Final Report

Identifying Determinants of Very Low Energy Consumption Rates Observed in Some Urban California Households

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Disclaimer
The statements and conclusions in this Report are those of the contractor and not necessarily those of the California Air Resources Board.

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1 ABSTRACT

California's 2050 climate goal calls for reducing carbon emissions by 80% below the 1990 baseline. Clearly reduced energy consumption in all sectors will be part of the solution. A small percentage of California electricity customers already live at consumption levels consistent with 80% emissions reductions. These "low users"—consumers in the lowest decile—offer concrete examples of the technologies and lifestyles involved in achieving drastic emissions reductions. We investigated a sample of urban California households to determine the extent to which income, house size, fuel substitution, and expert advice were associated with low usage. Surveys, telephone interviews, and a detailed customer dataset revealed aspects of appliance ownership and operation, building characteristics, demographics, attitudes, behaviors, and impacts of incentive programs. Surprisingly, the low-users encompass a diverse cross section of customers who are demographically similar to the general population. Low electricity usage was not a consequence of poverty, living in small apartments, or fuel substitution, although the lowest users are more likely than the general population to live alone. They employed diverse strategies to reach very low consumption but then often exceeded expert recommendations. Six profiles capture the diversity of the low user population, reflecting lowest usage, diverse cooling strategies, energy upgrades, and high quality of life. Relying on existing technologies the low user population reveals a host of low-energy lifestyles which demonstrate that California's climate policy goals are already achievable in the residential sector. The low user population can also inform decision-makers about successful policies and strategies to reduce residential energy use more widely.

2 EXECUTIVE SUMMARY

Background

California's AB32 requires that the state reduce its GHG emissions to 1990 levels by 2020, and Executive Order S-03-05 goes further, stipulating reductions 80% below 1990 levels by 2050. Although AB32 is primarily concerned with articulating goals and assigning responsibilities, ARB's responsibility to implement AB32 presents an opportunity to incorporate the results of this research study into the strategies delineated in the Scoping Plan, which are chiefly concerned with technical rather than social dimensions of energy use and GHG emissions. One way to interpret the 2050 target—which highlights a particular pathway to compliance—is to apply it to residential electricity demand and ask whether anyone is living at a level of energy use that corresponds to this future target, and if so what is involved in producing that result. This research is designed to explore the extent to which very low electricity usage in the current population could provide examples for an expanded customer outreach effort and a new perspective on the potential for the public to participate meaningfully in solutions to climate change. Very little research has addressed the circumstances accompanying very low residential electricity usage or attempted to provide a description of who these people are.

Methods

To examine the behavior of low energy using households, we selected several samples from the general population of residential customers within the Sacramento Municipal Utility District (SMUD) service territory using a master list of utility billing data. We took samples from the lowest decile of electricity consumption based on average monthly usage from 2008-2010. Because we wanted to contact them and ask them questions about their current residence, households which had not lived in the same residence for the duration of the study period were removed from the sample. Using a database that included consumer information and billing data made available by the utility, we calculated summary descriptive statistics to identify trends in technical and socioeconomic variables within different subsets of households. We then used regression analysis to examine the relationships between these variables and energy consumption in the general population.

In addition to the statistical analysis of the billing data, we conducted in-depth surveys and phone interviews in summer and fall of 2012 to gain insights into the specific circumstances and behaviors that result in or correspond with very low energy usage. To accomplish this we worked with SMUD staff to extract separate random subsamples of renters and owners. We sent electronic surveys to 2,846 renters and 500 owners via email, while we mailed hard copies of the survey to 1,030 renters and 130 owners. Response rates were 15.7% for renters (607/3,876) and 18% for homeowners (113/630). We conducted phone interviews with a subset of owners who completed the survey and indicated a willingness to participate in an interview. We completed 21 interviews out of a pool of 39, or 54%. The surveys and interviews were designed specifically to elicit information regarding behaviors and characteristics of households that were not available from billing data. Our questions focused on air conditioning and other strategies for keeping cool in the summer.

Results

This study has several implications for regulatory programs, and addresses misconceptions that have arisen around the topic of low energy use in the absence of a rigorous empirical study. We found that households whose electricity consumption falls within the lowest decile are

demographically diverse, showing similar variation in income, age, race, and education as the general population. To communicate this diversity, we derived six profiles of low users based on demographic variables as well as select answers to qualitative questions in our survey. Because they are based on both qualitative and quantitative data the six profiles are not mutually exclusive. They include **Well Off and Energy Efficient** (18.5%), **Excellent Quality of Life** (24%), **Thermally Unflappable** (15.6%), **Ultra-low Users** (30.3%), **Sacramento Average** (22%), and **Unhappily Low Energy** (4.8%). Several profiles highlight the different ways members accomplish their low usage. Well-Off and Energy Efficient refers to those in the upper income, education, and home size tiers who indicated a pursuit of energy efficiency improvements. Thermally Unflappable refers to those enjoying an average-or-better quality of life and who rarely or never use their A/C. Ultra-low Users are those whose consumption approximates California's 2050 target. The last profile attempts to capture the folk theory about who would be expected in the low use population, using criteria such as house size, income, and statements about quality of life. Respondents' attention to strategies for minimizing or avoiding A/C use yielded the most detailed responses in our surveys. Both its energetic and symbolic importance suggests that because low users so often exceeded utility recommendations, that utilities' messaging could be revised to include *non-use*. Building on the insights from the six profiles we identified four pathways to low usage, the first two of which are the most policy-relevant insofar as they leverage behavior and voluntary actions: **Energy Efficiency**, **Non-Use**, **Just How It Is**, and **Constraints**. Additional research is needed to estimate the relative sizes of these categories, but the responses to our open ended questions suggest at least half of the lowest decile falls into the first two categories, whose engagement with the subject of energy is high.

Conclusions

We examined the lowest residential electricity users in an urban area of California. We found many low users able to communicate their accomplishments and interest in the topic in ways that are anticipated neither by conventional wisdom regarding low usage nor by expert advice. We found that a subset of this population started by following expert advice on energy matters and through diligence and/or creative divergence from those scripts ended up achieving usage at these very low levels. But very low usage is something individuals with widely varying amounts of money, expertise, and dedication and from all walks of life have achieved. Very low usage is not the exclusive province of apartment dwellers or the poor; but is associated with diverse motivations and strategies, as our low usage profiles emphasize. We invite ARB and other policy-makers, researchers, and local planners to consider the implications of very low energy usage for policy and outreach related to AB32 as well as longer-term climate goals. Our recommendations start by acknowledging low usage as real. Specifically, ARB should build on insights from this research by rendering diverse examples of low usage visible to a wider audience. The next step is to translate these findings into an outreach campaign, to encourage others to explore ways to reduce their consumption of energy. The social, demographic, and possibly motivational, distances between the low users we've studied and the publics who are not in the low usage tiers is revealed to be much smaller than imagined. Going beyond outreach campaigns, the fact of low usage could be leveraged into a more broad-based evaluation of how much potential additional home energy conservation and efficiency may have been overlooked. The fact that low usage practitioners come from all backgrounds opens up new ways of thinking about what is possible in terms of how much we could individually and collectively contribute to the attainment of climate goals by reducing our energy consumption.

3 INTRODUCTION

Climate change is understood to require very large shifts in the ways we produce and consume energy. California's legislature and executive branches (AB32 and Executive Order S-03-05) anticipate this by eventually requiring an 80% reduction in the absolute amount of greenhouse gas emissions within the state over the next few decades (Global Warming Solutions Act 2006, Schwarzenegger 2005). How this is to be accomplished is not entirely clear, but California's Scoping Plan, which outlines steps for implementing AB32, relies heavily on technological advances, shifts in energy supply, upgrades to energy infrastructure, and improvements in the efficiency of end use devices and buildings (CARB 2008 *Scoping Plan*, Long 2010, Energy and Environmental Economics 2009). Although most studies that explore options for meeting long term climate change objectives reflect this preference for high technological solutions (Pacala and Socolow 2004), a few have identified a role for personal level choice at the household scale using current technologies (Dietz et al 2009). Given the scale and scope of meeting this challenge, why are households only occasionally recognized as having something to contribute to averting climate change? How might our reliance on experts and exclusion of public input or insight have compromised our efforts to grasp low usage potential? Why is the public left out of these conversations? How large of a role could they conceivably play in meeting these targets? What would we like to know about residential energy consumption patterns or behavior that could help answer these questions?

Focusing attention only on average consumption levels, as is common in the realm of energy policy, can suggest that there is a 'natural' level of energy consumption, a level that would be difficult to diverge from without special efforts. Studying variation in energy consumption and the outliers, by contrast, can direct attention to both existing differences as well as illuminating potential lessons from a more heterogeneous view of energy use. Because we see an expanded role for households in climate change policy, we are interested in the degree to which variation in energy consumption has been recognized and studied, and, more importantly, what attention low users have received from this research community.

Variation in energy consumption across households was studied extensively in the 1970s and eighties (Socolow 1978, Diamond 1984, Schipper et al. 1989, Hackett and Lutzenhiser 1991). Studies of variation in energy use direct attention to the role of social and demographic factors, but also point to the circumstances under which the social nature of energy consumption is revealed (Hackett and Lutzenhiser 1991). Variation among residential energy customers has also received attention in recent years via information-driven social norm messaging programs that target higher users through information mailed to customers, including a usage comparison across demographically similar households and a series of recommended actions (Dougherty et al 2011). Another outreach effort, pioneered by the Gainesville Regional Utility, puts customer usage information on the web for anyone to access. The expectation is that by encouraging customers to compare their usage with other households (whether similar or not), the large variation among households will motivate change, and reductions in use (http://gainesville-green.com/). Others, such as Seattle City Light, have studied variation among their residential customers, as well as high usage, as a way to identify opportunities for large savings (2010, also Meier 2010).

Although low usage is obviously one component of the variation in energy consumption discussed above, members of the energy research community, as well as the rest of the energy sector, have paid less attention to low usage specifically. The work by Hackett, whose research

into the energy usage of rural 'homesteaders' in Northern California (1980), and Johnson et al., who studied energy consumption among the Amish (1977), are two exceptions. Both studied groups who were culturally and demographically homogeneous and whose identity revolved to varying degrees around a rejection of mainstream values, consumption patterns, and lifestyle.

The present project takes their work as a point of departure and inquires into the outliers within a heterogeneous urban population whose status as low users is not only invisible to members of the society within which they live, but also to themselves. The only distinguishing characteristic of this statistically (rather than socially) defined group is their low electricity usage.

Jane Jacobs pioneered the study of what she called the 'unaverage' in her work on cities. She argued that unaverage clues are useful because statistical methods—that invariably focus attention on the average—provide no information about *how* things are working within a system. Rather than seeking to generalize, hew to the mean, she urged research that paid attention to the irregular, the outlier, the exceptional. Her interest in understanding the social dynamics that make cities work parallels our interest in the social dynamics that make low energy consumption possible. "City processes in real life are too complex to be routine, too particularized for application as abstractions. They are always made up of interactions among unique combinations of particulars, and there is no substitute for knowing the particulars (1961)."

There are several reasons to study these outliers. In the absence of a clear idea of how we can reduce our energy consumption (by up to 80%), studying those whose present consumption is aligned with the same GHG emissions which policy prescribes for everyone in 2050 takes advantage of what we think of as a natural experiment. Another reason that studying outliers could help us advance toward this goal is that it presents an opportunity to increase participation in this unprecedented effort. Households that are already achieving low usage on a level commensurate with 2050 goals should be recognized and made visible; particularly when expert advice (e.g., buy a Prius, CFLs, or ENERGYSTAR appliances) do not begin to get us where we need to go.

What we term the *folk theory* of who would be expected in the lowest decile (predominately poor people, those who live alone, or are never home) fails to acknowledge or take seriously both the population we investigated as well as our reasons for doing so. While a higher proportion of poor people or people living alone may be found in the left tail of the population distribution of electricity use, those "explanations" don't help us understand what is involved in living at these low levels of electricity consumption, or whether anyone is consciously, purposefully, or even happily engaged in producing that result. The social, economic, and demographic diversity we discovered among the lowest decile of electricity consumers is obscured by attention to the statistical fact of a lower *average* income or household size in this subpopulation. The kinds of questions we're interested in asking require a different approach; an approach that recognizes that the population we're studying is made up of outliers, of unaverages.

4 PROJECT OBJECTIVES

Since we knew so little about low usage and low users at the start of this research project, the objectives were to understand who low users are and what their lives entail that permits this low usage. What follows is a list of the questions that guided this research project:

- **Is very low electricity usage real?** Are households whose electricity consumption registers below the tenth percentile even occupied?
- **Who are low users?** How is the population similar or different from the general population? Are they satisfied with their quality of life at this low energy level or dissatisfied?
- **What explains low usage?** What circumstances, patterns of behavior, strategies, and attitudes are associated with low usage? Concerted effort? Happenstance? Efficient technologies? Behaviors? Or are these customers simply poor and unable to afford higher energy consumption?
- **What insights from studying low users can inform policy?** Is it possible to take low user habits, priorities, strategies, and attitudes and craft a new approach to energy outreach? Are demographic similarities between low users and the general public adequate or helpful in bridging the gap, inspiring others to see their energy use in a new light?

Hypotheses

Physical, economic, and behavioral explanations for low energy consumption patterns are frequently articulated but have not, generally, been tested. The list of hypotheses below is derived from a set of assumptions that experts and others make about who consumes very little energy and why. A primary objective of this research was to rigorously test common assumptions associated with the hypotheses delineated below.

1. Income

- Common assumption/null hypothesis: People use much less electricity because they are poor.
- Counter-hypothesis: Higher-income households appear in the lowest category.

2. Demographic circumstances

- Common assumption/null hypothesis: Lowest users live alone.
- Counter-hypothesis: Average-sized families also appear in the lowest category.

3. Physical circumstances

- Common assumption/null hypothesis: >70% of lowest users live in small apartments.
- Counter-hypothesis: >30% of households in the lowest decile are single-family and/or larger homes.

4. Natural gas substitution

- Common assumption/null hypothesis: people who use less electricity substitute gas for a higher than average share of their domestic tasks/appliances.

- Counter-hypothesis: Low electricity households use no more gas on average than the population as a whole, and may use less.

5. Relationship between actions and expert advice

- Common assumption/null hypothesis: In general, people use much less electricity because they have followed expert advice on energy matters.
- Counterhypothesis: Typically, low electricity consuming households have pursued strategies not advocated by experts or have ignored expert advice.

6. Awareness

- Common assumption/null hypothesis: The majority of low electricity consuming households do not think of their energy consumption levels as unusual.
- Counterhypothesis: Low electricity consuming households span a range of awareness of how non-standard their consumption patterns are.

Another key objective of this research was to establish profiles describing the group of very low energy users. Profiles of low energy consuming households can supply examples for replicating conditions, strategies, and behaviors observed to correspond to very low usage. Descriptive information, emphasizing the priorities, struggles, and achievements of the people living in low-consumption households can be used to help raise public awareness and know-how through such programs as CoolCalifornia.org.[1] Prescriptive information, which focuses on specific strategies that other households can pursue, will also offer crucial support to voluntary as well as regulatory initiatives. In both cases, research results will introduce concrete examples of much lower usage to policy makers and energy professionals who can translate factors that enable low usage into a series of actions, strategies, and recommendations.

[1] Coolcalifornia.org is a project of the California Air Resourced Board in partnership with several other organizations. The goal is "to provide resources to all Californians so they can take action, reduce their environmental impact, and be part of the climate change solution." http://coolcalifornia.org/about-us

5 MATERIALS AND METHODS

All of the primary data sources in this study hinged on obtaining permission from the utilities in the service area. Specifically, three consecutive years of customer usage data as well as a list of demographic and residence descriptors were obtained directly from the Sacramento Municipal Utility District (SMUD); as was contact information necessary to conduct surveys and interviews. The initial version of this project was an extension of a long-standing data-sharing arrangement between the City of Berkeley and Pacific Gas & Electric (PG&E). However, in response to the Research Screening Committee's suggestions that a different, larger, city would be more representative of the State as a whole, the study site was moved to Sacramento.

Since residential customers in California typically use natural gas as well as electricity, and in this service territory the two fuels are supplied by different utilities, we endeavored to obtain natural gas usage data from Pacific Gas & Electric (PG&E) to supplement the electricity consumption data. Although negotiations with PG&E extended over several months, ultimately PG&E refused to provide us with customer level data. Because the study was designed around low usage of electricity, natural gas data were not essential, but a more complete picture of the low usage population's total energy budget would have allowed us to say a bit more about the potential for—or degree of—fuel substitution. We were able to obtain some data on natural gas consumption, appliance use, and ownership through our surveys, SMUD's Residential Appliance Saturation Survey (RASS), and summary statistics provided by PG&E.

This research involved a written survey and telephone interviews with residential electricity customers about their energy usage patterns. To contact utility customers we needed SMUD's approval which involved demonstrating that our data security procedures were adequate, as well as satisfying the requirements the Institutional Review Board (IRB) of the University of California, which governs human subjects research. The participant contact information we needed to conduct this research was exclusively for purposes of administering the surveys and interviews and was kept in a secure location and was destroyed at the conclusion of this research phase in accordance with the protocols outlined in our Nondisclosure Agreement with SMUD. All parties agreed that safeguarding customer privacy was the top priority. Language pertaining to data security in that agreement appears below:

> All research conducted by UC Davis, by faculty, staff, or students is required to be reviewed and approved by the campus Institutional Review Board (IRB) for compliance with Federal requirements for the protection of human subjects. Approval is contingent on securing the informed consent of research participants, adequate protection of confidentiality, and the provision of security and limited access to participant-specific data. IRB approval was granted May 23, 2012. The IRB Number assigned to this study is #329722-1.
>
> Any data are received from utility collaborators that contain personal identifiers (e.g., account numbers, names, addresses, telephone numbers, email addresses), is assigned a unique randomly generated ID number. An encrypted file (the "key") that contains only the raw ID (e.g., account number) and the new random ID was then produced. An analytic file that contains the transferred data and the new ID (with all original personally-identifiable data stripped from it) was constructed and used in subsequent research. The original raw data file was physically archived in a secure location. This file will only be accessed again for validation purposes. The key file is saved in a separate secure location. Only two members of the research team, the project manager and the graduate student researcher with whom he will be working, know the locations of these files and have access to them.
>
> When survey data for sample households are collected, they are similarly reassigned the appropriate project ID and stripped of all identifying information prior to analysis. Only 'de-identified data sets' are used in analysis and only by project staff who have (1) been trained in handling confidential data and (2) have agreed to safeguard data sets and all other project

materials from intentional or unintentional disclosure to third parties as a basic condition of their employment. These procedures comply with the UC Policy on the Security of Research Subjects' Personally Identifiable Data Held by Researchers, which is found here: http://cphs.berkeley.edu/datasecurity.html.

SMUD maintains a database of its residential customers which includes a large number of fields describing the physical and demographic features of their customers' households in considerable detail. An extract of the bottom quartile of this dataset represents the foundation of this research project. After obtaining these data from the utility, along with summary statistics for the entire population, our first priorities were to (a) familiarize ourselves with the characteristics of this population, and (b) generate survey samples that would be representative of the share of the population on which we focused our efforts: the lowest decile—households whose electricity usage was lower than ninety percent of the utility territory's population.

The distribution of residential electricity consumption varies somewhat between jurisdictions (see Figure 5.1). Climate, building design, demographic variables, the history of electrification, and many other factors can influence the shape of this distribution. But in other respects, the curves also share certain characteristics. The median consumption tends to be considerably lower than the mean because the right tail of the distribution, high consuming households, extends much farther out than the left tail, which tends to drop off fairly abruptly (Lutzenhiser and Bender 2010). Multi-family dwellings, typically apartments, are associated with slightly lower consumption, on average, than single-family dwellings which are predominately detached houses. Figure 5.2 shows the distribution of residential electricity usage of the bottom quartile of customers for SMUD. Although data covering this quartile were used in the research to compare usage across various segments of the population, including to the entire population for which we obtained summary statistics from the electric utility, most of the research project focused on the portion of the curves to the left of the dashed line denoting the tenth percentile (333 kWh/mo).

Because we shared the Research Screening Committee's interest that a key output of the research be a series of profiles of low use customers whose demographic or other characteristics match those found in the general population but whose usage levels are starkly different, we found it necessary to focus our efforts on those households in the lowest decile. The only way to generate these profiles, and to develop case studies, was to focus on those customers whose usage distinguishes them as being in fact starkly different from the mean (or median).[2]

[2] The initial research proposal identified the zero to tenth percentile range as the most suitable sample for examining this low user population. In response to Research Screening Committee (RSC) suggestions, this was adjusted to the 5th to 25th percentile range, with the goal of minimizing inclusion of unoccupied households on the low end, and to include a broad range of low users whose usage behaviors, physical circumstances, and attitudes were anticipated to be (more) diverse, and more familiar to the anticipated audiences of any recommendations that might be generated through this study. However, upon receipt of a preliminary dataset from the electric utility in February 2012, the research team discovered several things that caused us to readjust those parameters. First, the adjusted data range selected in response to RSC comments did not in fact include the low users, which for purposes of this research we defined as those whose usage is within 0.5 standard deviations of 80% below the 2010 median residential electricity consumption level for this utility service territory. Because the population of interest included occupied residences below the 5th percentile of electricity consumption, it was necessary to shift the lower bound of the sample back down again. The distribution of residential electricity consumption (See Figure 5.2) in this utility territory meant that usage levels above the lowest decile were insufficiently distinct from the mean to warrant inclusion in the survey population.

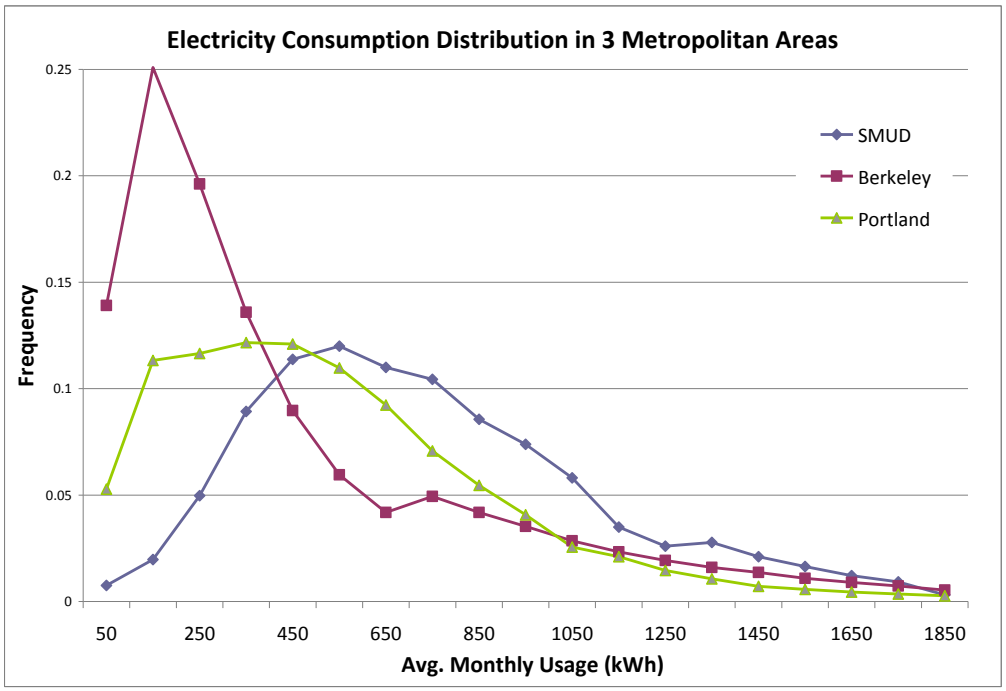

Figure 5.1: Distribution of residential kWh consumption in three West Coast cities/metro areas[3]

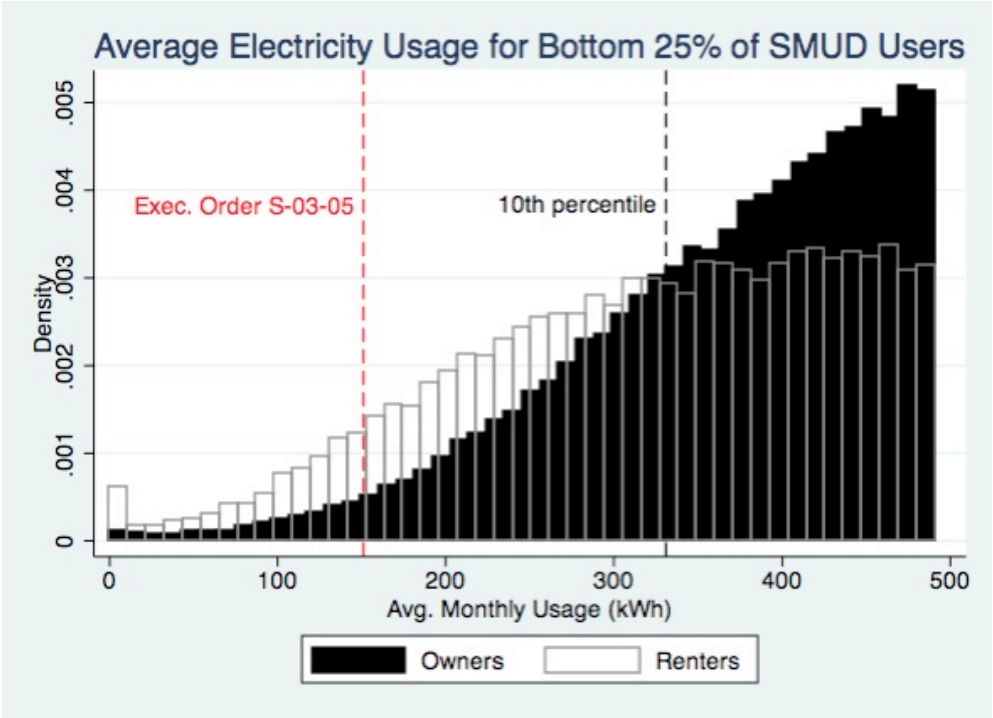

Figure 5.2: Average monthly electricity usage of bottom quartile of residential electricity customers

[3] Data for Portland are from PGE, and reflect only one SE Portland zip code; data for Berkeley are from PG&E and reflect the entire city of Berkeley. Both are from 2006. The curves represent the entire populations in each city.

Data Sources

The utility statistics used in this research project included general population summary statistics and account level data for the lowest quartile. Additional data for this project were taken from the 2008 SMUD Residential Appliance Saturation Survey (RASS). PG&E supplied aggregated data on residential natural gas usage for summer and winter.

Statistical Methods

The first phase of the analysis made use of utility billing data for households in the bottom 25% of electricity consumption in the service territory (n=83,561). This data includes three measures of energy usage for 2008, 2009, and 2010: average monthly kWh, total kWh, and the ratio of summer peak consumption to non-peak consumption. In addition to these measures, the data also included demographic information for the household head, renter/owner status, physical characteristics of the residence and other household information such as income, residence length and participation in utility programs.

As a preliminary analysis, we used regression techniques to obtain estimates of the impacts of variables of interest on levels of electricity usage for the general population. We employed a truncated regression model to account for the fact that we did not include any households above the 25th percentile for electricity consumption. While some of the variables are continuous, many are categorical. This feature of the data limited our ability to obtain precise estimates and also resulted in somewhat awkward interpretations of the parameters.[4] The results from this analysis represented the average relationships between demographic variables and physical housing characteristics on electricity usage in the entire utility population.

Although regression analysis is a powerful tool for explaining relationships between variables, it provides estimates of average relationships and in this research we were interested in a sample of the population that is clearly "unaverage" in terms of their energy consumption. As a first step in examining the features of low energy using households more closely, we calculated summary statistics of the demographic, housing, and energy variables for targeted subsamples of the data, including usage for renters vs. owners and demographic patterns within different segments of the low-energy using population (< 1%, 1-5%, 5-10%, 10-15%, 15-20%, 20-25%). Despite the descriptive nature of these simple statistics, comparisons between different subsamples offered preliminary evidence that could be evaluated in the context of the hypotheses of interest. In addition to these intra-sample comparisons, we compared patterns and distributions for the variables of interest in the full sample (bottom quartile) to patterns and distributions that exist in the entire utility population. Many of the population estimates came from the latest RASS conducted in SMUD territory in 2008.

[4] With continuous data, the parameter estimates from linear regression can be interpreted as the average marginal effects of an explanatory variable on electricity usage. For example, an estimated coefficient of 20 for a variable measuring the number of people living in a home would be interpreted as "each additional person living in a household increases household electricity usage by 20 kWh per month". Since categorical variables necessitate the use of dummy variables in regression models, the interpretation for that same coefficient for a category of, say, 2-3 residents (with the "1 person" category omitted) becomes "households with 2-3 residents consume 20 more kWh of electricity per month on average than households with only 1 resident".

In addition to the statistical analysis of the billing data, in-depth surveys and phone interviews were used to gain insights into the specific circumstances and behaviors that corresponded to very low energy usage. To accomplish these goals, separate random subsamples of renters and owners falling in the 0-10th percentiles were extracted from the initial sample. Beginning with a sample of 33,261 households that fell in the bottom 10%, we identified and removed households believed to be unoccupied or particularly unusual based on the following filters:

- Current address does not match the address in the data (3,934)
- Average monthly usage is <30 kWh (184)
- Owners have been living in home for less than 2.3 years (1,168)
- Summer peak loads less than one half of winter peak loads (950)
- Solar PV customers with net-metering (56)

These filters left us with 27,025 households (14,627 renters and 12,398 owners), from which we randomly selected 3,940 renters and 630 owners and invited them to participate in an energy use survey. In a cover letter mailed to the survey sample we explained that participation was voluntary and responses would be kept confidential. We included an address and phone number for anyone to contact us if they had questions or concerns about the survey. The survey was designed to elicit detailed information about energy infrastructure in the home and energy use behavior. Electronic surveys were sent out to 2,910 renters and 500 owners via email, while 1,030 renters and 130 owners were sent hard copies of the survey. Response rates for the surveys were 15.4% for renters and 18% for owners.

Survey design followed Dillman's Total Design Method, which spells out a series of techniques that have been shown to increase response rates (Dillman, Smyth & Christian 2009). Repeated, personalized reminders including additional questionnaires are a key element of this method. The logistics and cost of mailing these reminders (and transcribing the responses) is considerable, which is one reason why electronic surveys offer certain advantages over their hard-copy predecessors. In practice, well-designed web-based surveys following Dillman's method have been found to result in higher response rates at significantly lower cost than mailed surveys (ibid., Monroe & Adams, 2012).

The customer contact information we received from the utility included email addresses for a portion of the population. Because of the promise of high response rates using an internet survey platform, we examined the possibility of oversampling customers for whom we had an email address. We compared summary statistics for households in the lowest decile with and without email addresses and found no significant differences between the two groups across all demographic categories (see Appendix B for a comparison of the two subpopulations). Because of this, we decided to oversample those households who had provided email addresses to the participating utility to improve our response rate.

Survey respondents were linked to their demographic and housing information in the billing data, which allowed for detailed descriptive analyses of survey responses. A key component of the survey analysis was identifying low user *profiles*. These profiles represent different ways of classifying individual households found in the bottom 10% of energy usage based on survey responses and demographic/housing information. Each profile captures a set of social or demographic characteristics. By differentiating among the lowest users we hoped to shrink the

(imagined) social distance between low users and the rest of the population, who may recognize themselves, or familiar characteristics, in one or more of these profiles.

The final phase of the analysis involved conducting phone interviews with a subset of owners who completed the survey and indicated they would be willing to participate in an interview. These interviews were designed to be brief (10-15 minutes) and were structured around a questionnaire that focused on air conditioning behavior and recommendations for how other households could reduce their energy consumption. Thirty-nine survey respondents indicated a willingness to participate in a follow up interview. We were able to contact and schedule interviews with 21 of those respondents, for a response rate of 54%. Respondents were called at different times of the day over the course of two weeks. If we encountered voicemail or no answer we left a message explaining our reason for calling and/or tried the number again, varying the time of day or evening, calling back as many as six times. Six of those we called refused to participate for one reason or another. The remaining 11 respondents we were unable to reach. The interviewees spanned five of the six profiles, and we drew on their responses to illustrate in greater detail what attitudes and strategies informed their approaches to using very little energy.

6 RESULTS AND DISCUSSION

Quantitative Results Summarized

Descriptive statistics using billing data from SMUD provided a preliminary platform for comparing low energy users to the general population. Although average values of variables for low-using households are different than population averages, results show that the low-using population is diverse in terms of demographic and economic variables. The billing data also allowed us to estimate average relationships between energy consumption and several important explanatory variables, such as income, education, age, housing characteristics, and number of residents.

Results from Ordinary Least Squares (OLS) and truncated regression models are presented for all households, owners, and renters in Table A.1, which appears in Appendix A. These provide estimates of average relationships between electricity usage and variables of interest. Because our dataset includes only the bottom 25% of electricity users in SMUD territory, the truncated regression model is the preferred specification. The estimated coefficients show that on average, higher electricity consumption is associated with larger residences, older residences, more permanent residents, younger household heads, higher incomes, and longer periods of continuous residence. For the entire population, each additional square foot of floor space is associated with an increase in household monthly usage by approximately 0.11 kWh, while increasing home age by one year increases monthly usage by 0.86 kWh in the owner population, but not the renter population. Each additional person living in the household contributes an additional 17-21 kWh per month depending on residence type. Households with heads older than 54 years old consume anywhere from 10-48 fewer kWh per month compared to households with heads between the ages of 35 and 44. Poor households earning less than $30,000 per year and own their dwellings consume about 20 kWh less per month than households earning $50,000-100,000, however, there is no statistically significant difference in consumption between these two groups amongst renters. The same trend holds for the top end of the income range, as homeowners earning more than $150,000 consume 26 kWh more per month more than the middle-income bracket, but high-income renters have the same level of consumption. Another interesting finding is that households with heads having a college degree consume approximately 7 kWh less per month than households with heads who started college, but did not finish. This result does not hold in the renting population.

The regression results provide evidence supporting many well-established theories about low energy consumers. Holding all other variables constant, households with higher incomes, larger homes, more people, and more educated heads consume more electricity per month on average. Age of household head is negatively correlated with electricity usage, while Asian-American households tend to use less electricity than other ethnic groups. However, it is important to note that the econometric results above assume linear relationships between variables and provide estimates of average impacts in the population. A focus on averages directs attention toward the familiar, common, unremarkable, and doesn't say much about the potential mechanisms that may lead to low usage. But households found within the low use tiers are by definition outliers; that is what makes them interesting to this research project. Despite the fact that households in the bottom quartile of electricity usage are on average poorer, smaller, less educated, and older, the wide distributions of these variables within the bottom quartile and the poor fit of the regression model suggest that other factors, such as behavior, may also be an important contributor to low

energy use. The specific behaviors, strategies, preferences, and attitudes that may not be widely distributed across the population coincide with low usage and it is these characteristics and the various combinations of them that we wished to understand.

To dig deeper into the specific circumstances of low energy users, we analyzed a completed set of in-depth surveys that were distributed to a random sample of renters and homeowners in the lowest decile of energy consumption. Households spanning all demographic categories (income, education, age, race, household size, etc.) are represented in the responses. Survey responses indicate that appliance ownership levels vary within the low usage tier and A/C use behavior has a significant impact on summer peak electricity usage. In addition to short-form, multiple choice type questions, free form answers were also recorded, which elicited additional insights, including household tolerance for heat, the diversity of cooling strategies employed during the summer, a range of motivations for low usage, detailed descriptions of efficiency upgrades, and the roles of behavior and energy efficient technologies. Cost savings is a motivation for some to use less electricity, but not for others.

The final piece of analysis utilized interviews that were conducted with homeowners in the lowest decile of energy users. Interviews focused on A/C use and behavior and provided more specific details on house cooling strategies. Responses indicated that these strategies are multi-faceted and involve diurnal behaviors (opening & closing windows, turning on and off fans), changes to physical parameters (tile floors, insulation, air sealing, solar shades, shade trees), and routines (avoid cooking indoors on hot summer days; spend more time outside). Interviewees were also asked for recommendations for reducing home energy usage and suggested opening windows to take advantage of the Delta breeze, using window fans, improving air sealing and insulation and turning things off when not in use (e.g. A/C, lights, electronics, home office).

Demographic Comparison between the General Population, Lowest Decile, and Survey Respondents from the Lowest Decile

This section details how the lowest decile compares to the general population, and also how well our survey sampling of the lowest decile matches the demographic characteristics of the population from which it was drawn. Figures 6.1 – 6.4 compare all three populations with respect to the four demographic categories: income, education, age, and ethnicity. Renters and homeowners are treated separately.

Utility customers in the lowest decile differ from the general population in a few respects. With respect to income, age, education, and ethnicity, the overall distribution of the population whose electricity consumption falls below the tenth percentile is quite similar to the general population. Age, ethnicity, and education tracked each other very closely. Income is measured categorically in five bins. In the case of the renter population in the lowest decile, their income distribution matched the general populations' quite closely, with the largest difference occurring in the lowest bin (<$30K) 46% (7,256/15,922) vs. 32% (26,651/83,598)). In the case of homeowners, the income distribution for the lowest decile appears to be shifted to the left as three of the five income bins were within 5%, but the lowest and highest bins are essentially reversed.

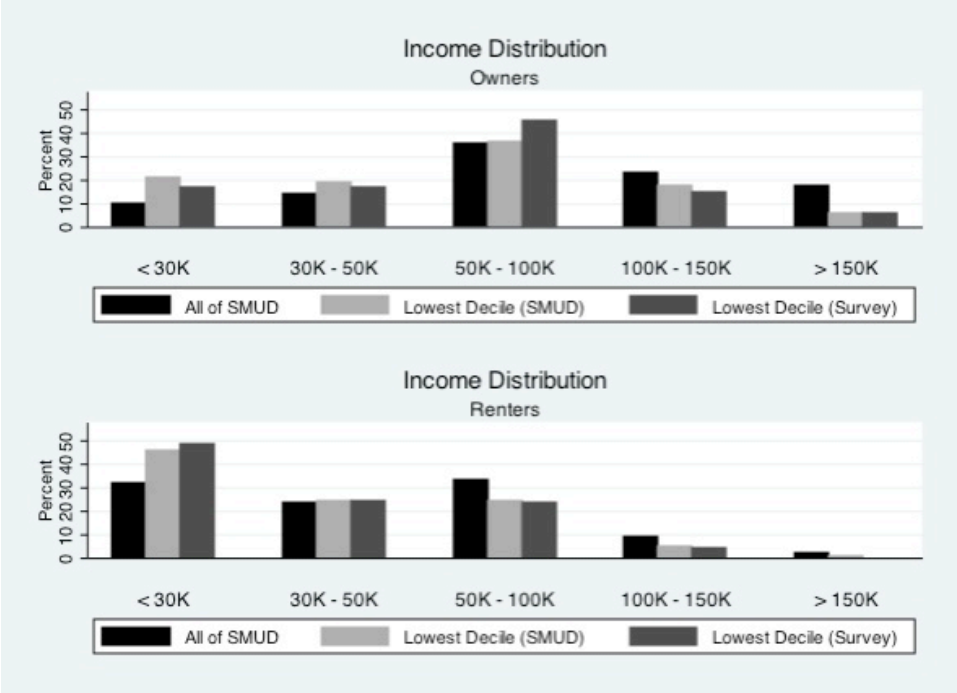

Figure 6.1: Income distribution of SMUD general population, the lowest decile of the SMUD population, and our survey sample of the lowest decile

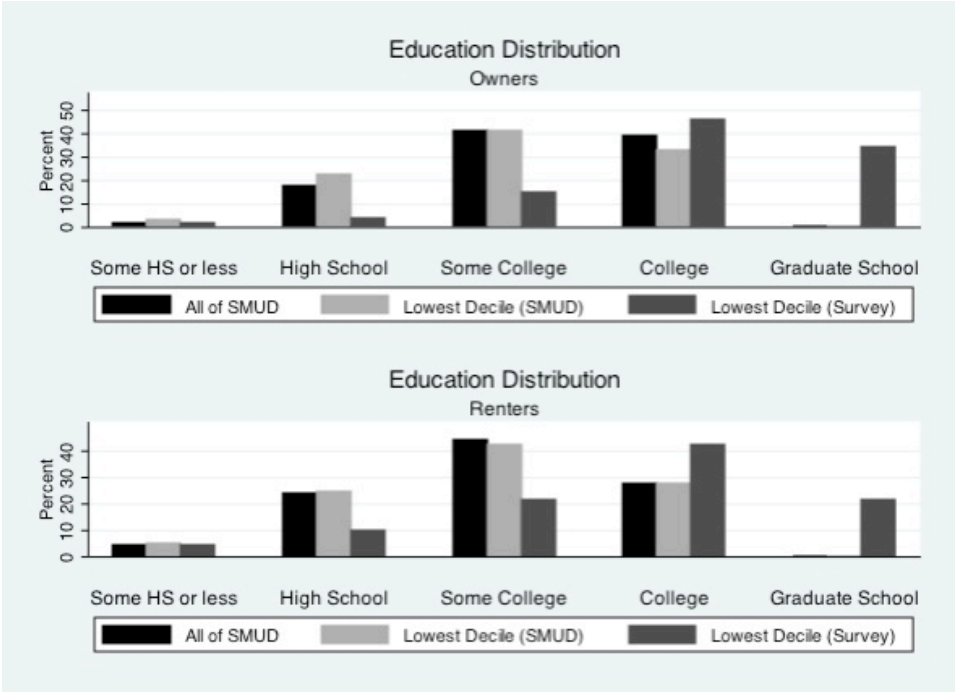

Figure 6.2: Educational attainment of SMUD general population, the lowest decile of the SMUD population, and our survey sample of the lowest decile

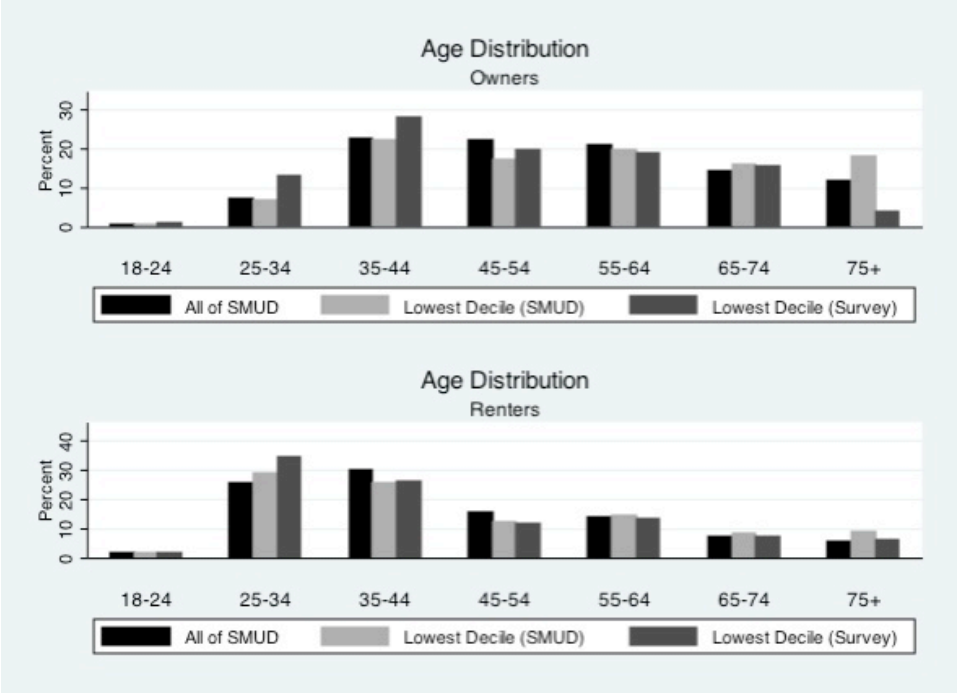

Figure 6.3: Age distribution of SMUD general population, the lowest decile of the SMUD population, and our survey sample of the lowest decile

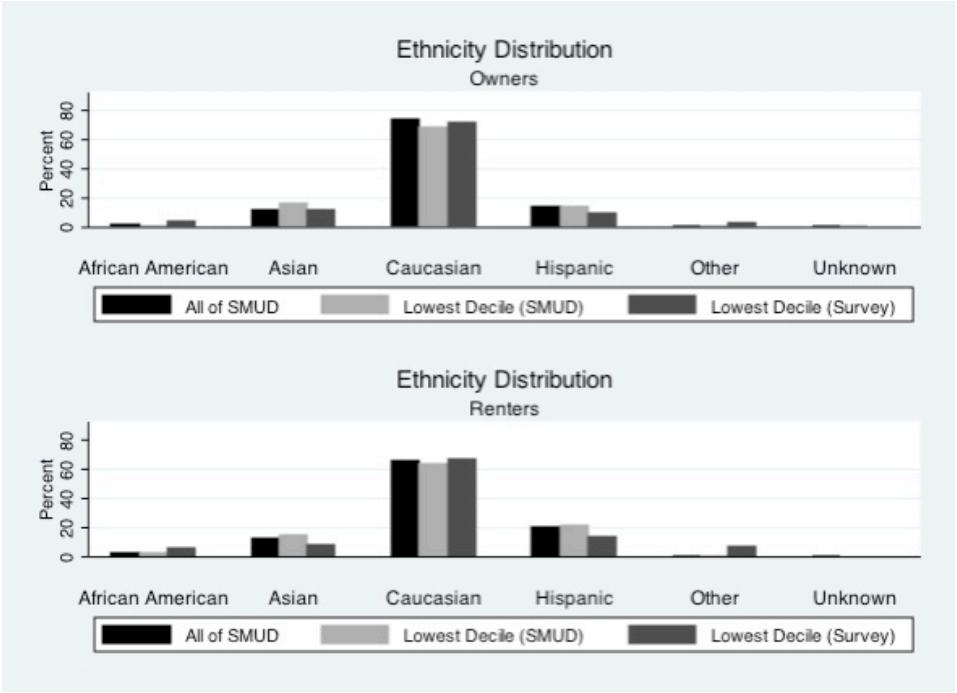

Figure 6.4: Ethnicity of SMUD general population, the lowest decile of the SMUD population, and our survey sample of the lowest decile

The two categories in which our survey sample of the lowest decile did not match the lowest decile population very well were age and education. Our survey respondents were slightly younger and better educated than the population we sampled. Notwithstanding the similarity between the lowest decile population for whom we did—and did not—have an email address (see Appendix B, Table A.2), our decision to oversample those households that had provided email addresses to the participating utility skewed the responses on these two parameters. We had not considered the possibility that within the email population the responses might skew differently than in the population that we contacted by mail. Our decision to oversample those with email addresses did yield slightly higher response rates among this population (570/3,346 or 17%) than among those we contacted by mail (140/1,160 or 12%). Having observed this, we would modify the sampling in future research, and oversample customers who were older than 75 years and renters whose education had stopped short of 4 years of college, all else being equal.

At least at this general level of population demographics, the similarity between the very low users and the general population is noteworthy. We discuss this at greater length in later sections of the report.

Demographics of Lowest Decile

The following six charts describe some of the salient attributes of the population of very low electricity customers whom we surveyed. Where possible, we have included a population average from the SMUD RASS for reference. We asked these utility customers a series of demographic questions to verify the information that we already knew from the utility dataset, or to obtain more fine-grained information. All charts list owners and renter populations separately.

Figure 6.5 shows a more fine-grained division of income. Owner-occupied households are fairly normally distributed around the $50-$100,000 income bin, while renters are more spread out. The roughly one-third of renters whose income was <$20,000 is noteworthy. While this finding evokes the assumption underlying hypothesis #1 on income, the fact that low users appear in most of the other income bins as well suggests any simple equation of low usage and low income is premature.

Hypothesis #1

- **Null-hypothesis**: People use much less electricity because they are poor.
- **Counter-hypothesis:** Higher-income households appear in the lowest category.

Because the majority of households in the lowest decile are not poor renters, we reject hypothesis #1, even as we acknowledge that poor renters are overrepresented in the lowest decile compared to the general population.

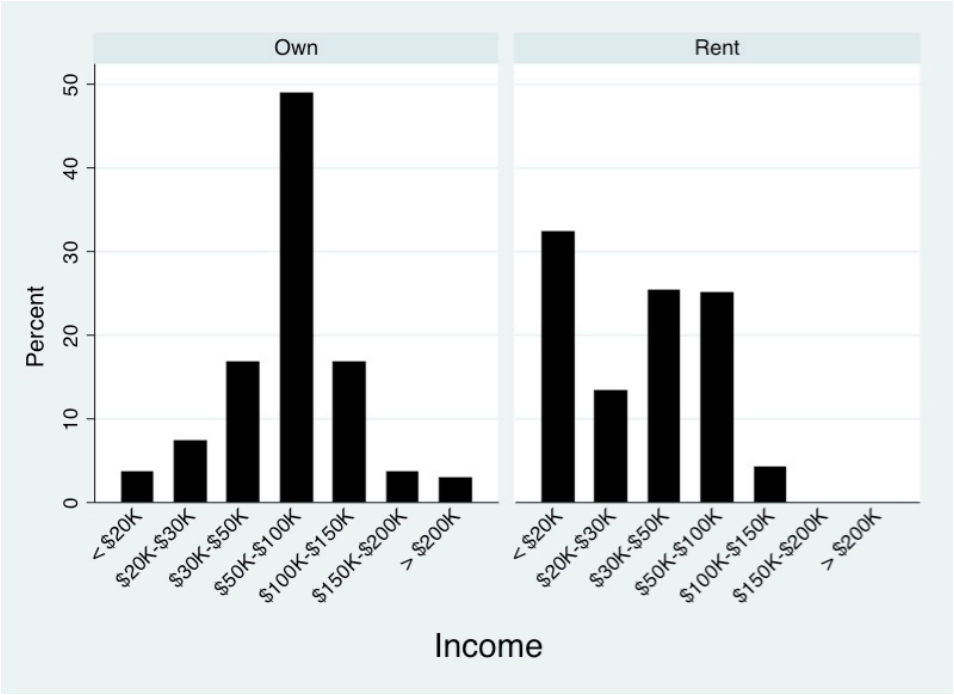

Figure 6.5: Income distribution of lowest decile respondents

The average number of occupants in the households that responded to our survey was 1.6 persons (Figure 6.6). This is significantly less than the 2.6 person population average for Sacramento County (2010 Census).[5] The high incidence of single people in this sample for both owners and renters, as well as the very small number of larger households/families is noteworthy. Because the distribution of household size is skewed toward those living along we accept the null hypothesis.

Hypothesis #2

- **Null-hypothesis:** Lowest users live alone.
- **Counter-hypothesis:** Average-sized families also appear in the lowest category.

[5] http://www.clrsearch.com/Sitemap/California/Sacramento-County

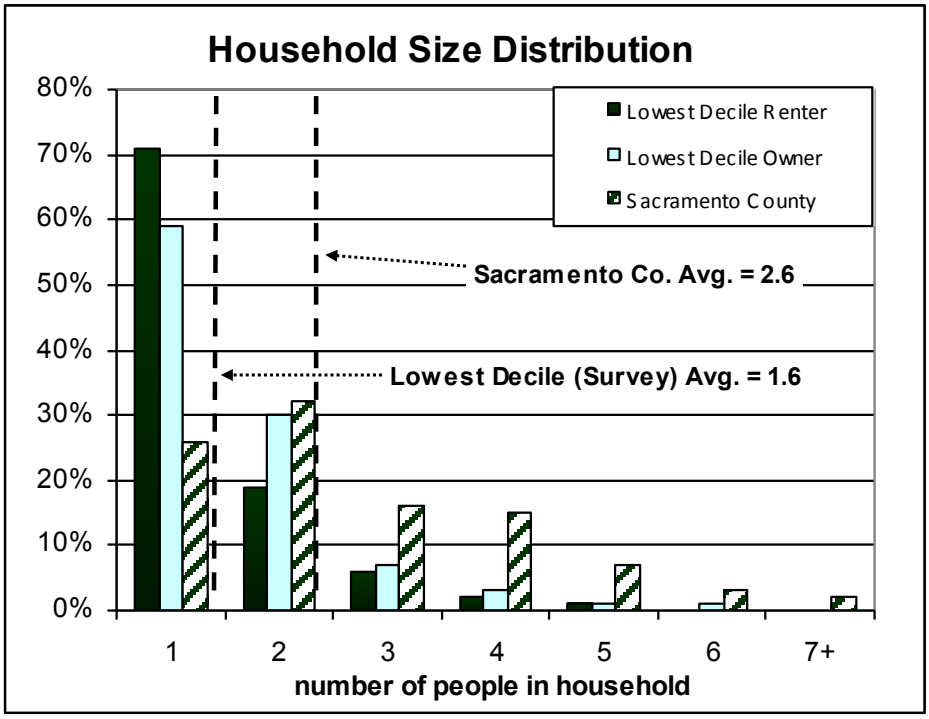

Figure 6.6: Number of residents in lowest decile households & Sacramento Co.

As Figure 6.7 indicates, the distribution of homeowners and renters by age is not particularly surprising. Renters exhibit a peak in the 25-34 age bracket, whereas homeowners in our sample are slightly older and slightly more evenly distributed by age. Figure 6.8, which lists ages in years rather than bins, shows how broadly distributed the age range of this population is.

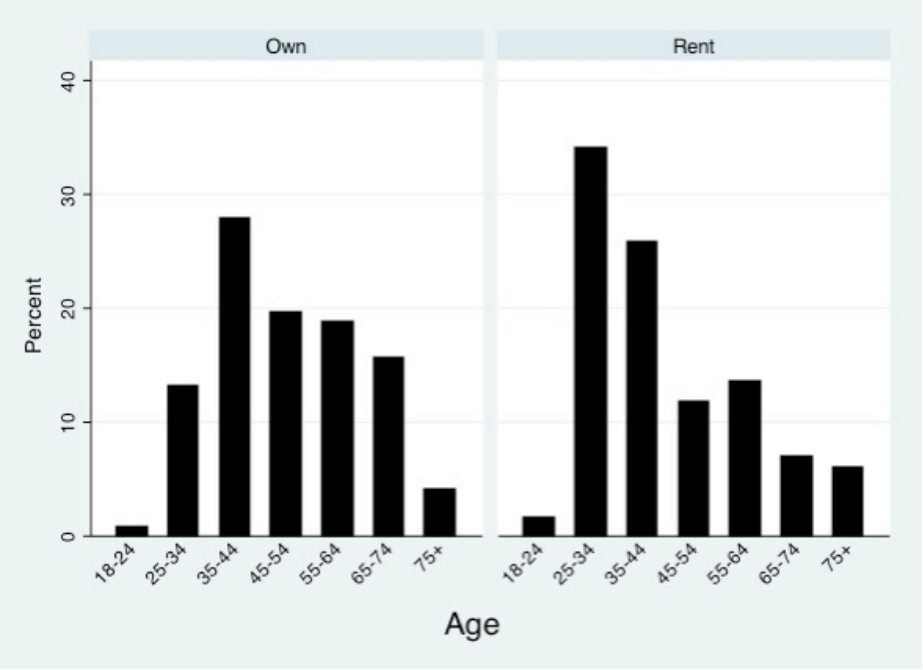

Figure 6.7: Age distribution of household head (bins) in lowest decile

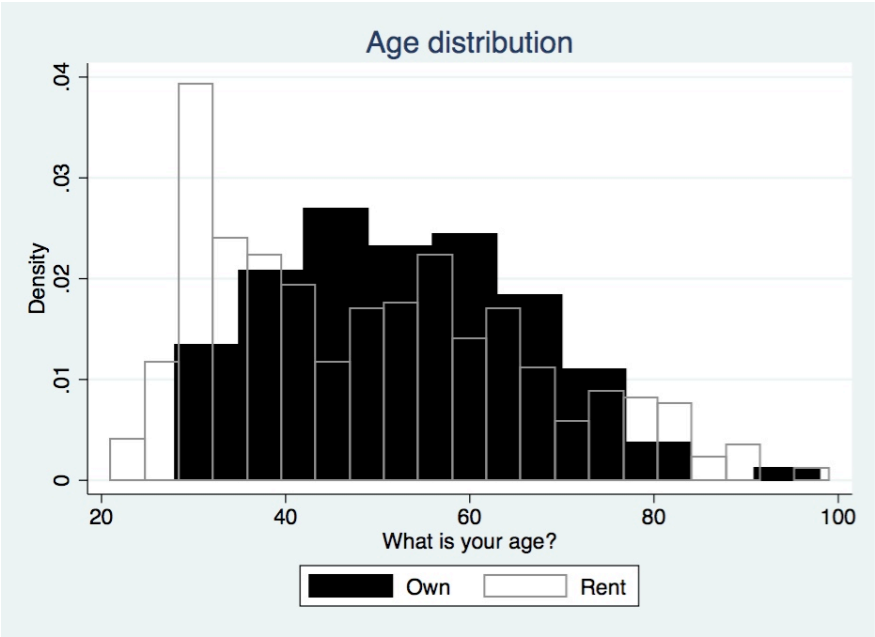

Figure 6.8: Age distribution of household head (years) in lowest decile

Home size is the subject of hypothesis #3 and it is presented in Figure 6.9.

Hypothesis #3

- **Null-hypothesis:** >70% of lowest users live in small apartments.
- **Counter-hypothesis:** >30% of households in the lowest decile are single-family and/or larger homes.

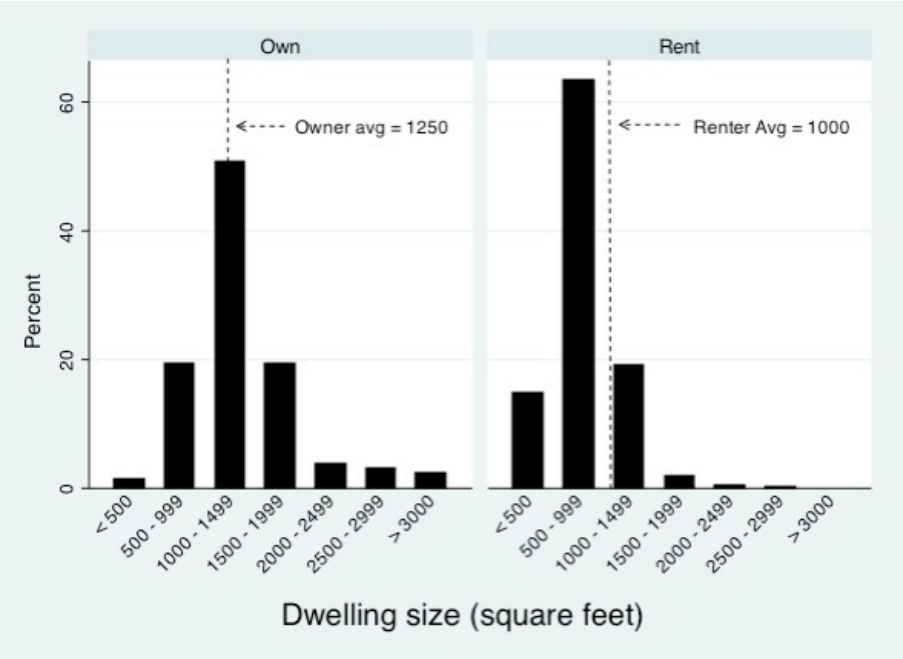

Figure 6.9: Distribution of home size in lowest decile and population avg from SMUD RASS

The square footage of the average owner-occupied home in our sample of the lowest decile is indistinguishable from the population average, while the renter average in the lowest decile is somewhat smaller than the population average. But because home size is logged in 500 sq. ft. bins, we can't make any more precise comparisons between the two populations. However, 46% of the lowest decile population in our sample are homeowners, which means that the diversity of home size for the entire lowest decile population (homeowner + renter) is considerably greater than the null hypothesis predicted. We therefore reject the null-hypothesis, even though for the renter population by itself the conclusion is ambiguous.

Electrical Appliance Saturations

Figures 6.10 – 6.12 compare appliance saturations noted in the Residential Appliance Saturation Survey (RASS) and in our survey of the lowest decile. Appliances are not a direct proxy of electricity use, but a household with a large number of appliances is assumed to have the potential to use more electricity. The rise in so-called plug loads in recent decades is, furthermore, thought to be an important driver of increased residential electricity consumption (Sanchez et al. 1998). The fact that these low use households appear to own the typical suite of major and minor appliances, even at slightly higher rates than the general public, is noteworthy.

In our survey, we asked respondents to identify what appliances they owned and used from a list of 27 electrical devices. The most common electrical ones are listed in Figure 6.10 and 6.11 and the most common natural gas ones are listed in 6.12.

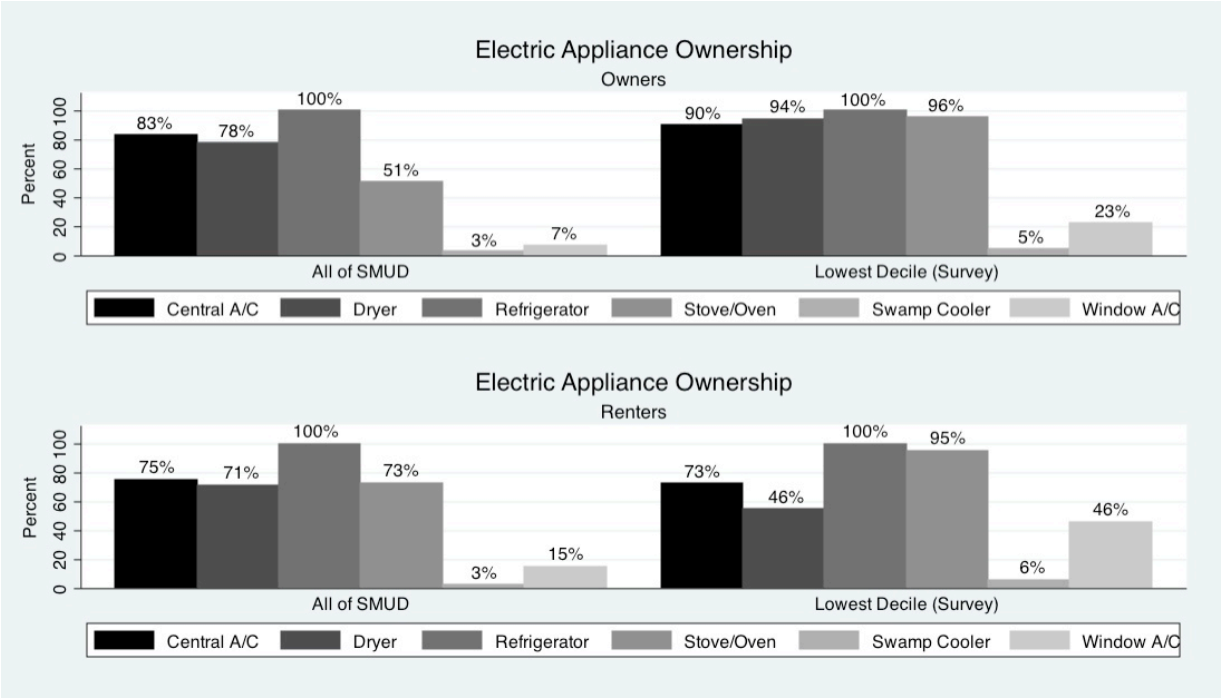

Figure 6.10: Ownership rates of major electrical appliances (general population data from the RASS, other data from our survey).

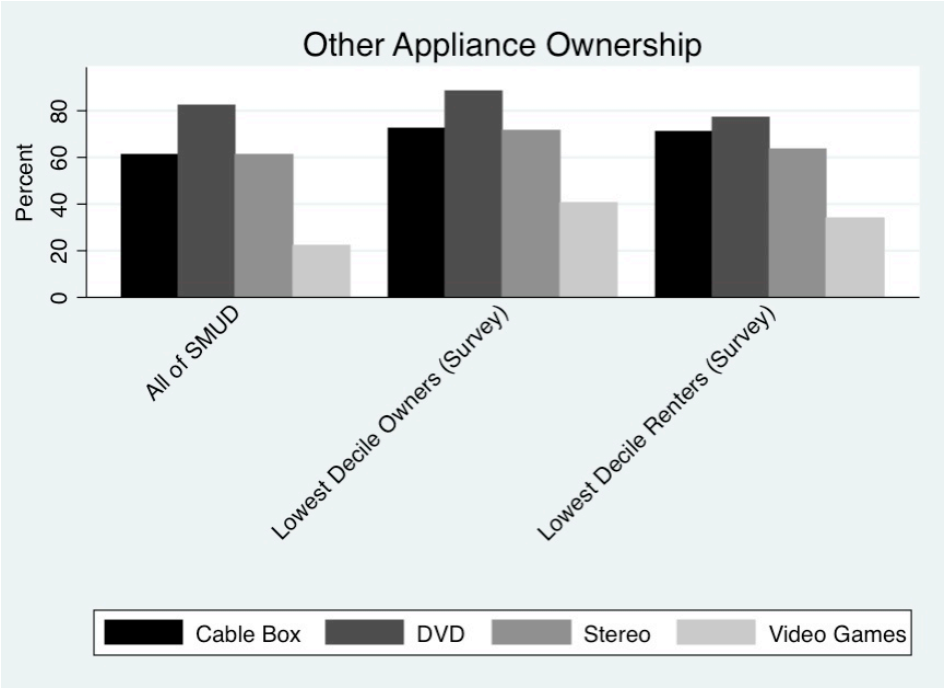

Figure 6.11: Ownership rates of consumer electronics (general population data from the RASS, other data from our survey).

Ownership of both major electrical appliances and of consumer electronics in the lowest decile are in all but one case *higher* than observed for the general population. Only the saturation of electric clothes dryers among renters in the lowest decile is lower than for the equivalent demographic in the general population. This is surprising. Obviously ownership of all these end use devices does not correlate well with overall electrical usage.

Natural Gas Appliance Ownership and Usage

Gas appliance ownership

Comparing gas appliance ownership among the general population and the lowest decile respondents, our results suggest similar ownership rates overall (see Figure 6.12). Though the saturations of each appliance category differs somewhat, on balance the differences in ownership rates come very close to cancelling each other out. Lowest decile homeowners have a slightly lower gas furnace and water heater saturation but are slightly more likely to own a gas oven and gas dryer. For renters the ownership rates on clothes dryers and furnaces are reversed, but similar for ovens and water heaters. Looking just at gas appliance ownership rates among the lowest decile, these do not appear to be responsible for lower electricity usage. Hypothesis #4 addressed this question:

Hypothesis #4

- **Null-hypothesis***:* people who use less electricity substitute gas for a higher than average share of their domestic tasks/appliances.
- **Counter-hypothesis:** Low electricity households use no more gas on average than the population as a whole, and may use less.

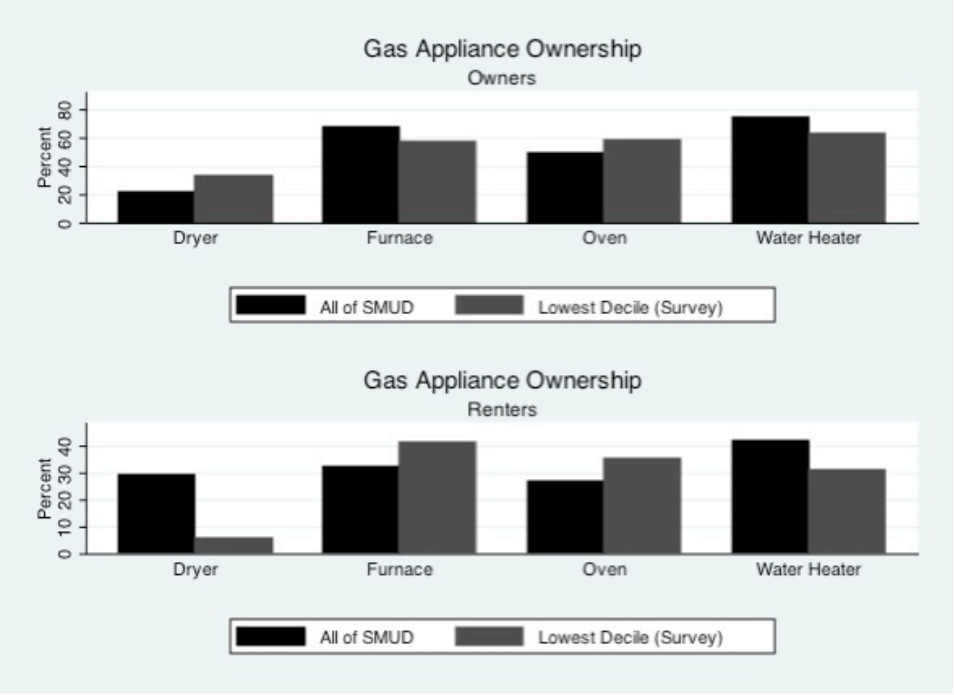

Figure 6.12: Prevalence of gas appliances in the home (All Owners/Renters data from the SMUD RASS, Lowest Decile data from our survey).

Gas usage

Data from the gas utility suggest that the general population (not differentiated by type of customer) uses an average of 19 therms/month in the summer, and 68 therms in the winter. Results from our survey of the lowest decile suggest that on average renter households use 14 therms in the summer and 29 therms in the winter, based on average reported bills of $17.01 and $36.06 respectively (see Figures 6.13 and 6.14). Homeowners in the lowest decile who responded to this question reported using an average of 10 therms in the summer and 43 therms in the winter, based on average reported bills of $12.65 and $53.29.

Although we were unable to directly compare the lowest decile (renter and owner) populations to the aggregated (whole population) figures supplied by the natural gas utility, it is clear that both renters and homeowners who responded to our survey question about their average gas bill report lower average usage than the figure reported to us by the gas utility for the general population in both summer and winter.[6] We therefore reject the null hypothesis #4 (see also above). Low energy users are not using more gas because of fuel switching – they are using both less electricity and less natural gas.

[6] But since we don't know anything about the *distribution* of residential natural gas consumption within this population, we cannot speak to the relationship of these lower consumption levels to the population mean.

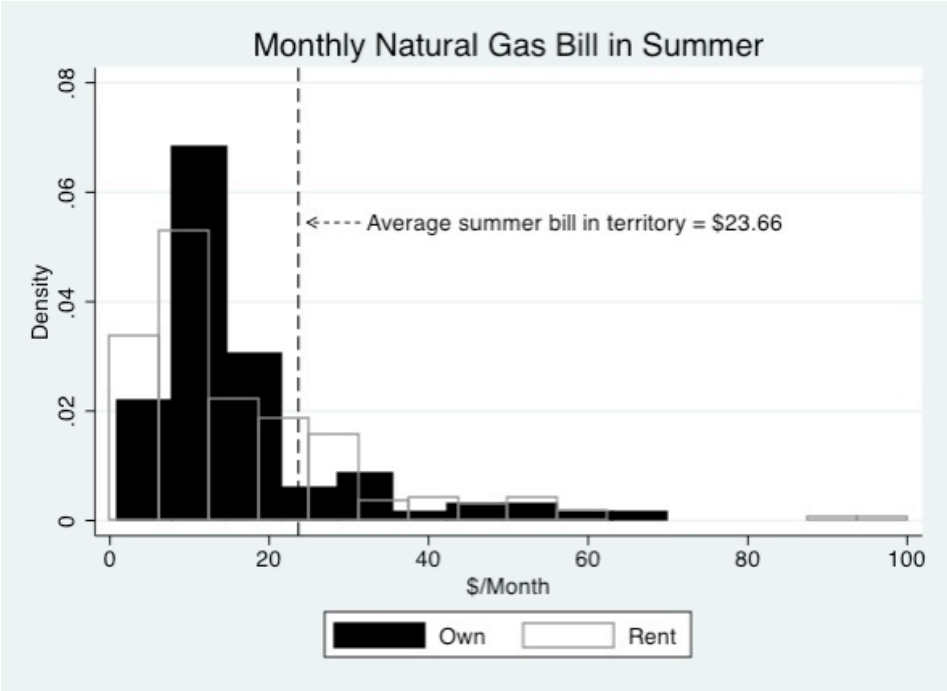

Figure 6.13: Distribution of typical survey respondents' natural gas bills in the summer in lowest decile

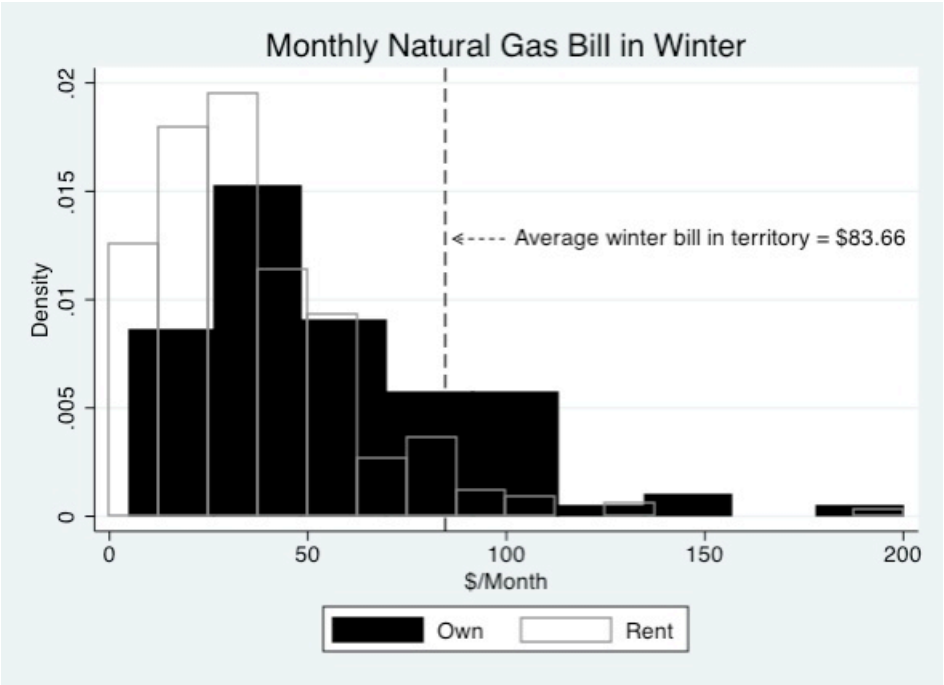

Figure 6.14: Distribution of typical survey respondents' natural gas bills in the winter in lowest decile

Air Conditioning

Besides elevating the summer load in this Northern California utility territory, air conditioning also plays an important conceptual role in shaping how consumers understand and think about their electricity consumption. Air conditioning, whether used within a given household or not, is a key point of reference in most energy discussions for the people we spoke with. Several of the open-ended responses to survey questions suggested this importance, and, therefore, in our interviews, we explored the topic in greater depth. When discussing low electricity use, it is a topic that is impossible to avoid. Air conditioner use is understood to be both a chief cause of high bills, and also—for many of the low users—a point of reference in their pursuit of reduced electricity consumption.

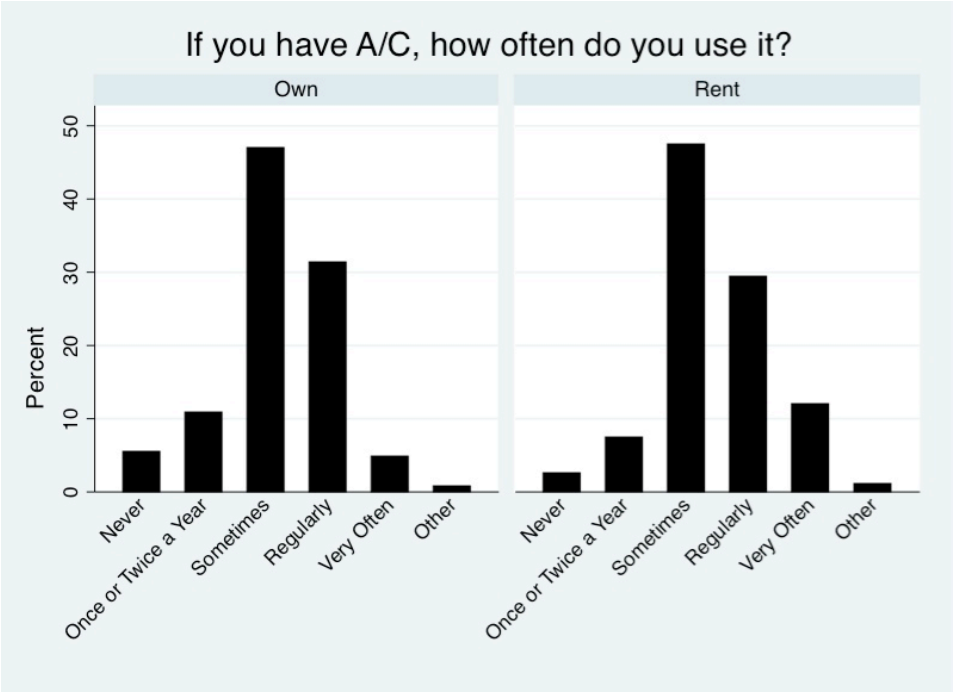

Figure 6.15: Usage intensity of air conditioning (for households with either window or central AC) in lowest decile

Low users are not averse to using their air conditioner (A/C), as Figure 6.15 shows. Both populations who have available some form of A/C evidence a distribution of use that includes a large fraction who use it *sometimes*, with the second most common answer being *regularly*. About ¾ of respondents with A/C fall into one of those two categories. But not all of them have air conditioning. Starting with central A/C, 10% (16/155) of homeowners and 27% (141/521) of renters do not own one (Figure 6.16). The saturation figures for window A/C are much lower. If we add the households who have neither window nor central A/C and those who say they only use it once or twice a year or never (Figure 6.15) the total is close to 20% of renters and homeowners.

Figure 6.17 shows the degree to which those who report frequent AC use also have higher electricity consumption within this tier. Those who indicated relatively infrequent A/C use are distributed fairly evenly across the lowest decile range, compared to those who never use A/C

who are concentrated just below 200 kWh/mo and those who use A/C once or twice a year peaking about 100 kWh/mo higher.

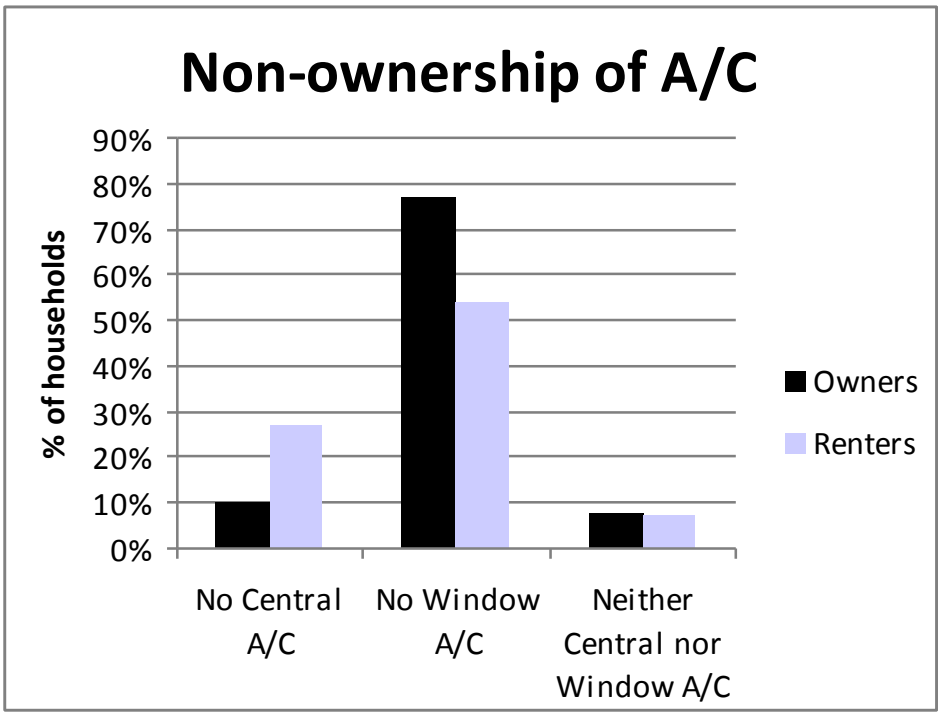

Figure 6.16: Air conditioning non-ownership in lowest decile

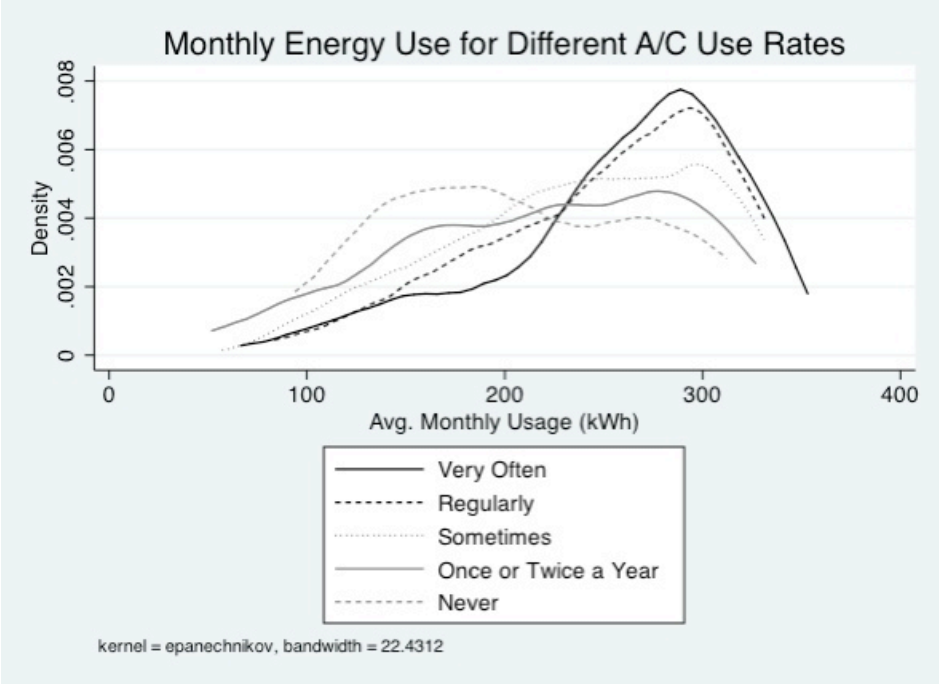

Figure 6.17: Self-reported A/C usage vs. total monthly kWh consumption in lowest decile

Figure 6.18 suggests that people who don't have or use A/C rarely (38% (259/676) of the lowest decile population) are not, as the folk theory of low users would have suggested, grouped off to the left in the low income bins but are rather, at least for homeowners, symmetrically distributed about the $50-$100,000 income bracket. For renters, the distribution looks different, but if anything it is more evenly distributed across more income brackets. In light of this income distribution, it is tempting to see A/C non-use as something the majority of households included in this chart have chosen rather than something they can't afford to turn on.

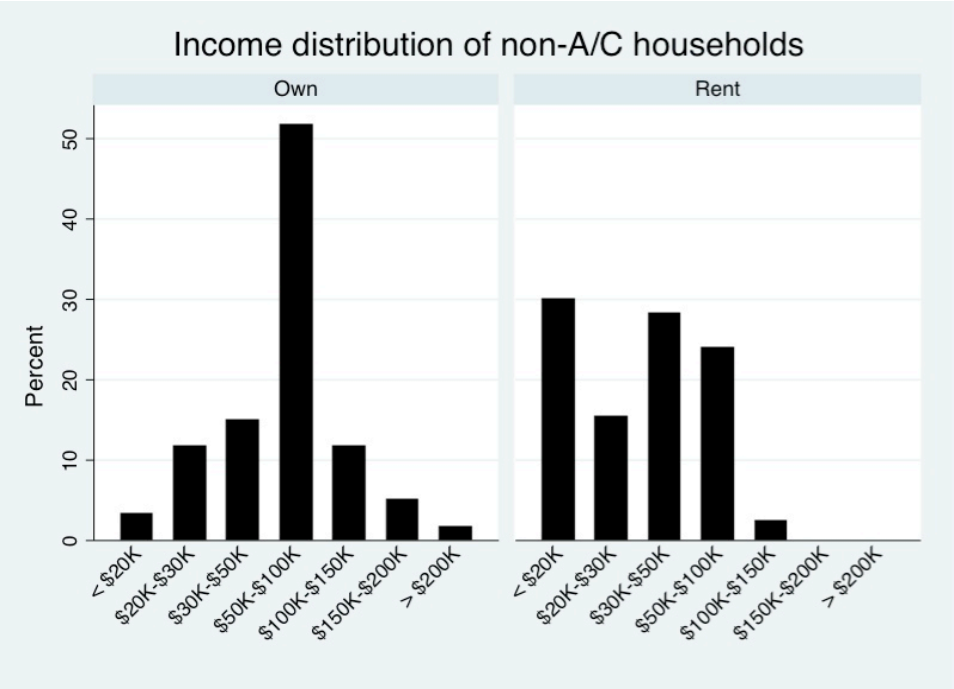

Figure 6.18: Income distribution of households that do not use air conditioning in lowest decile

Figure 6.19 provides an opportunity to test the degree to which people's self-reported A/C use registers in terms of the summer peak to off-peak ratio. We assume that the summer peak is attributable to A/C use, and at least in this instance there seems to be a discernable gradient across these six categories of A/C usage frequency in relation to the summer peak: the greater the reported air conditioner usage, the greater the summer peak load.

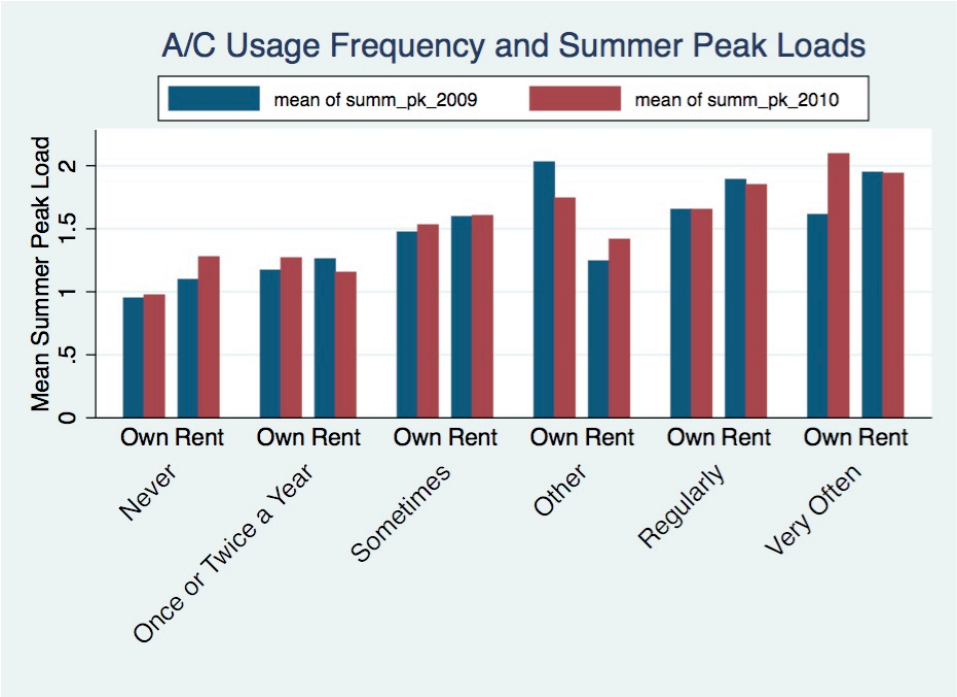

Figure 6.19: Summer peak loads for different air conditioning use behaviors in lowest decile

Figure 6.20 is a very similar plot, but it shows the distribution of two of the six A/C frequencies plotted against the peak to off-peak ratio. Responses about air conditioner use line up well with the data we have on the peak. A/C usage among the low use population varies considerably, and those who rely on it the least also tend to use the least electricity overall.

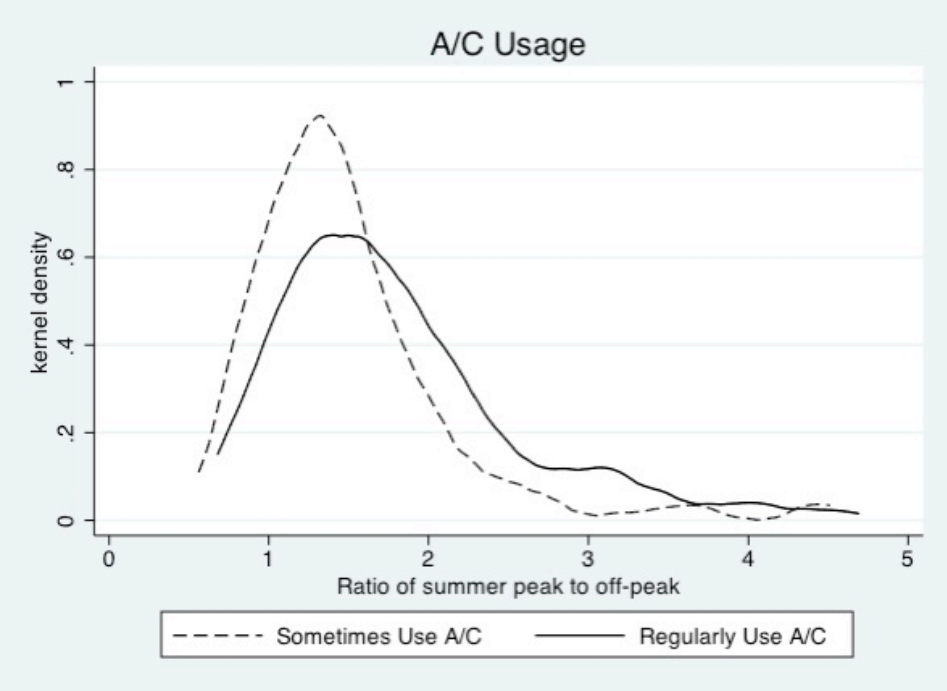

Figure 6.20: A/C usage frequency vs. summer peak loads (distribution) in lowest decile

Qualitative Responses: Behaviors and Constraints

The answers to several survey questions (15, 17, and 34) illustrate to what extent respondents recognize that their usage is low, how they think about their (low) usage, and how they explain it. We coded the answers to be able to organize these responses into categories. This was a multi-level task that yielded three types of responses:

1. Motivations or beliefs
2. Circumstances or constraints
3. Actions or behaviors

The motivations for using less energy included concern for the environment, being "conscientious," "conservative with energy," and "I have a frugal mindset." Others ventured that "wasting water, gas and electricity is immoral," "I live very simply but with quality." But comments such as these comments surfaced only infrequently. We hadn't specifically asked about motivations or beliefs.

About one quarter (23% (35/151) of owners and 23% (120/521) of renters) mentioned at least one constraint in relation to their energy usage. We identified four constraints, listed in Figure 6.21:

- I live alone
- Not home much/work all day
- I can't afford to use as much energy
- I live in a small apartment

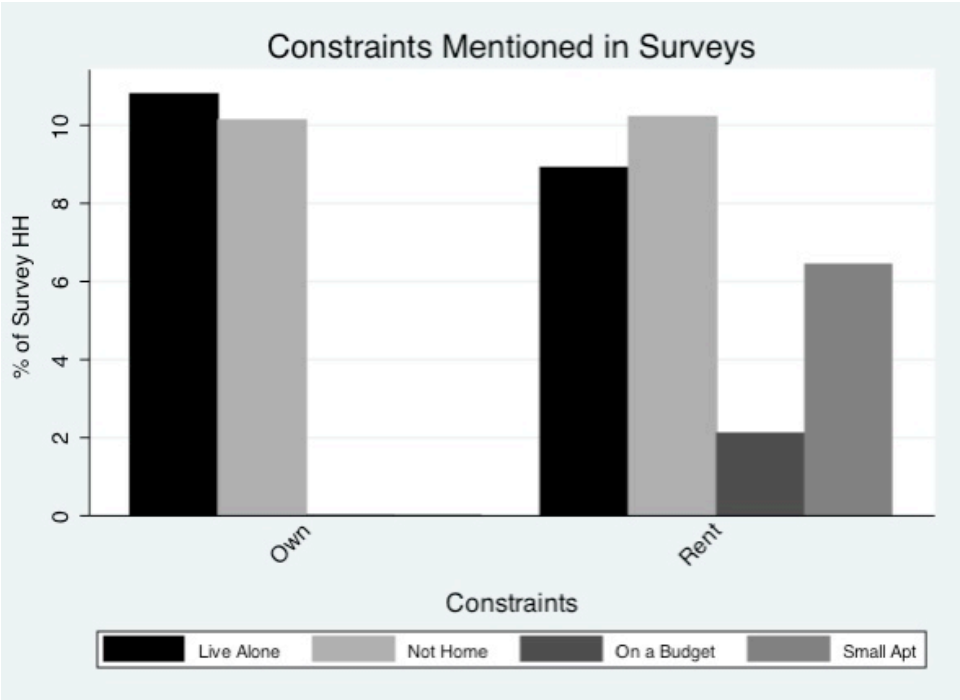

Figure 6.21: Identification of constraints in relation to low energy usage in the lowest decile

Because of the comparative nature of the question, most of the answers reflected respondents' sense of how they differed from their neighbors rather than an absolute condition or

even their own judgment of this circumstance. Not all who answered this question assumed their energy was lower, and some were certain it was the same as or higher than their neighbors. Many of the respondents were familiar with the notion that a larger house, more people living together, or when someone works from home all correspond to higher energy usage compared to someone living alone in a small apartment and who leaves the house and goes to work every day. Figure 6.21 captures the extent to which respondents felt these circumstances applied to them, and had (or might have) bearing on their energy usage. A financial constraint was the least common of those mentioned in response to this question, and the issue is dealt with more in the section on quality of life later in this chapter as well as in Chapter 7.

Returning to energy-relevant actions, we asked in our survey what—if anything—customers in the lowest decile had done to reduce their energy consumption. We didn't differentiate in this question between natural gas and electricity end uses. Figure 6.22 reveals that the majority of both renters and homeowners had done something.

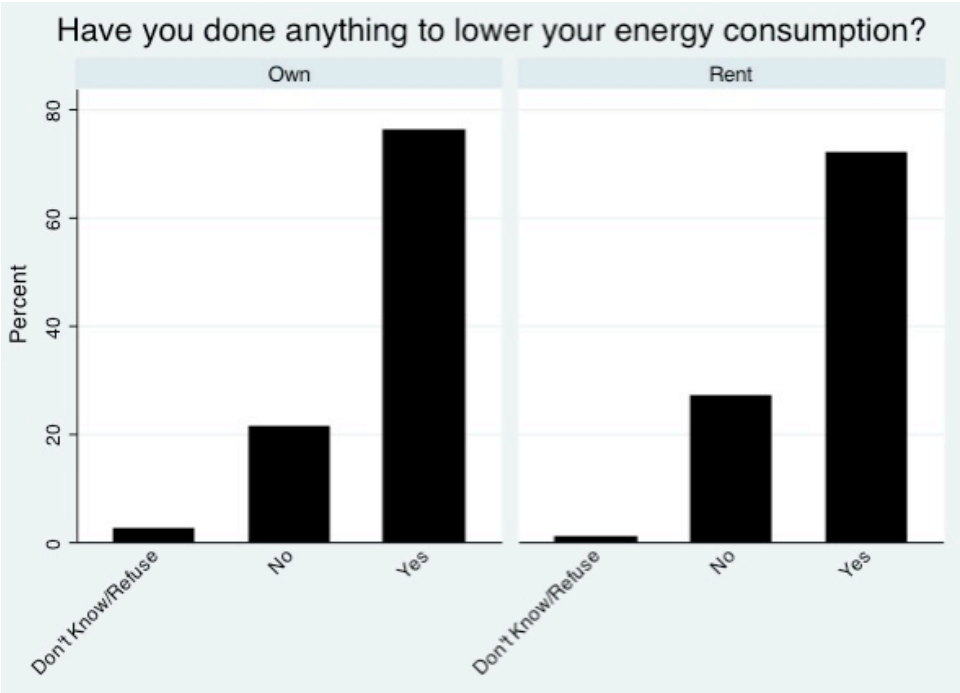

Figure 6.22: Taking action to reduce energy consumption in the lowest decile

The list of actions and behaviors mentioned in response to questions about what they did is extensive. The first set of responses that we coded concern air conditioning and its alternatives, what we refer to as thermal management practices (Figure 6.23). Sixty-five percent (98/151) of owners and 54% (259/521) of renters mentioned at least one thermal management practice. The most common response by far is labeled *Judicious A/C Use* in the figure below. This is necessarily a somewhat broad category in so far as most respondents recognize that when it comes to electricity consumption air conditioning is an important factor, one that comes to mind easily.

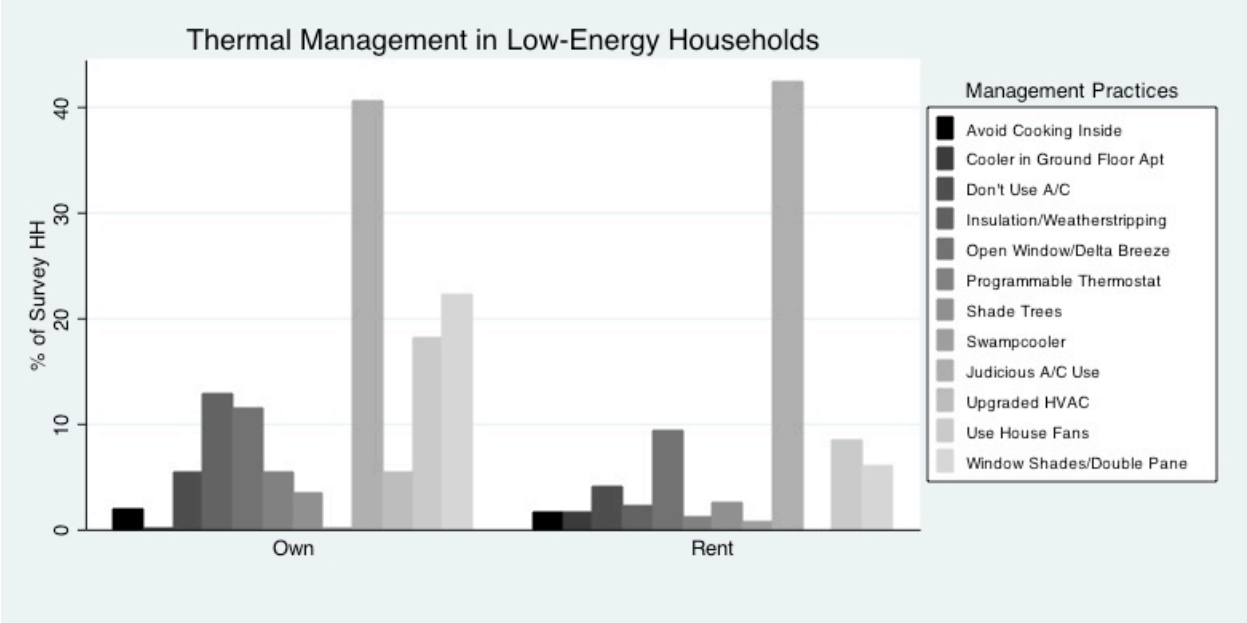

Figure 6.23: Approaches to dealing with Summer Heat in the lowest decile

This response category reflects respondents' recognition that the standard approach to cooling has energy implications, and that they are (or would like to be seen as) doing something about it. More specifically, the three answer categories grouped under the *Judicious A/C Use* heading are:

- Mention thermostat setting of A/C, e.g., 78F, 80F, etc.
- Run A/C rarely, only when necessary; never run when not at home, at night, etc.
- Run A/C less than the neighbors, only when it's 100F outside, etc.

The fact that roughly forty percent of respondents fit this category suggests that A/C is a component of their cooling portfolio (of varying importance as we'll see below), as well as, for many, a point of departure for other, associated actions and behaviors. The list of other practices is heterogeneous, including one-time physical changes to the building and it's surroundings (shade trees, weather stripping, insulation, double pane windows, upgraded HVAC, programmable thermostat), alternative cooling technologies (swamp cooler, fans), and manual interventions on, typically, a diurnal schedule during the summer (open/close windows and doors to take advantage of the Delta breeze, draw/close curtains, avoid cooking indoors on hot days). These actions frequently occurred together. (This and all subsequent quotes are taken from survey and interview responses. The number following the quotation is an identification number.)

> Programmable thermostat is installed and generally set higher/lower than average (typically 78 in Summer and 68 in Winter) Air conditioning is typically not turned on until internal temp reaches 78-85 degrees (i.e. it's generally only used on triple digit days) Make use of "passive solar" via decidious trees planted in front (South side) of house. Thermal drapes are used on South-facing downstairs windows; shutters are used on upstairs South & West-facing windows Utilize prevailing breezes, fresh air & ceiling fans/fans to maximize natural "air conditioning" as often as possible. (3262)

Dealing with the summer heat is obviously high on many low users' lists, but it is worth noting that SMUD mentions a list of *Summer Conservation tips* on its website that is quite similar:

> ***Summertime***
>
> *Conservation is most critical during the summer months, when air conditioners make heavy demands on our power supplies. The easiest way to keep your home cool is not to let it heat up in the first place. So you want good insulation, caulking and weather stripping. Shade trees, overhangs and awnings help, too. Beyond that:*
>
> - *Keep windows closed during the heat of the day, and draw blinds and draperies to keep the heat out.*
> - *Set the thermostat at 78 degrees or higher. You'll gain savings of about 5 to 10 percent on the operating cost of an air conditioner for every two degrees of cooling you're willing to give up.*
> - *Change the filter regularly. An air conditioning unit with dirty filters can use 5 to 10 percent more energy.*
> - *Use fans instead of the central air conditioning unit whenever possible. Individual fans cost about 90 percent less to operate.*
> - *Adjust ceiling fans to turn counter-clockwise in the summer. (Usually this means that the switch on the fan should be in the "down" position.)*
> - *Turn off unnecessary lights.*
> - *Lay off appliances during hot afternoons and evenings. Many appliances create heat and moisture, making the air conditioner work harder. Limit use of ranges and stoves, dishwashers, dryers, washing machines, and other heat-producing equipment to early morning or late evening when temperatures are cooler.*
> - *Rig a clothesline in the yard and give your dryer a break.*
> - *Prepare cold meals such as salads and sandwiches. Cook hot meals only late in the evening, when it's cooler.*
> - *If you have a refrigerator or freezer in your garage that isn't full, consider getting rid of it. These appliances tend to be older and hog energy.*
> - *SMUD's Shade Tree program offers free shade trees for customers whose homes have an eastern, western or southern exposure that heats up during the summer.*[7]

The broad overlap of the two lists suggests that this population is familiar with SMUD's recommendations and also engages in many of the listed actions. Two actions, including the

[7] https://www.smud.org/en/residential/save-energy/learn-energy-efficiency/conservation-tips.htm

second-most common action mentioned by renters, however, were not found on SMUD's list: opening the windows to take advantage of the Delta breeze and not using the A/C at all.

Energy Behaviors

In their answers, respondents elaborated on their practices and the habits they've developed. The tension between a desire to conserve energy while remaining *comfortable* was evident in most responses that fall into the category of thermal management.[8] But often the listed activities encompassed a variety of end uses, purposes, and motivations. The following examples are typical:

> I am careful about using lights when there is plenty of outside light available and turn them off when not in use. I have replaced many of my lights with compact fluorescent light bulbs where possible. I try and control the temperature in my house by keeping it closed during the heat of the day while opening windows and running a fan to fully ventilate with cool air at night. This helps virtually eliminate the need for the air conditioner except during very hot nights when sleeping is difficult. Instead of using the heater in the winter I wear extra layers. (3805)

> Turn off/unplug seldom used devices. Not use heater or AC until uncomfortable. (55/82F) (1120)

> i try to cook before noon, i line dry my laundry, i wash laundry in cold water, i use a fan instead of a/c when possible (242)

> Strategic placement of fans for use with air conditioning. Use fans in morning to move cool outside air indoors. Use interior and exterior shades to reduce heating in summer. Computer and stereo connected to power strips so entire system can be turned off when not in use. Gas heater and stove lines are turned off in summer, my stove has 3 pilots that generate a lot of heat, so I usually get by with microwave. (287)

> In addition to the obvious things, like turning off lights and appliances when not using them, or even unplugging them, we turn down the water heater in the summer, have LED lights in high traffic parts of the house, only use the window AC units at unbearable triple digit temperatures to cool down the room for bed time, nag the landlord for double pane windows, DIY insulate the house in the winter, cook efficiently with the oven and stove top (i.e.: reusing a hot pan or hot water that's already boiled)... Stuff like that. (937)

> Use fans, not the air conditioner. Use sweaters, not the heater/furnace. Minimize use of washer/dryer and make it efficient (larger loads and hang clothes). Shorter showers. Turn off lights, turn off all appliances and unplug when not in use. Limit use when possible. Be conscious of use and limiting it when I can. (2876)

> All light fixtures now contain fluorescent bulbs. Most washing is done with cold water, and many items are line dried if possible. Lights are turned off in unoccupied areas of apartment. Window coverings are used during late afternoon hours (when sun shines in) during summer. (2062)

In attempting to accept or reject hypothesis #5, the answers to a question that we asked about what if anything respondents had done to lower their energy consumption at home provide some guidance. On the one hand, we received responses like these:

> Instead of setting the thermostat higher in summer and lower in winter, I turn off the central heat/air at night. (2491)

[8] The survey was conducted during the summer which no doubt had some effect on elevating the salience of this subject.

> We only use the air conditioning when the temperature reaches triple digits, otherwise we put a bowl of ice in front of the fan to keep cool. For heat, our apartment is small enough to be heated when we use the oven when we cook or bake. (1066)

> Stopped using air conditioning (3575)

But others were clearly attentive to expert recommendations. As we saw above, the list of thermal management practices in many cases mirrors the list found on the electric utility's website and in their outreach materials. At other times, the expert recommendations were mentioned alongside tactics not found on official lists.

> Walked through the PG&E web site and used their check list, replaced all light bulbs with energy efficient bulbs, use natural light more, wash clothes and dishes late at night, don't run the heater during the winter. (3729)

> I try to turn off all the appliances when not in use (ex. computers/printers/etc) rather than standby. I try to keep the air conditioner and heater off, and instead use a fan, blanket, or drink fluids. We put some energy light bulbs in some of our lamps. We lowered the temp on the water heater. (3197)

In their answers to this question, respondents frequently mentioned switching to CFLs, but a similar number mentioned relying on natural light. Because respondents' answers to this question exhibited such a diverse range of strategies, both expert-supplied as well as their own, we accept the counterhypothesis (below). While following expert advice is something a significant portion of low users did, many appear to have exceeded those recommendations, or augmented those with other, complementary, strategies.

Hypothesis #5

- **Null-hypothesis:** In general, people use much less electricity because they have followed expert advice on energy matters.
- **Counter-hypothesis:** Typically, low electricity consuming households have pursued strategies not advocated by experts or have ignored expert advice.

Lutzenhiser found similar behaviors in his study of responses to the 2001 California energy crisis. In certain categories, responses exceeded official recommendations, and perhaps more importantly registered on a different scale (2002). Particularly around thermal comfort, expert recommendations typically specify particular thermostat settings, conceived as being slightly higher or lower than the norm, e.g. *set thermostat to 78F, or 85F when on vacation*. Many utility customers, however, both in Lutzenhiser's study and in ours, often simply turned off their A/C rather than following the advice to change the thermostat setpoint.

We encountered this in the context of heating and cooling, but also in terms of many other appliances that were turned off for the season, or unplugged when not in use (presumably to reduce standby losses). This suggests a more active mode of interacting with energy using devices, where control is exercised outside of the script suggested by the thermostat or even, in the case of phantom/standby power concerns, the on/off switch.

While the goal (cooling or preventing a hot interior) may be appreciated and accepted by these customers, if perhaps for less time or to a lesser extent than the neighbors who "run their ac all the time even when no one's home," they often draw the line at giving over control to the

thermostat. As Kempton & Krabacher (1986) observed, it is not at all uncommon for people to interact with their thermostats in ways not intended by the manufacturers. Sometimes their decision rules about when and why to adjust the thermostat even elude energy researchers. The interviews that focused on summer cooling strategies bore this out as well.

Substitutions: Cataloguing Strategies and Behaviors

Official suggestions about how to find a balance between comfort and energy usage make assumptions about how far the public can be encouraged to diverge from what is considered normal practice. Thermostat set points, using curtains to keep the sun out, and relying on fans to complement the air conditioner are typical, and we've seen that many in the low use tier follow these suggestions, constructing more or less elaborate regimes using these and other tactics that produce conditions they find acceptable or even pleasant. But some of the low users have redefined what is normal. Their patterns diverge from—go beyond—the standard protocol. By focusing their attention on how to minimize electricity consumption, experimenting, and perfecting their approach, they have arrived at solutions that lie outside the range of official suggestions. Going beyond a standardized protocol, their solutions tend to incorporate or utilize particular features of their houses, exploit building orientation, use shade, conform to domestic routines, etc. By striking out on their own, exceeding official suggestions, they have discovered or invented habits and patterns that allow them to live comfortably while relying far less or not at all on air conditioning, or other end use devices.

While this effort requires a certain level of commitment, time, and the resources to experiment with different strategies, materials, and routines, many of the low users that we encountered seemed pleased with their achievements, proud that in a very palpable sense what they were doing 'worked.' For many of these individuals, not having or using A/C is not viewed as a limitation but an opportunity, a matter of pride, even. Many of them could afford A/C but they prefer to achieve thermal comfort in the heat of the summer another way.

> This is a 1910 Victorian, and it's got double hung wood frame windows. So, in the summer, in the evening, I open the windows from the top and the bottom. I open the front door and the back door, which I rearranged a little bit when I bought the house so they're in alignment with each other. And there's a hallway that connects them, and the rooms are off the various hallways. So, in the night time, I open up, and I let the breeze come through the windows and the doors. It cools the house, and sometimes I leave it open all night long, and it charges the house, it's cool. So I have lath and plaster walls, which serve as thermal mass, so they get charged at night with cool, and it lasts most of the day on a hot summer day. So when it's a hundred outside, it's usually eighty or less in here. And then, you know, when it starts feeling warm in the evening, that's when I know it's cooler outside, it's time to open up and reverse the situation. So, thermal mass gets charged with heat during the day a little bit, and then it discharges it at night when that wind, the air is blowing through and removes some of the heat. I know I'm unusual; this not the normal way that people live. (152)

The strategies low users pursue in the course of their daily lives include a heterogeneous mix of different behaviors, adjustments, decision rules, and priorities. Table 6.1 below is intended to provide a framework within which to locate many of these diverse actions, a way of ordering them. Most energy relevant behaviors involve a device of some kind: a light bulb, an air conditioner, a dishwasher, a TV, a clothesline. Because these devices are heterogeneous in function, energy use, and cultural importance (to name just a few), the scripts people use or have invented for them are not always easily categorized. One way to approach this is to identify the principles these diverse strategies reflect. This typology links actions with principles allowing us

to consolidate them into a smaller number of categories. All the examples are taken from low user's responses to our survey or interview questions.

Table 6.1: Low use pathways: a typology of functional equivalence

Parameter	Principles	Examples	Result
Space	Match scale to task	Space heater vs. furnace; microwave vs. oven; el. blanket vs space heater, fan vs. A/C	Reduced electricity
	Optimize physical space	Insulate, keep sunlight out, open windows	
Time/ Scheduling	Operate for shorter duration/ less frequent	Manual AC control; use timers; power strips, turn off (when gone, at night, not in room), shift to off-peak,	
	Run only full loads	Dishwasher, laundry, shower sequentially	
Sufficiency	Adequacy	Wash laundry cold	No electricity for that function
	Manual alternative	Line dry clothes	No electricity
	do without	Get rid of AC, TV, clothes dryer	
Efficiency	Upgrade to more EE version	Replace A/C, windows, CFLs, appliances	Reduced electricity

While choosing to use a space heater instead of turning on the furnace may require less energy, it also suggests a conceptual model of how different energy technologies are related and potentially substitutable. Underlying this view of substitutability is a hierarchy based on functional equivalencies with differing energy implications. The space heater may be adequate to the task, but because it heats a smaller area than the furnace it uses less energy. Similarly, washing laundry cold is considered by some to be functionally equivalent to washing clothes in warm or even hot water. These tactics can also be located along a continuum, representing different levels of commitment to reducing energy consumption. The particular set of substitutions varies from person to person, reflecting a (perhaps temporary) balance—between comfort and energy, or between maximum household-level energy reduction and devoting time and energy to other pursuits.

Tips and Tricks: Approaches to Reducing Energy Use

As Table 6.1 indicates and as discussed above, low users' approaches to using less energy are heterogeneous; they range from the simple to the complex, cheap to expensive, routine to unusual. Moreover, they range all the way from the self-generated, quirky habit to the off-the-shelf purchase of a piece of hardware. What this table doesn't reveal is the variation in how others—unfamiliar with the practice of engaging in this activity—might perceive the degree of difficulty associated with it; their particular level of comfort around, for instance, line drying clothes or opening and closing drapes twice a day. This appears to come naturally to some while others might be disinclined to even consider it, or not know how to go about arranging their lives or domestic space to incorporate this action. The diversity of tactics we encountered in this research can easily overwhelm efforts to catalogue them.

The temptation to generate a master *list* of strategies employed by the low users should be weighed against a *narrative* that showcases concrete examples of low use, but embedded in the practical details of many different lives. Expert advice, and the lists of actions that typically accompany it, are as we've seen a point of departure, but this research suggests opportunities to do this even better, to take seriously the context in which these people pursue reductions in their energy consumption.

Nevertheless, these actions can be grouped in a number of different ways. Although they overlap, a basic classification distinguishes the behavioral strategies (often grouped under energy conservation), from the technical strategies (typically energy efficiency), and from what we might call philosophical approaches (which in this study this often revealed themselves as *non-use*):

Behavioral: changes to habit, routine, substitute manual task for machine or automation,
Technical: upgrade appliances, modify building envelope, adjust technical parameters,
Philosophical: do without the A/C, TV, clothes dryer, adjust to diurnal temperature swings, wear fewer clothes

Another typology differentiates strategies

- by function (heating, cooling, washing, cooking, lighting, laundry, etc.),
- by degree of manual control (wash dishes by hand vs. energy efficient dishwasher),
- by cost (furnace upgrade vs. turning down the thermostat)
- by level of effort or frequency (pull shades vs. plant trees vs. insulate walls)
- by reducing run time (turn off or use timers when not in use, eliminate standby) or
- by substituting away from a particular device (line dry vs clothes dryer, hand wash dishes, open windows at night vs A/C).

Some strategies concentrate on making improvements to the building envelope—insulating walls, finding or making shutters, drapes, or blinds, while others focus on becoming habituated to wider fluctuations in temperatures over the course of a day or season (spend more time outdoors, wear fewer clothes, look forward to Delta breeze). Figure 6.23 above identified a dozen actions or categories of actions related to thermal comfort which are reproduced here:

- make, install, use window shades (shutters, film, drapes, curtains), install double pane windows
- open windows to take advantage of the Delta breeze, install screen doors
- set thermostat >75F, rarely use A/C, run it (much) less than the neighbors
- use fans (whole house, attic, box, ceiling)
- plant shade trees
- avoid cooking inside on hot days, turn pilot lights off
- use a swamp cooler
- insulate walls, floor, ceilings, weather-strip doors and windows
- take advantage of the fact that it is cooler on the ground floor
- install, use a programmable thermostat
- do not use A/C at all
- upgrade the HVAC system

Although tricks related to managing the heat were the most common ones mentioned by respondents, similar lists could be generated for other end uses as well. Some of the strategies enumerated are cribbed from utility-supplied lists of recommended actions, while others may be peculiar to the individual circumstances the person is faced with or reflect a greater propensity to strike out on one's own, to experiment with the materials at hand. Quite a few also mentioned talking about how to do all of this with others, learning from others, sharing what they've found to work with their colleagues and friends and family members. Several things are noteworthy about the actions identified by our respondents.

- their sheer diversity of actions, strategies, habits, interventions
- the degree to which they were adapted to the particular situation.
- the iterative or cumulative nature of learning, of acquiring a proficiency with the subject through experimentation

Behavioral strategies as mentioned by these respondents are by their nature social, they are learned, and they (can) become habit—part of how one lives. Eventually they may cease to be thought of as discrete actions.

Types of Low Users

Once we established some relationships between different styles of how people interact with their energy hardware, it was only a small step to outlining a set of categories that attempt to classify the types of low user according to their approach to *energy conservation*. Table 6.2 is not the definitive treatment of the subject but it does reflect a broad set of distinctions that our research has revealed.

Building on the insights from the typology of substitutions (Table 6.1), a matrix that organizes energy behaviors according to eight principles, including doing without, running only full loads, matching the scale of the device to the task, and upgrading to a more energy efficient version, we identified four approaches to low usage—four types of low user—the first two of which are the most policy-relevant: **Energy Efficiency**, **Non-Use**, **Just How It Is**, and **Constraints**. Additional research is needed to estimate the relative sizes of these categories, but the coded responses to our open-ended survey questions suggest at least half of the lowest decile falls into the two first groups, whose engagement with the subject of energy is generally high.

The first category, **Energy Efficiency,** includes people who follow expert advice on energy efficiency, augmenting an investment in technologies or building improvements with more or less elaborate routines and behaviors. The second, **Non-Use,** includes people who go about low use in a slightly different way. Because they identify themselves as content to not have so many appliances or other electrical devices, or to use them (much) less frequently, they manage to use little electricity without having invested in technical upgrades. The third category, **Just How It Is,** includes people who use little energy without recognizing it as exceptional. Either their habits are of such long standing that they no longer recognize them as such—they have disappeared—or their lifestyles result in low usage without it having ever been a goal. Consequently they have little to say about the subject. The fourth category, **Constraints,** includes people whose usage is low not because they aspire to it but because one or more constraints, including not being home much, living alone or in a small apartment, or the inability to afford to spend more on energy, keeps their usage low.

The remainder of this chapter examines the survey (and interview) questions focused on behaviors, knowledge, and attitudes related to energy. The survey included nineteen questions on these subjects, of which five were open-ended:

(Q15) Self perceptions of own energy consumption compared to others
(Q17) Actions taken to lower energy consumption
(Q27) Details about energy conversations and/or energy advice given or received
(Q32) Perception of quality of life in relation to increased energy consumption
(Q34) Explanations of their very low usage once it was so identified

The narrative responses we received to these questions are the basis for the typology above. The descriptions of each category reflect our attempts to group the voluminous and diverse responses into a set of categories that does not violate the spirit in which they were uttered. While the strength of the individual commitments to low energy use and the alignment of their approach with the category label we've assigned them obviously varies, the volume and tenor of the responses supports the typology in the table below. The rest of this chapter examines in more detail what underlies this typology.

Table 6.2: Types of Low Users

Types of Low Users	Description	Actions
Energy Efficiency	Actively engaged on energy, self-motivated (varying combinations of behavior and efficient technologies)	Thermal mgmt routines, upgrades
Non-Use	Actively engaged on energy, prefer to have and use less stuff	Turn off/don't have/ don't use
Just How It Is	No special efforts mentioned, and little self-awareness about energy	x
Constraints	Low energy use attributed to budget, living alone, not home much, or small apartment	not emphasized

Thinking and Talking about Energy: Awareness, Conversations, Advice

Electricity is rarely used for its own sake. The kinds of services that electricity provides are intertwined with our domestic routines, habits, social norms related to comfort and convenience, and a great many other patterns of behavior. The relationships among fuels and social norms and behavior are complex and have co-evolved (Shove 2003). In our survey, we asked a series of questions about how respondents think and talk about energy. Three questions were asked as indirect measures of the degree to which people living at these low levels of electricity usage: (1) are they consciously engaged in producing this low usage?, (2) to what extent was low electricity consumption a conscious goal?, and (3) are they aware of their 'success?'

Although we tried to avoid phrasing or question sequences that encouraged respondents to tell us what they thought we wanted to hear, this possibility cannot be ruled out entirely. The answers to these three questions suggest that only a slight majority of respondents who rent recognize that their energy use is lower than their neighbors, while closer to seventy percent of homeowners recognize this.[9] Hypothesis #6 addresses the level of awareness low users exhibit about their exceptional electricity use levels.

[9] It is of course possible that their energy use is not lower than their neighbors. We looked at a full ten percent of the population in this study, so their reference group could also be similar in their usage.

Hypothesis #6

- **Null-hypothesis**: The majority of low electricity consuming households do not think of their energy consumption levels as unusual.
- **Counter-hypothesis:** Low electricity consuming households span a range of awareness of how non-standard their consumption patterns are.

Figure 6.24 suggests we must reject the null hypothesis.

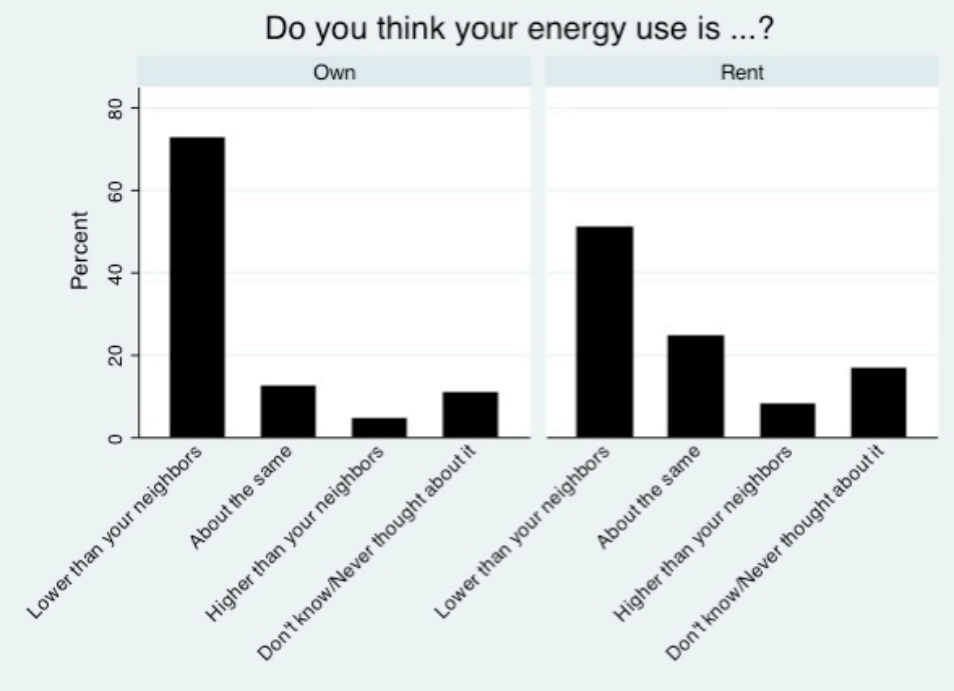

Figure 6.24: Perceived energy consumption relative to neighbors

Respondents typically think about energy quite a lot, and although they claim to talk about it with others (only) sometimes, most were happy to describe their interactions with others on the subject of energy. These conversations range across a lot of territory (Figures 6.25 and 6.26).

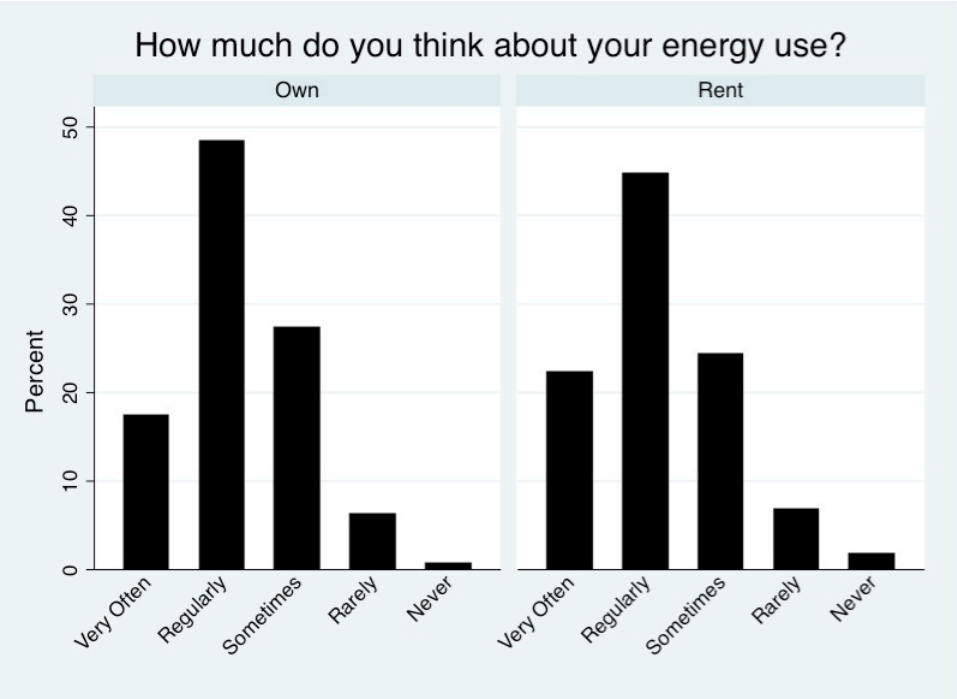

Figure 6.25: Salience of energy consumption in the home in the lowest decile

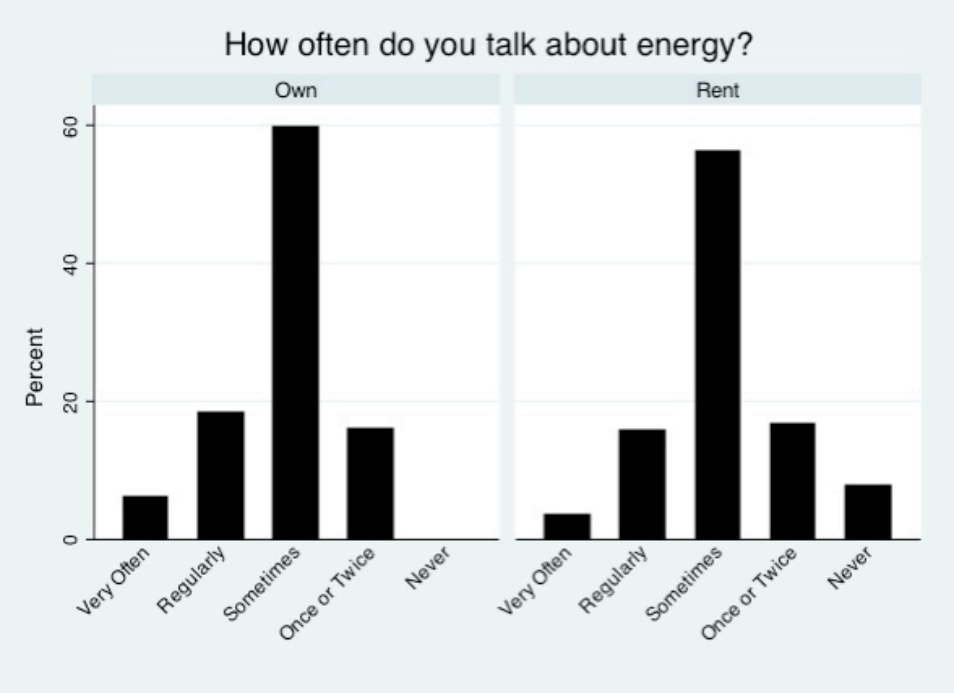

Figure 6.26: Conversations about energy consumption in the lowest decile (frequencies were not further clarified)

Some have eagerly learned from others:

> It's always nice to learn a new, easy trick whether we adopt it or not. I found out from a friend that the thing that a microwave delegates the most energy to is its display. We didn't end up adopting the tactic of only plugging it in to use the microwave. (937)

> The advice on heating and cooling the home received from family and friends has been useful. They've also lent me floor fans which helps circulate the air. (1490)

Many conversations revolve around air conditioning and alternatives to it. It is clear from the descriptions of these conversations that the low users generally appreciate that while they have figured out ways to live with less energy, others aren't always in a position to implement their recommendations or seem to have different priorities:

> I understand comfort is quite personal, so I don't push my agenda beyond my own home. But I do talk about my own habits, and my reasons behind them, and how easy it is to implement them (and that comfort can be had at 80 degrees). (2737)

> I "promote" installation of whole house fan and how wonderful it works; cools off home much faster than A/C. (424)

> People always want to know about the small way I live -- sometimes enthusiastically; sometimes with animosity. I explain it all away by saying that my needs are few; needing to live that way; enjoying the mild irony and the benefits all around. (264)

> Mostly I tell people that I don't use the air conditioner much, just wear fewer clothes and drink water. It makes me more acclimatized to the heat. (2378)

> Generally, I'm responding to others' complaints about the high cost of utilities, so I share my strategies. Unfortunately, it seems like families and other factors constrain other folks' ability to save energy in the same ways I do. (1453)

Others' curiosity about low usage:

> People always want to know what I do to minimize my utility bill and I explain (as previously discussed in earlier answer).(90)

> Just that mine is so much lower than anyone else I know. Mostly they think it is strange that I don't care for air conditioning and don't have it. (45)

A mutually stimulating exchange of energy tips:

> I have extremely low energy consumption and, as a result, utility costs. I tell anyone who wants to know how I do it. If I receive a suggestion that will help me conserve more, I take it under consideration. (35)

> Sometimes family members have expressed concerns that I may not use air conditioning when it might be called for, although I doubt this generally. One friend suggested putting up some kind of sun drapes or the like outside my kitchen window. I was concerned about how they would be controlled, and whether this would be acceptable to the management of the building. Generally, I do have a policy of keeping windows and blinds closed if a window is expressed to direct sunlight, as well as generally in summer. One exception is early in the morning, when the sun has risen but there is a cooling breeze so that the net effect of opening this and other windows to permit cross-ventilation will be to cool the space. This I term "natural central air conditioning." (1336)

> My brother and I are both interested in saving energy and lowering utility costs, so we often exchange ideas that have worked for us. I work in the environmental field, so my coworkers are

also generally interested in energy conservation, and we exchange tips and ideas. I use my coworkers and my brother for ideas about things to try to save energy, and I pass on ideas I've garnered to them. These interactions are all very positive--we're all working toward the same goal, yet we recognize that because of different circumstances, we can't always choose the very most energy-efficient thing (for instance, I'd love a battery electric vehicle, but there's nowhere to charge it at my apartment complex). (3105)

I gave family members a checklist of ways to reduse energy cost. started a group or green gaurdian at work to help monitor energy use and help cut down on waste (3288)

Ignorance of energy basics is another theme:

Most of the people in my apartment complex seem not to modify their habits according to the weather or season. They leave their windows closed and run the ac or heater almost all the time. I guess they don't know any better. Or maybe they don't mind paying high electricity bills. (2378)

Some lament the struggles to make energy efficiency technologies work satisfactorily:

Have mostly compared notes and asked about improvements each other has made. Have talked about the dislike of CFL's in terms of light quality, risk and challenge of fit for different fixtures and programmable light switches. Have also talked about the frustration of the delay in getting hot water to start with the tankless water heater which is even more of an issue after a low flow head was added to the kitchen faucet. (442)

We are always talking about how cold it is in the office, and how different people like different temperature settings—e.g., 78 degrees vs 68 degrees. We also talk about the Delta breeze and how wonderful it is at night--makes Sac summers tolerable! (1261)

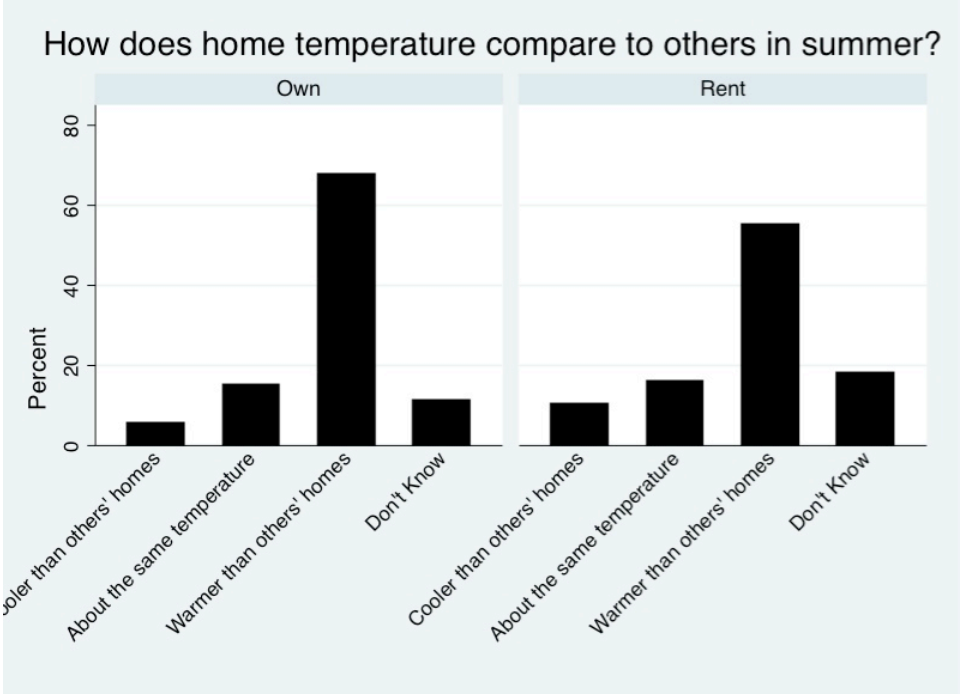

Figure 6.27: Difference in perceived indoor summer temperature between survey respondents' homes in the lowest decile and the general population

More homeowners (67% (102/152)) than renters (56% (276/497)) think their homes are warmer in the summer than others (Figure 6.27). Besides using the answer to this question as one of the criteria in developing the profile of those low users we term *Thermally Unflappable* (see Chapter 6), the prevalence of this answer also speaks to the fact that with or without A/C, summers in Sacramento can get pretty hot. A recurring theme in many of the interviews as well as in some of the survey answers was the habit of their neighbors to leave their A/C on 'all the time.' This was quite obviously not likely to be a practice for the low use households, and on that basis alone it is easy to conjecture that others' houses would be cooler in the summer.

Energy Usage and Quality of Life

We asked a two-part question in the survey about respondents' sense of their quality of life (Figure 6.28), and, separately, about their view of the relationship between energy usage and quality of life (Figure 6.29).

The follow up question was: "If you consumed more energy in your home, do you think your quality of life would be _better _worse _about the same _don't know." A majority of respondents said *about the same* (Figure 6.29). Less than 10% (60/634) said better. More interestingly, the percent who anticipated worse quality of life with greater energy consumption was as much as or more than the percent who suggested it would be better.

We then asked them to elaborate on their answer. The percentages listed below and in Figures 6.30 and 6.31 are calculated relative to the total number of those who answered the open ended question (51 homeowners, 231 renters). Ten percent (48/486) of renters and 7% (10/148) of homeowners felt there was a positive relationship between increased energy usage and their quality of life.

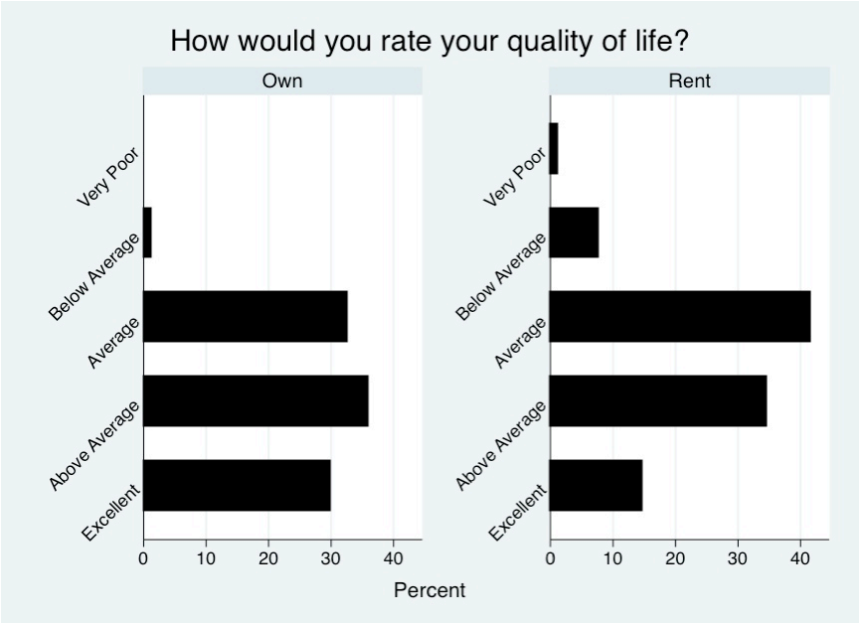

Figure 6.28: Self-reported quality of life in the lowest decile of electricity consumers

They specifically identified increased (thermal) comfort as the anticipated result of the hypothetical increase in energy use. A larger share (13% (64/486) of renters, 17% (25/148) of homeowners) expressed the opposite view, that increased energy usage would either correspond

to a reduced quality of life, or that reducing energy usage would improve their quality of life. The largest share of these respondents (60% (291/486) of renters, 66% (97/148) of homeowners) answered that they saw no relationship between energy usage and quality of life, and/or felt that things were fine the way they are.

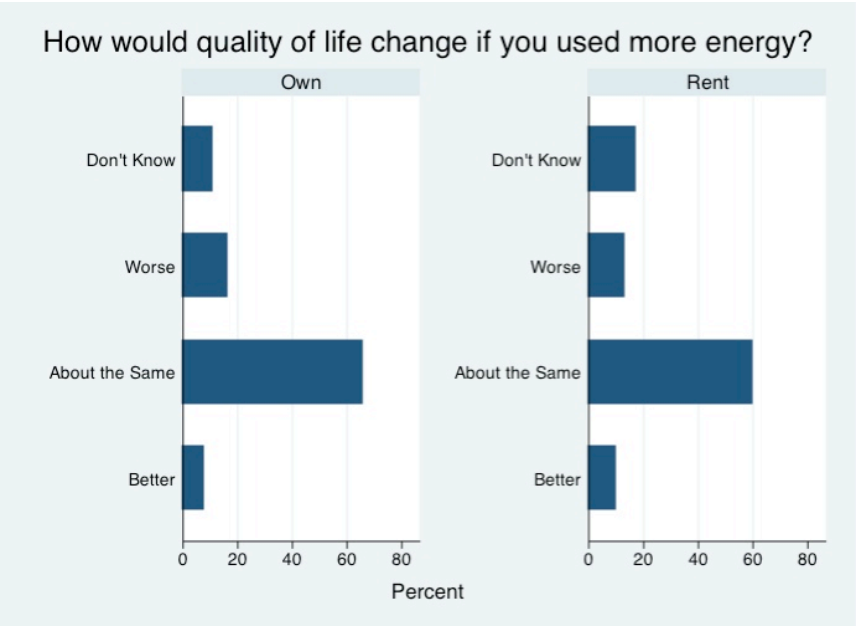

Figure 6.29: Self-reported quality of life in relation to increased energy use in the lowest decile of electricity consumers

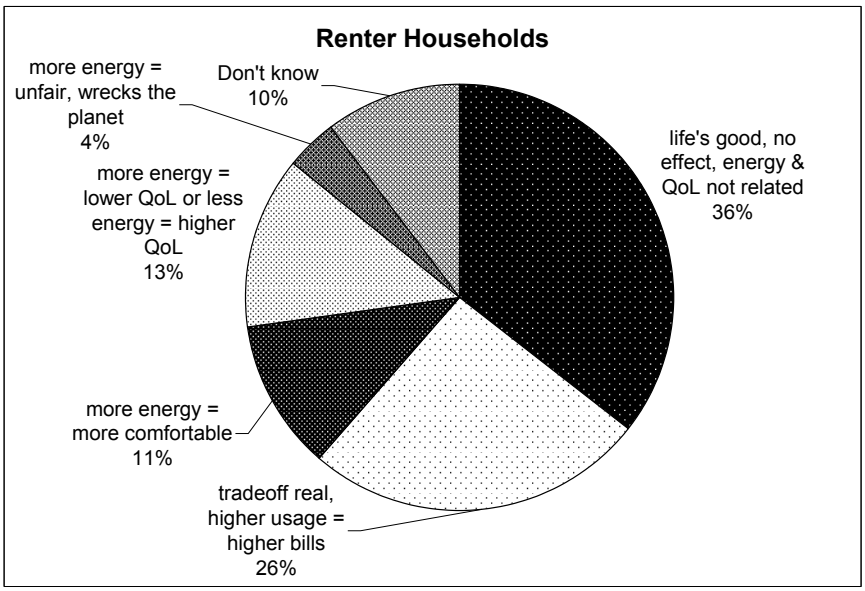

Figure 6.30: How increased energy use impacts quality of life for renters (open-ended question) in the lowest decile

In addition, 12% (6/51) of homeowners and 4% (9/231) of renters felt there were social or environmental reasons why increased energy usage would specifically be detrimental, and in their view would impinge on their quality of life as they understood it. *Equity, guilt, waste, fairness, over-consumption, helping the planet, simple living, earthly share, feeling bad* were phrases used by these respondents to describe the consequences of increased energy use. Finally, 26% (60/231) of renters and 24% (12/51) of homeowners felt that increased energy use represented a tradeoff, that the higher usage implied would translate to higher bills, and that those higher bills would explicitly not correspond to a better quality of life for them. This was the one category of responses where financial constraints reduced their choices about energy; and their present low use circumstances could be attributable—at least in part—to a lack of money to pay for more energy services.

Adding together those who see a tradeoff and those who feel there is a positive relationship between increased energy use and comfort, we find that 37% (86/231) of renters and 30% (15/51) of homeowners who responded to the open-ended part of the question view extra energy as yielding a tangible benefit, *excluding the disbenefit of paying for the extra energy*. Forty-three percent (282/658) of those who answered the multiple choice question answered the open-ended portion of the question, and nearly all of those (85% renters, 92% homeowners) who said it would negatively affect their quality of life responded to the open-ended portion. They appear to have interpreted the question slightly differently than we intended. In their interpretation, more energy corresponds to a worse quality of life, not because the extra energy would be negative or unnecessary, but because the extra expense of paying for that extra energy would be negative.

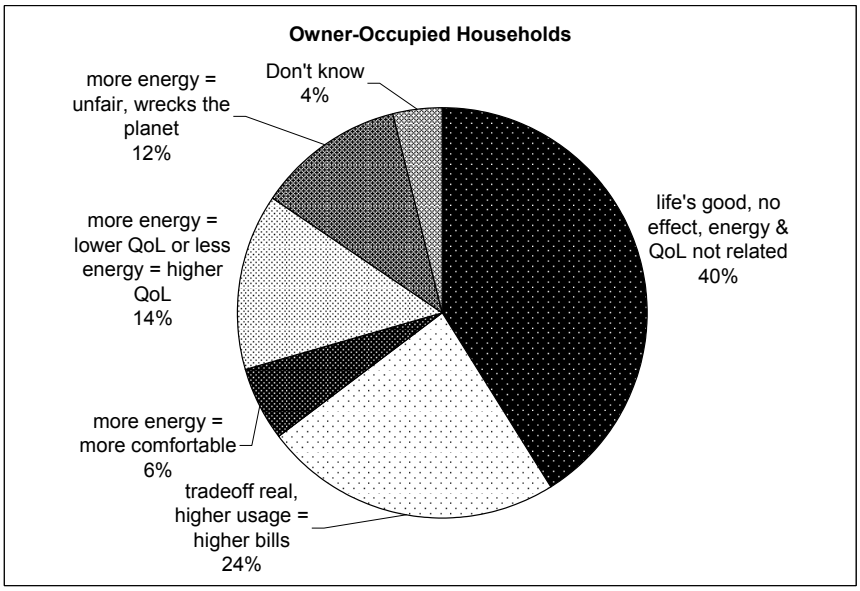

Figure 6.31: How increased energy use impacts quality of life for homeowners (open-ended question)

A majority (53% of renters; 66% of homeowners) of these lowest decile respondents who explained their reasoning did not hue to that interpretation, preferring instead to think of a hypothetical energy consumption increase as either irrelevant or detrimental to their quality of life, or specifically damaging to the planet.

Energy Efficiency Incentives and Energy Audits

As noted previously, hypothesis #5 addresses the degree to which low users achieved their low usage by following expert advice, or by other routes. Expert advice and the incentives and programs that surround it are designed to help residential customers improve the energy efficiency of their houses, their appliances, or to persuade them to make other changes that improve energy performance. As such, it seemed reasonable to examine the extent to which those households whose usage is lowest have taken advantage of these programs. We asked four questions related to audits and incentives in our survey. We asked whether these low use customers had had a home energy audit (Figure 6.32) or participated in utility incentive program to improve energy efficiency of their home (Figure 6.33), and we asked them to describe those incentives. Finally, we asked them if they thought the incentives had reduced their electricity bill (Figure 6.34). Very few reported having a home energy audit.

We asked the respondents who had received incentives (33% (50/153) of homeowners; 16% (77/492) of renters) to list them. Among the homeowners, the incentives that they mentioned fell into three broad categories: thermal appliances (window or central AC, furnace, fan, thermostat), general appliances, including water heaters and refrigerator rebates, and envelope upgrades (windows, insulation, air sealing). Seventeen percent of renter households who received incentives identified a different set. The largest category of incentives that the renters reported receiving was in the form of a reduction in their monthly bill resulting from having used less energy (sometimes electricity, sometimes gas) than in the prior year. Demand response, peak pricing, and time of use were another popular category. In addition to windows and insulation, shade trees and solar shades were mentioned by renters. A few general appliances and heating- and cooling-related replacement rebates rounded out the list. A small number of renters who responded to this question did not distinguish energy assistance (low income, senior, etc.) from the framing of incentives that we had intended—to mean a monetary and/or physical exchange designed to facilitate or encourage a reduction in electricity usage. We believe that this confusion influenced the relatively higher ‘no’ response by renters to the question that Figure 6.34 addresses. Slightly more than 50% (27/48) of homeowners and slightly less than 50% (42/89) of renters who participated in an efficiency program felt that it had reduced their electricity bill.

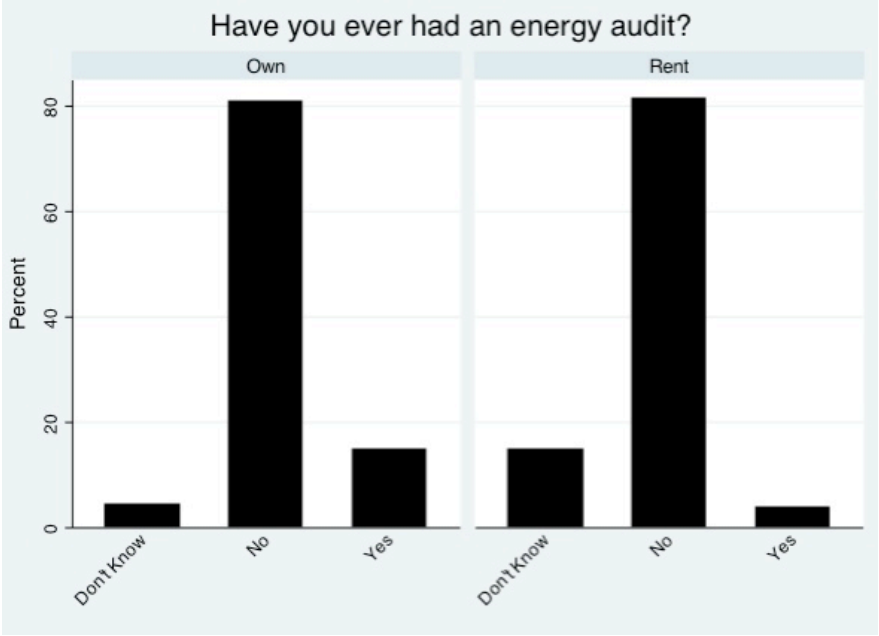

Figure 6.32: Participation in utility energy audit for those in the lowest decile

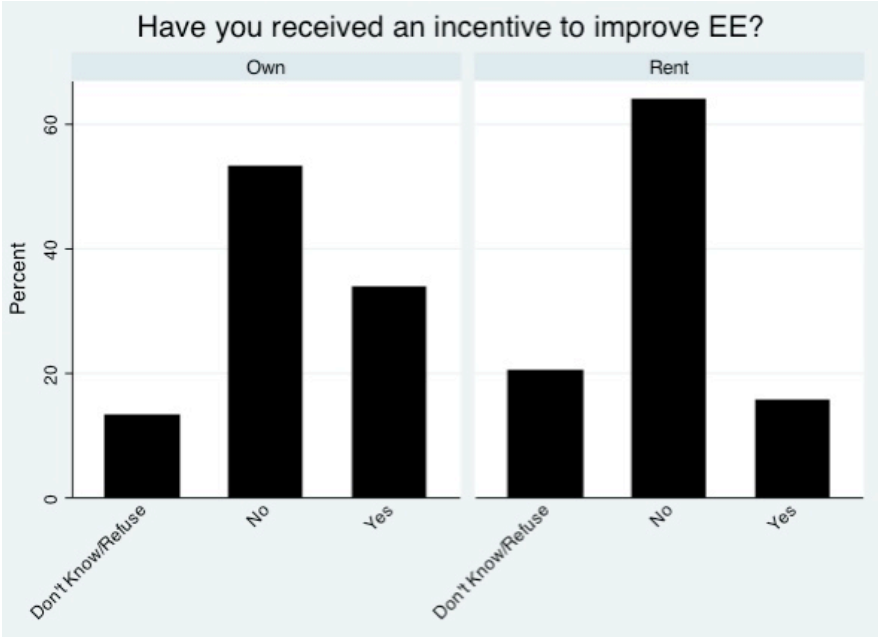

Figure 6.33: Participation in utility incentive programs for those in lowest decile

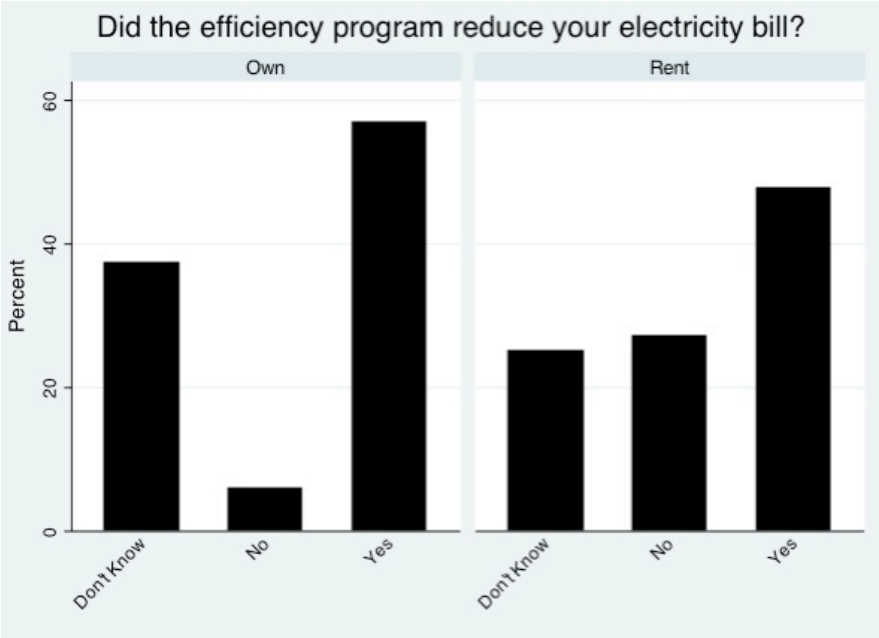

Figure 6.34: Electricity bill impacts from energy efficiency program for those in the lowest decile

Low users approach energy conservation from many different perspectives. We previously noted the specific strategies and routines, or in some cases the lack of either, and we have tried to organize the responses in a way that would start to give shape to the low use population. As noted in Table 6.2, we identified four types of low users:

- **Energy Efficiency**,
- **Non-Use,**
- **Just How It Is,** and
- **Constraints**

This classification represents our attempt to utilize the data that we have, and that was necessarily exploratory since we knew nothing about the energy behaviors or other qualitative dimensions of low use at the outset. While we have not yet established relative shares of the four types of low user, the discussion of profiles in the next chapter (Chapter 7) will help to assess how the population aligns with these categories.

7 LOW USAGE PROFILES

Very little research has focused on people who use very little energy, and what makes their low usage possible. One of the objectives of this project was to identify profiles within the sample that might enrich our understanding of who these very low users are, highlighting some of the ways that they are similar to or different from the intended audiences. The household profiles generated by this research suggest the possibility of exploiting this very low usage for purposes of replicating low usage in households that are currently using (much) more electricity. In this approach, expert knowledge would be utilized not to prescribe standard bundles of technical solutions to everyone, but the lived experiences of low electricity households would be examined for strategies, circumstances, patterns of behavior, and other characteristics that correspond to low energy consumption patterns aligned with the mandates of California's Global Warming Solutions Act (AB32) and Executive Order S-03-05. The idea of generating several profiles through which to examine low usage was also expected to yield insights about policy recommendations.

All of the households examined in this research use less electricity than 90 percent of the utility customers. Therefore, at this first level, any of them should potentially have something to teach the rest of the population about using considerably less electricity. But as already discussed, the folk theory about what sort of households are to be found in this very low user population assumes a low income, small living quarters, and a lack of choice about energy matters. Those living in that tier are imagined to be there involuntarily; therefore, it is assumed little of policy relevance can be learned from studying them.[10] While poor people unhappy with their low energy use appear in our sample, numerically this is but one of several and certainly not the dominant one. We refer to this profile as *Unhappily Low Energy*.

We have identified five additional profiles that capture other characteristics of the lowest decile population: **Well Off and Energy Efficient**, **Excellent Quality of Life**, **Thermally Unflappable**, **Sacramento Average**, and **Ultra-Low Users**. They are discussed below at greater length. To generate them, we filtered the sample according to their answers to different questions and demographic criteria.[11] These categories are intended to familiarize the imagined audiences of the results from this research with the low use population. These profiles concretize low usage by presenting different slices through this population with the expectation that audiences would recognize something in the presentation, and possibly find it evocative. Policies designed to translate what we are learning about low usage can treat these profiles as points of departure.

The fact that the profiles overlap to some degree (Table 7.1 and 7.2) is not an oversight but an important aspect of low usage these profiles are meant to highlight: low (or even lowest-) energy use cuts across many—perhaps all—categories, demographic, social, economic. While we attempted to segment the population of low users in the previous chapter according to four types, the purpose of the profiles discussed here is different. Low users, like the population at large, are a heterogeneous group. Income, energy efficiency investments, quality of life, and ultra-low energy use, to name a few variables, occur in many different combinations within the

[10] This is debatable, but certainly the other profiles yield more readily accessible insights and more closely align with demographic groups typically envisioned as audiences of energy policy.

[11] We did not include motivations as a component of these profiles because our survey and interview questions focused on establishing who the low users are, and how they accomplish low usage, not why. The ability to ask what motivated them to use little electricity required us to know more about them than we did at the outset.

lowest decile population. The purpose of these profiles is to capture some of these characteristics while keeping track of the potential overlap. Tables 7.1 and 7.2 highlight the degree of overlap.

Relying on statistics from the utility dataset, the SMUD Residential Appliance Saturation Survey (RASS), as well as our survey and interview responses, we were able to identify and describe the following categories within the low use population. The criteria that we used to generate these profiles appear in the list below.

1. Well Off and Energy Efficient (51 out of 277[12] = 18.5%)

- Quality of Life - Above Average or Excellent
- Education - At least a 2-year college degree
- Income - Greater than $50,000
- Home Size - Larger than 1,000 ft2
- Own all of the following electric appliances: refrigerator, washing machine, dryer, electric water heater, central A/C, dishwasher, microwave, TV, DVD, computer
- Have done something to improve their energy efficiency

2. Excellent Quality of Life (158 out of 658 = 24.0%)

- Quality of Life - Excellent

3. Thermally Unflappable (53 out of 340 = 15.6%)

- A/C - have either Central or Window
- Use A/C either Once/Twice a year or Never
- Temperature warmer than others' homes in the summer
- Quality of Life - Average or Better

4. Ultra-low Users (208 out of 687 = 30.3%)

- Average usage 52 - 208 kWh/month

5. Sacramento Average (103 out of 469 = 22.0%)

- Income - between $30,000 and $100,000
- Home Size - between 500 and 1,500 ft2
- Education - at least a high school degree and at most a 4-year college degree
- Quality of Life - Average or Above Average
- Age - between 25 and 64 years old

6. Unhappily Low Energy (23 out of 476 = 4.8%)

- Income - Less than $50,000
- Home Size - Less than 1,000 ft2
- Quality of Life – Below Average or Very Poor
- Age > 35

[12] One note about the size of each profile: the larger number in the parentheses refers to the total number of low users who responded to ALL the questions on which this profile is based. Missing data on one or more of the list of criteria eliminates that respondent from the pool.

Taking the population for each profile to be the number of survey respondents who don't have any missing values for the variables used in creating the restrictions, we get the following shares.

Table 7.1: Distribution of respondents across the profile categories

Number of profiles respondent belongs to	Number of survey respondents	Percent of total survey respondents
0	257	37%
1	302	43.5%
2	116	16.7%
3	18	2.6%
4	2	0.3%
Total*	695	100.0%

*438 out of 695 survey respondents (63%) fall into at least one profile

Table 7.2: Cross tabulations of profiles for respondents fitting two or more profiles

	Well off and efficient	Unhappily low energy	Thermally Unflappable	Sac Average	Ultra-low	Excellent QoL
Well off and efficient	51					
Unhappily low energy	0	23				
Thermally unflappable	5	0	53			
Sac Average	2	0	7	103		
Ultra-low	12	3	31	29	208	
Excellent Quality of Life	25	0	18	0	50	158

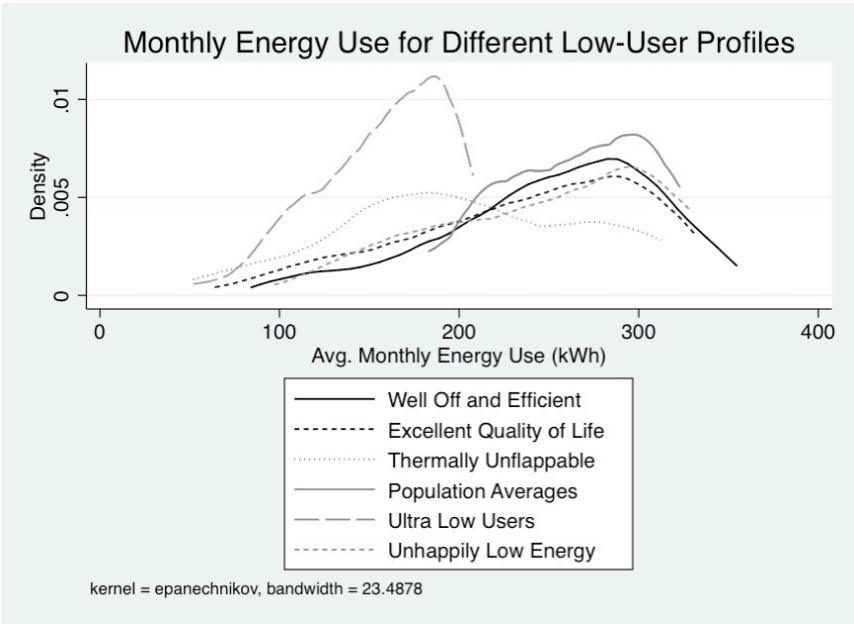

Figure 7.1: Distribution of monthly electricity consumption across the six profiles compared

Figure 7.1 compares the electricity consumption of the six profiles, showing the range as well as a measure of central tendency. The two profiles that stand out from the rest are the Ultra Low Users, which are concentrated around 180 kWh/month and the Thermally Unflappable with a similar if much less pronounced peak. The others cluster around 300 kWh/month, but have long tails toward the lower bound of the population, a distribution not unlike what we observe for the lowest decile as a whole. Figures 7.2 - 7.4 will be discussed in the case studies below.

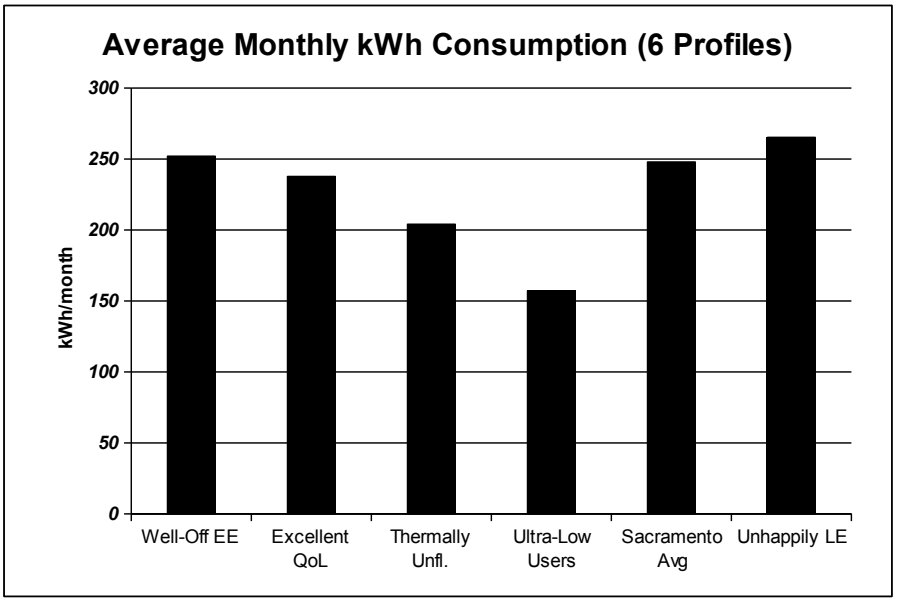

Figure 7.2: Average monthly electricity consumption across the six profiles compared.

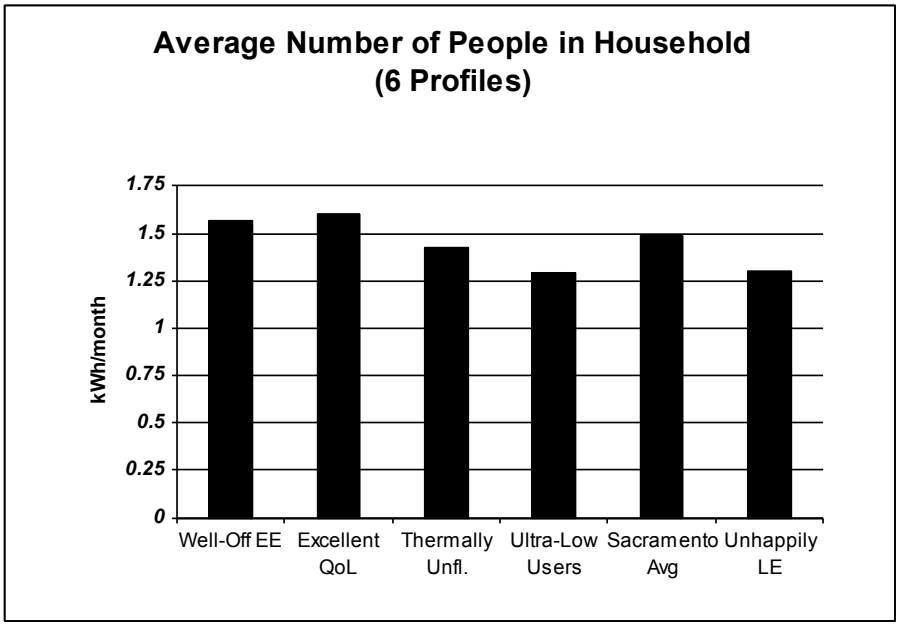

Figure 7.3: Average household size across the six profiles compared.

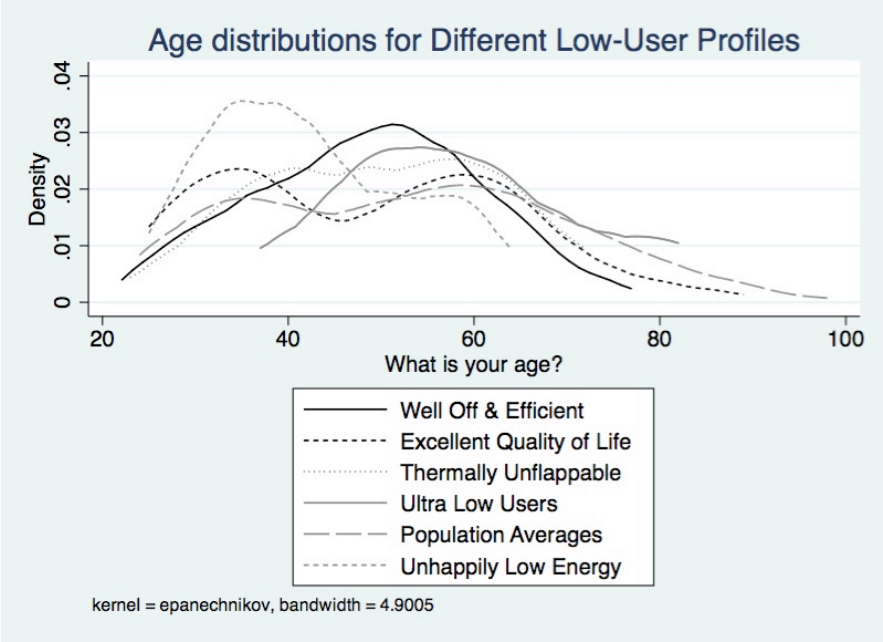

Figure 7.4: Age distributions of the six profiles compared

Case Studies of Six Profiles

1. Well Off and Energy Efficient (19% of eligible sample)

This profile was conceived as the opposite of the Unhappily Low Energy designation, with a high income, large house, the full suite of electrical appliances, and self-identified above average or excellent quality of life. To round out the profile, we also stipulated that those in this group must have participated in or engaged in some effort to improve the energy efficiency of their dwelling.

As Figure 7.2 illustrates, this profile includes households whose electricity consumption is as low as 100 kWh/month, a level that is well below the 2050 target anticipated in Executive Order S-03-05.

Five of the interviews that we conducted were with people who are in this profile. We've included answers from several of them below. The first set of answers below is from a single woman who fits into both this profile as well as the Ultra-Low Users. Her average monthly kWh consumption for the three-year period 2008-2010 was 208 kWh. We asked her to identify two or three of the most important ways that she keeps cool in the summer:

> Have all the blinds drawn. Keep the house dark. Or, I may have the windows open. The last resort would be the air conditioner. I grew up in San Francisco, so air conditioning to me is just not the first thing I grab for. So, keep the house as dark as I can, and then also I do open the windows to let a breeze in if I can. And then the air conditioning systems would be the third thing. I try not to use appliances until late in the evening and everything. Even the dryer warms up the house, and so I try not to use that at all.
>
> As a Bay Area kid, we had fog. I mean, air conditioning in a car was a luxury. So, when I moved here, I learned very quickly that we do really have summers here. You can be as stoic as you can be, but there's a point in time that you're just being stupid, and when the dog looks like it's about to pass out. So, I have

> now learned that it is okay to turn on the air conditioner, as long as I use it judiciously. I don't leave it running at night, because it dries me out. So, I still use it sparingly, I don't leave it on during the day. I try not to use energy, because I know we have, you know, energy watching and everything like that. I try to be as conservative with use as I possibly can. Use it when I absolutely have to. I'm not going to put it on when it's 85 degrees outside. When it starts hitting 99, 100 then I start using it. I'm a little bit more liberal with putting it on and everything. (388)

We also asked the people that we interviewed if they had recommendations for others in similar circumstances who use more energy. This is the answer from the woman (above) who lives alone:

> But, see if you can try to be comfortable and not try to cool the house down to an iceberg. I know it's probably more comfortable that way, but try to see if you can stay within what's recommended. And, like in fall, you know, do the same things. Don't use your appliances; maybe try to eat light meals that don't require cooking. Try to make the house dark during the day when you're not there. There's only one person in this house, but just try to be considerate, because there's other people who might need the energy. I work in a hospital, so I think of people who need the energy so we don't have a problem, that have like, oxygen at home. That sticks in my head, that they need energy a lot more than I do. And just, you know, try to be as conservative as you possibly can. Don't make yourself uncomfortable. That's not the point of it. But just think in the back of your mind, do you really need to be doing that right now? Or do you really need to have it at 75? Try to find a cool part of the room. Luckily my den is a nice, cool spot, so I just go in there and hang out there most of the time when I come home, because it's nice and cool in there. And that's what I can think of. (388)

Another interviewee in this profile lives with his wife and two children. In the course of remodeling they had replaced the A/C, put in double-pane windows, and insulated. Their average electricity consumption was 266 kWh/month. His/their strategies for staying cool are below:

> I keep everything shut during the day. Blinds drawn, all of that. And then open up at night. The other thing is, we had it insulated a few years ago. Additional insulation in the attic, and the other thing is trees surrounding the house.
> Interviewer: Do you rely on a thermostat to control the temperature in your home in the summer?
> P10: No, I wouldn't say rely on it, we use it, but…
> Interviewer: Okay. And what temperatures do you set that at?
> P10: In the summer, 78 to 80.
> Interviewer: Okay. And do you adjust that sometimes? How often do you interact with the thermostat?
> P10: Infrequently. The days that we turn it on, I'd say we might…just turn it on, and then that's it. And then just turn it off at night. That's the average.
> Interviewer: Above what temperature do you consider it to be uncomfortably hot in the summer indoors?
> P10: 82. Yeah, for me, I'm speaking family, because I'm not the only one. I can go up to 85. That's okay, but 82 is pretty much what the wife will stand. So it's 82.
> Interviewer: And under what circumstances does that happen?
> P10: You know, coming home later during a hot spell, that kind of thing. (269)

A third person lives alone and has the same monthly electricity bill as the family above:

> Interviewer: Since you moved into the house you live in now, have you changed the way you cool, adopted new strategies, or modified any other methods of keeping cool?
> P11: That's kind of difficult. You know, I lived in a place that had no air conditioning before I moved in here, or only had a little window unit. So, I've learned to use the whole house fan more often, like in the morning when it's cool out. And I've done a lot of energy improvements since I've lived here to keep it more moderate. You know, like, more insulation, and dual pane windows, and things like that. (190)

We asked about upgrades to appliances and the house vs. behaviors and habits, and this third person stated:

> Well, yeah. I feel like both are really important, and so I really strive to do both. Frequently, any time I can upgrade something, or I need to replace something, I'm looking for something more energy efficient. For example, my dishwasher is about ready to die, and I'm carefully researching what is the most water efficient and energy efficient, relatively affordable model that I can get, and I'm probably going to go with something much more expensive than I had originally intended. So I'm always looking for the more energy efficient things, but I'm also pretty conscious in my daily patterns, and will put up with more heat than most people. Or in the winter, I'll let it be a little bit cooler than I really like, and just dress warmer, just for the purpose of saving energy. (190)

A couple who live downtown without central A/C explain how they keep things cool:

> Okay. Well, when we're at home, one of the things that we did is when we bought the house thirteen years ago. There were a couple of window units on the second floor- this is an old house. It's over a hundred and ten years old. It's Norfolk Victorian, and it was designed in a particular way…you know, there's more overhangs, do that depending on what direction the sun is, it will keep the sun out of the windows. But, one of the things that we've done is we put in, like, fake wood blinds with like, three inch slats, and we turn them in a way so that it blocks the sun from coming in. And as soon as we put those up in place of the vinyl blinds that were in there when we bought the house, it lowered the temperature on the second floor probably five degrees. It was amazing.
> The other thing was we put in a whole house fan. We took out the window units because they're ridiculous, you know? Old, and not very efficient. But, we put in a whole house fan that could draw from the whole house. In Sacramento we have, except for maybe a couple of weeks in the year, we have a very good, strong delta breeze that comes in from Altamont Pass at the end of the day, and it just kind of, it cools the place down at maybe, nine or ten at night. That's the weather pattern. We'll have thirty or forty degree temperature swing. A lot of people here I think maybe don't take advantage of it. They just keep their house shut up and try to cool it rather than let cool air in. Once we figured out, I mean we're not from here, but once we figured out that that was the pattern, we realized that we could get by. Especially since we're downtown and there are very big trees around us that help as well, you know, we didn't plant them five years ago, but there they are, so…So anyway, putting in a whole house fan definitely was the best thousand dollars we ever spent, because it does cool down the house pretty quickly. Sometimes we have to run it all night to get cold air in by four o'clock in the morning, but generally speaking, I would say there's only two weeks out of the year when it's too hot to sleep on the second floor. It's pretty amazing when you think we're in a place that gets up to a hundred and fifteen.
> Well, we have a basement, and the basement stays at about seventy-eight. It's only after it's been really hot for a really long time that it starts to heat up down there. But it stays relatively much cooler down there. So, there have been summers when I just move. I take my laptop and I go downstairs. There have been times, I think in the past, where people who have lived in houses have slept in the basement during the heat. You know, it's just like, what people did before they had air conditioning. (96)

Finally here is how the same woman describes a conversation with her neighbors about reducing their high energy bills:

> I know people who…there's only two of us in the house, and, you know, this was right after we moved in. You know, our next-door neighbors who've lived there the same amount of time, you know, moved in at about the same time as we did. And…maybe a year later, we were talking about what our electric bill was. Because they were saying, "Oh my god, it's so high" And, it was like, three hundred something dollars. "How much was yours?" And we said, "Oh…thirty-five?"
> Well, they had a Jacuzzi outside, which they have gotten rid of. They never opened their second floor. And they finally figure out that, open your windows on your second floor and vent it out, right? They were coming in from someplace else, too. They were relying on air conditioning, and that's just, you know, sucking up juice. Since then, I think, they definitely rely on central air, and we don't have it. But I think

> that, since learning about what we were doing, they did alter their behavior. They actually open their windows now. And they got rid of the Jacuzzi! (96)

These people actively sought out energy upgrades for their typically large houses, and combined these with typically detailed strategies and routines for using little electricity. The chief insight about the people in this profile is that the energy efficiency route, when combined with a fair amount of attention to energy-related habits and behaviors, can lead to usage that is in some cases comfortably below the tenth percentile, even for families.

2. Excellent Quality of Life (24% of eligible sample)

This profile is very simply defined as including all households which identified as experiencing an above average or excellent quality of life. No other restrictions obtain; the idea being that for this profile what matters is simply that these low use households are pleased with their circumstances. What characteristics the group as a whole exhibits will be explored below.

We interviewed nine households who fit into this profile. We've excerpted from three of them below. Coincidentally, these three two-person households are also members of the Ultra-Low User profile discussed below. This first interview below was with a woman who lives with her husband. Their average consumption was 192 kWh/month. Their house is between 1,000-1,499 square feet, built in 1910. They've lived in it for 15 years. Their income is between $100,000 and $150,000.

The three sets of things that she emphasized were:

(a) developing energy-inspired routines and habits around a large number of tasks, such as:

- use cold water for washing all of our laundry,
- spend more time outside where it is cool because of the shade trees
- timing showers to coincide to limit indoor humidity
- sleeping on linen sheets is a lot cooler than sleeping on cotton
- limiting computer time,
- don't bake in the summertime
- stopped decorating the house with lights at the holiday times;

(b) doing without a bunch of appliances and electrical devices, such as:

- clothes dryer
- TV
- electric clocks
- big computers that give off heat;

and (c) making modifications to the house and its environs, such as:

- shading with "old-fashioned metal shade screens that we put up just in the summertime on the west-facing windows. And that works really well. You see them on old people's houses around."
- replaced all the mini-blinds with cloth curtains
- put the tiles floors in where there was carpeting, and the tile feels cooler, and
- plant shade trees. (364)

This couple's average monthly consumption is 126 kWh. They did a bunch of things to optimize their old two-story house, from realigning the doorways to optimize the breeze to building window insulation panels:

> So, the thermostat on my heating system controls nothing related to cooling. So in the summer, I do nothing. The thermostat is just- it has a temperature reading on it, and I use that just to see what temperature it is in the house. But it controls nothing as far as cooling. Absolutely no mechanical cooling except for ceiling fans. And they're not controlled by thermostat. I installed one window air conditioner for the room I was sleeping in, and the noise was such that I learned to live without it. I took it out and I never put it back in. It's in the attic in a box.
> We use these sheets of rigid foam insulation we buy at Home Depot. They are an inch or an inch and a half thick; I think I have both, depending on when I bought the stuff. It comes in four by eight sheets of pretty common insulation material. I cut them to fit inside my windows. So, on a hot summer day, I insert them into the frame of the window, and it blocks the light as well as the heat. Because it has aluminum on both sides, it reflects a lot of the heat back out. So that's one way we keep the heat out in the first place, so that we don't need air conditioning.
> And then, you know, when it starts feeling warm in the evening, that's when I know it's cooler outside, it's time to open up and reverse the situation. So, thermal mass gets charged with heat during the day a little bit, and then it discharges it at night when that wind, the air is blowing through and removes some of the heat. I know I'm unusual; this not the normal way that people live. (152)

A third couple, whose usage was similarly low at 206 kWh/month, had very little to say besides mentioning their whole house fan and upgrades to their insulation:

> There's nothing magic, really. This house has nothing magic in it (197)

Their house is between 1,500-1,999 square feet, built in 1963. They've lived in it for 47 years. Their income is between $30,000 and $50,000. The last two households above share some traits (ultra-low usage, older, white, two person household, but the specifics diverge. One has a Central A/C they use rarely, the other doesn't have any A/C. Perhaps the largest difference is in how they represent their level of engagement with the issue even as they arrive at essentially the same, untypical, result. Some go to great lengths while others see their accomplishments in a different light or may not even be aware that they are unusual.

The Excellent Quality of Life profile includes plenty of thoughtful people willing to talk about their energy consumption and how the go about their lives, but overall it is a fairly heterogeneous group.

Figure 7.5 shows the income distribution of this group. Roughly one-quarter of those eligible (158/658) households identify themselves as experiencing an excellent quality of life. This figure, along with several others discussed above, casts doubt on any simple equation of energy consumption with quality of life. People with incomes below $20,000 and above $100,000 are represented here. Not only is the population of those who use very little electricity distributed across all income brackets, those lowest users who are pleased with their circumstances are also found across a large band of incomes.

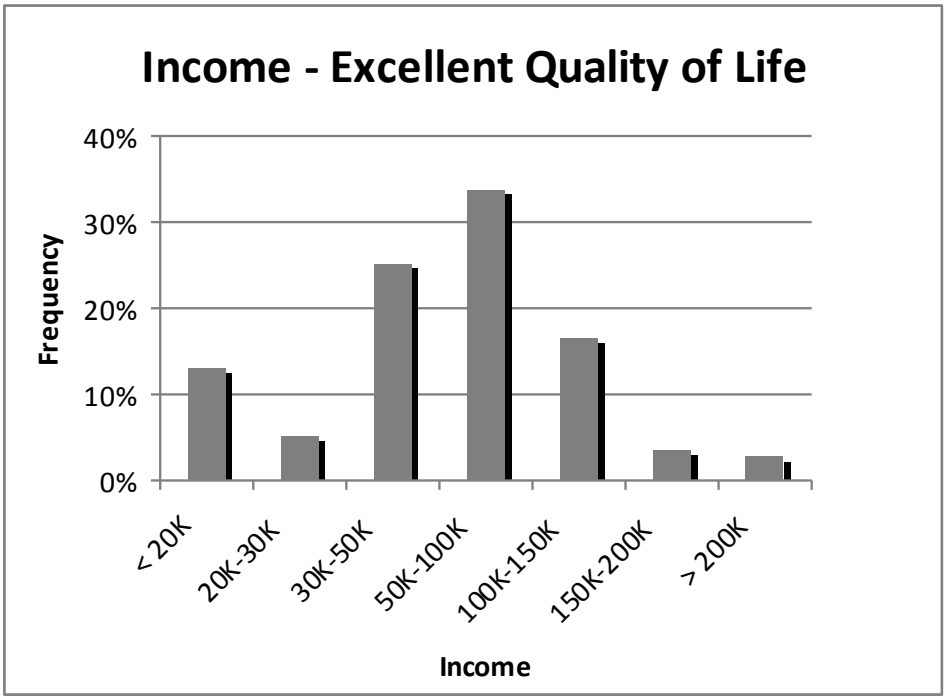

Figure 7.5: Income distribution within the Excellent Quality of Life profile

3. Thermally Unflappable (16% of eligible sample)

We created this profile because cooling practices emerged as a crucial dimension of the experiences discussed by the low users. The members of this group have air conditioning but rarely, if ever, use it. They assume that the summer temperatures in their homes are probably higher than is typical, but they do not view the low- or non-use of A/C as a limitation. Members of this group consider their quality of life to be average or better.

We have already said a lot about air conditioning and alternatives to it in this report. The idea behind generating a profile around this behavior is intended to highlight the choice to do without an air conditioner in a climate with a high saturation of this end use technology. The saturation figures are commonly assumed to correspond to usage. Non-users of a piece of hardware as expensive and culturally visible as a central A/C is not something we know much about, outside of emergencies, when as we've seen some people are quite willing to exceed official recommendations and shut the A/C off (Lutzenhiser 2002).

What motivates or permits this group to get by without A/C. Under what circumstances do they use it if at all? What are their reasons for this non-use? Figure 7.6 suggests it is probably not cost—at least for those in the higher income brackets. The distribution of income within this profile is very similar to what we observed for those identifying as having an Excellent Quality of Life. What is also noteworthy about the income distribution within this profile is the alignment of this attitude with population concentrations. While about two-thirds of those identified as Thermally Unflappable in the lowest decile have incomes between $30,000 and $100,000, this income range also corresponds to more than half of the general population (for both renters and owners) within the utility territory (see Figure 6.1). In other words, the incomes of the majority of the low users who are thermally unflappable are in the same range as the incomes of the majority of everyone living in the utility territory.

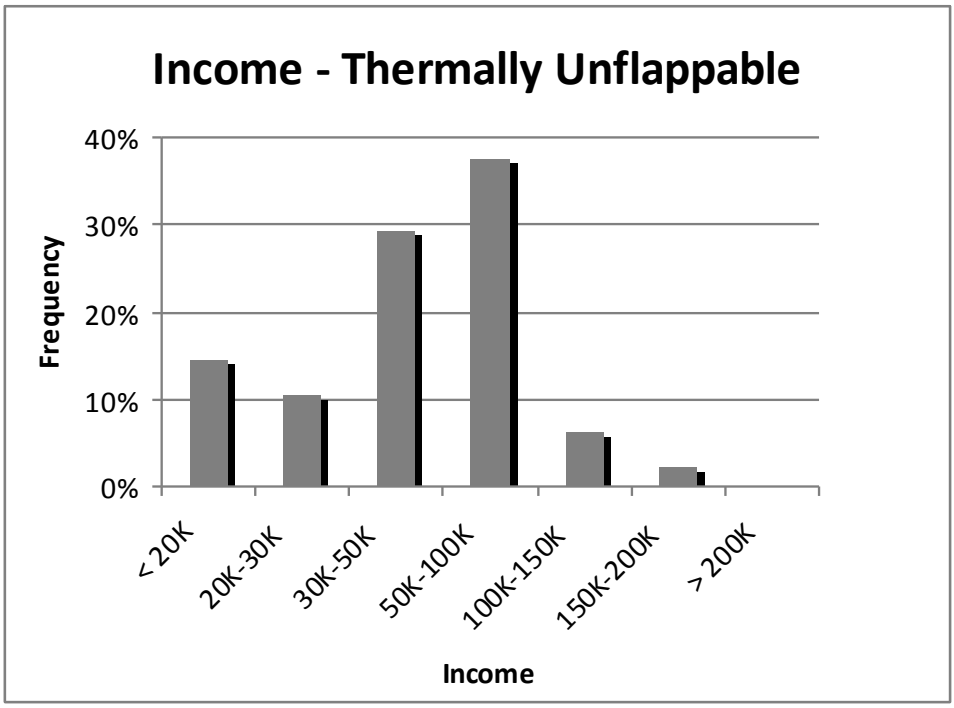

Figure 7.6: Income distribution within the Thermally Unflappable profile

We conducted two interviews with members of this profile. Below are excerpts from both of them.

> P14: Well, our house is equipped with plantation shutters, and also we have tile. Throughout the house we have hardwood floors. And our house has…six fans. And then what we do is, we close the shutters, so we don't allow the sun to come into the room. That way, we block the sun. So that's how we keep cool.
> Interviewer: Do you rely on a thermostat to control the temperature in your home during the summer?
> P14: Not really, because we don't usually use the air conditioning, because our house is open.
> Interviewer: Do you attribute your low usage to any particular habits and behaviors?
> P14: No, we just…it's like if we are cold, we just wear a sweater. We're not in the habit of putting on the air conditioning, you know. Or if it's hot, or if it's cold, put the heater on. We just wear two sweaters, and then we are comfortable in the house like that. (257)
>
> I use my whole house fan when it cools down outside. Oh, and another…I take cold showers. Not complete showers, I just get my hair wet. (348)
>
> P23: I have friends who will not give up their comfort. They need to be absolutely comfortable all the time. I think that's the biggest factor. They will turn on the AC when it's warm, and they'll turn on the heat when it's cold. Right now, it's cold, but I don't have the heater on. I don't know; it's just behavior. And the whole house fan is magical. It's the best invention ever.
> Interviewer: That's great. When you say that you have friends that won't give up their comfort, would you characterize yourself as uncomfortable? Or is it maybe part of the attitude about defining comfort, and what people are tolerant of?
> P23: Defining comfort. I was born and raised in San Francisco. And over there, it never gets this hot or this cold ever. And I guess because it's much cooler…the coolness is consistent. So I guess as far as the summertime, or the winter, I'm more tolerant. And in the summertime, it's just…because I was raised…my father was the only breadwinner in the house. There were six of us. And my father was very careful with

> how we left doors open, turned on the lights, left them on, and stuff like that. So all of that was ingrained in me, so I'm pretty unique in that sense, where I am careful. (348)

Many people, not just members of this profile, remarked about the air-conditioning habits of their neighbors, especially how hard it was for them to understand their neighbors' tendency to leave it running all day when they are not home.

4. Ultra-low Users (33% of eligible sample)

Ultra-low users are the members of the sample whose usage falls below the third percentile of the general population, or between 52 and 208 kWh/mo. No other eligibility criteria obtain. This group is of symbolic significance as their consumption levels of electricity most closely approximate the 2050 target identified in Executive Order S-03-05. When examining low usage, a common assumption is that some significant fraction of the people associated with the low usage accounts are not home, or have moved. A methodological consequence of this assumption is to raise the minimum usage threshold to exclude unoccupied households. Households in this Ultra-Low User profile would have been excluded had this research project followed that practice. If we think of the lowest decile as including best practices within that band of consumption—and this research project is organized to identify some of them—then this profile, by virtue of having a much lower upper bound, intensifies that goal. In this lowest tier we again find diversity across demographic categories, suggesting that, at least in principle, usage below the third percentile is not limited to any particular group.

The fact that the Well-off and Efficient category overlaps with this profile is instructive. As we have seen in the interview excerpts from people who are in that category (above), their usage is in some cases well within this range. Outward markers of financial wellbeing also appear to be compatible with electricity usage at a level lower than 97% of the general population. To the extent that policymakers or the public assume a fundamental tradeoff between choice, comfort, and convenience and very low electricity consumption, this overlap and this profile should help to counterbalance that notion. The fact that one-third of the households identified as Sacramento Average also fit the ultra-low user profile underscores the extent to which the very lowest energy consumption is not a good predictor of income, square footage, or any of the other criteria used to generate that profile—or vice versa.

Below are three charts that examine income distribution within this large subcategory of the low user population. The first (Figure 7.7) is like the previous charts. The income distribution is here much more discrete, with roughly 1/3 of the population in one of three non-adjacent income brackets. But perhaps the most striking feature of this population is the household size. As Figure 7.3 indicated, the average is noticeably smaller than for all but one of the others at 1.25 people. This works out to 80% single occupant households and 17% with 2 people. This suggests that it is uncommon to be in this tier with more than one person. We were able to interview nine households in this profile, including three of the two-person households who we met above in the Excellent Quality of Life profile (152, 197, and 364).

> P08: I got a brand new system! I want to say…about three years ago. I got a new heater and a new air conditioner. I had to upgrade it plus the damn thing was so noisy! So I have upgraded that. I have it checked out yearly by the company. He laughed at me when I showed him what I did. I tried to protect it during the winter, so that it doesn't get water and leaves in it. I actually put a cover on it when it's not in use during the fall. And then…I haven't had it done yet, but I have them look at the air ducts when they come out. That's a project for the future to be done.

Interviewer: So, once you got the new air conditioner, did you find that your habits around that changed? Or were they pretty much the same?
P08: Pretty much the same. I have to say I probably put it on a little bit more. Because it's a little bit more energy efficient, I didn't feel as guilty, so maybe I used it a little bit more than when I used the old one, because the old one like I said was noisy, and I just felt guilty wasting energy. (388)

P05: Well, I live upstairs. So I can keep my windows open. And right here where I live, it's how the sun hits the windows where I live, too. And the shade, I'm in the back of a building, where I get afternoon shade. So I can keep my windows open for most of the time. But when it gets too, too uncomfortable, I can close them up and turn on my air conditioner, which I try not to do because I prefer the fresh air. And I'm safe, because I'm upstairs. So, I know people who live downstairs that can't live that way at all. That seems to be a major difference.
Interviewer: Interesting. In my experience the heat rises, and so it's often cooler downstairs than upstairs, but I'm hearing a very different stratification in your case.
P05: Circulating the air is key to keeping it cool and fresh. And the best way is through the windows, and I think the cheapest. Yeah, and I just feel so claustrophobic without my windows open. So it's a lot of things. And I'm just cautious about not using my air conditioner more than I need to. I don't have animals, so I don't have to cool my house when I'm not home. You know what I mean?
Interviewer: Oh yes, absolutely. People do that, and it's surprising to some of us.
P05: Yeah, because I'm thrifty. I've learned that I've had to do that to survive in the world. And it makes me feel good when I feel like I'm being careful and conscientious, and responsible. Does that answer that question? (213)

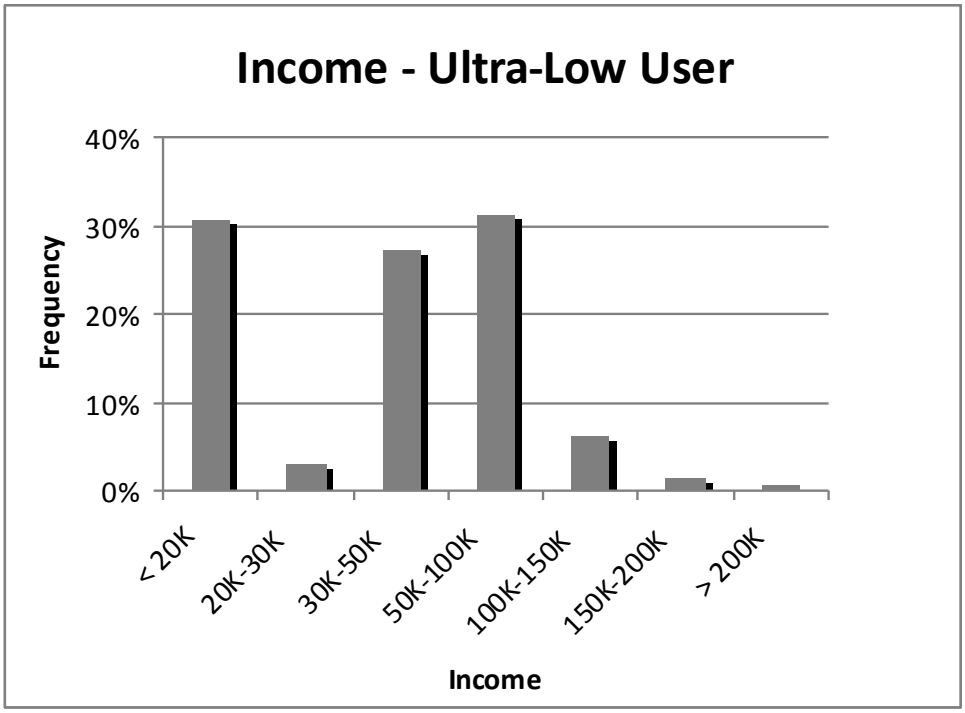

Figure 7.7: Income distribution within the Ultra-Low User profile

The income distribution within the Ultra-low User profile (Figure 7.7) is fairly similar to what we saw for both the Excellent Quality of Life and Thermally Unflappable category, at least for the $30,000-$100,000 range. The difference is that those with incomes below $20,000 are also equally well represented here. But, again, the share of renters in the general population whose incomes are < $30,000 is about the same as the share of Ultra-low users with those

incomes (58 of the 68 households with incomes below $30,000 in the figure above are renters). This reinforces the observation that, at least for income, low usage, or in this case ultra-low usage, is distributed very similarly to how it is distributed for the general population.

Shifting attention to the other end of the income spectrum, Figure 7.8 shows the incomes of the households in the overlap of two of the profiles: Ultra-low Use and Well-Off. While the overlap is not numerically large, the fact that some of the wealthiest households are also found in the lowest usage bin undermines a key premise of the folk theory of low usage, that it's poor people who occupy the low(est) energy tier.

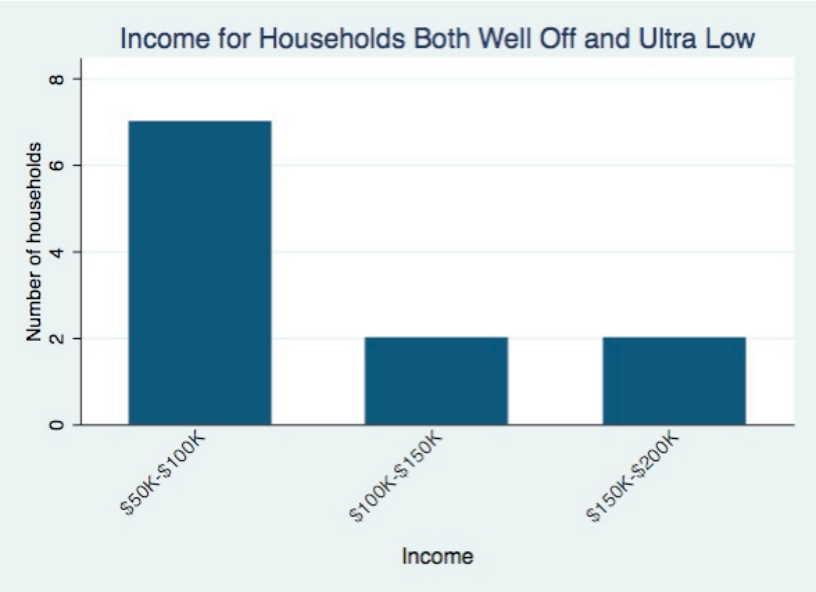

Figure 7.8: Income distribution of the households that appear in both profiles 1 and 4

Ultra-low users are a heterogeneous group. Like the lowest decile, other energy use tiers also end up including lots of otherwise dissimilar people. Whether the diverse pathways by which people end up in this profile are interpreted by others whose usage is not as low but who may share some characteristics as an invitation to explore this territory remains to be seen. But to the extent that the 2050 target can be interpreted to allow for this usage level, the diversity within this profile seems promising.

5. Sacramento Average (22% of eligible sample)

This profile reflects mid-range values across a number of different demographic categories: income, home size, education, and age. Quality of life is considered by members of this group to be either average or above average.

In answers to the survey questions about what they have done to lower their energy consumption, respondents who belong to this profile mentioned a broad cross section of things, from infrequent use of the dishwasher, washing machine, and dryer, to preferring to open and close windows and use fans to cut down on the amount of time the A/C is running. Higher A/C thermostat settings (78F and 80F) were also mentioned frequently as were the use of CFLs and turning things off.

On the relationship between increased energy use and quality of life, Sacramento Average respondents made the following observations:

I don't prefer to spend my money on utilities. I try to keep my overhead low so that I can enjoy other things (travel, food, experiences) that do improve my quality of life. (1833)

I would be worrying about wasting electricity. - Using up something that I didn't really need. (3301)

It would be depleted natural resources which would cause me to feel I wasn't doing my part to help the environment. I would be paying out more in bills which would give me less money to spend on other things and not help the economy. (223)

I like to conserve whether I can afford a lot or not. On the other hand, I do think it is nicer to have comfort. It is either one way or another because I can have comfort even with less unless the temp gets too extreme. (267)

I don't mind saving energy so it wouldn't matter if I have a little discomfort once in a while (57)

It bears repeating that households whose characteristics align with the middle range of a series of characteristics are also found to be in the ultra-low energy use category. Figure 7.9 compares the incomes of those households who occupy both of these profiles.

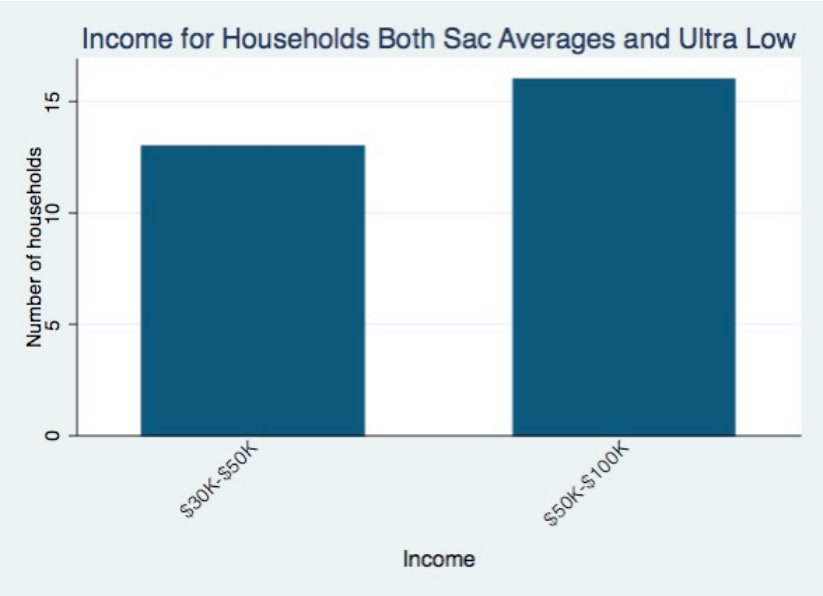

Figure 7.9: Income distribution of the households that appear in both profiles 4 and 5

6. Unhappily Low Energy (5% of eligible sample)

As mentioned above, this profile is designed to capture the folk theory about this tier of the population as using little energy not by choice. They are unable to consume as much energy as they would prefer because of circumstances beyond their control. Low income and small home size are considered the chief criteria, and we have relied on these to generate this profile. Quality of life is judged below average or very poor. The age restriction above 35 years is included to exclude students from this category, but its effect on the size of the profile population turned out to be very slight.

Although some low users fit this stereotype, this study has shown that the tier of low users—even the tier of ultra-low users—encompasses a diverse cross section of the population, and that this profile is not an accurate characterization of low use *per se*. Some individuals and households would use more energy if they could, and it is important not to lose sight of that fact. But for the present purposes, it is important to recognize that low electricity usage—as examined in this study—and being too poor to afford more energy services are two different issues that overlap to some extent. The fact that some poor people use much less energy than the average (as observed in this study), while others use more than the average,[13] points to the fact that poverty and energy usage are related in ways that are more complex than a simple assertion that very low energy users are probably poor.

We have attempted to demonstrate that the relationship between income and electricity use, as well as income and more direct measures of happiness or quality of life is not fixed. One illustration of this is that the mean kWh consumption level of this Unhappily Low Energy profile is actually slightly higher than the others (see Figures 7.1 and 7.2). Although the resolution of our dataset does not permit us to calculate this for the present population, others have observed that, "low-income dwellings generally use more energy per unit area; [which] is largely a reflection of the low quality of poor people's housing." (McAllister 1991)

We have tried to estimate the share of the lowest decile made up of those whose energy use is low not by choice but by circumstance. It is important to understand how we approached this question because in the absence of any prior investigation of low user demographics, speculation about who would be found at the low end of the energy use spectrum converged on this group. Furthermore, any statistical analysis of this tier seems to confirm this impression, as we showed in the quantitative results section of Chapter 6. We have, therefore, tried to estimate the size of this group, its share of the low use population using three different methods:

(1) Adding up what we refer to as constraints mentioned by respondents in the course of explaining their (low) energy use,
(2) By carefully reviewing the answers to the open-ended question about the relationship between more energy use and quality of life, and
(3) Generating this sixth profile of those whose income, home size, and quality of life assessment would seem to correspond to the caricature of low users as unhappy or poor.

In Method (1), identifying constraints is not a filter for unhappiness *per se*, but a tally of circumstances that (a) a subset of low users identify as (partially) explaining their low usage, and (b) are recognizable markers of modest conditions, or conditions at odds with our notion of middle class domestic life. Figure 6.21 illustrates this method. While living alone in a small apartment and not being home very much are neither necessary nor sufficient criteria for low usage[14], finding that some low users fit that description is also not surprising. About one fifth (21% (32/153) of owners and 23% (119/519) of renters) of the low users who responded to the relevant questions mentioned at least one of these constraints in relation to their energy usage (live alone, not home much, on a budget, or small apartment).

[13] Various bill paying assistance programs both at the local, state, and federal level, are designed to help poor people pay their heating bills and as such these are premised to some degree on the existence of high energy usage among poor people.
[14] This is true for a significant share of the general population as well.

In Method (2), examining subtleties within the responses to our open-ended question about energy consumption and quality of life revealed a slightly larger—if also self-selected—share of the low users who identified positive attributes to consuming more energy. This group consists of

- those who identified increased (thermal) comfort as the anticipated result of a hypothetical increase in energy use (6% (3/51) of homeowners and 11% (26/231) of renters), and
- those who felt that increased energy use represented a tradeoff—that the higher usage implied would translate to higher bills, and that those higher bills would detract from their quality of life (24% (12/51) of homeowners and 26% (60/231) of renters).

This was the one category of responses where financial constraints were seen as reducing their choices about energy; and we consequently interpret their present low use circumstances—at least in part—to a lack of money to pay for more energy services. If we ignore the self selection in the response rates to the last question, combining those figures we find 30% (15/51) of homeowners and 37% (86/231) of renters of the lowest decile in this category.

In Method (3), we used a set of filters tied to income, home size, and respondent's age, in addition to an unfavorable answer to the question about their present quality of life. This yielded a combined rate of 5% (23/476), but since this filter did not yield any homeowners, the share of the (renter) population who fit the parameters of this profile is 6% (23/353).

These three attempts to gauge the share of the low user population that uses little energy at least in part because of some type of constraint are the best we can do with the available data. The wide range of values and the difficulty interpreting the responses to the questions about quality of life and energy suggest some of the uncertainty around these estimates. But in light of our various attempts to quantify subsets of this population we think it unlikely that more than 30% of homeowners and 37% of renters within the lowest decile can be considered constrained.

8 SUMMARY AND CONCLUSIONS

This research started from the premise that low usage, and the patterns of living that make it possible, is for all practical purposes invisible, and that rendering it visible could open up new possibilities for encouraging the public to take more responsibility for reducing its energy consumption. To make low usage visible, this project examined the usage patterns among residential urban customers in the lowest decile of the population served by SMUD using three primary sources of information: a database that included customer energy use and demographic variables, an in-depth survey of renters and homeowners in the lowest decile of the population, and a series of telephone interviews drawn from this population.

This study was designed around four main research questions:

1. Is very low electricity usage real? Are households whose electricity consumption registers below the tenth percentile even occupied?
2. Who lives in the very low usage tier? How is the population similar or different from the general population?
3. What circumstances, patterns of behavior, strategies, and attitudes are associated with low usage?
4. What insights can be derived from a study of low usage that could inform policies designed to encourage reductions in electricity consumption by others?

To help answer the first question we created a set of filters to exclude what we suspected might be unoccupied households beyond the filters that the utility had created to generate the low user dataset on our behalf. The remaining sample included only accounts with sufficient variability (year-to-year and peak-to-off-peak) that we felt comfortable treating them as occupied. Our survey response rate (15.4% for renters and 18% for homeowners) confirmed that there were occupied households in this range, and that even the very lowest tiers were populated with a diverse range of people willing to answer our survey questions and talk to us about their usage over the telephone. Although for practical purposes we identified a lower bound in our study (45kWh/mo), there is no reason to think there aren't occupied households below that cutoff.

We explored the second question, "Who lives in the very low usage tier? How is the population similar or different from the general population" using a variety of techniques. This research project was not chiefly concerned with examining *average* characteristics of the lowest decile but with understanding the range and diversity of this population. Is it homogeneous? Are there demographic or other criteria that distinguish the lowest decile from the general population, that suggest *a priori* reasons why low usage might be difficult to replicate?

In trying to identify and understand the opportunities and obstacles to replicating low usage across a wider portion of the population it is less helpful to know that *on average* the lowest users are slightly less wealthy or live in slightly smaller houses than to know that people in every income bracket, every age and race category, people with varying levels of education are all represented in significant numbers in this tier. The variation across these variables within the bottom decile is very similar to the general population.

The third question, "What circumstances, patterns of behavior, strategies, and attitudes are associated with low usage?" expands the qualitative dimensions of the second question. Answers to a number of the open-ended survey questions as well as the telephone interviews revealed how

people in this tier achieve their low usage, why they are engaged to a greater or lesser degree in the pursuit of a low energy lifestyle, and what differentiates them among each other.

We derived six profiles from among the lowest decile population to understand in detail what characteristics they may share with others whose usage is not currently low, or what could make low users familiar to potential audiences. The six profiles include **Well Off and Energy Efficient** (18.5%), **Excellent Quality of Life** (24%), **Thermally Unflappable** (15.6%), **Ultra-low Users** (30.3%), **Sacramento Average** (22%), and **Unhappily Low Energy** (4.8%). Well-Off and Energy Efficient includes those in the upper income, education, and home size tiers who indicated pursuit of energy efficiency improvements. Thermally Unflappable includes those who identify as enjoying an average or better quality of life and who rarely or never use their A/C. Ultra-low Users are those whose present electricity consumption level already approximates California's 2050 target of 80% below 1990 levels. The last profile, Unhappily Low Energy, attempts to assess the veracity of the folk theory about who would be found in the low use population, using criteria such as house size, income, and a statement about quality of life.

The degree of overlap among these profiles is an indicator of the cross-cutting nature of low usage, and it calls into question a number of preconceptions about how energy use and social variables align. Wealthy members of this population are found in the lowest use tier; Excellent Quality of Life does not scale with income; and as a group, those identified as Unhappily Low Energy actually use slightly more electricity than the other five profiles.

Building on the insights from the typology of substitutions developed in Chapter 6, a matrix that organizes energy behaviors according to eight principles including doing without, running only full loads, matching the scale of the device to the task, and upgrading to a more energy efficient version, we identified four approaches to low usage, the first two of which are the most policy-relevant: **Energy Efficiency**, **Non-Use**, **Just How It Is**, and **Constraints**.

Table 8.1: Types of Low Users

Types of Low Users	Description	Actions
Energy Efficiency	Actively engaged on energy, self-motivated (varying combinations of behavior and efficient technologies)	Thermal mgmt routines, upgrades
Non-Use	Actively engaged on energy, prefer to have and use less stuff	Turn off/don't have/ don't use
Just How It Is	No special efforts mentioned, and little self-awareness about energy	x
Constraints	Low energy use attributed to budget, living alone, not home much, or small apartment	not emphasized

Additional research is needed to estimate the relative sizes of these categories, but the open-ended responses to our survey and interview questions suggested that at least half of the lowest decile falls into the first two groups, whose engagement with the subject of energy is high. The first category, **Energy Efficiency,** includes people who have followed expert advice on energy efficiency, augmenting the investment in technologies or building improvements with more or less elaborate routines and behaviors. The second group, **Non-Use,** go about it in a slightly different way. Because they are content not to have so many appliances or other electrical devices, or to use them less frequently, they manage to use little without investing in upgrades. The third category, **Just How It Is,** use little energy without recognizing it as exceptional. They find the subject unremarkable and have little to say about their efforts. The fourth category,

Constraints, includes people whose usage is low not because they aspire to it but because one or more of what we call constraints, including not being home much, living alone or in a small apartment, or the inability to afford to spend more on energy, keeps their usage low. While it may be tempting to discount the fact of low electricity usage by focusing only on people living alone, the majority of single person households in this utility territory are not in fact in the lowest decile. Any efforts to target renters or small households should take this into account.

The final research question, "What insights can be derived from a study of low usage that could inform policies designed to encourage reductions in electricity consumption by others?" seeks to bring these insights to bear on the matter of policy. How can we translate findings that suggest a multiplicity of pathways to low usage in the present into marketing and outreach campaigns, images, and inspiring case studies, examples, and stories that could augment or anchor the policy framings of residential energy conservation and energy efficiency? In the absence of this translation or interpretation of these findings, we can't say whether the diverse pathways by which people end up using very little electricity will be interpreted by others whose usage is not as low but who may share some characteristics with them as an invitation to explore this territory.

Energy efficiency can be a key ingredient in and a point of departure for very low usage. A majority of low users in our study followed some type of expert advice on energy behaviors, and a significant number invested in upgrades to their house or appliances. Recognizing that these efforts can, in combination, yield usage below the tenth or even below the third percentile is important because it suggests far greater reductions are achievable starting from familiar strategies than is commonly assumed. This research also suggests opportunities to enroll the public as co-producers of a new approach to taking responsibility for our energy use, creating a more participatory energy future (Neiman 1989).

The lengths to which many of those in the lowest decile were willing to go to accomplish their low usage, the specific routines and tricks many of them devised for keeping cool without running the air conditioner, or optimizing other household tasks, from the quirky to the mundane, could animate the topic of energy considerably. The realization that others, including perhaps one's neighbors, care about the issue of energy that much, and/or have managed to reduce their energy consumption, should be used to enliven and concretize conversations about energy. Energy usage is, after all, very much embedded in a social context, shaped by a shared understanding of what is normal, and what is involved in achieving comfort (Shove 2003, Lutzenhiser & Gossard 2000, Lutzenhiser 1993). Introducing these people's stories, their dedication, or even those who manage to use little energy without trying to a wider audience can anchor the goal of reduced energy consumption.

The lowest decile is made up of a diverse range of people, many of whom are engaged in the pursuit of low energy and are willing to reflect on the particulars of how they have achieved comfort *and* low usage. They are potentially a source of information, guidance, and inspiration to others who may not have realized or had a chance to discover the ways in which the lifestyles they have grown accustomed to could be enriched by the pursuit of much lower energy consumption.

9 RECOMMENDATIONS

Energy Outreach

We now know who the lowest electricity users are, and we have reason to think that their experiences and insights could be useful and possibly inspiring to a much broader audience. We also recognize that within the realm of energy policy it is atypical to invite input from the public, much less from outliers. Outreach materials, tips, and guidance are rarely developed with input from non-experts. But when thinking about how to pursue the very significant reductions in greenhouse gas emissions now under discussion we think all options should be considered, and incorporating what we have learned about the lowest users into policy and outreach efforts holds considerable promise.

One of the objectives of this research has been to dispel the assumption that those who use very little energy are fundamentally unlike the rest of the population and, therefore, presumably do not conduct themselves in ways the imagined audiences would recognize or appreciate, or would feel comfortable adopting themselves. Because the social, demographic, and possibly motivational, distances between the low users we've studied and the publics who are not in the low usage tiers is revealed to be much smaller than imagined, a key challenge is to communicate these insights effectively. Some people (individuals or groups) may be open to the possibility of taking on more responsibility for their energy consumption, but without an invitation or a story that presents a coherent set of circumstances known to yield lower usage, they may not consider it. We have not taken advantage of the experience and insights of these individuals hitherto because no one thought to ask them.

This section of the report outlines a series of recommendations for how state policy makers and utility program designers could incorporate some of the key insights from this research. The ultimate audience is the public, but at this stage we are concerned with making the results from this research useful to those who already engage with various publics on the topic of energy. Our findings build on and complement existing utility outreach efforts, which, as we have seen, are very successful, at least among the population we studied.

Recommendations for State Policy Makers

- **Incorporate low usage into policy framings**. Find ways to recognize and incorporate the independent pursuit of low usage by a segment of the population into the conversation about how to achieve climate change objectives.
- **Leverage the discovery of low usage** into a broad-based reevaluation of the limits to how we have approached home energy conservation and efficiency.
- **Emphasize the importance of behavioral practices**, not just widgets.
- **Low usage is possible**. Introduce the fact of very low usage to the public. Include the diversity of people, circumstances, and pathways by which they achieve this low usage. Prepare case studies and distribute them.
- **Expand the conversation.** Including the outliers legitimizes their efforts and enriches the conversation. By discussing the topic in a new light we can all learn. Our energy usage is shaped in part by what we consider normal, what we think our peers are willing to do when it comes to arbitrating between, for instance, comfort and energy, so expanding what is considered feasible can only advance the effort to reduce energy consumption.

Recommendations for Utilities

- **Learn from low users**. Augment the existing lists of recommendations with strategies observed among the lowest users. Invite them to contribute their insights and experience.
- **Emphasize the importance of behavioral practices**, not just widgets.
- **Tell stories.** Embedding lowest usage recommendations within the experiences of the lowest users has the potential to increase the salience of the subject.
- **Use actual consumption figures in outreach.** Anchoring the recommendations to the specifics of a (very) low bill has the potential to advance the conversation, moving beyond the (relative) framing of energy efficiency to the (absolute) framing of California climate change targets.
- **Celebrate lowest users.** Organize contests. Recognize their accomplishments.
- **Consider using social media.** Invite input from lowest users as well as those who are not. Organize a conversation where peers can share their experiences. Thinking of decisions about energy use strictly in terms of the individual or household is a mistake. Some of the changes discussed in this report could come about through peer support and accountability.
- **Adopt the approach pioneered by Gainesville, FL.** They placed all customer utility information on the web in a searchable platform "to enable us all to make better decisions about our energy usage."

Suggestions for Future Research

- **Quantify the prevalence of different types of low user identified in this report**. Investigate the motivations within the low use population paying attention to the ways the findings could be used to support effective outreach.

- **Examine strategies for leveraging the diversity of the low user population into a program for emulating low usage.** Rather than generating a monolithic set of guiding principles, elaborate strategies that draw from and align with the diverse populations that exist throughout California.

- **Examine how non-low-users interpret or make sense of information about low-use.** How helpful is it when the two populations are matched demographically? Do they view low use by people much like themselves as an invitation, an opportunity to explore low use? What kinds of information or support would complement the knowledge that low usage is possible and achieved by otherwise similar people?

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APPENDIX A - REGRESSION TABLE

Table A.1: Factors Explaining Energy Consumption in Lowest Quartile of Electricity Users

Dependent variable = average monthly electricity usage from 2008-2010	(1) OLS Whole Sample	(2) TruncReg Whole Sample	(4) OLS Owner Occupied	(5) TruncReg Owner Occupied	(7) OLS Renter Occupied	(8) TruncReg Renter Occupied
Sqft	0.0473**	0.108**	0.0491**	0.113**	0.0315**	0.0657**
	(0.00395)	(0.00844)	(0.00436)	(0.00946)	(0.00818)	(0.0172)
Sqft^2	-9.95e-06**	-2.25e-05**	-9.45e-06**	-2.14e-05**	-8.95e-06**	-1.79e-05**
	(1.01e-06)	(2.12e-06)	(1.11e-06)	(2.41e-06)	(2.04e-06)	(4.12e-06)
Home Age in 2009	0.490**	0.858**	0.603**	1.132**	0.0205	-0.274
	(0.0650)	(0.145)	(0.0715)	(0.157)	(0.169)	(0.395)
(Home Age in 2009)^2	-0.00887**	-0.0168**	-0.0102**	-0.0198**	-0.00392*	-0.00544
	(0.000714)	(0.00143)	(0.000800)	(0.00158)	(0.00165)	(0.00350)
Owner = Y	0.0576	0.722				
	(1.400)	(3.223)				
Sacramento = Y	-1.588	-4.075	0.0447	-0.0254	-11.72**	-27.86**
	(0.926)	(2.279)	(0.986)	(2.413)	(2.701)	(6.631)
People in Home	7.927**	21.58**	7.956**	21.49**	6.422**	17.42**
	(0.375)	(1.099)	(0.403)	(1.172)	(1.026)	(2.915)
Summ_Pk_2009	0.222	0.385	0.171	0.262	0.703	1.408
	(0.682)	(1.611)	(0.731)	(1.623)	(1.370)	(3.585)
Summ_Pk_2010	3.014**	8.586**	3.137**	9.154**	2.360	5.597
	(0.837)	(2.534)	(0.908)	(2.776)	(2.217)	(5.818)
Length_Res_Yrs	-0.122**	-0.271**	-0.0751	-0.164	-1.142**	-2.315**
	(0.0440)	(0.101)	(0.0455)	(0.104)	(0.178)	(0.346)
Email = Y	10.40**	25.69**	9.720**	23.89**	14.49**	34.89**
	(1.314)	(3.332)	(1.406)	(3.548)	(3.649)	(8.988)
Age = 18-24	13.39**	30.28*	16.48**	36.64**	1.731	5.639
	(4.821)	(12.33)	(5.529)	(14.19)	(9.696)	(24.35)
Age = 25-34	4.133**	9.987*	4.419*	10.79*	2.256	5.497
	(1.603)	(4.031)	(1.822)	(4.614)	(3.354)	(8.257)
Age = 45-54	-2.662*	-7.199*	-2.144	-5.527	-3.847	-11.47
	(1.327)	(3.247)	(1.431)	(3.479)	(3.539)	(8.474)
Age = 55-64	-4.696**	-11.76**	-4.072**	-10.08**	-6.823	-17.56*
	(1.332)	(3.214)	(1.428)	(3.431)	(3.713)	(8.539)
Age = 65-74	-5.165**	-13.23**	-4.746**	-11.86**	-6.410	-17.51
	(1.560)	(3.722)	(1.646)	(3.900)	(5.104)	(11.54)
Age = 75+	-6.322**	-16.59**	-5.552**	-14.49**	-21.12**	-48.07**
	(1.733)	(4.092)	(1.826)	(4.285)	(6.011)	(12.63)
Education = Some Hs Or Less	0.326	-0.105	0.552	0.890	-1.799	-5.602
	(2.759)	(6.021)	(3.157)	(6.774)	(5.798)	(13.17)
Education = Hs	2.475*	5.060	3.154*	6.755*	-1.153	-3.662
	(1.179)	(2.796)	(1.265)	(2.976)	(3.210)	(7.510)
Education = College	-3.103**	-7.497**	-2.925**	-6.948**	-4.526	-10.08
	(1.008)	(2.430)	(1.065)	(2.554)	(3.145)	(7.288)
Education = Graduate School	-1.996	-8.574	-7.547	-21.76	30.92*	82.21
	(7.180)	(17.21)	(7.792)	(18.03)	(15.03)	(48.31)
Ethnicity = African American	-0.615	-1.276	-1.576	-3.358	0.587	2.229
	(4.009)	(9.767)	(4.411)	(10.63)	(9.802)	(24.18)

Ethnicity = Asian American	-14.98**	-36.25**	-16.16**	-38.55**	-9.482*	-24.23*
	(1.312)	(3.018)	(1.379)	(3.146)	(4.218)	(9.611)
Ethnicity = Hispanic	0.814	1.696	0.935	1.937	0.181	0.179
	(1.192)	(2.924)	(1.292)	(3.159)	(3.072)	(7.345)
Ethnicity = Other	-19.26	-41.50	-25.92	-55.60	8.271	13.64
	(16.50)	(33.02)	(18.96)	(36.93)	(28.55)	(61.45)
Ethnicity = Unknown	-4.165	-12.19	-18.97	-46.63	87.79**	1,344**
	(36.42)	(91.78)	(37.71)	(82.36)	(5.104)	(49.89)
Gender = M	-3.544**	-7.749**	-3.760**	-8.204**	-1.269	-2.872
	(0.865)	(2.071)	(0.919)	(2.186)	(2.547)	(5.910)
HH Income = 30K Or Less	-8.522**	-17.75**	-10.05**	-20.77**	1.424	3.590
	(1.458)	(3.275)	(1.591)	(3.530)	(3.743)	(8.520)
HH Income = 30 To 50K	0.0492	0.346	-0.0221	0.198	0.942	2.265
	(1.198)	(2.856)	(1.285)	(3.044)	(3.245)	(7.604)
HH Income = 100 To 150K	0.529	0.911	0.203	-0.000411	2.238	4.362
	(1.203)	(2.980)	(1.265)	(3.106)	(3.932)	(9.506)
HH Income = 150K Or More	10.01**	26.74**	9.910**	26.33**	-5.837	-16.75
	(1.670)	(4.672)	(1.717)	(4.760)	(7.992)	(19.15)
Dwell type = Multi	-31.60**	-65.58**	-32.23**	-64.51**	-30.15**	-68.76**
	(1.925)	(3.731)	(2.433)	(4.585)	(3.333)	(6.977)
Constant	307.2**	318.9**	300.6**	298.4**	347.1**	430.2**
	(4.399)	(10.25)	(4.854)	(11.36)	(10.38)	(24.41)
Observations	47,124	47,124	40,634	40,634	6,490	6,490
R-squared	0.057		0.057		0.086	

Robust standard errors in parentheses. Excluded reference categories include Age = 35-44, Education = Some College, Ethnicity = White/Caucasian and HH Income = 50 to 100K

** p<0.01, * p<0.05

APPENDIX B –DEMOGRAPHICS FOR EMAIL & NON-EMAIL ACCOUNTS

Table A.2: Summary Statistics for Email & Non-Email Accounts

	Email (n=23,058)	Non-Email (n=55,339)
Income		
<30K	19.6%	30.5%
30-50K	20.3%	21.5%
50-100K	36.1%	31.1%
100-150K	17.3%	12.4%
>150K	6.7%	4.5%
Age		
18-24	1.4%	0.9%
25-34	22.2%	14.3%
35-44	29.3%	22.3%
45-54	16.5%	15.3%
55-64	16.2%	17.8%
65-74	9.4%	13.1%
>75	5.0%	16.3%
Education		
Some HS or less	2.3%	4.3%
HS	18.6%	24.6%
Some College	42.0%	41.8%
College	36.8%	29.0%
Graduate School	0.3%	0.3%
Ethnicity		
African American	1.4%	1.5%
Asian American	15.8%	14.4%
Caucasian	66.3%	66.2%
Hispanic	16.4%	17.8%
Other	0.1%	0.1%
Unknown	0.0%	0.0%

APPENDIX C - SURVEY INSTRUMENT

UC DAVIS
HOUSEHOLD ENERGY SURVEY

Instructions

YOUR PARTICIPATION IS VERY IMPORTANT.

The purpose of this survey is to collect information. Your identity and answers will be held in the strictest confidence.

Do your best to answer all of the questions. If you do not know the answer to a question, please provide your best estimate and move on to the next one.
When you have finished, please return the survey in the attached envelope to the address below:

236N
Energy Efficiency Center
University of California Davis
One Shields Avenue
Davis, CA 95616

Thank you for participating!

Alan Meier

Alan Meier
UC Davis Principal Investigator

Your Home and Appliances

1. **Do you own or rent your home?** _____

2. **How long have you lived at this address?** _____ Years

3. **What is the approximate square footage (of livable space) in your home?** _____ Sq ft

   - ☐ Less than 500 square feet
   - ☐ 500 - 999 square feet
   - ☐ 1000 - 1499 square feet
   - ☐ 1500 - 1999 square feet
   - ☐ 2000 - 2499 square feet
   - ☐ 2500 - 2999 square feet
   - ☐ More than 3000 square feet
   - ☐ Don't know

4. **In what year was your home built?** _____ Approx Year

5. **Is this your full time residence?**

   - ☐ Yes
   - ☐ No
   - ☐ Other (Please specify):

6. **How many people live here currently?** _____ Full-time

   _____ Part-time

   _____ Occasionally

Your Home and Appliances (Cont.)

7. Please indicate how many of the following *electric* devices you have and use in your home:

Appliance	Number	egularly Used	Rarely Used
Refrigerator in the house	_____	☐	☐
Refrigerator in the garage or basement	_____	☐	☐
Freezer, separate	_____	☐	☐
Microwave Oven	_____	☐	☐
Dishwasher	_____	☐	☐
Central Air Conditioning Unit	_____	☐	☐
Window Air Conditioning Unit	_____	☐	☐
Whole House/Attic Fan	_____	☐	☐
Swamp Cooler	_____	☐	☐
Television	_____	☐	☐
Cable Box	_____	☐	☐
DVD/Blu-Ray/VCR	_____	☐	☐
Computer	_____	☐	☐
Printer/Fax Machine	_____	☐	☐
Wireless Router	_____	☐	☐
Video Game Console	_____	☐	☐
Stereo	_____	☐	☐
Washing Machine	_____	☐	☐
Clothes Dryer	_____	☐	☐
Water Heater (electric)	_____	☐	☐
Stove/Range	_____	☐	☐
Separate Oven	_____	☐	☐
Furnace/Space Heater	_____	☐	☐
Hot Tub	_____	☐	☐
Swimming Pool	_____	☐	☐
Programmable thermostat	_____	☐	☐
In-Home Energy Display	_____	☐	☐

Other major appliances (describe below):

Your Home and Appliances (Cont.)

8. What type of water heater do you have?

- ☐ Tank (standard)
- ☐ Tankless/On-Demand
- ☐ Electric Heat Pump
- ☐ Solar
- ☐ Other (please specify)
- ☐ Don't Know

9. Do you have any of the following appliances?

- ☐ Gas furnace or heater
- ☐ Gas range and/or oven
- ☐ Gas clothes dryer
- ☐ Gas water heater

10. Are the exterior walls of your house/apartment insulated?

- ☐ Yes
- ☐ No
- ☐ Don’t Know

11. Do you have double-pane windows?

- ☐ Yes
- ☐ No
- ☐ Don’t Know

12. Would you consider your home to be drafty?

- ☐ Yes
- ☐ No
- ☐ Don’t Know

Your Behaviors

13. How much do you think about your electricity use?

- ☐ Very Often
- ☐ Regularly
- ☐ Sometimes
- ☐ Rarely
- ☐ Never

14. Do you think your energy use is --

- ☐ Higher than your neighbors
- ☐ About the same
- ☐ Lower than your neighbors
- ☐ Don't know/Never thought about it

15. What are the reasons your energy use might be higher, lower, or about the same as your neighbors?

16. Have you or other household members done anything to lower your energy consumption at home?

- ☐ Yes
- ☐ No

17. If you have done anything to lower your energy consumption at home (Yes to Question 16), please explain the actions or changes.

18. If you have air conditioning, how often do you use it?

- ☐ Very Often
- ☐ Regularly
- ☐ Sometimes
- ☐ Once or twice a year
- ☐ Never
- ☐ Other (Please specify):

19. In the summertime, compared to other people you know, do you think you generally keep your home…

- ☐ About the same temperature as others' homes

- ☐ Warmer than others' homes
- ☐ Cooler than others' homes
- ☐ Don't Know

20. Do you pay for your electricity usage separately, or is it included in the rent?

- ☐ Pay own
- ☐ Included in rent
- ☐ Other (Please specify): _____
- ☐ Don't Know

21. Do you receive a monthly natural gas bill?

- ☐ Yes
- ☐ No
- ☐ Don't Know

22. How much is your monthly natural gas bill typically? (your best estimate is fine)

$_____ in the summer

$_____ in the winter

- ☐ Don't Know
- ☐ Refuse

23. Have you ever had an energy audit of your home?

- ☐ Yes
- ☐ No
- ☐ Don't Know

24. Do you talk about energy usage with anyone?

- ☐ Yes
- ☐ No

IF YOU ANSWERED **NO** PLEASE SKIP TO QUESTION 28

25. If you talk to others about your energy usage, with whom do you speak? You can include more than one answer.

- ☐ Family member
- ☐ Neighbor
- ☐ Energy utility representative
- ☐ Other (Please specify):

26. How frequently do you speak with others about your energy usage?

- ☐ Very Often

- ☐ Regularly
- ☐ Sometimes
- ☐ Once or twice
- ☐ Never

27. Please provide any details about those conversations or advice you may have received and how you felt about it.

28. Have you received any incentives to improve the energy efficiency of your home?

- ☐ Yes
- ☐ No
- ☐ Don't Know

IF YOU ANSWERED **NO/DON'T KNOW**, PLEASE SKIP TO QUESTION 31

29. If you received incentives, please identify and describe the program/incentive.

30. If you received incentives, did the program or incentive reduce your electricity bill?

- ☐ Yes
- ☐ No
- ☐ Don't Know

31. How would you rate your quality of life?

- ☐ Excellent
- ☐ Above Average
- ☐ Average
- ☐ Below Average
- ☐ Very Poor

32. If you consumed <u>more</u> energy in your home, do you think your quality of life would be--

- ☐ Better
- ☐ Worse
- ☐ About the Same
- ☐ Don't Know

Please Explain:

33. How closely do you review your electricity bill?

- ☐ Not at all
- ☐ Some
- ☐ Closely

34. If you learned that your home electricity usage was much lower than the average, can you think of reasons that might help explain your low usage? Please list as many reasons as possible.

Your Household

35. What is your age? Years

36. What is the highest level of education you have completed?

- ☐ No formal education
- ☐ Grade school
- ☐ Some high school
- ☐ Completed high school/GED
- ☐ Some college or technical training
- ☐ Completed 2-year college degree
- ☐ Completed 4-year college degree
- ☐ Some graduate work
- ☐ A graduate degree
- ☐ Don't Know
- ☐ No formal education
- ☐ Refuse

37. What race or ethnicity do you consider yourself? You can include more than one category.

- ☐ Latino or Hispanic
- ☐ Black or African American
- ☐ American Indian or Alaskan Native
- ☐ Asian
- ☐ Native Hawaiian or Pacific Islander
- ☐ White
- ☐ Or some other race (please specify)
- ☐ Don't Know
- ☐ Refuse

Your Household (Cont.)

38. Please indicate which income category best describes your total household income for 2011, BEFORE TAXES and other deductions.

- ☐ Less than $20,000
- ☐ More than $20,000 up to $30,000
- ☐ More than $30,000 up to $50,000
- ☐ More than $50,000 up to $100,000
- ☐ More than $100,000 up to $150,000
- ☐ More than $150,000 up to $200,000
- ☐ Over $200,000
- ☐ Don't Know
- ☐ Refuse

Thank You!

Thank you for taking the time to respond to this survey! Your responses are greatly appreciated.

Please feel free to use this space for any comments or questions you may have regarding this survey.

APPENDIX D - INTERVIEW GUIDE

Hello, my name is Reuben Deumling. I am a researcher conducting a study with the California Air Resources Board about household energy consumption. I want to thank you very much for responding to our survey we sent out recently. On that survey you said you would be willing to participate in a short follow up interview – these tend to take about 7-10 minutes. I would like to speak to the person living in this household who is 18 years of age or older and who knows the most about your household's energy use. Would that be you or someone else? ___ O.K.

1 = Yes, Continue
2 = No, Not Available - Schedule Callback
3 = Refusals
4 = Wrong Number OR Missing Phone Number
5 = Disconnect/Business or Government/Blocked Call
6 = Non Contact
7 = Communication Barrier (specify: a) language, b) connection quality, c) other)
8 = No one over 18

This interview is voluntary. All of the information you provide will be kept anonymous and confidential. When the results are analyzed, your name will be removed from the data and will not be associated with your answers in any way. If I come to any question you would prefer not to answer, just let me know and I'll skip over it.
Continue.....1
Schedule callback.....2

In your responses to our previous survey, you addressed two issues that I'd like to explore in a bit more depth with you today over the phone.

The first has to do with staying cool in the summer.

1. What are the two or three most important ways you keep cool in the summer when you're at home? Please describe what you do.

2. Do you rely on a thermostat to control the temperature in your home during the summer?
<u>If **yes**</u>
    a. what temperature is your thermostat typically set to during the summer?
    b. How often do you typically adjust the set temperature?
    (daily, weekly, monthly, never, other)
<u>If **no** move to next question</u>

3. Above what temperature do you consider it to be uncomfortably hot in the summer **indoors**? <u>(clarify if temp mentioned is indoor or out)</u>
    a. Please describe under what circumstances that typically happens, if ever?
    b. What do you do on days like that?

4. Since you moved into the house you live in now have you changed the way you use your air conditioner, adopted new strategies, or modified any other methods of keeping cool)?
<u>If **yes** -</u> Can you elaborate?
    a. Why do you think your patterns have changed (*or didn't change)*?

5. Who in your household has decision-making power over air conditioner use?
    a. Is there anything else you'd care to say about how air conditioning use (or cooling) habits developed in your household?

Stepping back from dealing with the summer heat, I have one question about factors that may have contributed to your low usage of electricity more generally.

6. One common distinction is to think of physical changes to your **house or appliances** on the one hand, and **habits and behaviors** on the other. Do you feel that one of these contributed more to your low usage? I can give examples of each if you'd like.
   - *(improving insulation, shading, or weather-stripping, or purchasing more energy-efficient appliances)*,
   - *(opening and closing windows to moderate the temperature, keeping your thermostat set at a higher temperature in the summer, not using air conditioning, etc.)*

And finally I'd like you to reflect on other households with the same number of people who live in homes similar to the size of yours, but who use *more* electricity than your household.

7. Without knowing how these folks use more electricity, can you think of any recommendations you would give them? What might you suggest they do to reduce their electricity use?

That completes our interview. We greatly appreciate your time and cooperation. Thank you very much for your answers to our questions. Do you have any additional comments or questions for me?