Forging Partnerships at the Interface of Decarbonization and Affordable Housing

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ABSTRACT

Based on Sonoma Clean Power's first-of-its-kind fire rebuild program, Advanced Energy Build was designed to increase the numbers of new, all-electric homes in Sonoma and Mendocino counties. The program offered incentives for single family and multi-family new construction, with bonuses for low-income units and battery storage. This offering established a strong niche with local affordable housing developers despite a distinct lack of interest from market-rate builders. In all, the program assisted in the development of 549 all-electric housing units, 546 of which were lower-income homes. Over 20 years, these projects are expected to reduce greenhouse gas emissions by over 22,000 metric tons compared to mixed-fuel construction. Challenges included long project timelines and a preference for gas amenities in new high-rise apartment buildings. Additionally, adoption of induction cooking was low in the affordable housing space due to added costs over electric resistance stoves. Future efforts should focus on strategies to engage market-rate single family and multi-family developers, and ensure that all-electric homes perform as well or better than mixed-fuel homes.

Introduction

Over the past several years, there have been multiple efforts to increase all-electric construction in California, many of which are ongoing. This paper will discuss the Advanced Energy Build (AEB) program, a new construction program with all-electric incentives for new homes and multi-family buildings, active in Sonoma Clean Power's (SCP) community choice aggregation (CCA) service area from 2020 to 2025.

In an effort to respond to the devastating 2017 wildfires in the region, SCP created Advanced Energy Rebuild (AER). Active from 2018-2022, the program was designed to help affected homeowners rebuild more efficiently and resiliently through design assistance, incentives for above-code performance, and bonus rebates for battery storage installation. Funding was provided through an innovative partnership with Pacific Gas and Electric Company (PG&E) and the Bay Area Air Quality Management District. In total, 346 homes participated in the program, including 228 single-family residences, 96 multi-family units, and 21 accessory dwelling units (ADUs). A total of $3.5 million was provided to these projects, including $2 million from Sonoma Clean Power. Over 30% of homes were built all-electric, and an AER home performed 24% better than the energy code requirement on average.. Additionally, 42% of projects installed solar with battery back-up, providing resiliency during outages and future potential grid benefits.

Advanced Energy Build

Motivations and Goals

The intent of Advanced Energy Build (AEB) was to leverage the incentive structures, programmatic learnings, and remaining funding from the AER fire rebuilding program to expand this type of program to all new construction throughout the service area in Sonoma and Mendocino counties.

The 2019 Title 24 energy code did not integrate heat pumps into prescriptive baseline requirements for space conditioning and water heating or require pre-wiring to facilitate future electrification. Additionally, Public Safety Power Shutoff (PSPS) events (planned fire risk reduction outages) were impacting hundred of thousands of SCP customers, so measures to increase resiliency were at the forefront of customers' minds.

AEB was designed to address these factors and work with the developer community to shift toward more all-electric construction. The program goal presented to the SCP Board of Directors in 2019 included building 500 all-electric homes using $2 million in remaining AEB funding.

Program Design

Due to the rapid housing growth in the SCP service area and to encourage adoption of gas equipment alternatives, such as heat pump water heating and space conditioning, the AEB program was designed to focus on market-rate single family homes and accessory dwelling units (ADUs).. Additionally, the AER program had seen high all-electric uptake with completed projects, demonstrating interest in the region. Incentive levels were set lower than for AER to maximize the number of homes.

All single-family homes and ADUs in the program were required to achieve a delta Energy Design Rating (EDR) of 1.0, which equates to about a 5% increase in efficiency over 2019 Title 24 requirements. This EDR performance level was selected due to the stringent energy-efficiency requirements of the 2019 code and the additional expense necessary to significantly exceed those standards. Participating multifamily buildings were only required to meet code, a decision which is discussed in detail below.

As with Advanced Energy Rebuild, the program allowed construction of mixed-fuel homes, provided that they pre-wired for future electrification and installed an EV charger. These homes were eligible for a $1,000 incentive. It should be noted that, at this time, Sonoma Clean Power was offering free Level 2 EV chargers to its customers, lowering the barrier to meeting the charger requirement.

All-electric single family homes were eligible for a $3,500 incentive, while an ADU or multi-family home could receive $1,750. A $1,000 bonus incentive was available for homeowners who opted to install a battery back-up system of at least 7.5 kWh. See Table 1 for a full list of initial incentive amounts.

Table 1: Initial Advanced Energy Build Incentive Amounts

Program Pathway	Program Requirements	Single Family Home Incentive	Multi-family or ADU Incentive
Advanced Energy Home (mixed fuel home)	Delta EDR of 1.0, electrification pre-wiring, EV charger	$1,000	$500
All-Electric Home	Delta EDR of 1.0, EV Charger	$3,500	$1,750
Bonus for Renewable Energy	7.5 kWh battery storage	$1,000	$500

TRC Companies was selected to administer incentives, enroll projects, and confirm completion of program requirements. TRC staff also provided hands-on assistance and guidance.

Verification for single-family homes and duplexes was achieved through a requirement to have a Home Energy Rating System (HERS) professional inspect the project. Quality assurance was increased through a requirement to have the building model completed by Certified Energy Analyst (CEA), who then shared the project in the HERS registry with SCP. For multifamily buildings and high-rise residential, SCP engaged the program consultant, TRC Companies, to conduct a site visit and verify key all-electric features.

Program Implementation

Initial outreach to local production builders.

Advanced Energy Build was designed with production single family home builders in mind, especially those constructing neighborhood-scope projects. However, after extensive direct outreach and marketing, it became clear that this sector had limited interest in the program. At that time, most builders believed that buyers preferred natural gas for heating and cooking. Additionally, their primary concern was being able to sell the homes that were being built and all-electric construction introduced uncertainty they were not willing to take on.

Partnerships with affordable housing developers.

As outreach efforts continued, SCP began connecting with multifamily developers, especially those in the affordable housing space. Affordable housing developers were highly motivated by the incentives and interested in the tenant benefits of all-electric construction. Additionally, many of these organizations are non-profit entities with missions aligned to health, equity, and sustainability, making them a natural partner for the AEB program.

Over the course of the program, SCP partnered with several local affordable housing developers on these projects, including Danco Group, MidPen Housing, Related California, and Integrity

Housing. In total, affordable housing enrollments reached over 500 units with an associated $1.2M in potential incentives. Through these conversations, SCP staff learned that most of these organizations were already in the process of evaluating the costs and benefits of all-electric construction. A few have full-time staff focused on sustainable building practices and how to integrate them into projects.

These factors, along with an increased focus on equity initiatives, prompted SCP to create a new incentive tier for low-income construction, which is described below.

Incentive and Above-Code Requirement Revisions.

In mid-2020, SCP introduced new incentives that increased amounts for affordable housing units. Market-rate incentives remained constant, while all-electric affordable multi-family units were eligible for $2,500 and single-family affordable units were eligible for a $5,000 incentive. See Figure 1 for a detailed breakdown.

Figure 1: Revised AEB incentive levels

Project Type	Single Family	Multi-family	ADU
Advanced Energy Home	$1,000	$500	$500
All-Electric Home	$3,500	$1,750	$1,750
Affordable All-Electric	$5,000	$2,500	$2,500

This adjustment to incentive levels also included battery back-up bonuses for market-rate (up to $5,000) and affordable housing projects (up to $25,000). The affordable housing battery bonuses were tiered based on the number of units in the project.

In the 2019 Title 24 building energy code, the high-rise multifamily sector (four stories or more) was grouped with all non-residential buildings, which did not utilize the Energy Design Rating standard, requiring new program standards once these projects began enrolling.

The non-residential modeling software (CBECC-Com) was designed for large commercial spaces, rather than individual living units. As a result, the assumptions for lighting, HVAC, and ventilation were poorly suited to multi-family dwellings.

Secondly, CBECC software adjusts the baseline whenever a change is made, making it difficult to cite and validate a “percent-above code” requirement. Given the modeling and evaluation complexities involved with Title 24 for high-rise multi-family developments, SCP determined that no above-code standard would be implemented for this building type.

Challenges and Barriers

Market-Rate Housing Sector

The primary barriers for market rate developers included a lack of all-electric building experience, a desire to provide amenities to residents, and timelines that did not match up with program deadlines.

Developers are taking a risk when they adopt new building techniques and they often work with the same engineering teams on multiple projects. Building all-electric, especially for high-rise residential, means a disruption to the processes, methods, and relationships they've developed over years. They may also need to work with different subcontractors or distributors.

A top priority for developers of high-rise multi-family buildings is to ensure tenants want to live there. That often means attractive amenities, such as pools and spas (hot tubs), fire pits, and outdoor grills. While such gas end-uses are not a necessity, they can prove to be significant barriers to all-electric construction. Additionally, gas ranges are still viewed by builders and some prospective tenants as a luxury appliance, making the switch to induction another tough decision point.

Timelines for these projects can be a challenge as well, because it must be early enough in the design process to integrate all-electric requirements, but far enough along to have models and drawings available prior to the application submittal deadline. Indeed, both high-rise market-rate projects withdrew from the program, in part due to building construction timelines that did not align with the application deadline.

In the years since the launch of AEB, programs such as Building Initiative for Low-Emissions Development (BUILD) have offered new adopter incentives and free technical assistance to help overcome the additional costs and risks associated with the transition to all-electric projects. However, barriers in this market persist, especially outside of California.

Additionally, electric and heat pump versions of previously gas amenities meeting updated Title 24 standards are becoming more available, although satisfaction studies comparing tenant experiences are not readily available in the literature.

Affordable Housing Sector

AEB program staff found that the Bay Area's affordable housing developers are already making the pivot to all-electric new construction standards. One reason is that organizational missions of these entities tend to overlap with environmental and health concerns. And, unlike market-rate multifamily buildings, affordable housing developers are less concerned with gas-using amenities.

These projects generally receive significant federal and state tax credits through the California Tax Credit Allocation Committee (TCAC) and the Low Income Housing Tax Credit (LIHTC). Even so, funding, especially at the end of these projects, is tight and additional incentives can make a large difference to developers.

Although trends point to an increasing level of all-electric construction in the affordable housing space, most of those projects install resistance coil ranges in the individual units. This is of concern because the cooking experience of this type of stove is inferior to gas and, especially, induction cooking. These developers expressed concerns regarding overall costs and incompatibility with popular cookware materials, such as aluminum.

To help overcome this barrier, AEB offered $500 per induction range or cooktop and free cookware to residents. However, a resistance unit can cost as little as $300 and induction units cost an average of $2,808 in SCP service territory in 2024 (TECH Clean California n.d.). It should be noted, however, that induction ranges are available at local retailers for as little as $1,099. In the end, none of the affordable developments took advantage of this offer, further emphasizing the need to address this technology.

Case Study

During conversations from April to June 2022 with a local market-rate multi-family housing developer, several barriers to all-electric construction were uncovered. The 8-story, 168-unit high-rise development in Santa Rosa, California was eligible for $285,000 in Advanced Energy Build incentives. The developer also expressed a high level of interest and engaged with AEB staff on requirements and the potential to adjust project specifications to meet them.

A primary barrier was that they did not have a mechanical, engineering, and plumbing (MEP) engineer that was experienced in all-electric construction techniques, such as solar thermal water heating. SCP offered internal engineering support, suggested hiring a qualified MEP, and provided literature resources.

Another important, but less expected barrier was a desire to provide gas amenities to tenants. These included a fire pit, gas BBQ grills, and a spa for residents. SCP staff discussed various alternatives with the project engineers and the possibility of providing targeted exemptions.

One final challenge was that part of the first floor of the building was expected to be leased as a restaurant space. This created a likelihood of gas service being extended to the property, which posed some modeling challenges. Program staff proposed modeling that space separately from the rest of the structure.

Despite the best efforts of AEB program staff to accommodate the complexities of this particular development, concerns regarding cost, expertise, and the project timeline remained, and the project did not submit an application. This case study highlights the varied and multiple challenges to all-electric construction in regions where it is not standard practice.

Results

The program enrolled 14 total projects, with a combined 704 units. Eleven projects with a total 549 units completed construction and received incentives. Of these, 546 were affordable, all-electric multifamily units and ADUs. The other three units were market-rate single family homes or ADUs (see Table 2).

In total, the program provided $1,543,750 in incentives, with over 99% going to affordable housing units. One single family project received an incentive for battery back-up. No multi-family projects received battery back-up incentives.

Table 2: Units and Incentives Completed by Type

Type	Units	Incentives
Single Family	2	$9,000
ADU/Townhouse	70	$347,250
Multifamily	477	$1,187,500

Savings Methodology

As discussed, CBECC-Com software adjusts the baseline when making changes, making it difficult to compare mixed fuel and all-electric multifamily construction. Modeling two separate buildings is complex and cost-prohibitive, with unreliable results.

Carbon emissions savings from building all-electric versus mixed fuel were created through a multi-step process that relied heavily on 2019 California Residential Appliance Saturation Survey (RASS) data (California Energy Commission, 2021).

Because “new” construction in RASS is defined as any structure built after 2013, adjustments were made to account for the 2019 Title 24 code that AEB functioned under. According to a 2020 California Energy Commission presentation, the 2019 code was 7% more efficient than 2016 code. This adjustment was applied to the New Dwelling EUCs for single family (SF) and multi-family (MF) units in PG&E territory found in RASS Table 13 (electricity) and RASS Table 35 (gas). Townhome usage was created by comparing 2019 RASS electric EUCs for single family and townhome usage in Table 11, resulting in an estimate of 62% of SF usage for TH and ADUs. An additional 5% energy efficiency adjustment for single family, townhomes, and ADUs was applied to align with program delta EDR requirements.

This baseline is considered conservative, as some homes represented in the RASS study use baseboard electric heat, resistance electric water heaters, and coil resistance stoves, which increase the reported average EUCs. Additionally, the 2019 RASS study’s results do not differentiate between high-efficiency and standard electric technologies in end-use technology breakdowns.

Next, these figures were split into estimates for CEC Climate Zone 1 (CZ1) and Climate Zone 2 (CZ2) by comparing the RASS Table 13 figures to all household EUCs in RASS Table 15 (electricity) and RASS Table 37 (gas) to create a ratio for each climate zone. This resulted in the ratios shown in Table 3 and the baseline kilowatt-hour (kWh) and therm usage figures in Table 4. For example, in CZ2, the estimated electricity usage is 78% of PG&E territory averages while the gas usage is 106.5% of the territory average.

Table 3: Climate Zone Ratios for Gas and Electric Usage

Type	CZ1	CZ2
Electric	0.60	0.78
Gas	0.86	1.065

Table 4: Mixed-fuel Home Baseline Electricity and Gas Usage

	Type and Fuel	CZ1 – Annual	CZ2 - Annual
Electric Usage (kWh)	Mixed Fuel SF Annual kWh	4,602	5,982
	Mixed Fuel Annual TH kWh	2,853	3,709
	Mixed Fuel Annual MF kWh	2,240	2,912
Gas Usage (therm)	Mixed Fuel SF Annual Therms	246	320
	Mixed Fuel Annual TH Therms	170	221
	Mixed Fuel Annual MF Therms	148	193

Added electricity usage from heat pump HVAC installation for single-family CZ1 and CZ2 homes was based on 2019 RASS Table 15 and Table 27 for multi-family CZ1 and CZ2 homes. Townhouses and ADUs were estimated at 62% of single-family usage.

As 2019 RASS combines resistance water heaters and heat pump water heaters (HPWH), the average usage figures are not fully representative of water heater conversions with a coefficient of performance of greater than 1.0 (and often 2.0 or 3.0). In both climate zones, for the HPWH technology, the study used figures gathered by Silicon Valley Clean Power (2023) for 50-75 gal. models in MF, ADUs, and TH of 77 kWh per month and >75 gal. models of 111.8 kWh per month for SF.

For induction ranges, this study averaged the daily watt-hour usage of three different models in a 2019 Frontier Energy study and scaled to annual usage, resulting in a figure of 363 kWh per year for all home types. However, this assumption is also likely conservative, with estimates from other sources in the 200-250 kWh range.

This methodology resulted in higher heat pump HVAC usage for all-electric MF units than for townhomes and ADUs in CZ1, so assumptions may need to be adjusted for those home types in future analyses.

Emissions Savings

Emissions rates were based on a standard 12 lbs. CO_2 per therm and SCP's 2023 emissions intensity of 138 lbs. of CO_2^e per megawatt-hour (Sonoma Clean Power Authority, 2023). Table 5

presents an emissions breakdown for mixed-fuel and all-electric homes for single family, townhouse or ADU, and multi-family by climate zone.

Table 5: Emissions per Unit by Type and Fuel

Climate Zone	Type	Emissions (mixed fuel) - tons	Emissions (all-electric) - tons
CZ 1	Single Family	3.51	0.94
	ADU/Townhouse	2.38	0.61
	Multi-family	2.05	0.06
CZ 2	Single Family	4.57	1.21
	ADU/Townhouse	3.09	0.77
	Multi-family	2.66	0.67

Annually, combined greenhouse gas savings from AEB projects totals 1,117 tons $CO2_e$, a reduction of 88% compared to mixed fuel 2019 Title 24 construction. Over a 20-year period, those savings grow to 22,345 tons $CO2_e$ (see Table 6). Of this, single family homes accounted for 0.6%, ADUs and townhomes 14.5% and multi-family units 84.9%.

Table 6: Savings and Incentives by Unit Type

Type	Annual Savings (tons $CO2_e$)	20-yr Savings (tons $CO2_e$)
Single Family	69.1	134.5
ADU/Townhome	215.9	3,240.3
Multifamily	1,268.5	18,970.2
Total	1,117	22,345

Recommendations

Recommendation #1: Share Research Results and Demonstration Projects

Multi-family developers have struggled to keep up with new codes and standards, while offering designs that are attractive to tenants and property management companies. Evaluations of tenant experiences with electric alternatives to gas-using amenities can provide the information to help them to make sound, environmentally-beneficial decisions.

Additionally, not all product markets are fully developed. Commercial-grade spas with hybrid heating systems (heat pump with resistance backup) are lacking in the marketplace. Electrification proponents should seek out early-adoption examples, and work to share those outcomes with the broader development community, especially those in states without the strict energy code requirements found in California.

Recommendation #2: Drive Adoption Through Requirements and Incentive Bonuses

Electric resistance stoves are slow, unresponsive, and difficult to clean. By contrast, induction cooktops are safer, faster, and offer better temperature control. In market-rate construction, this difference should drive the market toward induction, though outdated perceptions remain. However, affordable housing developers must manage budgets carefully, and are not looking for appliance "upgrade" opportunities. However, the experience residents have in all-electric units shapes their perception of the electrification push and decarbonization generally, with cooking being a central interaction point.

Program designers operating in this housing sector should require installation of induction ranges and cooktops, while providing targeted incentives and complimentary cookware to ease this transition. Then, when tenants of these units go on to buy their own homes or are selecting a unit to rent elsewhere, they'll be more likely to understand the benefits of cooking on induction. Induction cooktop lending programs can add to familiarity with this appliance type.

Furthermore, addressing potentially higher energy costs, especially for lower-income residents should be prioritized. This is especially true in California where electricity rates are some of the highest in the country. Incentive bonuses that encourage installation of demand management features for heat pump water heaters, heating and cooling (e.g., smart thermostats), and electric vehicles can save costs for residents and property owners. Behavioral demand response programs provide a zero-technology option where residents can earn cash rewards for saving energy at times of peak grid stress.

Recommendation #3: Engage Builders to Address Barriers and Increase Adoption

To slow climate change, the U.S. will need to stop constructing mixed fuel buildings. Surveys of the building community can help identify any remaining gaps in program offerings for market-rate and affordable housing in California and around the country. For example, cold climate heat pumps are generally not necessary in most California climate zones, but are crucial to the energy transition in the Midwest and Northeast.

Additionally, design, engineering, and construction practices have all adapted significantly over the past 10 years to keep pace with changes to Title 24 energy code. The hard-earned lessons of California's building community will be invaluable to builders nationwide as other parts of the country follow the state's lead. The solutions and strategies these professionals have implemented will provide assurances to builders that these new techniques will work and ease decarbonization efforts in other regions of the U.S.

Finally, as this program was unable to enroll any multi-unit single family developments, program designers should look toward education and coalition-building with these market actors. They could also benefit from engineering assistance and incentive bonuses when implementing new building techniques and technologies to offset risks and added expenses.

Conclusion

Results of the Advanced Energy Build program demonstrate significant emissions benefits from all-electric new construction in the multi-family space, even under California's ever stricter Title 24 building codes. However, policymakers and regulators must be aware of the differing challenges of market-rate and affordable housing developers to increase adoption.

Market-rate developers are risk-averse, preferring proven technologies and building practices over more sustainable technology innovations. These market actors will need to see all-electric buildings and equipment, such as centralized heat pump water heating, implemented successfully before committing financial resources to their inclusion in building plans.

Affordable housing developers, on the other hand, are primarily concerned with optimizing tight budgets, so any unnecessary costs will be cut. Program implementers may have to completely close cost gaps or require certain features (like induction cooking), to ensure that the experience of all-electric living is better than for gas dwellings.

Engaging with, and listening to the priorities, constraints, and barriers of these market actors, will help all-electric new construction programs to target incentives effectively and respond to evolving challenges.

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