

Can Building Electrification Bring Resilience to Low Income Communities?

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ABSTRACT

California and many parts of the world have goals to drastically reduce greenhouse gas (GHG) emissions to mitigate climate change. In addition to decarbonizing the electric grid and electrifying transportation, building decarbonization¹ is key to meeting GHG targets. Building electrification is emerging as the most viable and cost-effective approach to achieve building decarbonization. However, with the race to electrify buildings, how will low-income communities and other vulnerable populations not get left behind? What are some of the necessary steps that must be taken to ensure that low-income communities do not continue to be tied to an aging fossil fuel energy infrastructure with rising rates as other customers with access to capital electrify their buildings? What are the roles for energy efficiency, load management, and distributed energy resources such as on-site renewable energy generation and energy storage? What are the resiliency impacts on low-income communities that electrify their buildings? As the impacts of climate change become more pronounced and the grid is modernized to adapt to a warming climate, how can these communities that are reliant on electricity be resilient, affordable, and safe? This presentation will examine these issues and will draw on findings of a study in Southern California to examine the implications of electrification from an equity and resilience perspective, with a focus on buildings and end-users.

Introduction

While the electrification of existing buildings may be more difficult and complex than new construction, the influx of resources needed can create an opportunity to correct course on historic trends of disinvestment in low-income populations and build in significant co-benefits. Accomplishing this will require a systemic approach that treats decarbonization, resilience, and equity as inseparable goals. Further, addressing these goals systemically provides the greatest opportunity for an effective and efficient transition overall. We will examine current research and trends that link decarbonization, resilience, and equity with a focus on affordable housing in order to illustrate pathways and strategies with the greatest potential for addressing the needs of low-income communities.

¹ Note—in this paper we use the term building decarbonization to include all energy-related measures that can reduce carbon emissions from buildings directly and indirectly, including electrification, energy efficiency and installation of solar. The term electrification is used specifically to refer to converting fossil fuel-based systems in buildings to all-electric.

Context: Energy Transition

Slowing the rate of climate change is a societal imperative. We are already reckoning with climate impacts increasing in frequency and intensity. With recent IPCC reports, the scientific community sounded the alarm on what the future will look like if decisive and aggressive action is not quickly taken to reduce our greenhouse gas (GHG) emissions. The body of supporting research draws direct lines from our collective emissions to dire looming consequences like humanitarian crises, food and water insecurity, forced migration, and premature deaths (IPCC Working Group II, 2022). There is a narrowing window before impacts are locked in and irreversible tipping points are triggered.

California has set ambitious climate targets in response to the clear need for action, with deadlines quickly approaching. California set its GHG reduction target to 40% below the 1990 level by 2030 with SB-32 (**Pavley, 2016**). With Governor Brown's Executive Order B-55-18, the State set an additional target for carbon neutrality by 2045 (**State of California Executive Department, 2018**). In 2021, Governor Newsom has requested that the California Public Utilities Commission (CPUC) and the California Air Resources Board (CARB) analyze pathways to reach carbon neutrality by 2030 (**Office of Governor Gavin Newsom, 2021**).

Achieving those climate goals will require decarbonizing buildings. Electrifying not only new buildings but also existing buildings is a key piece of building decarbonization. Residential and commercial buildings in California account for about 25% of the State's greenhouse gas (GHG) emissions when accounting for fossil fuels combusted on-site (direct emissions) and in upstream in generating the energy buildings consume (**California Air Resources Board, 2019**). As stated in AB 3232, direct emissions from combusting fossil fuels within buildings (e.g., gas-fired boilers, furnaces, gas stoves) account for 10% of all GHG emissions in the State (**Friedman, 2018**). Another source of emissions not accounted for in these statistics are from leaks across the methane gas supply chain: from production, local gas distribution pipelines, customers' gas meters, and behind the meter leakage (e.g., appliances within buildings) (**Carter, 2020**).

Addressing the role of buildings in climate action will require the following:

1. Removing fossil fuels from energy generation so that the carbon intensity of electricity becomes lower and eventually carbon-free,
2. Removing fossil fuels from the end-use within buildings and
3. Increasing energy efficiency and renewable energy (e.g., solar) at the building and community scale.

Energy efficiency remains important and is key to making decarbonization cost-effective and supporting grid harmonization. To the extent that electrification may be more expensive than the current mixed fuel state in certain situations, energy efficiency alone or paired with renewable energy can offset increases in energy bills. Energy efficiency measures like envelope improvements also have co-benefits like passive survivability during power outages.

Although necessary, electrifying existing buildings is a complex proposition. Unlike new buildings, which must comply with California energy codes, there are fewer touchpoints to require retrofits of existing buildings.

Electrifying existing buildings is not as simple as retrofitting a few appliances per household. Especially for older buildings, this transition can require upgrades to electrical distribution panels and the main electrical service, running new wires, and adding outlets. Doing so can uncover other underlying building issues, such as the discovery of mold or asbestos, triggering additional required renovations. However, as this report will discuss, the benefits of driving investment into existing building retrofits can include increases in energy efficiency, better air quality and public health, and the opportunity to improve the resiliency of building stock in the context of increasing climate impacts.

Electrification needs to be viewed in the context of resilience and equity to design better solutions. From a climate perspective, building electrification is a crucial decarbonization measure in California. It is an essential step in responding to the climate crisis and must move ahead at full speed. From a resilience perspective, the number of buildings that will have to be retrofitted can be seen as a disruptive change, with the potential for unintended consequences as well as benefits. From an equity perspective, those unintended consequences will fall most heavily on communities and households that are already most vulnerable, who will bear the greatest burden from climate impacts, and who have been chronically underserved by public investment. By providing a full accounting of the impacts of electrification (negative and positive) and examining who will experience those impacts most, it is possible to better design systems-based solutions that deliver the greatest societal benefit.

Potential Disruption and Unintended Consequences:

Retrofitting existing buildings can be disruptive. The number of existing buildings that need to be retrofitted in order to meet California’s decarbonization goal by 2045 is massive. Based on Southern California Edison’s analysis, this target would require electrifying 70% of all space and water heating in the state (Southern California Edison, 2019). Implementation will require regulatory requirements, financial investment, and technical support outside the typical touchpoints of new construction or change of ownership.

These interventions pose an acute risk of unintended consequences for rental buildings that lack protections for tenants. The status quo is already precarious for so many households across the state. As of February 2022, about 40% of adults in California were in households behind on rent or mortgage payments and faced a risk of eviction or foreclosure in the coming months (US Census Bureau, 2022). Retrofitting units could also trigger compliance with the American Disability Act (ADA) and spiral the retrofit into a more involved and costly process that requires relocating tenants. Temporarily or permanently re-housing tenants depending on the timeframe of construction could serve as a disincentive to landlords in undertaking decarbonization retrofits. In the stakeholder interviews conducted by the Better World Group, tenants’ rights advocates voiced a concern that some landlords may use a decarbonization retrofit process to evict low-income tenants to attract higher-income tenants, accelerating gentrification and displacement (Arup, 2021).

There is a risk of increased household expenses. Per unit of energy, electricity is more expensive than gas. However, replacing less efficient gas appliances with today’s all-electric equivalents has the potential of operational savings (Arup, 2021). In cases where there is no significant efficiency gain or a

household that did not previously have air conditioning begins using a heat pump for summertime cooling, there is a potential for higher monthly utility bills. Across California, about 23% of adults lived in households unable to pay an energy bill in full over the past year (US Census Bureau, 2022). 36% of adults reported having difficulty paying for other usual household expenses in the past 7 days (US Census Bureau, 2022). There is significant financial pressure already on households, which heightens the consequences of any increases in energy costs.

At the same time, as buildings begin to move away from gas, the remaining gas customers will bear the cost of maintaining the aging gas infrastructure. This poses a risk associated with not electrifying, as buildings that continue to rely on gas may become stranded assets. This issue is of particular concern for low-income communities that are chronically left out of infrastructure investment as well as energy retrofit programs and are more sensitive to rate increases. Efforts to protect low-income communities or affordable housing from the first costs of decarbonization by excluding them from requirements may therefore have unintended consequences. These communities must be at the center of consideration for implementation support, rather than excluded outright.

There is a potential loss of some resilience during power outages for some customers. There is a perception that electrification will eliminate the option of using household appliances during outages. This option provided a critical lifeline to some households in Texas during the 2021 ice storms, as households were able to use gas stoves for warmth and to melt snow for drinking water when both electric and water lines were down. However, in other outages, this same capability of using gas stoves for heating during outages has instead resulted in fires and carbon monoxide poisoning. While the use of gas appliances during outages can increase household resilience, this level of resilience may only be valid for a limited number of households in California because many gas appliances require electricity to operate. Older furnaces that have a standing pilot light and do not have electric fans may be able to operate without electricity, for example. More modern gas furnaces have electric ignitions, and more centralized systems often have many components that require electricity (e.g., fans, dampers, VAV boxes). Conventional gas water heaters can be manually lit, but tankless (i.e., on-demand) systems feature electricity-powered control panels to operate. Standard safety features on gas ovens prevent the cooking flame from manual ignition. The primary potential loss during an outage that does not impact the natural gas system (e.g., like an earthquake would) is the use of a gas stove: a lit match can typically bypass the electric ignition of stovetop burners.

In summary, with the exception of some gas stoves, it is predominantly older systems that could function in a power outage and are en route to being phased out based on appliance age. Many critical energy end-uses like charging for medical devices and communication or air conditioning during heatwaves are already electricity-dependent. So, the critical resiliency question for many households is already tied up in how to access power during long-duration outage events. The scale of the resilience loss associated with electrification needs to be further quantified but is likely overstated.

Increased demand on the grid. Building new all-electric buildings and electrifying existing structures will increase the overall demand on the grid. This growth in demand is coupled with a changing demand profile due to the increasing availability of electric vehicles. The risk is an imbalance between supply and demand that triggers outages. If widespread electrification is not combined with expanded

capacity, energy efficiency, and demand response through more advanced grid controls that are locally responsive, the grid could be overloaded and damaged.

Benefits of Building Electrification

Building electrification also brings benefits, from reduced or avoided harm to new opportunities, including:

Removing the combustion of fossil fuels within buildings improves air quality indoors and out. A by-product of natural gas combustion within buildings is a variety of air pollutants (e.g., nitrogen dioxide, carbon monoxide, nitric oxide, formaldehyde, acetaldehyde, and particulate matter). Through the use of appliances like gas stoves and wall heaters, these pollutants that are emitted within homes and eventually flow outdoors are linked to adverse health impacts like respiratory illnesses, cardiovascular diseases, poor pregnancy outcomes, and premature death (Zhu, Connolly, Lin, Mathews, & Wang, 2020). In a 2020 study, UCLA's Fielding School of Public Health found that using a stove and oven simultaneously for 1 hour resulted in concentrations of nitrogen oxide indoors that surpassed national and statewide outdoor air quality standards in 90% of modeled scenarios (Zhu, Connolly, Lin, Mathews, & Wang, 2020).

Some of the equity implications of this health hazard include that the concentrations of these pollutants are higher for renters (more constrained space) and in homes poorly ventilated and/or lacking range hoods, which are more likely to be the case for low-income communities. Renters also have less control over the appliance choices within their homes and may not be able to afford maintenance (Zhu, Connolly, Lin, Mathews, & Wang, 2020). These issues compound with other environmental justice issues like overall greater exposure to poor air quality and less access to preventative medical care, translating to a higher risk of worse health outcomes.

Avoiding gas leaks would improve air quality. Natural gas is 70-90% composed of methane, a potent greenhouse gas (Lacroix, Goldberg, Gustafson, Rosenthal, & Leiserowitz, 2020). The global warming potential of gas is actually higher before combustion, highlighting the environmental impacts of upstream and midstream leaks on top of the health impacts of the released methane. Although hard to predict, leaks are increasingly detectable thanks to satellite observations (Tabuchi, 2019). The community of Porter Ranch in Southern California is still wrestling with health impacts years following the leak at the SoCalGas storage facility in Aliso Canyon in 2015 with thousands of residents reporting illnesses. The leak from the blowout resulted in 100,000 metric tons of methane released into the air over four months (Kloczko, 2020). The methane released in a single gas-well accident at an Ohio fracking site in 2018 eclipsed the methane emissions of the entire oil and gas industries in many countries over a year. About a hundred neighboring residents needed to evacuate, and there were complaints about throat irritation, dizziness, and breathing problems (Tabuchi, 2019).

The negative impacts on outdoor air quality are compounding for low-income environmental justice communities who also structurally have less adaptive capacity (e.g., financial means, preventative health care access) to avoid detrimental health outcomes.

Reduced risks of gas explosions. There have been instances of gas pipeline explosions like the 2010 event in the Bay Area. An electrical failure triggered a pressure surge within PG&E's natural gas pipelines in San Bruno. It overwhelmed a segment installed in 1956, found later by investigators to

have been poorly welded together, and featured a visible crack. The explosion lifted a 3,000-pound segment of pipe into the air. Natural gas continued to leak from the rupture and feed flames, resulting in 8 deaths, 58 injuries, 38 destroyed homes, 70 damaged homes, and a community shaken by the trauma (Bowe & Pickoff-White, 2015).

Reduced risks of cascading impacts triggered by earthquakes. California faces a high earthquake hazard, and past events have illustrated some of the downstream impacts of disruptions and damage to the gas system. Customers reported 14,062 natural gas leaks following the 1994 Northridge Earthquake, including in some buildings outfitted with seismic gas shutoff valves (Strand, 1997). The consequences looked like the following:

- *Fires:* There were at least 50 gas-related structure fires, including 24 in single-family homes, 5 in apartment buildings, 3 in businesses, and 6 in mobile home parks. In total, 144 mobile homes were destroyed. As the Los Angeles Fire Marshall at the time highlighted, if the earthquake had occurred later in the day (rather than at 4:30 am) or was accompanied by strong winds, the leaks could have been more rampant, and fires could have spread more freely (Strand, 1997).
- *Added strain on emergency response:* Fire departments responded to over 1,000 reports of gas leaks on top of calls for fire help and emergency medical services - contributing to a five-fold increase of what the county fire department typically sees (Strand, 1997).
- *Disrupted service:* In the aftermath, SoCalGas's efforts included 122,300 restores (Strand, 1997). Thanks to code updates, seismic gas shutoff valves have become more ubiquitous in Southern California, but the lengthy wait times to restore natural gas service haven't changed. SoCalGas recommends that customers contact their support services or a professional to reset the valve, check for leaks, and re-light pilot lights but warns that after a major event, "it may take many days or weeks before someone can come to your location" (SoCalGas, 2022). Pipelines that rupture during earthquakes will take longer to remediate. The San Francisco Lifelines Council study estimated that in a magnitude 7.9 earthquake, 95% of the electrical infrastructure would be restored in a week, compared to 6 months for 95% of the gas infrastructure (The City and County of San Francisco Lifelines Council, 2014).

Avoiding stranded assets. Properties and communities that do not transition away from natural gas may bear the cost of maintaining natural gas infrastructure or becoming stranded by the gas system. Ratepayers support the maintenance of this aging infrastructure, so when that customer base dwindles as electrification ramps up, the remaining customers are on the hook to upkeep the aging infrastructure through higher monthly bills (Arup, 2021). Another risk is that as a neighborhood electrifies, it may become no longer cost-effective to maintain a gas line that serves a single or small number of customers, presenting a risk of those assets becoming "stranded" by the gas system.

New cooling capacity. More than 35% of California homes do not have air conditioning; among communities of color more than 40% lack cooling at home (CDPH, 2016). The state already experiences triple-digit heat waves and will continue to face them with increasing frequency and intensity given climate change. Upgrading a household from a gas furnace, which can only provide heating, to an electric heat pump that can provide both heating and cooling, provides residents with adaptive capacity to maintain healthy, comfortable indoor conditions. This resilience benefit is particularly relevant to households with medically vulnerable family members, elderly occupants, or

children (Arup, 2021). Low-income communities and communities of color are currently and increasingly more exposed to extreme heat events due to heat island effect (e.g., neighborhoods with more pavement and fewer trees) and buildings with poorer performing envelopes (e.g., less or no insulation, single-pane windows, windows without solar control coatings, less airtight construction).

Potential for operational savings. While electricity is currently more expensive than natural gas, increases in efficiency associated with replacing aging equipment can result in reduced operational energy costs. This is especially true when electrification is combined with other energy efficiency and weatherization improvements.

Job creation. The amount of work required to retrofit buildings will generate skilled, well-paying jobs. A UCLA Luskin study has estimated that electrifying 100% of California's new and existing buildings, a step towards statewide carbon neutrality by 2045 target called for by Executive Order B-55-18, would require over 100,000 full-time workers in the construction industry and up to 4,900 full-time manufacturing workers (Jones, 2019). In the residential sector, much of the work is provided by small local businesses. Technical training and mid-stream incentives of contractors are key to supporting the transition. As is proactively addressing and transitioning the current gas industry job roles that don't have a clear place in an all-electric future. Currently, there is a shortage electrical engineers and contractors throughout the building industry, with many companies struggling to find candidates to conduct electrification work.

In summary, the transition to electrification creates an opportunity. The resources required to electrify buildings can be strategically leveraged to drive investment into low-income and vulnerable communities, building local resilience and reversing the patterns of chronic disinvestment. By planning ahead, working with impacted stakeholders and maximizing social co-benefits, investment in decarbonization can drive resources into communities that are most vulnerable to the impacts of climate change and have been historically excluded from the benefits of infrastructure and energy programs.

A Closer Look at the Affordable Housing Sector

The climate crisis is concurrent with an affordable housing crisis. Even before the pandemic, the State faced a severe shortfall: over 1.2 million low-income renters did not have access to an affordable home as of 2019 (California Housing Partnership, 2021). Rent growth is outpacing wages, and financial pressures are most pronounced in low-income communities of color. California's affordable housing market is extremely overstrained and fragile, so electrification mandates with price tags could trigger cascading unintended consequences. Even slight increases in rent or energy costs could push households over the edge into homelessness. To not only mitigate this risk but bring benefits to low-income communities, approaches to residential building electrification should focus on affordable housing and recognize the constellation of issues this sector faces to maximize co-benefits of interventions.

The preservation of affordable housing is essential to community resilience. Access to shelter and energy are fundamental and essential to the resilience of any community. Keeping people housed, keeping housing and energy affordable, and keeping housing safe over time in the context of climate

impacts must be a central focus of infrastructure planning. Having large populations of unhoused people is not only inhumane, but it also creates burden on public resources and emergency systems, leaving less adaptive capacity for society as a whole in the context of major emergencies.

Affordable housing and low-income communities are most vulnerable. Low-income communities and communities of color already bear a disproportionate share of climate burdens and have the fewest resources available to adapt and recover from disasters. California is reckoning with a housing shortage, a housing affordability crisis, and a homelessness emergency. Affordable housing—including both regulated and naturally occurring affordable housing—has experienced chronic disinvestment. As a consequence, units occupied by, or available to, low-income households are more likely to have older, less efficient equipment.

Deferred maintenance poses a risk. The majority of these units that provide affordable housing are located primarily in low-income communities that are also overburdened by pollution and lack of infrastructure investment. These units are often chronically under-resourced, with significant backlogs of deferred maintenance. Rent stabilization, while critical for protecting tenants from sharp rent increases, also limits the amount of cash flow on properties that can be invested in maintenance. This challenge was exacerbated during the COVID pandemic, often to crisis levels, as a result of rent deferrals.

Low-income communities are grappling with energy burden and struggling to cover other household costs. Energy burden is typically defined in financial terms: as paying over 6% of household income on energy bills. Energy burden is used to contextualize energy costs to what they mean for a household, but it's inherently a flawed metric. It is a measure of what households spend, not what it costs to keep their homes safe, healthy, and comfortable. People will respond to their bill costs and constrain their use if needed, especially when it's coming head-to-head with other household critical expenses like food, rent, and car payments. Thus, the disparity seen in the data is likely an underestimate. Across the US, low-income households pay a higher percentage of their income on energy bills 16.3% compared to 3.5% in non-low-income households (US Department of Energy, 2019). Energy burden across California is disproportionately concentrated in low-income communities and communities of color. Black, Hispanic, Native American, and older adult households, as well as families residing in low-income multifamily housing, manufactured housing, and older buildings experience disproportionally high energy burdens nationally, regionally, and in metro areas (Drehobl, 2020).

Deferred maintenance is a key barrier. President Biden has recently started a weatherization assistance fund that allocated \$3.5 billion for investment in more energy efficient options for low-income U.S households over the next five years. However, due to regulation there have been barriers in low-income households receiving these funds. Homes may be deferred from these funds if inspectors find that additional work is needed outside the weatherization upgrades. Many low-income households have many infrastructure issues outside those covered by weatherization guidelines. According to the Energy Coordinating Agency, around half of all weatherization assistant application in Philadelphia resulted in a deferral. Low-income owners are less likely to have access to capital to support other

retrofits around health and life safety that may be required in order permits to be provided for energy-related work.

Deferred maintenance keeps households in harm's way longer. Los Angeles and other cities have passed seismic retrofit ordinances for soft story and non-ductile concrete buildings. Compliance with the Los Angeles ordinance is informative for the design of potential electrification retrofit ordinances. The length of time required to implement ordinance-mandated retrofits was shortest in communities that were predominantly higher income and white, and longest in communities that were predominantly poor and Latino, leaving the latter communities at risk longer (Lee, 2021). Older units with inefficient systems and deferred maintenance are ill-prepared to meet the challenges of climate impacts and are more vulnerable in a variety of ways. Affordable housing is at risk in rural and suburban communities at the wildland-urban interface. Flooding and other hazards can make housing uninhabitable. Perhaps most important from an energy perspective, the lack of insulation and cooling makes units particularly susceptible to extreme heat. Affordable housing, particularly housing outside of denser urban areas, are also at high risk of fires, and are also susceptible to outages related to fire and fire prevention.

Existing energy programs are not enough to support low-income communities through the transition. Low-income and multi-family owners and residents face a variety of barriers to implementing energy programs, including limited cashflow, limited access to capital, complex financing arrangements and split incentives (UC Berkeley School of Law, 2019). Many affordable housing buildings have complex capital stacks (similar to having multiple mortgages) that can make it challenging for them to access incentive programs, as each lender or investment partner must sign off on any additional loans or investments. Many low-rate loan products exist for this market segment and specifically for energy efficiency scopes, have limited impact on projects that cannot support additional debt. Programs that do not cover the full cost of retrofits, including health, safety and code upgrades, then projects cannot move forward. These challenges, combined with the often piecemeal nature of energy incentive programs, can be a barrier for implementation. Carveouts for disadvantaged and low income communities from programs such as Self-Generation Incentive Program (SGIP), Charge Ready, Solar on Multifamily Affordable Housing (SOMAH) and others are important, but their siloed nature with separate timelines and application processes create complexity that may make it difficult for owners to access and manage.

Split incentives between tenants and owners have made traditional programs ineffective in reaching this market sector, leaving low-income residents with more inefficient systems and higher energy bills. Historically, energy programs have had limited benefit for multi-family housing due to split incentives between owners and occupants. The split incentive describes the relationship between landlord and tenant in affordable housing, which results in a disinvestment from electrification options. If the landlord supplies energy options their goal is to have the lowest cost (opposed to the highest efficiency) because they do not pay monthly bills (Bird & Hernandez, 2012). While low-income households could most financially benefit from a decrease of energy use through electrification, their funds and split incentive make it a barrier. This lack of investment follows historical trends of disinvestment in low-income communities overall, and in communities of color specifically.

Preservation of existing affordable housing—both keeping housing affordable and keeping housing fit for purpose—is fundamental to a resilient society. COVID-19 only escalated pre-existing stressors, disproportionately impacting low-income renters, who have served at the frontlines of COVID response and overall societal function. These populations have faced the highest infection rates and suffered the greatest economic and personal losses. Chronic discrimination and disinvestment leave these same communities most susceptible to the impacts of climate change, with the fewest resources for recovery. Given these challenges and trends, it is reasonable to expect that any building decarbonization ordinances or programs are likely to have the slowest uptake in rental housing low-income communities of color, leaving out the tenants most sensitive to energy utility costs, health impacts, and potential displacement.

As part of Arup's study commissioned by the National Resource Defense Council (NRDC) to investigate the potential impacts a building electrification ordinance could have on the affordable housing sector of the City of Los Angeles, the Better World Group (BWG) surveyed and interviewed key stakeholders (Arup, 2021). Multiple stakeholders echoed that there is no bandwidth to even think about building decarbonization in the context of so many families in debt and on the brink of eviction. Non-profit affordable housing organizations are considering using existing financial reserves to meet rent deficits, as one executive director shared in the interviews. There is neither time nor money to tease out the realities of decarbonizing their buildings without significant support.

Decarbonization and electrification investment programs must be designed to specifically address and overcome these challenges. Doing so can reverse the trend of chronic disinvestment, maximize co-benefits, and transition the buildings that are least likely to transition. Such programs can result in more rapid deployment of electrification, more rapid reduction in GHG emissions, and acceleration of the market for all-electric systems overall.

Costs and Savings of Electrification in Multi-Family Housing

First costs and operational costs (or savings)

Arup was engaged by the National Resource Defense Council (NRDC) to study the impact of decarbonization and electrification on existing affordable housing in Los Angeles to inform their advocacy on potential policy pathways. The study encompassed energy modeling, cost estimating, and policy recommendations. Targeted outreach, conducted by the Better World Group, with tenants' rights groups, affordable housing operators, energy retrofit providers, and other key stakeholders was the first step in this work (Arup, 2021).

Arup modeled a prototypical multifamily building in Los Angeles across two densities, two vintages, and four equipment scenarios. Analysis addressed both central and common systems as well as in-unit systems and looked at both first costs and operational costs broken out for tenants and owners. This analysis was not intended to be an exhaustive study of LA's residential building stock but rather aimed to set a few data points and give shape to trends. The results helped highlight factors that impacted energy performance and thus energy-related costs.

The analysis modeled replacing appliances (space heating, water heating, cooking, and clothes drying) with today's all-electric equivalents in LA's temperate climate. The following were the key findings from this analysis:

- 1) Across both vintages and densities, there were operational cost savings driven by the increase in equipment efficiency. These savings were more significant for the older (1970's-

era) vintage. Even accounting for the split incentive issue seen in multifamily, both owners and tenants saw savings on utility bills in the electrified cases modeled.

- 2) The resulting savings weren't enough to defray first costs. In other words, if passed onto tenants, these costs will exceed operational savings from efficiency, resulting in a net cost increase for tenants. As voiced by stakeholder interviews at the start of this process, utility bill increases for low-income tenants is not tolerable.

A Pathway Forward

In order to be effective and minimize the likelihood of unintended consequences, building electrification programs must be developed through a different process and with different goals from past energy and existing building retrofit programs. Below we will outline key actions that will be needed to harness the full potential of decarbonization and electrification investment in California.

Set ambitious, inclusive goals. Experience shows that we get what we design for. Most societal challenges have been addressed one at a time through linear processes, and this too often results in missed opportunities and unintended consequences. In the age of climate impacts, we cannot afford to solve one problem at a time. While challenging and complex, the greatest opportunity lies in systemic approaches and integrative processes.

Decarbonization, adaptation, and equity must be linked as inseparable and mutually reinforcing goals to address both the drivers of climate change (GHG emissions) and climate impacts. Breaking the cycle of chronic disinvestment is fundamental to building resilience at the societal level—everyone stands to benefit from decarbonization, *and* everyone stands to benefit from ensuring people are housed, that housing is affordable, and that housing stays fit for purpose in a changing climate.

Transform the market from the bottom up. Evidence from a variety of programs designed to address existing buildings, from mandates like seismic retrofit ordinances, to energy efficiency program incentives, to voluntary green building certification systems like LEED suggests that buildings at the bottom of the market—particularly those buildings serving low-income communities and communities of color—are likely to be addressed slower if at all. In other words, while traditional market-based solutions are effective at moving market-rate buildings, they fail to penetrate low-income communities of color because these places are regularly either excluded from or directly harmed by traditional market forces. At the same time, the populations that inhabit these buildings have the most to lose from climate change and the most to gain from measures that reduce energy cost, improve public health, and keep housing fit for purpose. Targeting public investment toward the bottom of the market is strategic because:

- These buildings are least likely to transition on their own or could take the longest. Speeding up this process can accelerate overall emissions reduction.
- In accelerating this sector with public investment, the availability of products and labor will increase, which benefits the whole market.
- The most significant societal return on investment is through supporting the most vulnerable community members and keeping people housed.

Engage stakeholders and partners. Affordable housing is one of the most complex building sectors. One reason that traditional programs fail to meet the needs of this sector is that relevant stakeholders are left out of the process. Key stakeholders include non-profit affordable housing developers, for-profit affordable housing developers, landlords, property managers, tenant rights organizations, community-based organizations working in low-income communities, environmental justice organizations, funders, and local government agencies. Each of these groups has specific insights into the needs of affordable housing. Collaboration and partnership can open the door to innovative program design, increased relevance of programs, increased adoption rates, and maximization of co-benefits.

Prioritize affordable housing for pilot projects. The development of effective programs and policies will require more empirical data on all aspects of project design and implementation. Major questions exist around the actual costs of project implementation, particularly related electrification. Affordable housing providers face the same constraints as operators of other building types in relation to major retrofit projects, such as:

- The unpredictability of requirements for transformers and other power issues from utilities,
- The need to address other code updates related to ADA, seismic or health and safety issues, triggering the need for approvals from multiple city departments
- Contractors who are unfamiliar with new technologies or limited availability of key systems

These challenges can interact with additional constraints that are unique to this market sector, such as:

- The lack of operating capital due to restricted rents and depleted reserves, particularly following the COVID pandemic
- The need to assemble complex capital stacks to finance projects that include tight scheduling requirements and make uncertainty in permits and processes less tolerable
- Resident populations that are vulnerable and cannot be easily relocated—they often literally have no where else to go

These challenges underscore the difficulty of developing programs that meet the needs of this sector, and the need for pilot programs that shine a light on barriers in order to create better pathways to opportunity. Pilot programs should include dedicated technical staff that can shepherd projects through the process from beginning to end, including support securing funding and financing, design, permits, construction and monitoring and verification of performance. Programs that meet the needs of these buildings are more likely to be scalable to other sectors, but the opposite is not also true. Intentionally engaging affordable housing in pilot programs and identifying resources and processes that support full implementation in ways that protect renters is key to bottom-up market transformation, rapid deployment and maximizing of co-benefits.

Accelerate investment in resilience hubs in low-income communities. The California State Legislature recently passed SB 155 and SB 170 which calls for \$200 million from 2022-2024 to create

a new grant program for community resilience hubs. The promise of resilience hubs is clear—building that house trusted community-supporting organizations and are equipped with emergency backup energy systems to provide critical services during outages, such as emergency cooling or heating, device charging, communications, etc. However, many organizations that have considered becoming hubs have had limited success, often because they are being led by community-based non-profit organizations with limited experience or capacity to lead major retrofit projects. Again, these buildings will require full support through implementation, but can serve as high value pilot projects for electrification combined with generation, storage and backup capacity with very high level of co-benefits.

Create mechanisms for better coordination between utilities and government agencies. A key barrier to implementation to major energy retrofit projects cited by affordable housing stakeholders is the lack of coordination between utilities and multiple government agencies related to energy infrastructure and code requirements. Integrated mechanisms to champion projects that serve low-income populations are needed through the process to reduce risk and cost associated with implementation. Incentives tied to affordable housing provision, extended covenants or other legal commitments associated with renter protects

Mandate retrofits. Because of the limited touchpoints to regulate existing buildings and the scale of change needed to electrify buildings to meet California’s climate targets, mandates are essential. Rather than exclude affordable housing, as is often done from public policy, affordable housing should be front and center in policy design. Requirements for building electrification should be paired with strong renter protections, including protection from evictions and limits on the amount of first costs. Mandates should disallow pass-throughs of first costs to low-income residents, with subsidies or incentives available targeting non-profit and small owners.

Expand protections. The ability of owners to implement decarbonization measures without passing on first costs to tenants will require significant subsidies and incentives. Qualification for receiving subsidies and incentives can be contingent on commitments related to the on-going provision of affordable housing. This process can be used to extend the length of affordable housing provision for deed-restricted affordable housing and introduce new covenants and commitments for naturally occurring affordable housing. Active engagement with stakeholders is required to protect tenants, while still encouraging adoption and implementation. In addition, incentives can be combined with pathways to alternative ownership structures, particularly for owners seeking to exit the real estate market, so that properties can be transitioned to land trusts, tenant collectives, or public housing providers.

Expand incentives and aggregate funding sources. The costs of implementation are significant, however benefits will accrue not only for building owners and occupants but across society. The potential for returns on investment varies. Broader accounting for social co-benefits is needed to make the case for public and private investment. New sources of funding are needed to prevent the full burden of action from falling on ratepayers. New financing products are needed that are tailored to the affordable housing sector, including the creation of direct grants and low-interest loan programs based on the provision of affordable housing or qualifying businesses in communities of concern.

A key challenge to implementation is that current incentives come from a variety of sources (such as SGIP for heat pumps and energy storage), SOMAH for solar, Charge Ready for vehicle

charging) and may require separate and cumbersome application requirements. This is particularly challenging for small and non-profit owners and providers with limited capacity. New programs and delivery pathways, including integrated one-stop-shop services, are needed to aggregate dollars from different sources to support a full range of related retrofit measures, including efficiency and resilience upgrades, mitigation of problems discovered through the project, such as mold or asbestos. Green banks and accelerator programs are potential solution pathways. Such emerging organizations must work in close collaboration with utilities and housing departments.

Phased implementation. Especially for existing buildings, planning for electrification and executing in phases is key to bringing down associated costs. Planned improvements to base building wiring and electrical infrastructure and equipment selection in advance can position building owners to transition to all-electric when in-place gas equipment reaches end-of-life. Otherwise, with needed upgrades or supply chain lead times, building owners risk getting locked into another gas appliance or system for the next ~20 years.

Provide technical support for owners and contractors. Parts of the all-electric market (e.g., centralized water heating) are still emerging, and even the readily available technologies lack consumer familiarity (Miller, 2021). There needs to be support across the consumer experience, helping owners identify viable options for multi-family housing and phased implementation in ways that keep costs down. Contractors—especially those contractors serving affordable housing properties in low-income areas—have a critical role to play as well. Proactive training to help contractors make the business case, paired with mid-stream incentives for electric equipment, can position contractors to be on the front lines of California’s energy transition. Focus on qualifying disadvantaged businesses can help bring benefits to low-income communities of color through both implementation and job creation.

Support affordable housing operators better manage loads. In addition to reducing loads through energy efficiency, building operators can better manage costs and carbon and reduce peak demand through demand response measures. Demand response is key to supporting the resilience of the grid overall, while limiting the need for additional generation capacity. Push the market to provide effective and accessible demand response mechanisms that can be used by operators or affordable housing and other buildings in low-income communities that may have limited staff resources to program and maintain complex controls systems. Provide training and technical support to operators to take advantage of these systems.

Conclusion

Building electrification is critical to meeting California’s decarbonization goals. Getting there will require retrofitting the majority of existing buildings in the state. This scale of disruption and change has the potential to trigger unintended consequences, particularly for chronically overburdened and disadvantaged communities—either by burdening them with costs or leaving them out of benefits. However, new approaches to designing policy, programs, and incentives provide an opportunity to reverse patterns of disinvestment and bring needed improvements to existing affordable housing stock. Achieving these benefits requires a systemic approach that links decarbonization, resilience, and

affordable housing preservation as inseparable goals. Prioritizing investment at the bottom of the market has the potential to accelerate overall market transformation while maximizing societal co-benefits.

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