Who are the low energy users? Lessons for climate policy

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Abstract
California, like many other regions, has GHG emissions goals requiring drastic reductions from baseline levels. However, a small percentage of households already live at electricity consumption levels consistent with the state's goal of 80 % below 1990 levels. Low energy use is often associated with undesirable characteristics, such as poverty, thermal discomfort, or small dwelling size. We investigated the demographics, behaviour, and satisfaction of these low users to see what attributes best correlated with low use. We studied about 700 households drawn from the lowest 10 % of electricity consumers in Sacramento, California. Surprisingly, the low users encompassed a diverse cross section of customers. The low users were similar to the general population in terms of age, income, education, appliance ownership, and dwelling characteristics. Low-use households tended to be smaller, but not enough to explain the entirety of low usage. Surveys and interviews revealed that those in the lowest 10 % typically pursued low consumption deliberately and enthusiastically, and were aware of their status as low users. The topic of energy conservation was salient in their social conversations. They employed diverse and creative strategies to maintain thermal comfort without excess energy use, often exceeding expert recommendations. Finally, the distribution of self-reported quality of life was no different from that of the general population living at much higher consumption levels. Overall, the key determinants of low use were a positive engagement with improvisation and experimentation, and the salience of energy in personal or social life, rather than poverty or other circumstantial constraints. The association of low energy use with deprivation has been an obstacle to promoting more aggressive goals for reduction of residential use. In contrast, the population of low users should be treated as a valuable source of peer advice and lifestyle modelling.

Introduction: why study low users?
Climate change mitigation requires large shifts in the ways we produce and consume energy. Many nations and have committed themselves to this task despite the enormity of the challenge. The Paris Climate Plan created a framework for these commitments and the various mechanisms to achieve them. California's legislative and executive branches anticipated the Paris Climate Agreement by 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). The former requires that the state reduce its GHG emissions to 1990 levels by 2020, whilst the latter stipulates reductions to 80 % below 1990 levels by 2050. How this is to be accomplished is not entirely clear, but California's Scoping Plan, which sets out the steps for implementing legislative goals, relies heavily on technological advances, shifts in energy supply, upgrades to energy infrastructure, and improvements in the efficiency of end use devices and buildings (Calfornia Air Resources Board 2008, Long 2010, Energy and Environmental Economics 2009). Most studies that explore options for meeting long term climate change objectives share this preference for technological solutions (e.g. Pacala and Socolow 2004), while a few have identified a role for personal choice at

the household level using current technologies (e.g. Dietz et al 2009).

Governments and policymakers typically fit residential energy demand into broader GHG reduction policy by projecting average consumption levels and then calculating the amount by which the projected average consumption must be reduced to meet targets. These projections take into account population changes, impacts of building codes, and appliance efficiency regulations. However, the efficiency improvements are rarely sufficient to reach desired targets, or else require heroic assumptions about the success of current and future measures. We thought that a more useful way to consider the residential component of GHG reduction would be to study those who were *already* living at or near the levels recommended for 2050 – that is, households conducting a sort of natural experiment in future living. These households certainly exist, but very little is known about them.

Research on heterogeneity in energy consumption is rare, and research specifically on low use is rarer still. There is an extensive literature on fuel poverty in Europe (and elsewhere), describing the struggles of those too poor to afford basic energy services (Boardman 1991 and 2012, Thomson 2013, Sovacool 2015). The investigation of fuel poverty is laudable and necessary, but it contributes to the assumption that very low energy use necessarily indicates a state of deprivation. The conventional wisdom about households consuming little energy is that they are poor, and/or small, and/or single. It follows that low users are not likely to be a source of lessons or solutions scalable to the general population since they demographic outliers who live in an unhappy state of deprivation. Thus the behaviours and practices of low users are neglected as a research topic, and the cycle of ignorance is perpetuated. Our proposal to study the attributes of the lowest ten per cent of energy consumers was met with puzzlement, and reiterations of the prevailing assumptions about who these people were. Nevertheless, we felt that understanding low energy use, much as for any complex socio-technical system, would require parsing a tangle of habits, attitudes, and circumstances.

Research objectives

At the outset we had three broad objectives. First, we wanted simply to understand who low users were, in terms of basic demographic attributes and life circumstances. We used survey data to compare the lowest decile (ten per cent) of electricity users to the general population of the same service area. We looked at a range of demographic attributes, such as age, income, ethnicity, education, dwelling size, and number of household occupants. We wanted to test the prevailing assumptions about low energy consumption by looking not just at average values, but by considering diversity and distribution within the tier of low users.

Our second objective was to gain a more nuanced insight, beyond the basic demographics, of the pathways to low usage. We hoped that the responses to survey questions and telephone interviews would reveal the mechanics whereby people in the lowest decile achieved their low usage. What behaviours, strategies, and attitudes could we find amongst our low user group that might differentiate them from demographically similar people with higher energy consumption? Did they actively pursue the goal of low usage, or was it something that just happened as the ancillary result of circumstantial constraints? Did they scrupulously follow expert advice, or did they innovate on their own? Did they interact with other low users, or were they alone in their pursuits? Were they more tolerant of discomfort? How satisfied were they with their quality of life, and how did that relate to energy use?

Finally, in order to estimate the relative importance of different types of low users within the lowest decile, we combined economic, social, and philosophical criteria to create household "profiles".

Materials and methodology

Our study of households consuming little energy was conducted with the cooperation of the Sacramento Municipal Utility District (SMUD), based in California's state capital.[1] SMUD is one of the largest municipally owned utilities in the United States, providing electricity to 900 miles^2 (2,330 km^2) of urban and suburban zones, containing 1,4 million residents.[2] Our sample pool were the households in SMUD's lowest decile of electricity consumption, based on average monthly usage from 2008–2010. We excluded households known to be using solar, households whose erratic usage pattern might indicate a second home, and households who had not lived at their current residence for the entire span of the study period. On the other hand, we rejected SMUD's suggestion to exclude households below the threshold of 200 kWh/month on the assumption that they represented either vacancy or measurement errors. Doing so would have eliminated precisely the kinds of outliers we hoped to study; indeed some of SMUD's occupied households used as little as 52 kWh/month.[3]

The utility's database allowed us to calculate summary descriptive statistics describing technical and socioeconomic variables within different subsets of households. We used regression analysis to examine the relationships between these variables and energy consumption in the general population. To supplement the utility's data, in 2012 we conducted an in-depth survey of a random sample of homeowners and renters from the lowest decile of consumption. The survey gathered information on household composition, ethnicity, habits, appliances, alternative fuel use (i.e. natural gas), self-perceptions of energy profiles, sources of energy information, and social interactions around energy. Response rates for the survey were 16 % for renters (607/3,876) and 18 % for homeowners (113/630). The final phase of the analysis was telephone interviews with homeowners who had completed the survey and indicated willingness to participate in an interview. These open ended discussions delved more deeply into attitudes and behaviours. Of thirty-nine eligible homeowners, we conducted interviews with twenty-one households. The survey questions were designed to

1. The study was conducted under California Air Resources Board Contract Number 09-326. The full report, "Identifying Determinants of Very Low Energy Consumption Rates Observed in Some California Households" (hereafter referred to as Deumling 2013) is available at https://www.arb.ca.gov/research/apr/past/09-326.pdf.

2. See https://www.smud.org/en/about-smud/company-information/company-profile.htm.

3. Deumling 2013, p. 7, Figures 5.1 and 5.2. Monthly usage for the overall population ranged from 50 to 1,850 kWh/month. The boundary of the lowest decile lay at about 330 kWh/month.

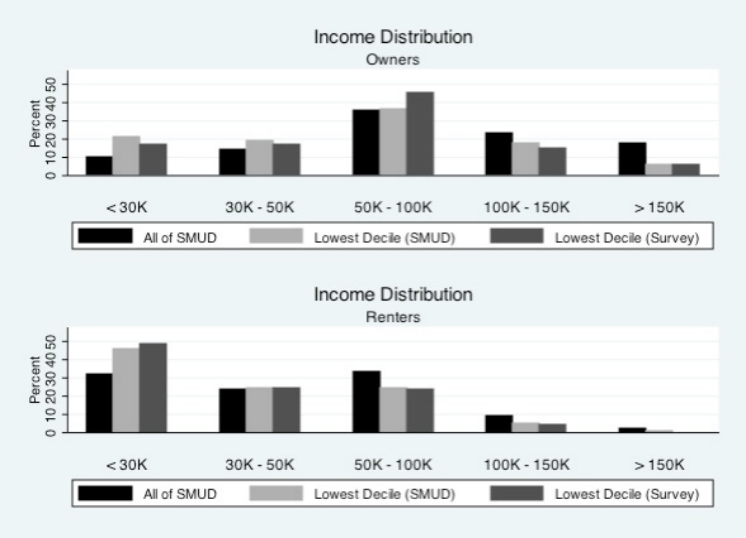

Figure 1. Income distribution.

cover the full range of energy end-uses, but it soon emerged that summertime thermal comfort was central to respondents' thoughts on energy services. The telephone interviews focused chiefly on cooling strategies.[4]

Comparing low users to the general population: myths versus facts

This section compares the general population of SMUD's service area with the tier of low users. How well did these sets match in terms of income, housing characteristics, education, age, and household occupancy? And what light did this shed on prevailing assumptions about low use?

Billing data from SMUD provided a starting point for comparisons between low energy users and the general population, across a range of demographic variables. Regression results[5] supported many common assumptions about low energy consumers. Holding all other variables constant, households with higher incomes, larger homes, more educated heads, and more people consumed more electricity per month on average. Higher energy consumption was also associated with older residences, younger household heads, and longer periods of continuous residence. However, a regression analysis of linear relationships amongst variables only shows the average effects of variable change. It was indeed true that *on average*, Sacramento's low user households were poorer, smaller, older, less well educated, and had fewer people than the general population. But over-reliance on averages was precisely our objection to existing approaches, in that it obscured useful inferences from the diversity within the low users tier. We wanted to know whether the typical theories about low use (such as poverty) could adequately explain the entire phenomenon, or whether low users were diverse enough to require further, alternative explanations. Thus it was more useful to compare the diversity of low users with the diversity of the general population. Our investigation revealed that the diversity of lowest decile households was comparable to that of the general population for most demographic attributes. The presence of all demographic types within the lowest decile meant there was no *a priori* reason why low usage could not be replicated amongst similar consumers with higher use.

Of the three most common theories about the causes of unusually low energy use – low income, small dwelling size, and few household occupants – our analysis led us to reject the first two as inadequate, in and of themselves, but accept the third. Income analysis of owner-occupied households showed that in the three middle bins (representing annual incomes from $30 K to $ 150K), the distribution of lowest decile group and the general population differed by no more than 5 %.[6]

The most noticeable difference between low users and the general population was that the percentage occupying the lowest and highest income bins (representing annual incomes <$30 K and >$150 K) was essentially reversed. In the case of renters, the distribution of the lowest decile again matched the general population fairly well in the broad middle range of incomes, with conspicuous divergence in the highest income bin (where low usage renters were almost invisible) and the lowest (which contained 46 % of the lowest decile versus 32 % of the general population). In summary, there is no denying that poor renters are overrepresented in the lowest decile. But the majority of low usage households dwelt in the middle-income ranges. Since middle class (and even high-income) households were well represented, we rejected low income as an adequate explanation of low electricity use.

With regard to dwelling size, the floor area of the average owner-occupied home in our lowest decile was indistinguishable from the general population; while the size of lowest decile

4. For regression table see Deumling pp. 77–73; for survey questions pp. 76–83; for interview template pp. 84–85.

5. For the sole purpose of the regression analysis we compared the lowest quartile (rather than decile) of electricity customers with the general population of the SMUD service area. In contrast to the rest of the study, the goal here was to establish linear relationships between electricity usage and the variables of interest, thus the use of the somewhat broader data set was preferable. Results from regression models are presented in Deumling 2013, pp. 72–73, Table A.1.

6. Deumling 2013, p. 13, Figure 6.1 comparing incomes of SMUD's overall customer population, lowest decile, and our survey respondents. For more detailed income distribution of our survey respondents see p. 16, Figure 6.5.

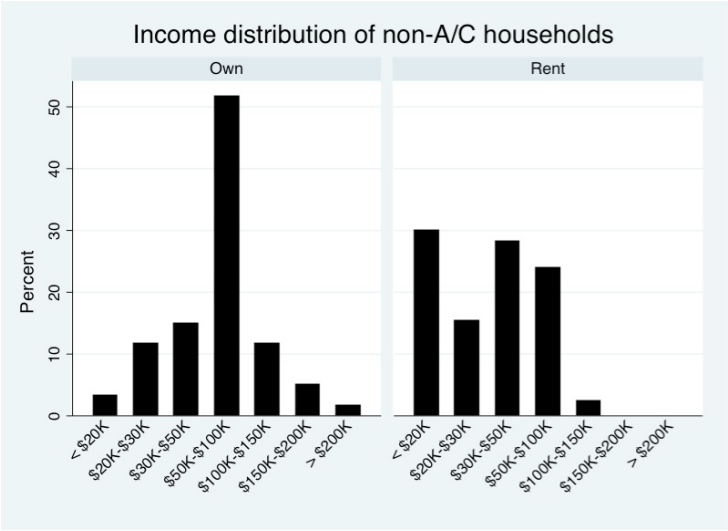

Figure 2. Income distribution of non-A/C households.

rental units was somewhat smaller than for the general population.[7] Analysis was hampered by the fact that rental unit data is logged in 500 square foot bins, so the comparisons were somewhat imprecise. But since 46 % of the lowest decile population were owners, the range of home size for the entire lowest decile (homeowner + renter) was still quite broad. We therefore rejected the small home theory as inadequate, despite the somewhat ambiguous conclusion for renters alone.

Finally, with regard to number of household occupants, the average headcount for our respondents' households was 1.6, which was significantly lower than 2.6 for the general population.[8] The high incidence of single-person households, and the scarcity of large households, was true for both owners and renters. We accepted that low occupancy was a cause of low usage, in and of itself.

Key differentials of low use: actions and attitudes

While the average lowest decile household in Sacramento had somewhat lower income, home size, and and occupancy than the average general population household, the diversity of low user households was great enough to merit investigation into other explanations of low use. We used the survey and the telephone interviews to explore subtler, less obvious attributes that might distinguish lowest energy users from their demographically similar fellow citizens. Again, the direction of our inquiry was informed by prevailing myths about low usage. For example, given the usual assumption that low use is the undesirable result of constraints, we looked in the opposite direction: low use as an *intentional* goal. Did some households actively pursue reduced energy consumption? Did they know they were doing something different, and if so, what? Were they more avid about seeking advice from energy professionals, such as their utility provider? Or were they more likely to rely on peer information and DIY approaches? This stage of the study was necessarily exploratory and conjectural. Our goal was to find suggestive correlates that could guide future control-group studies searching for firm causes.

The survey included nineteen questions (fourteen multiple-choice, five open-ended) on energy related behaviours and beliefs. It quickly became clear that summertime cooling strategies were the central point of reference for users' mental models of energy use: even when questions did not specifically ask about it, responses centred on air conditioning (A/C). Participants in the subsequent telephone interviews also had a great deal to say about their personal philosophies of thermal comfort. This was not surprising, given Sacramento's infamously long, hot and humid summer season. (The survey was conducted during the summer, which no doubt further elevated the salience of this subject.)

A more surprising result was the poor correlation between A/C ownership, electricity consumption, and income. The survey asked subjects if they owned an air conditioner (either window or central), and then asked A/C owners to estimate their frequency of usage in two differently worded questions. As expected, frequent A/C use correlated to higher overall electricity consumption.[9] Those who reported using A/C "regularly" or "very often" typically consumed around 300 kWh/ month, while non-owners, non-users, and those who used it "once or twice a year" consumed only 200 kWh/month. However, the mere presence of A/C in the home was a poor predictor of frequency use. Those who owned A/C but who reported using it "never", "once or twice a year", or "rarely" ranged from 15 % to 35 %, depending on question wording and number of choices. More interesting still was the income distribution for non-owners, non-users, and rare users, a total of 39 % of respondents. As the graph below shows, they are not grouped off to the left in the low-income bins, as the common assumption about low users would predict. Instead they are distributed fairly symmetrically, with homeowners showing a peak between USD $50–100,000, and renters distributed even more evenly across the brackets.

7. Deumling 2013, p. 19, Figure 6.9.

8. Deumling 2013, p. 17, Figure 6.6. We further compared the lowest decile with the general population as to age distribution (Figures 6.3, 6.7 and 6.8) educational attainment of household head (Figure 6.2), and ethnicity (Figure 6.4).

9. Deumling 2013, pp. 23 ff, and Survey Questions 7 and 18.

These data suggested that avoiding A/C use was a behaviour that a significant number of households had chosen, rather than one that they had been forced to adopt. Many of our respondents could have afforded A/C but preferred to achieve thermal comfort in the summer heat by other means. This was an early clue that the conscious, deliberate pursuit of low consumption was at least as significant as circumstantial constraints. This was further born out by answers to the open-ended survey questions, and especially by the many comments in the telephone interviews, describing A/C non-ownership or non-use as a matter of pride, or an opportunity to be creative, rather than as a limitation.

The fact that staying cool (rather than staying warm) was the central concern of our subjects does not make our findings less useful for regions with more temperate summers, or colder winters. The provision of thermal comfort uses the lion's share of residential energy in developed economies of all climates, and is central to people's conceptualization of energy services. Behaviours and attitudes around staying cool are a reasonable proxy for thermal management at either end of the temperature spectrum. Furthermore, the sense of thermal comfort is more socially constructed than, say, the need for illumination or cooked food – so if the research objective is to understand the range of behaviours & attitudes in energy use, then the study of thermal comfort practices will offer more fertile data than illumination or electronic entertainment. Finally, on a warming planet, managing peak summer loads will become the central concern for more and more regions.

SELF-AWARENESS

Our survey included several questions designed to detect the presence (or absence) of a conscious, deliberate effort to conserve energy. Questions 14 and 19 asked respondents to compare themselves with their friends and neighbours: Did they believe their electricity usage to be lower or higher than others, and were their homes warmer or cooler in summertime? Questions 15, 16 and 17 then asked them to explain their (self-evaluated) ranking as energy consumers. Did they describe deliberate actions taken to lower their use? Did they cite reasons that could be interpreted as constraints? Or did they simply claim ignorance? Finally, Question 34 posed an open hypothetical: "*if* you learned your electricity usage was lower than average", how would you explain it?

Responses to Question 14 showed that close to 70 % of homeowners and just over 50 % of renters believed their energy use to be lower than that of their neighbours.[10] The proportions were similar for Question 19: 67 % of homeowners and 56 % of renters thought that their homes were warmer in summer (i.e. less cooled) than others.[11] As for self-explanation, the responses to Questions 15, 16, 17 and 34 sorted into four broad types: circumstantial constraints, motivations and beliefs, actions and behaviours, and an opaque resistance to explanation we dubbed "just how it is".

We coined the rubric "just how it is" to encompass two overlapping but not identical types of respondents: the unaware and the uninformative. Questions 14 and 19 had ascertained that some respondents were simply unaware that their usage was atypically low (even though it in fact was). On the other hand, Questions 15, 16, 17 and 34 showed that some respondents realized their usage was probably low, but had no explanation for that fact. These folks somewhat resembled the "constrained" consumers, in the sense that low usage was a natural result of their lifestyle, but unlike constrained consumers they did not feel there was anything noteworthy or even explicable about their energy use. (It is possible that their behaviours were of such long standing that they were no longer able to articulate them – i.e. they had become fully unconscious *practices* - but the true nature of this type of low user remains opaque.)

About 23 % of both homeowners and renters cited constraints in their explanations, such as living alone, not at home much ("I work all the time"), small dwelling size, and limited finances ("I can't afford to use more energy").[12] Notably, financial constraint was the least common of these.

With regard to motivations and beliefs, we did not originally intend to explore this dimension, and none of our questions specifically asked it. Strictly speaking, motivations are a *rationale* for low use behaviours rather than a *description* of the sort we were originally interested in. Nevertheless, a number of respondents spontaneously mentioned motivations and beliefs, such as concern for the environment. Typical comments were that "wasting water, gas and electricity is immoral," that they were "conscientious" about their impact on the planet, or that it was a virtue to be "frugal" or "conservative with energy". Others said they were simply happiest when living "very simply but with quality". Motivation became significant as an emergent finding on what differentiated low users.

The richest feedback was in the area of conscious actions. A majority of both renters and homeowners mentioned having deliberately "done something" to lower their energy use.[13] Their lists were extensive and heterogeneous, mentioning investment in energy efficient devices and technologies (CFLs, Energy Star appliances, double-glazed windows, HVAC upgrades); functional substitutions (cold instead of hot water for laundry, space heaters instead of central, clothes line instead of dryer); and low energy routines and habits (adjusting clothing and bedding, taking shorter showers). Of course strategies for minimizing energy use while staying cool in summer were prominent. These included setting the A/C no lower than a certain minimum, running it only when outdoors was over 100 F, or never when out, or never at night. Also mentioned were modifications to the home and surroundings (shade trees, weather stripping, insulation, tile floors, double pane windows, programmable thermostats; alternative cooling technologies (fans, swamp coolers); summer-specific changes of routine (lighter clothing, sleeping on ground floor, preparing cold meals); and a diurnal cycle of opening and closing doors and windows to take advantage of the Delta (evening) breeze.

We now had our first estimate of the breakdown between those whose low usage was the result of circumstantial con-

10. Deumling 2013, p. 38, Figure 6.24.

11. Deumling 2013, p. 41, Figure 6.27. Even respondents who did not believe their energy use to be lower (or their home less cooled) than that of their neighbours may still have recognized themselves as low users: given that our pool was a full 10 % of the population, their neighbours could also have been low users.

12. Deumling 2013, p. 27, Figure 6.21.

13. Deumling 2013, p. 28, Figure 6.22.

straints, and those who deliberately chose to pursue it as goal. A majority of consumers in the lowest decile, across a range of demographic groups, believed their low usage due at least in part to active, conscious effort. Although the estimate was crude, and the line between "constrained" and "conscious effort" was sometimes ambiguous,[14] it was clear that there were multiple pathways to low usage. Since the path of active, conscious pursuit of low use was poorly covered in the literature, the salient attributes of low users merited further investigation.

ENGAGEMENT

An important and unresolved issue in attempts to reduce residential energy consumption is the effectiveness of advice experts. A great deal of effort goes into different kinds of outreach (home improvement checklists, published usage data, incentives, subsides, "nudges", and the like) but all of these are from the top down. As a rough gauge of low users' degree of reliance on expert advice, the survey included two questions on whether they had availed themselves of energy audits or incentive programs offered by SMUD. Fewer than 20 % of respondents reported having had a home energy audit. Somewhat more (<40 %) had participated in some kind of incentive program (window or central AC, furnace, fan, thermostat), general appliances, including water heaters and refrigerator rebates, and envelope upgrades. These numbers seemed low, but we needed more insight into the role of professional advice. As we perused the lists of energy saving actions taken by our "deliberate" low users (in the section above), it seemed that a common characteristic was that they exceeded professional advice. It's not that low users ignored expert advice – their responses clearly reflected attention to SMUD's outreach materials – but this advice was treated a point of departure rather than an endpoint. Engaged, pro-active low users came up with their own standards and solutions that exceeded official recommendations, or else augmented them with do-it-yourself approaches.

It was instructive to compare the list of cooling strategies on the SMUD website[15] at the time of our project with those adopted by our respondents. All of the utility's recommendations appear at some point in our low users' lists, but the reverse was not true: the low users had approaches that the utility did not mention. For example, the idea of simply shutting off the A/C was conspicuously absent from SMUD's recommendations. The evening routine of opening doors and windows to catch the Delta breeze – the second-most common item mentioned by renters – was also absent. SMUD's suggested minimum A/C setting was 78 F, lower than that reported by our respondents. Very low-tech folk remedies – a damp towel around the neck, setting a bowl of ice cubes in front of the fan - had no place on the utility's list. Adaptations to the peculiarities of an individual's domestic routines or dwelling (orientation, age, layout, etc) were beyond the scope of the master list. Although we focus here on cooling strategies, in fact the desire to exceed expert recommendations pertained to other end uses as well, such as some users' habit of unplugging devices when not in use.

Most importantly, the missing element in the utility's outreach was an encouragement of individual initiative – the type of iterative experimentation whereby a consumer might acquire proficiency in energy conservation. And yet the willingness to strike out on one's own was precisely the quality that came through clearly in low users' own accounts of their pathways. Their characteristic attitude toward energy conservation one of active engagement in the subject: the pleasurable pursuit of improvement through tweaking, adaptation, and customization. Their stories often featured a mode of engaged interaction with energy using devices, in which users exercised control in ways that deviated from the scripts suggested by manufacturers or experts. It was not that low users didn't want to be comfortable, but they drew the line at giving over control to thermostats or other devices.

More than thirty years ago, Kempton & Krabacher (1986) observed that it was not uncommon for people to interact with their thermostats in ways not intended by the manufacturers. Sometimes customers' decision rules eluded even energy researchers. More recently, Lutzenhiser's study of responses to the 2001 energy crisis (2002) described a divergence between official recommendations and customer behaviours similar to the one we observed: expert recommendations typically specified particular thermostat settings (e.g. set thermostat to 78 F, or 85 F when on vacation), while many customers preferred to simply turned off their A/C.

LOW USE AND SOCIAL COMMUNICATION

If low users are distinguished by their tendency to think outside the box – by experimenting with DIY solutions or using technology in off-script ways – how do they learn to behave in this way? If they typically exceed expert recommendations, then what other sources of information are they drawing upon? In both the survey and the interviews, respondents mentioned conversations about their practices and beliefs, sharing their efficiency strategies and insights with colleagues, friends, and family members, and learning from others in turn. Although respondents described conversations about energy as taking place (only) "sometimes", in fact they could describe their regular interactions on the subject in detail.[16] The conversations covered a range of topics. Given the local climate, many revolved around alternatives to A/C, but other frequent topics were the challenges of making energy efficiency technologies work satisfactorily, or tips about hot weather meals, or descriptions of seasonal routines, or the small victory of convincing a neighbour to discard an energy guzzling appliance. Our respondents not only thought about energy a lot, it was woven into the fabric of their social interactions. Behavioural 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, and become established norms.

Our correlation between social conversations and lower energy usage aligns well with the literature describing energy behaviours as embedded in social context, shaped by a shared understanding of what is normal and comfortable (Shove 2003, Lutzenhiser & Gossard 2000, Lutzenhiser 1993, Hackett and Lutzenhiser 1991, *inter alia*). Shove (2003) has described the co-

14. Some respondents mentioned both constraints and voluntary pursuit of low use.

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

16. Deumling 2013, pp. 39–40 and pp. 80–81 (Survey Questions 25–27).

evolution of domestic technologies, individual behaviours, social norms, and energy consumption. The necessary, typical, or normal services that energy is expected to provide are especially inseparable from our social norms of (in Shove's words) "comfort, cleanliness and convenience". It should not be surprising that frequent social conversations about energy are conducive to a critical re-evaluation of "normal" levels of consumption.

QUALITY OF LIFE: ENERGY AND HAPPINESS

Our survey included two questions on consumers' perceived relation between energy use and quality of life. Question 31 simply asked respondents to rate their quality of life on a five-part scale. Roughly one-quarter of our low users rated their quality of life as excellent, while fewer than 10 % experienced a "below average" or "poor" quality of life. These numbers reinforced our sense that the relation between energy use and quality of life was not simple. In the next question we posed a hypothetical scenario in which consumers used more energy: they were first asked to *re*-scale their anticipated quality of life in this scenario, and then asked to explain their reasoning. About 65 % chose "about the same," fewer than 10 % anticipated that more energy would improve their quality of life, and greater than 15 % expressed the opposite opinion, that more energy would *lower* their quality of life. (The remainder didn't know.)

However, it was difficult to interpret the reasons given for a hypothetical quality life in a higher-consumption scenario. About 26 % (of those responding to this question) said that since increased energy use would mean higher bills, their quality of life would diminish. That share corresponded well to our estimate those who used little energy due to financial constraints. Just over 5 % felt increased energy usage would lower their quality of life for social or environmental reasons, citing "social equity", "waste", "over-consumption", "saving the planet", "simple living" and "guilt". About 10 % stated that more energy would mean increased comfort and therefore a better quality of life. The remainder didn't offer reasons, beyond a simple reiteration of the opinion that more energy would improve or diminish their quality of life. These findings were problematic in (at least) two ways. First, respondents who perceived a negative relation between increased energy use and quality of life were heavily over-represented. Overall, only 44 % of those who had re-scaled their quality of life then continued to the explanation step. Yet almost *all* of those who thought that higher energy use would make them less happy elaborated on their reasons. Why were the negative-relation group so much more motivated to respond? We also worried that since respondents interpreted "quality of life" so differently – some defining it financially, some philosophically – their responses might be incommensurable. Since we did not originally intend to ask about motivations, we were poorly prepared to deal with the spontaneous emergence of value-driven responses. We hope future research on low users will benefit from our missteps.

Leveraging heterogeneity: profiles in low usage

The two chief takeaways of our investigation were now clear. First, the lowest decile of electricity consumers was a heterogeneous group, cutting across demographic, social, and economic categories; and second, there were multiple pathways to low energy use. Low income, and/or small household, and/or small dwelling could all lead to low usage, but there were other ways to get there as well.

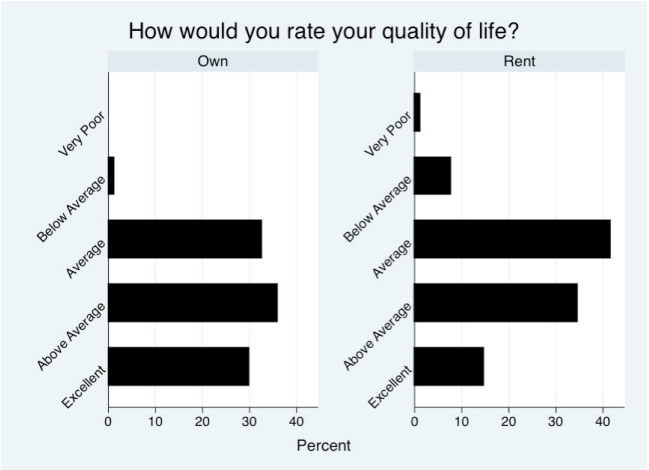

Figure 3. How would you rate your quality of life?

Within the tier of low users, quantifiable demographic attributes (age, education and income) mixed with more intangible qualities (technical aptitude, quality of life perception, philosophy of comfort) in unanticipated ways. It was possible to be high income but low energy, or low energy but high life-satisfaction, or perfectly average demographically yet consuming far less energy than average, or apathetic about environmental motivations but nonetheless practicing a low energy lifestyle. Some combinations were more likely than others, but the makeup of our lowest decile was much more diverse than anticipated. In the commercial world, retailers respond to market heterogeneity by creating profiles of different demographic and lifestyle groups. Targeted advertising features actors or messages chosen to appeal to highly specific segments. In theory, a similar segmented strategy could be employed in energy efficiency campaigns, by combining the profusion of consumer data with the analytics prowess of firms such as Opower. And yet this has not generally been the case: regulatory agencies and utility providers seem averse to segmented messaging. Typical efficiency checklists are one-size-fits-all, and appeals to reduce consumption are aimed at the entire customer base.[17]

The final stage of our project was to explore what market segments or niches might look like in the field of residential energy demand, with the eventual goal of concretising efficiency messages by embedding them in fully fleshed portraits of real world households. The challenge was to classify our low users into profiles that were both faithful to the data, and as complex and fully fleshed as real life. Our six profiles were based

17. There have been some efforts to leverage social media to target energy reduction messages more effectively. Dougherty et al (2011) describe data-driven social norm messaging programs that target high users through information mailed to customers, including a usage comparison across demographically similar households and a series of recommended actions. Seattle City Light has studied variation among their residential customers, as well as high usage, as a way to identify opportunities for large savings (2010, also Meier 2010). An outreach campaign by the Gainesville [Florida] Regional Utility puts customer usage information on a searchable public website "to enable us all to make better decisions about our energy usage" (Gainesville Green, no date). Although these give the appearance of targeted outreach tailored to market niches, in fact the same behavioural strategy is deployed for the entire audience. At the other end of the usage spectrum, subsidy or assistance programs are aimed at a narrow market niche (low income consumers), but these are a form of support rather than an effort to change behaviours.

on different combinations and weightings of the demographic data and the responses to our questionnaires. Some categories were simply demographic, while others incorporated more behaviours or attitudes. Some profiles combined non-commensurable criteria, because in real life social, philosophical, and economic attributes don't always align in predictable ways. We then estimated the proportion of the lowest decile occupied by each profile; and searched the non-qualifying attributes of each profile population for any significant correlates. Here we here highlight some of the most interesting insights.

The first profile, Well Off and Energy Efficient (18 % of survey respondents) included all those in the upper levels of income, education, and home size who also indicated a pursuit of energy efficiency technologies. The chief insight here was that the energy efficiency route, combined with a fair amount of attention to energy-related habits and behaviours, allows large households with a full suite of electrical appliances to live well within the tenth percentile.

Excellent Quality of Life (24 % of survey respondents) was based on a single criterion, self-identification of an above-average or excellent quality of life. The idea was to identify any of our low users who were very pleased with their circumstances. The category included household incomes below $20 K and above $100 K. The earlier statistical analysis had shown that low users were widely distributed across income brackets; now we also understood that *happy* low users were similarly well distributed. There was no simple equivalence between energy use and quality of life.

The criteria for the third profile, Thermally Unflappable (16 % of survey respondents), were (a) owning an air conditioner, (b) using it "rarely" or "never", and (c) describing quality of life as "average" or better. Since surviving the long hot summers was such a preoccupation for most local residents, it seemed important to understand people who were happy (or at least happy enough) *not* using A/C. The distribution of income within this profile was very similar to that for the previous profile, Excellent Quality of Life.[18] The income distribution of this profile also aligned well with that of the general population: about two-thirds had incomes between $30 K and $100 K. In other words, the incomes of the majority of the low users who were thermally unflappable were in the same range as the incomes of the majority of the general population. Thus the motivation for non-use was unlikely to be cost.

Ultra-low Users (30 % of survey respondents) were those whose energy consumption fell within SMUD's lowest 3 % – that is, between 52 and 208 kWh/month – closely approximating California's 2050 target. The most striking feature of this profile was the average household size, which at 1,25 people was noticeably smaller than for all but one of the other profiles. Single-occupant households made of 80 % of the profile, and 2-person households another 17 %. It was nearly impossible to achieve ultra-low use with a large household, but income was much less of a determinant. Income distribution here was much more discrete than for other profiles, occurring mostly in three non-adjacent income brackets. This aligned with the earlier finding of contrasting routes to low use: the path of low-income and high deprivation versus the path of high income, high information, and high engagement.

The Sacramento Average profile (22 % of survey respondents) included households with demographic values that were mid-range for the general population, along with a quality of life deemed average or above average. It turned out that these households were not only "typical" for Sacramento, but also "typical" of the low user population in the sense that their approaches to low energy use were creative and diverse. Responses mentioned the usual range of strategies: home retrofits, use of fans and CFLs, infrequent use of heat generating appliances (e.g. clothes dryers), or frequent adjustment of windows. Stories from these "average" households who embrace a low energy lifestyle could be particularly persuasive to the general public. The fact that these average low users are demographically identical to their higher-use neighbours highlights the role of behaviour and motivation as a key differential.

Finally, the Unhappily Low Energy profile (5 % of survey respondents) was designed to estimate the proportion of the lowest decile occupied by those matching the description of energy poverty. The basic criteria for inclusion were household income below $50,000, home size below 1,000 ft^2, and quality of life rated "below average" or "very poor". We searched for any indications that low energy use was indeed not by choice (e.g. any mention of income constraints, thermal discomfort, etc). Finally we looked for statements that identified low energy consumption as a (or the) reason for poor quality of life, such as expression of deprivation or unhappiness that also mentioned energy bills or thermal discomfort, or a belief that higher energy consumption would mean higher quality of life. Of course the imprecision inherent in interpreting open-ended responses meant that our estimates were necessarily rough, and further research is warranted. But taking into account all of the filters, no more than 5 % of our respondents fit the profile of Unhappily Low Energy.[19]

Conclusions: implications for efficiency outreach

It is important to recognize that low energy usage and being too poor to afford more energy services are two different issues that overlap to some extent. Our study of Sacramento households confirmed the prevailing assumption that households using less energy were *on average* poorer, lower occupancy, and living in smaller homes than the average for the general population. However, these average correlations could not adequately explain all of low usage. Since we wanted to investigate the possibility of scaling low lifestyles to a wider population, average values were far less helpful than the realization that the tier of low users includes significant numbers of households from every demographic category. We dispelled the notion that energy-frugal consumers were so unlike the rest of the population that more typical consumers would never be able to emulate their behaviour. Since there was no demographic niche that did *not* contain at least some very low energy households, there was no obvious barrier to replicating low usage across a broader population.

If we are to achieve the very significant reductions in greenhouse gas emissions now under discussion, we need more ef-

18. Deumling 2013, p. 58, Figure 7.6.

19. For further explanation of the Unhappily Low Energy estimate see Deumling 2013, pp. 62–64.

fective ways to persuade a broad audience that future goals are feasible rather than forbidding. Official suggestions about how to reduce energy consumption are wary about how far the public can be encouraged to diverge from what is considered normal practice. This assumption that current average consumption represents what is "normal" or "natural" conveys the discouraging message that diverging from the norm would be would be difficult to accomplish without duress. Our findings suggest downplaying the normal or typical, in favour of more attention to heterogeneity, and in particular to the low end of energy consumption. Most of the low users in our study were able to redefine what is normal or natural without living in discomfort or deprivation.

Nieman (1989) suggested creating a more participatory energy future by enrolling the public as co-producers of policy. We too support peer-to-peer outreach as a more effective model for information transfer than dissemination from experts to the public. It seemed that for many of our respondents the pursuit of low energy consumption *began* with a sense of engagement and enthusiasm, while the specific techniques or devices followed. If enthusiasm is a key determinant, then replicating this quality is best accomplished via the narratives of people similar to the target audience segment. Stories from "relatable peers", featuring the type of anecdotes and experiments that we heard, would surely be more compelling than a master checklist. Indeed, if the hallmark of conscious, deliberate low users is a sense of agency and mastery, then the top-down outreach model could actually be counterproductive, in that it privileges expert knowledge instead of encouraging DIY experimentation. A richer understanding of the diversity of low use pathways could lead to more meaningful public participation in solutions to climate change.

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