HOT, COLD, & *Clean*

Policy Solutions to Promote Equitable and Affordable Adoption of Heat Pump Retrofits in Existing Buildings

JULY 2022
Policy Report

Climate Change
and Business
Research Initiative

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

UCLA School of Law Emmett Institute on Climate Change & the Environment

BANK OF AMERICA

JULY 2022 | POLICY REPORT

HOT, COLD, & CLEAN

Policy Solutions to Promote Equitable and Affordable Adoption of Heat Pump Retrofits in Existing Buildings

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

UCLA School of Law Emmett Institute on Climate Change & the Environment

ABOUT THIS REPORT

This policy report is part of a series on how specific sectors of the business community can drive key climate change solutions and how policymakers can facilitate those solutions. Each report results from workshop convenings that include expert representatives from the business, academic, policy, and environmental sectors. The convenings and resulting policy reports are sponsored by Bank of America and produced by a partnership of UC Berkeley School of Law's Center for Law, Energy & the Environment (CLEE) and UCLA School of Law's Emmett Institute on Climate Change and the Environment.

AUTHORS

Ethan N. Elkind

DIRECTOR, CLIMATE CHANGE AND BUSINESS PROGRAM, CLEE AND UCLA SCHOOL OF LAW'S EMMETT INSTITUTE ON CLIMATE CHANGE AND THE ENVIRONMENT

Ross Zelen

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

Katie Segal

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

Additional contributions to the report were made by Ted Lamm of CLEE and Sean Hecht and Cara Horowitz of UCLA School of Law. The authors also thank Hayley Lai (UC Berkeley Class of 2024) for her contributions to the report through her role as a research assistant at CLEE.

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 EMMETT INSTITUTE ON CLIMATE CHANGE AND THE ENVIRONMENT

The Emmett Institute on Climate Change and the Environment is among the leading environmental law programs in the country, with faculty members renowned for their public service, teaching excellence, and scholarship in state, federal, and international law. Located in Los Angeles, a diverse city facing unique environmental justice and climate change challenges, the Emmett Institute provides J.D. and LL.M. students unmatched opportunities for mentoring, career placement, and experiential learning. Through groundbreaking research and public interest initiatives, the Emmett Institute helps shape climate change and environmental law and policy in California, the United States, and jurisdictions around the world.

DESIGN

Template design and layout:
Jordan Rosenblum

Document design and layout:
Odd Moxie

Image credits:
Adobe Stock

ACKNOWLEDGMENTS

The UC organizers thank the following experts for their participation in the January 2022 convening that informed this analysis and their contributions to this report:

Jeff Allen
FORTH

Matt Baker
CALIFORNIA NATURAL RESOURCES AGENCY

Panama Bartholomy
BUILDING DECARBONIZATION COALITION

Michael Colvin
ENVIRONMENTAL DEFENSE FUND

Rory Cox
CALIFORNIA PUBLIC UTILITIES COMMISSION

Nick Dirr
ASSOCIATION FOR ENERGY AFFORDABILITY INC.

Veronica Garibay
LEADERSHIP COUNSEL FOR JUSTICE & ACCOUNTABILITY

Denise Grab
ROCKY MOUNTAIN INSTITUTE

Jennifer Gress
CALIFORNIA AIR RESOURCES BOARD

Hannah Kaye
PACIFIC GAS & ELECTRIC

Chelsea Kirk
STRATEGIC ACTIONS FOR A JUST ECONOMY

Commissioner Andrew McAllister
CALIFORNIA ENERGY COMMISSION

Beckie Menten
EAST BAY COMMUNITY ENERGY

Jennifer Nelson
CALIFORNIA ENERGY COMMISSION

Keith O'Hara
ECO PERFORMANCE BUILDERS

Laura Renger
SOUTHERN CALIFORNIA EDISON

Srinidhi Sampath Kumar
CALIFORNIA HOUSING PARTNERSHIP

Alison Seel
VEIC

Abigail Solis
SELF-HELP ENTERPRISES

Jose Torres
BUILDING DECARBONIZATION COALITION

Tom White
EDEN HOUSING

This report and its recommendations are solely a product of UC Berkeley and UCLA Schools of Law and do not necessarily reflect the views of all individual convening participants, reviewers, or Bank of America.

The authors and organizers are grateful to Bank of America for its generous sponsorship of the Climate Change and Business Research Initiative. We dedicate this series to the memory of James E. Mahoney (1952-2020), who helped launch it and championed sustainability initiatives throughout his impactful career.

I. INTRODUCTION & EXECUTIVE SUMMARY

California's residential and commercial building sector accounts for nearly a quarter of the state's greenhouse gas emissions, with combustion of fuel for heating buildings generating more than 10 percent of state emissions.[1] As the state moves toward all-electric buildings, and as climate change exacerbates the need for air conditioning, replacing older gas-powered furnaces and air conditioning units with heat pumps—a highly efficient technology that provides space and water heating and cooling—can increase efficiency, comfort and resilience. Heat pump deployment in existing buildings is a key aspect of the overall integrated strategy to achieve carbon-free targets for the buildings sector.

California's buildings largely rely on a combination of electricity and natural gas to heat and cool interiors and run appliances like furnaces, water heaters, stoves and clothes dryers. To reduce the greenhouse gas emissions from these uses, the state will need to move to all-electric building energy applications, particularly as the electrical grid moves toward 100 percent zero-carbon electricity by 2045 per Senate Bill 100 (De León, 2018). Eliminating gas combustion inside buildings, especially those without strong ventilation, can also significantly reduce exposure to harmful air pollution.[2]

Heat pumps are a key strategy to achieve these emission reductions. Using a long-established technology, they offer a highly efficient way to provide space and water heating and cooling. Heat pumps can reduce the emissions and improve the overall habitability of buildings by electrifying a range of traditionally gas-fired appliances:

- Heat pumps for space heating, ventilation, and air conditioning (HVAC) use electric-powered compressors to move heat into or out of a structure. Space heat pumps are more efficient than existing gas-fired heaters and air conditioning units and are a single cost-effective unit that provide both heating and cooling.[3]
- Heat pump water heaters (HPWHs) use electricity to move heat from one source (typically ambient air) to water instead of combusting gas. Heat pump water heaters can be more than three times more efficient than conventional electric-resistance water heaters, and they are generally cost-competitive with fossil fuel-powered systems.[4]

Eliminating natural gas from air and water heating significantly reduces a home's climate impact, and the heat pump process uses half as much energy as other electric home-heating sources on average. And because these appliances can be enabled to automatically communicate with the electric grid, utilities can manage their operation to help improve grid reliability and resilience.

Yet heat pump installation is relatively rare in California. Heat pumps often have higher upfront costs (though they offer long-term energy savings) and typically face installation challenges, such as electrical panel upgrade requirements or a lack of consumer and contractor awareness.

In 2021, the California Energy Commission (CEC) adopted the first building energy efficiency code in the nation to include electric heat pumps as a baseline technology for new and significantly renovated homes. But the state will still need a different strategy for its existing buildings, more than 75 percent of which were built before the state developed its first Title 24 Building Energy Efficiency Standards in 1978. With approximately 14 million existing residential homes in the state and slow building turnover, state leaders will need to concentrate their efforts to encourage the replacement of appliances to reduce emissions in line with state climate targets.[5]

How can California leaders spur manufacturers, suppliers, contractors, and utilities to make heat pumps the preferred option for appliance replacements? How can they incentivize building owners and landlords to make the switch? And

how can these building energy upgrades avoid the risk of tenant displacement and increased cost burdens among lower-income Californians?

This report focuses on policy, financial, and workforce solutions needed to address these questions, based on a convening of leaders from state and local government, electric utilities, and environmental and economic development organizations, hosted by UC Berkeley School of Law's Center for Law, Energy and the Environment (CLEE) and UCLA School of Law's Emmett Institute on Climate Change and the Environment in January 2022. The group sought to examine opportunities to promote heat pump adoption in California's existing buildings in an equitable manner and formulate recommendations for state policymakers.

Building on the law schools' January 2021 report *Building toward Decarbonization*,[6] which focused on accelerating building electrification in high-priority communities, this report outlines participants' vision for increasing the adoption of heat pump technologies, focusing on key barriers limiting progress toward that vision and actionable solutions to overcome those barriers. The convening participants first defined high-priority areas and populations for deployment, including areas rebuilding from wildfire damage, low-income renters without air conditioning, and communities with existing gas infrastructure near the end of its useful life. They then identified top barriers and solutions including:

BARRIER 1: A LACK OF CONSISTENT STATE POLICY ON HEAT PUMP INSTALLATION IN EXISTING BUILDINGS, INCLUDING LEGAL AND REGULATORY REQUIREMENTS AND LONG-TERM PLANNING PROCESSES

- The state legislature could require a clear statewide building decarbonization roadmap that prioritizes heat pump adoption, including a specific date for phaseout of fossil fuel appliance sales, such as through a zero-emission standard.
- The legislature and California Public Utilities Commission could reform the existing rate structure to support heat pump deployment.
- The California Department of General Services could use its buying power to increase investor confidence in the heat pump marketplace.
- The California Air Resources Board, Public Utilities Commission, and utilities could develop a refrigerant management program that supports heat pump deployment.
- The California Air Resources Board and California regional air districts could regulate baseline indoor air quality in residential and commercial buildings.

BARRIER 2: BUILDING ENERGY UPGRADES PRESENT THE RISK OF INCREASED COST BURDENS AND TENANT DISPLACEMENT AMONG LOWER-INCOME CALIFORNIANS

- The state legislature and local governments could pass and enforce tenant protection policies to ensure that heat pump deployment in existing rental and low-income housing does not lead to rent hikes and displacement.
- The California Public Utilities Commission and utilities could enhance on-bill financing to overcome the landlord-tenant split incentive conundrum.
- Utilities, local governments, and building owners could collaborate to implement green leases with heat pump deployment requirements for multi-unit and commercial buildings.
- Local governments could implement renovation requirements for multi-unit dwellings to ensure heat pumps are installed whenever a primary or seismic renovation occurs.
- The state legislature could direct the California Public Utilities Commission to use new ratemaking strategies to protect low-income Californians from over-paying for a legacy gas system.
- The state legislature could create an all-electric "Right to Cooling" policy with funds to enable heat pump deployment for low-income Californians.
- State agencies and local governments, in partnership with affordable housing owners and operators, could develop trust-building processes to ensure equitable heat pump deployment.

BARRIER 3: HIGH UPFRONT COSTS INCREASE THE NEED FOR PUBLIC FUNDS AND FINANCING SOLUTIONS

- The California Public Utilities Commission could end rebates for gas water heaters and instead redirect funds to expand heat pump incentives.
- The California Department of Housing and Community Development, California Energy Commission, and local governments could work to establish a Community Development Block Grant to fund and leverage electrical grid improvements and heat pump deployment.
- The state legislature could appropriate funds to help defray the upfront costs of retrofitting and installing heat pumps in high-priority communities.
- The California Public Utilities Commission, in coordination with utilities and the Technology and Equipment for Clean Heating (TECH) Clean California team of building decarbonization program administrators, could increase incentives for necessary electrical preparation activities, such as panel upgrades, smart panel systems, and other technologies to address electrical load.

BARRIER 4: LACK OF CONSUMER KNOWLEDGE AND ADEQUATE SUPPORT FOR A SKILLED WORKFORCE TO SCALE HEAT PUMP INSTALLATION, MAINTENANCE, AND REBATE PROGRAMS

- The California Public Utilities Commission, California Energy Commission and utilities could develop midstream incentives to encourage contractors, retailers, and technicians to promote heat pump installations.
- The California Workforce Development Board could develop and support installer training programs for heat pump installations and could pre-qualify contractors.
- The state legislature could bolster existing SB 1477 funding efforts in coordination with the California Public Utilities Commission to provide customers and consumers with better technical assistance.
- Advocates and government officials could rebrand heat pumps to be more easily understood by average consumers.


27
Mode
Quiet
Auto Clean
Temp
Fan
good sleep
On Timer
Time Up
Set
Off Timer
Time Down
Cancel

II. OVERVIEW: HEAT PUMPS PRESENT A KEY CLIMATE SOLUTION

HEAT PUMP TECHNOLOGY IS A STRAIGHTFORWARD METHOD TO IMPROVE BUILDING ENERGY PERFORMANCE

Heat pumps use a long-established technology to create a highly efficient way to provide space and water heating and cooling. In the summertime, they work like any other AC unit (or refrigerator), using electricity-powered compressors to remove heat from the air inside and push cooled air back into the building. In cooler months, heat pumps instead draw heat energy from outside air and move it into buildings to provide warmth. Heat pumps deliver cooling and heating efficiently, using half as much energy as other electric home-heating sources, on average.[7] Yet heat pumps are currently used in less than 6 percent of new home construction in California and are installed at an even lower rate in existing buildings.[8]

Heat pumps function by moving heat for a specific purpose, in contrast to traditional technologies that generate heat by combusting a fuel source, an inefficient conversion process in which any gas-powered furnace or boiler will waste some energy.[9] By eliminating the need for on-site combustion of gas and offering air conditioning services, a heat pump functions as a single unit to reduce greenhouse gas emissions and improve in-home air quality.[10]

This report focuses on the following heat pump applications:

- Electric heat pumps for space heating and cooling, which as described above provide energy-efficient methods to transfer heat either in or out of a building and dehumidify better than standard central air conditioners, resulting in less energy usage and increased comfort.

- Heat pump water heaters, which employ the same technology as heat pump space heating systems to create hot water, are two to three times more efficient than conventional electric resistance water heaters, and are generally cost-competitive with fossil fuel-powered systems.[11]

The most common type of heat pump is the air-source heat pump, which transfers heat between the house and outside air through either a ducted or ductless (i.e. "mini-split") system. Geothermal heat pumps transfer heat between the house and the outside ground or a nearby water source, typically by pumping water underground to absorb or shed heat relative to the outside air temperature. Although geothermal heat pumps cost more to install, they have low operating costs because they take advantage of relatively constant ground or water temperatures, as opposed to the fluctuating and often more extreme outside air temperature.

Heat pumps have advanced greatly over the past decade, largely due to technological innovations and increased investment in research and development.[12] Two-speed compressors allow heat pumps to operate close to the heating or cooling capacity needed at any particular outdoor temperature, saving energy by reducing compressor wear. Two-speed heat pumps also work for zone control systems, often seen in multi-unit dwellings or homes with climate controlled rooms. Zone control systems utilize humidity dampers to allow the heat pump to keep different rooms at different temperatures. Some models of heat pumps are equipped with variable-speed or dual-speed motors on their indoor fans to keep the air moving at a comfortable velocity. Newer motors can also minimize drafts and noise and maximize electrical savings. Finally, improvements in the refrigerants used for heat pump technology--which new California Air Resources Board regulations will require to cut global warming potential (GWP) by over half by 2030—will greatly improve the appliances' emissions profile.[13]

HEAT PUMPS ARE A KEY PART OF CALIFORNIA'S BUILDING DECARBONIZATION EFFORT

As California leaders seek improvements in all sectors to meet the state's climate goals of reducing greenhouse gas emissions 40 percent below 1990 levels by 2030, doubling building energy efficiency savings by the same date, and achieving statewide carbon neutrality by 2045, they have begun to recognize building decarbonization as a central component of state strategy.[14] According to recent reports, the state is not currently on pace to meet its greenhouse gas reduction targets.[15] With mobile source and wildfire emissions increasing, regulators and legislators are increasingly focusing on stationary and area sources like the built environment. Building electrification—replacement of gas-powered appliances with electric-powered systems—is essential to achieving state greenhouse gas emission reduction targets.[16] Furthermore, electric heat pumps will only become more efficient and cleaner as the renewable energy mix of the electricity supply gradually increases.

In order to meet the ambitious emission reduction targets, building owners and industry will need significant policy support. Buildings are responsible for 10 percent of direct emissions (from on-site fuel combustion and leakage) and 25 percent of systemwide emissions (including direct and electricity generation emissions).[17] Currently, more than 90 percent of California's furnaces and water heaters run on gas or propane.[18] The California Air Resources Board's recent Draft 2022 Scoping Plan Update noted the challenge facing the building sector, stating "[a]chieving carbon neutrality must include transitioning away from fossil gas in residential and commercial buildings, and will rely primarily on advancing energy efficiency while replacing gas appliances with electric alternatives."[19]

California's new energy code will require heat pumps in new buildings

In 2021, the California Energy Commission approved the first building code in the nation to include highly efficient electric heat pumps as a baseline technology.[20] As the state's energy policy agency, the Energy Commission was tasked by the Warren-Alquist Act in 1974 with periodically updating and adopting building standards to increase energy efficiency of buildings and reduce greenhouse gas emissions.[21] The Energy Commission proposes (and the California Building Standards Commission adopts) Building Energy Efficiency Standards (also known as Title 24) updates every three years for new construction and renovations to existing buildings. By January 2023, the code will require new homes and buildings statewide to be equipped with at least one highly-efficient heat pump for space or water heating or face higher energy efficiency requirements.[22] If builders use any gas appliances, the code requires them to offset the higher emissions with additional efficiency measures. These provisions will deliver considerable climate and air quality benefits. Buildings must also be "all-electric ready" in order to help owners avoid costly panel and wiring upgrades down the line.[23]

Yet the Title 24 standards apply only to new construction and not the 14 million existing residential homes.[24] With state analysts expecting that currently existing buildings will still constitute half of the building stock in 2050, California will need to retrofit millions of homes to reach state climate targets.[25] The Energy Commission's recent Integrated Energy Policy Report (IEPR) set an ambitious goal of installing at least 6 million heat pumps by 2030.[26] The California Air Resources Board's Draft 2022 State Strategy for the State Implementation Plan also targets that zero-emission heat pumps should be used for all new space and water heaters (for either new construction or replacement of burned-out equipment in existing buildings) beginning in 2030.[27] Given that the current operating lifespan of water heaters is approximately 10 to 15 years, and even longer for HVAC equipment, state leaders will need to align policy signals and financial incentives to dramatically increase adoption of heat pumps in existing buildings.

Additional state policies support heat pump deployment

Significant state legislation has supported heat pump deployment in recent years. In 2015, Senate Bill (SB) 350 (De León) directed the Energy Commission to develop a plan to double building energy efficiency savings by 2030, in connection with other state clean energy goals.[28] Assembly Bill (AB) 3232 (Friedman, 2018) directed the Energy Commission to assess the state's potential to reduce building emissions 40 percent below 1990 levels by 2030.[29] The commission's subsequent AB 3232 assessment

concluded that "reducing direct emissions – which are largely due to onsite use of fossil gas – will require large-scale deployment of electric heat pumps."[30]

SB 1477 (Stern, 2018) directed the California Public Utilities Commission (CPUC), in consultation with the Energy Commission, to develop programs aimed at reducing greenhouse gas emissions associated with buildings. The bill created two programs to accelerate heat pump deployment for Californians: Technology and Equipment for Clean Heating (TECH) and Building Initiative for Low Emissions Development (BUILD).[31] The TECH Initiative, administered by the Public Utilities Commission, focuses on existing buildings, and provides consumer education, workforce training, incentives, and other market development support for low-emission space and water-heating technologies.[32] The BUILD Program, administered by the Energy Commission, provides incentives and technical assistance to support the adoption of advanced building design and all-electric technologies in new, low-income all-electric homes.[33] For initial funding, TECH received $120 million and BUILD received $80 million over four years from the state's cap-and-trade program. Both programs are implemented by teams of third-party organizations selected through competitive solicitations.

The first BUILD implementation plan went into effect in early 2022.[34] BUILD projects are limited strictly to new residential projects that are all-electric and have no hookup to the gas distribution grid. Additionally, all required and eligible technologies must be installed at homes that are permanently fixed to the foundation, excluding mobile homes.[35]

The TECH program aims to be the state's flagship heat pump market transformation initiative for space and water heating, designed to integrate with and complement other existing incentive programs. The program is open to single- and multi-unit residences within investor-owned gas utility (IOU) territories, which covers almost the entirety of the state, and will direct at least 40 percent of program benefits directed towards low-income and historically disadvantaged communities.

TECH includes three simultaneous efforts:

- First, the program focuses on the technology supply chain by providing midstream incentives for heat pumps and offering workforce training to interested contractors.
- Second, through six regional pilot programs and the annual "Quick Start Grant" solicitation, TECH funds smaller-scale pilot projects that test potential solutions to market barriers to widespread heat pump deployment.
- Finally, cost data from all TECH-funded appliance installations, along with the pre-and post-installation meter data at that residence and information on greenhouse gas impacts, will be posted on a public database to enable public analysis supporting future building decarbonization policies.

LOCAL AND UTILITY PILOT PROGRAMS

In addition to statewide programs, utility and local leaders are implementing pilot programs concurrently. Examples include:

- Marin Clean Energy's Low-Income Family and Tenants Program for multifamily residential buildings, funded through the Energy Savings Association Program budget[134];
- Pacific Gas & Electric and Southern California Edison Wildfire Rebuild Program, which provides incentives for customers to go "above code" by pursuing all-electric construction through the installation of heat pump water heaters and heat pump HVAC technologies, heat pump dryers, and induction stoves in structures destroyed by wildfires[135];
- Southern California Edison's San Joaquin Valley Affordable Energy Pilot, wich funds heat pump water heaters and heat pump HVAC technologies in low-income homes in California City, Ducor, and West Goshen that are currently using wood or propane for heating. Notably, the pilot also includes tenant protections: if the utility installs the new appliances, the landlord must agree not to raise rent beyond average or evict for 5 years after the retrofits.[136]

TECH incentives and offerings became available in December 2021 and are currently available in Pacific Gas & Electric (PG&E) and Southern California Edison (SCE) electric utility territory, as of May 2022. While TECH is still in the process of launching and reaching both local governments and building owners, the program's implementation will address many of the barriers discussed herein.

HEAT PUMPS PROVIDE SIGNIFICANT CO-BENEFITS FOR BUILDING RESIDENTS

In addition to reducing carbon emissions, replacing gas appliances with heat pumps brings indoor air quality benefits, reduced operating costs, and more affordable air conditioning during extreme heat events. Indoor combustion of gas in appliances emits a wide range of pollutants, including carbon monoxide, nitrogen oxide, particulate matter, and formaldehyde, which can cause asthma and other respiratory illnesses with annual impacts in the billions of dollars.[36]

California (like all other states and the federal government) has no residential indoor air quality standards, limiting the ability of regulators to address any specific pollutants. While the California Division of Occupational Safety and Health (Cal/OSHA) has authority over indoor air quality for workplace settings, residential indoor air quality has not been a topic of public health concern until recently.[37] The indoor air quality and public health benefits from heat pumps will be particularly significant for those living in California's extreme climates (especially cold climates), who are at high risk from harmful indoor air pollution due to their greater reliance on gas appliances for temperature regulation. Given that heat pumps continue to prove reliable in colder climates, the comparably warmer California climate should be well-suited for the technology.

The California Air Resources Board and regional air districts have also begun to address space and water heater emissions as part of pollution reduction strategies by shifting toward cleaner heat pump technology. Space and water heaters are the greatest source of nitrogen oxide (NOx) emissions in the building sector, and unlike other appliances, vent directly outdoors into the ambient air, affecting the local and regional air quality. Nitrogen oxides are a key criteria pollutant as a precursor to ozone and secondary particulate matter formation, which impacts lung and cardiovascular health. The California Air Resources Board Draft 2022 State Implementation Plan proposed a zero-emission standard at the point of sale for space and water heaters.[38] Air districts throughout the state, including the Bay Area Air Quality Management District, are considering zero-NOx appliance standards for space and water heating with compliance dates ranging from 2027 to 2031 based on equipment type, use, and size.[39] The zero-NOx standards would essentially mandate electric heat pump systems upon replacement of existing furnaces.

Heat pumps also offer reduced operating costs. The efficiency of the heat pump means that it costs less to operate in the long term, as compared to a less-efficient gas water heater or a gas furnace plus electric air conditioning.[40] Heat pumps can also provide resilience to extreme heat events by offering more affordable air conditioning, improving home comfort in the process.

Finally, heat pumps can be enabled to help automate usage and help efficiently manage the grid. In Connecticut, for example, an electric utility successfully piloted a demand response program with heat pump water heater users, curtailing power during cold weather to save energy and ensure the grid remained stable.[41]

FINANCIAL AND INFRASTRUCTURE BARRIERS LIMIT HEAT PUMP INSTALLATIONS, ABSENT POLICY SUPPORT

Despite the increasing availability and long-term cost-effectiveness of heat pump technologies, economic barriers remain. While new all-electric construction saves money by foregoing the often expensive gas piping infrastructure required, retrofitting older buildings with heat pump technology may require owners to upgrade their electric panels to meet the increased new demand in electric usage and add electric wiring through existing walls.[42]

Even with incentives and rebates, high upfront costs to install heat pump technologies can be cost prohibitive.[43] According to one recent analysis of life-cycle costs, a heat pump HVAC unit can save users up to $550 per year compared to a gas-combined system.[44] However, increased upfront costs and increased electrical costs can negate those savings:

- When customers retrofit a residence, a ductless heat pump can cost them between $3,500-$5,500 in non-capital construction costs for the price of electrification and envelope improvements.[45]
- A heat pump water heater can require $800-$1,000 in non-capital construction costs.
- Panel upgrades or distribution upgrades can cost up to $6,000 in non-capital construction costs, and gas utilities can charge upwards of $500 just to turn off no longer needed gas service.[46]

When upgrading paneling (e.g., from 100 amperes to 200 amperes to accommodate higher electrical loads), an installer typically must obtain a permit from the appropriate jurisdiction and coordinate with the local utility.[47] It can take three to six months to accommodate the additional work for both water and space heaters. If building owners and residents need more extended remodeling or electrical work, such as for wiring, ductwork, and venting changes, they are more likely to be dissuaded from investing in heat pump technology.

Additionally, existing utility rate structures may not compensate customers for the demand flexibility they might provide by using this electric technology at off-peak times (i.e. via lower rates for off-peak usage), which diminishes customers' ability to offset the cost of a heat pump retrofit when factoring in increased electrical demand. These high capital and installation costs mean that an owner's heat pump retrofit investment can take years or even decades to generate financial savings. Residents with limited access to capital may therefore be unable to afford the project altogether without financial assistance.

If a building owner or operator is interested in installing a heat pump, they may encounter some upfront electrical or physical infrastructure issues such as:

- Limited electrical panel capacity to handle increased load from heat pump installation and any other electric appliances
- Space limitations for indoor/outdoor heat pump space or water heater equipment (gas furnaces generally only have one relatively small indoor component to heat a building; an electric heat pump needs to have both an indoor and outdoor component)
- Limited path to transport or handle a larger tank inside a building, existing structural conditions, and outdoor placement challenges
- Piping connections for heat pump water heaters
- Extra coordination with subcontractors for new equipment
- Increased maintenance costs to ensure maximum operational efficiency

However, solutions exist to address electrical infrastructure limitations. While an expense, smart panels and other load-balancing technologies—which can monitor and control circuits within a home to deliver energy to appropriate locations at appropriate times based on factors such as electricity prices, demand, and capacity—allow for more dynamic home energy management. These smart panels can help solve grid reliability issues and provide peace of mind for building owners. Smart panels enable electrification without electrical service or transformer upgrades, if the existing electrical infrastructure cannot support increased loads. However, there are limited incentives for smart panels or underlying upgrades.


SECONDARY
RETURN

III. VISION FOR EQUITABLE & AFFORDABLE HEAT PUMP ADOPTION IN EXISTING BUILDINGS

Participants in the January 2022 convening offered a vision for a prioritized, structured effort to deploy heat pump technologies in existing buildings. The plan would optimize public and private resources across the demands of environmental and equity promotion and economic efficiency. This vision would also provide streamlined financial support that could reach customers before the time of purchase, and facilitate development of the workforce that installs and maintains the technology.

Implementing this vision would result in heat pump installation in all existing building retrofits. Success would mean all consumers have a simple, easy path from heat pump purchase to installation (especially in urgent replacements and when rebuilding after wildfire events), with full incorporation in the latest building codes and standards for new construction.

As millions of heat pumps become ubiquitous in the building stock, they will help reduce gas usage in buildings while increasing total electricity consumption from buildings. Any successful vision must include seamless integration with the state's electrical grid, including the buildout of resilient power generation and energy storage to meet the increased load from heat pumps.

The group also identified the top-priority communities and needs for electrification that maximize environmental, equity, and economic goals as a starting point for this effort.

HIGH-PRIORITY AREAS INCLUDE:

1. Communities with a high proportion of renters, including low-to-moderate income housing, schools, community centers, and workplaces.

2. Residents in hotter climate zones without air conditioning, to support the "right to cooling," as well as residents in the coldest climate zones which use gas-powered space heating most often.

3. Lower-income and disadvantaged communities that are most harmed by the health impacts of gas, propane, and wood combustion, as well as communities who stand to benefit the most from investments in clean, resilient, and affordable technologies, including tribal communities, mobile-home communities, and communities that meet the Public Utilities Commission's definition of "environmental and social justice communities"[48] and the state definition of "disadvantaged communities," per the California Office of Environmental Health Hazard Assessment CalEnviroScreen 4.0[49] screening tool.

4. Communities with existing gas infrastructure near the end of its useful life that are in need of near-term replacement, which allow for the deployment of incentives for heat pumps as a non-pipeline alternative.

5. Communities rebuilding from wildfires that require new utility distribution infrastructure to return to service, such as those in the Wildfire and Natural Disaster Resiliency Rebuild program (WNDRR).[50]

6. Communities using wood-burning for heat that are not connected to existing gas lines.

The solutions identified in the following section seek to implement the vision described above with a primary focus on these high-priority areas.

IV. BARRIERS AND PRIORITY POLICY SOLUTIONS

Participants at the January 2022 convening identified a range of barriers to achieving their vision for widespread heat pump adoption in existing buildings, prioritizing the high-priority areas such as lower-income or other disadvantaged communities. The group then discussed foundational policy, finance, and workforce solutions to address inconsistencies within state and local requirements, as well as high upfront purchase and installation costs and workforce transition concerns.

THE BARRIERS CENTERED ON FOUR THEMES:

- A lack of consistent state policy on existing building heat pump installation, including in existing legal and regulatory requirements and long-term planning timelines
- A need to center equity in heat pump deployment to prevent unintended consequences, such as displacement and increased cost burden
- High upfront costs that increase the need for public funds and financing solutions
- A lack of information and training to adequately support a skilled workforce and consumers with knowledge of heat pump installation, maintenance, and rebate programs

This section describes those barriers in detail and highlights the top-priority policy solutions participants identified to overcome them.

BARRIER: A LACK OF CONSISTENT STATE POLICY ON EXISTING BUILDING HEAT PUMP INSTALLATION, INCLUDING IN REGULATORY REQUIREMENTS AND LONG-TERM PLANNING PROCESSES

While the state legislature and energy regulators have established aggressive greenhouse gas emission reduction targets and long recognized the clear link between achieving those targets and electrifying the building stock, California still lacks clearly defined state policy supporting a transition to electrification.

AB 3232 and SB 1477 have provided foundational steps, but the state's building energy efficiency codes, utility regulations, and energy efficiency and affordable housing policies still fall short of demonstrating robust support for heat pump retrofits in existing buildings. At the same time, electrification advocates are collaborating with local governments to advance phase-out ordinances that will accelerate heat pump deployment. However, local phase-outs create a patchwork of rules, presenting challenges for regional infrastructure planning.

Solution: The legislature could require a clear statewide building decarbonization roadmap that prioritizes heat pump adoption, including a deadline for phaseout of fossil fuel appliance sales, such as through a zero-emission standard.

Participants reinforced the need for a statewide building decarbonization mandate with accountability metrics. Any potential future statewide building decarbonization roadmap could determine ways to mandate and further incentivize heat pump adoption. This roadmap could operate similarly to the ways that previous California programs (e.g. Renewable Portfolio Standard, SB 350, and AB/SB 32) require renewable energy resources, lower emission technologies and electric vehicle deployment through holistic, economy-wide strategies. The legislature could affirm regulators' legal authority to require heat pumps and all-electric appliances in existing structures.[51]

Multiple agencies are currently addressing different portions of the building electrification question. The California Air Resources Board 2022 State Strategy for the State Implementation Plan will be voted on this year and could require zero-emission heat pumps for all new space and water heaters beginning in 2030. Regional air districts similarly address appliance emissions, and the California Energy Commission will implement their aggressive Title 24 standards beginning in 2023. Additionally, more than 50 California cities and municipalities have adopted all-electric building codes to expedite deployment of heat pumps for new construction.

Going forward, comprehensive statewide policy could provide market certainty by including a clear phaseout date for fossil fuel appliance sales, such as through developing a new zero-emission standard that would ultimately ban the sale of new fossil-fuel appliances.[52]

For example, the City of Oakland, East Bay Community Energy, AEA, Eden Housing, and other stakeholders are working together to accomplish the ambitious goal of electrifying all existing buildings in Oakland by 2040.[53] The governor could bring similar stakeholders together alongside agency leaders to craft a roadmap that outlines California's plan to achieve installation of six million heat pumps.

Additionally, the legislature could take leadership on crafting a roadmap. Participants noted the need to eliminate legal barriers to reducing gas service, such as by clarifying the utility's obligation to serve.[54] In California, the Public Utilities Code requires energy utilities to "furnish and maintain . . . adequate, efficient, just, and reasonable service" for customers in their service territories.[55]

Because utilities may violate their obligation to serve by terminating or phasing out gas service in areas whenever one customer remains on the gas system, the legislature could provide critical clarity around legal obligations, resource planning and targeted outreach is critical. The legislature could amend the law to explicitly determine a reasonable service timeline for customers and service areas. This would allow utilities to communicate clearly with ratepayers, informing them of the substitute service provided by electricity and heat pump technology. Currently, this process grants customers certain due process rights, including notice and an opportunity to be heard prior to service termination. Reforming these requirements while protecting customers would allow for more rapid heat pump deployment.

Solution: The legislature and California Public Utilities Commission could reform the existing rate structure to support heat pump deployment.

Heat pumps provide a household with an additional form of energy storage capacity. The heat pump can use the cheapest and cleanest electricity to prepare for household needs at other times of day. For example, a heat pump water heater can utilize times of high solar energy production and store that energy in the form of hot water. Later in the evening, the hot water is ready for use without having to use more electricity at times of greater demand and lower available renewable energy. This form of energy storage reduces overall grid costs and saves ratepayers money.

However, existing electricity rate structures and projected rate increases do not entirely comport with this optimistic view of energy storage. Current rate structures have not integrated dynamic energy storage possibilities. As a result, customers may be discouraged from adopting heat pump technologies if they cannot see a reduction in utility bills. While customers who install heat pumps save significant costs on gas, increased electrical demands can cost customers more in the long-run.[56] Even with a complete reduction of gas, heat pump space heaters and water heaters result in slight bill increases for electricity. The efficiency benefits of electric heat pumps result in substantial greenhouse gas reductions, but are fairly minor on an overall wattage scale. Customers will remain in the same tier of electricity demand, or go into higher tiers.

Participants suggested a myriad of solutions to address these challenges, including:

- The Public Utilities Commission could work with utilities to ensure all heat pumps enroll in demand response programs to aggregate load management benefits. Recently, the Public Utilities Commission expanded the Self-Generation Incentive Program (SGIP) Heat Pump Water Heater program by $40 million, for a total budget of $84.7 million.[57] The SGIP program requires that the water heater owner enroll in a demand response program. To manage water heating needs and the grid, the program requires the ability to pre-heat water during off-peak hours when electricity use is low, avoiding added grid strain during peak hours. Half of the funding is dedicated solely to low-income utility customers, and incentives are also available for

electric panel upgrades and refrigerants with low global warming potential (GWP). Managing the load of heat pumps could bring significant grid benefits to California, especially during times of extreme weather. The California Independent Service Operator (CAISO) and California Energy Commission could also assist in forecasting demand response benefits.

- Utilities could consider cost-based time-of-use volumetric rates with larger time-of-use price differentials that accurately reflect grid costs and greenhouse gas emissions, so heat pumps can net greater savings depending on their usage pattern. The "volumetric rate" is the price that a customer is charged for each unit of electricity used from the grid, and it is usually expressed in terms of dollars per kilowatt hour ($/kWh).[58] Residential electric bills are usually determined by volumetric rate, which are electricity costs that vary due to electricity use. The more electricity (i.e. kilowatt hours) used, the higher this portion of the bill. The traditional volumetric rate incorporates the costs of generating and delivering electricity, as well as other grid investment and public policy costs. By designing rates with an increased time-of-use differential reflective of greenhouse gas emissions, utilities could incentivize heat pump adoption because heat pumps are more efficient and use less electricity. The time-of-use rates could better reflect time-dependent generation and distribution costs, as well as incorporate the greenhouse gas impact of electricity generation.
- The Public Utilities Commission could direct electric utilities to develop advanced dynamic rates within its Long-Term Gas Planning Proceeding.[59] This would increase the financial benefits of electrification by compensating customers for real-time use changes in response to grid needs.
- The legislature, in coordination with energy regulators and utilities, could redefine panel upgrades as a regulatory asset in order to help utilities spread the costs out over the life of the upgrade. A regulatory asset is a specific cost of service recovery that a regulatory agency permits an energy utility to include on its balance sheet, allowing more aggressive financing of projects.
- The legislature, in coordination with energy regulators and utilities, could create a smart electrical panel incentive program to support existing homeowners to take the initial steps towards building electrification and heat pump adoption.

Solution: The California Department of General Services could use its buying power to increase investor confidence in the heat pump marketplace.

Because the State of California owns and has master contracts for thousands of buildings, the state's purchasing power on large-scale contracts could help build the marketplace by purchasing thousands of heat pumps. Participants noted that the Department of General Services (DGS) could assist with purchasing heat pumps at scale and help school districts, housing authorities, local governments, and hospitals to purchase heat pump technologies.

Currently, the Department's Office of Sustainability develops and implements strategies and programs for state facilities, including energy efficiency retrofits and electric vehicle charging infrastructure. As outlined in their 2022-2023 priorities, the Department of General Services plans to "complete energy retrofits to achieve energy savings and decrease the state's carbon footprint."[60] The Department's previous leadership in fleet and asset management has advanced electric vehicle charging infrastructure, highlighted by the more than 35 state facilities that now offer vehicle charging options.[61] Since the Department oversees the state's building stock and reutilization of state and federal surplus property, it has many opportunities for integrating heat pump technology into baseline requirements.

Solution: The California Air Resources Board, Public Utilities Commission, and utilities could develop a refrigerant management program that supports heat pump deployment.

Some participants noted the importance of ensuring the continued reduction of heat pumps' climate footprint. While significantly cleaner than gas appliances, each heat pump uses some form of refrigerant to operate. These refrigerants are often hydrofluorocarbons (HFCs) with high global warming potential (GWP). Therefore, policymakers will need to develop a phaseout timeline for high-GWP refrigerants in existing buildings to support development of low-GWP refrigerants. The state could also identify financial assistance for low-income residents and businesses and align those incentives with refrigerant management strategies. As a starting point, the California Air Resources Board has a robust database on low-GWP incentive programs offered by utilities and local governments.[62]

The state could also support manufacturers in developing low-GWP refrigerants. As part of the Public Utilities and Energy Commissions' efforts to decarbonize buildings, the agencies could incentivize heat pump equipment that uses low-GWP refrigerants and space and water heating equipment that uses mid-range GWP refrigerants. The Public Utilities Commission defines "high-GWP" refrigerants as those with a GWP above 750, consistent with the Air Resources Board's recent regulatory proposal for new stationary air conditioning systems starting January 1, 2023.[63] California Senate Bill 1013 also requires the California Public Utilities Commission, Energy Commission, and the Department of Housing and Community Development to consider offering incentives for low-GWP refrigerants in their existing energy efficiency programs.[64]

Washington state provides a model for action. Governor Inslee signed House Bill 1050 in 2021 to direct state agencies to set a maximum global warming potential for HFCs used in new stationary air conditioning equipment.[65] The new law also established a state purchasing and procurement preference for recycled refrigerants and required the consideration of HFC emissions in mandatory utility conservation activities and in codes adopted by the State Building Code Council.[66]

Solution: The legislature, California Air Resources Board, and California regional air districts could regulate gas-fired furnaces and water heaters, or regulate baseline indoor air quality in residential and commercial buildings.

Participants discussed the role of both the California Air Resources Board and regional air districts in addressing gas-fired furnaces and water heaters. Most notably, the California Air Resources Board Draft 2022 State Implementation Plan proposed a zero-emission standard at the point of sale for space and water heaters.[67] Regional air districts have authority to regulate stationary and area sources, and therefore air districts can adopt rules and regulations to implement zero-nitrogen oxides (NOx) emission standards for furnaces and water heaters. The Bay Area Air Quality Management District's proposed rules 9-4 and 9-6, which are currently in development, limit emissions from natural gas-fired fan type residential central furnaces, and they are considering zero-NOx appliance standards for space and water heating with compliance dates ranging from 2027 to 2031 based on equipment type, use, and size.[68] The zero-NOx standards would apply to appliance manufacturers, retailers, wholesalers, and installers and would affect consumers when they replace their existing furnaces. These rules would essentially mandate electric heat pump systems at the time of replacement, and the Bay Area Air Quality Management District expects to hear the rule during the fourth quarter of 2022. Ultra-low-NOx combustion technology is already required for furnaces in the South Coast Air Quality Management District, and the South Coast is considering a host of building electrification regulations through their 2022 Air Quality Management Plan.[69]

Additionally, the legislature, in coordination with the California Air Resources Board and local air districts, could establish indoor air quality standards for California. The Air Resources Board has authority to regulate indoor air cleaning devices.[70] The legislature and the Board could coordinate to expand authority to all indoor appliances that combust fuel. As the building sector contributes a growing percentage of NOx emissions statewide, air districts are pushing for more stringent action on residential gas-fired appliances. Additionally, the Air Resources Board could include a formal finding on the timeline of reduction in natural gas use necessary to achieve state climate goals as part of upcoming policies and decisions, such as the AB/SB 32 Scoping Plan Update.[71] Including formal findings could inform utility planning processes and state infrastructure funding decisions, helping air districts take action to require electrified appliances in service of both indoor air quality and criteria pollution reduction. At a time when California's nonattainment air districts (South Coast and San Joaquin Air Quality Management Districts) are searching to reduce sources of pollution, the building sector is a priority source that policymakers, utilities, and nonprofit organizations are all rallying behind. State and regional leaders could harmonize indoor air quality standards with state and local buildings codes to limit indoor combustion.

BARRIER: BUILDING ENERGY UPGRADES RISK TENANT DISPLACEMENT AND INCREASED COST BURDENS AMONG LOWER-INCOME CALIFORNIANS

As heat pump technology scales, policymakers will need to ensure higher costs and mandates do not fall on low-income communities and renters. The transition to heat pumps in existing buildings should proceed in an equitable manner that ensures affordability for those least able to bear increased housing or energy costs. Local governments administer and enforce tenant protection policies that are either local, state, or federal in nature. Protecting tenants in existing rentals, and especially low-income housing, is critical consideration in electrifying California's building stock. As developers deploy heat pumps and undertake building upgrades, these installations pose specific threats to low-income renters being displaced or suffering from additional rent burdens.

Today, 45 percent of Californians are renters and approximately 25 percent are living on low to extremely low incomes.[72] More than 33 percent of the state's residents are enrolled in the California Alternate Rates for Energy (CARE) program, which provides discounts on both electric and natural gas bills.[73] Lower-income residents are more likely to rent and to live in multifamily housing than higher-income Californians, reducing their ability to invest in electrification—even as lower-income communities are often disproportionately affected by the health impacts of home natural gas use due to smaller, older housing stock and limited ability to maintain and replace older appliances. Over one quarter of California's homes predate the initial 1978 residential energy efficiency standards, and the vast majority were built before the 2000s, highlighting the challenge posed by the state's older housing stock.[74]

Renters generally lack the property rights to make the decision to adopt heat pumps. Yet owners have few incentives to invest when renters pay the utility bill. Improvements like adding heat pumps primarily produce benefits for the person paying the bills, while the cost of the improvement falls to the owner.[75] This dynamic creates a "split incentive" that prevents greater adoption. The split has long stood in the way of energy retrofits in tenant-occupied buildings. California may be able to adopt some lessons learned on how to tackle the split incentive from existing energy efficiency programs.

Solution: The California Public Utilities Commission and electric utilities could enhance on-bill financing to overcome the landlord-tenant split incentive barrier.

As landlords are typically responsible for capital investments to a property, state, utility, and local government entities could incentivize them to invest in rental housing upgrades if they can reduce the "split incentive" barrier. The state could outline a policy roadmap of how property owners can recoup investments in the tenant's habitability while protecting rental stability.

In many commercial landlord agreements, the landlord can recover cost through amortizing tenant improvements, which allows the landlord to charge the tenant for upgrades over the duration of the lease term. In commercial leases,

energy upgrades by the landlord can pay for themselves through cost savings well before an owner has been repaid through amortization. Other times, commercial landlords can choose to avoid amortization and other payback mechanisms in favor of adopting lease language that allows the landlord to recoup all operational savings resulting from energy efficiency improvements, up to the point where the landlord has been repaid for their original expenditures.

Generally, residential landlords can only recover the costs of upgrades through specific mechanisms. Participants noted that California electric utilities could adopt tariffed on-bill financing or repayment programs to remove the onus from landlords and allow the utilities to invest in upgrades. A tariffed on-bill program allows a utility to pay for cost-effective energy improvements and recover costs for the improvements over time through a dedicated charge on the utility bill that is immediately less than the estimated savings from the improvements.

First, California electric utilities could adopt tariffed on-bill financing or repayment programs to recover costs. A tariffed on-bill program allows a utility to pay for cost-effective energy improvements and recover costs for the improvements over time through a dedicated charge on the utility bill that is immediately less than the estimated savings from the improvements.[76]

The tariffed on-bill model differs from on-bill loans and repayment models in that tariffs are not a loan, but rather a utility investment for which cost recovery is tied to the utility meter according to terms set forth in a utility tariff.[77] The Public Utilities Commission proceeding R.20-08-022 addresses financing and the package of programs where tariffed on-bill finance is possible.[78] In Northern California, advocates have begun work to expand PG&E's on-bill financing program to include residential customers in addition to businesses.

One model, based on the Pay As You Save system, has been successfully implemented in 8 states by 18 utilities.[79] Investor-owned, cooperative, and municipal utilities have all participated, and more than 5,000 properties have been upgraded.[80] Utilities offering tariffed on-bill financing programs reported high adoption rates for building energy efficiency upgrades and low rates of nonpayment, even in areas characterized by conditions of persistent poverty.

State leaders should consider bolstering existing financing programs aimed at scaling multifamily energy efficiency deployment. The GoGreen Affordable Multifamily Energy Financing Program offers homeowners, renters, business owners, and affordable multifamily property owners access to financing.[81] GoGreen is a California state-administered program, in partnership with electric utilities, and aims to offer favorable terms and expedited approvals to help deploy energy efficiency technology, such as heat pumps. The California Hub for Energy Efficiency Financing (CHEEF), an arm of the State Treasurer's California Alternative Energy and Advanced Transportation Financing Authority, is a public-private platform for contractors, private financial institutions, utilities, and state agencies to conduct transactions and share data supporting efficiency projects.[82] CHEEF enlists financial institutions (e.g., credit unions, banks) to provide credit enhancement instruments, and is funded by utility ratepayers through the Public Utilities Commission.

Overall, the goal of any tariffed on-bill financing mechanism should be to allow building owners the ability to finance over long periods of time (even in rental units with high turnover rates); leverage utility bill savings to defray investment costs (rather than rely on consumer credit or home equity); and ensure cash-positive outcomes that prevent low and moderate income customers from experiencing increased energy burdens.[83]

Solution: Utilities, local governments, and building owners could collaborate to implement green leases with heat pump deployment requirements for multi-unit and commercial buildings.

Commercial buildings account for a large portion of California's energy usage, and leased space is normally about 50 percent of all commercial building energy use.[84] While most of the equity concerns around building decarbonization focus on residential and multi-unit dwellings, commercial building emissions represent both a large source of emissions and a large number of low- and moderate-income business tenants.

Every rental lease agreement provides an opportunity to dictate payment responsibilities for utilities, infrastructure, and installations. Participants supported boosting the usage of 'green leases' to support both residential and commercial tenants paying for building decarbonization improvements. A green lease differs from a standard lease by having terms and conditions that advance sustainability goals, such as allowing the tenant and owner to share in cost savings once energy efficiency investments have been paid back.[85] Green leases can collaboratively transform buildings into higher-performing ones, allowing commercial tenants to invest in decarbonization technologies.

Green leases allow California commercial property owners the opportunity to work with industry leaders to improve energy efficiency and building health for workers, especially given the uncertainty of post-COVID return to work policies.[86] While people stopped coming to offices, commercial buildings did not see the energy use reductions expected. According to Johnson Control, less than 10 percent of organizations experienced an energy use reduction of greater than 20 percent during 2020.[87] During COVID, building owners and operators were bound by leases to maintain the same temperature standards as when the buildings were occupied, and they often faced barriers gaining access into tenant spaces. Heat pump technology allows for more easy temperature control and could provide solutions in specific commercial applications. Participants noted that a green lease rooted in transparency and partnership could improve tenant-landlord relationships to the point where they can collaborate to address future challenges and reduce emissions through deploying heat pump technologies.

In 2022, the federal Green Lease Leader program expanded to multifamily properties, with the recognition that green leases can also act to reduce energy inequity at a time when many residents are struggling to pay rent and utilities.[88] Unlike commercial leases, most residential lease agreements cannot include cost recovery clauses allowing amortization and recovery costs from residents due to short lease terms. Therefore, the split incentive barrier is

difficult to overcome in this market. As an alternative solution recommended through stakeholder engagement efforts, Green Lease Leader has added a new prerequisite specific to multi-unit dwellings family that focuses on implementing efficiency upgrades when units are vacant between residents. An additional barrier for multi-unit building owners is access to tenant utility data. Green Lease Leaders identifies example lease language that can be used to support transparency, help with compliance for benchmarking mandates, and assist data collection for ESG reporting, such as GRESB, while still maintaining tenant privacy.[89] Overall, green leases provide some opportunities for deploying heat pumps in commercial and multi-unit buildings. State leaders and electric utilities could educate landlords and tenants about the availability of green leases. While protecting security and privacy through masking and anonymizing data, electric utilities could target education campaigns to the largest energy users in hopes to maximize impact.

Solution: Local governments could implement renovation requirements for multi-unit dwellings to ensure heat pumps are installed whenever a primary or seismic renovation occurs.

Given the challenging magnitude of electrifying all existing buildings, deploying heat pumps whenever a building undergoes a permitted renovation provides an opportunity to address buildings incrementally. By requiring heat pump installations when either primary or seismic renovations occur as part of city building standards or a reach building code, local governments could protect tenants and conveniently integrate heat pumps. For example, the City of Santa Monica's Energy Reach Code is designed to encourage all-electric construction and renovations.[90] In Santa Monica's case, the Reach Code requires all-electric design, energy efficiency, and either heat pumps or higher efficiency standards if gas infrastructure is installed.[91]

Participants noted that when appliances fail in tenant-occupied dwellings, it is the tenants who suffer when space heating/cooling or water heating fails. Landlords and tenants want to get the appliance working immediately to avoid additional inconvenience. Because of the additional physical and energy infrastructure often needed to install a heat pump and the need to fix the appliance expediently, the technology does not get adopted. Installing a replacement gas appliance within a few days is a minor inconvenience, but a tenant cannot wait weeks or months without air conditioning or water heating for a heat pump solution. By requiring heat pump retrofits at the time of any significant renovation, this barrier can be reduced because the dwelling is normally unoccupied and installers can take appropriate time to install any needed paneling or electrical infrastructure.

If tenants are remaining in the unit after a primary renovation, determining who pays for the upgrade and how much of the costs are allowed to be passed through to the tenant become important policy considerations. The City of Los Angeles's Primary Renovation program allows landlords to recoup funds from tenants for insulation improvements, electrical panel upgrades, and heating or cooling system improvements.[92] This program allows an increase to a rent-stabilized unit's monthly rent beyond the allowable increase—up to

an additional 10 percent—to recoup the cost of approved retrofits.[93] Landlords can recover costs through this program once every five years. However, some participants worried about the potential risk of passing through primary renovation costs to tenants. Some recommended that local governments could mandate rents be maintained after renovations, in order to allow existing tenants to return without increased costs. Variations of protections would be needed, given different restrictions on rent-controlled, non-rent-controlled, and deed-restricted units.

Furthermore, to protect small 'mom-and-pop' landlords, local governments could create financial hardship exemptions or provide more information about heat pump incentive programs. If larger and corporate landlord investors were unable to electrify their buildings and deploy heat pump technologies, a linkage fee program could be implemented to support building electrification in disadvantaged communities. Additionally, local governments could prohibit subsidies for any property owners in current or previous violation of habitability within the Health and Safety Code.

Alternatively, local jurisdictions could also consider requiring heat pump deployment as a part of seismic retrofit programs. Currently, the California Earthquake Authority is investing in seismic hardening for soft-story buildings.[94] Existing funding for heat pump deployment could be leveraged into seismic safety retrofit buildings, and could alleviate pass-through cost issues. The City of West Hollywood's seismic retrofit ordinance banned pass-through costs for tenants.[95] Building owners in West Hollywood are responsible for the full price of the mandatory retrofits, but can petition for rent increases to cover costs if they can prove financial hardship from doing upgrades.[96] Similar justifications could be used for heat pump and building electrification upgrades, if supported by state resources.

DEPLOYING HEAT PUMPS WHILE PROTECTING AGAINST DISPLACEMENT

Local governments play a critical role in protecting low-income renters. As building decarbonization upgrades reach low-income housing, temporary and permanent displacement is a threat for renters on the edge of homelessness. Deploying heat pump technology in existing affordable housing will require targeted and thoughtful equity and anti-displacement considerations. Numerous community-based organizations, including Strategic Actions For a Just Economy, have assessed the needs of tenants for equitable deployment.[97]

Their recommendations include:

- Local governments could limit pass-through costs for decarbonization retrofits to rent stabilized tenants in covenanted affordable units, and explore ways to protect renters in non-rent stabilized units.
- Local governments could include relocation assistance and 'right of return' for tenants temporarily displaced by housing retrofits.[98]
- Local governments could protect renters in deteriorated housing conditions from displacement when demolition is suggested as a pathway to heat pump deployment.

Solution: The state legislature could direct the California Public Utilities Commission to use new ratemaking strategies to protect low-income Californians from over-paying for a legacy gas system.

If higher-income building owners switch to heat pumps and eliminate gas infrastructure, they risk leaving lower-income building owners to pay more to maintain the legacy gas grid. Continued investments in gas equipment have "a growing likelihood over time of becoming stranded assets and a liability for carbon offsets" according to the Energy Commission's 2021 Integrated Energy Policy Report assessment.[99]

By prioritizing low-income deployment and ensuring consistent implementation, policymakers can avoid a stranded gas system that passes along high costs to those least able to afford them. The California Air Resources recent Draft 2022 Scoping Plan Update noted the importance of centralized planning and aligned efforts, so the transition to electric appliances does not lead to low-income individuals paying for the entire gas delivery system. The Update noted that the "transition [to electric building appliances] must include the goal of trimming back the existing gas infrastructure, so pockets of gas-fueled residential and commercial buildings do not require ongoing maintenance of the entire limb for gas delivery."[100]

The California Public Utilities Commission could consider developing a "plus-up" as part of the CARE program to install heat pumps, where residents in disadvantaged communities could receive additional incentive funds on top of existing programs. In order to incentivize multifamily housing retrofits, the Public Utilities Commission could include heat pump integration in the Multifamily Affordable Solar Housing (MASH) program.[101]

Participants suggested that the legislature, along with California Air Resources Board, could consider dedicating Greenhouse Gas Reduction Funds generated by the state's cap-and-trade program to fund heat pumps for renters in disadvantaged communities most at risk for paying higher natural gas prices. Additional recipients could include communities suffering from higher levels of air pollution. Disadvantaged communities lacking access to both electrical or gas infrastructure could also receive priority, as they are reliant on propane or diesel generators. In addition to displacing natural gas, a subset of funds could prioritize replacement of other fossil fuel energy sources for vulnerable customers.

Participants also noted the importance of addressing mobile home space and water heating needs. Costs associated with replacing space or water heating in mobile homes can often exceed the value of the entire home. Solutions could include bolstering the CPUC Mobile-home Park Utility Conversion Program, which is entering a new phase to support future electrification of existing and manufactured homes. Creation of a Mobile-home Park Electrification Standard that supports replacing the entire unit will assist utility efforts to phase out gas infrastructure. Overall, participants emphasized the need to prioritize low-income communities with existing gas infrastructure nearing the end of its useful life.

Solution: The state legislature could create an all-electric "Right to Cooling" policy with funds to enable heat pump deployment for low-income Californians.

As climate change exacerbates extreme weather during the summer months, more California communities need quality space cooling to protect public health. The state legislature could update the current law—which requires any rental unit to have proper heating in order to be legally habitable—to include proper cooling capacity.[102] The policy could also require all-electric solutions as a means to prevent increased adoption of gas appliances. Legislators could update the current policy to focus on addressing human rights in a warming climate by setting a temperature or heat threshold requiring developers to include cooling as part of any building code update.

As a potential out-of-state model, Arizona law requires that all rental units must have "essential services," defined as "running water, gas or electrical service, or both if applicable, and reasonable amounts of hot water or heat, air conditioning or cooling, where such units are installed or offered."[103] This right to cooling is a baseline, and some parts of Arizona have specific standards that apply beyond this baseline. Considering that almost the entire state of California can now reach unsafe heat conditions, the legislature could set a similar statewide right to cooling and require building owners to install all-electric cooling solutions.

Solution: State agencies and local governments, in partnership with affordable housing owners and operators, could develop trust-building processes that ensure equitable heat pump deployment.

In order to overcome the landlord-tenant split incentive, renters first need to be motivated to seek these all-electric upgrades. Therefore, heat pump deployment success will depend on state, local, and industry leaders developing an outreach process that incorporates trusted sources and focuses on building relationships. Trusted sources, such as community-based or membership organizations, can help tenants interface with the electric utility or overcome digital or language barriers that prevent adoption or application. Also, many tenants need trusted resources to understand and work through lease provisions that can prohibit replacing appliances without landlord approval.

These trusted organizations can potentially identify preferred local contractors and retrofitters where available. Community-based organizations have played an integral role as part of the deployment of the Solar on Multifamily Affordable Housing (SOMAH) program and may provide lessons for establishing similar successful organizational infrastructure. The SOMAH program administrators selected local community-based organizations to interface with property owners, local government officials, and residents.[104] Building from the SOMAH model, utilities and local governments could find affordable housing owners and operators willing to participate in heat pump retrofits in a manner that educates residents and alleviates concerns. State officials may also look to convene community-based organizations about lessons learned from state and federal building weatherization programs, including the California Department

of Community Services and Development's Weatherization Assistance Program or the federal Low Income Home Energy Assistance Program.[105] Additionally, community-based organizations can work with utilities to find large affordable housing owners and operators, and determine which aging building stock to prioritize for heat pump replacement.

Participants noted the City of Oakland's Building Decarbonization plan, which included a Racial Equity Impact Assessment (REIA). An REIA is a systematic examination of how different racial and ethnic groups will likely be affected by a proposed action. The Oakland Building Decarbonization REIA took a citywide approach to addressing the concerns and questions of Black, Indigenous, and people of color (BIPOC) customers, businesses, and communities.[106] While the City's efforts are ongoing, the process provides a model for the state and other jurisdictions to use.[107] Ultimately, outreach leaders will need to center heat pump programs in a community-driven process that will build trust within vulnerable communities.

BARRIER: HIGH UPFRONT COSTS INCREASE THE NEED FOR PUBLIC FUNDS AND FINANCING SOLUTIONS

The greatest barriers to rapid heat pump deployment may ultimately be high upfront costs and long payback periods. While heat pumps can offer clear life-cycle cost savings, homeowners and tenants may be limited by infrastructure upgrade costs and availability. Homes often need to increase electrical capacity when transitioning away from a gas-powered space or water heater. For most homes, upgrading the electric paneling will be sufficient to integrate the load from a new heat pump. If the existing panels are not enough to power the heaters, appliances, or electric vehicle chargers being contemplated as part of a home electrification project, replacing them with higher ampere (AMP) panels or new "smart panels" able to handle the increased load can add thousands of dollars and extended time periods for the additional work. Occasionally, the wires and utility power distribution lines also need upgrades, adding costs and time.

Heat pump unit and smart electrical panel costs are likely to improve significantly in coming years as the technologies mature. But in the meantime, they can present a challenge for homeowners, tenants, and landlords facing high upfront costs for retrofits and installation. This hurdle can be especially difficult among residents in the high-priority communities identified earlier in this report, where many customers may not be able to afford the full costs of a retrofit. Even with aggressive incentives and targeted outreach, low-income homeowners and tenants in affordable housing will tend to prioritize maintaining access to space or water heating over installing a heat pump.

Among the solutions proposed to assist low-income homeowners and existing building occupants, participants noted that the Technology and Equipment for Clean Heating (TECH) Clean California program offers incentives for necessary electrical preparation activities, such as panel upgrades, smart panel systems, and other technologies to address electrical load.[108] Participants suggested increasing incentives, based on data-driven feedback of customers and program

administrators. Additionally, the state legislature could appropriate funds directly from the state General Fund to the Public Utilities Commission, California Energy Commission, or other agencies to administer a program to defray upfront costs of retrofitting and installing heat pumps in high-priority communities.

Solution: The California Public Utilities Commission could end rebates for gas water heaters and instead redirect funds to expand heat pump incentives.

Building off the work of SB 1477, the California Legislature, Public Utilities Commission, and Energy Commission could create additional incentives or alterations to the existing incentive structure to target heat pump appliances. Agencies could monitor overlap between BUILD incentives and other incentive programs in the state to find any existing rebates that contradict an all-electric appliance approach and instead reallocate that funding to support heat pumps. Lead agencies, such the Energy Commission, could coordinate with utilities, local governments, and other involved agencies to align incentive-based programming to scale heat pump deployment, integrate planning, and avoid duplication.

In addition to the California Public Utilities Commission, Energy Commission, and Air Resources Board, other agencies with jurisdiction over aspects of the built environment include the California Tax Credit Allocation Committee, California Debt Limit Allocation Committee, California Department of Housing and Economic Development, and the federal Department of Housing and Urban Development. The state could also assess the opportunity to apply federal incentives to HVAC manufacturers, suppliers, and distributors, potentially from the U.S. Department of Energy's energy efficiency programs.

Participants recommended prioritizing incentives for two largely unaddressed sectors. First, lead California agencies such as the California Public Utilities Commission and Energy Commission could develop upstream and midstream incentives to support suppliers, manufacturers, distributors, installers, and retailers (fully discussed on page 40).

Second, additional electrical panel upgrade incentives could support customers needing additional capacity to handle the new electrical load from heat pumps. Since most California buildings built before 1990 are likely to need both panel and building upgrades, utilities, developers, and installers will need to coordinate to help communities achieve sufficient panel upgrades to meet the heat pump targets.[109] Smart panels can manage increased load from heat pump space and water heating, electric vehicle charging, and integrate battery storage. While costly, smart panels can enable whole-home building electrification without transformer upgrades. Some utilities will upgrade transformers at no cost to an individual customer, while other utilities will attempt to saddle the customer with the cost of the upgrade, which can run more than $100,000.[110]

The state could benefit from lessons learned from other heat pump incentive programs. For example, Massachusetts's MassSave program offers up to $10,000 per home for the purchase and installation of an Air Source Heat Pump.[111] MassSave runs through a collaboration of utilities, which could be a model

for California to follow under the encouragement of the California Public Utilities Commission. New York's NYSERDA and Minnesota Air Source Heat Pump Collaborative are offering modest state-funded rebates.[112] In Canada, British Columbia has removed the provincial sales tax on all electric heat pumps to stimulate deployment.[113] Additionally, California could look at the structure and outcomes of Italy's trial policy of providing a 110 percent tax discount (distributed over multiple years) for heat pump installation, which was in effect from July 2020 to December 2021.[114]

One way to increase incentive funding availability is to end all gas rebate programs. The Public Utilities Commission could sunset existing gas rebate programs, such as the Energy Efficient Statewide Plug-Load and Appliance Program. In January 2022, the Sierra Club filed a motion with the Public Utilities Commission to ban rebates for natural gas water heaters as part of the Energy Efficient Statewide Plug-Load and Appliance Program.[115]

Solution: The California Department of Housing and Community Development, California Energy Commission, and local governments could work to establish a Community Development Block Grant to fund and leverage electrical grid improvements and heat pump deployment.

As more federal and state funds become available, state agencies could work collaboratively with private capital providers to streamline the release and distribution of heat pump incentives, treating the funds like a Community Development Block Grant.[116] A Community Development Block Grant (CDBG) is administered by the U.S. Department of Housing and Urban Development for resilience-focused housing projects that minimize future disaster risk.[117] While the program is better suited for resilience activities (e.g., making buildings more resilient to changing storm patterns), a grant can be used for improving building codes. A CDBG or other block grant could be targeted at low-to-moderate income communities within certain geographic areas. The Infrastructure Investment and Jobs Act of 2021 allocated $550 million to the Department of Energy for a new Energy Efficiency Conservation Block Grant program to assist eligible governments to develop, promote, implement, and manage energy efficiency and conservation policy and projects in their jurisdiction.[118]

In addition to the Department of Energy Block Grant, there are different allocations within the traditional CDBG program, including for disaster mitigation projects that rebuild infrastructure, COVID-19 relief efforts to assist states and cities in responding to the public health crisis, and CDBG Section 108 loan guarantees to protect financing for renewable energy projects in frontline communities. While applying heat pump deployment to these different allocations might require creativity, CDBG partnerships could allow affordable housing owners and operators greater flexibility to match and build on the disbursement of funds. The process would need clearly designated state and local agencies with oversight responsibilities, but the California Department of Housing and Community Development has experience and expertise in administering the CDBG program.

Finally, the state could leverage a block grant through using the Climate Catalyst revolving loan fund to allow non-profit and affordable housing providers to participate in heat pump retrofits.[119] Administered by the California Infrastructure and Economic Development Bank (I-Bank), the state could use the Catalyst fund to leverage and administer funds.

BARRIER: LACK OF CONSUMER KNOWLEDGE AND ADEQUATE SUPPORT FOR A SKILLED WORKFORCE TO SCALE HEAT PUMP INSTALLATION, MAINTENANCE, AND REBATE PROGRAMS

Without a workforce that can help promote and install heat pumps, policy and financial solutions will not translate to the average customer. When customers contact HVAC and water heater installers and technicians, the installers become the front line of climate action. State policy programs rely on a skilled and trained workforce that is willing and incentivized to educate customers about heat pump technology. In turn, the installers will need a strong value proposition to want to learn how to install the technology and get customers eager to adopt heat pumps. California will also need a workforce trained on the safe handling of refrigerants and with sufficient electrical knowledge to ensure energy systems work reliably. Many installers are ready and eager to add new skills to their trade, but are limited by time and a lack of sufficient incentives. Preparing installers with targeted education and support will assist deployment as demand for heat pumps improves. The virtuous cycle will continue as demand grows and job opportunities expand.

In order to scale heat pump deployment, policymakers will need to support this new and expanded workforce with policy, financial, and educational resources. Participants generally noted that policymakers and utilities should consider labor an investment rather than a cost of the decarbonization transition and focus on the quality as well as the quantity of jobs. They ultimately will need to craft deliberate policy interventions to advance job quality and social equity.

Solution: The California Public Utilities Commission, California Energy Commission, and utilities could develop midstream incentives to encourage contractors, retailers, and technicians to promote heat pump installations.

Policymakers classify incentive programs for building decarbonization products as midstream, upstream, or downstream, depending on who receives the incentives. Upstream programs provide incentives for manufacturers to make more efficient products, while down stream programs provide rebates for consumers, encouraging them to purchase more efficient products. A midstream program provides incentives for retailers to stock and sell a higher percentage of highly efficient products than they would have otherwise.

Participants noted the need to concentrate on midstream incentives to overcome installer and customer resistance to heat pump deployment. While upstream (manufacturer credits) and downstream (customer rebates) incentives have received attention from policymakers, there is a policy gap

around midstream support for retailers, distributors, technicians and installers. Participants supported the creation of installer rebates available to retailers, contractors, and installers who encourage customers to purchase heat pumps. Policymakers will need to ensure that installers are supported, educated, and motivated to increase heat pump adoption to boost both demand and job opportunities. Utilities have developed midstream incentives to transform the marketplace by financially supporting distributors who offer discounts on space and water heat pump equipment for installation on existing residential homes.[120] Participants noted that any installation incentive should have multiple redemption opportunities, as the goal is to motivate installers to deploy heat pumps at scale. For example, allowing an installer to receive financial incentives for the first ten heat pumps could motivate the workforce to champion building decarbonization.

The Northwest Energy Efficiency Alliance's Ductless Heat Pump Project provides some useful lessons forCalifornia's midstream efforts.[121] Working with partner installers, the Project installed more than 100,000 ductless heat pumps in the Northwest Energy Efficiency Alliance's residential retrofit target markets between 2008 and 2020. The majority of the installations came from master installer or oriented installer projects. Customers were required to hire a certified installer to qualify for a rebate, and both the utility and program administrator maintained a list of master installers that customers could choose from. Installers were motivated to earn the certification by the free marketing and the additional revenue stream generated through their participation in the program. As a result of supply chain training, product installation support, and targeted marketing, more than 80,000 of the 100,000 heat pumps received a utility rebate and more than 90 percent of heating, ventilation, and air conditioning (HVAC) companies in the Northwest were installing ductless heat pumps as of 2019.[122]

The California Public Utilities Commission has taken efforts to address midstream energy efficiency incentives through a Market Transformation Initiative.[123] In 2019, the Commission began a process to fund regional energy networks to transform building decarbonization and energy efficiency markets. Practices include using midstream incentives to influence education, installation, and retail stocking practices, ultimately supporting a portfolio of energy efficient retail products.

Overall, building off the work of SB 1477, agencies and utilities in California could create new incentives to motivate contractors, technicians, and retailers to learn more about heat pumps and deploy the technology in their respective communities.

Solution: The California Workforce Development Board could develop and support installer training programs for heat pump installations and could pre-qualify contractors.

By improving profitability, state policy can encourage installers to switch from gas appliances to heat pumps. As part of Governor Newsom's proposed $962.4 million in building decarbonization, the California Workforce Development

Board (CWDB) could build upon successes and lessons learned from existing initiatives.[124] To achieve a just transition through decarbonization programs, the CWDB framework emphasized a "high-road" approach based on high-quality jobs, high-quality work, and wages and benefits sufficient to support both, through demand-side, supply-side, and just transition policy strategies. These strategies, including skilled workforce and wage standards, job training programs, displaced worker assistance, and community workforce agreements, could be aligned with specific policy (such as public investments and incentive programs) aiming to mitigate climate change. "High road" jobs focus on employing economically disenfranchised communities, aiming to boost shared prosperity and environmental sustainability. The CWDB could build upon the High Road Training Partnerships by bringing together labor unions, installers, and communities to establish labor standards for workforce development in the electrification transition.

CALIFORNIA WORKFORCE DEVELOPMENT BOARD HIGH ROAD TRAINING PARTNERSHIPS

Created as a partnership between the Alameda County and Oakland Workforce Development Boards, Building and Construction Trade unions, California Community College Districts, California State Registered Apprenticeship Programs, and local community organizations including Rising Sun Center for Opportunity, the initiative has created a High Road to Building Decarbonization in the San Francisco Bay Area.[125] The partnership is a model for other regions of the state to address heat pump deployment and building decarbonization through supporting employers, unions, workforce developers, and educational institutions with appropriate job training programs. The state recently announced a rolling fund of $90 million for a High Road Training Partnerships: Resilient Workforce Fund Program, with applications reviewed on a quarterly basis.[126]

Participants discussed optimizing heat pump policy outcomes while supporting the creation of and access to good-paying jobs, deemed by the State of California as a "high-road" approach to economic development.[127] The High Road Action Plan published by the California Workforce Development Board included a strategy to develop a pipeline for training installers and heat pump maintenance professionals.[128] Local government actions, such as Community Workforce Agreements, are most successful when they have strong pre-apprenticeship programs that work closely with the building trades unions and can ensure inclusion of historically marginalized workers.

Participants offered numerous recommendations for how to develop and support state-funded programs to support installer training, including:

- Condition workforce incentives on skill standards or offer incentives (i.e., accelerated permitting, financial remuneration, etc.) for projects that meet certain workforce criteria.

- Condition rebates and incentives for building electrification on skill standards and/or responsible contractor criteria to attract high performing contractors, ensure work quality, and prevent wage and labor law violations common in the residential construction market.
- Prioritize legacy gas workforce integration into the clean energy economy through a workforce transition.
- Coordinate with apprentice programs (i.e., HVAC technician schools) to offer training incentives, especially supporting community college and vocational school workforce development opportunities, in disadvantaged communities.

Additionally, participants noted that agencies can help to stimulate market transformation and improve consumer confidence by pre-qualifying contractors as eligible to receive public or ratepayer incentives for heat pump appliances. As fully discussed in a 2019 UCLA Luskin assessment of California Building Decarbonization Workforce Needs, individual jurisdictions could also implement a contractor vetting process to expedite contractors through the qualification process.[129] While many utilities across the country pre-qualify contractors for various programs, California investor-owned utilities and agencies have refrained from doing so due to concerns of potential legal vulnerability resulting from recommending contractors.[130]

Solution: The state legislature could bolster existing SB 1477 funding efforts in coordination with the California Public Utilities Commission to provide customers with better technical assistance.

Participants emphasized the lack of workforce knowledge and experience using heat pumps. Therefore, in order to overcome the "hassle factor" of customers educating themselves on the technology, the state and local governments could support broad education campaigns. Using the lessons learned from the BUILD and TECH Technical Assistance programs for market-rate housing developers, policymakers could develop educational reference materials to explain all available technologies for all-electric buildings and any technical issues pertaining the installation, maintenance, and performance of heat pump equipment. While every residence will have differences, developing turnkey solutions for large multi-family buildings and high-priority communities will build momentum for additional resources.

As the TECH program scales its consumer awareness campaign, titled *The Switch is On*, program leaders can ensure greater market penetration by providing contractors and installers with a designated clearinghouse for all available heat pump incentives and programs.[131] Participants noted the significant progress in communication among government agencies, local governments, nonprofit program administrators, manufacturers, installers, and customers in just a few years. Having a one-stop shop for all heat pump incentives and programs, supported by government and coordinated by communication staff to provide a resource to local governments and private sector installers, could overcome additional adoption barriers.[132]

Solution: Advocates and government officials could rebrand "heat pumps" to be more easily understood by average consumers.

All stake holders involved in building decarbonization could consider whether a rebranding effort for heat pumps would result in improved understanding among average customers of the technology. Recent national conversations have surmised that the term "heat pumps" is not logical, considering they provide space cooling as well as heat, and thus the industry could potentially rebrand with a new name.[133] If a sleek name could translate into broad customer awareness, a robust education campaign could then facilitate the massive demand needed for heat pump technology adoption.

V. CONCLUSION

An equitable transition to efficient and all-electric buildings will deliver important benefits to the whole state. Crucially, heat pump technologies provide both heating and cooling during a time of increasingly extreme weather, and they are the crux of building electrification efforts critical to achieving state climate goals. Deploying them in existing housing will furthermore reduce residents' exposure to pollutants from burning gas.

However, to support a cost-effective and equitable gas transition, electrification must happen through a geographically targeted and whole-house approach. As state and utility leaders envision the future of gas infrastructure, strategically deploying heat pump technology could relieve ratepayers of unnecessary costs to support a potentially obsolete gas system, deliver ratepayer savings, support energy affordability, and improve overall system efficiency, safety, and resiliency.

DANGER **DANGER**

HAZARD OF ELECTRIC SHOCK, BURN OR EXPLOSION.

- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying this equipment before working on or inside equipment.
- Always use a properly rated voltage sensing device to confirm all power is off.
- Replace all devices, doors, and covers before turning on power to this equipment.

Failure to follow these instructions will result in death or serious injury.

29	27	25	23	21	19	17	15	13	11	9	7	5	3	1
KIT ⌀	KIT ⌀	BATHS	KIT ⌀	----	GUEST BATH ENTRY	SMOKE DETECTORS	GARAGE LTS & 2 INT Room	GARAGE GFI	GARAGE GFI	GUEST BEDROOMS	SUB	PANEL	Surge	Surge
DISHWASHER	COMPUTER	DISPOSAL	REF in GARAGE	DRYER	----	COOK TOP	----	----	----	----	----	HEAT	----	UNDER PANEL

REFERENCES

All URLs last visited June 1, 2022; some may be paywall- or subscription-restricted.

1 California Air Resources Board (CARB), *California Greenhouse Gas Emission Inventory* (2019 Edition), p.14, available at https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2017/ghg_inventory_trends_00-17.pdf.

2 RMI, "Appliance Pollution" (fact sheet) (April 2021), available at https://rmi.org/wp-content/uploads/2021/04/rmi_factsheet_appliance_pollution.pdf.

3 U.S. Department of Energy, "Heat Pump Systems" (webpage), available at https://www.energy.gov/energysaver/heat-pump-systems.

4 Michael Gartman et al., *Heat Pumps for Hot Water: Installed Costs in New Homes*, Rocky Mountain Institute (July 2020), available at https://rmi.org/wp-content/uploads/2020/07/heat_pump_water_heater.pdf.

5 California Air Resources Board, *Draft 2022 Scoping Plan Update* (May 2022), pp. 169-171, available at https://ww2.arb.ca.gov/sites/default/files/2022-05/2022-draft-sp.pdf; see also California Department of Housing and Community Development, *California's Housing Future: Challenges and Opportunities*, (2018), pp. 6-7, available at https://hcd.ca.gov/policy-research/plans-reports/docs/sha_final_combined.pdf.

6 Ethan N. Elkind and Ted Lamm, *Building Toward Decarbonization,* University of California, Berkeley Law School Center for Law, Energy, and the Environment (January 2021), available at https://www.law.berkeley.edu/wp-content/uploads/2021/01/Building-toward-Decarbonization-January-2021.pdf.

7 U.S. Department of Energy, "Heat Pump Systems" (webpage), available at https://www.energy.gov/energysaver/air-source-heat-pumps.

8 Reuters, "New California rules move state away from natural gas in new buildings" (August 11, 2021), available at https://www.reuters.com/legal/litigation/new-california-rules-move-state-away-natural-gas-new-buildings-2021-08-11/.

9 Department of Energy. "Furnaces and Boilers" (webpage), available at https://www.energy.gov/energysaver/furnaces-and-boilers.

10 Sherri Billimoria et al.,*The Economics of Electrifying Buildings: How Electric Space and Water Heating Supports Decarbonization of Residential Buildings*, Rocky Mountain Institute (2018), pp. 16, 20, available at https://rmi.org/insight/the-economics-of-electrifying-buildings/.

11 Asa S. Hopkins et al., *Decarbonization of Heating Energy Use in California Buildings*, Synapse Energy Economics (October 2018), pp. 19-20, available at https://www.synapse-energy.com/sites/default/files/Decarbonization-Heating-CA-Buildings-17-092-1.pdf.

12 Michael Kenney et al., *California Building Decarbonization Assessment*, California Energy Commission, (2021), p. 5, available at https://www.energy.ca.gov/publications/2021/california-building-decarbonization-assessment.

13 *See* Michael Kenney, *California Building Decarbonization Assessment*, *supra*, pp. 6, 97 "...Senate Bill 1383 established economy-wide goals to reduce HFC emissions by 40 percent from 2013 levels by 2030, which if successful, would eliminate 7.5 million metric tons of carbon dioxide equivalent (MMTCO2e) from residential and commercial buildings in 2030. The California Air Resources Board has adopted regulations to require HFCs producing equipment to have a GWP no higher than 750 by 2025... and for companies with refrigeration equipment containing more than 50 pounds of refrigerant to reduce their greenhouse gas emissions by 55 percent by 2030... Conventional refrigerants typically have GWP values of around 1,500-2,000, calculated by their climate-forcing potential relative to carbon dioxide."

14 Senate Bill (SB) 32 (Pavley, Chapter 249, Statutes of 2016), Cal. Health & Safety Code § 38566 (setting 2030 emission reduction target); SB 350 (De León, Chapter 547, Statutes of 2016, Cal. Health & Safety Code § 44258.5; E.O. B-55-18 (Gov. Edmund G. Brown, September 10, 2018) (setting 2045 carbon neutrality goal).

15 California State Auditor, *Report 2020-114: Review of California Air Resources Board* (February 2021), available at http://auditor.ca.gov/pdfs/reports/2020-114.pdf.

16 Michael Kenney, *California Building Decarbonization Assessment*, *supra*, p. 97.

17 Id. at p. 16.

18 Hopkins et al., *Decarbonization of Heating Energy Use in California Buildings*, *supra*, p. 10

19 California Air Resources Board, Draft 2022 Scoping Plan Update (May 2022), pp. 169-170, available at https://ww2.arb.ca.gov/sites/default/files/2022-05/2022-draft-sp.pdf.

20 California Energy Commission, "2022 California Building Energy Efficiency Standards (Energy Code)" (August 2021), available at https://www.energy.ca.gov/news/2021-08/energy-commission-adopts-updated-building-standards-improve-efficiency-reduce-0.

21 Warren-Alquist Act, Cal. Pub. Res. Code § 25000, available at https://www.energy.ca.gov/sites/default/files/2022-01/CEC-140-2022-001.pdf.

22 California Energy Commission, "2022 Energy Code Update Summary" (webpage), available at https://www.energy.ca.gov/sites/default/files/2021-08/CEC_2022_EnergyCodeUpdateSummary_ADA.pdf.

23 Id.

24 See Amber Mahone et al., E3, *Residential Building Electrification in California: Consumer Economics, Greenhouse Gases, and Grid Impacts* (April 2019), pp. 12-14, available at https://www.ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf.

25 Id. at p. 13.

26 Michael Kenney et al., *Final 2021 Integrated Energy Policy Report* (*IEPR*) *Volume I Building Decarbonization,* California Energy Commission (2022), pp. 48-50, available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=241361.

27 California Air Resources Board, *Draft 2022 State Strategy for the State Implementation Plan* (January 31, 2022), p. 87, available at https://ww2.arb.ca.gov/sites/default/files/2022-01/Draft_2022_State_SIP_Strategy.pdf.

28 Senate Bill (SB) 350 (De León, Chapter 547, Statutes of 2015), Cal. Health & Safety Code § 44258.5.

29 Assembly Bill (AB) 3232 (Friedman, Chapter 373, Statutes of 2018), Cal. Pub. Res. Code § 25403.

30 Kenney, *California Building Decarbonization Assessment*, *supra*, p. 15.

31 SB 1477 (Stern, Chapter 378, Statutes of 2018); Cal. Pub. Util. Code §§ 921-922. See also CPUC, Decision Establishing Building Decarbonization Programs, D.20-03-027 (March 26, 2020), available at https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M331/K772/331772660.PDF.

32 TECH Clean California, "About the TECH Initiative" (webpage), available at https://energy-solution.com/tech/.

33 California Energy Commission. "Building Initiative for Low Emissions Development (BUILD) Program Fact Sheet," (March 2022) (press release), available at https://www.energy.ca.gov/sites/default/files/2022-03/BUILD_FactSheet_ProgramOverview_ada.pdf

34 Erica Chac et al., *Building Initiative for Low-Emissions Development* (*BUILD*) *Program Implementation Plan,* California Energy Commission (2020), p. 3, available at https://efiling.energy.ca.gov/getdocument.aspx?tn=234936.

35 See Order Instituting Rulemaking Regarding Building Decarbonization, California Public Utilities Commission D. 20-03-027, (March 26, 2020), available at https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M331/K772/331772660.PDF; California Energy Commission, "2022 Building Energy Efficiency Standards Computer Compliance Programs" (webpage), available at https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2022-building-energy-efficiency.

36 Yifang Zhu et al., Effects of Residential Gas Appliances on Indoor and Outdoor Air Quality and Public Health in California, UCLA Fielding School of Public Health (April 2020), available at https://coeh.ph.ucla.edu/effects-residential-gas-appliancesindoor-and-outdoor-air-quality-and-public-health-california.

37 Cal.Labor Code §§6300 et seq.; 8 Cal. Code Regs. §§332.2.

38 California Air Resources Board, Draft 2022 State Strategy for the State Implementation Plan (January 2022), p. 27, available at https://ww2.arb.ca.gov/sites/default/files/2022-01/Draft_2022_State_SIP_Strategy.pdf.

39 For more information about the Bay Area Air Quality Management District Building Electrification efforts, visit https://www.baaqmd.gov/rules-and-compliance/current-rules.

40 Steven Nadel et al., American Council for an Energy-Efficient Economy (ACEEE), *Opportunities for Energy and Economic Savings by Replacing Electric Resistance Heat with Higher Efficiency Heat Pumps* (May 2016), available at https://www.aceee.org/research-report/a1603.

41 Jeff St. John, "Heat Pump Water Heaters Can be Demand Response Assets," Greentech Media (June 25, 2019), available at https://www.greentechmedia.com/articles/read/energyhub-shows-that-heat-pump-water-heaters-can-be-demand-response-assets.

42 Kenney, California Building Decarbonization Assessment, *supra*, p. 15.

43 Ethan N. Elkind and Ted Lamm, *Building toward Decarbonization*, *supra*. p.11.

44 Amber Mahone et al., *Residential Building Electrification in California, supra,* p. 21.

45 Id. at p. 27.

46 Id.

47 See e.g., Cavan Merski, "Addressing an Electrification Roadblock: Residential Electric Panel Capacity" (blog post) (August 2021), available at https://www.pecanstreet.org/2021/08/panel-size/.

48 California Public Utilities Commission, Draft Environmental and Social Justice Action Plan 2.0 (March 25, 2022), pp. 20-21, available at https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M465/K846/465846599.pdf.

49 SB 535 (De León, Chapter 830, Statutes of 2012), Cal. Health & Safety Code §§ 39711 et seq.; AB 1550 (Gomez, Chapter 369, Statutes of 2016), Cal. Health & Safety Code § 39713; CalEnviroScreen available at https://oehha.ca.gov/calenviroscreen.

50 For a discussion of the Wildfire and Natural Disaster Resiliency Rebuild (WNDRR) program to help disaster-affected properties rebuild with all-electric service, see CPUC, R.19-01-011 Phase II Staff Proposal (Draft) (August 25, 2020), pp. 21-46, available at https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M345/K591/345591050.PDF.

51 *See* Cal. Health & Safety Code §§ 19610-19162. (The California Energy Commission's Title 24 energy efficiency authority extends only to new and modified existing structures, but state and local governments can mandate retrofits to address urgent public needs, as they have in the context of seismic safety.")

52 Ethan N. Elkind and Ted Lamm, *Building toward Decarbonization*, *supra*. at pp.6-7.

53 City of Oakland "Presentation: Equitable Decarbonization in Oakland - Challenges and Opportunities." (2020), available at https://cao-94612.s3.amazonaws.com/documents/ElectrifyingExistingBuildings_final.pdf.

54 *See* Cal. Pub. Util. Code §§ 328, 451.

55 Id.

56 See Mahone et al., *Residential Building Electrification in California: Consumer Economics, Greenhouse Gases, and Grid Impacts*, *supra*, pp. 12-14.

57 California Public Utilities Commission, "CPUC Provides Additional Incentives and Framework for Electric Heat Pump Water Heater Program" (April 7, 2022) (press release), available at https://www.cpuc.ca.gov/news-and-updates/all-news/cpuc-provides-additional-incentives-and-framework-for-electric-heat-pump-water-heater-program.

58 Alejandra Mejia Cunningham et al., *Rate Design for Beneficial Electrification*, Building Decarbonization Coalition (2021), available at http://www.buildingdecarb.org/uploads/3/0/7/3/30734489/bdc_report_2_rate_design.pdf.

59 California Public Utilities Commission, "Assigned Commissioner's Amended Scoping Memo And Ruling," (October 14, 2021), available at https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M415/K275/415275138.PDF.

60 California Department of General Services (DGS), *2022-23 Strategic Plan* (March 23, 2022), pp. 16-17, available at https://www.dgs.ca.gov/-/media/Divisions/DGS/DOCUMENTS/Strat-Plan-2022-ADA.pdf.

61 California DGS Office of Fleet and Asset Management, "Resources for Electric Vehicles" (March 23, 2022), available at https://www.dgs.ca.gov/OFAM/Resources/Page-Content/Office-of-Fleet-and-Asset-Management-Resources-List-Folder/State-Electric-Vehicle-Charging-Guide.

62 California Air Resources Board, "Low-GWP Incentives" (webpage), (March 23, 2022), available at https://ww2.arb.ca.gov/resources/documents/low-gwp-incentives.

63 Chac et al., *BUILD Program Implementation Plan*, *supra*, p. 34.

64 Cal. Pub. Res. Code §§ 76002, 76004, 76006. *See also* Senate Bill 1013 (Chapter 375, 2018, Lara).

65 Washington House Bill 1050 (Chapter 315, Laws of 2021), available at https://lawfilesext.leg.wa.gov/biennium/2021-22/Pdf/Bills/Session%20Laws/House/1050-S2.SL.pdf?q=20210929134333.

66 Id.

67 California Air Resources Board, Draft 2022 State Strategy for the State Implementation Plan (January 2022), p. 27, available at https://ww2.arb.ca.gov/sites/default/files/2022-01/Draft_2022_State_SIP_Strategy.pdf.

68 Bay Area Air Quality Management District, "Notice of Preparation of an Environmental Impact Report and Notice of Public Scoping Meeting for the Proposed Amendments to Rules 9-4 and 9-6 Project," (2022), available at https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-9-rule-4-nitrogen-oxides-from-fan-type-residential-central-furnaces/2021-amendments/documents/20220519_02_nop_rules09040906-pdf.pdf?la=en&rev=0d134e0d12ef455f88cc379731f8e195.

69 *See* SCAQMD, Rule 1111 Reduction of NOx Emissions from Natural-Gas-Fired, Fan-Type Central Furnaces at 1111-3 (last amended Sept.4, 2020), http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1111.pdf; see also *South Coast Air Quality Management District 2022 Air Quality Management Plan*, available at http://www.aqmd.gov/home/air-quality/clean-air-plans/air-quality-mgt-plan.

70 Cal. Code of Regs, Title 17, § 41986. *See also* Assembly Bill 2276 (Chapter 770, 2006, Pavley).

71 California Air Resources Board, *Draft 2022 Scoping Plan Update*, *supra*, pp. 169-171; *see also* Cal. Health & Safety Code §§ 38510, 40000.

72 National Low-Income Housing Coalition, *Out of Reach: The High Cost of Housing,* (2021), p. 26, available at https://nlihc.org/sites/default/files/oor/2021/Out-of-Reach_2021.pdf.

73 For more information on the CPUC CARE program, visit https://www.cpuc.ca.gov/consumer-support/financial-assistance-savings-and-discounts/california-alternate-rates-for-energy.

74 Amber Mahone et al., *Residential Building Electrification in California, supra*, p. 12.

75 *See* Ethan N. Elkind and Ted Lamm, UC Berkeley School of Law Center for Law, Energy & the Environment (CLEE), *Low Income, High Efficiency: Policies to Expand Low-Income Multifamily Energy Savings Retrofits* (June 2019), available at http://www.climatepolicysolutions.org/wp-content/uploads/2019/06/Low-Income-High-Efficiency-June-2019-1.pdf.

76 Department of Energy, "Issue Brief: Low-income Energy Efficiency Financing through On-Bill Tariff Programs," (2019), available at https://betterbuildingssolutioncenter.energy.gov/sites/default/files/IB%20L-I%20EE%20Financing%20through%20On-Bill%20Tariffs_Final_0.pdf.

77 Id.

78 California Public Utilities Commission, Order Instituting Rulemaking to Investigate and Design Clean Energy Financing Options for Electricity and Natural Gas Customers. (April 1, 2021), available at https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M374/K626/374626933.PDF.

79 Bruce Mast et al., *Towards an Accessible Financing Solution*, Building Decarbonization Coalition (July 2020), pp. 4-5, available at https://www.buildingdecarb.org/uploads/3/0/7/3/30734489/bdc_whitepaper_final_small.pdf.

80 Id.

81 For more information about the GoGreen Affordable Multifamily Energy Financing Program, a project of the California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA), visit https://www.treasurer.ca.gov/caeatfa/cheef/multifamily/regulations/index.asp.

82 For more information on California Hub for Energy Efficiency Financing (CHEEF), visit https://www.treasurer.ca.gov/caeatfa/cheef/index.asp.

83 Mast, *Towards an Accessible Financing Solution*, Building Decarbonization Coalition, *supra*, p. 2.

84 U.S. Department of Energy, *Energy Efficiency in Separate Tenant Spaces – A Feasibility Study*, (April 2016), pp.1-2, available at https://www.energystar.gov/sites/default/files/asset/document/DOE%20-%20Energy%20Efficiency%20in%20Separate%20Tenant%20Spaces_0.pdf.

85 Andrew Feierman, *What's in a Green Lease? Measuring the Potential Impact of Green Leases in the U.S. Office Sector* (May 2015), p. 6, available at https://www.imt.org/wp-content/uploads/2018/02/Green_Lease_Impact_Potential.pdf.

86 Adam Aston, "How tenants continue to press for greener commercial buildings, despite COVID-19" *GreenBiz Media*, November, 10, 2020, available at https://www.greenbiz.com/article/how-tenants-continue-press-greener-commercial-buildings-despite-covid-19.

87 For more information on Johnson Controls' 2020 Energy Efficiency Indicator Study visit, https://www.johnsoncontrols.com/-/media/jci/insights/2020/feature-story/files/hq201004_eei-2020-media-one-page-summary-v3.pdf?la=en&hash=086EF3E7B0EB35082A6F7213B4FFF24178B65BF2.

88 For more information on Green Lease Leaders, visit https://www.greenleaseleaders.com/.

89 For more information on GRESB, visit https://gresb.com/nl-en/.

90 City of Santa Monica, Climate-Friendly Buildings: A New Construction Guide to Support Santa Monica's Energy Reach Code (2020), pp. 3-4, available at https://www.smgov.net/uploadedFiles/Departments/OSE/Categories/Green_Building/SantaMonica_Climate-Friendly-Buidings_2020.pdf.

91 Id.

92 City of Los Angeles Housing Department, "Primary Renovation Program" (webpage), available at https://housing.lacity.org/rental-property-owners/primary-renovation-program.

93 Id.

94 California Earthquake Authority, "Brace and Bolt Grants" (webpage), available at https://www.earthquakeauthority.com/Prepare-Your-House-Earthquake-Risk/Brace-and-Bolt-Grants.

95 James Mills, "City Council Decides Not to Force Tenants to Pay a Share of Earthquake Retrofit Costs," *Wehoville*, October, 16, 2018, available at https://wehoville.com/2018/10/16/city-council-decides-not-force-tenants-pay-share-earthquake-retrofit-costs/.

96 Id.

97 Chelsea Kirk. *Los Angeles Building Decarbonization: Tenant Impact and Recommendations,* Strategic Actions for Just Economy (2021), available at https://www.saje.net/wp-content/uploads/2021/12/LA-Building-Decarb_Tenant-Impact-and-Recommendations_SAJE_December-2021-1.pdf.

98 UCLA Lewis Center for Regional Policy Studies, "Eviction Protections and Mitigations" (webpage), available at https://www.lewis.ucla.edu/programs/housing/tenant-protections/housing-eviction-protections-and-mitigations/.

99 California Energy Commission, *Draft 2021 Integrated Energy Policy Report, Volume I*, (Dec. 2021), p. 16, available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=240864.

100 California Air Resources Board, *Draft 2022 Scoping Plan Update*, *supra*, pp. 169-171.

101 California Public Utilities Commission. "CSI Multifamily Affordable Solar Housing (MASH) Program" (webpage), available at https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/california-solar-initiative/csi-multifamily-affordable-solar-housing-program.

102 Cal. Civil Code §§ 1941.1(a)(4). a dwelling shall be deemed untenantable for purposes of §§ 1941 if it substantially lacks [h]eating facilities that conformed with applicable law at the time of installation, maintained in good working order.

103 *See* Arizona statute Title 33-1364(A).

104 California Public Utilities Commission. "Solar on Multifamily Affordable Housing (SOMAH) Program" (webpage), available at https://www.cpuc.ca.gov/somah.

105 California Department of Community Services and Development. "Weatherization Assistance Program" (webpage), available at https://www.csd.ca.gov/Pages/Residential-Energy-Efficiency.aspx; United States Department of Health and Human Services (HHS). "Low Income Home Energy Assistance Program (LIHEAP) (webpage), available at https://www.acf.hhs.gov/ocs/low-income-home-energy-assistance-program-liheap.

106 Marybelle Nzegwu Tobias, *City of Oakland 2030 Equitable Climate Action Plan: Racial Equity Impact Assessment* (2020), available at https://cao-94612.s3.amazonaws.com/documents/FINAL_Complete_EF-Racial-Equity-Impact-Assessment_7.3.2020_v2.pdf.

107 City of Oakland. "Racial Equity Impact Assessment" (2021) (presentation), available at https://cao-94612.s3.amazonaws.com/documents/ElectrifyingExistingBuildings_final.pdf.

108 TECH Clean California, "About the TECH Initiative" (webpage), available at https://energy-solution.com/tech/.

109 Tianchao Hu et al., *Compilation of Published PM2.5 Emission Rates for Cooking, Candles and Incense for Use in Modeling of Exposures in Residences*, Lawrence Berkeley National Lab (2012), available at https://www.osti.gov/biblio/1172959/.

110 Peninsula Clean Energy, "Electric Vehicle Infrastructure Cost Analysis Report" (white paper) (November 5, 2019), pp. 20-22, available at https://www.peninsulacleanenergy.com/wp-content/uploads/2020/08/PCE_SCVE-EV-Infrastructure-Cost-Analysis-Report-2019.11.05.pdf.

111 Mass Save, "Heat Pump Rebate" (webpage), available at https://www.masssave.com/saving/residential-rebates/heat-pump.

112 Associated Press, "Heat Pumps on Rise After Minnesota Passes New Energy Law," *U.S. News* (July 10, 2021), available at https://www.usnews.com/news/best-states/minnesota/articles/2021-07-10/heat-pumps-on-the-rise-after-minnesota-passes-new-energy-law; New York State Energy Research and Development Authority. "Heat Pump Incentives" (webpage), available at https://www.nyserda.ny.gov/ny/sun-pumped/Heat-Pump-Incentives.

113 Andrew Duffy, "Province to play the big spender as B.C. economy recovers" *The Canadian Press*. (February 22, 2022), available at https://www.castanet.net/news/BC/360818/Province-to-play-the-big-spender-as-B-C-economy-recovers.

114 Cooling Post, "Italian Heat Pump Incentive: A Sustainable Blueprint" (webpage) (August 18, 2020), available at https://www.coolingpost.com/world-news/italian-heat-pump-incentive-a-sustainable-blueprint/.

115 Sara Gersten et al, "Sierra Club Motion To Prohibit Energy Efficiency Funding For Non-Cost-Effective Gas Appliance Incentive Measures" (motion), January 13, 2022, available at https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M441/K160/441160400.PDF.

116 California Department of Housing and Community Development, "Community Development Block Program-Community Development" (webpage), available at https://www.hcd.ca.gov/grants-funding/active-funding/cdbg/cdbg-cd.shtml.

117 U.S. Department of Housing and Urban Development, "CDBG-MIT Overview" (webpage), available at https://www.hudexchange.info/programs/cdbg-mit/overview/.

118 Pub.L. 117-58.

119 California Infrastructure and Economic Development Bank, "Climate Catalyst Program" (webpage), available at https://www.ibank.ca.gov/climate-financing/climate-catalyst-program/.

120 California Air Resources Board Funding Wizard. "SCE Heat Pump Equipment Rebates" (webpage), available at https://fundingwizard.arb.ca.gov/web/node/5435.

121 For more information about the NW Ductless Heat Pump Project, visit https://betterbuiltnw.com/news/goingductless-com-passes-the-torch.

122 Id.

123 California Public Utilities Commission, Decision Framework for Energy Efficiency Regional Energy Networks And Market Transformation, 19-12-021 (December 19, 2019), available at https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M321/K507/321507615.PDF.

124 Governor Newsom 2022-2023 January Proposed Budget Summary, (2022), available at https://www.ebudget.ca.gov/2022-23/pdf/BudgetSummary/Infrastructure.pdf.

125 California Workforce Development Board, "High Road to Building Decarbonization in the San Francisco Bay Area" (press release) (2021), available at https://cwdb.ca.gov/wp-content/uploads/sites/43/2021/04/2021.HRTP_.RisingSun_ACCESSIBLE.pdf.

126 California Grants Portal, High Road Training Partnerships: Resilient Workforce Fund Program, (webpage) March 25, 2022, available at https://www.grants.ca.gov/grants/high-road-training-partnerships-resilient-workforce-fund-program/.

127 Carol Zabin et al., *Putting California on the High Road: A Jobs and Climate Action Plan for 2030* (2020), available at https://laborcenter.berkeley.edu/wp-content/uploads/2020/09/Putting-California-on-the-High-Road.pdf.

128 Id. at pp. 95-97.

129 Betony Jones et al., *California Building Decarbonization Workforce Needs and Recommendations,* UCLA Luskin (2019), p. ES-vii, available at https://innovation.luskin.ucla.edu/wp-content/uploads/2019/11/California_Building_Decarbonization.pdf.

130 Id.

131 TECH Clean California, "Switch Is On" (webpage), available at https://www.switchison.org/.

132 Id.

133 See e.g., Mike Munsell, "Do Heat Pumps Need a Rebrand?," *Canary Media* (January 28, 2022), available at https://www.canarymedia.com/articles/heat-pumps/do-heat-pumps-need-a-rebrand.

134 For more information on Marin Clean Energy's Low-Income Family and Tenant program, visit https://www.mcecleanenergy.org/multifamily-savings/.

135 For more information on Pacific Gas & Electric's Wildfire Rebuild Program, visit https://www.pge.com/pge_global/common/pdfs/safety/emergency-preparedness/natural-disaster/wildfires/natural-disaster-rebuilding.pdf; for Southern California Edison's Wildfire Rebuild Program, visit https://energized.edison.com/wildfire-safety.

136 For more information on Southern California Edison's San Joaquin Valley Affordable Energy Pilot, visit https://www.sce.com/zh-hans/node/1943.

Center for Law, Energy
& the Environment (CLEE)
UC Berkeley School of Law
390 Simon Hall
Berkeley, CA 94720-7200

www.clee.berkeley.edu

Emmett Institute on Climate
Change and the Environment
UCLA School of Law
405 Hilgard Avenue
Los Angeles, CA 90095

law.ucla.edu/emmett

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

UCLA School of Law Emmett Institute on Climate Change & the Environment

BANK OF AMERICA