CADMUS

# MEMORANDUM

To: Peter Thompson and Caroline Francis, PG&E

From: Laura James and Cynthia Kan, Cadmus

Subject: Market Potential for Bill Neutral Energy Efficiency Financing Projects in the Multifamily Sector: Results (CALMAC Study ID PGE0413.01)

Date: March 16, 2018

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Complex ownership and funding structures, and split incentives between owners and tenants (where the building owner owns the equipment or structure but the tenant pays the electricity bills), are barriers to energy efficiency upgrades in multifamily buildings. PG&E is exploring ways to increase multifamily sector participation in its energy efficiency programs by using financing tools. To support this effort, PG&E commissioned Cadmus to conduct a preliminary study, relying on secondary data, to explore the potential bill neutrality of measures that could be deployed in a multifamily setting. For the study, Cadmus considered two questions relevant to planning for multifamily sector financing programs:

1. What are the potential savings for multifamily in-unit and common area/whole-building upgrades, and which measures are most likely to be bill neutral or better when financed?
2. What are the key characteristics of the multifamily housing market in PG&E's service territory?

Our analysis resulted in the following key findings:

- Cadmus assessed whether the savings from energy efficiency measures commonly installed in multifamily buildings were equal to or greater than the financing charges over a 12-month period (i.e., bill neutral). Financing charges were based on the full measure cost and various scenarios for cost of capital, financing term, and energy savings baseline. Few measures passed the bill neutrality test under most scenarios. Assuming a 4% cost of capital and 10-year term, which would be considered standard for a utility financing program, and an energy savings baseline set by building codes or equipment standards for each measure, only ceiling and wall insulation passed the bill neutrality test. Only a scenario with a 0% cost of capital, 15-year term, and existing conditions baseline provided significant opportunity. Additional research would be needed to confirm the deemed savings and costs used in this analysis are reasonable and achievable for multifamily properties in PG&E territory.

- Although the San Francisco Bay Area and surrounding counties have a mild climate, this area has a high concentration of older properties built before California's energy codes existed. These buildings may offer greater energy savings opportunity due to their age, and the geographic concentration could make program marketing and operation less challenging.

- Outside the Bay area, landlords in counties with weak rental markets may be interested in energy efficiency upgrades as a way to differentiate their properties. Rural counties like Butte, Madera, Merced and Placer counties have relatively high rates of rental vacancy.

- Sutter, Yolo, and Stanislaus counties all have vacancy rates under 2%, indicating higher demand for available rental space, and are in hotter climate zones (Climate Zones 11 and 12, in the Sacramento and San Joaquin Valleys). In these counties, comfort may be a more important issue for renters, and landlords may have more funds available to make energy efficiency upgrades that improve comfort.

Detailed findings are also available in the attached Excel workbook (CALMAC Study ID PGE0413.02).

## *Bill Neutrality Assessment*

First, Cadmus estimated savings and costs for energy efficiency measures commonly installed in multifamily buildings, then used that information to identify measures with the potential to be bill neutral. For this study, a measure passed the bill neutrality test if it generated annual energy bill savings equal to or greater than the financing charges over the same 12-month period. Financing charges were based on the full measure cost.

### Data Sources

Cadmus identified 135 different measures across 30 different measure categories (e.g. clothes washers, dryers, insulation, HVAC, etc.) for which we could identify savings and cost estimates. For measures that affect a whole building, such as central HVAC systems or ceiling insulation, we used multifamily savings estimates where available, and otherwise used commercial savings estimates. The complete list of measures is available in the attached workbook.

We compiled savings and cost estimates, including base and incremental costs, from multiple secondary sources. We reviewed dozens of sources, but ultimately relied on a few studies that provided the most comprehensive information. We limited the number of sources we consulted, to ensure underlying assumptions were as consistent as possible. Table 1 presents our final source list. Where estimates were available from multiple sources, we prioritized sources by comprehensiveness (the number of estimates provides for the same measure), date of study (with most recent chosen over older data), and proximity to PG&E territory. The workbook cites the specific source for each estimate.

**Table 1. Sources for Measure-Level Energy Savings and Cost Estimates**

| Title | Author/Publisher | Date |
|---|---|---|
| Technical Resource Manual | California Municipal Utilities Association | 2016 |
| Database for Energy Efficient Resources (DEER) | California Public Utilities Commission | Various (2005-2017) |

| | | |
|---|---|---|
| 2010-2012 Ex Ante Measure Cost Study - Final Report | Itron | 2013 |
| Wisconsin-based research (unpublished) | Cadmus | Various (2012-2017) |

We relied on California-based values wherever possible, and used data specific to PG&E territory where available. For weather-sensitive measures such as a central air conditioner or ceiling insulation, where the savings estimate varied by climate zone, we applied the estimate for Climate Zone 13 (which includes California's Central Valley and has some of the hottest/most extreme temperatures in PG&E's service territory). Since our hypothesis was that few if any measures would be bill neutral, we chose Zone 13, an area with more extreme temperature shifts, as the most likely to result in bill neutral savings. We weighted electricity and natural gas baseline usage by the distribution of fuel types in PG&E territory. We assessed savings based on both a pre-existing (early replacement) baseline, and a code/equipment standard (replace on burnout) baseline, as appropriate, and where data was available for both baselines.

## Methodology

To determine bill neutrality for measures with savings and cost data available, Cadmus modeled the potential bill savings and expected monthly financing payment. We assessed bill neutrality with annual capital costs of 0%, 4%, and 8%, and at three-, five-, eight-, 10-, 15-, and 20-year terms (capped at the estimated useful life of the measure). Cadmus assessed potential bill savings from each measure using five different rates, as shown in Table 2 and as appropriate for the type of measure.

**Table 2. Electric and Natural Gas Rates Used in Analysis**

| Service Type | Electricity Schedule | Natural Gas Schedule |
|---|---|---|
| Residential | E-1 | G-1 |
| Residential (CARE) | EL-1 | GL-1 |
| Master-Metered | EM | GS |
| Master-Metered (CARE) | EML | GSL |
| Common Area Meters (Small Commercial) | A-10 | G-NR1 |

PG&E uses tiered rates for residential and master-metered buildings. Cadmus simplified the rates to allow for a more straightforward calculation. For the residential E-1 rate, Cadmus used data on the average consumption by E-1 customers by month, provided by PG&E, to calculate the average dollars per kWh paid by residential customers. We applied that value as the residential rate to determine bill savings. We extended this calculated rate to the EM class as well, since consumption data for that customer class was not available, but the tiered rates are equivalent to the E-1 rates. For the CARE rates (EL-1 and EML), we used the average per-kilowatt-hour charge published by PG&E in March 2017. The A-10 rate is not tiered, so Cadmus used the published rate.

For natural gas rates, Cadmus assumed that all usage was at the base rate. The specific rates and the source for each are included in the workbook.

## Key Findings

As expected, increasing the capital cost or reducing the financing duration both result in higher monthly charges. In addition, changing the rate from the standard rate to the CARE rate for residential or master-metered projects results in lower bill savings. However, bill neutrality was most sensitive to the baseline assumption. The least-restrictive scenario we applied in this study uses the following assumptions:

- financing at 0% cost of capital and with a 15-year term,
- a meter on a standard rate (non-CARE), and
- a project that results in early replacement and therefore assumes the pre-existing baseline.

Table 3 shows the measures that passed the bill neutrality test under this least-restrictive scenario, and where bill neutrality persists when the baseline is shifted to code or a regulatory standard. (Measures with a project cost less than $500, such as boiler pipe wrap, were excluded because they are unlikely to require financing.) Table 3 also shows how each measure that passed the least-restrictive test performed when the scenario changed to a 4% cost of capital and a 10-year term.

**Table 3. Results of Bill Neutrality Test Under Two Scenarios**

| Measure Description | 0% Cost of Capital, 15-year term | | 4% Cost of Capital, 10-year term | |
|---|---|---|---|---|
| | Pre-existing Baseline | Code/ Standard Baseline | Pre-existing Baseline | Code/ Standard Baseline |
| **Master Metered** | | | | |
| CEILING/ATTIC INSULATION (Base = R-0) | **Pass** | **N/A** | **Pass** | **N/A** |
| CLOTHES WASHER | **Pass** | **Fail** | **Pass** | **Fail** |
| ECM | **Pass** | **Pass** | **Fail** | **Fail** |
| MINI-SPLIT AC | **Pass** | **Fail** | **Fail** | **Fail** |
| POOL PUMP | **Pass** | **Fail** | **Pass** | **Fail** |
| WALL INSULATION | **Pass** | **N/A** | **Pass** | **N/A** |
| WATER HEATER | **Pass** | **Fail** | **Pass** | **Fail** |
| **Residential** | | | | |
| CLOTHES DRYER | **Pass** | **Pass** | **Pass** | **Fail** |
| COOKING OVEN/STOVE | **Pass** | **Fail** | **Fail** | **Fail** |
| MINI-SPLIT AC | **Pass** | **Fail** | **Fail** | **Fail** |
| WATER HEATER | **Pass** | **Fail** | **Pass** | **Fail** |
| **Small Commercial** | | | | |
| CLOTHES WASHER | **Pass** | **Fail** | **Fail** | **Fail** |
| POOL PUMP | **Pass** | **Fail** | **Pass** | **Fail** |

## *Multifamily Market Characterization*

Because Cadmus found few major measures that met the bill neutral threshold (as shown in Table 3), PG&E requested Cadmus conduct a high-level assessment of the multifamily buildings market in PG&E territory and determine general characteristics that are indicators of opportunities for energy saving improvements.

### Data Sources and Methodology

Cadmus used data from the 2009 *Residential Energy Consumption Survey* (RECS)[1] and the 2016 *American Community Survey* (ACS)[2] to characterize the multifamily market and inform potential future PG&E program planning in this sector.

The RECS contains highly detailed information on building shell and energy equipment, as well as some general information on the number of units by building type and building age. Cadmus did not analyze every one of the several hundred data fields included in the survey, instead selecting key data to give a broad overview of the sector. The full data set can be downloaded from the U.S. Energy Information Administration website. Cadmus used the 2009 RECS data instead of the 2015 RECS data because the 2009 survey was expanded to allow for more granular analysis. The expanded data set was structured to provide estimates for the state of California, rather than only providing estimates for the five Pacific states as a region.

The 2016 ACS provides more general information on building type, as well as details of occupancy and housing cost, such as total number of units, number of buildings by size and type, occupancy rates, rental rates, and average rent. The data is available at the county level for 40 of California's 58 counties; 33 of those 40 counties are in PG&E territory. Using the California Energy Commission's climate zone map, we also identified the primary climate zone for each county, and aggregated county data by climate zone. Finally, we applied the California Department of Finance's 2017 county population estimates. The Excel workbook provides all analysis at the climate zone level and the county level. It also includes ACS summary data, for use in future research.

### Analytic Highlights

Below we present highlights from the analysis of each data set, such as building age and distribution of number of units, saturation of certain measures, and areas where we found the highest concentration of multifamily structures built before Title 24 took effect.

#### *2009 RECS Analysis (California)*

The statistics below describe multifamily homes in California.

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[1] U.S. Energy Information Administration, Residential Energy Consumption Survey, 2009. Data accessed online: https://www.eia.gov/consumption/residential/data/2009/index.php?view=microdata

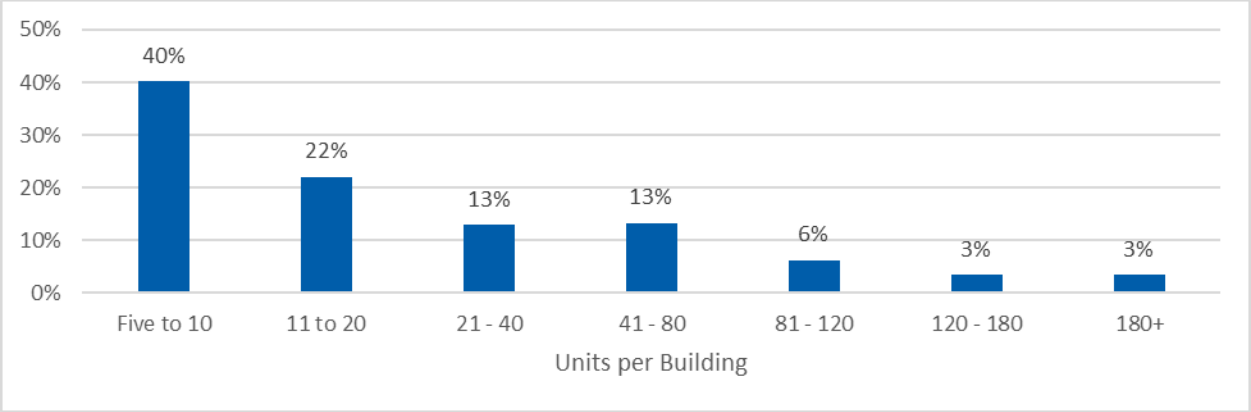
[2] U. S. Census Bureau, American Community Survey, 2016. Data accessed online: https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t

**General Characteristics**

Most multifamily buildings have at least five units, with a median in the 11-20 unit range. The majority of these buildings were built before Title 24 codes, which likely increased the energy efficiency of new construction, went into effect in 1978. Most multifamily residents are renters.

- 74% of multifamily units (those in buildings of two units or more) are in buildings of five units or more[3]
- Figure 1 shows the distribution of buildings with five or more units, binned by building size. Of the buildings with five or more units, 40% have of 10 or fewer units per building

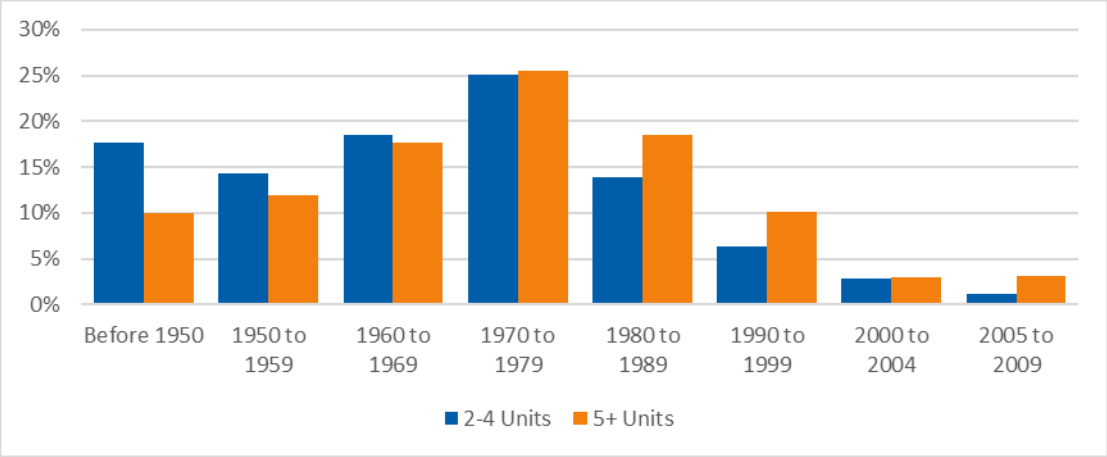
**Figure 1. Distribution of Multifamily Building Stock with 5+ Units, Binned by Number of Units per Building**




- 88% of units in buildings with two units or more are occupied by renters
- 65% of multifamily buildings with five or more units were built before 1980, and 76% of multifamily buildings with two to four units were built before 1980 (See Figure 2). The California Energy Code is part 6 of Title 24 of the California Code of Regulations, which contains the regulations that govern the construction of buildings in California and would apply to major renovations and new construction. It was created in 1978, and would not have applied to buildings built before that year. However, we assume that some fraction of buildings built before 1978 have undergone major renovations triggering Title 24 compliance.

[3] PG&E's multifamily upgrade program defines a multifamily building as having five or more attached dwelling units in each building. See https://multifamilyupgrade.files.wordpress.com/2015/02/pge-multifamily-upgrade_customer-handbook_v20174.pdf

Figure 2. Multifamily Existing Building Stock by Decade of Construction

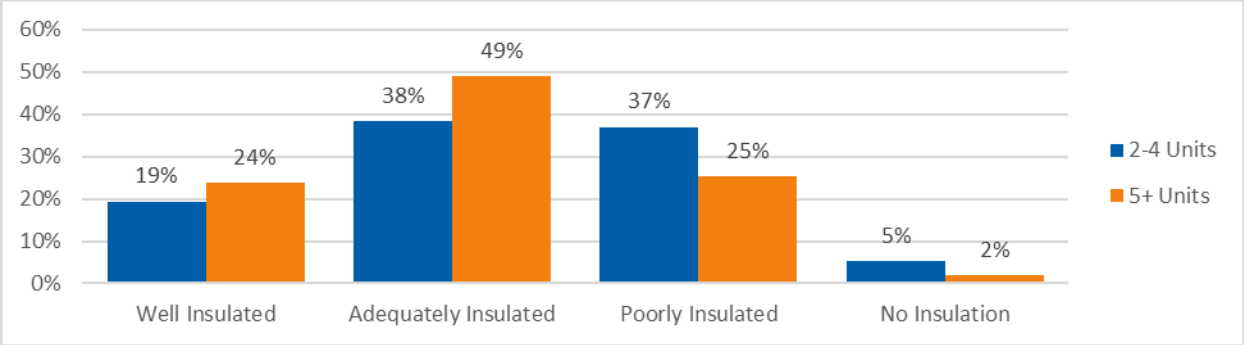



**Building Shell**

The majority of multifamily residents think their unit is sufficiently insulated. A small percentage have taken small or moderate steps to improve their building shell performance, by adding weather-stripping or new windows.

- The majority of multifamily residents think their unit is adequately insulated (49%) or well-insulated (24%) (See Figure 3)

Figure 3. Resident Perception of Building Insulation Level



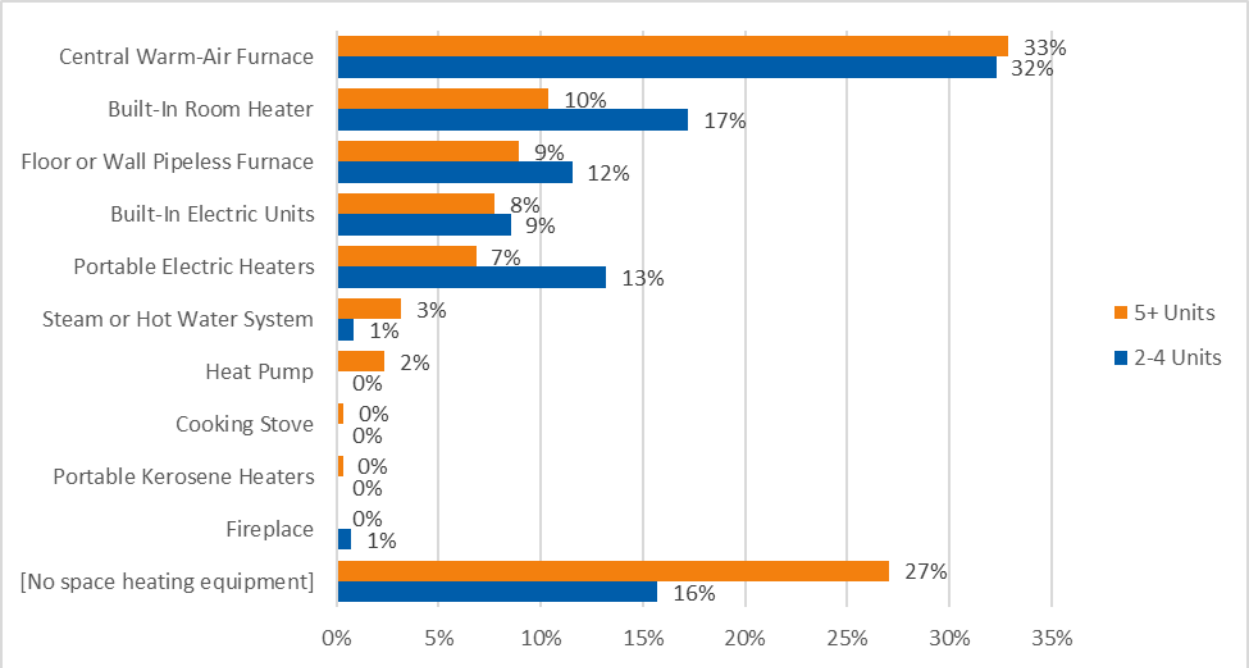

- 13% of multifamily residents have added some type of caulking or weather stripping, and 3% have added insulation
- 13% of multifamily residents have updated at least some of the windows in their apartment/condo

### Space Heating

Among multifamily units that have space heating, natural gas heat sources are more common than electric heat sources. Larger buildings, with 5 or more units, are less likely to have space heating than smaller buildings. About 25% of units with space heating equipment in larger buildings use a zonal heating device.

- 42% of multifamily units use natural gas for heating, 33% use electricity, and 24% have no major heating equipment
- 27% of units in buildings with five or more units have no heating equipment, compared to 16% of units in buildings with two to four units
- Forced air furnaces are the most common type of heating equipment, but other types of equipment are present in significant numbers (see Figure 4)

**Figure 4. Distribution of Types of Space Heating Equipment**

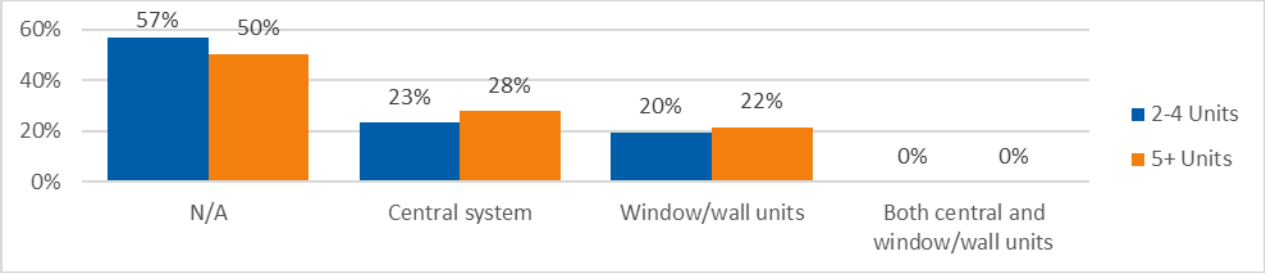



### Cooling

Just over half of multifamily units do not have air-conditioning equipment. Among those that do, central air-conditioning is slightly more common than wall or room units.

- 52% of multifamily units do not have cooling equipment (no central unit, wall unit, or room unit equipment). 27% have central air conditioning and 21% use a window or wall unit (See Figure 5)

Figure 5. Distribution of Cooling Equipment

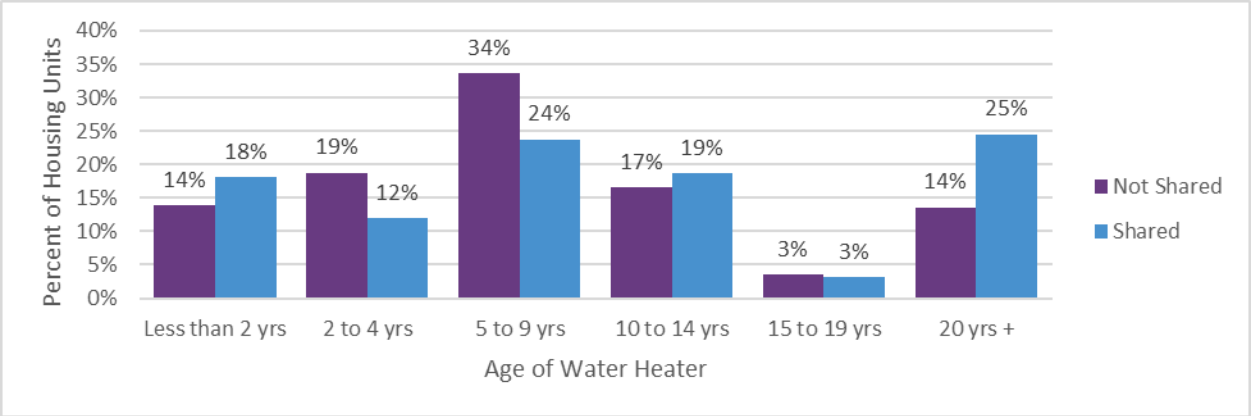



**Water Heating**

About half of multifamily units use shared water heating equipment, which is often much older than the expected useful life for this equipment. Water heaters in individual units tend to be newer than shared water heating equipment.

- 50% of multifamily units use a shared water heater
- As shown in Figure 6, 34% of water heaters that are *not* shared with other units are 10 years or older, compared to 46% of water heaters that are shared by multiple units. (The bill neutrality analysis assumed non-heat pump storage water heaters had a 10-year useful life)

Figure 6. Distribution of Water Heaters by Age




## *2016 ACS Analysis*

The statistics below describe *all* homes (unless otherwise specified) in the 33 counties outlined in the 2016 ACS that are in PG&E territory, across nine climate zones.

**Building and Unit Distribution**

Piloting programs in areas of concentrated eligibility can make programs easier to operate. Multifamily buildings in PG&E territory are concentrated in the San Francisco Bay area, which has a milder climate than other parts of the territory.

- Climate Zone 3 (which includes the San Francisco Bay Area) has the highest number of multifamily units of any of the nine climate zones in PG&E territory (742,262 units, 43% of the total in PG&E counties), despite having only 30% of the population in the 33 counties included in this study
- Santa Clara County has the highest number of 20-unit or more buildings, with 19% of all buildings of this size in the PG&E territory (San Francisco County has 18%). Santa Clara and San Francisco Counties have 12% and 5% of the population included in this study, respectively.

**Rental Market**

The split incentive between renters and building owners can make energy efficiency programs more challenging. The level of demand for rental units can also impact how willing building owners are to participate in a program. Corresponding to the high concentration of multifamily buildings, Climate Zone 3 counties also have the highest percentage of renters.

- San Francisco County has the highest percentage of rental housing among occupied housing units (62%)
- Across all counties in PG&E's service territory, rentals comprised 44% of occupied housing units

**Building Age**

Older buildings tend to have more energy saving opportunities. Climate Zone 3, although milder than other parts of the territory, does have older building stock. Within the climate zone, buildings in San Francisco are oldest.

- Climate Zone 3 has the highest percentage of residential buildings built in 1979 or earlier (69%)
- Of Climate Zone 3 counties, Contra Costa has the lowest percentage of buildings built in 1979 or earlier (55%), and San Francisco County has the highest percentage (82%)

## *Conclusions*

**Bill Neutrality**

***An existing conditions baseline is essential for ensuring that equipment measures achieve maximum savings.*** The bill neutrality of all measures was more sensitive to the baseline condition than to any other factor we evaluated. This distinction does not affect insulation or air-sealing measures, where the concept of "early replacement" does not apply.

***Along with baseline, cost of capital and financing term also affected results.*** Assuming a 4% cost of capital and 10-year term, which would be considered standard for a utility financing program, and an energy savings baseline set by building codes or equipment standards for each measure, only ceiling and wall insulation in a master-metered building passed the bill neutrality test. Only a scenario with a 0% cost of capital, 15-year term, and existing conditions baseline provided significant opportunity across all

measures. However, to provide more bill neutral options, measures could be partially financed or subsidized.

***Master-metered buildings had the most bill neutral measures.*** This result was due to the fact that master-metered buildings pay the same higher rate that residential customers do, but achieve whole-building savings on the same scale as commercial buildings.

**Multifamily Market**

Factors that could influence multifamily program design include geographic concentration of inefficient buildings, ownership and management structure (individual versus a property management company, for example), climate, building age, and the competitiveness of the rental market.

***Areas with strong demand for rental space combined with temperature extremes may be optimal for multifamily energy efficiency programs.*** Sutter, Yolo, and Stanislaus counties all have vacancy rates under 2%, indicating higher demand for available rental space, and are in hotter climate zones (Climate Zones 11 and 12, in the Sacramento and San Joaquin Valleys). In a strong rental market, landlords may have less incentive to compete for renters, but will have more funds available for building improvements. In addition, a market where rents are high regardless of the building energy efficiency, there may be higher demand for a "value-added" space that offers lower energy bills and increased comfort. Comfort will be most important in more severe climates.[4]

***Despite the mild climate, a multifamily financing program in Climate Zone 3 could potentially benefit from higher savings opportunities in older buildings and a concentration of eligible multifamily building stock.*** The San Francisco Bay Area and surrounding counties do not experience extreme temperatures, but do have a high concentration of older properties built before California's energy codes existed. The first version of the energy code went into effect in 1978. Areas with the highest concentrations of multifamily buildings constructed prior to 1978 include all counties in Climate Zone 3, including San Francisco, San Mateo, Marin, Alameda and Santa Cruz counties. However, because the analysis assumed Climate Zone 13 values for weather-sensitive measures, further analysis accounting for Climate Zone 3-specific costs and savings would need to be conducted.

***In rural counties like Butte, Madera, Merced and Placer counties, a multifamily financing program would need to account for the relatively high rates of rental vacancy.*** For multifamily housing, the split incentive is one of the most difficult obstacles to increasing uptake of energy efficiency improvements. In a weak rental market, there will be more competition among landlords. This may increase their willingness to consider energy efficiency improvements as a way to differentiate their property from other similar properties. However, in a weak rental market, landlords will be more sensitive to the upfront cost of improvements.

**Considerations for Additional Research**

[4] Program planners would need to consider how best to serve areas that receive electric service from the Sacramento Municipal Utility District and gas service from PG&E.

Additional research investigating the non-energy benefits of upgrades to multifamily housing could be useful. Research on non-energy benefits, such as the vacancy rate, operations and maintenance costs, late payment rate, safety, and tenant service call rate in weatherized buildings versus non-weatherized buildings may provide information that, in addition to program incentives such as rebates or financing, could promote energy efficiency uptake in multifamily buildings,

## *Recommendations*

As mentioned above, this study should be considered exploratory and the results directional in nature. The use of more in-depth analysis and/or additional, more detailed, data sources, could yield different results, and would be important to any program planning efforts undertaken in the future. Based on this initial analysis, though, planners of a future multifamily financing program would need to consider factors such as the baseline to be used, financing terms, and targeting.

In this analysis, the bill neutrality of all equipment measures was more sensitive to baseline condition than to any other factor evaluated, implying that a future program would maximize savings by encouraging landlords to replace functioning, but inefficient, equipment or claim savings through normalized metered energy consumption. To expand opportunities for bill neutrality, measures could also be partially financed or subsidized. Regardless of the proportion of financing proposed, additional research would be needed to confirm the deemed savings and costs used in this analysis are reasonable and achievable for multifamily properties in PG&E territory.

Master metered buildings offer a significant opportunity for bill neutral financing because they pay a higher rate to common area and whole building projects. However, in PG&E's current Multifamily Upgrade Program, few properties are master-metered, particularly for electricity. Planners of a future program would need to consider geography, climate, building age, rental market conditions, electric and gas rates, and building ownership and management structures.