Residential Housing Characteristics Study

Final Report

ET22SWE0022

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July, 17, 2023

Acknowledgements

The authors would like to acknowledge the contributions of energy specialists and Community Housing Opportunities Corporation working under the Energy Savings Assistance (ESA) program for their commitment to achieving savings in disadvantaged communities. Field survey data collection would not have been possible without their support. Gratitude is also shared with the homeowners and residents who participated in the survey.

EXECUTIVE SUMMARY

Background

Building electrification is the process of transforming building stock towards sole reliance on electrical end-use equipment by transitioning away from appliances that use natural gas, propane, and other non-electrical fuels for site energy consumption. Electrification is central to California's energy roadmap and decarbonization goals. Costs for electrification can be high. For example, to convert a home from a natural gas range to an electric range may require upgrades to electrical panels and receptacles. These types of barriers and cost multipliers are often more prevalent in disadvantaged communities (DAC) and hard-to-reach (HTR) housing since the building stock in these areas is often older, may have smaller capacity electrical infrastructure, and are more likely to have had fewer upgrades over time. To facilitate equitable electrification in DAC and HTR housing, programs must consider these types of barriers and strategize how to help offset associated higher costs. Financial support to offset these upfront costs and help ensure energy cost parity will be crucial to electrification of DAC and HTR households. Equitable electrification is the only appropriate outcome as California continues to develop resource planning and utility rates that prioritize electrical energy consumption, availability, and reliability.

Objectives

The study's objectives were to:

- Characterize existing DAC single family residence (SFR) building stock through publicly available census data relevant to electrification and electrification programs.
- Develop and validate a field survey by gathering information from a sample of 50 DAC and HTR housing sites.
- Characterize existing DAC SFR building stock and electrification readiness based on census and limited field survey analysis.
- Develop recommendations for future programs and interventions necessary for facilitating equitable electrification in DAC and HTR communities.

Methodology

The Project Team reviewed publicly available census and building data sources, including the United States Census five-year American Community Survey (ACS) and National Renewable Energy Laboratories' (NREL) United States Building Stock Characterization Study. The ACS data was used in a custom analysis that could not be accomplished by only using published summary tables of available on-line data tools. The census and building data analysis was augmented by 50 field surveys of DAC and HTR households' conditions.

Findings

Census analysis and field survey findings included:

- Average household income follows expected trends with increasing DAC populations. Average household incomes drop from $172,969 to $78,437 between non-DAC and fully-DAC regions.

- When rental and owned properties are broken out by building type, the rented-versus-owned ratio increases by a factor of three for single-family detached homes in DACs. Additionally, single family attached homes are twice as likely to be rentals rather than owned by the occupants.
- DAC buildings can be grouped and compared by construction dates (before or after 1960) to consider changes in electrical wiring for residential buildings (knob-and-tube versus later alternatives).
- Language barriers and lack of internet access can reduce awareness of, and access to electrification programs and valuable information about its benefits.
- DAC populations have higher percentages of non-English speakers and more instances of households without internet access.
- The field survey instrument tested at 50 homes was intended to evaluate the effectiveness and utility of the questions and survey approach. The results are a small sample and demonstrated that the survey tool's purpose, design, and shortcomings were instructive for any future statewide effort. The trial showed that the survey instrument was usable and there were no technical barriers to using it in the field.

Recommendations

This study revealed that a statewide field survey effort is necessary to make meaningful characterization of DAC and HTR housing conditions and their readiness for electrification. Prior to conducting a statewide field survey, improvements to the field data collection tool and methodology may be required. Recommended areas for methodology improvements include:

- Periodically review of the sample plan's underlying assumptions by comparing with actual collected survey data to check for standard deviations to facilitate real-time adjustments.
- Provide specific and targeted training to staff performing survey collections based on real-time assessments of survey information and photographs being uploaded into the system.
- Expand the pool of surveyors to include ESA and non-ESA entities, such as Community Based Organizations.

(U.S. Census Bureau a 2021)(NREL 2022)Abbreviations and Acronyms

Acronym	Meaning
ACEEE	American Council for an Energy-Efficient Economy
ACS	American Community Survey
AESC	Alternative Energy Systems Consulting
CalEPA	California Environmental Protection Agency
CPUC	California Public Utilities Commission
DAC	Disadvantaged Communities
EE	Energy Efficiency
ESA	Energy Savings Assistance
ET	Emerging Technology
HP	Heat Pump
HPWH	Heat Pump Water Heater
HTR	Hard-to-Reach
HVAC	Heating, Ventilation, and Air Conditioning
IOU	Investor-Owned Utility
NREL	National Renewable Energy Laboratory
PG&E	Pacific Gas & Electric
PUMA	Public Use Microdata Area
PV	Photovoltaic
SCE	Southern California Edison
SDG&E	San Diego Gas & Electric
SFR	Single Family Residence
SGIP	Self-Generation Incentive Program
SJV	San Joaquin Valley

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Introduction

On behalf of the CalNEXT program, The Ortiz Group, Alternative Energy Systems Consulting (AESC), and ASK Energy (collectively the "Project Team") are leading this California residential characteristics study addressing the lack of comprehensive information and the current data gaps on single family residential housing (SFR) structures in HTR communities and DAC areas.[1]

At the time of this study, there are few sources of information on buildings specifically in DAC regions and HTR communities, and no sources that include the details necessary to truly assess electrification readiness for these populations and their residences. This study was designed to fill those information gaps and will identify the specific electrification barriers, needs, costs, and home conditions in DAC areas and HTR communities. This information will inform future decarbonization and electrification program design considerations targeting this market segment.

This study provides an analysis of the single-family surveys conducted and secondary research (census data analysis and literature review) completed and applies those findings to the DAC/HTR market readiness and fit for electrification. The study's findings (this report) were distributed for peer review and feedback from CalNEXT partners, as well as from the TECH Clean California Ambassador Panel. .

Background

The California Public Utilities Commission (CPUC) defines DACs as "areas throughout California which most suffer from a combination of economic, health, and environmental burdens. These burdens include poverty, high unemployment, air and water pollution, presence of hazardous wastes as well as high incidence of asthma and heart disease." (CPUC a 2017). The DAC regions in California are specifically designated areas according to criteria established by the California Environmental Protection Agency (CalEPA) and the California Office of Environmental Health Hazard Assessment (OEHHA) as directed by Senate Bills (SBs) 535 and 1550, mapped in the CalEnviroScreen tool.[2] The most recent list of DAC regions went into effect in July 2022. These DAC designations are determined at the census tract level, consistent with United States Census geographical organization (U.S. Census Bureau a 2021). Based on the most recent census data, approximately 28 percent of California's population resides in DAC areas. These DAC regions were used to inform the methodology and results of this study.

The CPUC defines HTR residential customers as "those customers who do not have easy access to program information or generally do not participate in energy efficiency (EE) programs due to a language, income, housing type, geographic, or home ownership (split incentives) barrier" (CPUC b 2018), and further clarifies in Resolution G-3497 (CPUC c 2014, 63-64) that HTR customers are

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[1] This target market segment includes detached SFRs, attached SFRs in buildings with less fewer than five housing units, and manufactured homes (modular and mobile).

[2] https://oehha.ca.gov/calenviroscreen/sb535

investor-owned utility (IOU) customers who meet specific criteria by either satisfying the Geographic criteria and one additional criterion from the list below, or satisfying the Language, Income, and Housing Type criteria:

- Geographic: A customer with a geographic barrier (i.e., businesses or homes in areas other than the U.S. Office of Management and Budget Combined Statistical Areas of the San Francisco Bay Area, the Greater Los Angeles Area and the Greater Sacramento Area or the Office of Management and Budget metropolitan statistical areas of San Diego County) or is in a DAC.
- Language: A customer whose has a language barrier and whose primary language spoken is a language other than English.
- Income: Customers whose income is such that they qualify for the California Alternative Rates for Energy (CARE) or the Family Electric Rate Assistance (FERA) Program.
- Housing Type: Customers who rent and reside in a multifamily or mobile home.

Building electrification — a term often used interchangeably with building decarbonization — is the process of transforming building stock towards sole reliance on electrical end-use equipment by transitioning away from appliances that use natural gas, propane, and other non-electrical fuels for site energy consumption. Although there are considerations about the feasibility and prudence of full electrification that impact the pace and scale of electrification, such as upfront equipment costs and grid infrastructure limitations (Rapson and Bushnell 2022), electrification is central to California's energy roadmap and decarbonization goals. However, electrification requires substantial stakeholder investment and support, from entities ranging from policy makers to homeowners.

While new construction can accommodate full electrification in the design-build phase, upgrading existing buildings to full electrification presents additional challenges. A recent American Council for an Energy-Efficient Economy (ACEEE) research report on the decarbonization of affordable housing states that, "In contrast to all-electric new construction, electrification retrofits have unique challenges and considerations. Costs for electrification can be high. Many existing homes will require upgrades to electric service panels." (York, et al. 2022). For instance, converting a home from a natural gas range to an electric range may require upgrades to electrical panels and receptacles. To convert a home from a natural gas water heater to a heat pump water heater (HPWH) additional plumbing, condensate draining, water heater relocation, and electrical panel upgrades may all be necessary. These types of barriers and cost multipliers are often more prevalent in DAC and HTR housing since the building stock in these areas is often older, may have smaller capacity electrical infrastructure, and are more likely to have had fewer upgrades over time than their non-DAC/HTR counterparts. The report also identified energy cost uncertainty of electrified homes as another primary barrier likely to disproportionately impact DAC and HTR populations.

To facilitate equitable electrification in DAC and HTR housing, programs must consider these barriers and strategize how to help offset these higher costs. Financial support to offset these upfront costs and help ensure energy cost parity will be crucial to electrification of DAC and HTR households. This is necessary to avoid overburdening DAC and HTR residents who are already disproportionately impacted by climate change and the most negatively impacted by mandated and natural transformation towards electrification.

DAC and HTR households cannot be excluded from electrification efforts and left stranded with non-electric infrastructure due to neglect. Equitable electrification is the only appropriate outcome as California continues to develop resource planning and utility rates that prioritize electrical energy consumption, availability, and reliability.

Ongoing Efforts to Address Electrification Inequities

To address electrification inequities, a variety of programs and legislative efforts are making progress on transitioning SFRs towards electrification in California (Velez and Borgeson 2022) including:

- New residential building codes strongly encourage all-electric designs and high efficiency heat pumps (HP) and require electrification readiness even if gas appliances are specified.
- The Bay Area Regional Network (BayREN) programs provide a variety of incentives for high-impact electrification measures.
- The San Joaquin Valley (SJV) pilot programs are testing outreach and implementation methods for the electrification of existing homes in DACs.
- The ESA program provides a variety of measures to low-income households throughout California and has been integrating electrification measures and pilots in addition to more traditional EE goals. This includes an Energy Savings Assistance (ESA) pilot program that will provide funding for electrification of about 3,000 low-income DAC households in SCE territory.
- The Affordable Housing and Sustainable Communities grant program supports all-electric affordable housing developments.
- The TECH Clean California program funds incentives, pilot programs, and research projects specifically aimed at fostering adoption of HPs and HPWHs and has specific DAC and HTR goals.
- The Pacific Gas and Electric (PG&E) WatterSaver program provides incentives for HPWH replacements that include load shifting capabilities to mitigate the grid and customer energy cost impacts of water heating electrification.
- A forthcoming offering from the Self-Generation Incentive Program (SGIP) will also provide support for installations throughout the state.

Many of these programs have adders or are specifically targeted at low-income, DAC, or HTR households. The SJV pilot programs have specifically supported the electrification of households in the rural SJV area, overseen by SCE, Southern California Gas (SoCalGas), and PG&E. These novel programs are some of the first holistic, full electrification retrofit efforts, and provide many lessons learned for future programs. These pilots also include household outreach, home assessment, and resultant electrification and end-use measure installations. Program implementers assess each home with data collection surveys to determine what is needed for remediation (appliance replacement, electrical upgrades, etc.), then measures and funding are approved for the assigned implementers. In general, participant satisfaction is high, and these programs could serve as a model going forward.

Some of the key findings in the first evaluation of the SJV DAC pilot programs (Evergreen Economics 2022) include:

- Remediation needs varied substantially from home to home. There is no one-size-fits-all set of measures, and each home requires its own assessment and plan. Most measures (except for electrical service upgrade) could be done at the same time as equipment installation (e.g., a water heater stand during water heater installation).
- Electrical upgrades (service and panels) require a long timeline and need to be prioritized before the rest of the remediation. The accompanying IOU processes and permitting are challenging and need to be streamlined in future programs. Electrical upgrades at household and community levels result in timeline bottlenecks requiring management.
- The $5,000 remediation cap was found to be sufficient for most electric pilot participants except for mobile homes not located in trailer parks.
- Participants had a high awareness of ESA programs (over one-third participating in ESA separate from the SJV program).
- Mobile homes were uniquely challenging, including permitting from the California Department of Housing and Community Development (HCD). In SJV, mobile homes were generally privately owned on private land rather than in mobile home communities.
- Future programs resembling the SJV DAC pilot can yield data for a larger market characterization in future iterations. It will be prudent to develop common data collection protocols including storage format and fields. This could be done across various statewide programs to help facilitate further building stock datasets for future analyses like the goals of this study.
- Although the program provided bill protection to mitigate energy cost increases due to fuel switching, this was not well understood by participants, and many were concerned with energy cost increases. This was the most frequently identified barrier to enrollment and should be ameliorated through clear communication in similar programs.

In addition to the ongoing programs mentioned above, researchers have been studying the landscape of electrification in the state. In 2016, the California Energy Commission (CEC) published a report on the barriers and opportunities to serving low-income customers as mandated in Senate Bill 350 (CEC 2016). The report recommended an extensive list of actions for policy makers and program administrators to facilitate the EE market transformation of low-income residential and small business customers in DACs. As part of this study, the authors reviewed available building stock and demographic information to characterize low-income housing in California. They found that "structural barriers limiting access to clean energy for low-income customers" included low home-ownership rates, insufficient access to capital, building age, and remote locations (CEC 2016, 2-3). Older buildings were assumed to have more structural or design issues that make energy retrofits more costly or less feasible. Some particularly salient findings included:

- Low-income households have relatively high energy-cost burdens: 5.6 percent compared to 1.6 percent for moderate and high-income households.
- Low-income households are concentrated in urban areas: 93 percent urban, seven percent rural.
- SJV and Northern California have the highest poverty rates.
- Low-income SFR households are about twice as likely to be renters as moderate and high-income households with significant variability by geography.
- About 51 percent of low-income households are SFRs and six percent are mobile homes.

- There is little difference in the average building age between low-income and general population households.
- Low-income households are more likely to use natural gas or space heaters.
- Low-income residences are about 20 percent smaller than the general population (1,311 square feet compared to 1,643 square feet).
- About 20 percent of low-income households do not have a fluent English speaker over the age of 14 living in the residence, compared to 10 percent in the general population. Of those, 63 percent spoke only Spanish.
- Low-income households had about the same proportion of elderly occupants as the general population, but a 50 percent higher rate of a household member with a disability.

Some of these datapoints are further examined in this study referencing more current data sources, including the 2020 *Housing Equity and Building Decarbonization in California* which characterized low-income households and primary program opportunities using census data as seen in Figure 1 and Figure 2 (Rayef 2020).

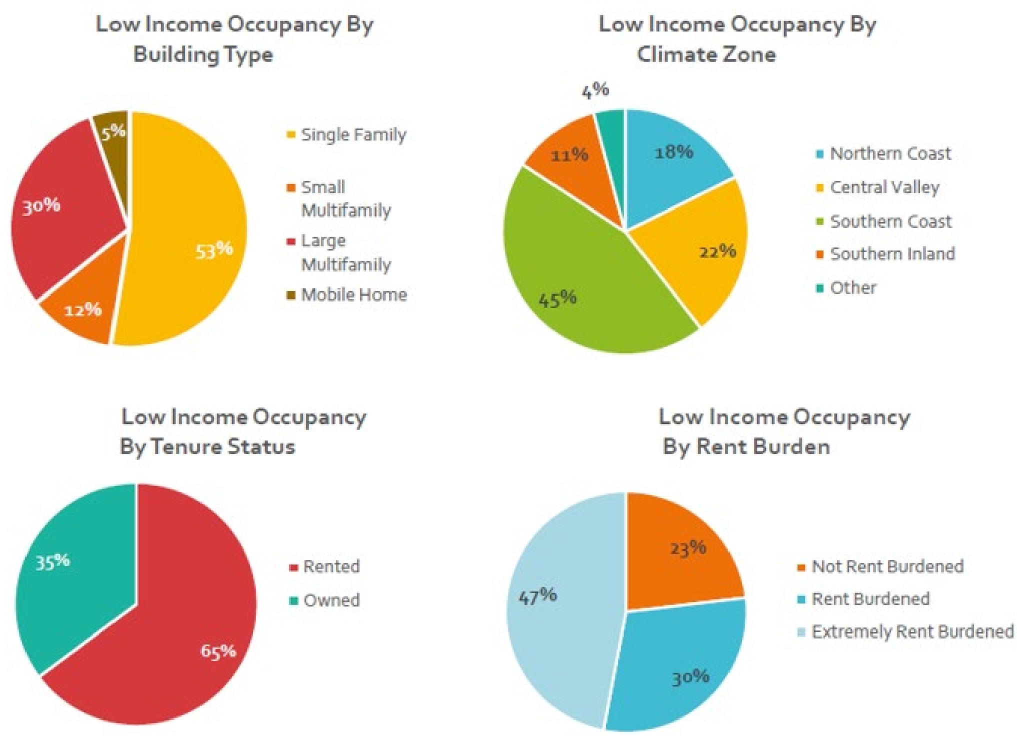


Figure 1: Low-income building type, location, tenure, and rent burden frequency.

Source: (Rayef 2020).

Building electrification efforts in California can **center low income residents** by directly addressing their material conditions and housing needs, with major potential impacts.

OPPORTUNITY	IMPACT
Extremely low income, extremely rent burdened Californians	2.5 Million People
Low income multifamily renters in Southern California	2.3 Million People
Low income single family homeowners in Southern California	1.9 Million People
Low income households spending >50% of their energy expenditures on heating fuel	1.7 Million People
Households spending >20% of income on energy expenses	1 Million People
Low income single family homeowners in the Central Valley	0.9 Million People

Figure 2: Recommended low-income electrification targets.

Source: (Rayef 2020).

Another valuable resource the Project Team reviewed was Redwood Energy's *A Pocket Guide to All-Electric Retrofits of Single-Family Homes* which provides a comprehensive list of available electric appliances, a how-to guide on these individual gas-to-electric measures, and estimated costs and benefits of each (Redwood Energy 2022). This guide contends that most homes up to 2,000 square feet can electrify with typical, existing 100-amp panels by using careful design and measure selection, which would help avoid panel upgrades that have proven to be one of the most challenging barriers to electrification of existing homes.

Objectives

The goals of this study are as follows:

- **Characterize** existing DAC SFR building stock through publicly available census data relevant to electrification and electrification programs.
- **Develop and validate field survey for gathering information from a sample** of 50 DAC and HTR housing sites.
- **Characterize existing DAC SFR building stock and electrification readiness** based on census and limited field survey analysis.
- **Develop recommendations** for future programs and interventions necessary for facilitating equitable electrification in DAC and HTR communities.

This data is foundational to sizing the total available market for emerging electrification technologies and developing effective, properly budgeted program pathways to serve and transform these communities.

Methodology & Approach

For this study, the Project Team conducted both primary and secondary research. The secondary research consisted of reviewing existing literature regarding DACs and electrification, and conducting analysis of publicly available census data. This included the most recent United States Census data and housing stock information from the National Renewable Energy Laboratory (NREL), which the Project Team used to characterize housing in DAC and HTR areas to the extent possible.

The primary research involved conducting a small sample of field surveys of single family residences (SFR) throughout DAC regions and HTR communities in the greater Bay Area of Northern California. The survey gathered datapoints specific to electrification readiness in the participating homes. Each of the homes surveyed were occupied by ESA-eligible low-income families. Fifty homes were surveyed to test the methodology and survey strategy.

Census Data Analysis

The Project Team reviewed publicly available census and building data sources for any datasets that could be analyzed for DAC region insights. The only datasets that could be obtained and isolated for DAC regions were the United States Census 2021 five-year American Community Survey (ACS) and the NREL United States Building Stock Characterization Study, which is a synthesis of other primary datasets (U.S. Census Bureau a 2021), (NREL 2022). Other resources, such as the United States Census American Housing Survey and California's Residential Energy Consumption Survey presumably contain relevant information but could not be obtained on a basis that allowed for isolation of DAC data such as single-site responses or census tracts. The ACS data was used in a custom analysis that could not be accomplished using only published summary tables or available online data tools.

The relevant subset of datapoints within the ACS for California were identified as listed in Table 1.

Table 1: Analyzed ACS Datapoints

Selected Datapoints
Access to Internet
Age of Householder
Building Type
Electricity Cost
Gas Cost
Gross Rent as a Percentage of Household Income
Mortgage as Percentage of Household Income

Selected Datapoints
Ability to Speak English
Food Stamps
House Heating Fuel
Household Income
Number of People in Household
In Possession of a Smartphone
Year Structure was Built
Tenure

Source: (U.S. Census Bureau a 2021)

The relevant subset of datapoints within the NREL building stock study for California were identified as listed in Table 2.

Table 2: Analyzed NREL Building Stock Datapoints

Selected Datapoints
Building Type
Range Fuel Type
Dryer Fuel Type
Washer
Exterior Wall Material
Roof Material
Attic Geometry
Foundation Type
Garage Size
Square Footage

Selected Datapoints
Unconditioned Floor Area
Infiltration
Insulation: Ceiling, Floor, Walls
Electric HVAC Systems

Source: (NREL 2022)

Both these sources had data available at the public use microdata area (PUMA) geographical level. PUMAs are defined as "non-overlapping, statistical geographical areas that partition each state or equivalent entity into geographic areas containing no fewer than 100,000 people each" (U.S. Census Bureau b 2022). PUMAs are aggregations of smaller census areas such as census tracts and blocks and were the smallest geographical areas available[3]. However, because the study required data at the smaller census tract or block level to have a direct correlation to the California designated DAC regions, the Project Team created a mapping of the DAC designated census tracts to the PUMAs available to complete a more thorough data analysis.

The Project Team consolidated the ACS and NREL datapoints listed in Table 1 and Table 2 for each PUMA and correlated to each PUMA's respective DAC percentage. These datapoints were assessed for PUMAs with 100 percent DAC populations and 70 percent DAC populations as shown in the Findings section. PUMAs with zero DAC populations were also isolated for comparison to DAC PUMAs in case census data differences between DAC and non-DAC populations were conclusive. Each of these represents geographical areas with differing levels of DAC populations. A PUMA with zero percent DAC population has no DAC-designated areas or population within it. A PUMA with 100 percent DAC population is entirely comprised of DAC-designated areas and populations.

The total populations captured by each of these three assessed groups are shown in Table 3. As the table demonstrates, it was prudent to look at both the 100 percent DAC PUMAs and the grouping with a lower DAC percentage cut-off to capture a majority of DAC populations in California (51 percent captured in the grouping of PUMAs with greater than 70 percent DAC population). This intermediate grouping will unavoidably contain some non-DAC household results; however, 86 percent of the population in that group are in DAC areas.

[3] PUMA is the smallest geography available using the PUMS file to create the customized analysis needed in this study

Table 3: Three Consolidated Groupings of Census Data Used in Analysis

	PUMAs with 0% DAC Population	PUMAs with More than 70% DAC Population	PUMAs with 100% DAC Population
Percent of California Total Population	28%	17%	3%
Percent of California DAC Population	0%	51%	9%
Average DAC Percentage of Dataset	0%	86%	100%
Total ACS Households	33,745	13,515	1,974
Total NREL Households	13,333	5,478	791

Source: Project Team

Field Survey Sampling Plan

The Project Team developed an initial field survey sampling plan based on the distribution of population across regions identified in the SB 535 Disadvantaged Communities Map (CA OEHHA 2022), statistical criteria assumptions, and target confidence levels. First, the total survey sample size was determined for a 95 percent confidence level, assumed standard deviation of 0.5, and margin of error of three percent. These assumed parameters are relatively conservative (i.e., a standard deviation of 0.5 is larger than expected). These suggest a target sample size of 1,068 homes. This sample size was distributed across the percentage of low-income populations in each building subtype and percentage of DAC population in each California county according to SB 535 designations. This preliminary sample size distribution is shown in Table 4.

Table 4: Field Survey Target Sample Size

County	All Building Types	Detached SFR	Attached SFR	Manufactured SFR
Alameda	18	14	3	1
Butte	1	1	0	0
Contra Costa	21	16	4	2
Fresno	60	45	10	4
Glenn	1	1	0	0
Imperial	13	10	2	1
Kern	45	34	8	3
Kings	7	5	1	1
Los Angeles	481	364	82	34
Madera	11	8	2	1
Merced	22	17	4	2
Monterey	2	2	0	0
Orange	54	41	9	4
Riverside	54	41	9	4
Sacramento	26	20	4	2
San Bernardino	89	67	15	6
San Diego	25	19	4	2
San Francisco	7	5	1	1
San Joaquin	39	30	7	3
San Mateo	5	4	1	0
Santa Barbara	1	1	0	0

County	All Building Types	Detached SFR	Attached SFR	Manufactured SFR
Santa Clara	10	8	2	1
Santa Cruz	1	1	0	0
Solano	5	4	1	0
Sonoma	1	1	0	0
Stanislaus	31	23	5	2
Sutter	2	2	0	0
Tulare	28	21	5	2
Ventura	5	4	1	0
Yolo	2	2	0	0
Yuba	1	1	0	0
Total	**1,068**	**812**	**180**	**76**

Source: Project Team

This sampling plan was developed for use in a statewide field survey effort that may be conducted at a future date where a material sample size of over 1,000 surveys would be collected. The larger sample survey to be conducted in the future would adhere to the following methodology: after approximately half the sample is collected, the underlying assumptions (e.g., standard deviation) will be reviewed in comparison to actual data collected. At that point, the sampling plan would be adjusted to yield the best possible statistical criteria if necessary. Note that the sampling plan will also be limited by the jurisdiction of the participating ESA contractors and the participating households. For instance, some remote locations with small populations may be inaccessible to the ESA program and the staff conducting the field surveys. Similarly, for the 50-survey sample that was collected as part of this project, the small populations selected for the survey were limited by the selection of a single ESA contractor serving parts of the Greater Bay Area, including the following counties:

- Alameda
- Contra Costa
- San Joaquin
- Solano
- Yolo

Field Survey Approach

The Project Team developed a field survey instrument designed to expeditiously collect various building and demographic information at each participating home. The questions were selected to provide key data on electrification readiness at each of these homes. The survey covers topics including, but not limited to, the following:

- Household demographics, such as renter/owner status and primary language spoken.
- Electrical panel and incoming utility service capacity
- Space heating systems
- Space cooling systems
- Water heating systems
- Other appliances (range, pool heater, clothes dryer)
- Solar photovoltaic (PV) systems
- Photo documentation of each of the covered topics

The full survey is shown in Appendix B: Field Survey. This data will be supplemented by publicly available data such as building age, square footage, and other types of data to support or supplement survey results. (For example, year built, foundation type, total interior livable area, utility, electric and natural gas service information [e.g., separate meter], among others).

Participating households will be given a $50 gift card in appreciation of their time.

The survey was administered by ESA contractor staff during their planned outreach field work with initial training by the CalNEXT Project Team. Survey participants were invited to participate in the survey during the visit when they were enrolled in ESA. Since the ESA contractor staff were already visiting SFR households throughout their own assigned five county territory. The survey tool was available on-line and accessible by tablet/mobile device. The ESA contractor staff completed the survey with the customer present.

Leveraging this existing network of field operations (ESA contractors) for data collection holds promise for achieving future market-wide surveys. However, based on lessons learned, modifications to the process and survey scope would be required for a field survey effort at scale.

ESA program eligibility is specifically limited to households enrolled in any number of public assistance programs (e.g., Medicaid, CalFresh food stamps, etc.) or that have household income below 250 percent of federal poverty guidelines (CPUC c 2021). Therefore, the field survey data collection methodology was limited to these low-income or qualifying households and is clearly indicated in this Final Report. The survey results were representative of low-income homes in DAC regions and HTR communities rather than in DAC regions alone.

The Project Team has finalized the first iteration of the field survey and the 50-home survey trial with the participating ESA contractor, CHOC. The Project Team found that the field survey methodology would need refinement for any future use or adoption. Recommendations will be refined after feedback from stakeholders is gathered on the proposed methodology and list of questions. Obtaining stakeholder feedback from ESA contractors, CalNEXT program partners and from members of the TECH Clean California Low-Income Ambassador Panel referenced in the approved project plan was completed in late May.

Findings

Census Data Findings

Data was collected and analyzed from both the 2021 ACS and the 2022 NREL Building Characterization Study. After reviewing all the variables available from these two studies, a subset of variables was chosen for further analysis. The analysis provided both specified value outputs and exposed trends between the chosen PUMA groups. The selected PUMA groups are based on the percentage of DAC population within the area (zero percent, greater than 70 percent, and 100 percent DAC).

Average household income follows expected trends with increasing DAC population as shown in Figure 3. Average household incomes drop from $172,969 to $78,437 between non-DAC and fully-DAC regions. Interestingly, rent as a percentage of income increases with DAC population percentages but mortgages as a percentage of income appear independent of DAC-designation.

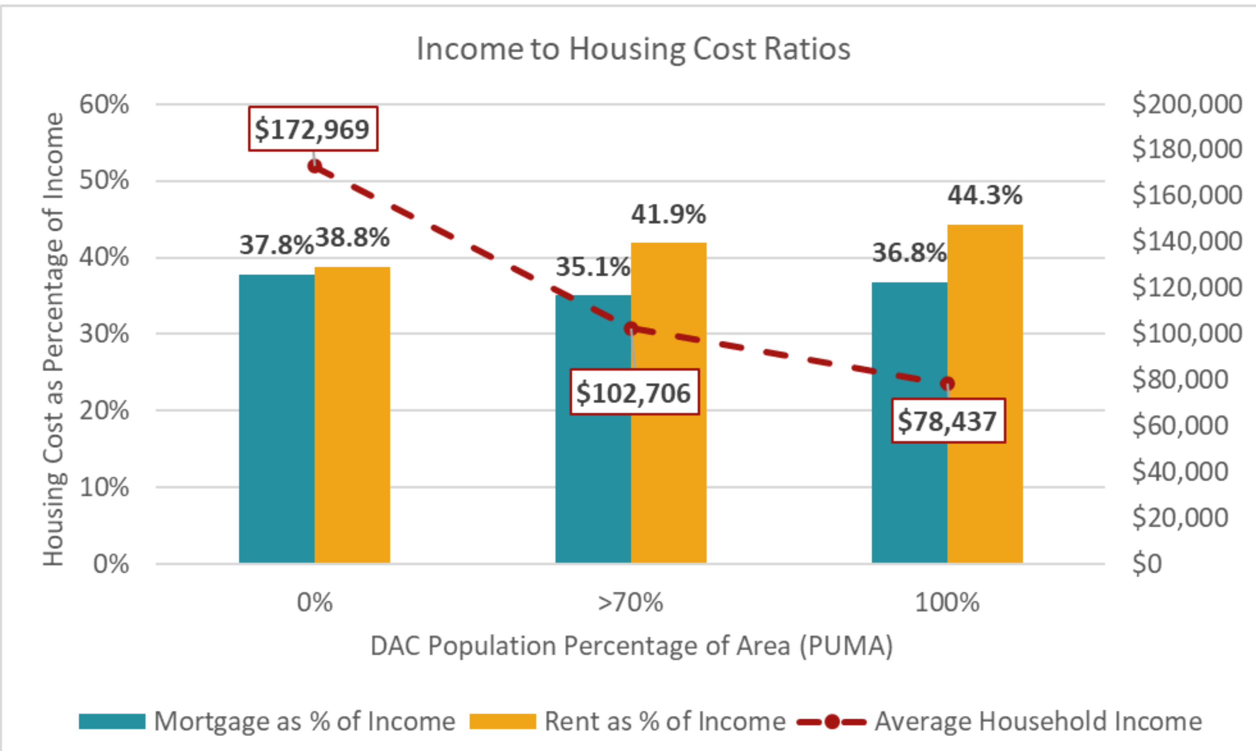


Figure 3: Income and housing costs by DAC PUMA group.

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

Figure 4 shows the building type distribution across the DAC group. The data suggest a higher market share of single family attached homes in higher DAC areas. This data includes both rental and owned properties.

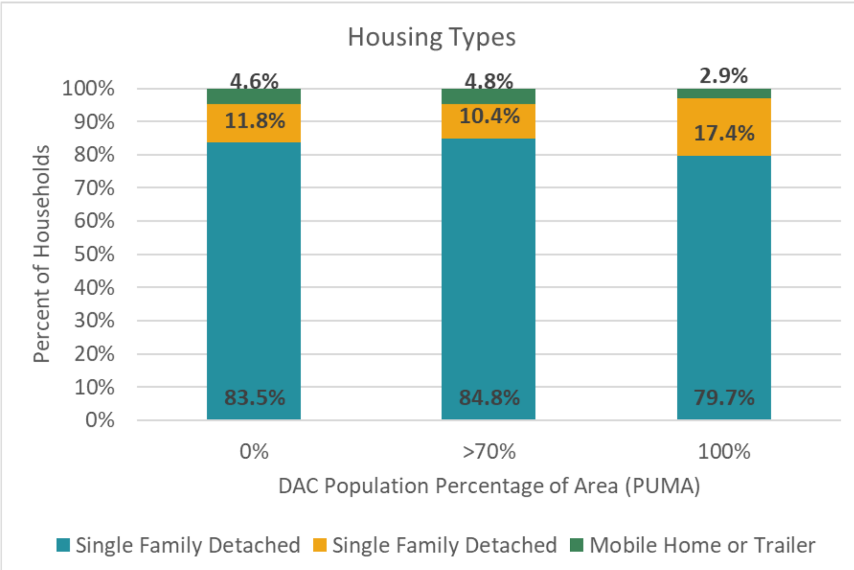


Figure 4: Housing types per DAC PUMA group.

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

Figure 5 depicts changing trends in home ownership between the DAC PUMA groups. The percentage of rented households increases dramatically with DAC status.

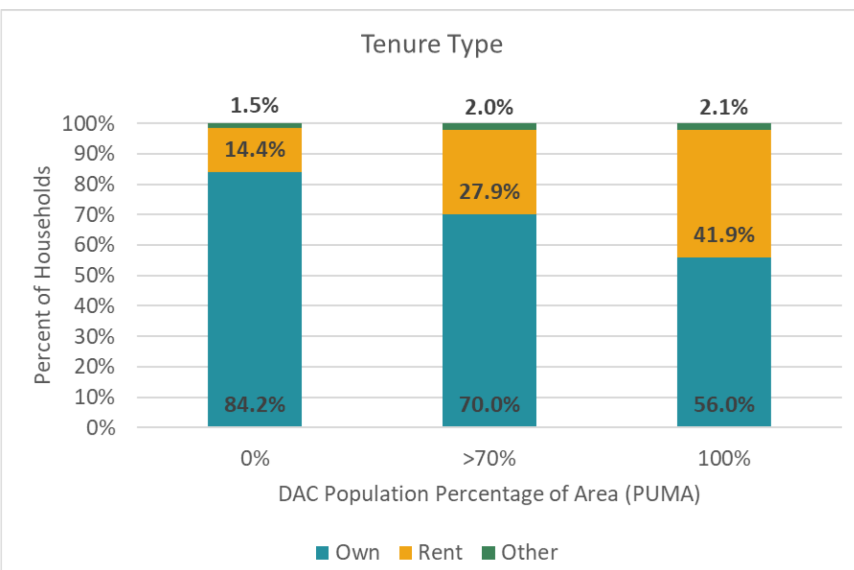
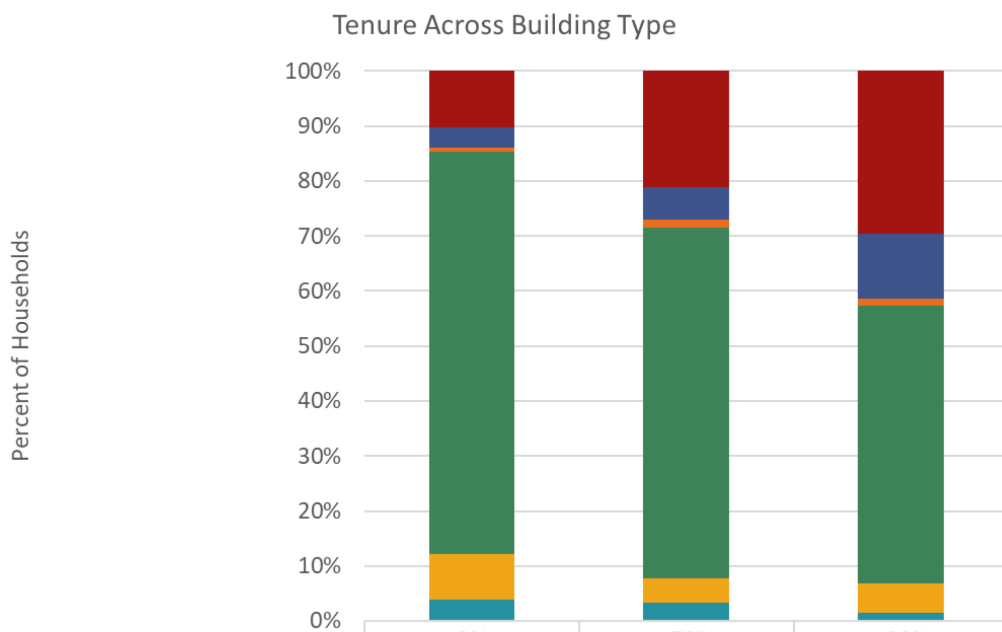


Figure 5: Tenure per DAC PUMA group.

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

If rented and owned properties are broken out by building type, the rented-versus-owned ratio increases by a factor of three for single-family detached homes between zero percent and 100 percent DAC PUMAs (as seen in Figure 6). Additionally, single family attached homes are twice as likely to be rentals rather than owned by the occupants for 100 percent DAC PUMA groups.



	0%	>70%	100%
Rented Single Family Detached	10.3%	21.1%	29.6%
Rented Single Family Attached	3.6%	5.9%	11.7%
Rented Mobile Home or Trailer	0.7%	1.5%	1.4%
Owned Single Family Detached	73.2%	63.7%	50.3%
Owned Single Family Attached	8.2%	4.5%	5.5%
Owned Mobile Home or Trailer	3.9%	3.3%	1.4%

DAC Population Percentage of Area (PUMA)

Figure 6: Distribution of households by tenure and building type per DAC PUMA group.

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

Figure 7 charts space heating fuel sources across DAC groups. Category "other" includes renewables, fuel oils such as kerosene, wood, and coal.

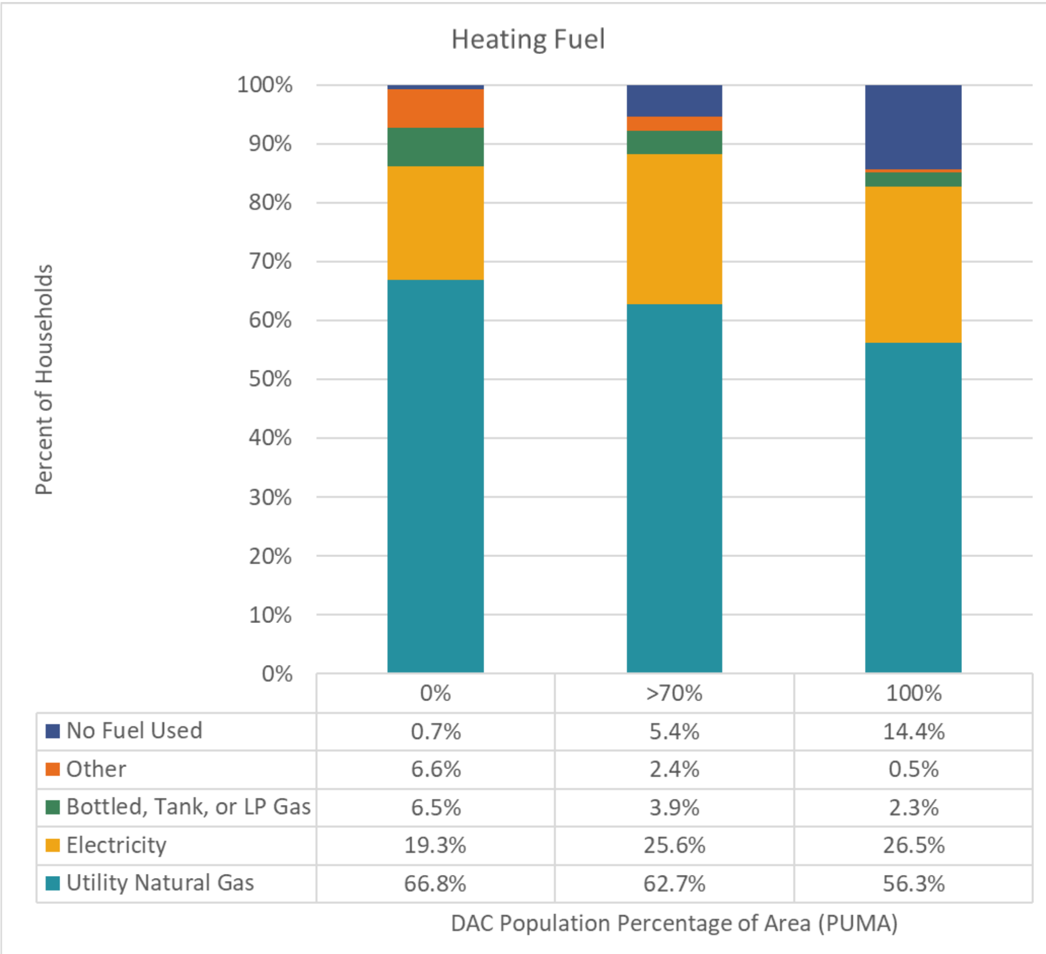


Figure 7: Heating fuel per DAC PUMA group.

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

"No fuel," a variable which increases with DAC population, refers to homes without working home heating systems which suggests DAC homes have far higher rates of homes without heating. It should be noted that some of these homes may not have space heating because their climate does not necessitate it. There is no way to conclude exactly why a house may have “no heating fuel used” from the ACS data.

Figure 8 shows the age of homes as distributed in the DAC PUMA groups. Zero percent DAC areas have newer homes while fully DAC areas are dramatically skewed towards older vintages.

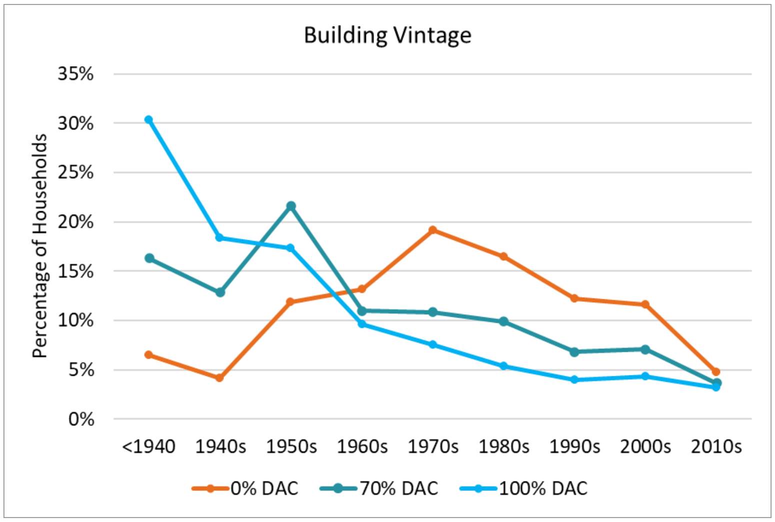


Figure 8: Year home was built per DAC PUMA group.

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

DAC groups can be compared based on construction before and after 1960 to consider changes in electrical wiring for residential buildings (knob-and-tube versus later alternatives). Figure 9 shows a roughly even split between homes built before and after 1960 for areas with over 70 percent DAC populations increasing to two-thirds of households in completely DAC areas built before 1960.

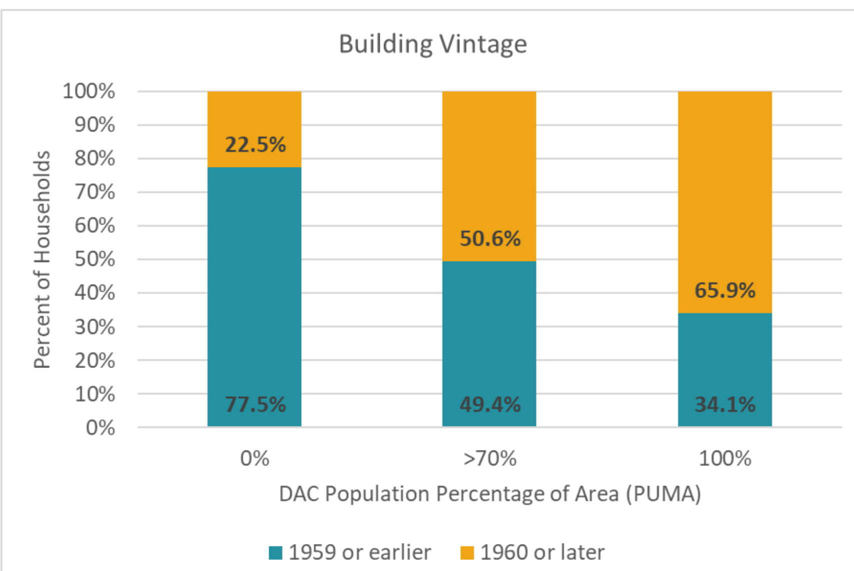


Figure 9: Homes built before and after 1960 per DAC PUMA group.

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

Language barriers and lack of internet access can reduce awareness of, and access to, electrification programs and valuable information about its benefits. DAC populations have larger percentages of non-English speakers and more instances of households without internet access. DAC status correlates more highly with the likelihood residents do not speak English rather than not having internet access, as can be seen by comparing Figure 10 and Figure 11.

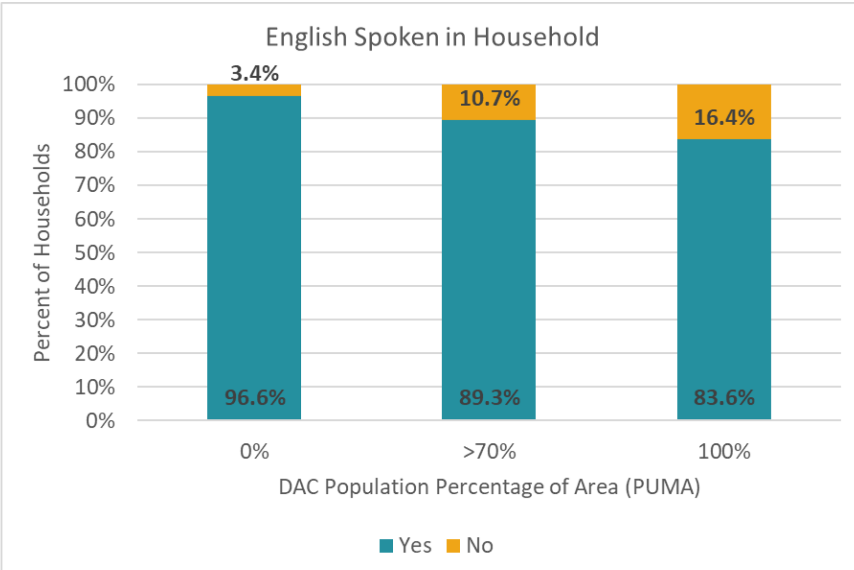


Figure 10: Homes with at least one resident (14 years old or older) who speaks English well; analyzed per DAC PUMA group.

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

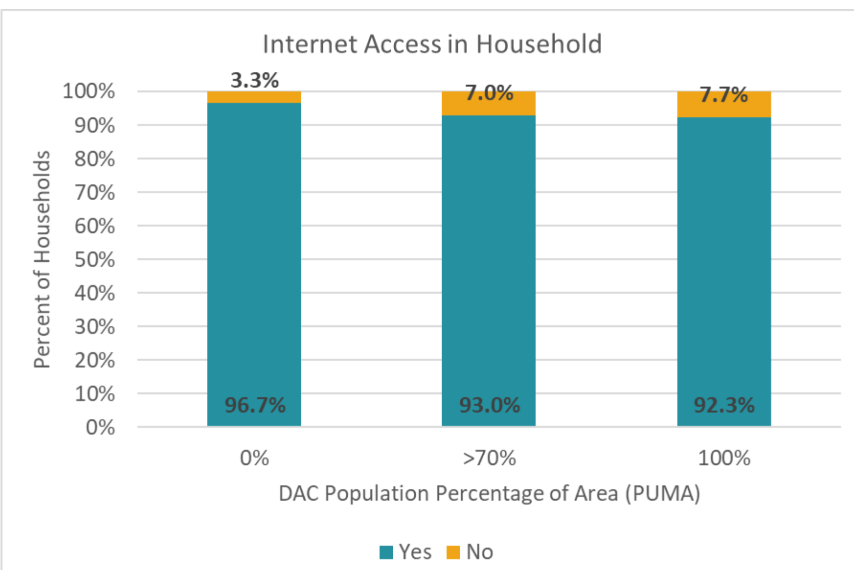


Figure 11: Internet access per DAC PUMA group.

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

Moreover, by comparing internet access in homes that speak English to those that do not have an English speaker living in the home, language is associated with whether a home has internet. When comparing Figure 11 to Figure 12, internet access remains consistent with the general statistics in English speaking homes. However, when comparing either Figure 11 or Figure 12 to Figure 13, the number of homes without internet access doubles for non-English speaking homes.

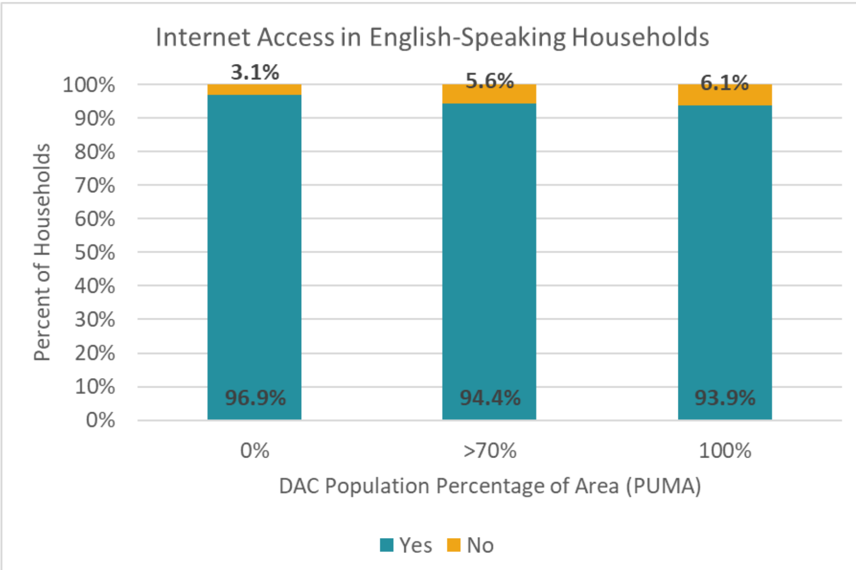


Figure 12: Internet access in homes with at least one English speaking resident; analyzed per DAC PUMA group.

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

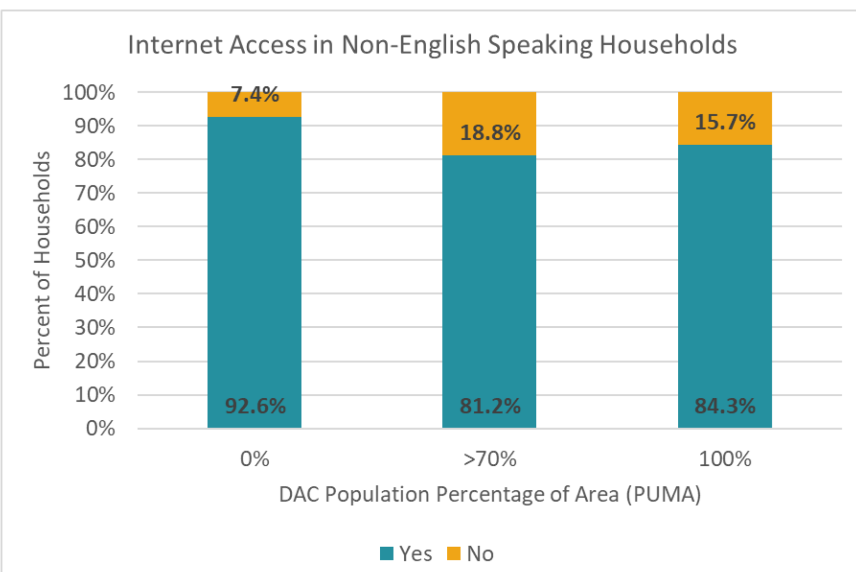


Figure 13: Internet access in homes without an English-speaking resident; analyzed per DAC PUMA group.

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

Another factor with strong influences on internet access is age. Figure 14 clearly outlines how the lack of internet access increases with each decade of residents' age group, and indicates how DAC status paired with increasing age significantly impacts a household's likelihood to have internet access[4].

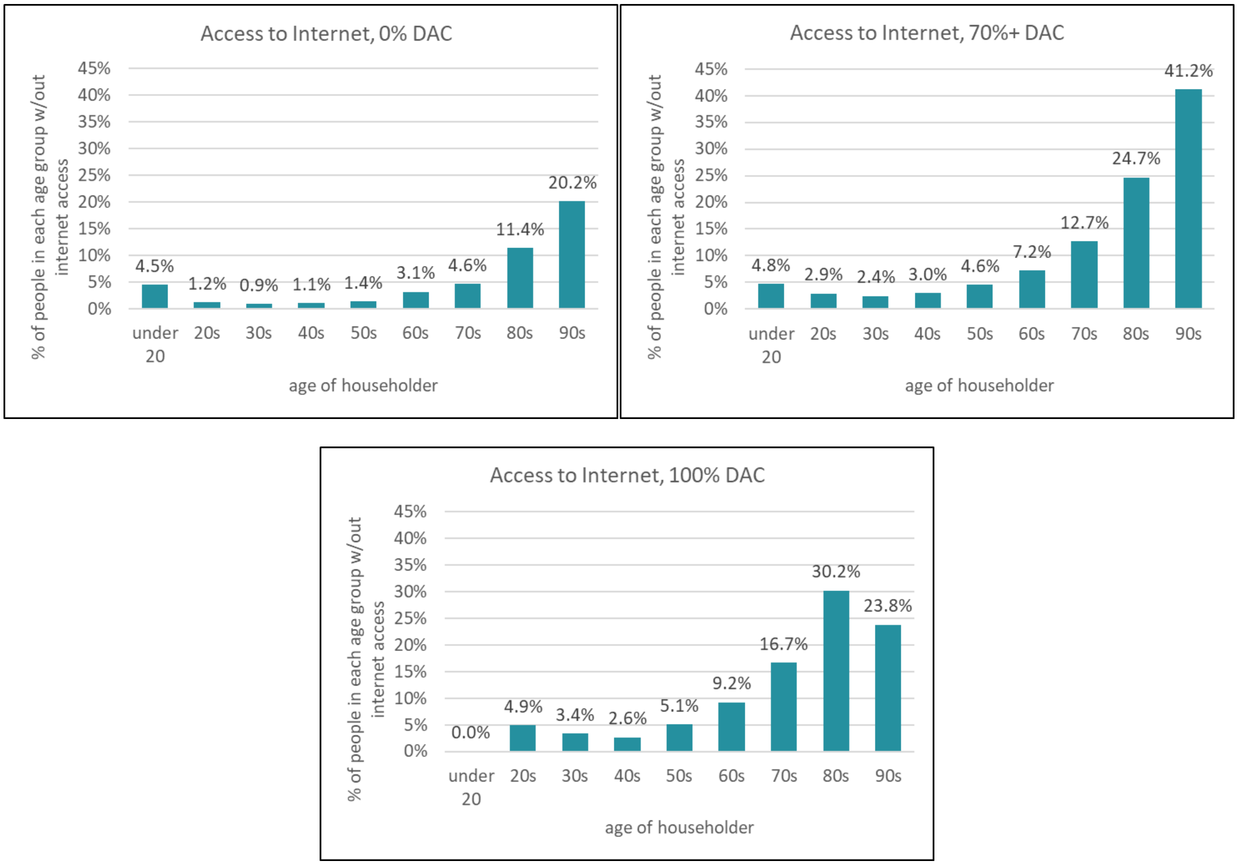
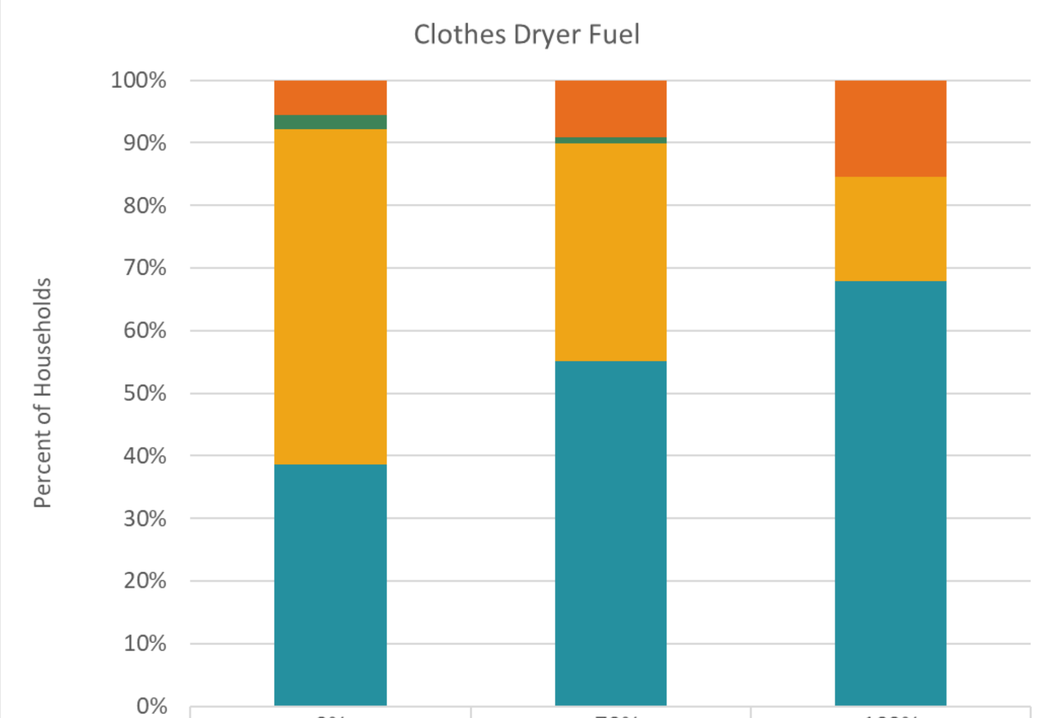


Figure 14: Lack of internet access by age group and per DAC PUMA group.

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

[4] The one inconsistency is with the 90-year-old age bracket of the 100 percent DAC PUMA group chart; while there is an even distribution of ages independent of DAC status as depicted in Figure 23 (Appendix B: Field Survey), the data pool for the 100 percent DAC PUMA group is quite small. Included in this group are only 21 homeowners who are 90 years of age and older. This is a clear example of the value of the over 70 percent DAC PUMA group, which provides both a larger geographical scope and a larger and more diversified data pool that includes a significant portion of DACs across California.

Figure 15 reviews dryer energy sources. Homes in the zero percent DAC PUMA group have a significantly higher percentage of electric source dryers, while the majority shifts to natural gas with increasing DAC status. Interestingly, where dryer energy sources vary significantly, cook ranges (Figure 24) and energy efficient washing machines (Figure 25) are consistent regardless of DAC status.



	0%	>70%	100%
None	5.6%	9.1%	15.4%
Propane	2.2%	0.9%	0.0%
Electric	53.6%	34.9%	16.7%
Natural Gas	38.6%	55.0%	67.9%

DAC Population Percentage of Area (PUMA)

Figure 15: Dryer energy source per DAC PUMA group.

Source: 2022 NREL and 2022 OEHHA data, analyzed by Project Team

Figure 16 looks at ducting in households with electric-only HVAC systems. For HVAC systems that have already been electrified, the trend for ducted heating decreases with the increase in DAC status. This suggests a higher rate of use of wall, window, and portable electric heaters in DAC areas.

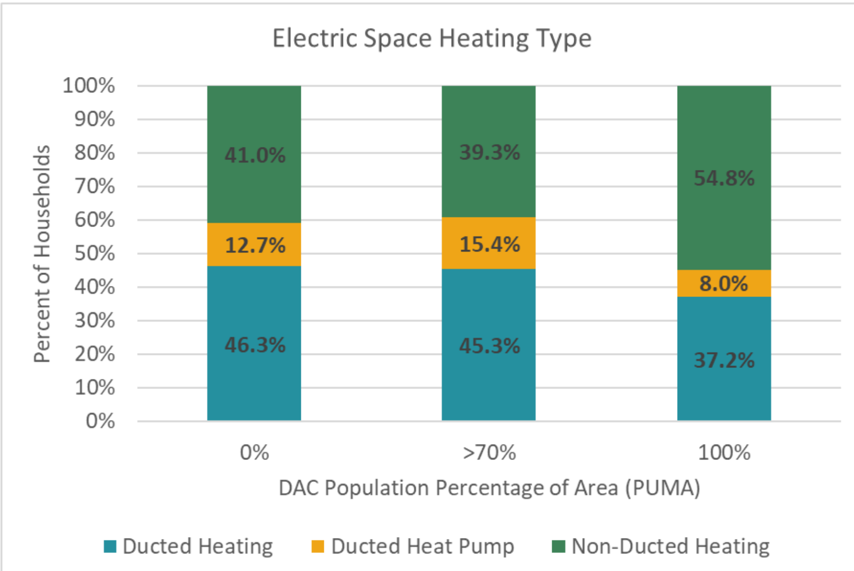


Figure 16: Ducting for electric HVAC systems per DAC PUMA group.

Source: 2022 NREL and 2022 OEHHA data, analyzed by Project Team

Stakeholder Feedback

During project planning for this study the Project Team identified three key stakeholder groups to provide feedback and guidance: **ESA contractors**, **CalNEXT Partners**, and members of the **TECH Clean California Low-Income Ambassador Panel**. Since the field survey of this project was limited, the Project Team engaged one ESA contractor, CHOC, with an assigned territory of five counties. Their feedback was solicited to inform the content of the field survey tool, and how the information was to be collected and used for this study.

ESA Contractor:

In early December 2022, The Ortiz-Group met with CHOC to review the list of EE measures and household systems that energy specialists (individuals who perform intake services for the low-income weatherization program) routinely assess. These measures and end-use systems were compared to the list of items included in the draft field survey tool. In the field, the assessment of measures, end-uses, customer information, that are normally collected and assessed as part of ESA enrollment were performed satisfactorily. Data points that are not commonly part of the ESA assessment were identified as areas requiring additional training (e.g., electrical panel size, utility service size, etc.).

CHOC advised that their energy specialists conduct all their assessments using a mobile tablet device and recommended that the study field survey followed a similar protocol. As a result, the Ortiz Group developed a web-based survey tool using the ZOHO platform with built-in features to allow energy specialists to take photographs and add them to the customer record in real time.[5] CHOC recommended that the energy specialists be given the option to enter and upload survey results later, from either a laptop or other device, to accommodate for low or absent cellular signals. The tool was adapted to accommodate the request.

In early January 2023, the Ortiz Group presented the initial version of the study survey tool to CHOC. The contractor provided feedback as to the sequence of questions and offered insights on why certain measures may not be accessible during a site visit (electrical panels may be blocked from view, conditions around the house may prevent the ability to assess or photograph due to hoarding or other issues such as inclement weather, dogs, etc.). The Ortiz Group adjusted the survey accordingly and removed "required" conditions from many fields. The tool was tested internally by the Ortiz Group at five sites.

The Ortiz Group conducted two survey run-through demonstrations with the CHOC team on January 19, 2023, and January 26, 2023. The field survey data collection commenced on January 30, 2023. The Ortiz Group was able to monitor the quality of submissions in real time through the ZOHO platform, making it possible to send the CHOC team feedback or recommendations in a timely fashion. Any recommendations for improvement or insights gained from the data collection process are included here and would be refined for any future statewide survey methodology effort.

Upon completion of the 50 surveys, CHOC provided some anecdotal feedback about the survey and process.

1. Field survey took longer than anticipated — many reported the housing survey took longer than the amount of time it took to perform the intake required for ESA participation.
2. The number of photographs taken in and outside the home caused some customers to question participation.
3. Since the surveys were conducted at the time of ESA enrollment, returning to the home (e.g., to survey or take photographs of electrical service panels) when weather permitted was not an option available to them.
4. Many of the questions on the survey were deemed unnecessary and the survey itself should be shortened.

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[5] https://forms.zohopublic.com.au/ortizgroup/form/HousingCharacteristicSurvey/formperma/gVVzmrkoDkDSmXEKzr_D6K_peLvpvjMSu7njCYGrcvQ

CalNEXT Partners:

A copy of the Draft Final Report was provided to all CalNEXT partners for review and feedback. The study received written feedback from VEIC and many of their comments have been incorporated in this report.

TECH Clean California Ambassador Panel:

On May 22, 2023, a webinar presentation of this study's findings and this report was held for TECH Clean California Ambassador Panel members. In addition to members of the Project Team (CalNEXT, Ortiz Group, AESC, ASK, and CHOC), the following organizations: [6]:

1. Community Resource Project
2. Climate Resilient Communities
3. Access Plus Capital
4. IDEATE California
5. Office of Governor, Central California Regional Director of External Affairs
6. El Concilio of San Mateo County

The presentation and Q&A were conducted primarily by Anna Solorio of the Ortiz Group. Initial questions about the study's overarching purpose were raised and answered in terms of the study taking stock of electrification readiness in low-income communities: how able are these households to move away from natural gas and propane and into electricity; what is the probability of DAC and HTR communities to electrify. The study was deemed a satisfactory start but more data was needed – both from census and from households.

Panel members asked whether additional topics could be included in a future statewide survey such as time of use (TOU)– specifically understanding from customers whether they know how to track their time of use and do they understand how TOU rates work?

The Project Team was asked whether the ESA contractor handed the questions over to the customer to answer the survey or whether the ESA contractor completed the survey, and explained that the ESA contractor completed the survey each time. The conversation turned to whether a customer directed online survey could be used and developed – and, provided the survey were in multiple languages, how it might serve as good supplementary approach for future data collection. The Project Team also explained that by having the ESA contractor complete the survey at the time of ESA enrollment, the acceptance rate among customers was high; approximately 90 percent of customers asked to participate did so. The Ambassador response was that the best way to do field surveys is to have a facilitator available to help customers fully understand the questions being asked.

The Ambassadors commented that the field survey seemed to have captured baseline data. But in talking about electrification, the next question is always: "what are folks willing to do or

[6] Technical difficulties prevented at least 4 others from attending the session and a duplicate session was held for them separately.

change?" To get someone to participate, education and information are key. Ambassadors asked: Did the survey capture this issue? The answer was that the survey did not. However, the Project Team acknowledged that these types of open-ended questions should be incorporated in the future. Questions such as, “Would you give up your gas stove? How much would you be willing to pay for it? Would you do it, if it was at no cost?” The same Ambassador followed up, asking when a statewide version of the study would be completed and whether the final data set for that survey was known at this time. The response was that there would need to be an application/proposal prepared for CalNEXT consideration (submitting the project for consideration at a future date) and that the questions for the survey would be refined based on this study for use in the next project.

Another Ambassador commented that while discussion touched on the subject of baseline characterizations and TOU, had the Project Team thought about capturing how much electricity customers participating in the survey were using? The Project Team explained that participant utility usage was not part of the study scope. However, the recommendation was made to consider participant usage as part of any future study of this type. Conversation led to electricity costs and whether customers could benefit from information around the costs of electrification (assuming there would be some increase in customer utility costs) and customer understanding of TOU rates (most residents come home from work during peak hours – how likely are they to see any savings?).

Discussion continued on the need to identify an equity basis other than DAC. They explained that not all who live in DACs are low-income/HTR and that some DACS don’t have any HTR populations. A new definition of equity or an expansion of what DAC means is needed. It would be helpful to expand or revisit SB300.

Regarding options for appliances (fuel change from natural gas/propane to electric), depending on how much information the Project Team needs receive, the survey must incorporate cultural needs and differences. For example, when community-based organizations (CBOs offer electric appliance upgrade measures, customers often decline due to strong cultural/identity ties associated with food preparation.

Ambassadors confirmed that viewpoint and stressed that ethnic heritage influences perceptions of “quality of cooking.” This is a challenge for the study and the state to understand and address. It may be necessary to show customers, who may or may not be reluctant to employ electric induction cooking, that it actually costs less. We need data to support the assertion that an electric induction cooking appliance can be more affordable than operating its natural gas/propane equivalent.

Customer engagement and information must go beyond costs and savings. Other barriers need to be addressed, such as being able to cook during power outages (stressing this was a significant barrier in the San Joaquin Valley). If people are made aware of the impact electrification can have in their homes, they might be more willing to make the change and to invest in the change. They must receive information and understand it in order to make the right decision (viz. financial issues, health and safety, the environment, etc.)

Ambassadors commented on the many interdependent efforts on electrification aimed at DAC and HTR in play at present, and that there doesn't seem to be any coordination between parties. Alignment would be beneficial and also reduce individual project costs. Making sure implementers of these projects are aware of statewide program offerings is important. Furthermore, Ambassadors stressed the importance of supporting contractors and implementers working with these populations to build strong relationships among themselves, the customers, and the IOUS.

As an action item, one Ambassador offered to review any survey tools developed for future use and that his organization would be willing to provide examples of the data it collects when it enrolls customers in low-income programs.

When asked if the data and findings included in the presentation would help them with future program designs (of low-income programs they work on or implement), Ambassadors answered yes. The data included and breakdowns presented were useful and could help shape future programs and policies.

Survey Trial Findings

The field survey instrument was tested at 50 homes to evaluate the effectiveness and utility of the questions and survey approach. The results are included in Appendix C: Survey Trial Results. However, since these results are for a small sample, they are not intended to be representative. Rather, they are presented to demonstrate the survey tool's purpose, design, and shortcomings in preparation for any future statewide effort. It is important to note that the full statewide dataset will allow correlation of any datapoint with any other. Such a dataset will provide a rich opportunity for complex conclusions across various programmatic considerations.

The survey trial data was too limited to draw conclusions about building stock characteristics as they relate to demographic characteristics of DAC and HTR customer segments. The trial showed that the survey instrument was usable and there were no technical barriers to using it in the field. Data and photos were easy to enter and upload without any functional issues. However, the 50-survey trial revealed some challenges with some of the survey questions and quality of responses:

- Photo documentation such as equipment nameplates and electrical panels was inconsistent.
- Incoming utility service capacity was often omitted or incorrect.
- Many answers for electrical panel size and circuit breakers were inaccurate, omitted or well outside the expected range.
- Cooling system size, heating system size, and water heater size results were highly variable with some answers outside the expected range (e.g., 500-gal storage tank, or voltage instead of Btu/hr.).
- The range/oven/cooktop question was not well-formed and resulted in self-conflicting answers.

Additionally, some questions appeared unnecessary. These included survey fields for secondary and tertiary space conditioning and water heating systems (few were reported, and it appeared to be a confusing survey component); electric panel type; and wiring type.

Remediating these survey quality issues is necessary prior to the implementation of any future statewide survey.

Recommendations

This study revealed that for any future statewide survey, several changes to the survey methods are necessary, including:

- We recommend that if or when a statewide field survey is conducted, it should adhere to the following methodology:
    - After approximately half the sample is collected, the underlying assumptions (e.g., standard deviation) should be reviewed in comparison to actual data collected.
    - The sampling plan may be adjusted to yield the best possible statistical criteria including making changes to how field data is collected and by whom. For instance, some remote locations with small populations may be inaccessible to the ESA program and the staff conducting the field surveys. Other entities such as a local CBO may be engaged to conduct the requisite number of surveys.
- Photo documentation may not be necessary if survey questions are answered accurately.
- The stove/range/oven survey questions allowed for self-conflicting answers. The questions should be consolidated and prevent self-conflicting answers (such as “induction oven”).
- Data from TECH and SJV program implementers may also be of use. Those programs may provide another network or source of data to be leveraged, in addition to the ESA contractors.
    - Some of the survey fields may be easier and more accurate if open-ended responses are allowed. In some cases, standardized, restricted response types may be limiting the survey effectiveness (heating system size which can be in kW, Btu/hr., or ton, for instance).
    - Based on effectiveness and usability of the data ultimately collected in the proposed statewide survey, a subset of the questions may be valuable to add in future census or California residential surveys (such as the Residential Appliance Saturation Survey). Future iterative surveys outside this project may want to consider including the questions tested here, especially for housing conditions that are expected to change over time.
    - Based on stakeholder feedback received on this project, the Project would benefit from engaging with other entities, such as the TECH Clean California Low Income Ambassador Panel to review survey questions and the tool for future use; Ambassador members' organizations would be willing to provide examples of the data it collects when it enrolls customers in low-income programs as well as feedback on the content of survey.

A challenge specific to data collection is the fact the personnel conducting the field surveys may require additional training and quality control. We propose to mitigate this challenge on several fronts. They are described here in the form of recommendations pertaining specifically to the staff conducting the surveys. Proposed recommendations or alternative approaches may include:

- Develop training curriculum that covers each end-use system included in the survey. At a minimum, training would include instruction on areas that are not required for ESA assessments:
    - How to determine incoming utility service capacity
    - How to evaluate electrical panel conditions

    - How to determine water heater, cooling system, and heating system sizes
- Develop and implement quality control procedures:
    - Automated within the web-based survey itself
    - Based on human review of survey submissions
- Identify separate dedicated surveyors accompanying the energy specialists on their ESA program intake site visits. These dedicated surveyors could be energy auditors or engineers knowledgeable of building systems who have prior understanding of electrification remediation, residential end-use characterization, and the survey topics. These surveyors could execute the questions in parallel with the energy specialists as they perform their ESA duties.
- Identify and use a non-ESA contractor to conduct the surveys, or a combination of contractor types to perform the survey work.

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Appendix A: Additional Census Analysis Findings

Figure 17: Cost of electricity and gas as percent of income; analyzed per tenure and DAC PUMA group.

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

Figure 18: Year homes were built with 1960 split delineated; analyzed per DAC PUMA group

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

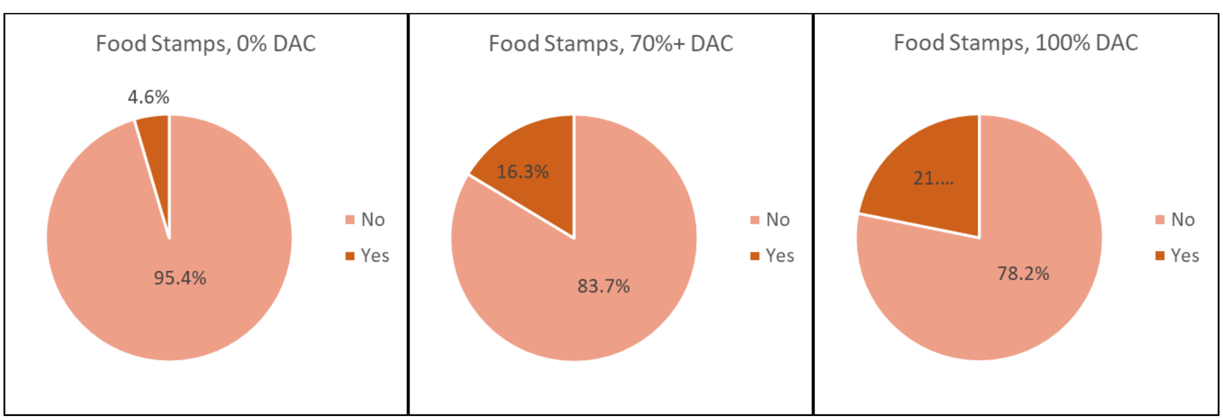

Figure 19: Food stamp recipients per DAC PUMA group

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

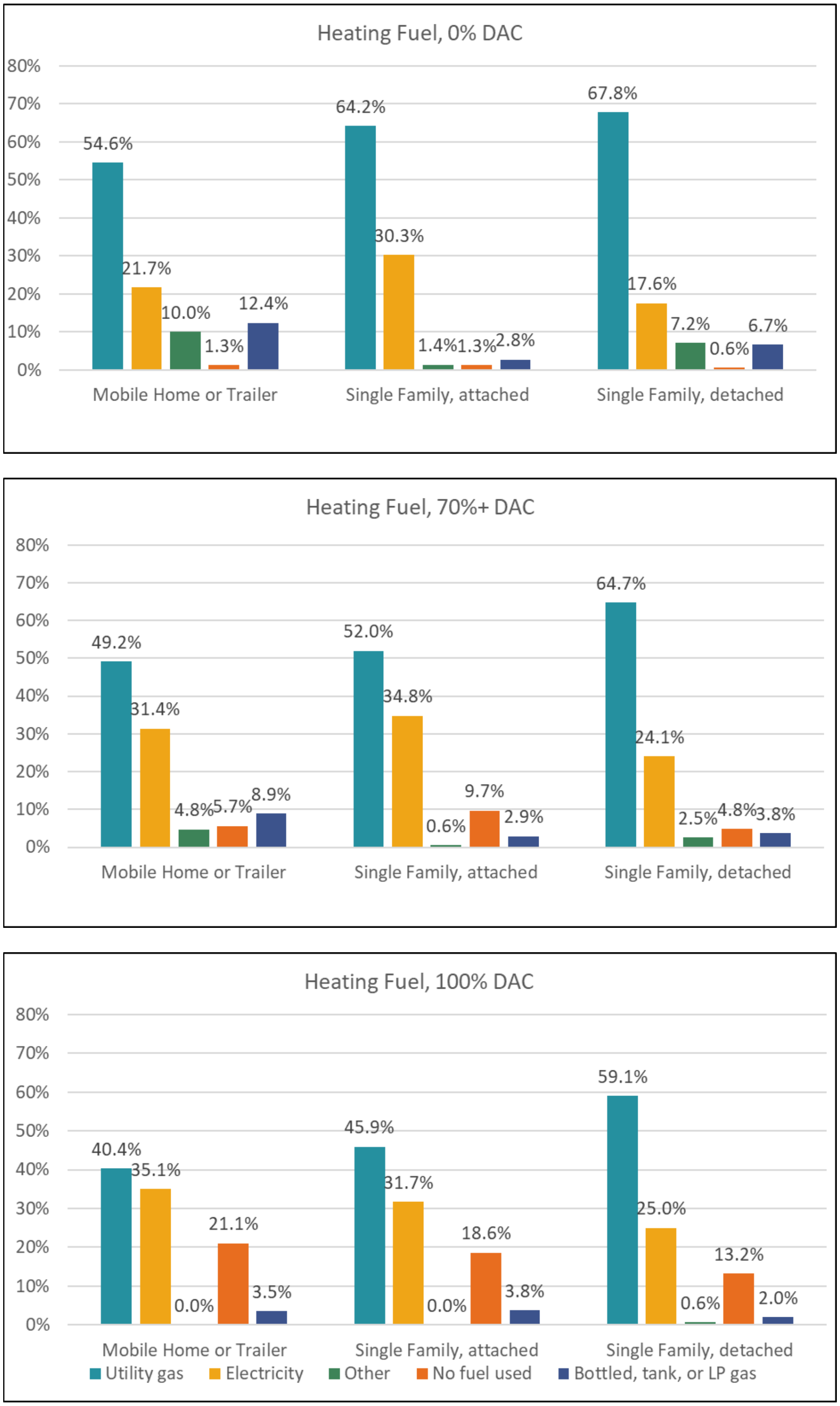

Figure 20: Heating fuel type per DAC PUMA group

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

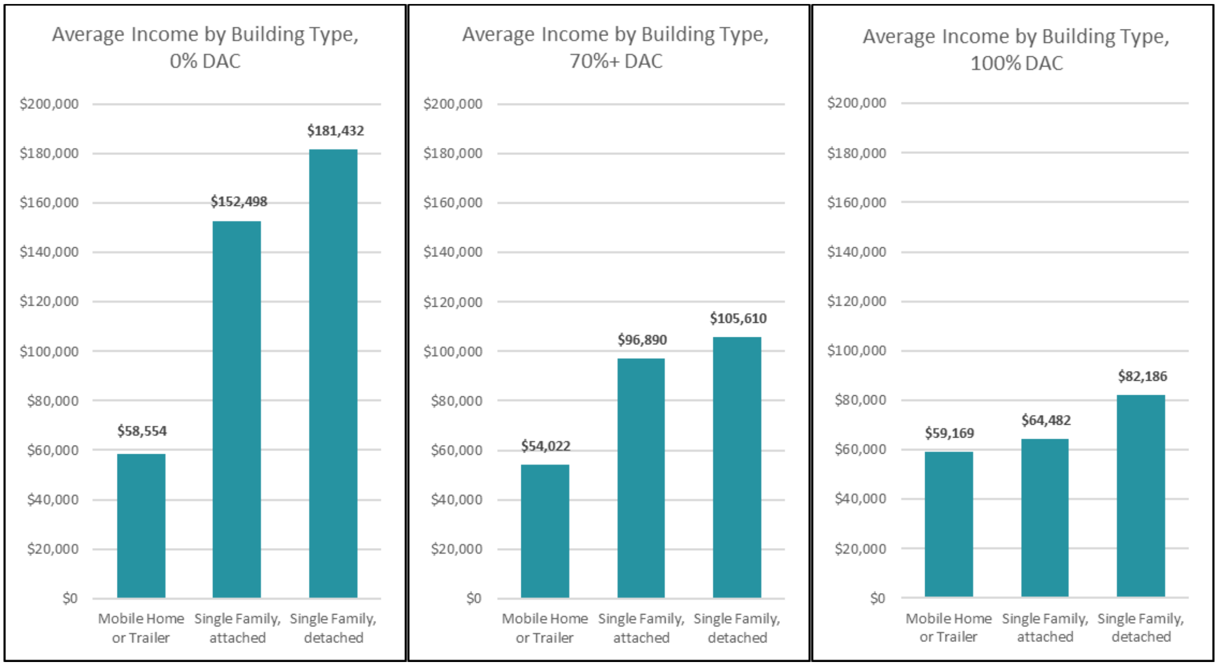

Figure 21: Income by home type; analyzed per DAC PUMA group

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

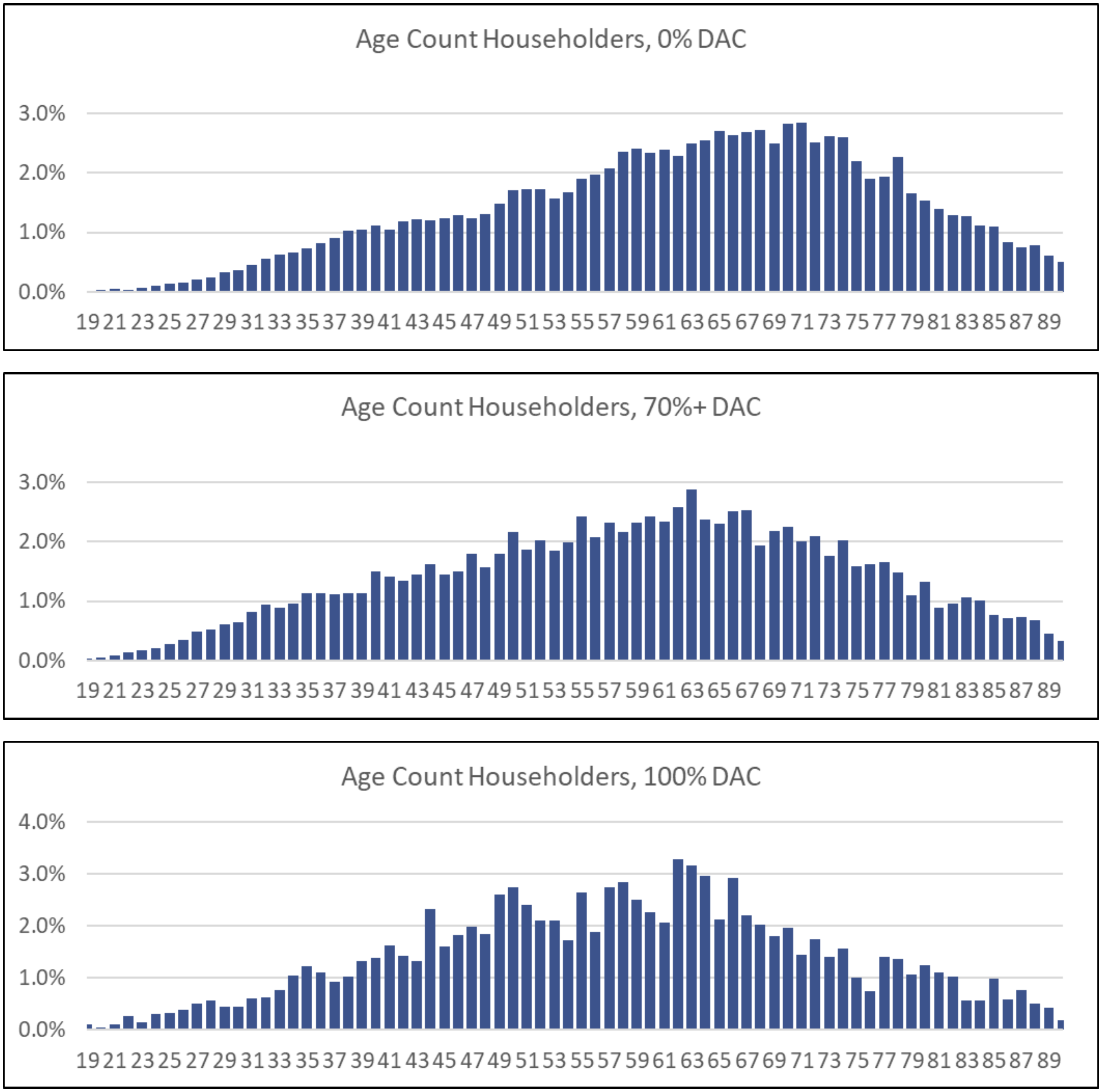

Figure 22: Age of householder per DAC PUMA group

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

Figure 23: Age of homeowners refined per DAC PUMA group

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

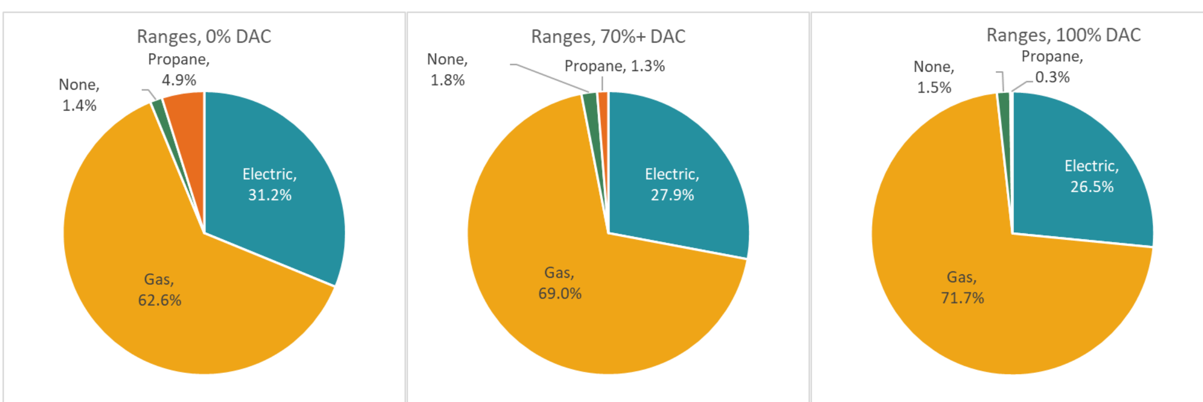

Figure 24: Range energy source per DAC PUMA group

Source: 2022 NREL and 2022 OEHHA data, analyzed by Project Team

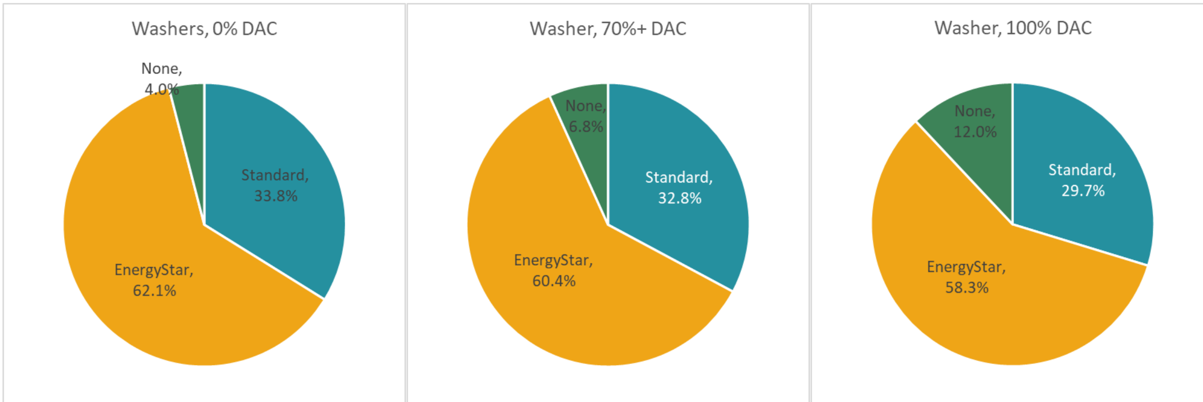

Figure 25: Washer efficiency per DAC PUMA group

Source: 2022 NREL and 2022 OEHHA data, analyzed by Project Team

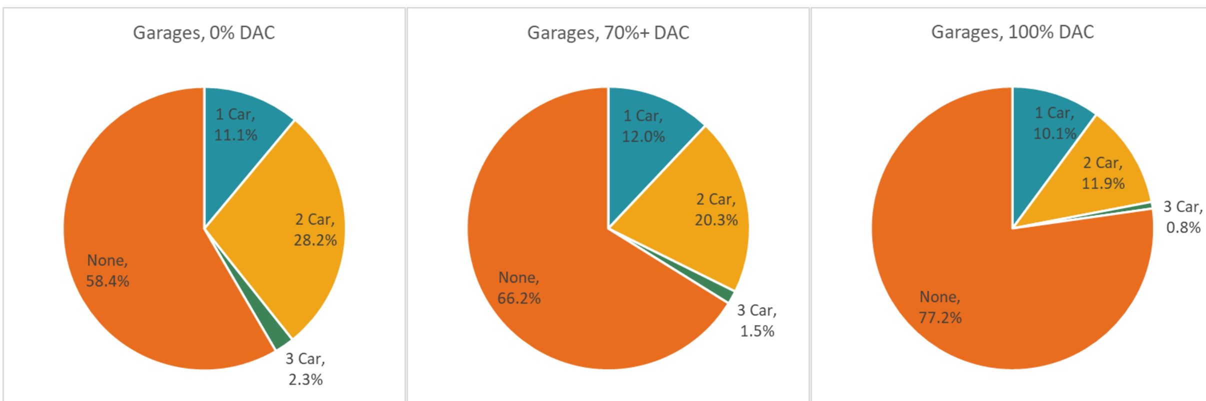

Figure 26: Garage types per DAC PUMA group

Source: 2022 NREL and 2022 OEHHA data, analyzed by Project Team

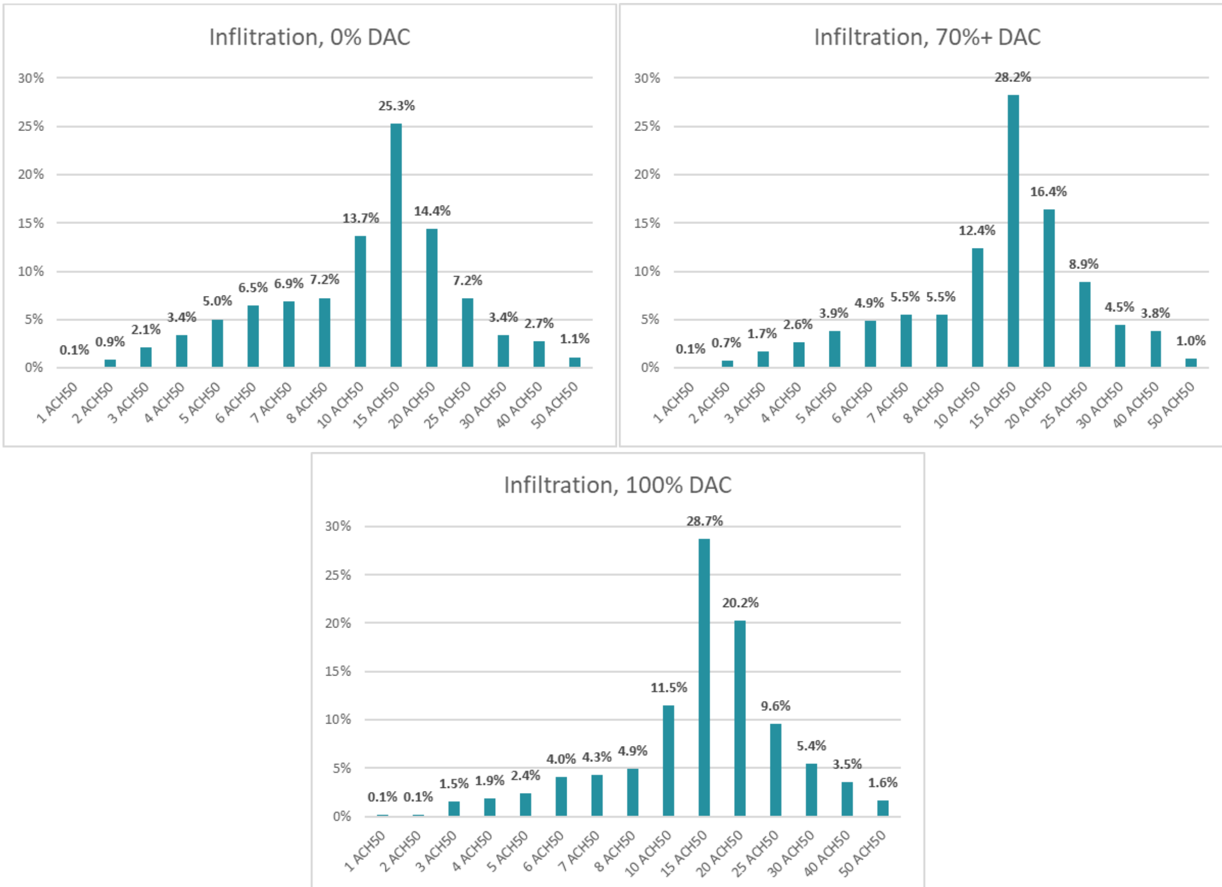

Figure 27: Home infiltration per DAC PUMA group

Source: 2022 NREL and 2022 OEHHA data, analyzed by Project Team

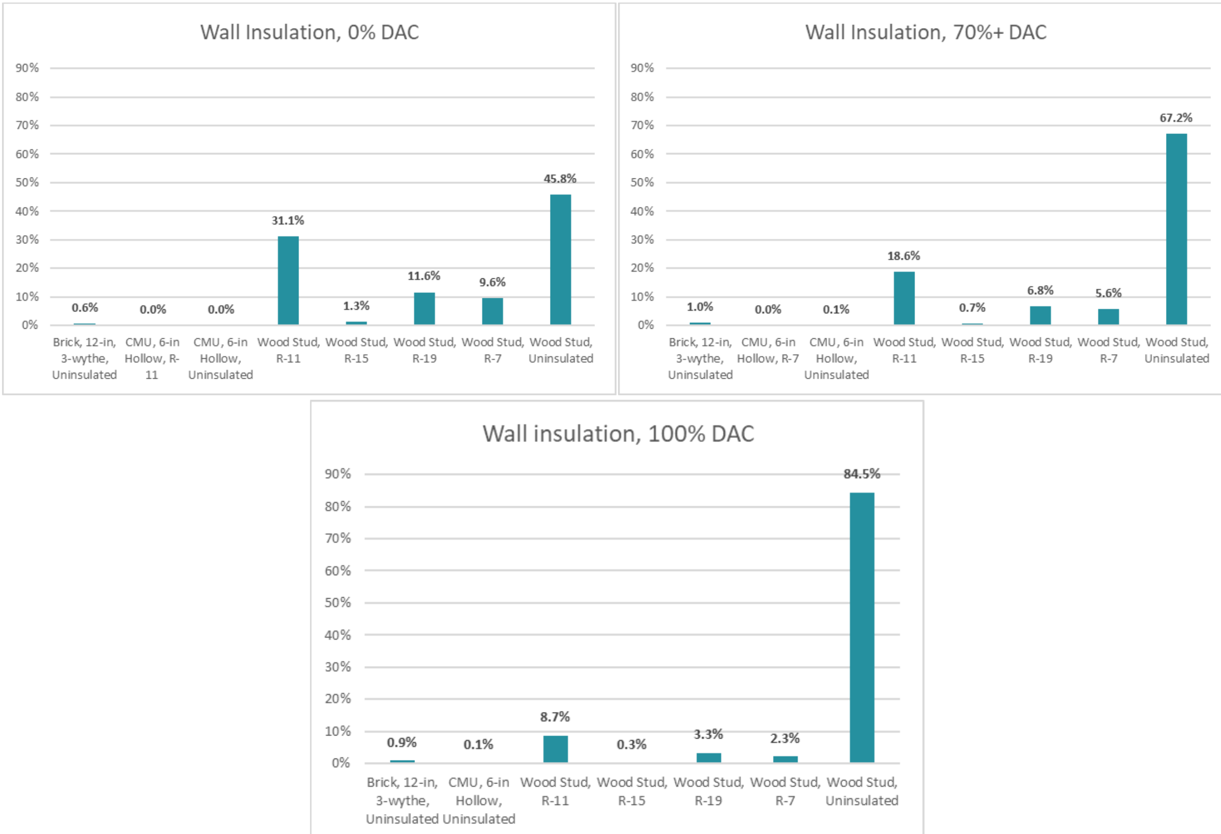

Figure 28: Wall insulation per DAC PUMA group

Source: 2022 NREL and 2022 OEHHA data, analyzed by Project Team

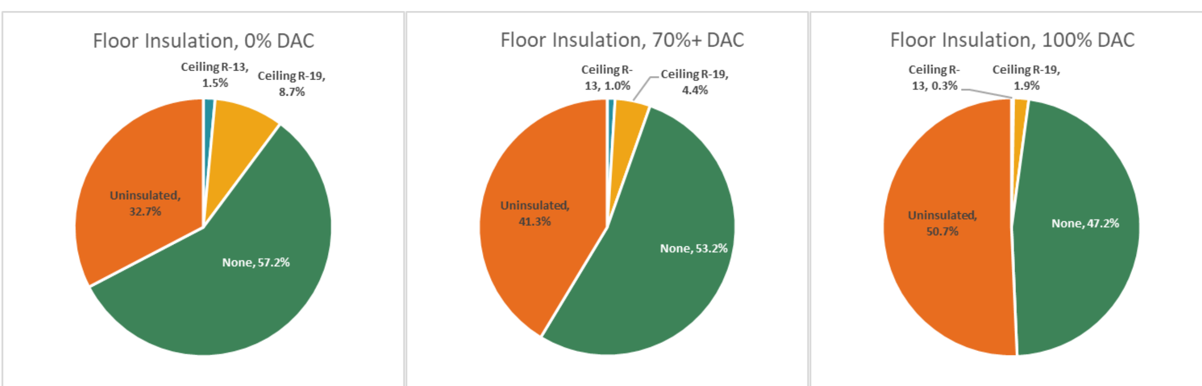

Figure 29: Floor insulation per DAC PUMA group

Source: 2022 NREL and 2022 OEHHA data, analyzed by Project Team

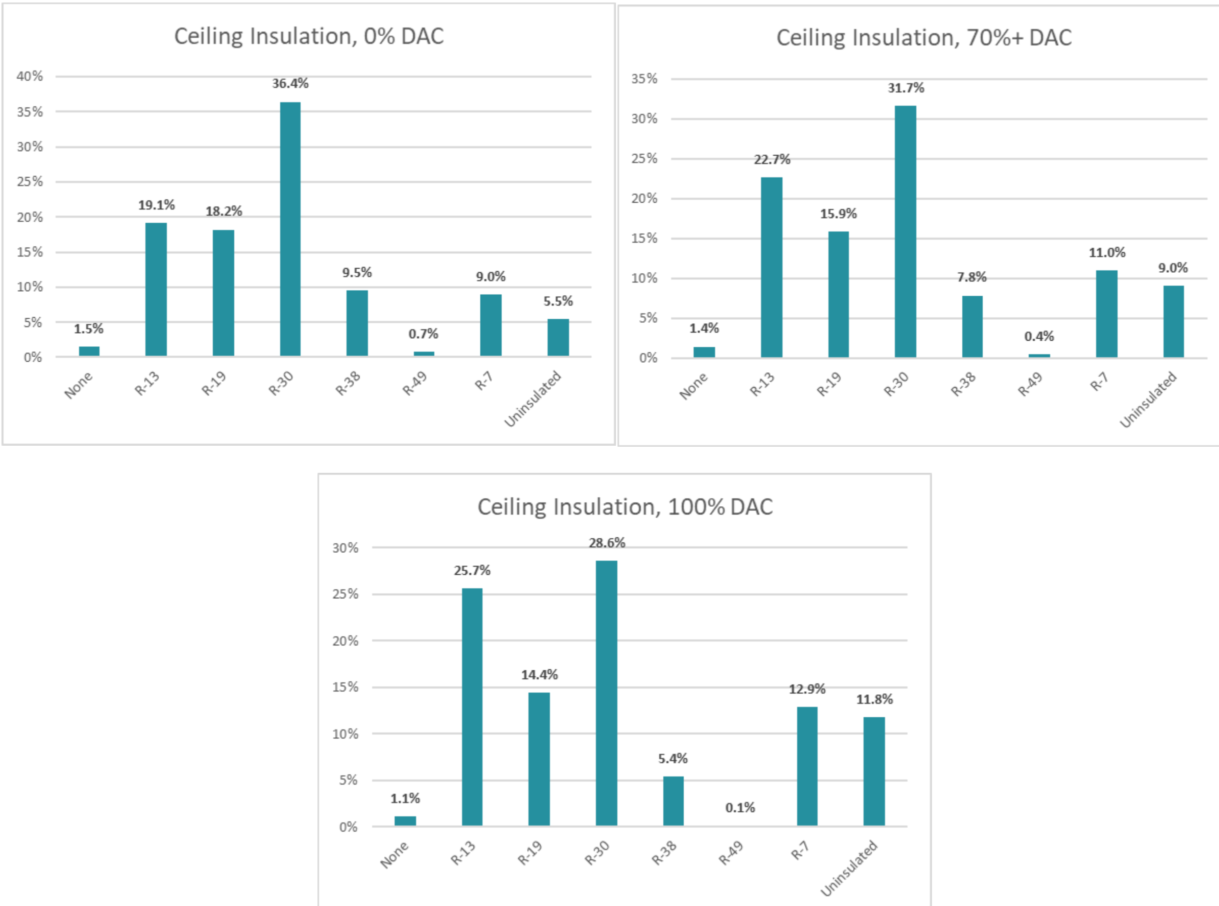

Figure 30: Ceiling insulation per DAC PUMA group

Source: 2022 NREL and 2022 OEHHA data, analyzed by Project Team

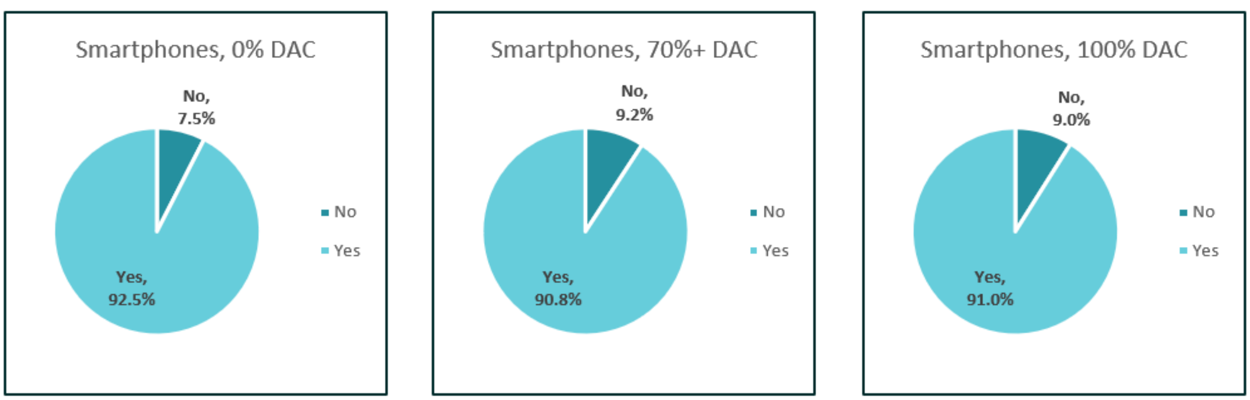

Figure 31: Does householder have a smartphone with internet access per DAC PUMA group

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

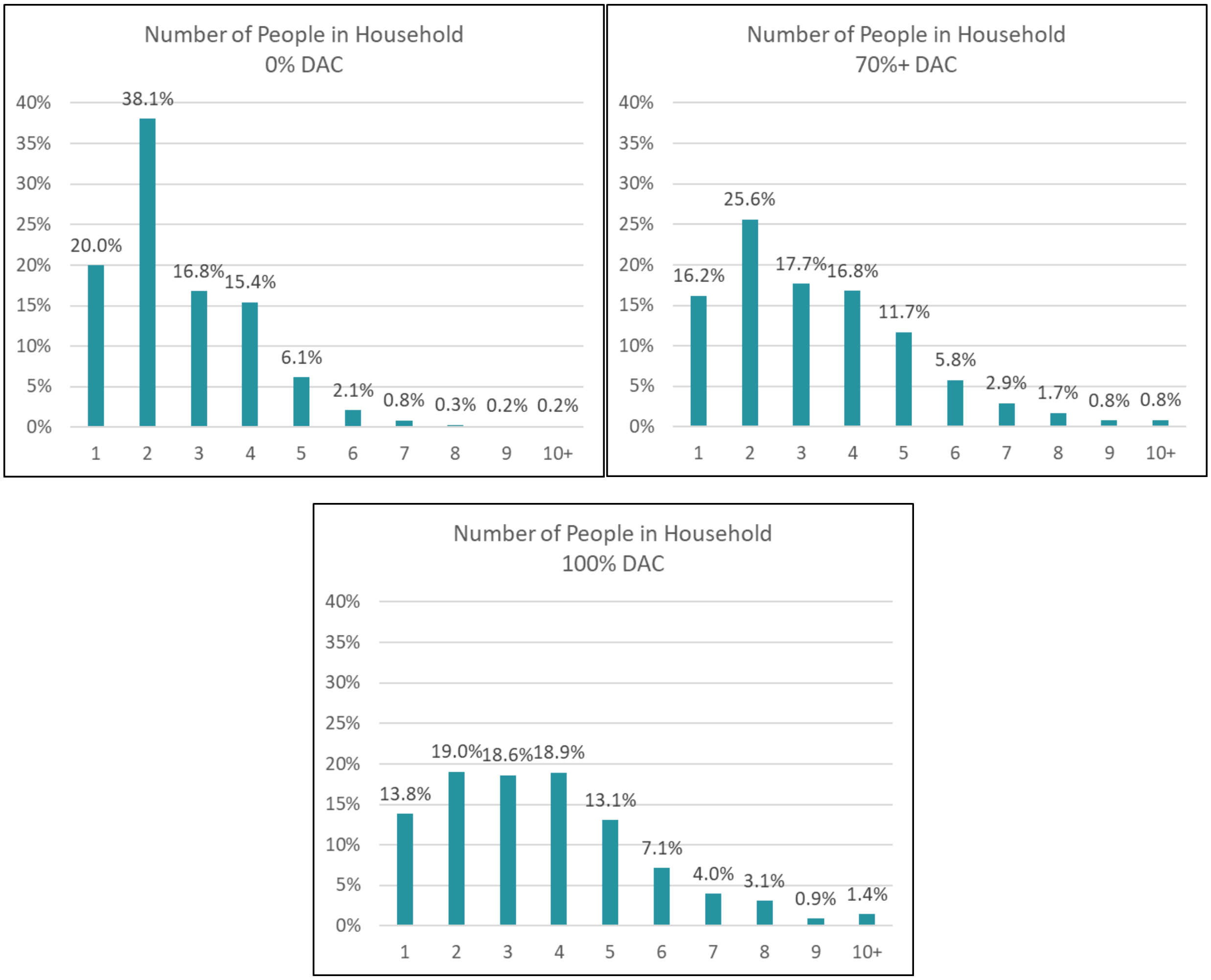

Figure 32: Number of people living in household; analyzed per DAC PUMA group

Source: 2021 ACS and 2022 OEHHA data, analyzed by Project Team

Appendix B: Field Survey

Web based survey mobile phone and tablet appliances – completed by contractor in person.

Housing Characteristic Survey

ESA Contractor - Field Data Collection

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

1. Survey Basics

Name of Auditor *

First Last Name

First & Last name

Date of Survey *

01/30/2023

MM/dd/yyyy

2. Customer Data

Address *

Street Address

City

Postal / Zip Code

Name of Person Interviewed *

First Name

Last Name

Total number of people who live here

Occupant Status

- ◯ Rent
- ◯ Own

Age of head of household

[ ]

Primary language spoken at home

[ ]

If primary language is not English, is someone in the household able to speak English?

- ◯ Yes
- ◯ No

Do any of the household members have a smart phone?

- ◯ Yes
- ◯ No

Does the household have internet access?

- ◯ Yes
- ◯ No

3. Basic Home Data

Building Type

- ◯ Single Family Detached
- ◯ Duplex, Triplex, or Fourplex
- ◯ Mobile Home
- ◯ Modular Home
- ◯ Other

[ ]

Garage?

- ◯ Yes
- ◯ No

If yes, is there room in the garage for a water heater?

- ◯ Yes
- ◯ No

4. Electrical Service

Utility incoming service capacity

Record amps

This number will be at the main circuit breaker, outside, where power comes in. If not easily located, write "Unable to determine" in this field.

Electric panel capacity

Record amps

If unable to determine by looking at panel, write, "unable to determine".

Electric panel year (if listed)

Record year

Year is usually on the label inside the panel door.

Electric panel type

- ◯ Fuse
- ◯ Breaker

Wiring type

- ◯ Knob & tube
- ◯ Non-metallic (e.g. Romex)
- ◯ Aluminum
- ◯ Armored cable
- ◯ Cloth insulated wire
- ◯ Other

Can ask customer, or if safe, look in attic.

Note: The circuit breaker sizes below will need to be collected when looking at the panel --- IF the panel has labeled breakers. If breakers are not labeled, we will see in the photos, but enter "breakers not labeled" in these fields.

If some or all are not present, enter "not present".

Water heater circuit breaker size (if present)

Record amps

Heater circuit breaker size (if present)

Record amps

Air conditioner circuit breaker size (if present)

Record amps

Stove circuit breaker size (if present)

Record amps

5. Space Heating

Do you use space heating equipment in your home?

◯ Yes

◯ No

If yes, is the heating system meeting your needs?

◯ Yes

◯ No

Do you use portable electric resistance heaters?

◯ Yes

◯ No

If yes, how many?

Record qty

Heating Systems (excluding portable electric heaters, skip if irrelevant)

Heating Fuel Source

	Primary Heating System	Secondary Heating System	Tertiary Heating System
Natural Gas	☐	☐	☐
Electricity	☐	☐	☐
Kerosene	☐	☐	☐
Propane	☐	☐	☐
Wood	☐	☐	☐
Other	☐	☐	☐

Equipment Type

	Primary Heating System	Secondary Heating System	Tertiary Heating System
Baseboard/wall electric heater	☐	☐	☐
Wall natural gas furnace	☐	☐	☐
Electric resistance forced air furnace (ducted)	☐	☐	☐
Natural gas forced air furnace (ducted)	☐	☐	☐
Forced air split heat pump (ducted)	☐	☐	☐

	Primary Heating System	Secondary Heating System	Tertiary Heating System
Packaged forced air heat pump (ducted)	☐	☐	☐
Ductless heat pump (mini split)	☐	☐	☐
Window unit	☐	☐	☐
Through-the-wall unit (PTHP)	☐	☐	☐
Wood stove/fireplace	☐	☐	☐
Propane or Kerosene ducted furnace	☐	☐	☐
Propane or Kerosene ductless furnace	☐	☐	☐
Other	☐	☐	☐

How is the heating equipment controlled?

	Primary Heating System	Secondary Heating System	Tertiary Heating System
On/off or timer (manual)	☐	☐	☐
Remote	☐	☐	☐
Single setpoint thermostat	☐	☐	☐
Programmable thermostat	☐	☐	☐
Smart thermostat (e.g. Nest)	☐	☐	☐
Other	☐	☐	☐

Is the system functional?

	Primary Heating System	Secondary Heating System	Tertiary Heating System
Yes	☐	☐	☐
No	☐	☐	☐

System Size

	Primary Heating System	Secondary Heating System	Tertiary Heating System
Record Btu/h or kW			

6. Space Cooling

Do you use space cooling equipment in your home?

◯ Yes

◯ No

If yes, is the cooling system meeting your needs?

◯ Yes

◯ No

Do you use portable air conditioners?

◯ Yes

◯ No

If yes, how many?

Record qty

Cooling Systems (excluding portable air conditioners, skip if irrelevant)

What type of space cooling equipment do you use?

	Primary Cooling System	Secondary Cooling System	Tertiary Cooling System
Window unit(s)	☐	☐	☐
Split heat pump/AC (ducted)	☐	☐	☐
Ductless air conditioner (mini-split)	☐	☐	☐
Package air conditioner (ducted)	☐	☐	☐
Split air conditioner (ducted)	☐	☐	☐

Evaporative cooler	☐	☐	☐
Ductless heat pump (mini split)	☐	☐	☐
Through-the-wall unit (PTAC or PTHP)	☐	☐	☐
Other	☐	☐	☐

If window units, how many are used in household?

Record qty

How is the cooling equipment controlled?

	Primary Cooling System	Secondary Cooling System	Tertiary Cooling System
On/off or timer (manual)	☐	☐	☐
Remote	☐	☐	☐
Single setpoint thermostat	☐	☐	☐
Programmable thermostat	☐	☐	☐
Smart thermostat (e.g. Nest)	☐	☐	☐
Other	☐	☐	☐

System Size

	Primary Cooling System	Secondary Cooling System	Tertiary Cooling System
Record Btu/h or ton (or other metric)			

7. Water Heating

Ever run out of hot water?

◯ Yes

◯ No

Water Heater type

	Primary Water Heater	Secondary Water Heater
Electric resistance tankless/instant	☐	☐
Electric resistance storage tank	☐	☐
Heat pump water heater	☐	☐
Natural gas tankless/instant	☐	☐
Natural gas storage tank	☐	☐
Propane storage tank	☐	☐
Solar	☐	☐
Other	☐	☐

If present, storage tank size

Gallons

If tankless, system size

Btu/hr or kW or other metric

Water Heater location

	Primary Water Heater	Secondary Water Heater
Interior closet	☐	☐

Interior	☐	☐
Garage	☐	☐
Exterior closet	☐	☐
Exterior	☐	☐
Other	☐	☐

If in closet, what are the closet dimensions?

Height (in) x Width (in) x Depth (in)

Unit of measure should be inches.

Does the closet have louvers, venting, openings for air flow?

- ◯ Yes
- ◯ No

Is the water heater located next to an exterior wall?

- ◯ Yes
- ◯ No

Is the water heater located within 4 feet of a drain?

- ◯ Yes
- ◯ No

8. Appliances

Clothes dryer present?

- ◯ Electric
- ◯ Electric Heat Pump
- ◯ Gas
- ◯ No clothes dryer

Range type

- ◯ Electric resistance
- ◯ Electric induction
- ◯ Natural gas
- ◯ Propane
- ◯ N/A
- ◯ Other

Oven (standalone)

- ◯ Electric resistance
- ◯ Electric induction
- ◯ Natural gas
- ◯ Propane
- ◯ N/A
- ◯ Other

Cooktop (standalone)

- ◯ Electric resistance
- ◯ Electric induction
- ◯ Natural gas
- ◯ Propane
- ◯ N/A
- ◯ Other

Is there a pool heater?

- ◯ Yes
- ◯ No

If yes, what type of pool heater?

- ◯ Natural gas
- ◯ Propane
- ◯ Electric resistance
- ◯ Heat pump
- ◯ Solar
- ◯ Other

What is the pool heater size?

Record Btu/hr

If not known, or if name plate is faded, enter "not known".

9. Solar PV

Are solar panels present?

- ◯ Yes
- ◯ No

Rated system power (kW) if known

kW

Is PV battery backup present?

- ◯ Yes
- ◯ No

What is the capacity of the battery backup (kWh or kW)?

If not known or if name plate is not visible, enter "not known".

10. Electric Vehicles

Own an electric vehicle?

- ◯ Yes
- ◯ No

Is there electric vehicle charging at the home or community?

- ◯ Yes
- ◯ No

Appendix C: Survey Trial Results

The following figures demonstrate the survey instrument's design, scope, and results to inform planning and revisions for any future Statewide survey. These results are not representative of DAC, low-income, or HTR housing.

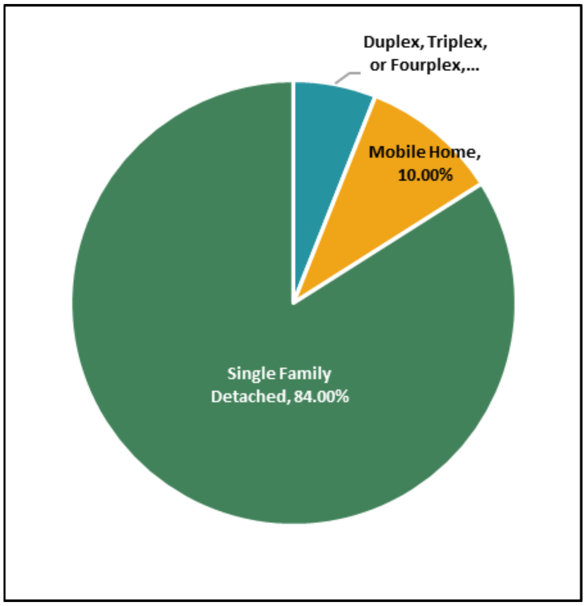

Figure 33: Trial survey building type

Source: Project Team

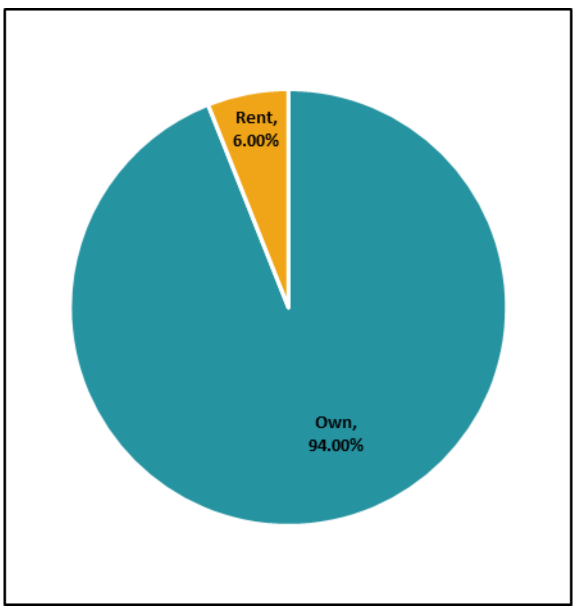

Figure 34: Trial survey building tenure

Source: Project Team

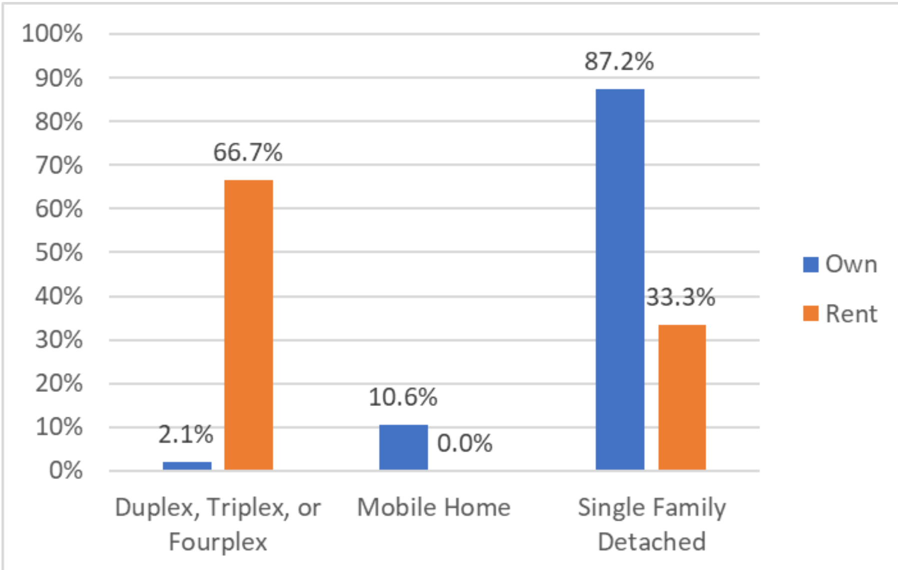

Figure 35: Trial survey building type and building tenure

Source: Project Team

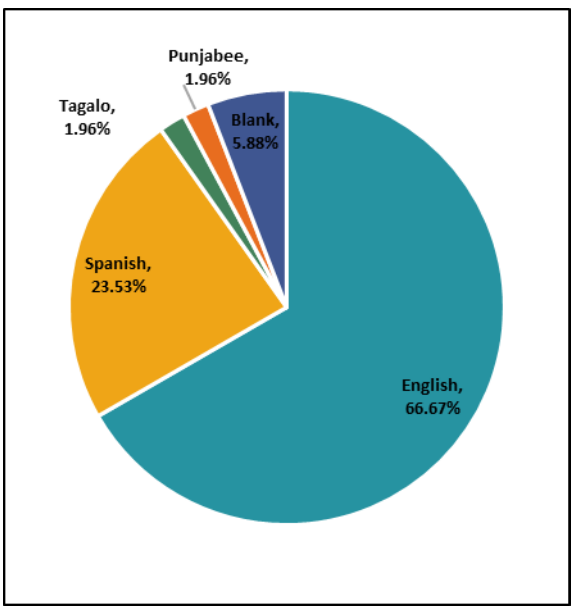

Figure 36: Trial survey primary household language

Source: Project Team

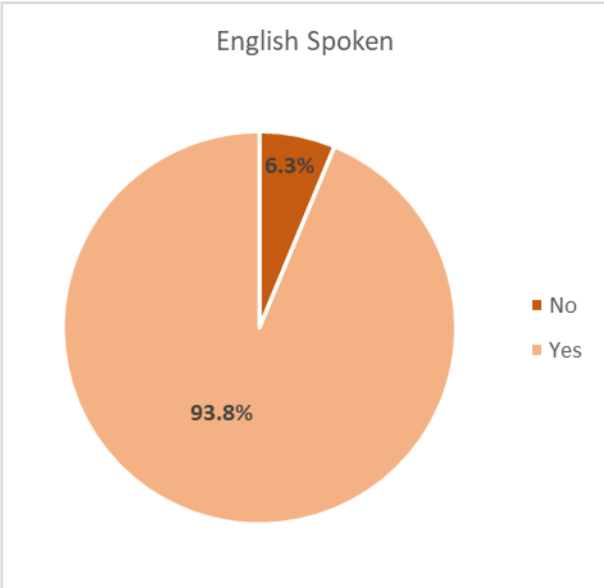

Figure 37: Trial survey English speaking households

Source: Project Team

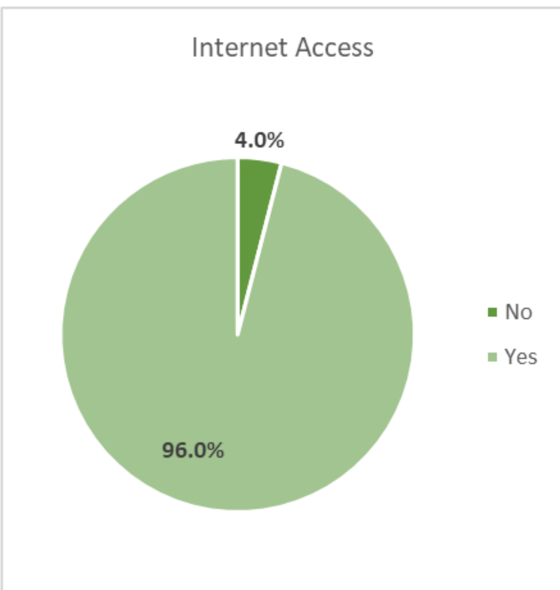

Figure 38: Trial survey internet access

Source: Project Team

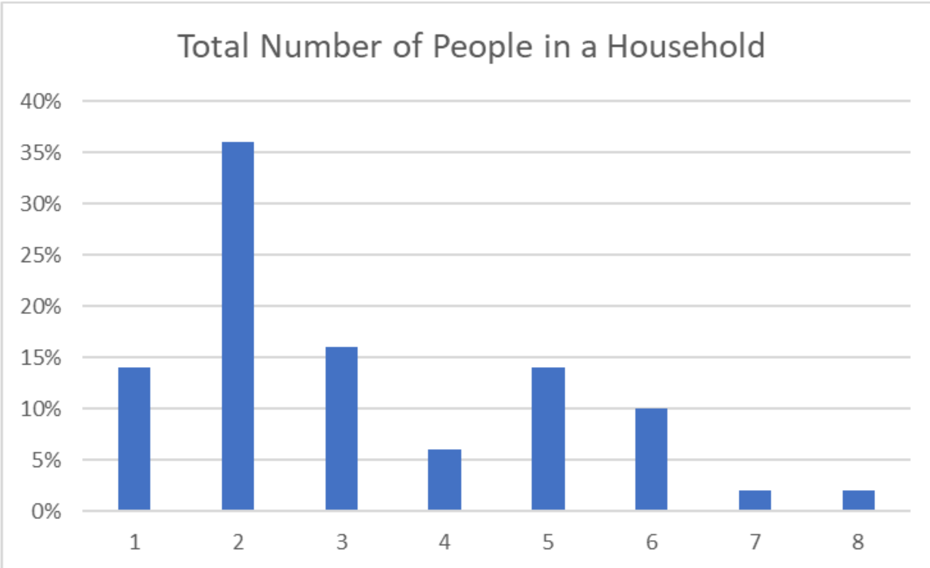

Figure 39: Trial survey household size

Source: Project Team

Table 5: Electric Panel and Breaker Sizes

Elec Panel Size (A)	Count	Elec Panel Age (yr)	Count	Water Heater Breaker Size (A)	Count	Space Heater Breaker Size (A)	Count	AC Breaker Size (A)	Count	Stove Circuit Breaker Size (A)	Count
50	1	1950s	1	10.5	1	10.5	1	15	3	15	0
60	6	1960s	0	15	2	15	16	21	3	20	6
100	14	1970s	5	20	3	20	12	26	2	30	8
125	16	1980s	3	30	7	30	5	30	8	40	2
150	1	1990s	3	Unk.	37	40	0	35	1	50	10
200	7	2000s	3			Unk.	16	40	9	60	1
210	1	2010s	3					50	8	Unk.	23
260	1	2020s	1					60	3		
Unk.	3	Unk.	31					Unk.	13		

Source: Project Team

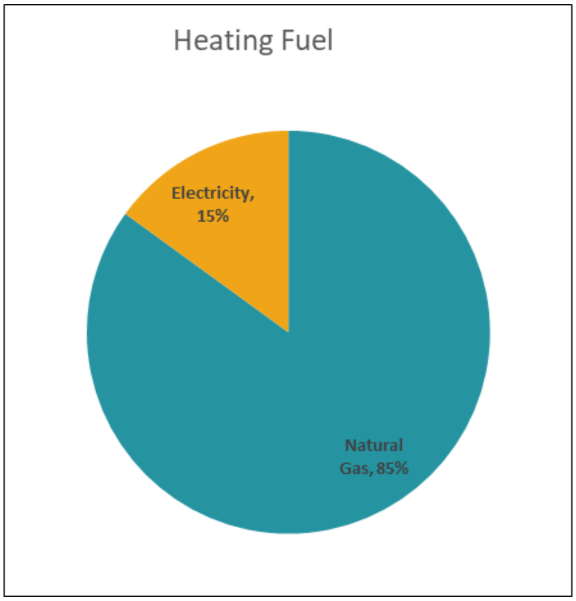

Figure 40: Trial survey heating fuel

Source: Project Team

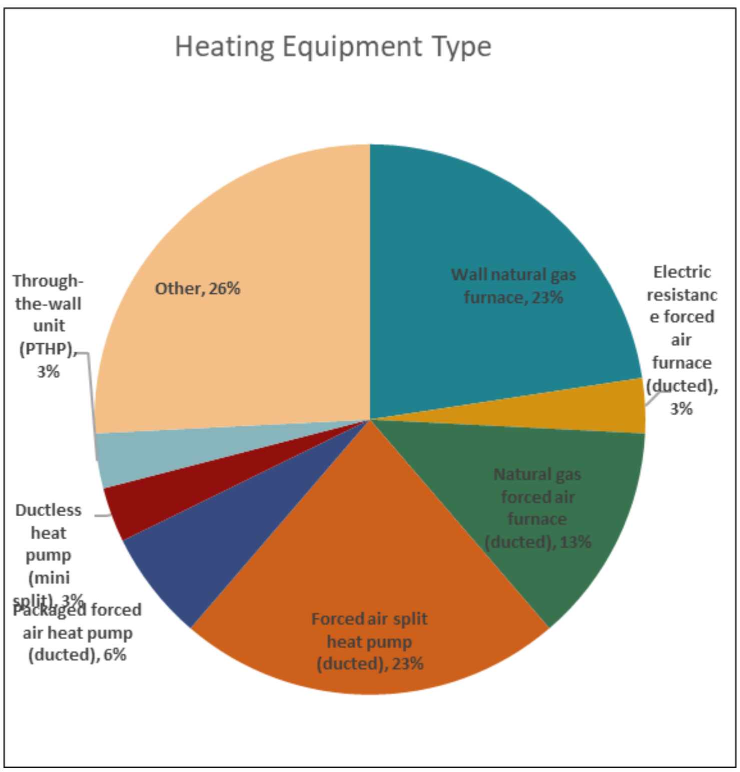

Figure 41: Trial survey heating equipment type

Source: Project Team

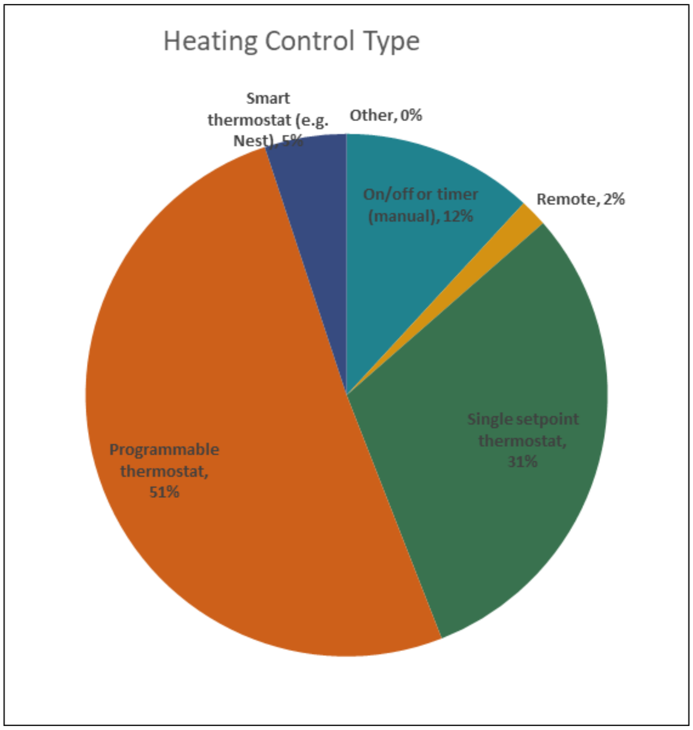

Figure 42: Trial survey heating system control type

Source: Project Team

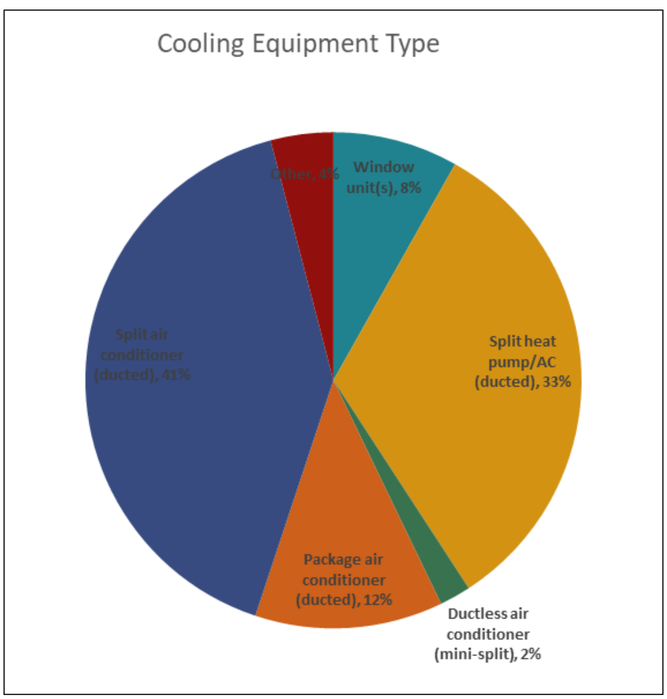

Figure 43: Trial survey cooling system type

Source: Project Team

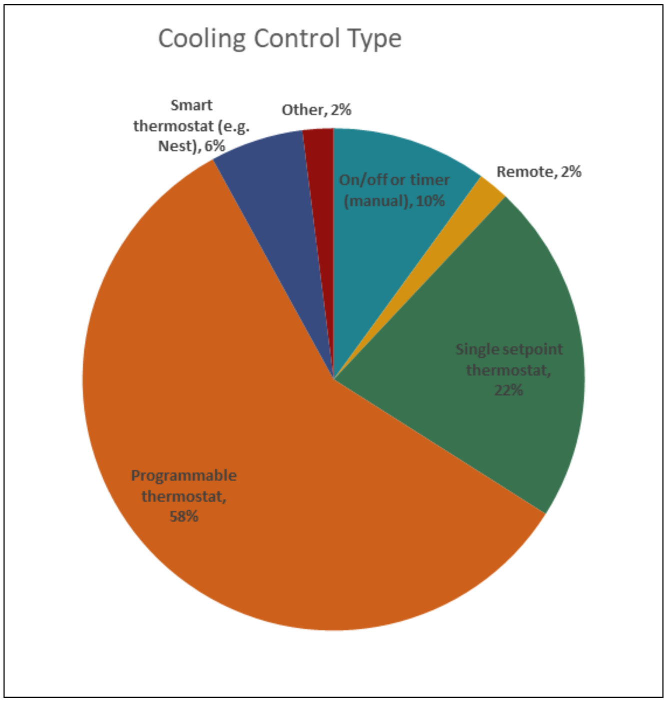

Figure 44: Trial survey cooling system control type

Source: Project Team

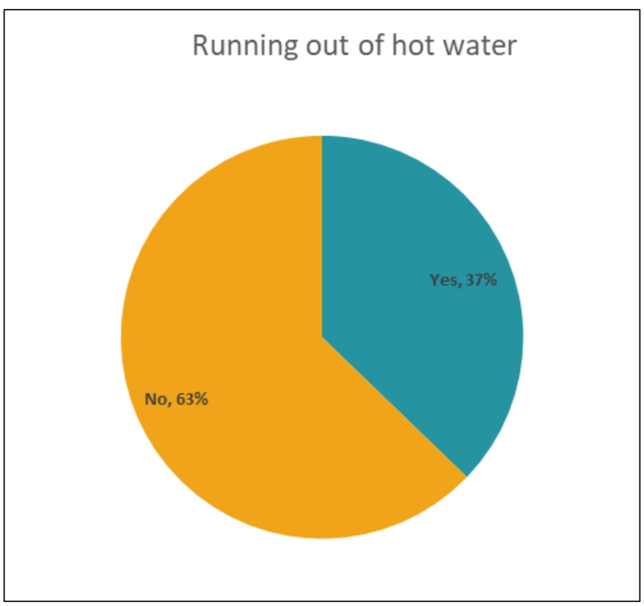

Figure 45: Trial survey hot water availability

Source: Project Team

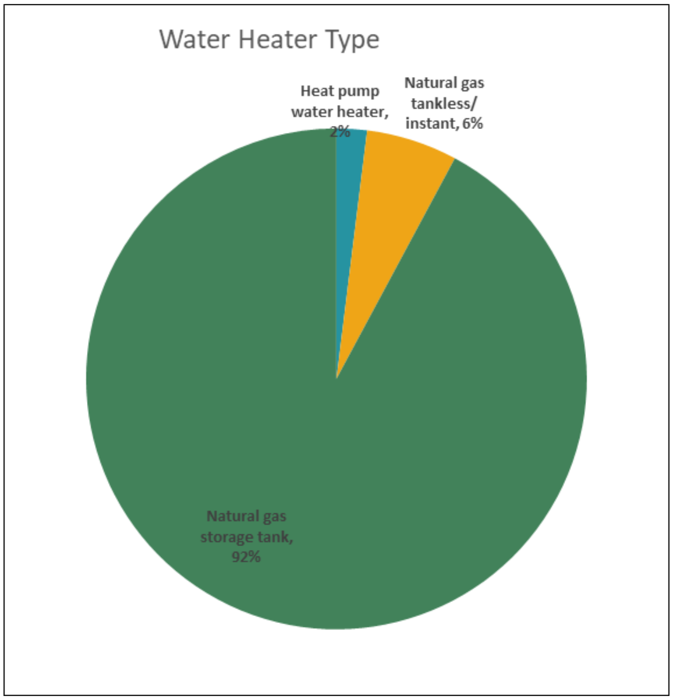

Figure 46: Trial survey water heater type

Source: Project Team

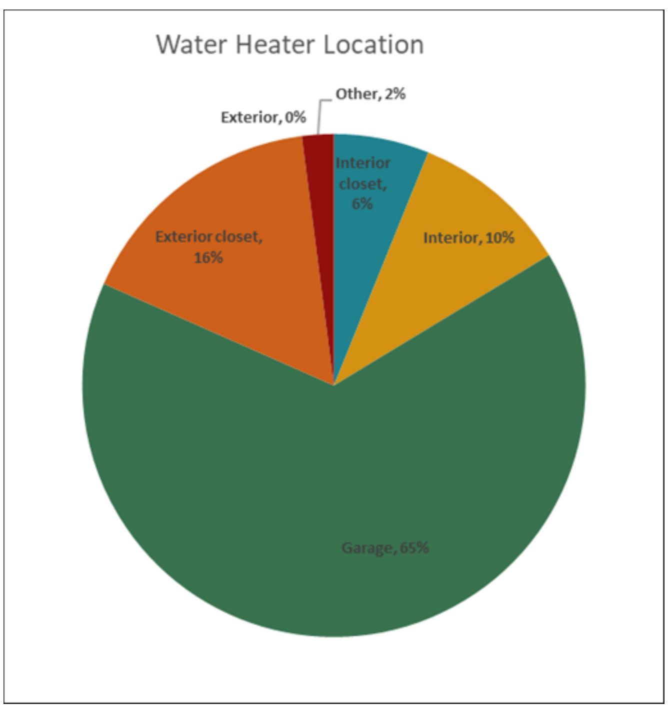

Figure 47: Trial survey water heater location

Source: Project Team

Table 6: Trial Survey Solar Panels and Electric Vehicles

Are solar panels present?	Own electric vehicle?	Is there electric vehicle charging in the home or community?	Count
No	No	No	33
No	No	Yes	4
No	Yes	No	1
No	Yes	Yes	1
Yes	No	No	7
Yes	No	Yes	2
Yes	Yes	Yes	1
Yes	Yes	No	0

Source: Project Team

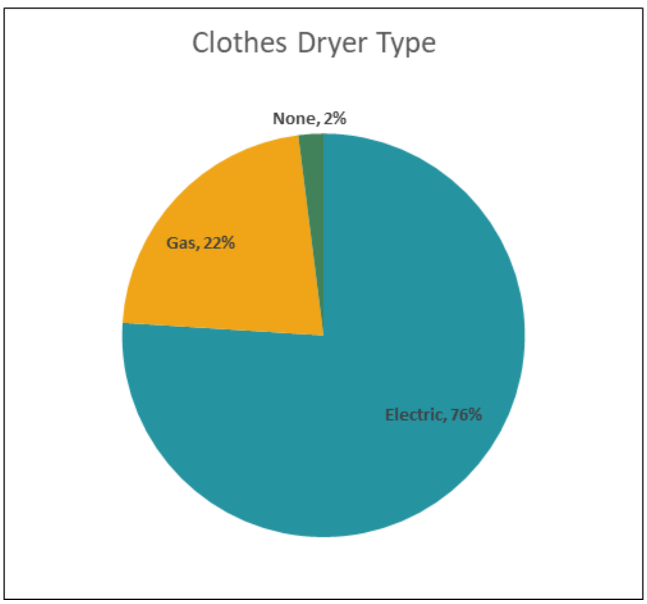

Figure 48: Trial survey clothes dryer fuel

Source: Project Team

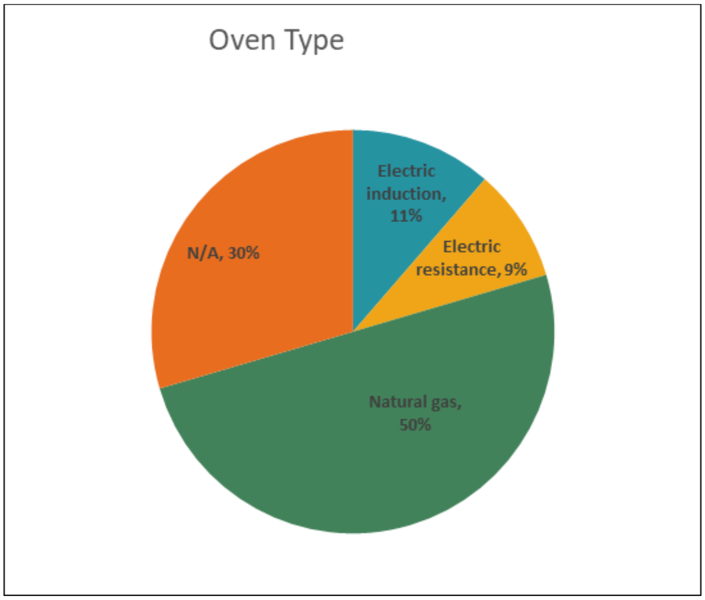

Figure 49: Trial survey oven type

Source: Project Team

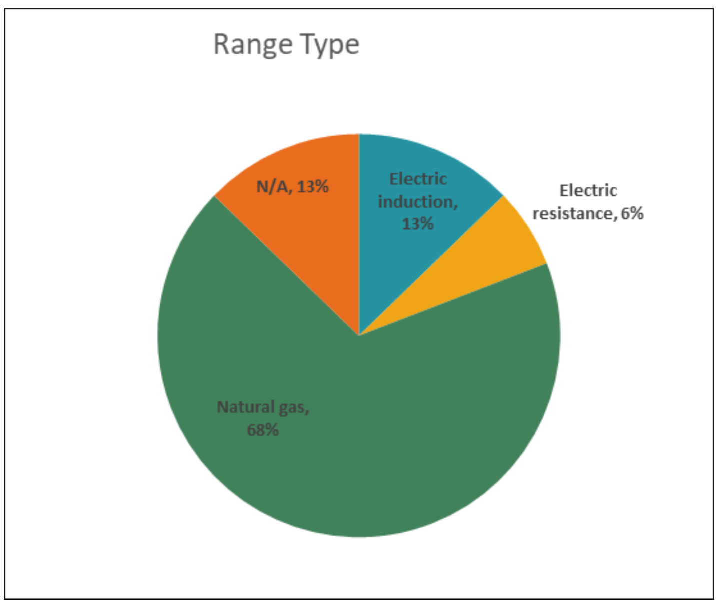

Figure 50: Trial survey range type

Source: Project Team

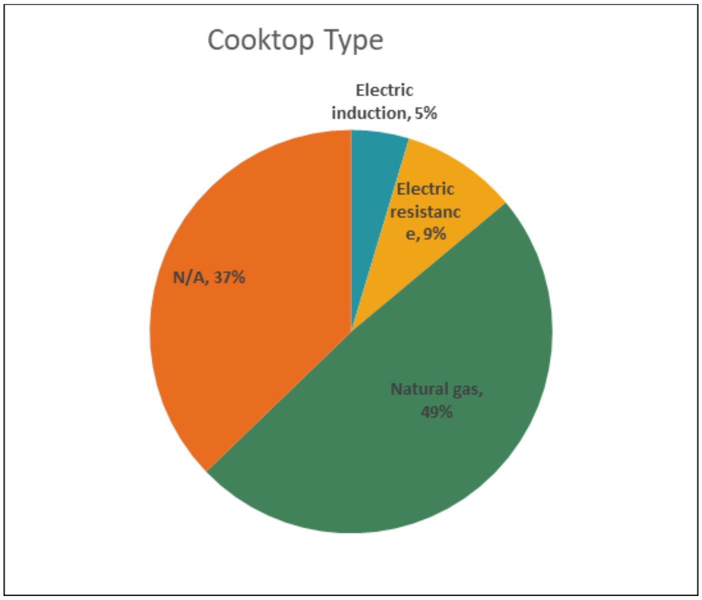

Figure 51: Trial survey cooktop type

Source: Project Team