



BayREN Home Energy Score Electrification Checklist Pilot Report

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StopWaste
Frontier Energy, Inc.

For questions about the BayREN HEScore Program,
please email HomeEnergyScore@frontierenergy.com.

www.BayREN.org/HES

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Local Governments Empowering Our Communities

BayREN Green Labeling Program

In support of the State of California's goal to double the energy efficiency of existing buildings by 2030, the Bay Area Regional Energy Network (BayREN) Green Labeling program aims to increase awareness and transparency of residential energy information. By doing this, BayREN will drive energy efficient investments that lead to energy savings in single-family homes. The main program offerings are real estate professional trainings on energy efficiency and promotion of the U.S. Department of Energy (DOE) Home Energy Score (HEScore).

Like a miles-per-gallon rating for a car, the HEScore is based on a standard assessment of energy-related assets to easily compare energy use across the housing market. During the assessment a multitude of data points are collected, translating into a score from 1 to 10, with 5 being an average home, 10 the most energy efficient, and 1 the least energy efficient. Along with the score, homeowners receive estimated energy consumption, estimated utility bills, and custom recommendations for energy efficiency improvements. HEScore is an attractive and scalable tool because the assessment and accompanying report are low-cost, simple to conduct, easily explainable to homeowners, and meet rigorous DOE quality control standards.

Since 2015, BayREN has scored over 11,000 homes in the Bay Area and works with more than 30 HEScore Assessors. A \$200 rebate is available for scores¹ and in-program pilots may provide other incentives and test innovative, scalable solutions. Recipients of the HEScore are provided referrals to energy efficiency programs, incentives, and financing tools (e.g., BayREN's Home Energy Advisor and Home+ program). The HEScore report provides a critical link between information and action.

Electrification Checklist Overview

The Electrification Checklist is a pilot launched August 2020 as a means to support State and local goals to decarbonize and electrify buildings. The Electrification Checklist is used concurrently with the HEScore assessment to collect additional data points to determine which gas-to-electric recommendations may be appropriate for each home. A sample Electrification Checklist is provided in Appendix G.

While the HEScore does collect information about water heaters and furnaces, it is generally focused on energy efficiency and building envelope upgrades and not on decarbonization. For example, the formula for producing a score relies more on insulation, window types, and appliance efficiency than the appliance fuel type (gas vs. electric). High-efficiency electric appliances such as heat pumps should receive a higher score due to their increased efficiency over gas or electric resistance models, but not because they contribute to fewer greenhouse gas (GHG) emissions (depending on the electricity mix).

Similarly, on the recommendations side there is no preference given for high-efficiency heat pump appliances. However, behaviorally, BayREN has worked for years to influence this shift, including encouraging Assessors to only make gas recommendations in emergency change-outs and the Electrification Checklist. Helping Assessors look for electrification opportunities when making gas vs.

¹ The City of Berkeley is not eligible for rebates due to the Building Emissions Savings Ordinance (BESO) that requires an HEScore at time of listing; Palo Alto is not eligible for ratepayer funded programs.

electric recommendations increases the frequency of electrification recommendations, which was a primary objective of the pilot.

In preparation for the launch in August 2020, BayREN hosted two webinars on the checklist and data collection best practices to ensure the safety of Assessors and the integrity of the data. All information is collected with safety as a priority. Unobtainable or unknown information may be left blank on the Electrification Checklist. The Electrification Checklist must be completed concurrently with an HEScore assessment. The Electrification Checklist is a voluntary pilot throughout BayREN territory, with the exception of the City of Berkeley who incorporated it into their Building Emissions Savings Ordinance (BESO) in November 2020. In addition to the \$200 initial score rebate, a \$100 rebate was provided from August 1, 2020 to January 15, 2022 upon the approval of the Electrification Checklist and the HEScore. This rebate was decreased to \$50 after January 15, 2022.

Electrification Checklist Data Points

The Electrification Checklist builds on information collected during a standard HEScore. In addition to the standard assessment information, the checklist collects more details on the water heater and heating, ventilation, and air conditioning (HVAC) equipment. The checklist includes information on the water heater's location, dimensions of the space, and assesses the surrounding air circulation to understand the potential for fuel switching to a heat pump water heater (HPWH). For HVAC equipment, the checklist notes how the heating and cooling systems are configured (i.e., the heating and cooling are combined or are separate systems), and whether the home has a window air conditioning unit. These additional data points align the HEScore recommendations with the BayREN Home+ program's heating and cooling requirements for fuel switching.

The checklist collects information on home assets not included in a typical HEScore that are pertinent to electrification potential, such as information on the electrical panel, clothes dryer, and stove. Data points include the size, type, and available breakers of a home's electric panel and subpanel(s) and the fuel source and approximate age of the clothes dryer and stove.

Electrification Checklist Results

From the start of the Electrification Checklist pilot in August 2020 until December 31, 2021, Electrification Checklists were included in 4,605 of 5,176 HEScores approved throughout that period—accounting for 89 percent of all scores.

Of those checklists, 882, or 19 percent of homes were considered “good” or “great” candidates for whole-house electrification. Here, we define a home as a “good” candidate for electrification if the main electrical panel is rated for 200 or more amps, the panel (or subpanel) has capacity and space for additional load to accommodate new electric equipment, and the home has existing appliances with a gas fuel source (specifically, domestic hot water, stove tops, dryers, or space heating). Of those, 178 homes have existing solar panels and are thus considered “great” candidates for electrification.

However, even when a home fits the “good” or “great” description above, the location and installation of gas appliances will affect how easily those uses could convert to electric appliances, which can influence the home's characterization as a suitable fit for electrification. Acknowledging some data collection errors, the number of good and great fits may be even higher than reported here. Home Energy Score trends for “good” and “great” candidates for electrification are further discussed in the

“Electrification Checklist and the Home Energy Score” section below. Also, while homes were evaluated for being a “good” or “great” fit for whole-house electrification, many are eligible candidates for one or more electrification measures.

The number of Electrification Checklists varies by county. Figure 1 shows the distribution of checklists completed across the nine Bay Area counties who are members of BayREN. Alameda County has the highest number of Electrification Checklists. Within Alameda County, the City of Berkeley requires Electrification Checklists as part of Berkeley’s BESO. The distribution of checklists completed is generally proportional to the volume of standard HEScores completed within each county: between 73 percent and 100 percent of HEScores in any one county were submitted with an Electrification Checklist, with a mean of 89 percent across all counties within BayREN territory.

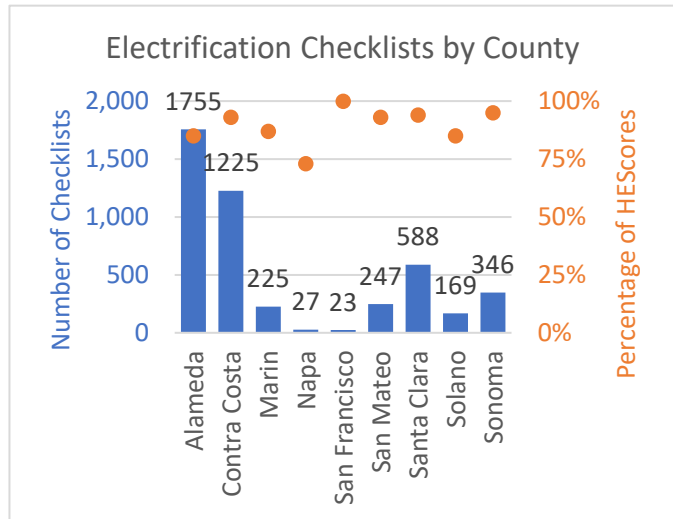


Figure 1: Total Number of Electrification Checklists by County

Equipment by Fuel Type

Figure 2 illustrates a sample of the Bay Area building stock by fuel type according to the checklists collected. The electric fuel type includes both electric resistance and heat pumps for clothes dryers, space heating, and water heating; and both electric resistance and induction cooking for stoves. Most homes in the Bay Area are mixed-fuel, including a mix of electricity and gas for space heating, water heating, cooking, and clothes dryers.

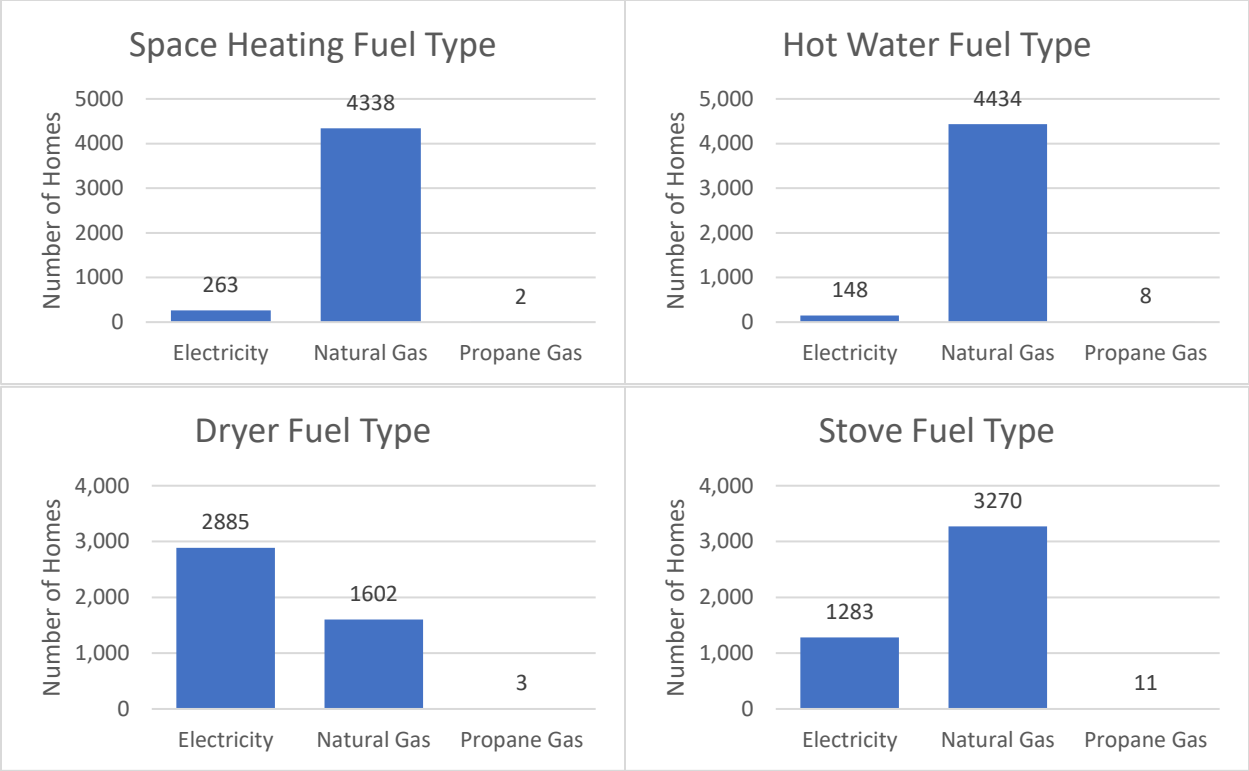


Figure 2. Number of Homes with Appliances by Fuel Type

Natural gas is the most common fuel type across all appliances except for clothes dryers which were majority electric. Homes that received an Electrification Checklist had natural gas for 96 percent of water heaters, 93 percent of space heating systems, and 71 percent of stoves. However only 35 percent of clothes dryers were natural gas. Electric clothes dryers were more prevalent in Alameda, Contra Costa, San Mateo, Santa Clara, Solano, and Sonoma counties. See Appendix A for fuel type by county for space heating, water heating, dryer, and stoves.

Space Heating and Cooling Configuration

The standard HEScore gathers the HVAC type and efficiency while the Electrification Checklist includes whether the heating and cooling are a combined ducted system or if the systems are separate and/or non-ducted. For homes with cooling systems, 95 percent of checklists indicated that the home had a combined space heating and cooling system such as central air conditioning, and 2 percent were reported to have window air conditioners.²

The configuration of the heating and cooling system is important as BayREN Home+ incentives are limited for electrification from natural gas equipment. As of 2021, Home+ incentives for switching from natural gas furnaces to heat pump space heating/cooling are available only to homes with a ducted system that includes both heating and cooling or homes with a gas wall furnace and no cooling load, and are not available for homes with a heat-only ducted system as is most common throughout the Bay

² The number of window air conditioning units may be underestimated based on seasonality. For example, HEScores and checklists collected in winter months may not record window air conditioning units if they are only installed during summer months.

Area. Assessors could recommend heat pump space heating even if the home was ineligible for a BayREN Home+ rebate. New TECH program rebates have expanded this eligibility in 2022.

Checklists indicate that 73 percent of central natural gas furnaces were combined with a central air conditioning system, yet a heat pump system was only recommended for 69 percent of these homes. We believe that heat pump space heating recommendations are lower because the majority of HEScores within the BayREN Green Labeling program are conducted simultaneously with Title 24 verification assessments required for new HVAC equipment. Assessors are not likely to recommend heat pump space heating equipment when a new central gas furnace was recently installed.

Water Heating Configuration

For water heaters, additional information was gathered on location and configuration to determine how easily a HPWH could be installed in place of a gas water heater. Gallon-for-gallon, HPWHs are taller and slightly larger in diameter than standard electric resistance or gas tank water heaters, require additional air circulation, and cannot be installed outside. Small closets and utilities rooms may not be ideal locations for a HPWH since they require a minimum volume of air to extract heat. This can be accomplished with a minimum volume of non-ventilated airspace (often 700-1,000 cubic feet) or venting the HPWH outside. The best locations to install a HPWH are in unconditioned spaces such as attics, basements, and garages as they put out cool air from the condenser unit after the heat is extracted.

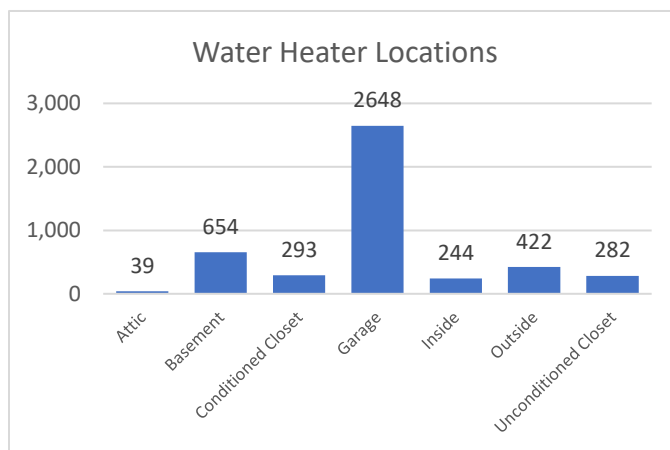


Figure 3: Existing Water Heater Locations

Figure 3 illustrates the common locations of existing water heaters for homes with an Electrification Checklist. Water heaters were most commonly found in the garage which usually have adequate air space and height to accommodate a HPWH. However, Assessors indicated that only 7 percent of homes have adequate existing air circulation *and* had their existing water heater within three feet of an electrical outlet. We discuss why Assessors may be misclassifying water heater configurations or missing opportunities to recommend HPWHs in the section “Discrepancies in the Electrification Checklist Data.”

Size of the Main Electrical Service

Typically, not part of the HEScore, Assessors collected information on the electrical panel. For safety reasons, panels with fuses are not considered suitable candidates for electrification. Main panels with sufficient capacity to supply all-electric space heating, water heating, cooking, and clothes drying are needed to fully electrify a home. Typically, 200 amps is considered sufficient to electrify the entire home, including an electric vehicle. However, reducing electric load and load-sharing devices may make it possible for some homes to electrify with as small as a 100-amp panel.

Nearly all the panels used circuit breakers, with only 1.2 percent identified as having fuses. Most panels were classified as having a capacity between 100 and 200 amps. If the panel utilized fuses, Assessors were advised against evaluating its electrical capacity. We found that the total capacity of the main

electrical panel varied greatly. However, only approximately 4 percent of the reported panel capacities were determined to be outliers, therefore it can be assumed that the data collected was largely accurate. See Appendix B for the distribution of electrical panel capacities.

The variation of the panel capacity may be due to several factors: Assessors reading figures directly from the main breaker, taking the panel capacity directly from the wiring diagram, or an Assessor manually summing the amperage listed on individual circuit breakers. The program accepts all reasonable estimates of the panel amperage capacity with photo verification due to this expected variation. See Appendix C for the classified panel amperage capacity between 100 and 200 by county.

Electrification Checklist and the Home Energy Score

The HEScore is a national asset rating that standardizes an energy assessment by using national assumptions and state average utility rates. On a 1 to 10 scale, a 10 is the most energy efficient home. Figure 4 indicates the HEScore all “good” and “great” candidates for whole-house electrification received.

Of the 882 “good” and “great” homes, 51 percent scored below a 5, which is the average home nationwide. The average score for “good” candidates was 4.8, which is only slightly above the average Bay Area score during the same period of 4.6. It is expected that homes with lower scores may need substantial upgrades and could benefit greatly from electrification.

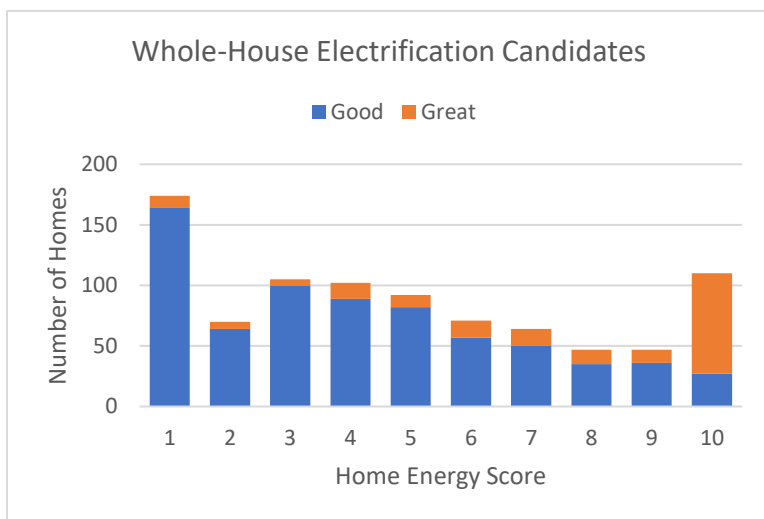


Figure 4: Home Energy Scores for Homes Classified as Good or Great Candidates for Electrification

However, the average score for “great” candidates was 7.6, meaning in addition to meeting the “good” fit requirements, they also have solar installed. Having solar positively influences the HEScore, meaning that while these homes may have higher scores, there may still be room for energy efficiency and/or electrification improvements. Higher scoring energy efficient homes may not be considered ideal candidates for electrification if they have newer, gas-fueled appliances installed. Eventually all homes will need to electrify to meet the State’s climate goals. Local governments may want to prioritize lower scoring homes and higher scoring homes with solar but fewer appliance upgrades for energy efficiency and electrification upgrades.

Discrepancies in the Electrification Checklist Data

While the Electrification Checklist provides insight into the electrification potential of Bay Area homes, there are discrepancies in the data perhaps due to varied interpretations of the checklist. Results from this report will enhance the Electrification Checklist, reducing future user error in categorizing home conditions. Discrepancies were apparent regarding air circulation surrounding the existing water heater and how the space heating and cooling system are configured.

Because HPWHs are required to be installed indoors with adequate air circulation, the Electrification Checklist gathers data points about the existing water heater’s location to optimize recommendations. Air circulation can be achieved through mechanical ventilation, passive venting such as a wall vent or louvered door, or by being in a well-ventilated space typically over 1,000 cubic feet in volume, such as a garage. Seventy-three percent of checklist responses said the water heater was in a large, well-ventilated area such as the attic, garage, or basement. And yet 87 percent of responses stated the water heater did not have adequate air circulation. It is possible that “air circulation” was conflated with “ventilation,” with Assessors assuming that the water heater location required venting to the exterior. Additional training elements to determine adequate air circulation and clarification of the wording of the checklist is necessary.

The configuration of space heating and cooling systems also provided discrepancies in data collected. The Checklist does not clearly state that the question regarding HVAC configuration should only be answered when both heating and cooling systems are present. It appears that in many cases, the Assessor responded with whether the heating system was centralized (ducted) or decentralized (such as a wall heater) and not whether the heating and air conditioning was a combined HVAC system or separate (such as a wall heater and window AC unit). This resulted in numerous homes without cooling to be incorrectly categorized as having heating *and* cooling. Revisions to the Checklist will clarify HVAC-related questions. Another revision will allow an additional HVAC systems to be entered and categorized. The current Checklist only allows for information on one HVAC system to be input, but the HEScore allows up to two HVAC systems.

Next Steps

BayREN will continue to offer the Electrification Checklist as an addendum to the HEScore data collection form. However, the \$100 incentive was reduced to \$50 on January 15, 2022. Revisions to the checklist will clarify information gathered on water heaters and HVAC systems, as discussed. For space and water heating and clothes drying, Assessors will be able to differentiate between electric resistance and electric heat pump systems, to understand the proliferation of heat pumps in the marketplace. Additional training and support will be offered to Assessors on the Checklist and on HPWH requirements, applicable BayREN Home+ rebates, and how to determine the capacity of an electrical panel. The future checklist may also include data on electric vehicles and other attributes that may indicate the electrification potential of the home.

Electrification Checklist Impacts on Energy Efficiency Recommendations

The BayREN HEScore program requires at least one recommendation for energy efficiency improvements to receive an approved report. Options for recommendations are aligned with the BayREN Home+ program’s incentives that include envelope upgrades (e.g., insulation and air sealing), induction stoves, heat pump dryers, and both natural gas and electric options for space and water heating. See Appendix D for HEScore recommendations before and after the implementation of the Electrification Checklist.

Since this pilot began, the share of homes receiving gas-fired space heating recommendations decreased from around 10 percent of scores to almost zero scores. At the start of the pilot, Figure 5 shows the split of recommendations was about 40 percent heat pump to 60 percent gas-fired systems. The share of

heat pump recommendations increased steadily, and by Q4 2021 over 90 percent of recommendations were for heat pumps. The same pattern was seen in space cooling.

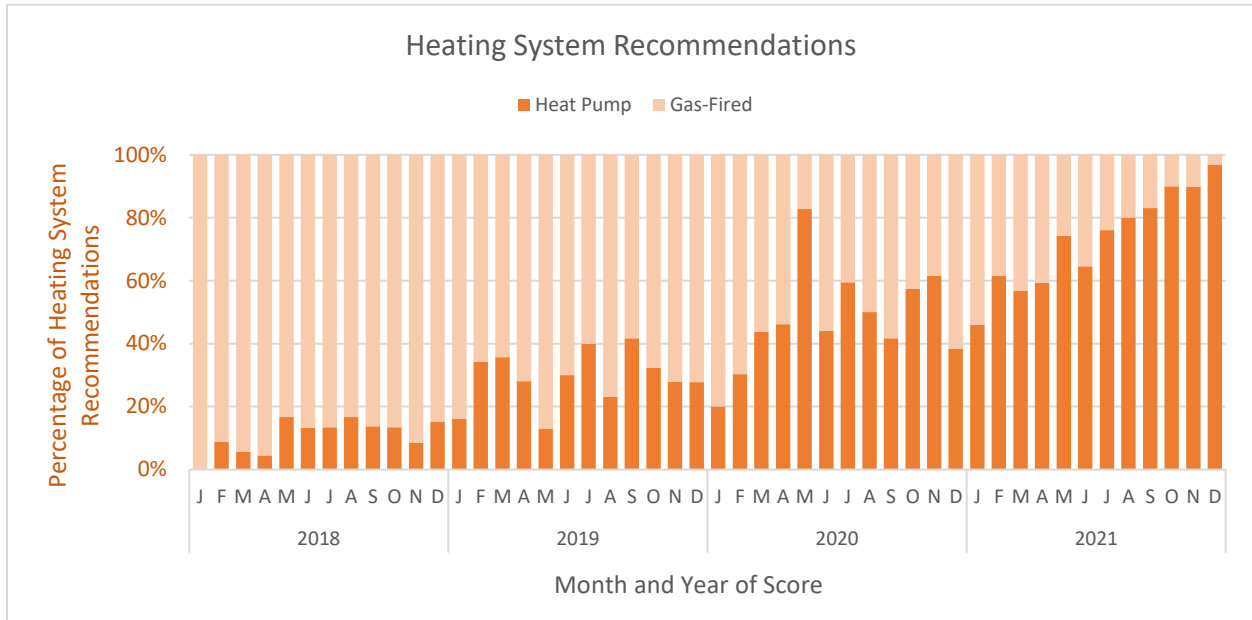


Figure 5. Shift from Gas to Heat Pump Heating System Recommendations

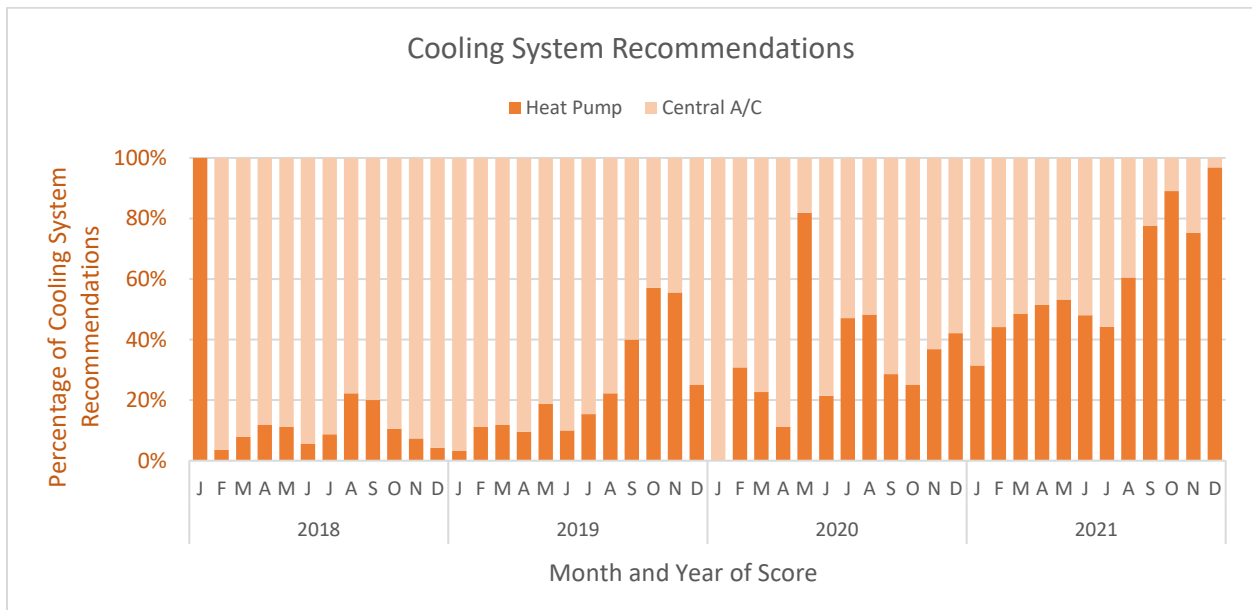


Figure 6. Shift from Central A/C to Heat Pump Cooling System Recommendations

Around a third of homes are now receiving heat pump water heater recommendations. The share of water heater recommendations of heat pumps remained around 40 percent until November 2021—when heat pump water heaters became virtually the only technology recommended (Figure 7).

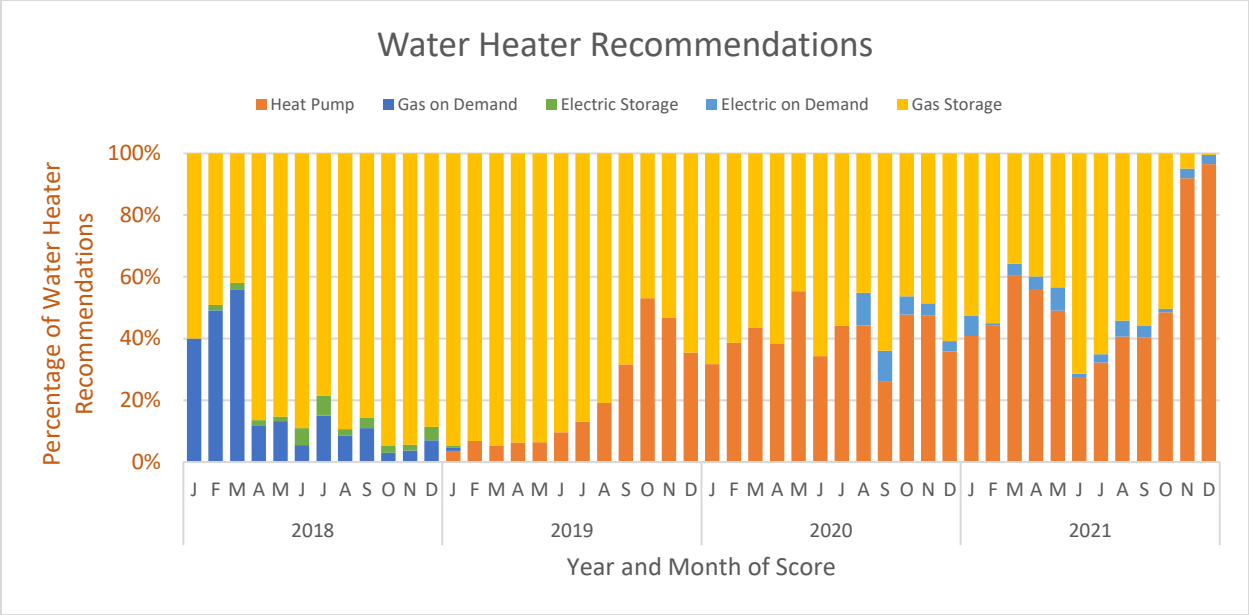


Figure 7. Water Heater Recommendations

Induction cooktop and heat pump clothes dryer recommendations were introduced with the pilot, so no prior data exists. However, since the beginning of the pilot, 1,722 heat pump dryers and 2,808 induction stoves were recommended to 30 percent and 49 percent of homes, respectively. Electric resistance or gas stoves and dryers cannot be recommended.

While the shift in electric recommendations has greatly increased, the top two recommendations regionally are building envelope measures—attic and wall insulation. These measures are an essential step to reduce energy load for space heating and are generally beneficial to implement prior to electrification. The third most common recommendation overall and in nearly all counties is induction stoves. However, recommendations do vary by county. This may be a result of certain counties promoting or having additional rebates for electrification measures, such as Marin County’s Electrify Marin Program. See Appendix F for recommendations by county, with and without the Electrification Checklist.

During the Electrification Checklist pilot period, only 11 percent of HEScores did not include an Electrification Checklist. Assessors were more likely to recommend electrification improvements when completing a Checklist than Assessors completing a standard score without the checklist. For example, 60 percent of scores that included an Electrification Checklist recommended induction cooking, while only 6 percent of scores that did not include an Electrification Checklist made that recommendation. Similarly, 37 percent of scores with an electrification checklist recommended a heat pump clothes dryer, while only 4 percent of scores without the checklist made that recommendation.

The presence of an Electrification Checklist had little impact on the percentage of scores receiving a recommendation for a central air conditioner or central gas furnace. However, those scores that included an Electrification Checklist recommended heat pumps more than twice as often.

More heat pump water heaters were recommended when an Electrification Checklist was completed (33 percent with compared to 18 percent of scores without), however a similar trend was also seen for gas storage tank water heaters (32 percent with compared to 16 percent of scores without).

Assessors who completed Electrification Checklists were also significantly more likely to recommend duct repair, wall insulation, and attic insulation, all which are industry standard recommendations prior to conversion to heat pump HVAC systems.

The additional training and practice of evaluating a home for its electrification potential may therefore increase the likelihood that an Assessor makes electrification vs. standard gas appliance recommendations. The impact on Assessors' recommendations was clear through this pilot and has a strong potential to impact residents' decisions. See Appendix E for the comparison of recommendations made with and without the Electrification Checklist.

Electrification Readiness of the Bay Area

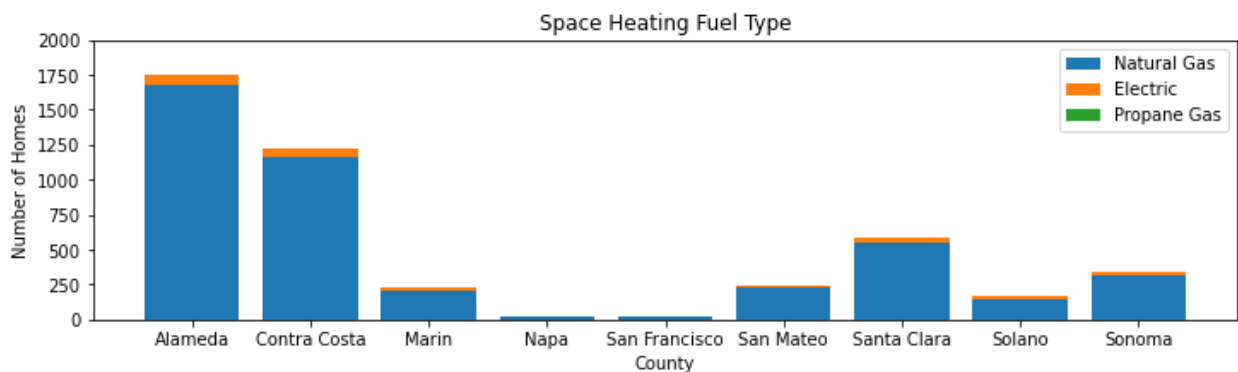
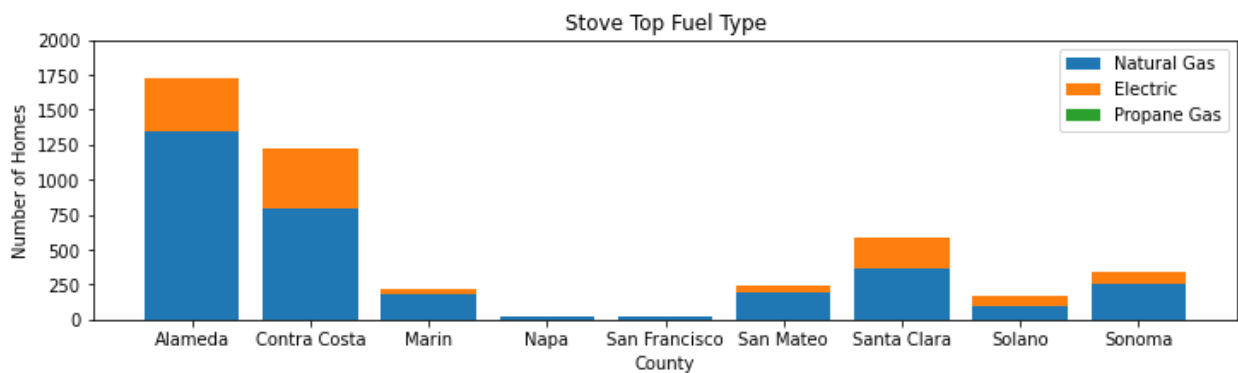
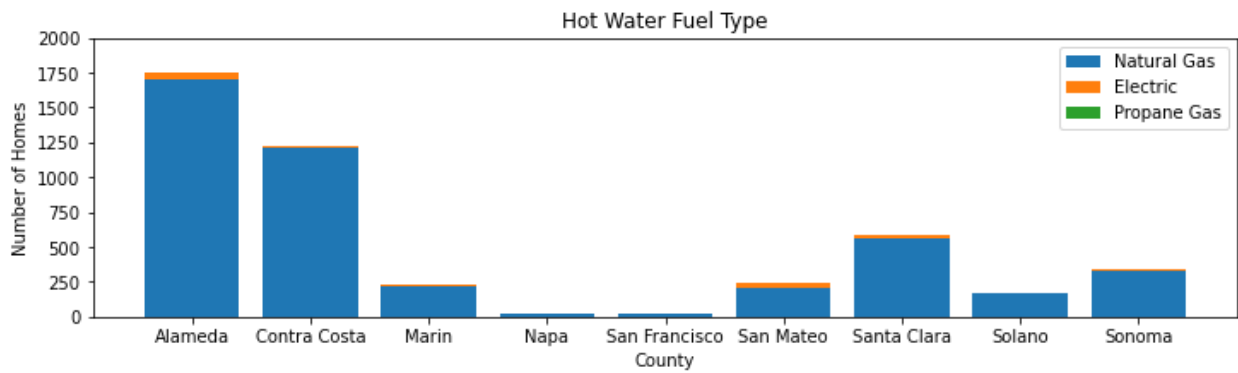
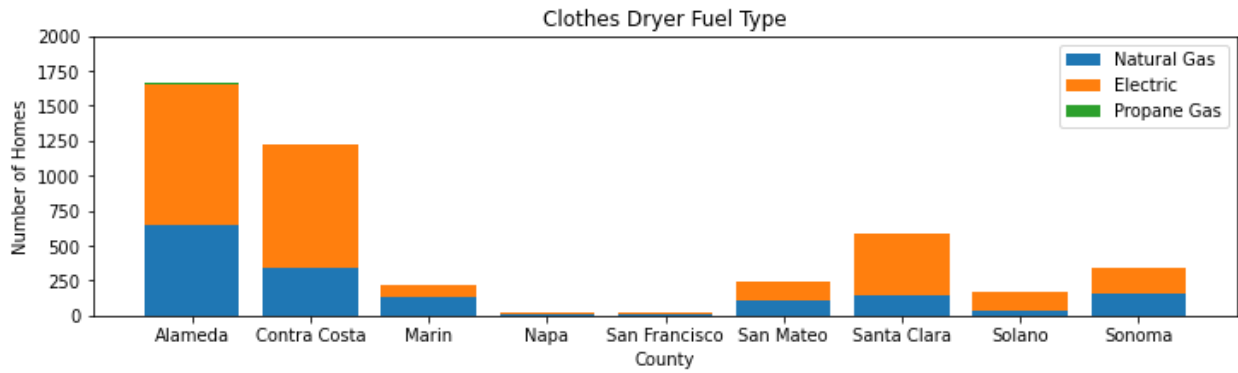
The HEScore Electrification Checklist pilot is one of several efforts throughout BayREN's programs and the State to decarbonize buildings. It complements requiring or preferring all-electric new construction through reach codes, local programs offering rebates to encourage voluntary electrification in existing homes, and resident and workforce education.

As an asset rating, the HEScore is a helpful tool to provide homeowners with information about the existing condition of their home and their electrification readiness. As an in-home assessment, it also provides more accurate information than parcel data or building permit history. Eventually all homes in California will switch to all-electric appliances to meet ambitious climate goals but initially targeting homes requiring fewer and easier upgrades to electrify may be beneficial. The Checklist reveals many homes in the Bay Area that are already considered a "good" or "great" fit (19 percent) for electrification and may be able to electrify all or portions of the home with only minor changes needed.

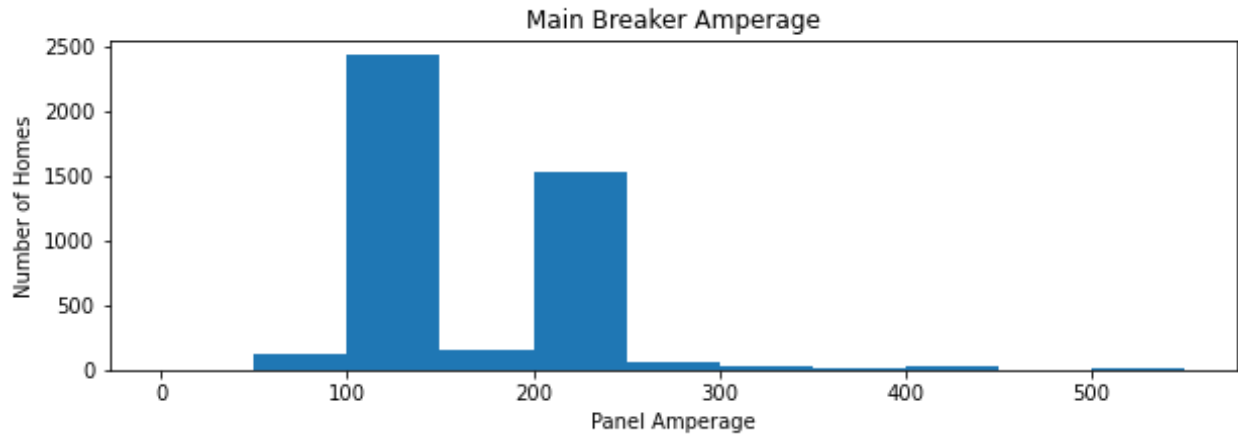
Factors that will influence the shift of energy efficiency recommendations from gas to high-efficiency electric appliances include availability and price of equipment, knowledge of the technology, and an easily accessible and well-trained workforce. The BayREN Green Labeling program's Home Energy Score Electrification Checklist helps to spread knowledge of the available equipment options to Assessors and homeowners and encourages an effort to re-train the workforce. The first 16 months of the pilot show a correlation between an Assessor completing the checklist and making more electrification recommendations. BayREN plans to continue to offer the Electrification Checklist to further efforts to decarbonize the existing residential building stock.

Appendices

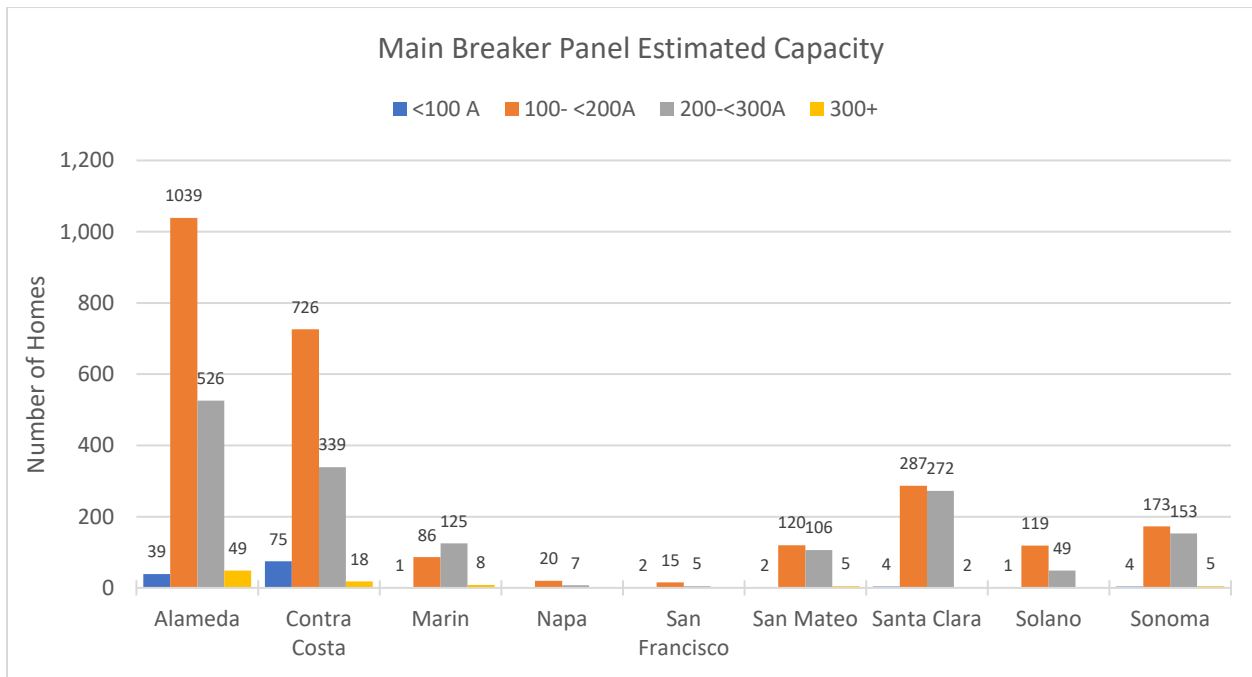
Appendix A – Fuel Type by County by Appliance



Appendix B – Electrical Panel Amperage by Panel Type

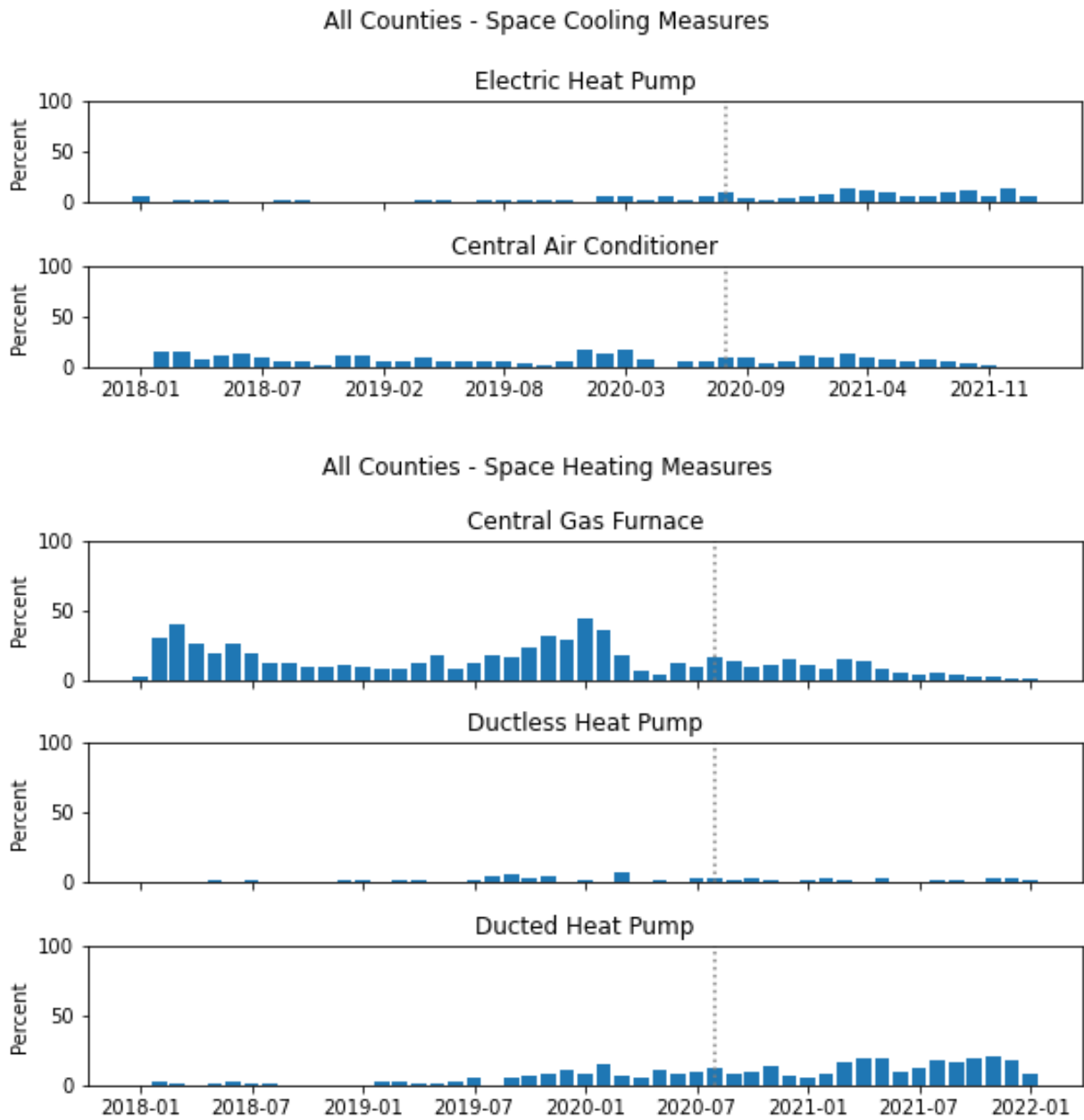


Appendix C – Electrical Panel (Breaker Type) Capacity by County

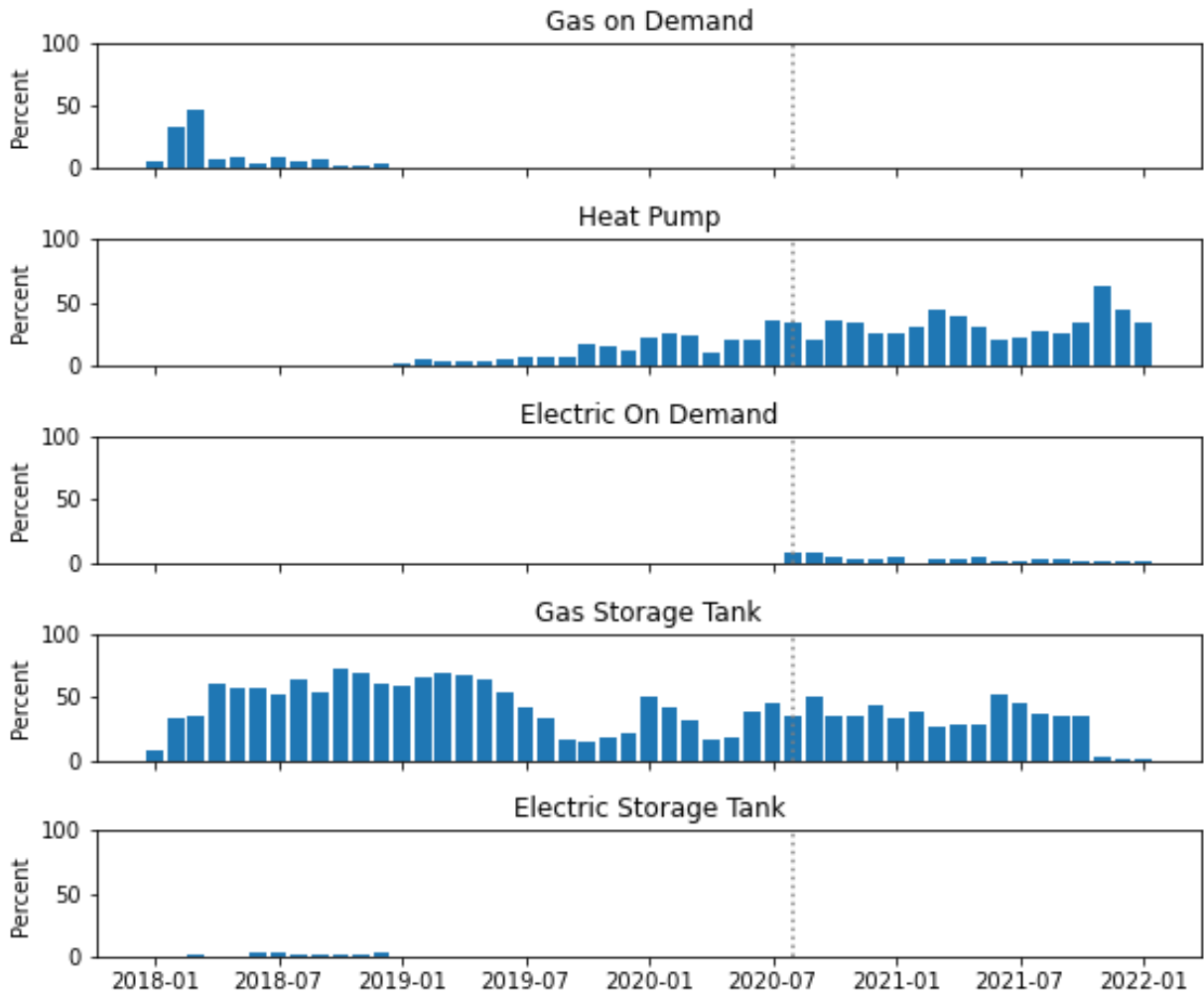


Appendix D – Measures Recommended as Percentage of Home Energy Score Reports

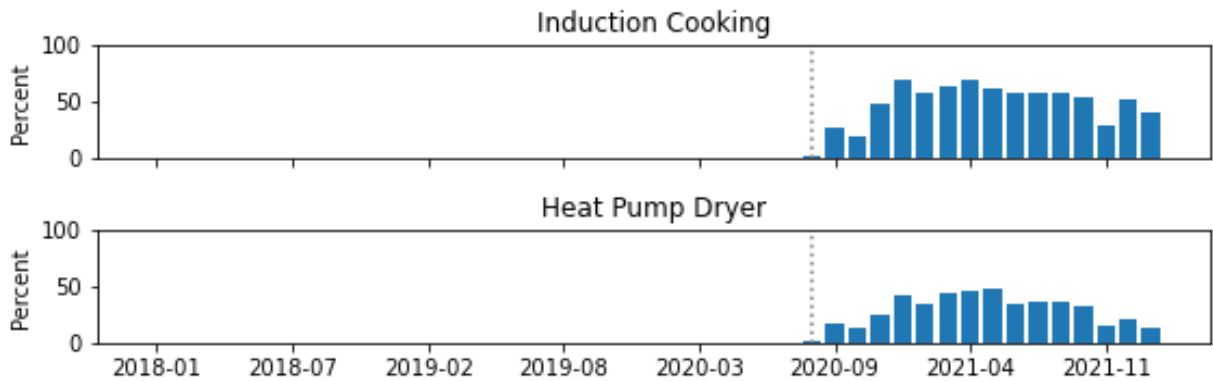
Dotted line represents roll out of Electrification Checklist.



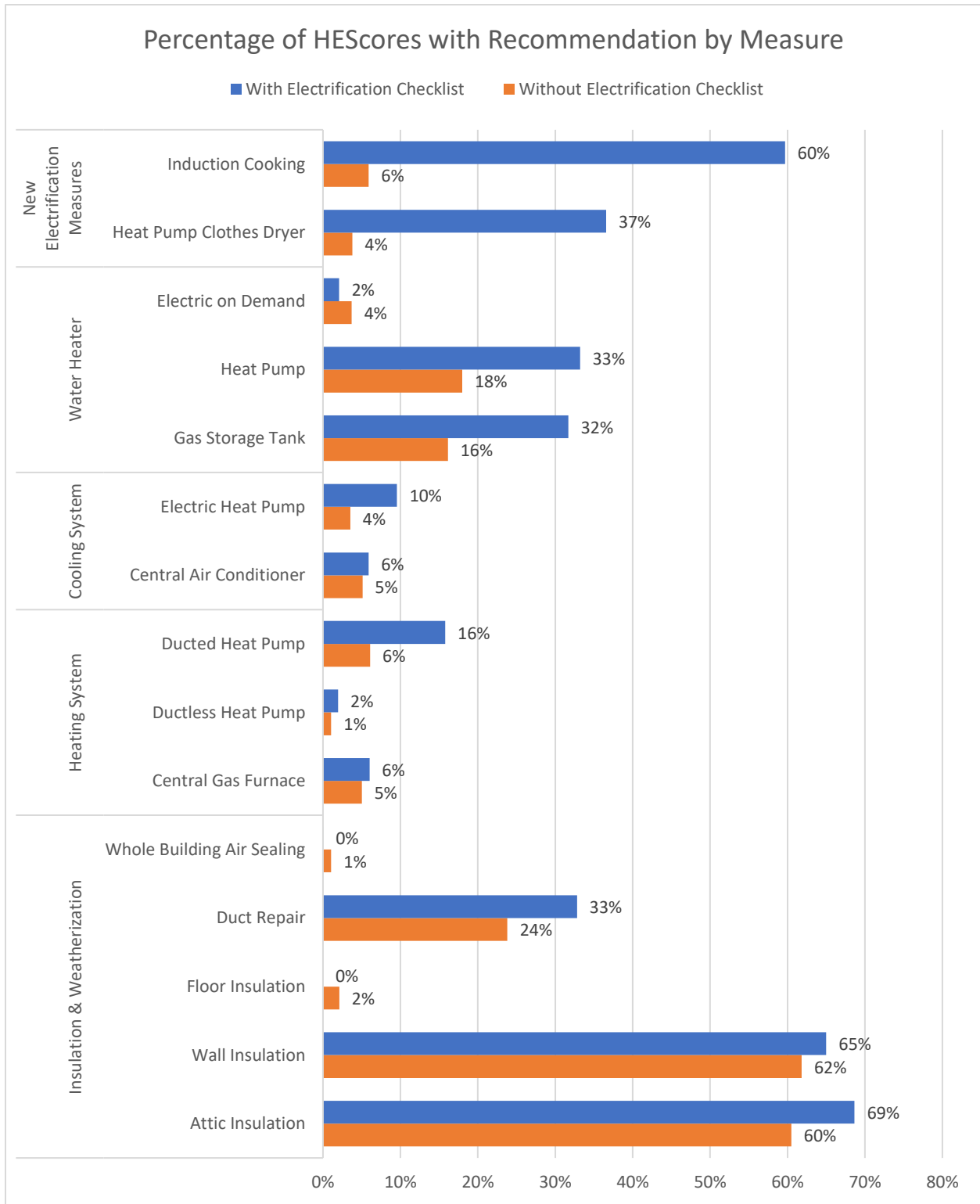
All Counties - Water Heater Measures



All Counties - New Electrification Measures



Appendix E – Recommendation Measures with and without Electrification Checklist During Pilot



Appendix F – Top Three Measures Recommended by County After ECL Released



Appendix G – Sample Electrification Checklist

Electrification Checklist

Address: _____ City: _____
Describe what information you could *not* collect and why: _____

Water Heater:

Fuel Type: Natural Gas Electric Propane Gas

Location: Outside Unconditioned Closet Basement Garage Conditioned Closet Inside Attic

If unconditioned/conditioned closet selected:

Dimensions of water heater location: _____ square feet

Ceiling height of water heater location (*round down*): 6 7 8 9 10 ft+

Location has ability for air circulation (*i.e. mechanical ventilation, is over 1,000 cubic feet in volume, or has non-mechanical venting such as louvered door or wall vent to the exterior*): Yes No

Outlet within 3 feet of water heater: Yes No

Space Heating & Cooling:

Space heating and cooling system: Combined (*i.e. HVAC is central and ducted*) Separate (*i.e. Non-ducted*)

Central Air Conditioning: Yes No

Window Unit Air Conditioning: Yes No

Clothes Dryer:

Fuel type: Gas Electric (or heat pump) Propane

Is the dryer 5 years or older: Yes No

Stove Top:

Fuel type: Natural Gas Electric Propane Gas

If electric: Coil Electric Flat Top Induction

Is the stove 5 years or older: Yes No

Electrical Service Panel:

Electrical panel type: Fuse Box Main Breaker

Main Electrical Panel:

Amperage: _____

Main panel serves the following large appliances: A/C Stove DHW Furnace EV PV

Any blank spaces/unused breakers: Yes No

Electrical subpanel: Yes No

Amperage: _____

Subpanel serves the following large appliances: A/C Stove DHW Furnace EV PV

Any blank spaces/unused breakers: Yes No

