and faster than either gas or traditional electric coil appliances. Many cooks say that induction cooktops are also more accurate.[ap]

LIGHTING UPGRADES

Lighting represents approximately 15 percent of electricity usage in the average home. Energy efficient lighting can provide the same amount of light at a lower cost, and installing LED lighting can save the average home about $225 annually. Dimmers, which reduce the intensity of light, and timers, which automatically shut off lights, can also reduce energy bills and consumption.[aq]

SOLAR PV

Photovoltaic (PV) panels transform sunlight into electricity by absorbing photons, creating an electric field and spurring electricity flow.[ar] At this point, the generated energy takes the form of DC electricity. Later, an inverter changes DC into AC power, making the energy usable for everyday needs in the home. Solar PV can save homeowners money, reducing or sometimes eliminating electricity bills altogether.[as] When solar panels are installed with storage systems, residents have a backup source of energy in case of a power outage and are able to use energy generated even when the sun isn't shining.[at]

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6 *CARB, 2022 Scoping Plan*, supra, pp. 211-212; Michael Kenney et al., CEC, *2022 Building Decarbonization Assessment* (August 2021), p. 3, available at https://www.energy.ca.gov/publications/2021/california-building-decarbonization-assessment.

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Berkeley Law

Center for Law, Energy, & the Environment

Center for Law, Energy & the Environment
University of California
Berkeley School of Law
1995 University Avenue, Suite 460
Berkeley, CA 94704

clee.berkeley.edu
Twitter: @BerkeleyLawCLEE
Facebook: @BerkeleyLawCLEE
LinkedIn: Center for Law, Energy & the Environment

ENERGY INSTITUTE AT HAAS

Energy Institute at Haas
University of California, Berkeley
319 Giannini Hall
Berkeley, CA 94720-5180

haas.berkeley.edu/energy-institute
Twitter: @energyathaas
Blog: energyathaas.wordpress.com