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Examining Equity in Building Decarbonization: Critical Issues and Opportunities

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Examining Equity in Building Decarbonization:
Critical Issues and Opportunities

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Abstract

Racist and discriminatory policies of the past—such as chronic disinvestment and redlining—have created environmental, health and socioeconomic inequality in many low-income communities and communities of color. Building decarbonization provides an opportunity to address these inequalities and design new policies that center equity and are intentional in providing benefits to the communities who need them most. A robust understanding of the broader equity implications of decarbonizing the building sector is key to ensuring that existing disparities are not perpetuated and that the benefits and opportunities beyond mitigating greenhouse gas emissions are fully realized. While this work provides an opportunity to address inequality, there may also be unintended negative consequences that result from these efforts if equity is not prioritized. This report examines equity in building decarbonization, synthesizing current literature, frameworks and reports to provide a cross-sectoral understanding of the critical issues and opportunities at the intersection of climate, health, energy, and housing. It serves to provide awareness of the interconnectedness of these issues and promote collaboration in creating holistic, equity-centered policies and programs—ones that not only reduce greenhouse gas emissions but address critical issues and opportunities related to *health and safety*, *energy burden*, *accessibility*, and *housing and labor*.

Table of Contents

Introduction

Climate and Equity Legislation

California has been a leader in clean energy and climate policy. In 2006, the state passed landmark legislation with Assembly Bill 32, the Global Warming Solutions Act, that required a statewide reduction in greenhouse gases to 1990 levels by 2020. This target was met ahead of schedule and was updated in 2016 with Senate Bill 32 which mandates a 40% reduction below 1990 levels by 2030 (State of California, 2016). In 2018, Governor Brown then signed Executive Order B-55-18 that requires the state to achieve net zero greenhouse gas emissions by 2045 (State of California, 2018). To meet these goals, the state must fully decarbonize its electrical grid and shift most energy and fuel sources in the transportation, buildings and industry sectors to electricity (Lamm & Elkind, 2021). These transitions are critical to avoiding the worst impacts of climate change.

In addition to greenhouse gas legislation, California has also enacted legislation to address equity. In 2012, the state passed Senate Bill 535 that requires 25% of the revenue from California's cap and trade program to be directed to projects that benefit disadvantaged communities. Disadvantaged communities are communities who suffer the highest environmental, health and economic burdens (State of California, 2012). In 2016, the state passed Senate Bill 1000 that requires environmental justice goals, policies and objectives be included in jurisdictions' general plans. This bill works to ensure that local governments are addressing environmental justice in long-term community planning (CEJA, 2016). Equity must be central to climate and decarbonization planning.

Building Decarbonization

Buildings are the second largest source of greenhouse gas emissions in California. When considering emissions from onsite consumption and electricity demand, they account for approximately 25% of the state's total emissions (CARB, n.d.). Decarbonizing the building sector—both new construction and existing building stock—is an essential component of reducing greenhouse gas emissions and meeting state climate goals. While California has made significant progress on updating new building code to align with climate goals, decarbonizing existing buildings is more challenging.

Building decarbonization refers broadly to all "activities and programs that reduce greenhouse gas emissions from buildings" (CEC, n.d.). It consists of three key components: *electrification, energy efficiency and renewable energy*. The first component, building electrification, is the process of removing fossil fuel-powered equipment and appliances and replacing them with efficient, all-electric alternatives. Many homes use gas for water heating, space heating and cooling, cooking and clothes drying (Tan and Jung, 2021). Replacing these end uses with electric options removes onsite fossil fuel combustion and transfers energy use to the electric grid. California currently has one of the cleanest grids in the nation and has committed to a 100% carbon-free grid by 2045 (Miller & Chen, 2019). Modern electric equipment and appliances include electric heat pumps for space heating and cooling, heat pump water heaters, heat pump clothes dryers and electric induction stoves. Building electrification also opens the door for smart grid technologies that support automatic and remote load management and flexible usage, allowing for better integration of intermittent renewable sources. (Lamm & Elkind, 2021).

The second component of building decarbonization is energy efficiency. Energy efficiency efforts work to reduce overall energy use. Common energy efficiency improvements include installing energy efficient lighting, sealing air leaks and ducts around doors and windows, adding insulation to an attic or exterior walls and upgrading to energy-efficient equipment and appliances (DOE EERE, n.d.a). Ideally, energy efficient equipment and appliance upgrades should also be electric. Modern electric options perform significantly better than electric options of the past and often better than modern gas counterparts (Miller & Chen, 2019).

The third component of building decarbonization is renewable energy. Renewable energy refers to energy sources that are replenished by nature—including but not limited to the sun, wind and water. Renewable technologies turn these fuels into energy, such as electricity, that can be used to power buildings without emitting greenhouse gases (NREL, 2001). The most common renewable technology used for buildings is solar photovoltaic systems (solar PV). Solar PV converts sunlight to electricity and can be implemented at a residential scale, commercial or community scale, and utility scale (Hayter & Kandt, 2011).

An Equitable Transition

Decarbonizing the building sector will require significant transformation. Changes to the built environment will highly impact the nexus of socioeconomic factors contributing to community development. To meet the state's climate goals, new policies and programs will be required to support this energy transition at the speed necessary to prevent the worst impacts of climate change. In addition to mitigating greenhouse gas emissions, this transition also provides an opportunity to upend the inequalities that exist under the current system and design a new system that centers equity and is intentional in providing benefits to the communities who need them most (Baker, 2021).

Racist and discriminatory systems and policies—such as chronic disinvestment, redlining, and resource deprivation—have created environmental, health and socioeconomic inequality in low-income communities and communities of color. Climate change will impact everyone but historically marginalized and underserved communities are more vulnerable to the impacts of climate change and experience these impacts at a disproportionate rate compared to high-income, predominantly white communities. The communities who have borne the largest burdens caused by the fossil fuel industry are also the ones who have had the least access to the benefits of the new energy system (SDRCC, 2021). Market-driven, trickle-down approaches have failed to deliver the benefits they promise to low-income communities (Miller & Chen, 2019). Policies and programs must be intentional and direct or these inequalities may only become further entrenched.

Processes must directly address starting-point vulnerabilities that have resulted from discriminatory policies and be intentional to prioritize targeted benefits to disadvantaged communities (Tan and Jung, 2021). An equity-first approach to building decarbonization requires planners and government officials to understand and address the inequities embedded in processes, institutions and systems. To center equity in policies and programs, equity must be examined across four dimensions: *structural, distributional, procedural, and interactional* (SDRCC, 2021). An equity first approach to building decarbonization must align across all four dimensions of equity. The San Diego Regional Climate Collaborative offers the following definitions of equity in their Equity-First Approach to Climate Adaptation Guide:

Structural Equity	*This involves making planning decisions that recognize and address the underlying structural and institutional systems that are at the root of economic, social, and racial inequities. It is an approach to decision making that overtly seeks to correct past harms and to anticipate and prevent future unintended consequences for underrepresented social and racial groups. An approach based on structural equity examines whether planning decisions to achieve climate resilience also eliminate poverty, create workforce development opportunities, address racism, increase civic participation and social cohesion, protect housing availability and affordability, increase educational outcomes, and improve public health outcomes.*
Distributional Equity	*This is about the fair distribution of resources, benefits, and burdens that result from climate resilience planning decisions. Distributional equity means prioritizing the allocation of finite resources and designing planning strategies to benefit communities that experience the greatest climate and environmental inequities and have the most unmet environmental health needs, while also ensuring that these communities do not disproportionately experience economic, social, or environmental burdens as a result of such planning decisions.*
Procedural Equity	*This is about creating outreach, engagement, and involvement processes that are transparent, fair, and inclusive. It focuses on increasing opportunities for engagement and ownership in decision-making, in all aspects of climate resilience planning, by the communities that are disproportionately impacted by and most vulnerable to climate change.*

Interactional Equity	*This includes interpersonal and informational justice and interpersonal power imbalances or perceived imbalances among stakeholders and planners. For instance, technical experts or professional planners may be perceived as having more power in engagement activities. Often, technical and expert knowledge may be elevated over community knowledge, culture, and lived experience. Acknowledging and remediating imbalances in adaptation processes and outreach and engagement creates fairness in the "interpersonal and informational aspects of encounters between parties" through honest information sharing, respect, and accountability.*

Figure 1: Definitions of Equity (SDRCC, 2021)

Building decarbonization is essential to meet climate goals and offers many additional co-benefits. However, there may also be unintended negative consequences that result from these efforts if equity is not prioritized. A robust understanding of what the broader equity implications of decarbonizing the building sector may be is key to ensuring existing disparities are not further entrenched. This report examines equity in building decarbonization, synthesizing current literature, frameworks and reports to provide a cross-sectoral understanding of the critical issues and opportunities at the intersection of climate, health, energy, and housing. It serves to provide awareness of the interconnectedness of these issues and promote collaboration in creating holistic, equity-centered policies and programs—ones that not only reduce greenhouse gas emissions but address critical issues and opportunities related to *health and safety*, *energy burden*, *accessibility*, and *housing and labor*.

Critical Issues and Opportunities

Health and Safety

Building electrification—the transition away from equipment and appliances powered by fossil fuels to those powered by electricity—is one of the key decarbonization strategies to support California in meeting its climate mitigation goals. While much of the focus in building electrification has been on reducing greenhouse gas emissions, electrification also provides significant opportunity to benefit public health by improving indoor air quality.

Buildings have long-relied on gas appliances for basic needs like space heating, water heating and cooking. In fact, over 90% of households in California use gas for at least one purpose. Common gas-powered appliances include furnaces, water heaters, stoves, ovens, clothes dryers and fireplaces (Zhu et al., 2020). In addition to emitting greenhouse gases such as carbon dioxide and methane, the onsite combustion from gas appliances also produces a wide range of air pollutants including nitrogen oxides (NOX), carbon monoxide (CO), nitrogen dioxide (NO2), fine particulate matter (PM2.5), ultrafine particulate matter (UFPs) and formaldehyde (HCHO)—all of which have been linked to negative health outcomes (Tan and Jung, 2021).

While outdoor air quality for certain pollutants has improved since the passage of the Clean Air Act in 1970, indoor air quality remains largely unregulated. According to the EPA, indoor air pollution for some pollutants may be two to five times worse than outdoor air pollution. At times, it may be even up to one hundred times worse (Seals & Krasner, 2020). With people in the United States spending an average of 90% of their time indoors, these high levels of pollutants can have significant negative health impacts (Zhu et al., 2020). Short-term health impacts from exposure to these pollutants may include respiratory illnesses, cognitive impairments, headaches, dizziness, stroke, seizure, increased blood pressure and even death. Long-term health impacts may also include cancer, cardiovascular disease, low birth rate and birth defects, sleep disorders and premature death. Replacing gas appliances with electric alternatives would remove the pollutants at their source and reduce the risk of these potential negative health impacts (Tan and Jung, 2021).

Gas water heaters and furnaces are responsible for most of the energy use in households and therefore emit the highest overall levels of pollutants and greenhouse gases. However, because California building code requires the appliances to be vented directly outdoors they do not have as strong of an impact on indoor air pollution. Gas stoves, on the other hand, are not uniformly held to this requirement and contribute most to indoor air pollution (Singer et al., 2017). As a result, nitrogen dioxide (NO2) and carbon monoxide (CO)—the two main pollutants produced from gas stove combustion—have been shown to increase to levels that violate outdoor air pollution standards. The United States Environmental Protection Agency (EPA) states that outdoor NO2 levels should not exceed 100 parts per billion (ppb) over a 1-hour average, Studies have shown that baking a cake in a gas oven can raise peak NO2 levels to 230 ppb and boiling water on the stove can raise peak NO2 levels to 184 ppb (Seals & Krasner, 2020)**.**

California law does mandate ventilation equipment be installed above stoves and ovens but it does not stipulate that it must be vented to the outdoors. Many homes have a ductless hood or a microwave range hood, both of which only circulate air through a filter and do not effectively clean the air. Ventilation systems also vary significantly in effectiveness, ranging from capturing 98% of pollutants in highly performing systems to only 15% of pollutants in low performing systems, with most failing to capture more than 75% of pollutants. A survey of 350 California residents also showed that of residents who have a range hood vented to the outdoors, 40-60% of residents did not actually use them while cooking (Seals & Krasner, 2020). Electric stoves don’t emit the levels of NO2 and CO that their gas counterparts do. As buildings are electrified, it is essential that gas stoves are replaced in addition to other major gas appliances. Replacing gas appliances offers more than just greenhouse gas reduction benefits. One study found that replacing a gas stove with an electric one decreased median NO2 concentrations in the kitchen by up to 51% (Paulin et al., 2017).

Children are especially vulnerable to the negative health effects from gas stove pollutants due to higher breathing rates and levels of physical activity, higher lung surface-to-body weight ratios and immature respiratory and immune systems. In addition to respiratory and cardiovascular issues, increased levels of NO2 may affect IQ, lead to learning deficits, and increase susceptibility to allergens (Seals & Krasner, 2020). One study found that children in households that use gas appliances for cooking have a 42% increased risk of experiencing asthma symptoms and a 24% increased risk of being diagnosed with asthma during their life compared to children living in homes with electric stoves. The severity of asthma symptoms—namely the intensity of wheeze and need for medication—also increases as levels of NO2 increase. A 15-ppb increase in NO2 increased wheeze by 15% and corresponded to a 50% increase in annual risk for respiratory symptoms (Lin et al., 2013).

While gas appliances increase indoor air pollution for everyone, increased concentrations of toxins from gas appliances disproportionately affect low-income communities. Factors that affect levels of indoor pollutant concentration include unit size, number of occupants, older or unmaintained appliances, and insufficient ventilation—all factors more common in low-income households (Seals & Krasner, 2020). Many low-income communities in California also face some of the worst outdoor air quality in the state. Emissions from indoor gas appliances compound the pre-existing environmental burdens experienced by disadvantaged communities and puts them at an even greater risk of negative health impacts. Disadvantaged communities also often have less access to healthcare or choose to seek out medical support less frequently, further exacerbating the health mortality and morbidity effects of air pollution (Zhu et al., 2020). Electrification is an opportunity to directly reduce pollutant exposure for these communities by preventing the indoor pollution contribution at the source (Tan and Jung, 2021).

Electrification also offers benefits for keeping residents at safe and comfortable temperatures inside their homes. With climate change, temperatures are rising and extreme heat events are becoming more frequent and more prolonged. Health impacts from heat events can include heat rash and heat stroke. Heat also exacerbates deaths from natural causes and chronic illnesses (Tan and Jung, 2021). According to the EPA, heat is already responsible for the highest number of weather-related deaths each year, even though most heat-related deaths are preventable (EPA, n.d.). To keep homes at a safe and comfortable temperature, cooling technology such as air conditioning should be installed. Studies show that air conditioning significantly reduces the negative health impacts of high temperatures. Electric heat pumps that provide both heating and cooling capabilities should also be prioritized in electrification efforts (Tan and Jung, 2021).

Another key decarbonization strategy is implementing household energy efficiency upgrades. Common energy efficiency improvements include installing energy efficient lighting, upgrading to energy efficient appliances, upgrading space heating and cooling systems, installing an energy efficient water heater, sealing air leaks and ducts around doors and windows and adding insulation to an attic or exterior walls (DOE EERE, n.d.a). Energy efficiency upgrades reduce greenhouse gas emissions by reducing overall energy use but also offer potential benefits for health and overall wellbeing. Weatherization efforts that improve the building envelope—such as sealing air leaks and adding insulation—can reduce the amount of outdoor air pollution that infiltrates the home (Tan and Jung, 2021). This is especially important in protecting residents from smoke as the frequency and intensity of wildfires in California increase due to climate change (IPCC, 2022). In addition to preventing outdoor air pollution from entering the home, weatherization efforts can also reduce pest infestations and can help maintain comfortable and safe temperature levels (Tan and Jung, 2021).

While energy efficiency implementation offers many potential benefits, many retrofit programs actually risk making indoor air quality worse because they are not holistic. Indoor air quality may be worsened as building envelopes are tightened if pollution is being produced from gas appliances inside the home and if the home lacks proper ventilation. As buildings become better sealed in an effort to be more efficient, ventilation decreases and toxins can become trapped inside the home. This may lead to unintended adverse health outcomes for residents (Zhu et al., 2020). One study found that weatherization efforts that only focused on tightening the building envelope led to a 20% increase in serious asthma events. Of the interventions modeled in the study, replacing gas stoves with electric stoves resulted in significantly improved health outcomes and health care savings (Seals & Krasner, 2020). Ensuring proper ventilation and movement of air, vapor, water, and heat throughout a building and its envelope needs to be essential in weatherization and retrofit projects (Tan and Jung, 2021).

There are multiple energy-related programs available to qualifying low-income Californians that provide weatherization services and energy efficiency measures. The federal Low-Income Home Energy Assistance Program (LIHEAP) and Weatherization Assistance Program (WAP) provides weather stripping, building envelope sealing, window and door replacement, attic and wall insulation, as well as energy efficient refrigerators, evaporative coolers and air conditioners. The state's Low-Income Weatherization Program (LIWP) and Energy Savings Assistance Program (ESAP) through the California Public Utilities Commission also provide weatherization services and energy efficiency measures for qualified low-income households. While these programs have provided many benefits to low-income communities, they do not provide the necessary electric appliance updates needed to complement the weatherization services and risk making indoor air quality for residents worse (Scavo et al., 2016). Energy efficiency programs must also prioritize improvements in indoor air quality for vulnerable communities by providing electric appliances and ventilation services at the same time.

Energy Cost Burden

In addition to providing health benefits, building decarbonization also offers an opportunity to reduce energy cost burden for households. Energy cost burden refers to the percentage of income a household pays towards household energy use. Nationally, low-income households have an energy burden three times that of higher-income households, leading to increased levels of energy insecurity (DOE EERE, n.d.b). Energy insecurity can result in difficult tradeoffs between paying for energy or other basic needs such as food, rent, transportation and healthcare (Miller & Chen, 2019). Energy insecurity can also worsen poverty. One study found that payday loans were most frequently taken out for the purpose of paying utility bills. The high interest rates on these loans only further contribute to poverty (Drehobl & Ross, 2016). These financial burdens can also impact stress and mental health, as well as exacerbate negative existing health conditions (Tan and Jung, 2021).

Building Decarbonization has the potential to offer a reduction in energy burden for low-income households through energy efficiency upgrades and onsite or community renewable energy generation (Scavo et al., 2016). Modern electric appliances are more energy efficient and can help reduce energy cost burden by reducing overall energy use in the home. Electric appliances also have the ability to connect to smart technologies that enable additional energy savings through managing the timing of electric energy use. High-performance building envelopes also offer cost reduction by reducing household energy load (Tan and Jung, 2021). While building electrification is a key strategy in decarbonization and offers potential economic benefits for many households, if market forces remain the key drivers of the transition and an equity-first approach is not taken, this transition has the potential to unintendedly increase energy burden for low-income communities who are not able to afford the upfront costs required to make the switch (Miller & Chen, 2019).

Natural gas is currently an integral part of California's energy system with nearly 80% of California households connected to the gas system. As the state transitions away from gas and increases use of the electric grid, it is important to consider the potential equity impacts of this significant energy transformation. Building electrification and electrification of the energy grid—both key strategies in meeting California's climate goals—will lead to a significant reduction in demand for natural gas. As demand for gas falls, cost for remaining gas customers is projected to increase (Aas et al., 2020). The California Public Utilities Commissions allows gas utilities to earn a fair return on their investments—a revenue requirement—in exchange for providing fair and reliable service for customers. As customers leave the gas system, investment costs to maintain and operate the gas system will be distributed to a smaller number of customers. This will increase the rates for remaining gas customers. As this happens, more gas customers may be incentivized to leave the gas system and rates may increase even more—creating a feedback loop that accelerates the transition and leaves remaining gas customers with a significantly higher energy burden. This will further increase the energy burden on low-income households who may not have the economic resources to transition away from gas (Aas et al., 2020).

Gas prices are also expected to rise as a result of recent safety-related incidents. The San Bruno gas pipeline explosion and Aliso Canyon gas storage leak have prompted safety-related investments in gas infrastructure. The state's revenue requirement for gas utilities was around $7 billion in 2019 and is estimated to increase to $9 billion by 2025 and $12.2 billion by 2050 due to ongoing safety-related investments. While California's gas revenue requirement will increase, gas throughput will decrease as demand decreases and individual rate payer's rates will rise. As long as gas infrastructure is being used, the system will require ongoing safety and maintenance investments. The state's electric system prices are also expected to rise due to electrification-driven load growth, the addition of zero-emission electric supply and storage needs, standard operation and maintenance costs, as well as investments in wildfire risk reduction. These rate increases, however, are far less than the expected increases in gas rates (Aas et al., 2020).

While gas prices will inevitably rise as a result of a highly-electrified building sector, gas prices would also increase in a clean energy future with low levels of building electrification and continued high use of the gas system. In 2050, an electric heat pump is projected to cost $34 to $44 per month to operate while a gas furnace reliant on renewable natural gas is projected to cost $160 to $263 per month to operate. The lower cost of the heat pump is due to the fact that it is five times more efficient than the gas furnace and because renewable natural gas—which would be required in order to meet the state's climate goals—is much more expensive than standard natural gas (Aas et al., 2020).

In 2019, natural gas commodity cost was less than $0.4/therm, making natural gas an inexpensive energy source. Renewable natural gas, however, is projected to cost $0.75/therm in 2050 in a highly electrified building scenario and between $1.4/therm and $2.4/therm in 2050 in a future with no building electrification. The additional cost for the no building electrification scenario is due to additional need for expensive hydrogen and synthetic natural gas in order to meet energy needs. While these options may be necessary for hard to decarbonize industries such as aviation, industry and trucking they are not a cost effective or necessary option for the building and electric sectors when electric options are readily available (Aas et al., 2020).

Utility bills for mixed-fuel households—those who use both gas and electric systems—are predicted to pay higher utility bills after 2030. One way to reduce overall gas infrastructure costs is to retire existing gas infrastructure through targeted electrification. Targeting specific neighborhoods to transition fully to the electric system would allow the closure of distribution lines, saving money on operation and maintenance. This would prevent households from paying into two different utility systems and also lower rates for all ratepayers by creating a smaller gas system to operate and maintain (Aas et al., 2020).

Renewable energy also offers significant opportunities to reduce energy burden. It provides an opportunity for participation in energy generation that the previous system did not. Rooftop solar or community solar programs reduce energy burden by providing individuals and communities direct economic benefit through self-generation, addressing energy burden at its core. Through a compensation mechanism known as net metering, a customer who generates renewable energy on site at their home is able to export surplus power back to the grid and receive credit towards their energy bill. This credit reduces their energy bill and therefore reduces energy burden. Virtual net metering also allows off-site renewable energy generation, like with a community-owned solar project, to be credited back to customers' utility bills (Paulos, 2017). Cost reduction through energy generation will be especially important as temperatures rise and the need for air conditioning to maintain safe and healthy home environments increases. Air conditioning is the most effective protection against heat-related illnesses and one of the most common reasons for not using air conditioning is the cost of running it (Tan and Jung, 2021).

The state has multiple solar programs that provide solar or solar incentives to qualified low-income households. Many of these programs have been highly successful in delivering benefits to low-income households (Scavo et al., 2016). To ensure that the benefits from renewable energy generation directly benefit disadvantaged communities, it is important that these communities have ownership of the generation technology—which many of the programs do provide. When renewable energy systems are owned by third parties, however, the majority of benefits flow to the third parties rather than to those who could benefit from them most. While third party arrangements can help reduce greenhouse gas emissions, they also risk replicating inequalities of the previous system and may not reduce energy burden for low-income communities (Baker, 2021).

As the energy transition takes place, it is essential that low-income households are prioritized and supported in this transition so that they don't bear a disproportionate burden of the transition costs. If market forces are the key drivers of electrification, low-income communities who are not able to afford the upfront costs or renters who don't have the choice to transition to all electric appliances will be left using gas at very expensive rates. This increase in energy burden may then impact other aspects of life too, as difficult tradeoffs in what to pay for must be made. Strategic planning and financial investment must be prioritized for disadvantaged communities in order to ensure an equitable transition (Miller & Chen, 2019).

Accessibility

While California has been a leader in advancing building decarbonization efforts, benefits of clean energy have not been evenly distributed and low-income households are often left without access to these benefits. The most straightforward barrier that low-income communities face in accessing electric appliances, energy efficiency upgrades and retrofits, and renewable energy is cost. Even if there is long-term economic benefit, the upfront costs required to make these upgrades can be prohibitive for low-income households (Scavo et al., 2016). The state offers multiple rebate programs that incentivize adoption of new technology by covering part of the upfront costs but for low-income households the costs often remain unaffordable. While these incentives may intend to support all Californians, in practice they privilege households with higher income (Fournier et al., 2020). In addition to up front costs, low-income households may also lack access to financing due to a lack of collateral or poor credit. Traditional financing, however, also isn't typically effective at incentivizing clean energy adoption because low-income households are often unable to take on additional debt. Additional financial support or alternative financing options that do not perpetuate systemic barriers will most likely be more effective (Scavo et al., 2016).

In addition to the cost barrier for the new technology, many low-income residents live in homes that may require rewiring, electrical panel upgrades, structural and maintenance repairs before the new energy technology can be installed (Miller & Chen, 2019). Older homes were also not designed with solar in mind so they may have other physical barriers such as structural issues, poor rooftop orientation for solar or an abundance of tree shading that blocks the roof. Repairs and retrofits can be costly and unaffordable, preventing energy updates. Other housing issues such as asbestos, mold and lead may also prevent energy efficiency work from being done (Scavo et al., 2016). Programs that provide incentives and services for weatherization, energy efficiency upgrades and solar technology require these issues be addressed first but resources to address these issues are not included in the programs (Miller & Chen, 2019).

Another significant barrier to access is status as a renter. Renter's lack the property rights required to make decisions around electrification, energy efficiency, weatherization and renewable energy upgrades. If a renter desires to make these updates, they do not have the agency to do so since the decision is up to the property owner (Miller & Chen, 2019). These types of updates typically benefit the individual paying the utility bill—typically the renter—so property owners are not incentivized to make these types of updates since they would incur the cost without receiving the benefits. This split incentive between landlords and tenants prevents upgrades from being completed, stalling important work needed to meet the state's climate goals and leaving the renter unable to access the benefits of the new system and technologies (Miller & Chen, 2019). Low-income residents are more likely to be renters. In 2016, 26% of low-income Californians owned their homes while 23% rented single family homes and 47% lived in multifamily housing, the majority of which are rented at market rate. Multifamily housing faces even more barriers due to complex ownership and financial arrangements and unique building characteristics and needs. A one-size-fits all model will not work for decarbonization work in multifamily housing (Scavo et al., 2016).

The complexity of incentive and subsidy programs available to support the energy transition can also be challenging to navigate, further limiting access because a time investment is required to understand the programs–time that low-income households often do not have available to them. Eligibility criteria typically vary by program and programs are often siloed. This can make coordination difficult, increase transaction costs and also result in unrealized potential energy upgrades that may be available if programs were more holistic or more complementary of each other. Language and education barriers can also prevent accessible participation in energy programs and in turn, the program's ability to maintain efficacy (Scavo et al., 2016).

Insufficient outreach is also a significant barrier to access. In a series of community meetings held in preparation for a report prepared by the California Energy Commision, it was found that community members were often aware of the California Alternate Rates for Energy (CARE) program that provides a monthly discount on energy bills for qualified low-income households but few were aware of available energy efficiency and weatherization programs also available. Communities may also be skeptical about programs marketed to them because utilities have not always been perceived as helpful or looking to serve the best interest of the community (Scavo et al., 2016).

Housing and Labor

An in depth discussion of critical issues related to the housing and labor sectors is beyond the scope and timeline of this report. However, it is important to highlight the close ties these sectors have with building decarbonization and briefly examine the critical issues and opportunities that result from the impact of the energy transition. Housing insecurity and poor home environments are linked to poverty and poor health. A lack of secure housing can disrupt healthcare management and poor housing quality can introduce toxic materials like lead, asbestos and mold. Nearly half of all rental units have quality deficiencies and low-income households rent two thirds of units with significant deficiencies (Tan and Jung, 2021). The housing crisis in California exacerbates these issues as many residents don't report issues out of fear of increased rent and risk of displacement. Building decarbonization efforts need to simultaneously address other housing deficiencies in order to be effective.

Electrification or energy efficiency upgrades can also lead to green gentrification and make renters at risk of displacement (Hays et al., 2021). A split incentive often keeps property owners from completing upgrades—especially when housing demand is larger than the supply—but when they do they may increase rent or even evict the current tenant in order to rent to wealthier tenants. This may lead to displacement of the current renter. Renter protections will be important in equitable decarbonization policy in order to ensure the targeted benefits go to those who they are intended to reach (Miller & Chen, 2019).

The energy transition will also have a major impact on the labor market. As jobs in the fossil fuel industry are phased out, it is essential to create a transition plan for those displaced by these changes. Historically, jobs in the fossil fuel industry have been higher paying and provided better benefits to workers than jobs in the clean energy system. Ensuring new jobs in energy efficiency and renewable energy provide sustaining wages, good benefits, and career advancement are essential in an equitable transition. It is important that labor standards and opportunities that support these workers be included in building decarbonization policy and planning from the start (Lamm & Elkind, 2021). The clean energy transition also offers opportunities to create local jobs for those seeking employment in low-income communities. In addition to strong workforce standards, workforce development programs must be intentional in creating pathways for employment by offering training that builds the necessary skills and prepares workers for job opportunities in the clean energy sector (Miller & Chen, 2019).

Conclusion

To meet California's climate goals, new policies and programs will be required to decarbonize the building sector at the speed necessary to prevent the worst impacts of climate change. In addition to mitigating greenhouse gas emissions, this transition also provides an opportunity for the state to design a new energy system that directly centers equity and is intentional in improving the lives of Californians who have been historically marginalized and underserved under the previous system. An equitable transition will require intentional policies and programs that provide access to the benefits of electrification, energy efficiency and renewable energy (Miller & Chen, 2019).

Disadvantaged communities must be prioritized in building decarbonization investments. Programs and policies must address the starting-line disparities and directly target low-income communities and communities of color who have borne the highest costs of the fossil fuel industry (Tan and Jung, 2021). Investing in comprehensive programs that target and support entire neighborhoods will remove many of the barriers that currently exist in accessing the benefits of the clean energy system. While disadvantaged communities should be prioritized, it is also important to have flexible, common sense boundaries. If a residence is located just outside of the disadvantaged community but has the same needs and circumstances, it should be included (Scavo et al., 2016). Equitable programs and policies must also create protections for renters in these communities so that the benefits go to those who they were intended to go to and avoid community displacement (Miller & Chen, 2019).

An equity-first approach to building decarbonization must begin with community engagement. Community voices need to be central in shaping new policies and programs. State and local governments should provide educational resources and funding for community engagement. It is also essential that state and local governments partner with community-based organizations who have built trust within the communities they serve to begin conversations around building decarbonization (Tan and Jung, 2021). Building decarbonization policies and programs for disadvantaged communities must also be holistic and integrated across climate, health, energy and housing. When programs are siloed, social, environmental and economic barriers continue to exist and potential benefits may be missed. Comprehensive and coordinated policy allows for complementary funding sources and lower transaction costs that can lead to improved health outcomes and economic opportunity (Miller & Chen, 2019).

A foundational knowledge of the critical issues and opportunities, as highlighted in this report, is essential to planning for an equitable energy transition. Each community has unique needs and there are many pathways to building decarbonization. This report serves to provide awareness around these critical issues and opportunities, and highlight the interconnectedness of climate, health, energy and housing. The following framework serves as a starting point for discussions around these issues. It provides questions and guidance to center equity in building decarbonization planning and promote collaboration across public and private sectors. Building decarbonization not only reduces greenhouse gases but also has the opportunity to significantly improve health outcomes, reduce cost burden and increase economic prosperity for disadvantaged communities.

A Framework for an Equity-First Approach to Building Decarbonization

Guiding questions and recommendations at the intersection of climate, health, energy and housing

Building decarbonization is a key strategy in mitigating greenhouse gas emissions but also offers the opportunity to improve health outcomes, reduce cost burden and increase economic opportunity for disadvantaged communities. This framework serves as a discussion guide for local planners, government officials, building professionals and community leaders to explore critical issues and opportunities at the intersection of climate, health, energy and housing. It offers questions and recommendations to center equity and promote collaboration in building decarbonization planning and implementation processes.

Step 1
Identify and explore the critical issue

→

Step 2
Analyze community engagement approach for critical issue

→

Step 3
Address and assess recognition of equity

Step 1: Identify & Explore the Critical Issue

Critical Issue	Questions and Recommendations
Health and Safety	● How can communities who have disproportionately borne the largest burdens from fossil fuel pollution be prioritized in electrification efforts? ● How can energy efficiency upgrade programs be paired with electric appliance updates in order to prevent the unintended negative consequence of increased indoor air pollution from gas appliances? ○ How can we increase community awareness of the indoor air pollution from gas stoves?

	◦ How can cultural cooking preferences be supported? • How can residential energy efficiency audits be made more holistic to also address health and safety issues? ◦ What indoor air quality regulations or guidelines could be adopted? ◦ How can audits be conducted with no risk to the tenant? • As temperatures increase due to climate change, how will we support residents most vulnerable to climate hazards such as increased heat impacts? ◦ What cooling adaptation measures exist and how do we ensure energy cost burden is not increased with the need for additional cooling?
Energy Burden	• Which communities are experiencing the highest energy cost burden? ◦ Do energy efficiency programs prioritize those who are most energy burdened? • Are community members aware of programs available to them to help reduce energy cost burden? ◦ Who benefits most from these current programs? Are these programs effective in reducing energy cost burden? • How will we ensure low-income communities do not become more cost burdened as we shift away from gas systems? ◦ How can these communities be prioritized in building electrification programs? ◦ How can regional local governments collaborate to ensure that low-income communities do not become more cost burdened as we shift away from gas systems? • What opportunities for wealth creation exist for disadvantaged communities as we transition to clean energy systems?

	◦ What opportunities can we create for homeowners? What opportunities can we create for renters or those not eligible for rooftop solar? ◦ Renewable energy asset ownership and control can provide energy bill savings and investment opportunities. ◦ Renewable energy assets paired with storage can also make communities more resilient during power outages, leading to additional cost savings. • What opportunities exist to advance energy democracy?
Accessibility	• What are the (structural, economic, and logistical) barriers homeowners in the community face in accessing electric appliances, energy efficient technology or renewable energy? ◦ Are community members aware of building decarbonization programs and support available? What opportunities exist to promote awareness? ◦ Are incentives helpful or is upfront cost prohibitive? Is financing accessible? ◦ Is access limited due to additional infrastructure needs? • How can policies and programs provide more access to electric appliances, energy efficient technology and renewable energy for homeowners? ◦ Is there a collaborative approach the region can take in elevating and implementing effective policies and programs in this space? ◦ Alternative financing structures not based on traditional credit checks may offer more access to residents. • What are the (structural, economic, and logistical) barriers renters in the community face in accessing electric appliances, energy efficient technology or renewable energy? How do we overcome the hurdle of split incentives between landlords and renters?

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Requiring rental energy disclosures may provide more agency for renters.
Adopting rental energy performance standards or basic retrofit requirements would increase access for renters.
Granting energy efficiency improvement rights to renters may remove some barrier to access.

Do pricing structures for rooftop solar and community renewable energy projects incentivize participation for both community members and developers? Is the project feasible?

Does the payment rate for providing power to the grid incentivize adoption?
Does partnering with a local CBO, school or municipality make the project more feasible?

How can alignment with other programs create funding opportunities that increase access?

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<tr>
<td>Housing and Labor</td>
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How may building electrification and energy efficiency upgrades affect affordability and potentially increase the risk of displacement of community members?
What protections currently exist for renters? What additional protections could be put into place for renters?

Creating affordability agreements with landlords in exchange for building electrification and energy efficiency upgrades can mitigate the risk of displacement.

What opportunities exist in affordable housing to support building decarbonization efforts?

Prioritize building electrification and energy efficiency upgrades in existing affordable housing where residents are not at risk for displacement.
Advocate for more new build affordable housing that is already required to meet high performance standards.

What local workforce development opportunities currently exist in building decarbonization implementation?

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	- Are workers who will be displaced by a transition away from fossil fuels and members of disadvantaged communities prioritized for training and jobs? - What training is needed around energy efficiency upgrades and renewable energy construction in order to meet the labor demand for the transition? - What skill sets are needed for these new positions? - Do new jobs provide a living wage and good benefits?

Step 2: Analyze Community Engagement Approach for Critical Issue

Community Engagement	Questions and Recommendations
	- Which communities disproportionately bear the largest burdens from the impacts of the fossil fuel industry? Which communities are experiencing increased harms due to historically inequitable and discriminatory policies and systems? - These communities should be prioritized in community engagement and programs should directly benefit these communities. - CalEnviroScreen provides data on pollution and other burdens - Do local planners, government officials and building professionals have a strong understanding of historical discrimination or inequity the community has experienced or is currently experiencing? What support is needed to strengthen this understanding? - Who are the community leaders and community-based organizations (CBOs) that could help plan and execute engagement with community residents?

    - Who does the community trust? Who does the community go to when they have questions?
    - What work are these leaders and CBOs already doing? Do they need additional support so they aren't overextended? Is there an opportunity to address multiple issues together?
- What cross-sectoral partners should also be engaged in order to support holistic policies and programs at the intersection of climate, housing and health?
    - Is there a way to identify the strength of network ties between private and public sectors to better support holistic policies and programs at the intersection of climate, housing and health?
- Are community engagement meetings accessible to community residents?
    - Is meeting information clearly communicated across multiple channels and is advanced notice given?
    - Is the meeting time and location convenient for residents? Are there in person and online options available?
    - Is child care available during the meeting?
    - Is the meeting translated?
- What is the budget for community engagement?
    - Are community leaders, CBOs and residents compensated for their time?
- What relevant information, terms, concepts or other background information on building decarbonization should be provided to participants and set them up for a meaningful and informed discussion?
    - What are residents' current levels of knowledge around building decarbonization processes and benefits? How does this knowledge vary? What information would be helpful to share?
    - What ways could information also be shared ahead of time?

	○ What opportunities are there to look at and assess data together? Does the data align with the experiences of the community? What might the data be missing? ● How will community engagement shift influence and decision-making power to disadvantaged communities? ○ How will community expertise, concerns, needs, ideas and solutions be heard and documented? ○ How will these concerns and ideas be addressed and help center equity in policies and programs?

Step 3: Address and Assess Recognition of Equity

Recognition	● Were disadvantaged communities able to meaningfully participate in the policy or program process with the resources and support they needed? ● Do the policies or programs decided upon reflect and center the needs and priorities of the community? ● Do community members directly benefit from the policy or program? ● Does the policy or program increase access and affordability to disadvantaged communities? ● Is the policy or program easy to navigate and understand? Are there opportunities to increase awareness of the policy or program? ● Is there flexibility and adaptability to iterate if needed? ● Is the policy or program coordinated with complementary programs? ● Did the policy or program deliver the benefits it was intended to deliver to those it was intended to reach?

	• Does the policy or program—and the processes of creating it—align with the four dimensions of equity (*procedural, distributive, structural and Interactional)?*

This framework draws heavily on ideas and concepts from the following resources:

- A New Lease on Energy: Guidance for Improving Rental Housing Efficiency at the Local Level by ACEEE and the Urban Sustainability Directors Network
- Building Toward Decarbonization by Center for Law, Energy and the Environment, UC Berkeley School of Law & Emmett Institute on Climate Change and the Environment, UCLA School of Law
- Health Effects from Gas Stove Pollution by the Rocky Mountain Institute, Physicians for Social Responsibility, Mothers Out Front and Sierra Club
- Decarbonizing Homes: Improving Health in Low-Income Communities through Beneficial Electrification by RMI
- Equitable Building Electrification: A Framework for Powering Resilient Communities by The Greenlining Institute and Energy Efficiency for All
- Equity and Buildings: A Practical Framework for Local Government Decision Makers by the Urban Sustainability Directors Network
- Low-income Barriers Study, Part A: Overcoming Barriers to Energy Efficiency and Renewables for Low-income Customers and Small Business Contracting Opportunities in Disadvantaged Communities by the California Energy Commission
- The Energy Justice Workbook by the Initiative for Energy Justice
- The Equitable Building Decarbonization Workshop Series by the City of Los Angeles' Climate Emergency Mobilization Office

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