Multifamily Benchmarking and Competition Pilot Program Design

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ABSTRACT

The 10 (Electricity)–10 (Gas)– 10 (Water)+ (Plus) Multifamily (MF) Benchmarking and Competition Pilot Program (which we will abbreviate 10-10-10+) is a plan to engage multi-family (MF) complexes to reduce electricity and gas usage by 10% and water by more than 10% within a 12-month period using an experimental design. The pilot will use a randomized encouragement design (RED) in a randomized control trial (RCT) in order to assess intervention strategies to motivate MF property owners and tenants (i.e., at aggregated MF complex level, which includes both tenants and common area meters) to save energy. MF complexes will be randomly assigned to a control group or one of two treatment groups. Three-hundred and sixty (360) MF complexes will be randomly selected into each group. In Treatment Group 1, property owners will receive feedback about their energy usage through a Comparative Usage Report, using analytics to generate benchmarking results such as Building Score and Energy Usage Intensity (EUI), to encourage property owners to reduce consumption. In Treatment Group 2, property owners will also receive feedback through the same Comparative Usage Report, but will additionally engage tenants with on-site marketing support and competition at MF complex-to-complex level. The MF market barriers are well documented, especially the split-incentive barrier between property owners and renters. By engaging the apartment complex as a whole, this program design will be able to engage both property owners and renters to collectively achieve energy efficiency and conservation goals. The initial pilot scope will include eligible apartment complexes (i.e., 15 units or larger MF complexes) in Los Angeles and San Bernardino Counties. Since the usage data will come from five utilities (Southern California Edison (SCE), Southern California Gas (SoCalGas) and three local water agencies), the initial data cleaning, data matching, and data alignment activities are challenging. This pilot is currently working on electric, gas and water data cleaning, matching and aggregation tasks to prepare for the RCT assignment. This pilot is expected to roll-out by the end of 2016.

Introduction

In recent history, climate change, increases in greenhouse emissions and threats to biodiversity represent some of the most important areas that policy makers and social and environmental scientist have been addressing. Importantly, energy efficiency and conservation are two of the most effective tools for countering adverse changes to climate. Considering that 40% of U.S. energy is consumed in residential and commercial buildings (EIA 2013) and electricity production generates the largest share of the greenhouse gas emissions, (32% in 2012; EPA 2012), discussions concerning energy efficiency and the search for viable solutions become even more valuable. There is also considerable demand for water conservation given the recent drought conditions in California. Households constitute an important conservation target, being major contributors to the emission of greenhouse gases and global warming (Abrahamse et al. 2005). Within the SCE territory, nearly one-third or 1.7 million households reside in MF complexes, and about 22% of these households are considered to be low-income. The aim of the current study is to address conservation through changing household consumption patterns in electricity, gas and water by introducing underused behavioral interventions and overcoming the split-incentive barrier.

Although there is currently a nationwide initiative, California has a long history of leading the country in implementing energy-efficiency and Integrated Demand Side Management (IDSM) programs in order to curb energy consumption behavior. However, a limitation of these dominant policy instruments has been that they assume standard (neoclassical) economic approaches in which agents are perfectly rational, stable in preferences, and consistent over time. Additionally, price signals have been used as a main policy instrument to influence consumption behavior, ignoring consumers' decision anomalies, biases and varied preferences.

Recent studies in psychology and behavioral economics provide a vast amount of evidence refuting the assumptions of the standard economic models: that individuals are rational, with stable self-interested preferences. Instead, recent research has shown that individuals have limited attention and are influenced by the social and physical environment. In terms of energy efficiency, this literature suggests that consumers are not motivated solely by monetary incentives and that this problem cannot be addressed by using price instruments alone. The literature in behavioral economics also contradicts standard economic models, showing that individuals do not always choose what is best for them in the long run. That is, people often exhibit lack of self-control, display bias or use heuristics in their decision-making. Realizing these limitations in the consumer decision-making process, policy makers have applied non-monetary interventions and strategies in a variety of contexts, including alcohol, cigarette and drug use, donating to charity, exercise, gambling, addiction, financial savings, environmental awareness, and energy savings (Allcott, 2011; Ashraf, Karlan, and Yin 2006; Ariely, Bracha, and Meier 2009; Ayres, Raseman, and Shih 2009; Benabou and Tirole 2003; Bryan, Karlan, and Nelson 2010; Charness and Gneezy 2008; Goldstein, Cialdini, and Griskevicius 2008; Kahneman; List, 2005). Although these interventions have been shown to be effective in a variety of domains, adoption of such interventions and strategies by the energy and water utilities has been relatively slow. This is particularly true with water utilities, where the potential for savings is much higher, and only a few behavioral interventions have been implemented to extract further savings.

The California Public Utilities Commission (CPUC) has mandated that all statewide Investor-Owned Utilities (IOUs) reach five percent (5%) of all residential customers to implement behavior-based programs. For SCE, this requirement translates to outreach of 215,000-plus predominately single-family residential customers, using targeted Home Energy Report mailings using comparative energy usage. Given California's water conservation emergency and diverse population, this MF pilot is designed to address the needs of both the MF population and energy/resource efficiency.

A recently published white paper, "Paving the Way for a Richer Mix of Residential Behavior Programs", developed by the California IOUs, CPUC and consultants, directed California IOUs to focus on one or more underused intervention strategies in their program designs, including social norms, social preferences and cooperation, framing, loss-aversion, incentives, commitment, feedback and competition.

In order to meet the above requirements and implement under-used behavioral approaches, this pilot program will employ a multi-pronged behavioral strategy to engage both property owners and tenants in MF complexes to decrease energy usage through social competition (group) and feedback strategies. In this pilot program, MF complexes will compete against each other in order to achieve ten percent savings in electricity, water and gas separately. This same concept can be scaled to conduct city-to-city competition, especially when using water agencies to mark the territory boundaries over existing electricity/gas services. The idea behind this underused behavioral intervention (in the energy field) is that constructing teams will motivate individuals to participate, leading to the success of the group.

This design is supported by behavioral economics literature indicating that, contrary to the classical rational agent assumption, it is not possible to understand the effects of competition if concepts of reciprocity and cooperation are neglected (Fehr and Fischbacher 2002; Lindbeck and Snower 1998; Pentland 2014). In line with this notion, the objective of the pilot program is that creating a competitive environment creates teamwork and cooperation among the team members, so success of the MF complexes will depend on the individual success as well. "Coordination and cooperation among peers are powerful shaping forces – our friends watch our backs, in sports and business teammates cooperate to win against other teams, and everywhere people support family, children, and the elderly (Pentland 2014)." However, cooperation among larger groups may be limited because individual self-interest may conflict with the best interests of the group (tragedy of the commons) or individuals consume more than their share of a resource. These problems may be especially relevant when individuals are not monitoring each other and there is no individual punishment. This study attempts to overcome (or at least reduce the effect of) these limitations by setting a clear goal, establishing group commitments and creating a strong social environment where people are motivated to compete in a within MF complex competition and/or a MF-to-MF complex competition. As indicated earlier, this can be evolved and scaled into a city-to-city competition.

Traditional programs motivating changes in consumption behavior have mainly focused on educational information and financial incentives only. The assumption underlying these programs is that once people receive information and an offer of financial incentives, this would motivate behavioral change. However, by assuming that educational information or financial incentives only is enough to elicit behavioral change, these earlier approaches have ignored the difference between the *perceived* value of the information and the *actual* value of the information. The proposed pilot study is intended to reduce the gap between the perceived and actual valuation of the information by emphasizing the strong social preferences and ties in a competitive environment in addition to the individual financial gains. Bond et al. (2012) demonstrates the importance of social influence for behavioral change using Facebook users. Specifically, they showed that users that received a social message from their social ties were more likely to change their behavior than people who received generic information. This suggests that social ties are important in eliciting behavioral change, and add support to our study design, which uses social norms to change energy behavior. The current study also utilizes social ties, but in a context where savings will be induced by employing group-to-group competition.

The study actually frames the message of savings to both property owners and tenants, which provides both financial gain and positive environmental externality, in a competition setting.

Theoretical Background and Literature Review

Recent increases in non-monetary interventions using behavioral economics and psychology have been shown to be effective in motivating consumers to conserve energy. In a variety of areas, many behavioral concepts have been implemented to "nudge" consumers toward behavioral change to increase health, wealth, and other benefits. There are some studies that have reviewed/tested concepts or designs similar to what is being proposed by SCE, although in different settings. However, few of these studies are larger than SCE's proposed pilot design. These studies indicate that there are further opportunities to implement various behavioral concepts within different settings to better identify what drives consumers' energy use. The goal of SCE's pilot program is to enable evidence-based and data-driven decision-making by applying some of the behavioral concepts and tools suggested in this study.

Studies have also shown that customers are more likely to make persistent changes in their energy behaviors if the new behaviors are easy and convenient to perform, skills and resources are available, peer pressure and social norm dictate the change, and when commitments to change are made in public settings (Costanza et al. 1986; Stern 1992; McMakin, Malone, and Lundgren 2002). As suggested by McMakin, Malone, and Lundgren (2002) and other recent studies, people are more likely to adopt energy-efficiency behaviors under certain conditions. For example, people are more likely to initiate behavioral change when they view these changes as personally benefitting themselves. In terms of energy efficiency, this means that people are more likely to conserve energy when it involves increasing their own comfort and well-being versus simply saving energy for environmental purposes (Becker et al.1981). Another factor that is important in behavior change is visibility. That is, when people can see their energy use and savings, they are more motivated to form goals to change their usage behavior (Kempton et al., 1992; Harding and Hsiaw 2014). This visibility is especially effective when the information is made personally salient (Tversky and Kahneman 1981; Costanza et al. 1986; Stern and Aronson 1984; Stern 1992; Chetty, Looney, and Kroft 2007; Finkelstein 2009).

Finally, people are likely to change their behavior when social pressure and norms dictate a change. Research shows that people are more likely to identify with "more similar" others (i.e., neighbors) than "less similar" others (i.e., people in the same country) and that these in-group ties tend to foster trust between group members and exert social pressure to conform to group norms (Pentland 2014). This suggests that energy efficiency behavior change is most effective when people are reminded of their social ties and people perceive that others in their group are making changes to conserve energy. However, it is not simply pressure to conform to social norms that motivates people to change their behavior; it is the aspect of social comparison that seems to be most effective. For example, Mani, Rahwan, and Pentland (2013) showed that social pressure is an effective tool to encourage homeowners to conserve electricity. In their study, homeowners were given social feedback on how much electricity they were using compared to the average person in their neighborhood, or the average person in their country. Results showed that when people were compared to their neighbors (vs. people in their country), they were more likely to conserve electricity. These results suggest that comparison group matters for energy conservation.

In addition to aforementioned strategies encouraging behavior change, the addition of competitive incentives has been shown to be effective in motivating people to put forth more effort in changing their behavior (Apesteguia and Palacios-Huerta 2010; Bracha and Fershtman 2012; Hutton and McNeill, 1981). For example, McClelland and Cook (1980) engaged four sections of a university-affiliated apartment complex in a series of six competitions to conserve energy. A separate but comparable apartment complex served as a control (no competition). Results showed that the apartment complex engaged in competition saved more energy than the control complex, indicating that incentivizing energy conservation through competitive incentives served as an effective strategy for behavior change. Competitive incentives have also been shown to enhance the effectiveness of other energy conservation strategies when used in combination with these strategies (e.g., participants in college dormitories conserved more energy when given real-time feedback vs. aggregated feedback in an inter-dormitory competition; Peterson et al. 2007; Bekker et al. 2010; and chicagoneighborhoodenergychallenge.com). This research adds support to the current pilot study design and highlights another important contribution of the pilot study – to our knowledge, these are among the few studies to (1) employ a competitive incentive design using non-university-affiliated multi-family apartment complexes and (2) assess both individual and master meters to measure energy usage (vs. solely master meters in university housing) in an experimental context.

Considering the findings from the literature, the pilot design is intended to utilize social ties by emphasizing the competition among the multi-family apartment complexes, creating a 10-10-10+ goal and commitment structure. Few, if any, studies have explored the competition among multi-family apartments.

Pilot Goals

The 10-10-10+ program will use a randomized encouragement design (RED) in a randomized control trial (RCT) settings to engage MF complexes to reduce gas and electricity use by 10% and water by more than 10% within a 12-month period.[1] The study design will follow three behavior program best practices: (1) Test different, underused behavior intervention strategies with innovative designs, (2) Ground the pilot in generally accepted social science research and behavior theories, and (3) Yield evaluable effects, especially to support energy savings reporting.

An additional objective of the pilot study is to use data analytics to generate California-specific benchmarking results as an effective intervention strategy for encouraging a reduction in

[1] This pilot program design may be expanded to include single-family units in conjunction with a Home Owner Association (HOA) and/or Condo units with an HOA; however, this is not the initial pilot program focus. Random Encouragement Design (RED) is often used in combination with Randomize Controlled Trial (RCT). In the context of this pilot, eligible apartment complexes with aggregated renter and common area meters will be randomly selected into three groups (control, Group 1 and Group 2). The Group-2 MF complexes will be encouraged to participate and receive on-site marketing activities to engage tenants.

energy usage. The data analytics can generate California-specific Energy Usage Intensity (EUI) and Building Score measures that can be used to compare baseline MF complexes' relative performance to other MF complexes. The data analytics include both energy and water consumption and allow tracking of performance over time. Similar to the EPA's Energy Star MF Portfolio Manager, the data analytics can generate California-specific Building Scores. These scores range between 1 (not at all energy efficient) and 100 (very energy efficient) in relative terms, will allow the pilot to compare one MF complex against another MF complex's energy efficiency level. In order to provide benchmarking information, data such as property type and energy consumption need to be provided by the MF complexes in aggregate (i.e., common areas and tenants in aggregation). There must be at least 12 full, consecutive calendar months of energy data for all active meters and all fuel types. This metric normalizes building variables, takes into account additional variables such as weather that may influence energy consumption, and thus allows MF complexes to be compared to each other.[2] [3] Electric, gas and water usage data will be provided by SCE, SoCalGas and three different local water agencies.

Pilot Sample Qualifications

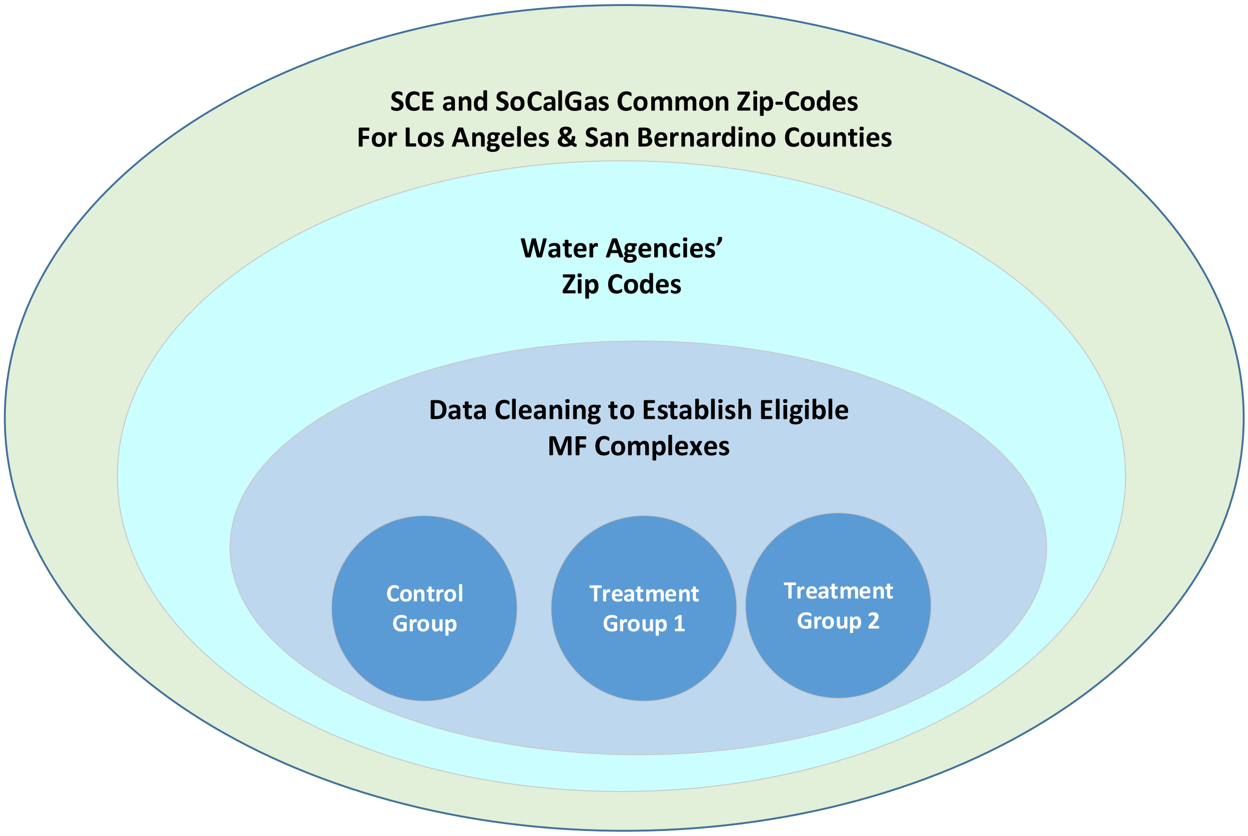
For MF apartment complexes to qualify for the pilot, the following criteria must be met:

- Only apartment complexes with 15 units or more will be eligible.
- The pilot program will engage a mixture of master-metered as well as individually-metered apartment complexes for electricity use.
- Master-metered MF complexes are typically the norm for gas and water, however, if individually metered properties exist, they will be included in the pilot.
- Ideally, the participating complexes will be a mixture of low-income, affordable, and market-rate apartment complexes.
- The participating MF complexes will be customers of SCE/SoCalGas at a minimum. To qualify for the pilot, the MF complex must support two out of three resources from the pilot sponsors (i.e., electricity and gas).

Data cleaning can be complicated, as illustrated below. The pilot program team must start with eligible shared electric and gas accounts, then map-in the three participating regional water agencies prior to the RCT assignment. For example, SCE and SoCalGas will establish jointly qualified MF complexes within Los Angeles and San Bernardino Counties first. Since the three water agencies are city/cities-oriented, their eligible MF complexes will be overlaid on top of the eligible electric and gas MF complexes.

[2] www.sce.com
[3] http://www.energystar.gov/buildings/index.cfm The benchmarking data analytics and methodologies used for this pilot program is consistent with the "EPA's ENERGY STAR Portfolio Manager"

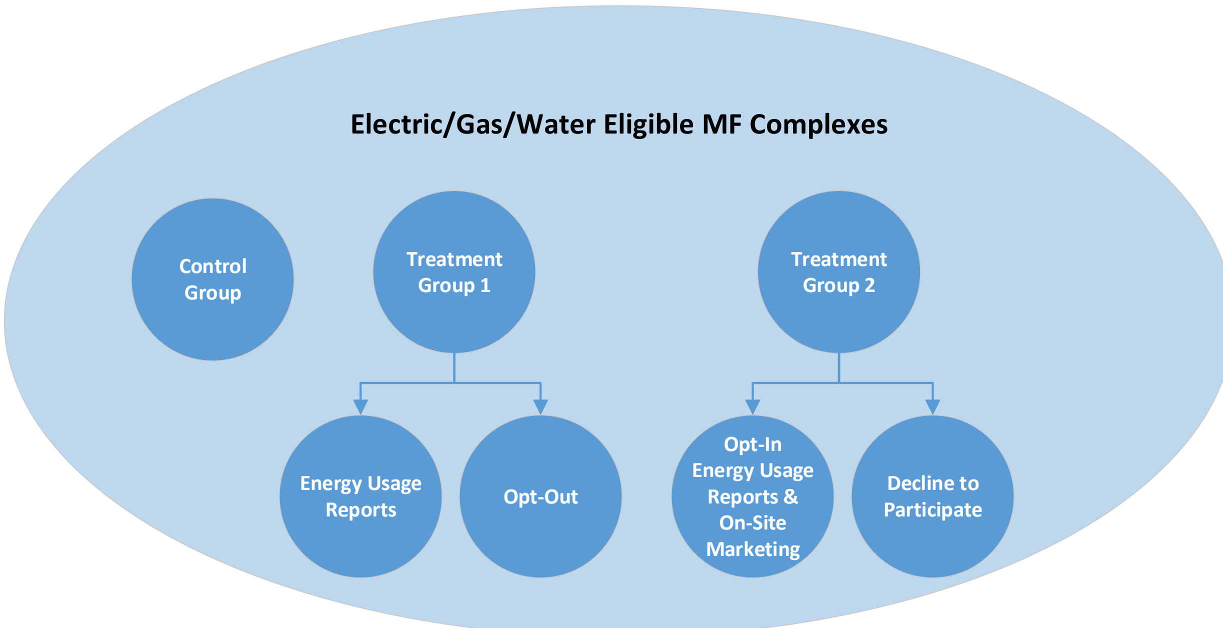
Illustration-1: Data Cleaning Approach to Establish a Qualified MF Complex Population



Pilot Design

This pilot will use a randomized encouragement design in a randomized control trial in order to determine the effectiveness of two different treatments (i.e., Energy Usage Reports with Building Score and EUI for property owners vs On-site Marketing Engagements) for two different groups (i.e., property owners vs tenants).

Illustration-2: A RED Design within a RCT



As indicated in ***Illustration-2*** above, MF complexes will be randomly assigned either to a control group or one of two treatment groups. For Treatment Group 1, participants will be automatically enrolled but can opt out. For Treatment Group 2, the participants will receive invitations to participate and will be treated as opt-ins. The MF complexes in the control group will be designated "as is" and will serve as a baseline for comparison to the treatment groups. Since the mailing and on-site marketing treatment will commence at the same time, this means that the recruiting within Group 2 must be completed ahead of the first mailing effort. The goal for Group 2 is to net 360 MF complexes from the randomly selected group. We are currently anticipating that 75% of randomly selected MF complexes will consent to participate for Group-2. For Group 1, the initial group will be larger than 360 MF complexes since a few opt-outs may occur during the course of implementation.

Treatment Group 1 targeting property owners will receive a Comparative Usage Report using the data analytics to generate the comparative usage information as feedback. Treatment Group 2 will also receive the same Comparative Usage Report for property owners, plus additional on-site marketing, competition and reward/s treatments (see details at Table-1, below) to engage tenants.

Table-1: Types of Treatment & Treatment Groups

	Control Group	Treatment-A: Invitation to Benchmarking	Treatment-B: Plus, On-site Marketing Support, Competition & Reward/s
Targets	--	Property Owners	Property Owners & Tenants
# of MF Complexes	360	360	360
Treatment Group 1 (opt-out)	--	Comparative Usage Report	--
Treatment Group 2 (opt-in)	--	Comparative Usage Report, plus	On-Site Marketing Support, Competition & Reward

Note – Treatment Group 2 will receive Treatment-A and Treatment-B at the same time. Each group with have 360 MF complexes, varying in size, starting with complexes with 15 tenant units or more. The initial analysis indicated that over 170,000 tenant units may be involved in this pilot effort.

The Treatment Group 2 will receive materials for on-site marketing in order to engage residents of the individual apartment units within the MF complex in competition in two levels. The first level will be a MF complex-wide competition. Energy consumption will be self-measured on a month-to-month basis and compared to energy usage in the same month in the prior year, using benchmarking outputs from the data analytics.[4] The next level of competition will be a MF complex-to-MF complex competition. On a quarterly basis, the participating MF complexes will receive a Comparative Usage Report, using benchmarking outputs from data analytics, such as Building Score and EUI. The Building Score and EUI will also form the basis for the different level of competition. There are interim awards to engage the tenants and to generate excitement. The final reward will be based on cumulative results but will be designed to show recognition of accomplishments at the MF complex level, including both property owners and tenants. See, ***Table-2*** for illustration implementation cadence.

[4] This metric will need to be normalized to at the per unit level.

Table-2: MF Competitive Report & Competition & Reward

Time	Mailings to Property Owners	On-site Marketing Support & Tenant Engagement with Competition	Reward/s
Month-1	Mailing-1	On-site Marketing Treatment-1	#1 - Announce reward options
Month-2	N/A	N/A	N/A
Month-3	N/A	N/A	N/A
Month-4	Mailing-2	On-site Marketing Treatment-2	#2 - Announce interim winner/s & provide reward/s
Month-5	N/A	N/A	N/A
Month-6	N/A	N/A	N/A
Month-7	Mailing-3	On-site Marketing Treatment-3	#3 - Announce interim winner/s & provide reward/s
Month-8	N/A	N/A	N/A
Month-9	N/A	N/A	N/A
Month-10	Mailing-4	On-site Marketing Treatment-4	#4 - Announce interim winner/s & provide reward/s
Month-11	N/A	N/A	N/A
Month-12	Mailing-5	Final On-site Marketing Treatment	#5 - Announce final winner/s & provide reward/s

As indicated in the ***Table-3*** below, the pilot is using data analytics to generate benchmarking outputs such as Building Score and EUI values and to form the basis of competition and reward. The competition can be evolved and scaled to form (1) MF complex self-competition, (2) MF complex-to-MF complex competition, (3) by grouping participating MF complexes into logical groups, a city-to-city competition can also be possible. For the pilot program in Southern California, a city-to-city partition using water agencies' territory as natural boundary may be a good option. We are anticipating three local water agencies to participate in this pilot implementation.

Table-3: MF Multi-Level Competition

MF Complex Self-Competition	MF Complex-to-Complex Competition	MF Complex City-to-City Competition
Trending of Building Scores and EUI values for a single MF complex over time	Trending of average/median Building Scores and EUI values for two MF Complexes over time	Trending of average/median Building Scores and EUI values for logical groupings of MF complexes over time

A 10% behavior-only (i.e., without plug-load appliance upgrades) reduction in electricity usage may be difficult to achieve; however, a 10% reduction in water usage should be easily achievable (EPA 2015; Mitchell and Chesnutt 2013). Based on studies-to-date for Opower based Home Energy Reports, behavior-only electricity and gas energy savings can be as low as 1.0% depending on the customer's targeting strategy. However, Mani, Rahwan, and Pentland (2013) showed that social network incentive caused electricity consumption drop by 17%, much higher than achieved in previous energy conservation campaigns and studies. In contrast with the earlier studies, this study managed to design an experimental setting where consumers could relate to the people in the comparison group. Such a design was expected to increase both trust and social pressure among the consumers, which eventually did influence consumers' energy consumption behavior. This is also aim of our proposed study.

It should be also noted that this pilot aims to measure not only the *effects* but also the *durability* of the intervention, especially once intervention stops after one year. Most recent studies on treatment persistence suggest that the effectiveness of non-pecuniary strategies decay over time (Ferraro and Price 2013; Allcott and Rogers 2014). However, in contrast to previous studies, we intend to create an environment encouraging close social ties, and thus, the rate of decay is likely to be lower than prior studies once we remove the stimulus. This persistence of treatment also has an impact on assessing the cost effectiveness of utility behavioral programs, as it is often the case that any behavioral and non-pecuniary programs are evaluated by the energy savings realized in the same year. However, this method of assessment ignores the possibility that reports delivered during a given year can result in additional conservation in future years (Allcott and Rogers 2014).

Conclusions and Potential Implications

The current pilot draws methodology from behavioral economics and psychology, employing behavioral interventions that focus on feedback/benchmarking and competitive incentives to induce MF complexes to reduce usage of electricity, gas, and water. The importance of this pilot lies beyond simply proposing a method of behavioral change; it also makes important methodological contributions to the field of energy efficiency. Unlike prior studies (see Jones & Vine, 2015), this pilot uses an experimental design to randomly assign MF complexes to each condition, allowing inferences to be drawn about the effectiveness of particular interventions for the MF population. Another unique aspect of the current pilot is the participant sample. Prior research using competitive incentives to encourage energy conservation have engaged students residing in university-affiliated apartment complexes, something that may limit the generalizability of the results. University students may be a unique subpopulation given that students may be more likely to participate in a program simply because it takes place in a university setting, they may have different energy use patterns than the general population (e.g., time spent at apartment, number of people residing in apartment, etc.), and may not value energy conservation if they are not paying for utilities (university residence hall or utilities included housing). This pilot program is the first to engage non-university-affiliated MF complexes (see Bekker et al. 2010; McClelland and Cook, 1980; Peterson et al. 2007) and assess energy usage through both individual and master meters. This is also the first study to do this on a large scale.

Here are a few key thoughts from this proposal:

- By performing the data analytics using a portfolio of MF complexes, it is possible to discern a rank order of EUIs and Building Scores, from the best MF complex to the worst MF complex. This will have significant program design and targeting implications since efficiency programs often default to "high energy usage" as proxy to "less efficient".
- While the benefits of benchmarking service are well understood, adding competition and reward into this mix may motivate more intense behavior outcome from property owners and tenants compared to using benchmarking services for property owners only.
- There are also many potential lessons to be learned from this data cleaning, alignment and matching process with five utilities participating in this process, while working with county assessor tax records.
- For a single fuel utility such as SCE and SoCalGas, this intensive data challenge must be mastered, so they can garner the benefits from the powerful data analytic capabilities.

Finally, results of this multi-family pilot program and subsequent studies will have broader implications for California policy makers. This pilot is unique in its innovative usage of benchmarking data analytics to test the implications of the aforementioned underused behavioral interventions, to engage both property owners and tenants. The results of this study could also encourage both utilities and the government to motivate residential multi-family complexes to participate in benchmarking activities.

References

Abrahamse W., Steg L., Vlek C., and Rothengatter T. 2005. A Review of Intervention Studies Aimed at Household Energy Conservation. *Journal of Environmental Psychology*. 25: 273-291

Allcott, H. 2011. "Social Norms and Energy Conservation." *Journal of Public Economics* 95 (9): 1082-1095.

Allcott, H., and Mullainathan, S. 2010. "Behavioral Science and Energy Policy." *Science* 327 (5970): 1204-1205.

Allcott, H., and Rogers T. 2014. The Short-Run and Long-Run Effects of Behavioral Interventions: Experimental Evidence from Energy Conservation. *American Economic Review*. 104 (10): 3003-3037.

Apesteguia, J., and Palacios-Huerta, I. 2010. Psychological Pressure in Competitive Environments: Evidence from a Randomized Natural Experiment. *American Economic Review* 100 (5): 2548-2564.

Ariely, D., Bracha, A., and Meier, S. 2009. Doing good or doing well? Image Motivation and Monetary Incentives in Behaving Prosocially. *American Economic Review* 99 (1): 544 555.

Ashraf, N., Karlan, D., and Yin, W. 2006. Tying Odysseus to the Mast: Evidence From a Commitment Savings Product in the Philippines. *Quarterly Journal of Economics* 121 (2): 673-697.

Ayres, I., Raseman, S., and Shih, A. 2009. Evidence From Two Large Field Experiments That Peer Comparison Feedback Can Reduce Residential Energy Usage. *NBER Working Paper No. 15386.*

Becker, L. J., Seligman, C., Fazio, R. H., and Darley, J. M. 1981. Relating Attitudes to Residential Energy Use. *Environment and Behavior* 13 (5): 590-609.

Becker, G.S., and Murphy, K.M. 1993. A Simple Theory of Advertising as a Good or Bad. *The Quarterly Journal of Economics* 108 (4): 941-964.

Bekker M.J., Cumming T.D., Osborne N.K.P., Bruining A.M., McClean J.I., and Leland Jr. L.S. 2010. Encouraging Electricity Savings in a University Residential Hall Through a Combination of Feedback, Visual Prompts, and Incentives. *Journal of Applied Behavior Analysis*. 43(2): 327 – 331.

Bracha, A., and Fershtman, C. 2012. Competitive Incentives: Working Harder or Working Smarter? *Management Science* 59 (4): 771-781.

Bryan, G., Karlan, D., and Nelson, S. 2010. Commitment Devices. *Annual Review of Economics.* 2 (1): 671-698.

Bond R.M., Fariss C.J., Jones J.J., Kramer A.D.I., Marlow C., Settle J.E., and Fowler J.H. 2012. A 61-Million-Person Experiment in Social Influence and Political Mobilization. *Nature* (489): 295 – 298.

Camerer, C., Issacharoff, S., Loewenstein, G., O'Donoghue, T., and Rabin, M. 2003. Regulation for Conservatives: Behavioral Economics and the Case for ‘Asymmetric Paternalism’. *University of Pennsylvania Law Review* 151 (3): 1211-1254.

Charness, G., and Gneezy, U. 2008. Incentives to Exercise. *Econometrica* 77 (3): 909-931.

Chetty, R., Looney, A., and Kroft, K. 2007. Salience and Taxation: Theory and Evidence. *American Economic Review* 99 (4): 1145-1177.

Cialdini, R. B., Demaine, L. J., Sagarin, B. J., Barrett, D. W., Rhoads, K., and Winter, P. L. 2006. Managing Social Norms for Persuasive Impact. *Social Influence* 1 (1): 3-15.

Cialdini, R. B. 2003. Crafting Normative Messages to Protect the Environment. *Current Directions in Psychological Science* 12 (4): 105-109.

Costanzo, M., Archer, D., Aronson, M., and Pettigrew, T. 1986. Energy Conservation Behavior: The Difficult Path from Information to Action. *American Psychologist* 41 (5): 521-528.

CPUC (California Public Utilities Commission). 2012. Decision Approving 2013-2014 Energy Efficiency Programs and Budgets. D.12-11-015.

Fehr, E., and Fischbacher, U. 2002. Why Social Preferences Matter - The Impact of Nonselfish Motives on Competition, Cooperation, and Incentives. *Economic Journal* 112 (478): C1-C33.

Ferraro, Paul J., Juan Jose Miranda, and Michael K. Price.2011. The persistence of treatment effects with norm-based policy instruments: evidence from a randomized environmental policy experiment. *The American Economic Review* 318-322.

Ferraro, P. J., and Price, M. K. 2013. Using nonpecuniary strategies to influence behavior: evidence from a large-scale field experiment. *Review of Economics and Statistics*, 95(1), 64-73.

Finkelstein, A. 2009. E-ztax: Tax Salience and Tax Rates. *Quarterly Journal of Economics* 124 (3): 969-1010.

Goldstein, N. J., Cialdini, R. B., and Griskevicius, V. 2008. A Room With a Viewpoint: Using Normative Appeals to Motivate Environmental Conservation in a Hotel Setting. *Journal of Consumer Research* 35 (3): 472-482.

Gneezy, U., Meier, S. and Rey-Biel, P. 2011. When and Why Incentives (Don't) Work to Modify Behavior. *Journal of Economic Perspectives* 25 (4): 191-210.

Harding, M., and Hsiaw, A. 2014. Goal Setting and Energy Efficiency. *Journal of Economic Behavior and Organization*. 107: 209-227

Hutton B., and McNeill D.L. 1981. The Value of Incentives in Stimulating Energy Conservation. *Journal of Consumer Research*. 8 (3): 291-298

Jones, C. M. and Vine, E. 2015. A Review of Energy Reduction Competitions Studies: Scaling Up Deeper Savings Through Comparative Feedback and Recognition. Unpublished manuscript.

Kamenica, E. 2012. Behavioral Economics and the Psychology of Incentives. *Annual Review of Economics* 4 (1): 427-452.

Kempton, W., Darley, J., and Stern, P. 1992. Psychological Research for the New Energy Problems: Strategies and Opportunities. *American Psychologist* 47 (10): 1213-1223.

Mani, A., Rahwan, I., and Pentland, A. 2013. Inducing Peer Pressure to Promote Cooperation. *Scientific Reports* 3 (1735): 2045-2322.

McMakin, A. H., Malone, E. L., and Lundgren, R. E. 2002. Motivating Residents to Conserve Energy Without Financial Incentives. *Environment and Behavior* 34 (6): 848-863.

McClelland L., and Cook. S.W. 1979. Energy Conservation Effects of Continuous In-Home Feedback in All-Electric Homes. *Journal of Environmental Systems*. 9(2): 169 – 173

Mitchell D.L., and Chesnutt T.W. 2013. Evaluation of East Bay Municipal Utility District's Pilot of WaterSmart Home Water Reports. *Policy Analysis for the Public and Private Sectors.* M.Cubed.

Pentland, A. 2014. *Social Physics: How Good Ideas Spread – The Lessons from a New Science.* The Penguin Press. New York.

Petersen, J.E., Shunturov, V., Janda, K., Platt, G., and Weinberger, K. 2007.Dormitory residents reduce electricity consumption when exposed to real-time visual feedback and incentives. *International Journal of Sustainability in Higher Education*, Vol. 8(1): pp. 16 - 33

Pink, D. H. 2009. Drive: *The Surprising Truth About What Motivates Us.* Riverhead Books. New York.

Samuelson, C. D., and Biek. M. 1991. Attitudes Toward Energy Conservation: A Confirmatory Factor Analysis. *Journal of Applied Social Psychology* 12 (7): 549-568.

Stern, P. C. 1992. What Psychology Knows About Energy Conservation. *The American Psychologist* 47 (10): 1224-1232.

Stern, P. C. and Aronson, E. 1984. *Energy Use: The Human Dimension.* New York: W. H. Freeman and Company.

U.S. Energy Information Administration. 2014. How Much Energy is Consumed in Residential and Commercial Buildings in the United States? Retrieved February 14, 2015 from http://www.eia.gov/tools/faqs/faq.cfm?id=86&t=1

U.S. Environmental Protection Agency. 2013. Sources of Greenhouse Gas Emissions. Retrieved February 14, 2015 from http://www.epa.gov/climatechange/ghgemissions/sources.html

Tversky, A. and Kahneman, D. 1981. The Framing of Decisions and Psychology of Choice. *Science* 211 (4481): 453-458.