City Hall
915 I Street
Sacramento, CA 95814

City of Sacramento
"Home Energy Equity Pilot" Case Study

1. Introduction

The City of Sacramento ("the City"), Habitat for Humanity of Greater Sacramento ("Habitat"), and Sacramento Municipal Utilities District ("SMUD") collaborated to facilitate two full-home electrification case study pilots utilizing $30,000 per home from the Urban Sustainability Directors Network ("USDN") Energy Innovation Fund. Homeowners were identified through Habitat's ongoing Home Preservation and Repair Program, which seeks to create long-term housing and financial stability for low-income homeowners through the completion of health and safety-related home repairs, energy and water efficiency measures, and accessibility improvements. The two homeowners received holistic home electrification, energy efficiency upgrades and energy resiliency investments including a new roof and insulation, solar panels, battery storage, heat pump water heater, heat pump HVAC[1], EV readiness, upgraded electrical circuits as needed, energy efficient appliances, weatherstripping, and more. These two homes are important case studies of how to further the City's climate objectives to reach carbon neutrality by 2045 by implementing a key Climate Action & Adaptation Plan measure to electrify existing buildings, while serving low-income homeowners who are interested in reducing their carbon footprint and utility costs.

2. Background

In 2019, the City Council of the City of Sacramento declared a climate emergency and committed to achieving carbon neutrality by 2045 (Resolution No. 2019-0465). Electrification of existing buildings was identified as a crucial step in the City's work to achieve carbon neutrality. In June 2021, the City Council adopted a framework for existing building electrification (Resolution No. 2021-0166), calling for accelerated development of a strategy for implementation. The City's Climate Action and Adaptation Plan (CAAP) is currently being updated[2], with existing building electrification as a climate action measure to reduce citywide greenhouse gas emissions by 10%. The City is now drafting an Existing Building Electrification Strategy ("Strategy")[3], prior to the adoption of the City's CAAP, in order to accelerate implementation and better position Sacramento to benefit from the substantial upcoming federal and

[1] Heating, Ventilation and Air Conditioning. This acronym is not defined in-text since it is considered common usage.
[2] The CAAP is anticipated to be adopted in early 2024. http://www.cityofsacramento.org/Community-Development/Planning/Major-Projects/General-Plan/About-The-Project/Climate_Change
[3] The Strategy is undergoing public review as of August 2023. https://www.cityofsacramento.org/Community-Development/Planning/Major-Projects/General-Plan/About-The-Project/Climate_Change/Existing-Building-Electrification

state funding for building electrification. The draft Strategy prioritizes an effective and equitable energy transition, with a focus on historically marginalized communities of color and low-income communities.

Parallel to the development of the Strategy, the City's Office of Climate Action & Sustainability and Office of Innovation & Economic Development began implementation of a range of pilot projects aimed at facilitating both electrification and critical building repairs for low-income homeowners. The zip codes along the Stockton Boulevard corridor (zip codes 95817, 95820, 95824, and 95828) emerged as a focus area due to a university campus development expansion ("Aggie Square") in an area of the City that has been historically underinvested.

Aggie Square Community Benefits Partnership Agreement

To address housing concerns in the area, the City and the Regents of the University of California ("UC Davis") committed $10 million to the Aggie Square Community Benefit Partnership Agreement for a range of programs and services that invest in housing stability. In Spring 2022, the City completed a survey to understand community needs. The survey collected results from 367 individuals within the identified zip codes surrounding Stockton Boulevard, in addition to UC Davis employees. The survey reached a variety of respondents, reflecting a range of ethnicities and ages, using interactive voice calling and flyering/outreach for a web-based written survey accessible in multiple languages. Survey results identified the greatest demand for Home Repair (76%) and Homeless Prevention (73%) Programs[4].

Using these survey results, the City issued a Request for Qualifications and subsequently entered into multiple contracts to deliver programs and services that would meet these community needs. Habitat was one of the selected providers to implement habitability and structural repairs for low-income homeowners, while furthering energy efficiency and equitable access to environmental health improvements. Habitat's contract additionally included $60,000 of USDN grant funding for two full home electrification projects.

Housing Stabilization through Home Electrification

A whole home electrification approach goes beyond just gas appliance replacement by also incorporating other long-term cost-saving and energy efficiency upgrades, including code-compliance safety repairs. Repairs for major health and safety code compliance issues can cost a homeowner tens of thousands of dollars. Given the financial constraints faced by single parents, veterans, individuals on fixed incomes, and families making minimum wage, these repairs often remain a distant dream.

By addressing long-deferred maintenance projects, critical repairs, and code violations for low-income communities within the context of home electrification, these sustainability-focused investments can help families avoid displacement and create equity that builds upon their investment in homeownership. Holistic home electrification investments not only elevate the living conditions within homes but also significantly reduce utility expenses for homeowners through energy efficiency upgrades, replacement of natural gas appliances with more cost-effective electric options, and—with solar paired with battery storage—allow for self-generation of electricity and further bill reductions through strategic use of battery power during peak pricing, or higher energy cost, times. Overall, these investments reduce

[4] The margin of error for the survey was 5.1% to 5.2%.

financial burdens through ongoing on-bill savings, reduce a home's carbon footprint, prepare low-income homeowners for future electrification technologies (e.g., electric vehicles), and support opportunities for families to build generational wealth through homeownership.

3. Home Energy Equity Pilot

The City brought together the Home Energy Equity Pilot using $60,000 in USDN Energy Innovation funding, supplemented by $500,000 in funding from the Aggie Square Community Benefit Partnership Agreement, $350,000 in grant funding secured from TECH Clean California's Quick Start Grant, and other leveraged funds from Habitat and SMUD. This Home Energy Equity Pilot will broadly fund upgrades to homes within the Stockton Boulevard corridor, including heat pump water heaters, heat pump heating and cooling systems, and home repairs, with additional upgrades as the leveraged funding allows. The USDN-funded portion of the grant enabled retrofits to the first two participating households. Additional leveraged funding is anticipated to fund heat pumps and home rehabilitation in approximately 20 additional households.

With the USDN Energy Innovation funding for energy upgrades—as well as leveraged resources from Habitat and SMUD[5] that allowed for installation of back-up battery storage—the Home Energy Equity Pilot completed two whole-home electrification and resiliency upgrades.

Homeowner Profile #1: Marcisha

Marcisha is a first-time homeowner and single mom who works full time at a local community center. Her home had several significant health and safety concerns which were left unaddressed because of the cost and extent of the repairs.

Image 1: Marcisha's home before the Home Energy Equity pilot.

Her roof had fallen into disrepair, with nearly half of the metal shingle overlay blown away by the wind, leaving her home vulnerable to leaks and other health hazards during the rainy season. Her house relied solely on wall-mounted heating and air conditioning units, rendering the interior nearly uninhabitable during Sacramento's extreme summers and, recently, much colder winters. Marcisha's bedroom did not have an air conditioning unit, making it the hottest room in the house. She would seek refuge in her daughter's room or the couch; the heat turning her home into a place of discomfort rather than solace.

Marcisha's home received the upgrades listed in Table 1 on the next page. The upgrade items go beyond just home energy efficiency and electrification, and reflect the whole home approach. Certain upgrades are grouped together if they are closely linked (e.g., heat pump HVAC and smart thermostat).

[5] Through Habitat and SMUD's current partnership agreement and upcoming Memorandum of Understanding.

Table 1: Upgrade items, costs and estimated savings for Home #1				
Upgrades for Home #1	**USDN Funding**	**Estimates for Other Funding[6]**	**Total Cost**	**Estimated Annual Utility Bill Savings[7]**
New roof	$ 10,711	$ 10,327	**$ 21,038**	
Rooftop solar system	$ 11,089		**$ 11,089**	$ 849 [8]
Back-up battery system		$ 24,635	**$ 24,635**	
Heat pump HVAC + smart thermostat		$ 16,747	**$ 16,747**	$ 530
Heat pump water heater		$ 5,784	**$ 5,784**	$ 255
Insulation + weatherstripping	$ 1,962	$ 469	**$ 2,431**	$ 274
EV-ready plug		$ 1,200	**$ 1,200**	
Induction stove		$ 2,383	**$ 2,383**	
Energy-efficient refrigerator		$ 927	**$ 927**	
Window screens		$ 800	**$ 800**	
Upgrading knob-and-tube wiring	$ 2,238	$ 2,962	**$ 5,200**	
Removal of AC + heater, gas line cap + indoor/outdoor repairs		$ 5,523	**$ 5,523**	
New fence		$ 541	**$ 541**	
Habitat labor	$ 4,000	$ 2,074	**$ 6,074**	
Dumpster + equipment rental		$ 5,711	**$ 5,711**	
TOTAL	**$ 30,000**	**$ 80,085**	**$ 110,085**	**$ 1,908**

Other than the estimated electricity savings calculated by the solar provider, the estimated utility bill savings were calculated through the general modeling of the XeroHome tool that the City created in collaboration with SMUD. XeroHome uses a home address and basic details of a home – when it was built, what kind of heating and cooling sources, insulation, etc. – to make recommendations for energy efficiency and electrification upgrades that can reduce energy costs and carbon emissions. The tool also includes modeled assumptions of annual bill savings and annual carbon dioxide (CO_2) emissions savings (shown in Table 2).

Table 2: Estimated Annual Carbon Dioxide (CO_2) Savings[9] for Home #1	
Upgrades for Home #1	**CO_2 Savings** (Tons/Yr)
Rooftop solar system	0.9
Heat pump HVAC	0.7
Heat pump water heater	0.7
Ceiling insulation	0.4
Weatherstripping	0.1
TOTAL[10]	**2.4**

[6] Some costs are estimated in cases where subcontractor invoices do not separate out labor (e.g., for electrician labor that is part of the HVAC, water heater, stove and wiring upgrades).

[7] Estimated annual utility bill savings are from XeroHome unless otherwise noted.

[8] Estimate provided by solar company.

[9] Estimates generated by XeroHome.

[10] Individual CO_2 savings estimates on XeroHome generate a total that is higher than the total CO_2 savings with all upgrades combined. However, the ceiling insulation CO_2 savings estimate likely underestimates savings due to the poor quality of the original roof.

Over a ten-month period across 2022 and 2023, Marcisha's gas utility bill totaled just over $300. By switching from a gas water heater, gas heater and a gas stove, Marcisha will be able to eliminate her gas bill. Thus, the water heater savings modeled by XeroHome appear to be realistic. The transition to a more efficient heat pump heating and cooling system and, importantly, a more insulated building envelope (through a new roof and attic insulation, as well as weatherstripping), will substantially reduce energy loss even if electricity consumption increases during the winter with heat pump heating. However, the overlapping nature of many of the home upgrades—for example, a more insulated building envelope with more efficient heating and cooling—makes it hard to estimate the combined impact of these projects on an energy bill.

Image 2: Solar panels being installed on Marcisha's new roof.

Ultimately, the annual utility bills savings will depend on potential lifestyle changes on part of the homeowner. Prior to the Home Energy Equity upgrades, Marcisha lacked sufficient air conditioning (AC) equipment to keep multiple rooms cool during hot summer days. By simply having the needed equipment to cool her home to the desired temperature, Marcisha's summer electricity usage may increase. But, this increase needs to be valued in the context of the quality of life benefits from a home that is a safe and comfortable temperature. Additionally, the combination of a solar system with back-up battery storage opens up the possibility of additional utility bill savings if Marcisha uses her back-up battery system during times of high energy costs.

This case study will be updated after one year of energy bills can be analyzed to understand the realized costs and savings of this work.

Homeowner Profile #2: Alpha and Pamela

Alpha and Pamela are a dynamic senior mother-daughter duo who are both on fixed incomes. In their home, the biggest health and safety-related issues were cost-prohibitive to address. The roof was showing signs of distress, they did not have air conditioning, and had just one wall-mounted heater for the entire house. Alpha and Pamela had to rely on fans and space heaters to keep their house at a reasonable temperature.

Beyond day-to-day comfort, the condition of their home posed many potential safety risks for

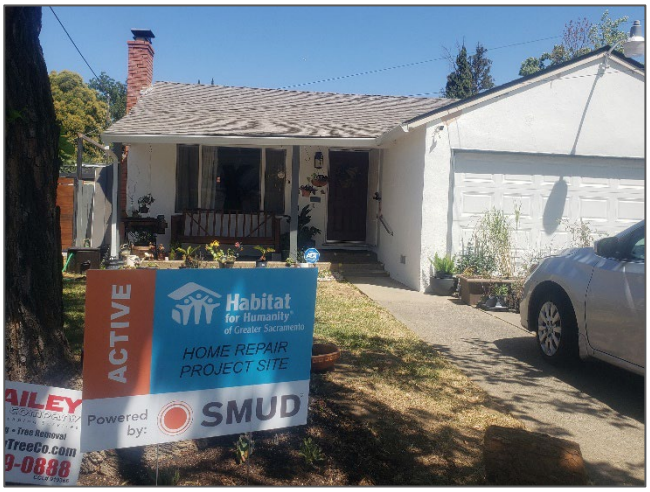

Image 3: Alpha and Pamela's home before the Home Energy Equity pilot.

Alpha, who is living with Alzheimer's and other health conditions. The extreme temperatures in the house greatly exacerbated Alpha's care needs, and Pamela feared that her mother would accidentally touch a hot stove top and burn herself or leave it on and possibly start a fire. However, with the upgraded Wi-Fi-enabled thermostat, Pamela can manage the temperature of the house remotely to keep Alpha safe. Additionally, their new, energy-efficient induction stovetop addresses fears around accidental burns or fires.

Alpha and Pamela's home received the upgrades listed in Table 3 below. The upgrade items go beyond just home energy efficiency and electrification to reflect the whole home approach. Certain upgrades are grouped together if they are closely linked (e.g., heat pump HVAC and smart thermostat).

Table 3: Upgrade items, costs and estimated savings for Home #2

Upgrades for Home #2	USDN Funding	Estimates for Other Funding[11]	Total Cost	Estimated Annual Utility Bill Savings[12]
New roof	$ 18,304	$ 1,079	**$ 19,383**	
Rooftop solar system	$ 11,224		**$ 11,224**	$ 861 [13]
Back-up battery system		$ 25,780	**$ 25,780**	
Heat pump HVAC + smart thermostat		$ 20,466	**$ 20,466**	$ 318 [14]
Heat pump water heater		$ 5,623	**$ 5,623**	$ 335
EV-ready plug		$ 1,231	**$ 1,231**	
Induction stove		$ 800	**$ 800**	
Weatherstripping + screen repair		$ 1,064	**$ 1,064**	
Removal of heater, gas line cap + indoor/outdoor repairs		$ 3,989	**$ 3,989**	
Habitat Labor	$ 471		**$ 471**	
Dumpster + equipment rental		$ 950	**$ 950**	
TOTAL	**$ 30,000**	**$ 60,982**	**$ 90,982**	**$ 1,514**

Table 3 includes estimated electricity savings calculated by the solar provider as well as estimated utility bill savings calculated through the modeling of the XeroHome tool. Table 4, on the next page, shows XeroHome modeled assumptions of annual CO_2 emissions savings for key upgrade elements.

[11] Some costs are estimated in cases where subcontractor invoices do not separate out labor (e.g., for electrician labor that is part of the HVAC, water heater, stove and wiring upgrades).
[12] Estimated annual utility bill savings are from XeroHome unless otherwise noted.
[13] Estimate provided by solar company.
[14] Alpha and Pamela's home did not have AC prior to the Home Energy Equity project, so the anticipated heat pump HVAC utility savings are only based on the heating usage of this home.

Table 4: Estimated Annual CO_2 Savings[15] for Home #2	
Upgrades for Home #2	**CO_2 Savings** (Tons/Yr)
Rooftop solar system	1.1
Heat pump HVAC	0.6
Heat pump water heater	0.9
TOTAL[16]	**2.5**

Over a 1-year period across 2020 and 2021, Alpha and Pamela's gas utility bill totaled over $700. By switching from a gas water heater and gas heater, Alpha and Pamela will be able to eliminate their gas bill. Thus, the water heater and HVAC savings modeled by XeroHome for the switch from gas to heat pump appliances appear to be realistic. The transition to a more efficient heat pump heating system with a more insulated building envelope (through a new roof and weatherstripping) will substantially reduce energy loss, even if electricity consumption increases during the winter with heat pump heating. However, the overlapping nature of many of the home upgrades—for example, a more insulated building envelope with more efficient heating and cooling—makes it hard to estimate the combined impact of these projects on an energy bill.

Ultimately, the annual utility bills savings will depend on potential lifestyle changes on part of the homeowner. Prior to the Home Energy Equity upgrades, Alpha and Pamela lacked AC equipment to keep their home cool during hot summer days. By simply having the needed equipment to cool their home to the desired temperature, Alpha and Pamela's summer electricity usage may increase. But, this increase needs to be valued in the context of the quality of life benefits from a home that is a safe and comfortable temperature, especially for seniors with other health risks. Additionally, the combination of a solar system with back-up battery storage opens up the possibility of additional utility bill savings if Alpha and Pamela use their back-up battery system during times of high energy costs.

This case study will be updated after one year of energy bills can be analyzed to understand the realized costs and savings of this work.

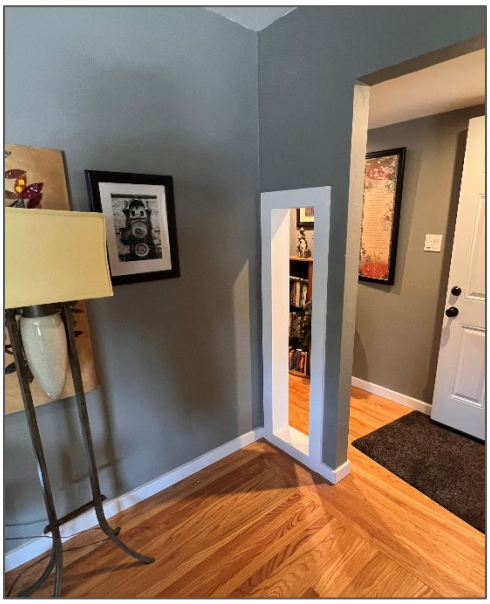

Image 5: Alpha and Pamela's original natural gas wall heater was entirely removed.

4. Lessons Learned

Home Repairs Provide Benefits Beyond Financial Savings

While the major repairs undoubtedly enhance the structural integrity and overall functionality of homes, it is crucial not to overlook the transformative impact of smaller repairs on homeowners' lives. The Home Energy Equity repairs have created a new sense of home security for Marcisha and Pamela. Both Marcisha and Pamela felt emotionally, not just financially,

[15] Estimates generated by XeroHome.

[16] Individual CO_2 savings estimates on XeroHome generate a total that is higher than the total CO_2 savings with all upgrades combined. However, the CO_2 savings estimate is likely an underestimate since it does not include an estimate for the improved insulation through a new roof.

burdened by the inadequate living conditions that they and their families were living in. Their homes now have been transformed into beacons of stability, progress, and reinvestment.

For Marcisha, the inadequate fencing around her home was a significant source of anxiety. Unhoused neighbors would use her backyard as a camping location and would walk through her property at all hours of the day. The installation of a fence not only enhanced the aesthetic but also provided security, allowing her kids to fully enjoy their home and property.

Image 6: The new fence around Marcisha's home.

For Pamela, the opportunity to upgrade to an all-electric and energy-efficient house is her personal action for combatting climate change. Pamela is furthering embracing conservation and sustainability by removing her lawn and planting succulents and native flowering plants. Beyond that, Pamela is also excited about the opportunity to expand her technological awareness, sharing that it helps "keep her young."

Holistic Home Approach is Important, but Costly

Through early outreach in the community, Habitat and SMUD identified the important lesson that electrification will be most successful when paired with a comprehensive evaluation and implementation of all health, safety, and affordability-related repairs needed on a home to create the best opportunity for housing stability and sustainability of affordable home ownership. It is challenging to reach the most vulnerable homeowners within the community—due to language barriers, lack of trust in government, concerns around scams, or the time and effort necessary to complete a retrofit—even if these programs are fully subsidized. Electric or energy efficient appliances, like a heat-pump HVAC unit, will create a healthier environment for a resident. But, if residents are living under a leaky or unstable roof, or with a pest infestation, the benefits of electrification will be undermined by ongoing livability issues in a home.

However, this whole home approach can be expensive, with the Home Energy Equity pilot homes averaging ~$100,000 in upgrade costs. The final scope of these home retrofits highlights the need for multiple layers of investment and budget for unexpected repairs, especially older and less-maintained homes in historically underinvested communities. For example, in order to install solar panels, each home needed a roof replacement. In Marcisha's home, significant dry rot damage was discovered during the roof repair process, which increased the roof repair cost by $6,500 over the initial estimate.

Yet, with this Pilot and the City's broader Existing Building Electrification Strategy being rooted in equity, the approach to full home electrification for low-income customers must be more comprehensive than that of more affluent communities to ensure low-income customers can enjoy the same basic housing comfort and safety. Full-home electrification and long-term energy stability should include proper attic insulation and sun-reflective roofing, dual-paned windows, safe and current electrical wiring and paneling, and evaluation and improvement of any other electricity-based system in the household in addition to heat pump units, weatherstripping, and new energy-efficient appliances.

Image 7: Marcisha's home after the Home Energy Equity pilot.

Partnerships, like the one between the City, Habitat, and SMUD—where additional funds are already being allocated to this kind of work—are necessary to leverage the investments being made by organizations like USDN. Climate-focused funding goals need to consider that, while a holistic home approach may serve fewer number of homes with a given amount of funding, the most vulnerable households need retrofits that address their basic needs in a comprehensive way.

This Work Takes Time

Coordinating subcontractors, partners, homeowner schedules, supply chain delays, and more can extend retrofits and whole-home electrification projects to 6-8 months from start to completion. Timelines can extend even longer if grant agreements need to be executed or construction projects need to be competitively bid. To reduce the impacts on homeowners who are continuing to live in their homes during the construction process, Habitat strives to stagger the scheduling of subcontractors. However, this further extends the construction timeline, especially if there are certain subcontractors that must be scheduled sequentially due to their interdependent work.

More broadly, this work moves at the speed of trust within a community. Habitat and SMUD are well known and respected organizations doing home preservation and electrification work in the community for years, which has allowed this Home Energy Equity Pilot to advance quickly into the project implementation stage. However, this trust has taken a significant amount of time to build and is an ongoing process, which includes each homeowner interaction. This may be the first smart thermostat, induction stove, heat pump water heater, solar panel system, and back-up battery that the homeowners have ever had. Hands-on education regarding efficient use and ongoing maintenance of these systems is part of the whole-home approach and electrification transition.

Benefits of a Whole Home Approach Are Hard to Estimate

Given the comprehensive nature of the building improvements—including replacement of nearly every major home appliance with a new, energy-efficient model plus a new roof and other building envelope

insulation upgrades—the combined efficiency impacts on the homeowner's electricity bill are hard to predict.

Additionally, both homes lacked adequate AC equipment to keep their homes cool during hot summer days. Summer AC usage may increase for both homes, as the new efficient heat pump cooling equipment makes this quality of life improvement possible. Even so, the exact electricity bill impact will depend on the time of use of the electricity, the realized solar generation, and whether the back-up battery storage is used to shift electricity usage from the grid to lower cost times of day. While the cost of electricity may have been previously been a limiting factor, it is possible that the financial security offered by these home investments may enable homeowners to use more electricity at home in order to live in a comfortable way.

Ultimately, these initial projects show the great potential of leveraging energy efficiency retrofits and electrification with home rehabilitation to achieve significant quality of life improvements for residents in these two homes.

Home Energy Equity as a Foundation for Resiliency

Not only can residents enjoy these benefits today, but the project investments prepare each household for the impacts of warming climate and extreme weather events. Extreme weather is becoming much more common in the Sacramento region, from summer heatwaves to winter atmospheric rivers and high-wind events. In January 2023, multiple weeks of heavy rain and strong winds hit Sacramento, leaving thousands of Sacramento homes—including Marcisha's—without power. Even with SMUD's best efforts, Marcisha and her neighbors did not have power restored until two weeks after the storm, resulting in numerous challenges, particularly the loss of hundreds of dollars' worth of refrigerated and frozen food.

With a solar panel system and back-up battery, Marcisha and Pamela can be confident that they will be able to operate essential appliances for extended periods, even during power disruptions. Marcisha is excited that her solar system will give her the ability to create power not only for herself, but also for the community. Similarly, the battery will allow her house to be a refuge for her neighbors if the community again faces an extended power outage. In the future, these homes may participate in SMUD's Virtual Power Plant, which pays homeowners for SMUD's access to their solar and energy storage systems in order to improve grid reliability during peak energy demand events.

5. Conclusion

Image 8: Alpha and Pamela's home after the Home Energy Equity pilot.

This case study shows the importance of a multi-pronged approach to energy efficiency and electrification. Many low-income homeowners still do not have the opportunity or ability to access energy-efficient and resilience-related technologies. Whole-home electrification upgrades are expensive and may be of secondary importance to more pressing home repairs or to the costs of simply making ends meet.

Linking home safety improvements with energy efficiency and electrification promotes financial stability, a healthier environment and carbon reduction. The lessons learned from this comprehensive approach will build upon the foundational equity criteria in the City's draft Strategy and will inform the final existing building electrification policies.

Partnerships between organizations like Habitat for Humanity, locally based utility companies like SMUD, foundations and grantors like USDN, and municipalities like the City of Sacramento will be essential to ensuring that historically underserved and underinvested communities are not left behind as we strive to reach our carbon reduction and energy transformation goals. These partnerships will be increasingly important as significant state and federal subsidies for electrification become available, with a unique opportunity to channel this funding into sustainable homeownership and equity creation in Sacramento's underinvested neighborhoods.