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Mass-Scale, Multi-Family Benchmarking and Conservation: Lessons from a Behavioral Energy and Water Competition Pilot

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Abstract

Multifamily residential (MFR) market barriers to energy efficiency are well documented, particularly the split-incentive barrier between property owners and renters. Utilizing a randomized encouragement design (RED), two Southern California utilities and three water agencies, have embarked on a large-scale, year-long pilot program designed to induce MFR complexes to reduce gas and electricity use by 10% each, and water by more than 10% (10-10-10+). A randomly selected group of MFR customers were split into one control group (N=1000), one treatment group (N=650) which received mailers, and another treatment group (N=360) which received mailers as well as on-site marketing materials such as tenant door hangers. The pilot uses competition and rewards to encourage participating MFR complexes to improve Energy Use Intensities (EUIs) and Building Benchmarking Scores. This pilot differs from other existing energy competition programs in that it employs a scalable RED) to drive conservation. Each complex's performance is tracked during the pilot period, and competition winners will be rewarded at the end of the competition. The pilot employs Residential Energy and Water Intelligence's Portfolio Analyst© software, as an alternative to the US EPA's Portfolio Manager, due to its ability to mass-calculate benchmarking results for the approximately 2000 properties involved in the pilot. Water conservation recommendations are developed through remote sensing analysis of MFR landscaping. While it is too early in the competition period to measure impacts of the behavioral interventions, the pilot's cutting-edge quasi-experimental design will facilitate rigorous savings estimation, and the techniques employed can be employed immediately by other utilities seeking to overcome similar barriers and challenges to encourage energy efficiency behaviors in MFR customers.

Introduction

California has a history of leading the country in implementing energy-efficiency and Demand Side Management (DSM) programs in order to promote energy efficient consumption behavior. Such programs offer attractive opportunities for households both in terms of private gains and social benefits. "Despite these apparent opportunities, there is a large and persistent difference between the levels of investment in energy efficiency that are projected to save consumers money and the investments that individuals actually pursue (Fowlie et al., 2015)". In addition, a limitation of these instruments and programs is that they assume standard (neoclassical) economic approaches in which agents are perfectly rational and stable in preferences. Households who opt-in to energy efficiency programs or invest in the technologies imply that they expect positive net benefits. Hence, in the existence of structural, behavioral, or informational barriers, households could underinvest in energy efficiency programs and adopt the technologies that lead to market failures. Traditional programs motivating change in consumption behavior have mainly focused on educational information and financial incentives, and were lacking proper experimental settings to effectively measure the impact on consumption. The assumption underlying these programs is that once households or landlords receive information and an offer of financial incentives, it would motivate behavioral change and encourage necessary investments. However, by assuming that educational information or financial incentives is enough to elicit behavioral change, these earlier approaches have ignored the household decision biases, cognitive limitation, principal-agent, and split incentive issues. The proposed pilot study is intended to address these issues by emphasizing the strong social preference in a competitive environment, by providing effective feedback mechanism and individual financial gains in an experimental setting.

Recent studies in psychology and behavioral economics provide a vast amount of evidence refuting the assumptions of the standard economic models. Instead, recent research has shown that individuals have limited attention, cognitive limitations, 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 energy conservation cannot be addressed by using price instruments alone (Allcott, 2011; Goldstein, Cialdini, and Griskevicius, 2008).

This pilot program will employ a multi-pronged behavioral strategy to engage both property owners and tenants in Multi-Family Residential (MFR) complexes to decrease energy usage through social competition (group) and feedback strategies. MF complexes will compete against each other in order to achieve ten percent savings in electricity, water, and gas separately. The idea behind this behavioral intervention is that constructing teams and social groups will motivate individuals to participate, leading to the success of the group. The design of a competitive environment can create 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 is powerful in motivating behavioral change (Pentland 2014). On the other hand, cooperation among larger groups may be limited because individual self-interest may conflict with the best interests of the group (i.e., tragedy of the commons). These problems may be especially relevant when individuals are not monitoring each other and there is no individual accountability. 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 to achieve the desired outcome – 10% 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. 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.

Addressing the Main Challenges in MFR Efficiency Programs

Many utility energy efficiency programs target the multifamily residential (MFR) dwelling segment. One of the goals of the California Energy Efficiency Strategic Plan for the residential sector was for energy consumption in existing homes to be reduced by 20% by 2015 and 40% by 2020 (CEC, 2011, p.11). In 2015 the residential sector in California consumed approximately 4,150 million therms (MMtherms) of natural gas (US EIA, 2016). A 40% reduction in consumption was equivalent to 1,660 MMtherms. However, the most recent energy efficiency supply assessment puts the 2020 cumulative market potential at only 2,000 MMtherms (Navigant, 2015, p. vii) for *both* single-family as well as the MFR segment.

Although we are offering a novel design and an empirical approach in underutilized setting with overlooked population – MFR renters and low-income households – we recognize the possible challenges of the implementation. Achieving the energy efficiency (EE) savings for the MFR building segment was likely to be difficult as this sector was considered to be “underserved” and “hard-to-reach” (Johnson, 2013). Demand Side Management (DSM) programs face multiple barriers in the MFR sector. The first barrier is limited time and financial resources for property owners and managers. Similarly, participating in utility DSM programs can be complex; there are often separate forms to fill out for electric, gas and water efficiency, each with different measurement and evaluation requirements. For low-income programs, landlords must get tenant approval prior to undertaking renovations, which imposes a big transaction cost on landlords. A lack of access to capital is also typical in the sector.

Finally, the biggest barrier to efficiency is that tenants don't want to pay for expensive energy efficiency equipment(s) as they are likely to move out before its benefits can be amortized. According to the Davis (2012) study controlling for household income and other characteristics, renters are significantly less likely to have energy efficient refrigerators, clothes washers, and dishwashers.

Likewise, landlords are hesitant to pay for expensive efficient equipment when they don't pay the energy bills. At the same time, landlords who don't pay for electricity are less likely to purchase energy efficient appliances (Davis, 2012). Differences in such interests and information asymmetry between the landlords and tenants linked with problems of split incentives. Additionally, Gillingham et al. (2012) study show that "the split incentive issue relating to insulation leads to greater additional energy consumption and emissions than issue from not paying for energy use." This landlord-tenant market failure was at the heart of the barriers to an efficient MFR building sector (Murtishaw and Sathaye, 2006). Even when MFRs are master-metered, and the landlord pays all of the utility bills, significant barriers to improved building energy use occur, because the landlord was not aware of his/her building performance against peer buildings. Studies suggest that when the decision environment is complex and the outcome of certain actions is not immediate and salient, people tend to act as if the information were nonexistent (Sallee, 2014). Utility billing information is often complex and not easy to understand for end-users. In addition, utility billing information, which is also a form of feedback, is not frequent, often provided monthly or every other month. Thus, considering that households have limited attention infrequent feedback may result in inefficiencies in energy or water consumption. Households fail to link the energy costs and their own behavior due to the non-salient information, this can apply to landlords as well.

There is an informational failure as well, where landlords don't have access to tenant utility bills, and thus might not be able to tell prospective renters what the utility bills are likely to be. Thus, this pilot also aims to investigate the effectiveness of information salience for the landlords, and affect on the tenants' behavior. Improving energy efficiency in rental housing becomes an even more pressing issue, as policymakers have noted that many low-income tend to rent rather than purchase their housing. Low-income renters' buildings are statistically significantly inferior to owner-occupied buildings when it comes to building shell and the energy efficiency of appliances (Nelson and Gebbia, 2017).

Low income and poor households often face difficult tradeoff between managing limited resources, constraints on attention, and making a "better" choice. In the context of the energy efficiency and DSM programs, ignoring such behavioral failures and cognitive limitations could raise equity concerns about the programs. Indeed, among other household decisions, following up with utility bills, understanding the contents, and initiating behavioral changes requires time, attention, and bearing the up-front cost. Also, households or landlords could highly discount the long-term benefits of their behavioral change and investment decisions. Hence, the problem is not limited to the availability of the information; information about energy efficient behavior and tips about how to conserve energy is free and readily available, but as Mani et al. (2013) suggests, individuals who face large constraints simply are unable to pay attention to it. Therefore, utility programs should aim to reduce the possible search cost problem for the best information or resources to provide the highest return for consumers' actions. In the absence of proper program design, DSM programs could be regressive for low-income households; distribution of the benefits of such programs could go from low-income to high-income households. Keefer and Rustamov (2017) showed that a bill that captures the households' attention would lead to at least a 4% reduction in consumption in the following month particularly among the lower income households. On the other hand, Automatic bill payment (ABP) programs, which reduce the price salience, increase the electricity consumption by 4%-6% among the residential customers (Sexton, 2015). Therefore, designing more salient billing and feedback information becomes important to address the energy efficiency challenges.

As utilities are required to capture all cost-effective energy efficiency in their service territories, new approaches will, by definition, be necessary to identify and capture these savings. AB 802 was passed in 2015 to implement the California Energy Efficiency Plan. This law requires CA utilities to provide benchmarked building energy consumption within 4 weeks to customers requesting the benchmark. According to a study by Recap Real Estate Advisors, only 2-3% of MFR properties have been benchmarked. (Trehubenko & Schmidt, 2011). Benchmarking provides the information for building owners to upgrade their equipment or make behavioral changes to reduce energy consumption. For example, the most common retrofits undertaken in San Diego MFR projects include domestic hot water, window replacement, space heating upgrades, and lighting.

In sum, there appears to be market opportunities for mass-scale benchmarking in the MFR sector. Energy benchmarking can reduce the information failures that are obstructing DSM programs. Rather than having customers "opt-in" by providing their own building data, automated benchmarking provides a way to help "lock-in" participation by using publicly available information from county assessors' offices. This switch from opt-in to lock-in results in opportunities to systematically monitor energy and water demand and increase conservation opportunities. Utilities are able to reach out to customers and say, "We have analyzed your gas bill and think that you might need new insulation and a new furnace. Here are incentives for both". This increases approach increases customer satisfaction, reduces energy pollution, and lowers the costs of acquiring new energy and water supplies.

The Communities for Conservation Pilot Research Design

Two Southern California utilities, and three water agencies, have embarked on a large-scale, year long, pilot program designed to engage MFR complexes to reduce gas and electricity use by 10% each, and water by more than 10%. The Communities for Conservation Pilot (CfC) offers competition and rewards to participating MFR complexes to improve Energy and Water Use Intensities (EUI/WUI) and Building Benchmarking Scores. This pilot differs from existing energy competitions by employing a scalable, Randomized Encouragement Design (RED) to drive conservation. "A randomized encouragement design consists of offering a randomly selected group an incentive to take a "treatment" whose impact on an outcome is of interest to researchers and policymakers (Mullally et al., 2013). While pure randomized settings are most ideal for the causal investigation, often it is not the feasible method. Thus, we are using this next best approach to implement the pilot study.

Each complex is tracked during the pilot period and winners of the competition will be rewarded after the competition period. The sample frame for the pilot were MFR complexes with 15 or more units that are in the joint electricity and gas utility service territories (N=~20,000). MFR complexes that met this criteria were screened to ensure that the number of residential accounts at each complex matched the number of apartment units listed in the real estate database. MFR complexes also had to have at least one non-residential (common area) electricity meter to be included (N=~4,000 complexes). The competition includes multiple categories of competitions, including:

1) Largest absolute kBtu/CCF reduction: "Largest Energy Saver"

2) Largest percent kBtu/CCF reduction: "Most Improved"

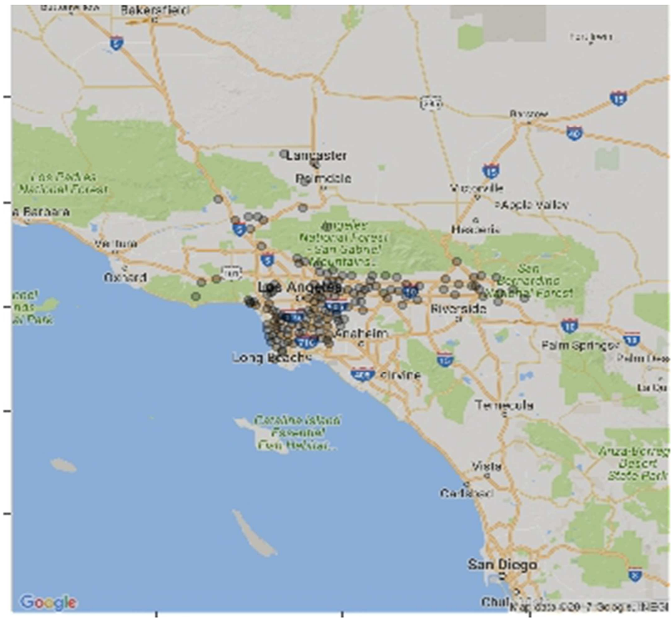
3) Highest benchmarking score: "Most Efficient"

The kBTU reduction calculations utilize weather-normalized Energy Use Intensities. The benchmarking score is accounts for weather, the presence of a pool, average apartment size, and other variables.

The final sample contained 2,354 complexes with approximately 70,000 electricity accounts after screening for geographical suitability and minimum energy usage. All the complexes were randomly assigned to one of three groups: one control group (N=1,054) and two treatment groups. The first treatment group (N=650) receives quarterly competition benchmarking reports by mail. The second treatment group is an opt-in group that receives that mailers as well as on-site marketing to managers and tenants (target N=~360 out of 600 eligible complexes). The first mailing with the baseline energy and water performance was sent in March of 2017 to be followed by 4 quarterly mailers. A map of the study area in Los Angeles and San Bernardino countries is shown in Figure 1.

The design of the study also allows us to investigate the heterogeneity across the different treatment groups and within groups, which helps us to investigate heterogeneous treatment effects. Failure to investigate the heterogeneity can lead to the bias and overstate estimates of treatment effect (Gerarden et al., 2015). The experimental design and ex-post analysis of the distributional effects allows us to have robust estimates of the energy savings by correcting such biases.

Figure 1 - Zip Codes in CfC Pilot



Methodology

Aggregating the energy and water usage for such a large sample is required in order to generate the behavioral competition mailers and other media. The CfC pilot employed Residential Energy and Water Intelligence's (Res-Intel's) Portfolio Analyst© software, an alternative to the US EPA's Portfolio Manager. In contrast to the EPA's tool that requires significant labor hours to input building and utility bill data, the Portfolio Analyst calculates benchmarking results on a mass-scale for the 2,300 properties in the pilot. The building benchmarking scores requires 1) resource usage for each MFR complex that includes both tenant energy and water as well as common area usage, 2) aggregate conditioned living area in square feet (FT^2) to calculate energy-use intensity in thousand British Thermal Units per square foot ($kBTU/FT^2$). This metric is used for the behavioral competition.

The software proceeded in three stages. The first stage was the parcel aggregation process for eligible MFRs to aggregate all of the building conditioned living space and number of apartment units. The aggregation algorithms make predictions about the real estate attributes for the MFR complex and categorizes them into single parcel developments, side-by-side single parcel developments, and multi-parcel developments that contain multiple parcels in each MFR campus or complex. Portfolio Analyst created a unique identification number for each of these categories. Figure 2 a) shows an example map of one multi-parcel development that sprawled across three different street names and consisted of 6 different real estate parcels. b) shows that ID number linked to assessor parcel numbers (APNs), and the aggregated conditioned living area.

Figure 2: Multi Parcel Development Example: a) map b) coding schema

MPD ID	APN	SQ FT	Aggregate SQ FT
1	4263032017	7,130	14,368
1	4263032015	7,238	14,368
3	4263032009	5,637	11,313
3	4263032007	5,676	11,313
4	4263035007	5,136	13,050
4	4263035008	7,914	13,050
7	4051022015	6,882	13,764
7	4051022014	6,882	13,764
8	4051026018	6,594	13,366
8	4051026017	6,772	13,366

If the data was available, the Portfolio Analyst also located building outlines on each real-estate parcel and used advanced spatial analytics to assist in the predictions about parcel aggregation (not shown—more information is available upon request).

The second stage was the aggregation of the utility bill accounts for residential/tenant customers as well as non-residential/common area customers. The utility service addresses were matched into the real estate street addresses. Res-Intel used several text-mining algorithms to accurately match the two datasets together while still allowing for variations in the spelling of the street names.

The account matching process was used to exclude complexes with less than perfect data. Complexes had to include two customer account attributes: 1) The residential criteria required that each complex had the same number of residential electricity accounts as the number of apartment units listed in the real estate database. 2) The nonresidential criteria required at least one non-residential account included in the complex.

The final stage was the calculation of the energy and water benchmarking scores. Portfolio Analyst calculates building benchmarking using the same methodology as Energy Star Portfolio Manager[1] with the following differences:

1. Uses the regional sample of MFRs from the US Census instead of the national sample to weight the regression models.
2. Controls for the presence of pools and irrigable area at each MFR complex due to their prevalence in Southern California. Spatial imagery is used to identify pools and the square footage of the irrigable area. An example of identifying irrigable area can be seen in figures 3 through 5. Figure 3 shows the MFR complex being analyzed. Figure 4 shows the MFR parcel overlaid with aerial imagery. The imagery data is thermal imagery, allowing us to identify irrigable area and pools by their color band. Figure 5 highlights the irrigable area patches identified in yellow; with most of the irrigable area in the southwest portion of the image.

[1] MFR documentation can be found here: https://www.energystar.gov/buildings/tools-and-resources/energy_star_score_multifamily_housing_united_states

Figure 3: Multi Family Residence

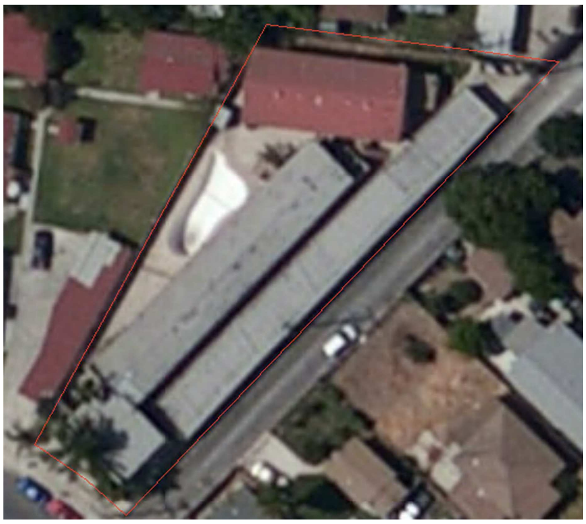


Figure 4: Imagery Overlay

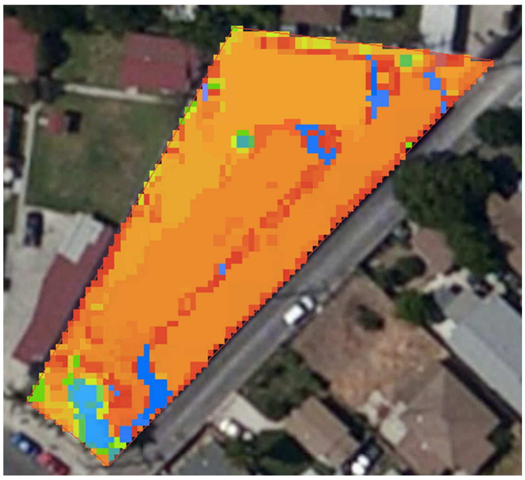
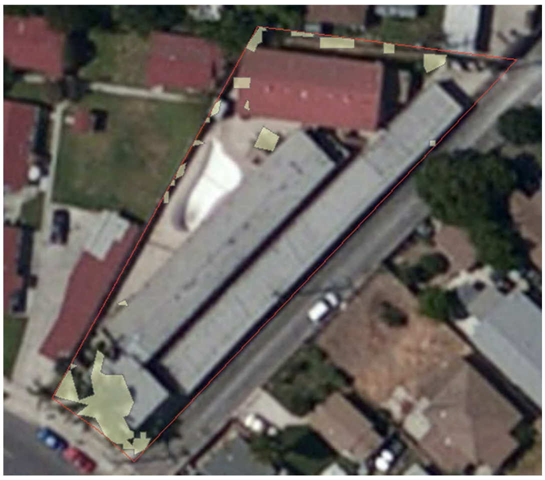


Figure 5: Multi Family Residence with Irrigable Area Extracted



The US EPA (2015) noted that over 14,000 commercial properties in the existing Energy Star Portfolio Manager system could receive water benchmarking if data on outdoor irrigable area was available (Schein and Sharma, 2015). The CfC pilot makes use of advanced remote sensing techniques to enable the water benchmarking.

3. Doesn't account for number of bedrooms at each MFR complex since that data is not available in real estate records
4. Includes MFRs with 15+ units rather than 20+ in the Portfolio Manager tool. The CfC project also reported complex energy and water use intensities, which were weather-normalized using US government weather data.

The benchmark scores calculated from the ratio of:

$$HouseholdIntensityScore(HIS) = \frac{ActualEnergyUsageIntensity}{PredictedEnergyUsageIntensity} \qquad \text{(Eq 1)}$$

If a household's HIS is greater than 1, it indicates that the MFR complex consumes more energy than is predicted by its building attributes. Therefore, a higher HIS score indicates lower energy efficiency. The goal of the Benchmarking is to create an intuitive 1-100 score for building owners and managers to better understand their energy consumption. In this step, plot the cumulative distribution of the HIS ratio for the relevant sample on a gamma curve.

5. The Portfolio Analyst calculates MFR occupancy directly from the electricity account data. Energy Star Portfolio Manager is not a viable software tool to perform mass-scale benchmarking. Property data has to be manually manipulated prior to inputting it into the software using its web services API. To successfully send data requires careful formatting and structuring of the data. Any data that does not meet the requirements will cause the data transmission to fail. When Res-Intel passed 14 months of non-calendarized data to Energy Star, results were successfully calculated for only 15 of the 145 complexes. More information on the differences between the two software tools can be found in Appendix A.

Once the competition metrics were calculated, the MFR Energy Report mailers and door-hanger media content was developed to convey information to each apartment manager (and tenants in treatment group 2) about their own energy and water usage as well as comparable properties in the competition. Carefully calculated metrics and designed feedback mechanism could shift the reference points for pilot participants who have the biased beliefs without altering those doesn't have same behavioral failures.

The CfC project also developed special customer contact methodologies. Since utilities typically haven't systematically integrated real estate data with service address data, the CfC marketing team needed street addresses with which to deliver media. Similarly, the CfC Home Energy Report mailers identified the highest probability customer mailing addresses from the utility billing data.

Results

During the 2nd half of 2016, the populations of MFRs in Los Angeles and San Bernardino counties were screened for inclusion in the behavioral pilot.

V. A. Property and Account Aggregation

Following data cleaning, a total of 69,003 MFR parcels in Los Angeles (LA) and San Bernardino (SB) counties comprised the MFR population. Duplicate street addresses eliminated about 850 of these, and the 5+ only MFR use code eliminated another 248. The parcel aggregation algorithms reduced the number of parcels by 4,106 as MFR complexes were created from the individual parcel data. Next, 43,805 MFRs were eliminated in zip codes outside utility service territories. Validation of the parcel aggregation was performed to verify the accuracy of the methodology. In Los Angeles county 126 MPDs and 92 Side-by-side complexes were randomly selected for validation. A number of single parcel developments (SPDs) were also reviewed. Res-Intel's methodology correctly identified more than 98% of the SPDs validated, 98% of the Side-by-side SPDs, and 87% of the MPDs.

Following the parcel aggregation step, customer accounts were joined into the street address database. The most important loss of MFR complexes came during the account-matching step. Over 60% of population of MFR complexes in LA and San Bernardino counties were eliminated due to a lack of matching addresses from utility bill data. Suggestions on how to reduce these losses are discussed in the lessons learned section below. Next, 3,653 complexes were dropped as they didn't meet the minimum complex size of 15+ units, with 4,071 remaining. Subsequently, approximately 600 complexes without a reasonable number of accounts compared to the number of apartment units in the real estate database were dropped. This included master meter only complexes and complexes with outdated or erroneous real estate data.

Finally, requiring a perfect match between the number of residential electricity accounts and the number of apartment units as well as a nonresidential meter dropped another 498, with 2,908 remaining. The perfect match criteria restricts the qualified population to improve project implementation by reducing any potential concerns that MFR tenants, landlords, and property managers' have about the accuracy of the data for their complex.

Finally, we matched in the gas utility data for complexes with at least one non-residential gas meter, which reduced the count to 2,354. These complexes represent the highest quality MFR qualified population for the project. Only 175 complexes with water data matched into the real estate database.

Table 1. Disposition of MFR Complexes by Step

Step	**Number of Parcels/Complexes Remaining**
Clean and standardize LA/SB county assessor data	69003
Eliminate duplicate street addresses	68154
Identify all parcels in target area with MFR-only use code	67906
Complexes after MPD rollup	63800
Restrict on SCG & SCE zip codes	19995
Complexes after joining assessor data to residential customer data	7724
Exclude all complexes with less than 15 units	4071
Complexes with perfect match (residential & >=1 non-residential electricity account)	2908
Complexes with >=1 non-residential gas account	2354

V. B. EUI/WUI and Benchmarking Results

Energy and water use intensities were calculated for the 2,354 complexes in the CfC competition. Exclusions were applied to an MFR complex if it had excessive missing data in its billing data, or if its weather normalization factor exceeded +\- 20% of its long-term climate normal, or if its EUI/WUI was +\- 2 standard deviations from the sample mean. Approximately 300 complexes were dropped due to these exclusions.

Figure 6: Average Monthly kWh/Ft2

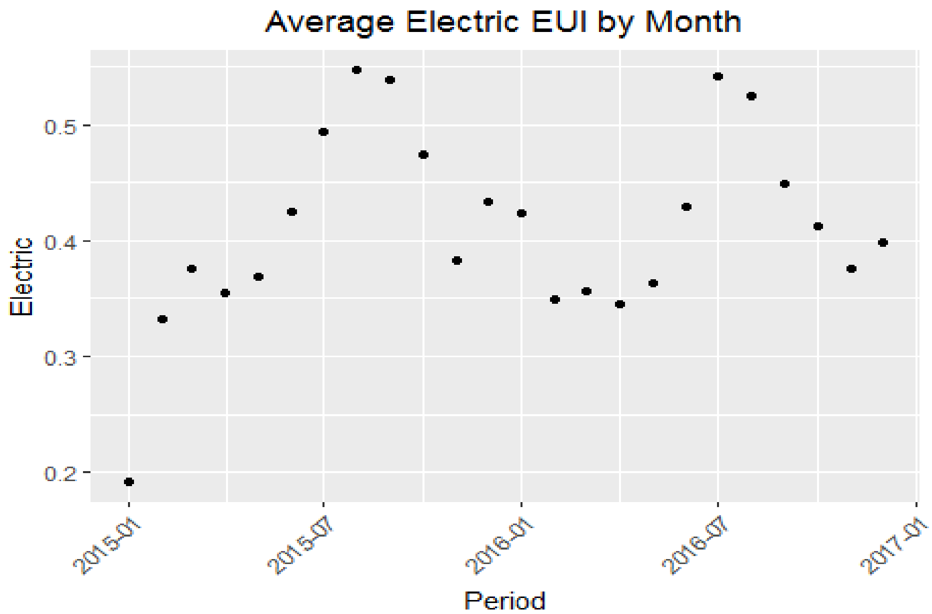


Figure 7: Average Monthly Therms/Ft2

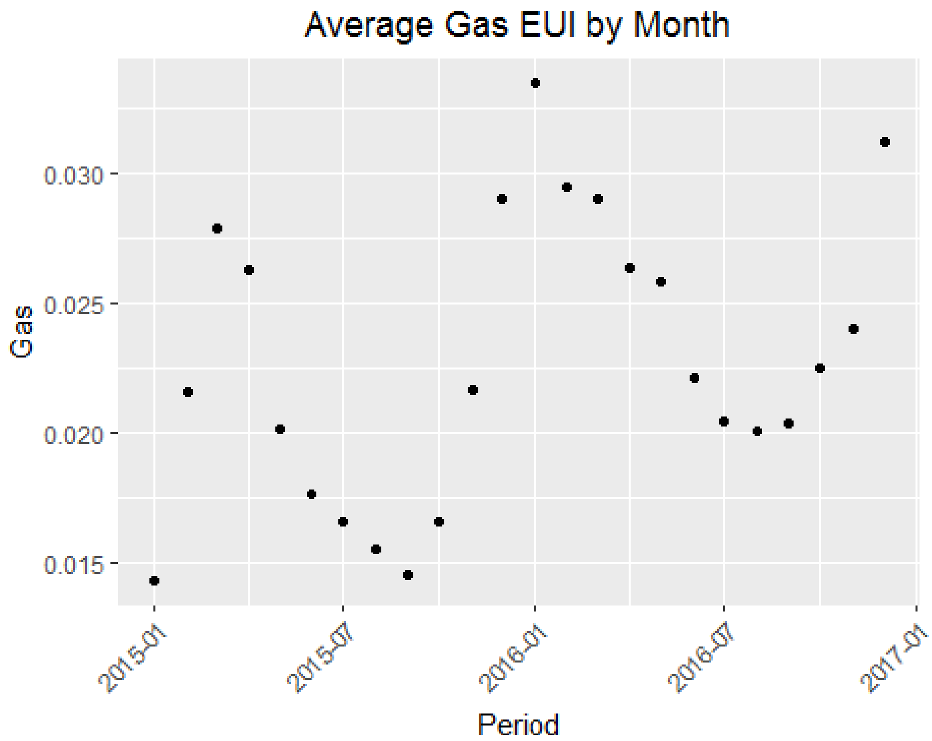


Figure 8: Average Monthly CCF Water/Ft2

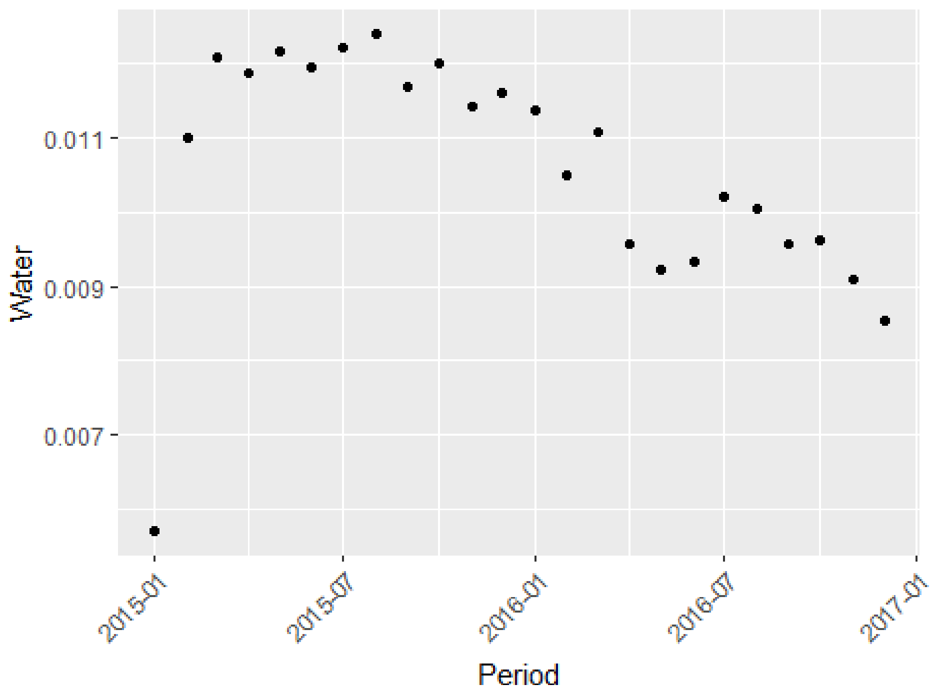


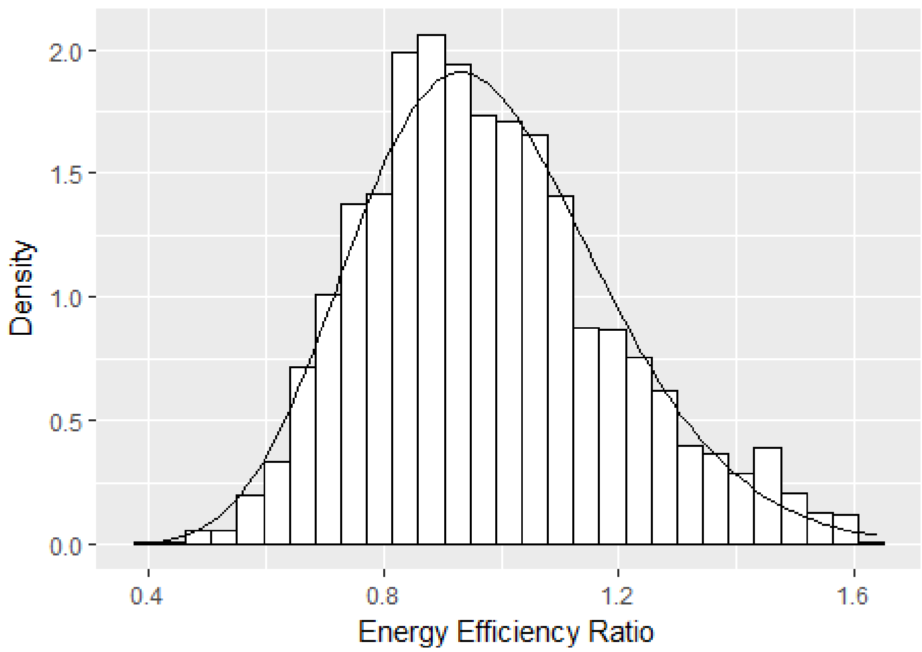
Figure 8 shows the decline in water consumption over the baseline period as the drought in California intensified and stakeholders reduced consumption. Next, we calculated the weather-normalized energy and water intensity results for the 2016 baseline period. The descriptive statistics for the weather normalized usage intensities are listed in Table 2.

Table 2. Weather Normalized Average Monthly Usage Results for 2016 Baseline Period

	Electric kWh/Ft2	Gas therms/Ft2	Water CCF/Ft2
Min	0.1748	0.0003	0.0021
Q1	0.3202	0.0202	0.0071
Median	0.3755	0.0274	0.0087
Mean	0.3906	0.0267	0.0098
Q3	0.4434	0.0336	0.0120
Max	0.7670	0.0914	0.0324
STD	0.0980	0.0115	0.0044

Finally, we present the results of the building energy and water benchmarking. The energy benchmark includes gas and electricity and is converted from site energy to source energy to account for losses from generation and transmission and distribution. The benchmarking is a function of the ratio between each building's actual annual EUI and its predicted EUI form a regression model that controls for weather, the presence of a pool and other building attributes. Figure 9 shows a histogram of this ratio for energy benchmarks in the competition's baseline period. The histogram shows relatively more buildings efficiency ratios just below the mean of 1.0, and also more buildings in the higher range (1.40).

Figure 9: Histogram of Energy Efficiency Ratio (actual EUI/predicted EUI)



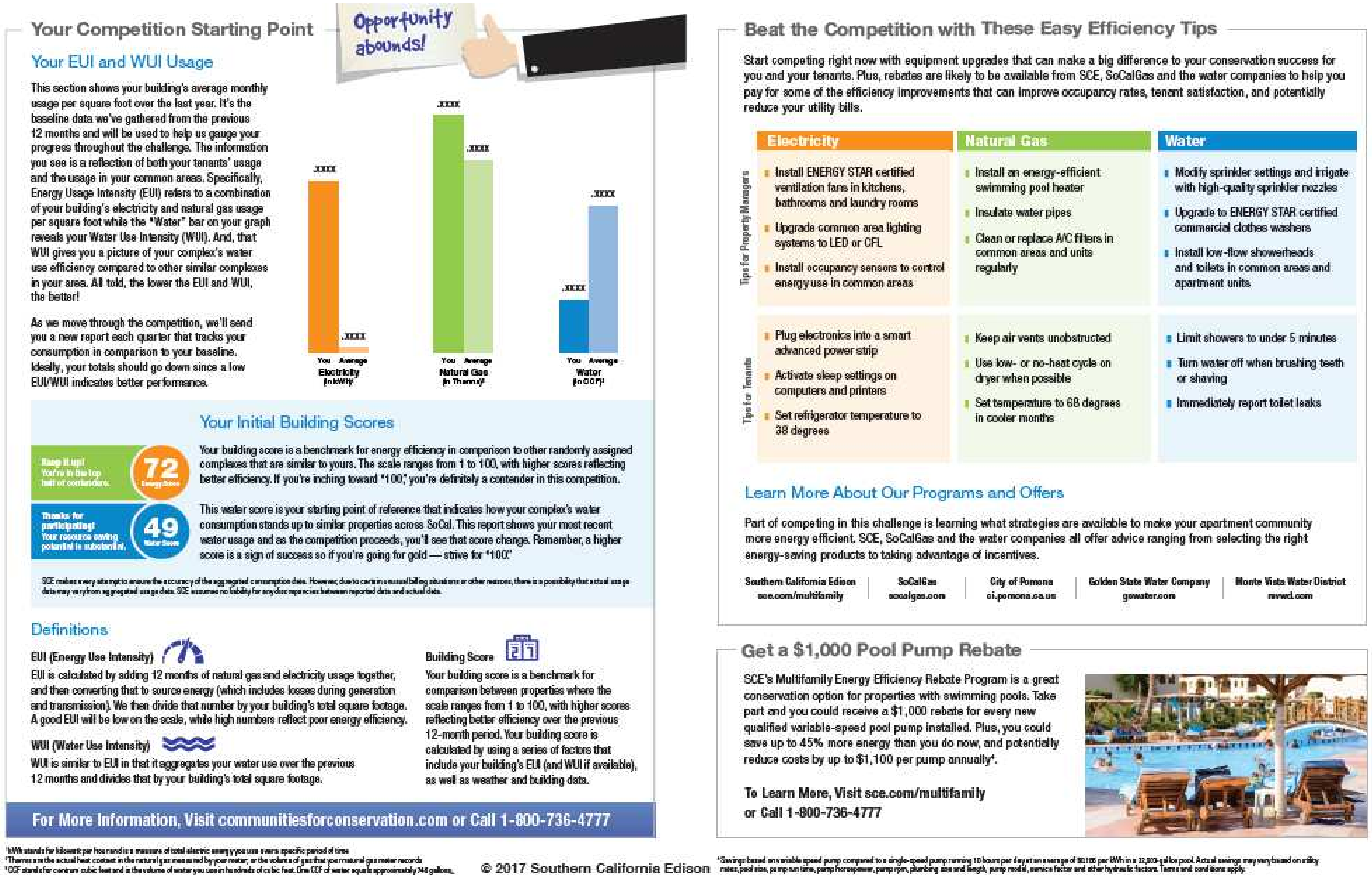
In sum, the EUI and benchmarking results in the baseline period were typically normal (after excluding approximately 10% of the complexes due to extreme data; mostly missing billing data). It is too early in the competition period to measure the impacts of the behavioral interventions between the control and the treatment groups.

V.C. Media and Marketing Materials

Specialist marketing materials were developed to could integrate the multiple data fields customized for each MFR complex. A draft of the baseline period quarterly report is shown in Figure 1. The "Your Usage" box shows average monthly electricity, gas, and water usage on a Ft2 basis for the 12 month baseline period (Jan-Dec 2016). The EUI/WUI results were weather-normalized to compare adjust resource consumption for 2016 compared to the average temperature for 1981-2011 period. The "Your Building Score" shows the energy and water benchmarking results. Finally, the next page shows three conservation tips for each resource.

Tips were limited to three for each type of fuel to reduce choice overload for both tenants and landlords. Choice overload exists when there are too many options which make it difficult for households to implement, which reduces the potential savings among the participants with a willingness to reduce their energy consumption and change their behavior. As mentioned above, translating intention into action seems to be difficult for consumers, particularly when the topic is energy efficiency. Consumers do not always know or cannot identify the most effective action that may lead to the highest returns. For instance, Lyngar and Lepper (2000) demonstrate that shoppers are more likely to make a purchase when they are presented with six options than when they are presented with 24 options. "Traditional economics struggles to explain this tendency, and assumes that more choices are always preferred to fewer choices (Pollitt and Shaorshadze, 2011)." This finding holds true when it comes to the information available about energy efficiency. In this pilot we provide tips that are based on evidence from previous studies to be most appropriate for the pilot participants.

Figure 10: Home Energy Report Mailer (DRAFT-TO BE UPDATED UPON PAPER REVISION)



Your Competition Starting Point

Opportunity abounds!

Your EUI and WUI Usage

This section shows your building's average monthly usage per square foot over the last year. It's the baseline data we've gathered from the previous 12 months and will be used to help us gauge your progress throughout the challenge. The information you see is a reflection of both your tenants' usage and the usage in your common areas. Specifically, Energy Usage Intensity (EUI) refers to a combination of your building's electricity and natural gas usage per square foot while the "Water" bar on your graph reveals your Water Use Intensity (WUI). And, that WUI gives you a picture of your complex's water use efficiency compared to other similar complexes in your area. All told, the lower the EUI and WUI, the better!

As we move through the competition, we'll send you a new report each quarter that tracks your consumption in comparison to your baseline. Ideally, your totals should go down since a low EUI/WUI indicates better performance.

Your Initial Building Scores

Keep it up! You're in the top half of contenders.

72 Energy Score

Your building score is a benchmark for energy efficiency in comparison to other randomly assigned complexes that are similar to yours. The scale ranges from 1 to 100, with higher scores reflecting better efficiency. If you're inching toward "100," you're definitely a contender in this competition.

Thanks for participating! Your resource saving potential is substantial.

49 Water Score

This water score is your starting point of reference that indicates how your complex's water consumption stands up to similar properties across SoCal. This report shows your most recent water usage and as the competition proceeds, you'll see that score change. Remember, a higher score is a sign of success so if you're going for gold — strive for "100."

Definitions

EUI (Energy Use Intensity)

EUI is calculated by adding 12 months of natural gas and electricity usage together, and then converting that to source energy (which includes losses during generation and transmission). We then divide that number by your building's total square footage. A good EUI will be low on the scale, while high numbers reflect poor energy efficiency.

WUI (Water Use Intensity)

WUI is similar to EUI in that it aggregates your water use over the previous 12 months and divides that by your building's total square footage.

Building Score

Your building score is a benchmark for comparison between properties where the scale ranges from 1 to 100, with higher scores reflecting better efficiency over the previous 12-month period. Your building score is calculated by using a series of factors that include your building's EUI (and WUI if available), as well as weather and building data.

For More Information, Visit communitiesforconservation.com or Call 1-800-736-4777

Beat the Competition with These Easy Efficiency Tips

Start competing right now with equipment upgrades that can make a big difference to your conservation success for you and your tenants. Plus, rebates are likely to be available from SCE, SoCalGas and the water companies to help you pay for some of the efficiency improvements that can improve occupancy rates, tenant satisfaction, and potentially reduce your utility bills.

	Electricity	Natural Gas	Water
Tips for Property Managers	Install ENERGY STAR certified ventilation fans in kitchens, bathrooms and laundry rooms Upgrade common area lighting systems to LED or CFL Install occupancy sensors to control energy use in common areas	Install an energy-efficient swimming pool heater Insulate water pipes Clean or replace A/C filters in common areas and units regularly	Modify sprinkler settings and irrigate with high-quality sprinkler nozzles Upgrade to ENERGY STAR certified commercial clothes washers Install low-flow showerheads and toilets in common areas and apartment units
Tips for Tenants	Plug electronics into a smart advanced power strip Activate sleep settings on computers and printers Set refrigerator temperature to 38 degrees	Keep air vents unobstructed Use low- or no-heat cycle on dryer when possible Set temperature to 68 degrees in cooler months	Limit showers to under 5 minutes Turn water off when brushing teeth or shaving Immediately report toilet leaks

Learn More About Our Programs and Offers

Part of competing in this challenge is learning what strategies are available to make your apartment community more energy efficient. SCE, SoCalGas and the water companies all offer advice ranging from selecting the right energy-saving products to taking advantage of incentives.

Southern California Edison sce.com/multifamily | SoCalGas socalgas.com | City of Pomona ci.pomona.ca.us | Golden State Water Company gswater.com | Monte Vista Water District mvwd.com

Get a $1,000 Pool Pump Rebate

SCE's Multifamily Energy Efficiency Rebate Program is a great conservation option for properties with swimming pools. Take part and you could receive a $1,000 rebate for every new qualified variable-speed pool pump installed. Plus, you could save up to 45% more energy than you do now, and potentially reduce costs by up to $1,100 per pump annually[4].

To Learn More, Visit sce.com/multifamily or Call 1-800-736-4777

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Lessons Learned and Conclusions

Any mass-scale data analytics project is likely to have limitations either in the data used or the methodologies employed. The CfC project experienced data limitations that hindered the inclusion of a larger portion of eligible MFR complexes. The water accounts samples from two agencies were relatively small, and another agency sent data for over 14,000 meters, but only a few were MFR complexes.

The limitations of the top-down MFR benchmarking methodology includes the reliance on county assessor building data that can contain outdated property information (FT^2, number of units, pool, etc.). The validity of the results would improve if property managers were able to correct any errors in the property database. As described above, the impact of errors in the property database were minimized due to the requirement that the number of residential electricity accounts at each complex had to equal the number of apartment units in the property database.

Another limitation of the top-down approach is utility billing practices that generate zero usage for many consecutive billing periods. If the complexes are not vacant, but rather the zero usage is due to missing meter reads, then this will bias the EUIs and benchmark scores for those complexes once they have been occupancy-normalized. Seattle City Light's mandatory MFR benchmarking program attributed many of the low usage complexes to bad meter data (Seattle Office of Sustainability and Environment, 2015). Without time-consuming manual validation efforts by property managers or program staff, these low EUI complexes with missing meter data would be misreported as high efficiency complexes.

Finally, the CfC project was not able to make use of the Portfolio Analyst's meter aggregation methodology because of irregularities in the meter lat/long database. On average, only 17% of the meters for each parcel had coordinates that were touching or inside the parcel boundaries. It is our understanding that utilities in California are aware of the issues associated with their meter data and are taking action to update this data. In theory, meter coordinates can be used to help attribute customer account energy usage to specific buildings on a parcel. An update of the meter coordinate data could improve the quality of the energy consumption aggregation performed.

As it stands now, the widely-used Energy Star Portfolio Manager is not suitable for mass-scale benchmarking. To successfully send data to Portfolio Manager through their API requires careful formatting and structuring of the data. Any data that does not meet the requirements will cause the data transmission to fail. Energy Star will not perform any scoring or calculations on complexes that have less than twelve months of continuous usage data for every meter. Because of issues with the electrical and gas data, when Res-Intel passed 14 months of non-calendarized data to Energy Star, results were successfully calculated for only 15 of the 145 complexes.

In sum, the pilot utilizes cutting edge innovations from behavioral sciences, big data and marketing analytics, geographical sciences, as well as the building sciences, to improve efficiency in the hard-to-reach MFR building segment. For California and the EU to meet their ambitious DSM targets, regulators and utilities need a broader array of programs besides retail focused channels that provide customer incentives or market transformations that improve the efficiency of retail offerings. The pilot is still underway at the time of writing, and results will be updated as available.

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Glossary

API	Automated Programming Interface
APN	Assessors Parcel Number
BTU	British Thermal Unit
CEC	California Energy Commission
CDD	Cooling Degree Days
DSM	Demand Side Management
EUI	End-Use Intensity
EPA	Environmental Protection Agency
FT^2	Square Feet
HDD	Heating Degree Days
HIS	Home Energy Intensity Score
HVAC	Heating, ventilation and air conditioning
IOUs	Investor Owned Utilities
MFR	Multi-Family Residence
MMBTU	Millions British Thermal Units
MMTherm	Million Therms
MPD	Multi-parcel development
NOAA	National Oceanic and Atmospheric Administration
SPD	Single parcel development
Therm	100,000 Btu

Appendix A

Table A-1. Res-Intel Portfolio Analyst v Energy Star Portfolio Manager Comparison

	Res Intel	Energy Star
Programmatic data upload through web application interface	X	X
Data cleaning and billing period adjustment	X	NA
Billing period calendarization (convert billing period usage to calendar month usage)	X	X
Calculate source energy from kWH and therm data	X	X
Minimum 12 consecutive months data requirement	NA	X
Estimate MFR thermostat setting	X	X
Calculate Heating Degree Days (HDD)	X	X
Calculate Cooling Degree Days (CDD)	X	X
Calculate annual energy use intensity (EUI) (energy/FT2)	X	X
Predict annual energy use intensity	X	X
Calculate HIS score (Actual EUI / Predicted EUI)	X	X
Controls for energy use associated with swimming pools when predicting annual EUI	X	NA
Calculate MFR energy benchmark score	X*	X**
Calculate Growing Degree Days (GDD)	X	NA
Calculate water EUI	X	NA
Predict annual water usage	X	NA
Calculate water benchmark score	X*	NA
* Uses Southern California building sample ** Uses national sample		

During a validation exercise, Res-Intel uploaded billing and property data for 145 MFR complexes in the competition. Energy Star was only able to calculate energy-use intensities for 104 of 145 complexes when using calendarized usage and for only 15 of the 145 complexes when using non-calendarized data.

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