Multifamily Program Cadet Energy Plus Heater Pilot

Billing Analysis of Electric Energy Usage

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INTRODUCTION

Energy Plus electric wall heaters, manufactured by Cadet, offer a new, low-cost opportunity for energy savings in multifamily properties through replacement of older in-wall heaters. This could be an appealing technology choice for multifamily property owners for whom cost is typically the number one consideration. These units are relatively inexpensive compared to other efficiency measures and have a low incremental cost above standard efficiency heaters.[1] The manufacturer claims that the heaters can use up to 30% less energy than standard electric heaters.[2] An independent field test conducted by Stellar Processes in a single home found approximately 7% electric savings.[3] The energy saving features are an on-board digital thermostat and a variable speed fan combined with intelligent controls that attempt to maintain a more consistent and comfortable room temperature within one degree of the thermostat set point. It also has a simple Night/Away button so that occupants can quickly and easily setback the temperature at night or when they leave. Savings will depend on occupant behavior to properly use the heater controls. The potential market for this type of technology is large, with tens of thousands of older in-wall heaters currently installed in Oregon, although they are generally only replaced upon failure.

Energy Trust's Existing Multifamily program recruited several property owners to participate in a pilot by offering to replace wall heaters in their buildings at no cost. The pilot used a randomized, controlled experimental design to direct the installation of heaters. Dwelling units at each participating property were randomized into a treatment and control group. In each treatment dwelling unit, two electric resistance wall heaters were replaced with Energy Plus heaters. The control group dwelling units were not visited or altered in any way and the tenants were not contacted.

Pilot Goals

This was solely a technical pilot and the primary goal was to determine if electric savings could be achieved by replacing standard efficiency electric resistance heaters with Cadet Energy Plus heaters in multifamily dwelling units. If the evaluation finds significant savings, the program may roll out an

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[1] Source: Energy Trust analysis of retail prices for Cadet wall heater assemblies. The retail price of the Cadet Energy Plus heater is about $85 more than the basic model it was designed to replace.
[2] Source: Cadet website (www.cadetheat.com).
[3] Source: Robison 2013. Preliminary field test of heater controls for Cadet Manufacturing. Stellar Processes, Inc.

incentive on a limited basis to promote installation of these heaters and monitor their savings. The Multifamily program estimated that replacing two standard wall heaters with efficient units could save roughly 270 kWh per year per dwelling unit. Preliminary analysis by Energy Trust, using the incremental cost of a replacement Cadet Energy Plus heater assembly over a standard efficiency heater assembly ($85), showed that the savings per dwelling unit must be 235 kWh per year, at a minimum, to be cost-effective. However, this depends on the assumptions used for cost and measure life. Currently, the baseline cost assumption is the replacement cost of a standard wall heater and the assumed measure life is ten years, although the life of the equipment is likely much longer.

Pilot Implementation

Two market rate and three affordable housing multifamily properties in the Portland Metro area were selected to participate in the pilot. Within each participating multifamily property, all one bedroom dwelling units were identified and randomized to achieve a ratio of two control units for every treatment unit. A total of 80 dwelling units were assigned to the treatment group and 160 were assigned to the control group, divided evenly between market rate and affordable housing properties. The breakdown of group assignment at each of the five participating properties is summarized in **Table 1**. After the dwelling units were randomized into treatment and control groups, the program worked with the property owners to schedule site visits and hired an electrical contractor to install all of the heaters. No training or instruction on how to operate the heaters was given to tenants, other than the manual provided by the manufacturer. All installations were completed in January and February 2014.

Table 1: Summary of pilot properties and assignment of units to randomized study groups.

Property Type	Property	Treatment Units	Control Units	All 1-Bedroom Units*
Market Rate	MR1	14	28	44
	MR2	26	52	97
	All Market Rate	*40*	*80*	*141*
Affordable Housing	AH3	10	20	37
	AH4	16	32	58
	AH5	14	28	53
	All Affordable	*40*	*80*	*148*
Total	**All Properties**	**80**	**160**	**289**

* This column refers to the total number of 1-bedroom units in each of the participating buildings, including those that were not selected in either the treatment or control groups.

Evaluation Goals

The primary goal of this billing analysis was to determine if there were any significant electric savings resulting from the replacement of standard electric resistance wall heaters with the Cadet Plus heaters in multifamily dwelling units. This analysis attempted to quantify the average annual electric savings per treatment dwelling unit. We also attempted to determine if there were any differences in energy savings between market rate and affordable housing properties and between high and low usage dwelling units. Ultimately, the results of the analysis will determine whether or not to promote more efficient electric resistance heaters in the multifamily market.

METHODS

Monthly electricity usage data from January 2012 to April 2015 were extracted from Energy Trust's utility billing database for all participating multifamily properties. Usage data for each unit was matched to the treatment and control group units using the address and unit number or meter number. Dwelling units that could not be matched to utility data were dropped from the analysis. Electric billing records with missing values, duplicates, or with billing periods that were too long or too short were removed from the analysis. Next, we computed the raw daily average electric usage for each billing period for each unit. Daily usage became the primary unit for the analysis. We used the raw daily average usage to compute the annual electric usage for each unit for 2013, the year prior to implementation of the pilot. Units with pre-pilot annual usage in the top and bottom 1% of the distribution were identified as outliers and removed from the analysis. Then, the distribution of individual electric usage readings was analyzed and the top and bottom 1% of daily average electric usage observations were also removed as outliers. The final attrition step in the analysis was to remove units with fewer than six electric usage observations either before or after the heater retrofit was completed.

To determine the energy savings attributable to the efficient heaters, the change in monthly electricity usage from the pre- to post-installation period was compared between the treatment and control units, while controlling for square footage and weather (heating degree-days). Weather data from 13 Oregon weather stations were obtained online from the National Climatic Data Center. Each multifamily building was matched to the nearest weather station based on its zip code. Daily average temperature values were used to calculate the heating degree-days (HDD) and cooling degree-days (CDD) for each billing period for each dwelling unit. HDD variables were computed for reference temperatures ranging from 45 to 70^{o}F. CDD variables were computed for reference temperatures greater than or equal to the HDD reference temperature, ranging from 45 to 85^{o}F. The HDD and CDD values were divided by the number of days in each billing period to obtain average daily HDD and CDD variables, which could be directly compared with the average daily electric usage.

Modeling Approach

The comparison in usage was made using a multilevel linear mixed effects regression model, to account for the nesting of pilot dwelling units within five separate sites and for the repeated observations over time within each unit. Average daily electric use was modeled as a function of average daily HDDs and CDDs, a study period (pre/post-installation) flag, a study group flag, and unit square footage. Interaction terms between the study period flag, study group flag, and HDD variables were added to model the effect of the heaters between treatment and control units—the difference in differences in electric usage. The multilevel model accounted for clustering of monthly observations within individual dwelling units and within the five multifamily properties. Additional terms were added to model the relationship between cold weather and electricity usage separately for each dwelling unit in the sample. The following formula describes the resulting linear mixed effects model:

$$Usage_{ijk} = \beta_0 + \beta_1 HDD_{ijk} + \beta_2 CDD_{ijk} + \beta_3 Group_{ijk} + \beta_4 Post_{ijk} + \beta_5 SqFt_{ijk} + \beta_6 Group_{ijk} * Post_{ijk} + \beta_7 Group_{ijk} * HDD_{ijk} + \beta_8 Post_{ijk} * HDD_{ijk} + \beta_9 Group_{ijk} * Post_{ijk} * HDD_{ijk} + u_{0j} + u_{0ij} + u_{1ij} HDD_{ij} + \epsilon_{ijk}$$

Where:

$Usage_{ijk}$ = the average daily electric usage for unit i within property *j* during billing month *k* ,
β_0 = the fixed intercept for all units,
HDD_{ijk} = Heating Degree-Days for unit *i* within property *j* during month *k*,
CDD_{ijk} = Cooling Degree-Days for unit *i* within property *j* during month *k*,
$Group_{ijk}$ $\{0,1\}$ = dummy variable where 1 indicates that unit *i* within property *j* is part of the treatment group, which is static across all *k* billing months,
$Post_{ijk}$ $\{0,1\}$ = dummy variable where 1 indicates that unit *i* within property *j* during billing month *k* is in the post period,
$SqFt_{ijk}$ = square footage of unit *i* within property *j*, which is static across all *k* billing months,
u_{0j} = random intercept for property *j* which is independent from ϵ_{ijk},
u_{0ij} = random intercept for unit *i* within property *j* which is independent from ϵ_{ijk},
u_{1ij} = random slope coefficient of HDD for unit *i* within property *j* which is independent from ϵ_{ijk},
ϵ_{ijk} = model error for unit *i* within property *j* during billing month *k*.

As noted above, HDD and CDD variables with different reference temperatures were tested in the model using all possible combinations from 45 to 85°F. The reference temperatures that resulted in the model with the best fit was selected as the final model, based on the fit statistics (AIC and BIC). A HDD and CDD reference temperature of 61°F proved to have the best fit for this sample of dwelling units.

The model provided two key parameter estimates for computing energy savings: the interaction term coefficients β_6 and β_9. Together, these coefficients describe the difference between the treatment groups in their change in consumption from the pre- to post-installation periods for a given number of HDDs while controlling for CDDs, square footage, between-unit differences and between-property differences. In other words, the sum of these coefficients is the average daily electric savings. A linear combination of these two coefficients was computed to estimate the weather normalized annual electric savings in kWh per dwelling unit, as described below. We also computed the pre-pilot normalized annual electric use and heating usage for the treatment group from the parameter estimates in kWh per dwelling unit, so that we could calculate the energy savings as a percent of annual electric load and heating load.

Average Annual Savings = $365 * \beta_6 + LRHDD * \beta_9$
Normalized Annual Usage = $365 * (\beta_0 + \beta_3 + AvgSqFt * \beta_5) + LRHDD * (\beta_1 + \beta_7) + LRCDD * \beta_2$
Normalized Heating Usage = $LRHDD * (\beta_1 + \beta_7)$

Where:
AvgSqFt = average dwelling unit square footage across all units in the sample,

LRHDD = long-run average annual HDDs for each weather station averaged across the properties, derived from the Typical Meteorological Year 3 (TMY3) dataset, and,
LRCDD = long-run average annual CDDs for each weather station averaged across the properties.

Subgroup Analysis

In addition to the overall pilot savings, we were interested to see if there were differences in savings between subgroups of units. The pilot sample was split evenly between dwelling units in affordable housing properties and market rate properties. We re-ran the same linear mixed effects weather model for all dwelling units in the pilot sample, separately for affordable and market rate properties, to see if we could detect a difference in savings. We were also interested if there was a difference in savings for high electricity usage units. Again, we re-ran the model for units that used above the median annual electricity usage in the year prior to the pilot. Annual electric savings were computed as described above.

Sensitivity Analysis

We were concerned about the influence of model specification on the energy savings results, so we tested several different approaches to see how much the results differed.

<u>Ordinary least squares regression.</u> First, we fitted a very simple, ordinary least squares linear regression model, predicting average daily usage using only the study group, post period, the difference-in-differences interaction term, and no other covariates. The coefficient of the interaction term was multiplied by 365 days to achieve the annual savings estimate.

<u>Simple linear mixed effects.</u> Next, we built up a simple linear mixed effects model that accounted for the nested structure of the dwelling units within properties and for the repeated observations on each unit. Average daily usage was predicted using square footage, study group, post period, and the difference-in-differences interaction term, but no weather variables.

<u>Post-period only linear mixed effects.</u> We tested a post-installation period only model. The theory was that since the dwelling units were randomized into treatment and control groups, the pre-pilot electric usage should be very similar between the groups, which it was. Thus, we believed it was reasonable to assume that any post-pilot differences in usage between the groups could primarily be explained by the installation of the heaters in the treatment group. All other changes, fluctuations, and differences should be randomly distributed across all units in the two study groups. Furthermore, because year to year differences in usage are inherently noisy and driven primarily by weather and a mix of other unmeasured factors, using a post-only analysis gave us an opportunity to potentially reduce the amount of error in the savings estimate. We used a linear mixed effects model similar to the best fit model described above, with observations restricted to the post-installation period. All post period variables and interaction terms were removed from the model. Annual savings were computed using a linear combination of the coefficients of the study group variable and its interaction with HDDs.

PRISM-like analysis. The last step of our sensitivity analysis was to use a PRISM-like (PRInceton Score-keeping Method[4]) unit-level, weather normalized annual usage, differences-in-differences approach. First, we fitted separate weather regression models for each dwelling unit for both the pre- and post-pilot periods, using HDD and CDD variables. All combinations of HDD and CDD reference temperatures were run for all unit-level regression models, from 45° to 85°F. The model results with the highest R-squared for each unit and time period were selected to calculate the weather normalized annual usage, using the TMY3 long-run HDDs and CDDs. However, if the model R-squared was less than 0.5 or the HDD coefficient was negative, then we assumed the unit was insensitive to weather and used the raw annual usage for the analysis. The model specifications for weather normalization were:

Average daily usage$_i$ = $\beta_0 + \beta_1 HDD_i(\tau_h) + \beta_2 CDD_i(\tau_c) + \varepsilon_i$
Normalized annual usage$_i$ = $365 * \beta_0 + \beta_1 LRHDD_i(\tau_h) + \beta_2 LRCDD_i(\tau_c)$
Normalized heating usage$_i$ = $\beta_1 LRHDD_i(\tau_h)$

Where:
i = dwelling unit indicator
β_0 = Estimated average daily "base load" usage for unit i
β_1 = Model predicted heating slope
$HDD_i(\tau_h)$ = Average daily HDDs at reference temperature τ_h
β_2 = Model predicted cooling slope
$CDD_i(\tau_c)$ = Average daily CDDs at reference temperature τ_c
ε_i = Unexplained error term
$LRHDD_i(\tau_h)$ = Long-run annual HDDs at reference temperature τ_h
$LRCDD_i(\tau_c)$= Long-run annual CDDs at reference temperature τ_c

Next, the difference was taken between the pre- and post-pilot normalized annual electric usage for each unit. To determine electric savings while controlling for square footage and property, we created a regression model where study group predicted the delta in annual usage. The coefficient of the study group variable was the annual electric savings.

RESULTS

Attrition Analysis

The final analysis sample contained 75 treatment and 146 control dwelling units; this represents 92% of the initial pilot sample. **Table 2** displays the number of dwelling units removed at each attrition step and the impact on the sample size and average pre-pilot annual usage. The treatment and control groups had nearly identical square footage and 2013 annual electric usage (**Table 3**).

[4] Fels, M. (1986). PRISM: An Introduction. Energy and Buildings, 9, 5-18. Retrieved from http://www.marean.mycpanel.princeton.edu/~marean/images/prism_intro.pdf

Table 2: Attrition steps of pilot dwelling units and billing records.

Attrition Step	Group	N Removed	% Removed	N Remaining	% of Total	N Billing Records	2013 kWh Usage
All pilot dwelling units	Treatment	0	0%	80	100%	--	--
	Control	0	0%	160	100%	--	--
Not matched to billing data	Treatment	0	0%	80	100%	2,899	4,405
	Control	0	0%	160	100%	5,598	4,327
Billing records too long or too short	Treatment	0	0%	80	100%	2,781	4,405
	Control	0	0%	160	100%	5,367	4,327
Outliers in pre-pilot annual kWh usage	Treatment	2	3%	78	98%	2,753	4,347
	Control	6	4%	154	96%	5,235	4,298
Outliers in daily average kWh usage	Treatment	0	0%	78	98%	2,725	4,347
	Control	0	0%	154	96%	5,168	4,298
Too few billing records	Treatment	3	4%	75	94%	2,653	4,309
	Control	8	5%	146	91%	5,041	4,299

Table 3: Final analysis sample dwelling unit characteristics.

Group	N	Mean Sq.Ft.	2013 kWh Usage
Treatment	75	607	4,309
Control	146	605	4,299

Energy Savings

The best fit linear mixed effects weather model produced equivocal results. Annual electric savings per dwelling unit for the heater replacements was estimated at 232 kWh (90% CI: -253, 718), but they were not statistically significant (**Table 4**). The annual electric savings estimate translates to 6% of average annual electric use and 14% of average heating usage (**Table 5**). The large standard error of the savings estimate indicates that there was considerable variability in month-to-month and year-to-year changes in electric usage in the pilot sample that was not explained by the model. The large amount of error translates to a high degree of uncertainty in the savings estimate.

Table 4: Average annual electric savings per dwelling unit from linear mixed effects model.

Annual kWh Savings	SE	90% CI LB	90% CI UB	p-value
232	228	-253	718	0.365

Table 5: Average annual electric savings per dwelling unit as a percent of 2013 electric use.

% Savings	% Heating Savings	Annual kWh Usage*	Heating kWh Usage*	% Heating Usage
6%	14%	4,164	1,711	41%

* The average annual electric use and heating usage per dwelling unit for the treatment group were computed directly from the model parameter estimates.

Findings for market rate, affordable housing, and high usage units were also not statistically significant. The annual electric savings results for each subgroup analysis are summarized in **Table 6** and savings as percentages of annual electric use and heating usage are show in **Table 7**. Market rate units had an annual savings per dwelling unit estimate of 306 kWh (-1,997, 2,608), or 13% of average heating usage. This estimate was far from statistically significant. Annual savings for affordable housing appeared to be lower, with 168 kWh per dwelling unit (-921, 1,257), or 16% of heating usage, and were even less significant. High users had a savings estimate of 357 kWh per year (-688, 1,402), or 14% of heating usage, but again, this was not a significant result. The high standard errors and wide confidence intervals indicate large amounts of uncertainty in the savings estimates for all subgroups.

Table 6: Average annual electric savings per dwelling unit, by subgroup.

Subgroup	Treatment Group N	Control Group N	Annual kWh Savings	SE	90% CI LB	90% CI UB	p-value
Market Rate	37	71	306	365	-1,997	2,608	0.556
Affordable Housing	38	75	168	373	-921	1,257	0.696
High Usage	35	75	357	490	-688	1,402	0.507

Table 7: Average annual electric savings per dwelling unit as a percent of electric use, by subgroup.

Subgroup	% Savings	% Heating Savings	Average kWh Usage*	Heating kWh Usage*	% Heating Usage
Market Rate	6%	13%	4,800	2,357	49%
Affordable Housing	4%	16%	3,758	1,082	29%
High Usage	6%	14%	5,645	2,639	47%

* The average annual electric use and heating usage per dwelling unit for the treatment group were computed directly from the model parameter estimates.

To test the sensitivity of the overall results with respect to model specification and analysis approach, we used a variety of alternative approaches described in the methods section. The results for each of these approaches are summarized in **Table 8** and **Table *9*** and are compared to the overall savings estimate from the best fit linear mixed effects weather model. Annual electric savings estimates for the most realistic models (ignoring the simple models) ranged from 232 to 289 kWh per dwelling unit or 14-19% of average heating usage. Although the savings estimates were all within the range of what was expected and were all above zero, they had low precision and none achieved statistical significance. However, as can be seen in **Table 8**, the post period only model has the highest precision savings estimate, as predicted, due to the removal of year-to-year variability in usage. The post-period only model estimated annual electric savings of 289 kWh per dwelling unit (-12, 590), or 19% of heating usage, which is borderline statistically significant. While this increases our confidence that efficient heater savings may be greater than zero, it does not give us good precision for the magnitude of those savings.

Table 8: Sensitivity analysis results – average annual electric savings per dwelling unit, using several different analysis approaches.

Analysis Method	Annual kWh Savings	SE	90% CI LB	90% CI UB	p-value
Best fit linear mixed effects weather model	232	228	-253	718	0.365
Ordinary least square linear regression without weather*	187	222	-336	710	0.461
Linear mixed effects model without weather*	221	196	-196	639	0.321
Post-period only linear mixed effects weather model	289	141	-12	590	0.110**
PRISM-like unit-level weather normalized annual usage difference-in-differences	251	228	-125	628	0.271

* These models do not control for weather and are likely overly simplistic.

** Borderline statistically significant at the 0.10 level.

Table 9: Sensitivity analysis results – average annual electric savings per dwelling unit as a percent of electric use, using several different analysis approaches.

Analysis Method	% Savings	% Heating Savings	Annual kWh Usage	Heating kWh Usage	% Heating Usage
Best fit linear mixed effects weather model	6%	14%	4,164	1,711	41%
Ordinary least square linear regression without weather*	4%	10%	4,464	1,786	40%
Linear mixed effects model without weather*	5%	12%	4,569	1,828	40%
Post-period only linear mixed effects weather model	7%	19%	3,956	1,517	38%
PRISM-like unit-level weather normalized annual usage difference-in-differences	6%	14%	4,164	1,760	42%

* The percent heating savings and average heating usage were estimated for these approaches, based on an assumed average of 40% heating usage, because the heating loads could not be directly computed from the models. These models do not control for weather and are likely overly simplistic.

To illustrate the amount of variability in annual electric use within dwelling units we created graphs of the changes in weather normalized annual usage from the pre-to-post installation periods for individual dwelling units in both the treatment and control groups. **Figure 1** shows the distribution of changes in annual electric use in each study group using the kernel density. **Figure 2** shows a scatter plot of the changes in annual usage as a function of the pre-period annual usage in each study group. The wide scatter and huge amount of overlap between the distributions of the treatment and control groups demonstrates that there is a large amount of noise in these data compared to the savings signal we are trying to detect.

Figure 1: Distribution of changes in normalized annual electric use per dwelling unit, by study group.

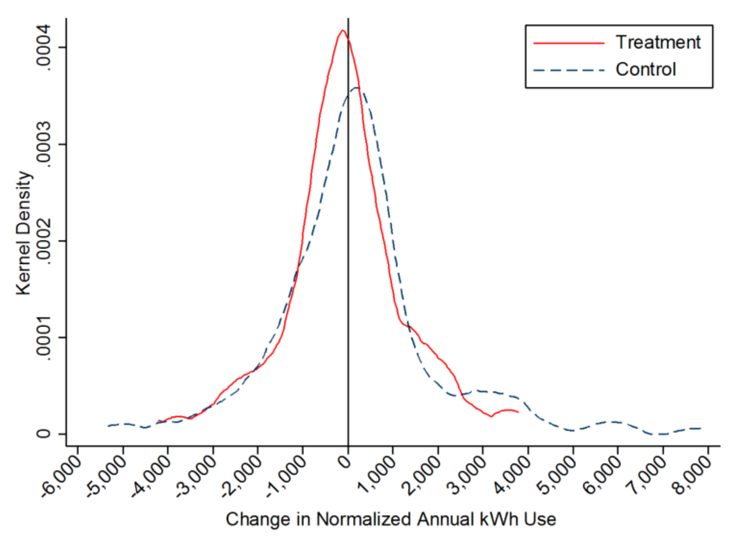
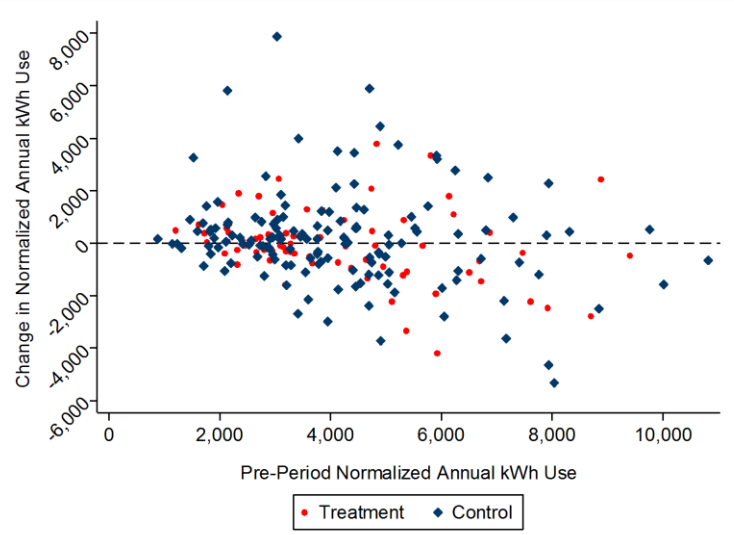


Figure 2: Scatterplot of changes in normalized annual electric use per dwelling unit versus pre-installation normalized annual electric use, by study group.



Sample Size Considerations

In response to the observed high variability in annual usage and savings estimates in the pilot sample, we performed some rough sample size calculations to determine how many more dwelling units we would need to install efficient heaters in to observe statistically significant results. Using the observed mean annual usage deltas and standard deviations for each study group from the PRISM-like analysis, we computed the required sample size with alpha of 0.05 and 80% power using the two-independent sample means method. Using these assumptions, the required sample size was 730 per study group. Using a linear mixed effects models that properly account for repeated observations and nesting within properties can reduce the amount of error, which may result in a lower required sample size. Also, as we observed, using a post period only model in a properly randomized sample can further increase precision, which may reduce the required sample size. That said, using the methods presented in this report could require up to 700 dwelling units with efficient heaters installed (plus as many control units) to observe statistically significant electric savings.

CONCLUSIONS & RECOMMENDATIONS

The findings from this billing analysis of the Multifamily program's Cadet Energy Plus heater pilot showed modest annual electric savings between 230 and 290 kWh per dwelling unit per year (6-7% of annual electric use and 14-19% of heating usage). Although the point estimates for annual electric savings were greater than zero, were within the range of what was expected, and were borderline cost-effective, the large amount of unexplained variability in the data gives us low confidence in the results. However, after testing several different analytical approaches and model specifications, we found the savings estimates to be relatively insensitive to model specification. One approach even achieved results that were borderline statistically significant at the 0.10 level. Unfortunately, conducting additional field tests to refine the savings estimates would require a large commitment of resources. Energy Trust would need to deploy the efficient heaters in roughly 700 multifamily units, with another 700 control group dwelling units, to confirm the savings with confidence using the same billing analysis methods presented in this report. It is possible that other analysis methods utilizing high frequency interval usage data could provide sufficient precision and temporal resolution to detect a signal using the existing pilot sample. This would require smart meter data that Energy Trust does not currently have access to and it could potentially increase the amount of unexplained variability in usage rather than decrease it.

There were a number of important limitations to this study. First, given the unanticipated large amount of unexplained month-to-month and year-to-year variability in electric use in the pilot dwelling units, the sample size was far too small to detect a significant level of electric savings. Nonetheless, because this study used a randomized controlled design, we can be confident that the point estimates were unbiased, if not statistically significant. Second, the heating season that followed implementation of the pilot (2014-2015) was the warmest winter on record in the Northwest. Due to the atypical weather and unusually low demand for heating in the post-period in both the treatment and control groups, it may have been especially difficult to observe any differences between them. This may have pushed the savings results towards zero. Lastly, this pilot targeted only one-bedroom apartments with an average size of about 600 square feet. These units were substantially smaller than the average sized multi-family unit in the region, which resulted in annual electric and heating loads that were also lower than average. If the heaters been installed in larger dwelling units with larger heating loads, we would expect larger absolute savings estimates, given that the same percentage savings was achieved.

To move forward with Cadet Energy Plus wall heaters as a retrofit efficiency measure for the Multifamily program, Energy Trust would need to obtain more precise estimates of the average annual electric savings. This information could be obtained by implementing a large second phase pilot, conducting pre and post sub-metering in additional dwelling units, slowly rolling out a new incentive and monitoring the usage of participants, or possibly by obtaining smart meter data from Energy Trust’s partner utilities and re-analyzing the existing sample. Either way, this would require an additional investment of time and resources. This analysis provides an indicator that Cadet Energy Plus heaters may produce modest electric savings in low usage one-bedroom apartments, from 14-19% of annual heating usage. However, the savings estimates are very uncertain and the best estimate we have would only make this a borderline cost-effective replacement measure. However, alternative delivery channels that have lower costs could enable this to become a cost-effective, small savings measure that could achieve substantial electric savings in aggregate, throughout the multifamily market.

Recommendation: Do not proceed with a Cadet Energy Plus wall heater replacement measure for Energy Trust’s Multifamily program at this time. Explore additional upstream delivery channels with potentially lower costs which could allow relatively small savings to be cost-effective. Any electric savings estimates used should be very conservative to hedge against the uncertainty in the savings estimates presented here and the possibility that actual savings could be much lower. If Energy Trust moves forward with a measure, then re-evaluate savings once more heaters are installed.