

Retooling Multifamily Programs to Accelerate Electrification Retrofits

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ABSTRACT

Designing programs that enable the electrification of existing multifamily buildings is a critical component of equitable long-term decarbonization strategies. As programs transition from more traditional forms of energy efficiency measures, there is a need to consider new program designs, approaches, measures, and incentive structures. Additionally, because electrification retrofits rarely align with the simple replacement structure akin to traditional energy efficiency measures, programs need to think beyond just simple “widgets” and identify the larger building components and associated electrical infrastructure to understand what is feasible at a given point in time. This paper will explore the various multifamily electrification program models that have been implemented in California to identify lessons learned, best practices, and recommendations for scaled approaches which can be tailored to local conditions. The paper will pull from the Association for Energy Affordability’s (AEA) firsthand experience implementing a variety of these programs, including ongoing evolution and iterative improvements in response to market dynamics, trends, and participant feedback. This will include a variety of program models, such as low income or market rate program designs, programs targeting multifamily decision makers or midstream actors, and programs focused on specific electrification measures or on comprehensive energy efficiency and electrification upgrades.

Introduction

California, as well as leadership at the Federal level, have been pushing towards an increasingly proactive low-carbon future. In California, the state has committed to 100% clean electricity by 2045 (SB100), zero net carbon by 2050 (Executive Order B-55-18), and reducing the state’s greenhouse gas emissions by 40% (SB32) and doubling its energy efficiency by 2030 (SB350). Building electrification, moving from fossil-fueled to high efficiency electricity-powered appliances that can use low carbon electric energy sources, provides a pathway to significantly decarbonize our housing stock while reducing energy consumption and improving the health and safety of inhabitants. While momentum builds to meet the statewide and national climate goals, existing multifamily housing stock presents a significant opportunity and challenge for electrification retrofits. This building type historically has been a challenging market to penetrate even for traditional energy efficiency programs, and as such, requires unique and deliberate program strategies when it comes to electrification retrofits. Within California, there are approximately 3.2 million multifamily households (5+ units/building), representing about 25% of all households in the state. Statewide, 80% of multifamily households reside in low-rise or one to three story buildings, 12% are mid-rise (four to six stories), and 5% are high rise (seven stories and above.)

Natural gas systems and appliances are currently prevalent in the majority existing multifamily buildings and their replacement represents a significant opportunity to reduce

greenhouse gas emissions, potentially lower utility costs, and make buildings safer. The primary natural gas end uses in multifamily buildings are the space heating components of heating, ventilation, and air conditioning systems (HVAC) and domestic hot water systems (DHW), as well as miscellaneous fossil fuel–burning systems and appliances including stoves and ovens, clothes dryers, and pool and spa heaters.

Electrification in the existing multifamily building sector faces the same obstacles inherent to the broader residential sector, including limited access to funds to offset upfront costs and retrofit challenges pertaining to electrical infrastructure upgrades and building modifications. However, the multifamily rental sector also faces unique challenges, such as the pervasive “split incentive” issue, which refers to the tendency of residential rental building owners to minimize in-unit energy upgrades that do not financially benefit them by reducing owner-paid utility bills. Additionally, multifamily buildings also have a wide variety of HVAC and DHW system types and configurations, including some highly custom systems, as well as infrastructural challenges related to limited panel capacity to add new electric load. Another obstacle to electrification arises from the diversity of multifamily building types, which range in size from low-rise buildings with less than 10 units to larger mid-rise buildings to high-rise buildings with many hundreds of units. A wide range of electrification measures and implementation strategies potentially come into play for the multifamily sector, including some that apply only to a specific area or single dwelling unit and others that apply only to large commercial central systems that serve whole buildings or larger areas.

Multifamily Electrification Opportunities and Challenges

Multifamily Electrification Measure Summary

Electrification measures consist of the replacement of existing fossil-fuel equipment with high efficiency electric equipment. The primary end uses this applies to in multifamily building are space heating, water heating, cooking, and laundry. In multifamily, there can be a wide variety of equipment and locations that meets each of these end uses. The number of possible permutations is significant given the variety of multifamily building structures. For example, apartment units may have all, some, or none of the following in the units: space heating equipment, hot water equipment, cooking equipment, or laundry equipment. The following list summarizes all the possible types of end uses that can be candidates for electrification in multifamily buildings

- In-unit Apartment equipment (end uses specific to individual dwelling unit, commonly but not always, on tenant utility meters): Space Heating, Domestic Hot Water, Cooking, Laundry
- Central System Equipment (end uses apply to multiple dwelling units on property common utility meters): Space Heating, Domestic Hot Water
- Common Area Equipment (end uses specific to the common areas of the property): Space Heating (Corridors, Community Spaces, Property Staff Offices), Hot Water (Shared Laundry Rooms, Community Spaces, Property Staff Offices), Pool and Spa Hot Water, Laundry (Shared Laundry Rooms).

Within each of these end uses is a wide variety of existing condition subtypes and measure subtypes, especially for multifamily properties, which come in a huge diversity of shapes, sizes, and vintages. As compared to traditional energy efficiency measures there is often not a simple retrofit opportunity where one is replacing existing equipment with a higher efficiency that has a similar form-factor. Electrification results in substantially different form-factor equipment, especially for space heating systems without existing air conditioning and for some water heating systems.

Figure 1 below outlines many of the possible existing and retrofit electrification opportunities, as well as the relative occurrence of such measure opportunities in California. The retrofit cost column represents general cost ranges, inclusive of material, labor, and electrical and miscellaneous building modifications needed to accommodate the retrofit. This retrofit cost represents the wide range of retrofit complexities and is meant to be a comparative analysis. Actual costs will vary from this range due to variables such as specific existing conditions and variations in material and labor costs. The column of California Prevalence accounts for relative occurrence in multifamily, based on AEA's experience implementing various multifamily retrofit programs and supported by 2009 RASS (California Residential Appliance Saturation Survey) results.

Category	Existing Condition	Electrification Measure	California Prevalence ¹	Retrofit Cost	GHG Savings Potential ²
DHW	Residential Tank Gas Water Heater (WH)	Residential Heat Pump Water Heater (HPWH)	high	\$3k-\$6k	High
DHW	Residential Tankless Gas WH	Residential HPWH	low	\$3k-\$6k	High
DHW	Central/Commercial Gas WH	Central/Commercial HPWH	high	\$2k-\$4k	High
DHW	Residential Gas WH	Central HPWH	low	\$3k-\$6k	High
DHW	Central Gas WH	Residential HPWH	low	\$3k-\$6k	High
DHW	Laundry Room Gas WH	Laundry Room HPWH	high	\$3k-\$6k	High
DHW	Commercial Pool Gas WH	Commercial Pool HPWH	medium	\$4k-\$8k	High
HVAC	Residential Gas Wall Furnace, No A/C	Residential Mini-Split Heat Pump (HP)	high	\$6k-\$12k	Medium
HVAC	Residential Gas Wall Furnace, No A/C	Residential Advanced Package Terminal Heat Pump (PTHP)	high	\$4k-\$8k	Medium
HVAC	Residential Gas Wall Furnace, Wall A/C	Residential Mini-Split HP	high	\$6k-\$12k	Medium
HVAC	Residential Gas Wall Furnace, Wall A/C	Residential Advanced PTHP	high	\$4k-\$8k	Medium
HVAC	Residential Gas Wall Furnace, Wall A/C	Residential Standard PTHP	low	\$2k-\$4k	Medium

¹ The categories of prevalence are gauges that roughly equate to the following: High >45%; Medium 10-45% and Low <10%.

² GHG savings based on relative natural gas savings and electricity load additions per measure type for California multifamily building stock and climate zones

HVAC	Residential Gas Ducted Furnace, No A/C	Residential Split DX HP	low	\$5k-\$15k	Medium
HVAC	Residential Gas Ducted Furnace, Split DX A/C	Residential Split DX HP	medium	\$5k-\$10k	Medium
HVAC	Residential Gas Ducted Furnace, No A/C	Residential Mini-Split HP	medium	\$6k-\$12k	Medium
HVAC	Residential Gas Ducted Furnace, Split DX A/C	Residential Mini-Split HP	medium	\$6k-\$12k	Medium
HVAC	Residential Packed Rooftop Gas with A/C	Residential Packaged Rooftop HP	medium	\$5k-\$10k	Medium
HVAC	Residential Packed Rooftop Gas with A/C	Residential Mini-Split HP (MSHP)	low	\$6k-\$12k	Medium
HVAC	Residential Gas Hydronic Fan Coil, No A/C	Residential Mini-Split HP	medium	\$6k-\$12k	Medium
HVAC	Residential Gas Hydronic Fan Coil, Split DX A/C	Residential Mini-Split HP	medium	\$6k-\$12k	Medium
HVAC	Residential Gas Hydronic Fan Coil, Split DX A/C	Residential Split DX HP	medium	\$5k-\$10k	Medium
HVAC	Commercial Central Gas Furnace (w or w/o wall A/C)	Various HP (MSHP, Standard PTHP, Advanced PTHP, VRF)	low	\$5k-\$20k	High
HVAC	Commercial Central Gas Hydronic Boiler (w or w/o wall A/C)	Various HP (MSHP, Standard PTHP, Advanced PTHP, VRF)	low	\$10k-\$20k	High
HVAC	Commercial Central Gas Steam Boiler (no A/C)	Various HP (MSHP, Standard PTHP, Advanced PTHP, VRF)	low	\$15k-\$25k	High
Cooking	Gas Range	Electric Induction	high	\$1k-\$3k	Low
Clothes Dryer	Residential Gas Dryer	Residential HP Dryer (or Condensing)	low	\$1k-\$3k	Lowest
Clothes Dryer	Commercial Gas Dryer	Commercial Electric Dryer (HP) ³	low	n/a	Lowest

Table 1. Summary of Common Multifamily Electrification Measures

Program Measure Eligibility

Given the wide variety of possible electrification measures in multifamily programs, identifying a succinct list eligible measures and their associated energy savings and rebates can be a challenge. California has developed several fuel substitution (electrification) work papers for residential single family and multifamily measures, but those workpapers account for only a fraction of the possible measure and base cases identified above. For existing conditions and retrofit conditions that do not match a workpaper, program implementers are often left with one of the following options: 1) develop custom measures, 2) select workpapers that do not match exactly, but are closely aligned to the actual situation or 3) eliminate those measures from program eligibility. The options that programs may need to pursue are often dependent on the regulatory requirements or emphasis of the given program.

³ Commercial Heat Pump Dryers are not readily available in North American market, as of Q2-2021

For example, many utility run programs must meet specific California Public Utility Commissions (CPUC) rules around claimed savings, claimed cost, cost effectiveness, and compliance with deemed or custom measure savings rules. In many of those situations, programs may need to choose from options 2 or 3 listed above. However, other programs that are outside of specific CPUC rules, or programs that have more flexibility (or emphasis, such as units of installed equipment or less regulatory rigidity regarding claimed savings, etc.) can develop expansive and flexible measure lists. For example, programs focusing primarily on air pollution reduction (NO_x or GHG reductions) and programs prioritizing market transformation (increased adoption of electrification technologies) often have the ability to develop a flexible program measure mix. In AEA's experience, having more options tends to be better to program participants, as the wide variety of existing and retrofit conditions may be incurred, and the best electrification retrofit solution(s) for a given property can have a lot of influences, such as retrofit feasibility, costs, age of building, historical preservation issues, accessibility, space, electrical capacity, etc. In many cases, a retrofit package may need to be tailored to that specific project condition, and thus may be unlikely to match an exact workpaper assumption.

Program Incentive Structures

Several studies have found that building electrification is more cost effective than fossil fuels for most new home construction, especially when considering the avoided cost of gas mains, services, and meters in all-electric homes and neighborhoods (McKenna, Shah, and Louis-Préscott, 2020). However, for retrofit applications the electrification retrofit option often costs more than the same fuel standard practice retrofit. There is a variety of reasons for that, including both material and labor costs which may be higher than the same fuel standard practice. There is much effort being placed on increase demand of electrification measures, which may provide some downward pressure on material and labor costs. However, many electrification measures have costs beyond the basic material and labor costs. For example, when changing from a natural gas technology to an electric technology, several ancillary costs come into play, such as:

1. Electrical infrastructure costs (new electrical breaker panels, new dedicated circuits and wiring) and a variety of other electrical costs on both sides of the meter (Aitchison, et al, 2020)
2. Building modification costs to accommodate the electrification retrofit, such as installing a Heat Pump HVAC in new location, adding ducting or louvers to accommodate a residential Heat Pump Water Heater (HPWH), or installing central HPWH equipment in separate locations from the storage tanks associated with the systems.

Additionally, early stages of electrification adoption experience some perceived risk from the contractors, property owners, or associated decision makers. Typically, perceived risk from the contractors results in either inflated bid costs to protect against any unknowns, or refusal to provide electrification proposals. For property owners or associated decision makers, perceived risk generally results in preferring to maintain a business-as-usual approach to upgrading equipment (which means maintaining existing equipment or replacing existing with like-for-like).

For each of these reasons, it is important to have an incentive structure that helps cover the higher cost of electrification retrofits as compared to business-as-usual, and as a financial lever to help overcome some of those perceived risks. If the incentives are attractive enough,

property owners and contractors may be willing to overcome many those perceived risks and decide to proceed with an electrification retrofit project.

Various incentive structures exist, including semi-custom incentives based on the number of apartments in the property, deemed incentives based on specific measures, or custom incentives based on the estimated GHG savings. In general, the custom and semi-custom incentives work well to maximize measure flexibility and ensure that incentives are specific to a specific project's savings potential, however, the lack of known upfront incentive amount can add time to the development of the project and uncertainty from the project stakeholders. Deemed incentives may result in some project getting incentives that are misaligned with a specific project's savings potential and may limit some creative and unique scopes of work but can be more streamlined and more predictable for project stakeholders.

Additionally, in AEA's experience, co-leveraging or layering with multiple programs is key to adopting electrification measures. For example, the majority of electrification projects that have participated in any programs implemented by AEA have utilized incentives from more than one program. Often programs can complement one another and enable projects to move forward when they otherwise would not have been possible as part of just one program.

Program Technical Assistance

In addition to the list of eligible electrification measures and the associated incentive amounts, there are a number of program details that can serve to improve and enhance an electrification program, such as program supported technical assistance. As compared to traditional energy efficiency measures, there is still a lot to be improved regarding selection of appropriate electrification retrofit, sizing and selecting the appropriate equipment, installing the equipment correctly, and setting up the equipment to operate correctly. As such, program supported technical assistance is key to help project stakeholders (property owners, onsite staff, occupants, and contractors). Often there is not just one retrofit option, so program supported technical assistance can provide a range of different options and not the pros and cons and considerations of each. Additionally, due diligence and feasibility assessments may be needed to determine whether an electrification measure can happen at all, and if so, what are each of the necessary considerations. It is important to note the electrical infrastructure impacts, the building modification impacts, and the operational and efficiency considerations, so that the retrofits can operate efficient and have a beneficial impact for the building and the utility bills. Finally, complimentary measures that are important in making the electrification project both feasible and recommended can be incorporated into the program supported technical assistance, including identifying complimentary load reduction measures, energy efficiency measures, utility rate options, and/or inclusion of solar PV.

Not only is this critical as part of pre-retrofit stage, but additional support is critical as installation contractors select and size the appropriate equipment. The parallels to traditional energy efficiency HVAC sizing are similar, but additionally many heat pump HVAC or HPWH technologies may have electric resistance auxiliary components to assist in high recover situations or when the ambient air temperatures are too cold for the technology to utilize the heat pump compressor at an impactful output capacity. Equipment that is incorrectly sized or installed and thus results in over reliance on this electric resistant auxiliary capability will have a much higher annual electricity consumption than those that are sized and installed correctly and can rely primarily on the highly efficiency heat pump compressors.

Finally, it is important to have program support during the installation and verification stages, to make sure everything is being installed and set up correctly, and that onsite staff and occupants are educated as to how to operate the new equipment.

Program Case Studies

There are a number of multifamily electrification programs that have experienced some of the opportunities and challenges listed above. The following program case studies provide a summary of the different ways various programs have incorporated various elements to address these elements.

Multifamily Low-Income Weatherization Program

A California statewide program utilizing cap and trade funds, focused on comprehensive whole building retrofits (apartments, central systems, and common areas) for existing low-income multifamily housing. The program provides rebates for electrification, energy efficiency and solar PV, with an incentive structure that is based on the estimate GHG savings resulting from a scope of work, which results in an extremely flexible measure structure. The incentives are higher for tenant benefiting measure to help address the split incentive. Program provided technical assistance is available all stages of projects. Because LIWP-MF is not funded with ratepayer funds, it is an excellent candidate to layer with other programs.

SMUD Multifamily Go-Electric Program

An existing building program in SMUD territory that provides incentives for electrification and energy efficiency measures, and EV charging stations. Incentives are increased for eligible equity projects. There is a menu-based incentive structure for electrification measures in apartments, central systems, and common areas, and eligibility is primary focused on the end use equipment (as long as the existing equipment was fossil fueled). The program also provides incentive adders for low-GWP equipment, panel and associated electrical infrastructure upgrades, and permitting costs. Program provided technical assistance is available all stages of projects.

MCE Low-Income Families and Tenants Program

An existing building program in MCE territory that provides incentives for electrification and energy efficiency measures for eligible low-income multifamily properties. There is a menu-based incentive structure for heat pump (HVAC and HPWH) measures in apartments, central systems, and common areas, and eligibility is primary focused on the end use equipment (as long as the existing equipment was fossil fueled). Limited funds are also available for replacing propane equipment with electrification measures. The program also provides incentive adders for panel and associated electrical infrastructure upgrades. Program provided technical assistance is available all stages of projects.

BayREN Bay Area Multifamily Building Enhancements Program

An existing building program in San Francisco Bay Area that provides incentives for electrification and energy efficiency measures for multifamily properties. The incentives are based on the number of apartments at the property (\$750/unit), plus incentive adders for

electrification measures. Measures in apartments, central systems, and common areas are each eligible. Projects must show that they have at least 3 measures in the scope of work and can meet a projected GHG savings of 0.25 MT CO₂e per apartment to be eligible for incentives, which is calculated using both deemed workpapers and custom calculations. Program provided technical assistance is available all stages of projects.

3C-REN Multifamily Home Energy Savings Program

An existing building program in tri-county area of Ventura, Santa Barbara, and San Luis Obispo Counties that provides incentives for electrification and energy efficiency measures for multifamily properties. The incentives are based on the number of apartments at the property (\$500-\$750/unit), plus incentive adders for electrification measures. Measures in apartments, central systems, and common areas are each eligible. Projects must show they have at least 3 measures in the scope of work and can meet a projected GHG savings of 0.25 MT CO₂e per apartment in order to be eligible for incentives, which is calculated using both deemed workpapers and custom calculations. Program provided technical assistance is available all stages of projects.

SCAQMD Multifamily Affordable Housing Electrification Program

An existing building program in South Coast Air Quality Management District territory that provides incentives for electrification for low-income multifamily properties. There is a menu-based incentive structure for electrification measures in apartments, central systems, and common areas, and eligibility is primarily focused on the end use equipment (if the existing equipment was fossil fueled). The primary goal of the program is permanent NO_x reductions, by replacing natural gas equipment with high efficiency electric equipment. Program provided technical assistance is available all stages of projects. As MAHEP is not subsidized with ratepayer funds, it is an excellent candidate to layer with other programs.

Lessons Learned and Recommendations

After accounting for each of the opportunities and challenges listed above, each of the programs that have been addressing electrification have encountered more detailed lessons learned and recommendations. The following outlines some of the lessons learned and recommendations resulting from these program examples.

Program Measure Cost Effectiveness Calculations

CPUC Decision 19-08-009 provided technical guidance for how to document and permit fuel substitution measures in California, primarily by requiring that program administrators must demonstrate that the proposed measure passes the “Fuel Substitution Test”. The Fuel Substitution Test has two requirements: (1) The measure shall not increase source energy and (2) The measure shall not harm the environment. This decision has been an important policy and regulatory document to guide program administrators.

However, how measures are calculated from a cost-effectiveness perspective have become more nuanced. For example, the therm reduction from an electrification measure is considered a “benefit” in cost effectiveness calculations, but the added load from the newly electrification end uses is included in the as denominator in the “cost” portion of cost

effectiveness calculations. This nuance is unique to fuel substitution measures and is not normally a consideration for traditional energy efficiency measures, which has resulted in modification and evolution of cost effectiveness tests.

Adaptability and Flexibility

There can be a wide variety of existing conditions and retrofit measures. Additionally, the technologies associated with electrification measures are rapidly changing, leading to emerging technologies and new product designs. Programs need to adapt to ongoing technology innovations in order to allow electrification measures as soon as they become available, and to not prematurely disallow promising measure opportunities.

Technical Assistance and Stakeholder Education

In addition to the technical assistance best practices outlined above, many property owners, decision makers, onsite staff, and contractors are unfamiliar with the full breadth of electrification technologies and equipment options, installation best practices, or creative solutions when barriers are incurred. Program provided resources, such as no-cost technical assistance support, is critical to enabling projects to proceed and ensuring those projects are completed with high quality retrofits.

Generous Incentives

At the current stage of the adoption curve as it relates to multifamily electrification retrofits, it seems that generous incentives will be important to increase adoption. While several early adopters could potentially proceed with more limited incentives, many properties need incentives such that the net cost is at least on parity with business-as-usual like-for-like retrofits, and for accelerated replacement the net cost may need to be even less than like-for-like, until such time that electrification becomes standard practice or is regulatorily mandated.

Additionally, layering of multiple incentives is key, whenever possible. While multiple ratepayer incentives can rarely if ever be layered, many programs use non-ratepayer funds that have a focus on GHG emissions, NO_x reductions, and/or market transformation, which can both be layered with each other and with up to one of the ratepayer programs, thus enabling projects to move forward.

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